Final
Remedial Investigation/Feasibility Study Optimized Uniform Federal Policy Quality Assurance Project Plan

Military Munitions Response Program
Munitions Response Services
U.S. Army Garrison West Point
Water Munitions Response Sites
West Point, New York

Contract No.: W912DR-15-D-0022
Delivery Order No.: W912DR17F0131

Prepared For:

U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT

and

UNITED STATES MILITARY ACADEMY
WEST POINT

U.S. ARMY GARRISON WEST POINT

Prepared By:

WESTON SOLUTIONS, INC.

September 2018

FINAL
REMEDIAL INVESTIGATION/FEASIBILITY STUDY OPTIMIZED UNIFORM FEDERAL POLICY QUALITY ASSURANCE PROJECT PLAN

MILITARY MUNITIONS RESPONSE PROGRAM
MUNITIONS RESPONSE SERVICES
U.S. ARMY GARRISON WEST POINT
WATER MUNITIONS RESPONSE SITES
WEST POINT, NEW YORK

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U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
2 Hopkins Plaza
Baltimore, MD 21201

and

UNITED STATES MILITARY ACADEMY
WEST POINT

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September 2018

Work Order No. 03886.552.131

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LIST OF ACRONYMS AND ABBREVIATIONS

%	percent
%D	percent difference
°C	degrees Celsius
ºF	degree Fahrenheit
µg/kg	micrograms per kilogram
µg/L	microgram per liter
µg/mg	microgram per milligram
2,4,6-TNT	2,4,6-trinitrotoluene
2,4-DNT	2,4-dinitrotoluene
2,6-DNT	2,6-dinitrotoluene
4-Am-DNT	4-amino-2,6-dinitrotoluene
ACHP	Advisory Council on Historic Preservation
AES	Atomic Emission Spectroscopy
AHA	activity hazard analysis
APE	Area of Potential Effect
APP	Accident Prevention Plan
ASTM	ASTM International
AVS	acid volatile sulfide
AVS-SEM	acid volatile sulfide-simultaneously extracted metals
BEM	buried explosion module
bgs	below ground surface
BTAG	Biological Technical Assistance Group
CA	corrective action
CAR	Corrective Action Request
CAS	Chemical Abstract Service
CB	calibration blank
CCV	continuing calibration verification
CEHNC	United States Army Engineering Support Center, Huntsville
CENAB	United States Army Corps of Engineers, Baltimore District
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

CHMM	Certified Hazardous Materials Manager
CMUA	concentrated munitions use area
COC	chain-of-custody
COPC	chemical of potential concern
COPEC	chemical of potential ecological concern
COR	Contracting Officer’s Representative
CQM-C	Construction Quality Management for Contractors
CRREL	Cold Regions Research Engineering Laboratory
CSM	conceptual site model
CTT	closed, transferring, and transferred
CVAA	cold vapor atomic absorption
CWA	Clean Water Act
CWM	chemical warfare materiel
DDESB	Department of Defense Explosives Safety Board
DERP	Defense Environmental Restoration Program
Df	dredging factor
DFW	definable feature of work
DFWMR	Division of Fish, Wildlife, and Marine Resources
DGM	digital geophysical mapping
DGPS	Differential Global Positioning System
DID	data item description
DL	detection limit
DO	Delivery Order
DoD	Department of Defense
DoDI	Department of Defense Instruction
DoDM	Department of Defense Manual
DOT	Department of Transportation
DPW	Department of Public Works
DQCR	Data Quality Control Report
DQI	data quality indicator
DQO	data quality objective
DUA	Data Usability Assessment

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

EDD	electronic data deliverable
ELAP	Environmental Laboratory Accreditation Program
EM	Engineer Manual
EMD	Environmental Management Division
EMI	electromagnetic induction
EMP	Explosives Management Plan
EOD	Explosive Ordnance Disposal
EOTI	Explosive Ordnance Technologies, Inc.
EPA	U.S. Environmental Protection Agency
ERA	Ecological Risk Assessment
ESL	ecological screening level
ESP	Explosives Site Plan
ESTCP	Environmental Security Technology Certification Program
EZ	exclusion zone
FCA	Function Check Area
FS	Feasibility Study
FUDS	Formerly Used Defense Sites
GDS	Geospatial Data System
GIS	Geographic Information System
GPS	global positioning system
GSV	geophysical system verification
H&S	Health and Safety
H0	null hypothesis
Ha	alternative hypothesis
HFD	hazard fragment distance
HHRA	Human Health Risk Assessment
HPLC	high performance liquid chromatography
HQ	hazard quotient
HRR	Historical Records Review
HTRW	Hazardous, Toxic and Radioactive Waste
IATA	International Air Transport Association
ICAL	initial calibration

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

ICP	inductively coupled plasma
ICP-AES	inductively coupled plasma-atomic emission spectroscopy
ICP-MS	inductively coupled plasma-mass spectrometry
ICS	interference check sample
ICV	initial calibration verification
ID	identifier
IDL	instrument detection limit
IDQTF	Intergovernmental Data Quality Task Force
IDW	investigation-derived waste
IPaC	Information, Planning, and Consultation System
ISO	industry standard object
IVS	instrument verification strip
kg	kilogram
km	kilometer
KO	contracting officer
LANL	Los Alamos National Laboratory
LCS	laboratory control sample
LCSD	laboratory control sample duplicate
LIMS	Laboratory Information Management System
LOAEL	lowest observed adverse effect level
LOD	limit of detection
LOQ	limit of quantitation
m	meter
MAG	magnetic gradiometer
MAMMS	Multiple Award Military Munitions Services
MB	method blank
MC	munitions constituents
MD	munitions debris
MDAS	material documented as safe
MEC	munitions and explosives of concern
mg/kg	milligram per kilogram
mg/L	milligram per liter

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

MIS	multi increment sample
MMRP	Military Munitions Response Program
MOA	Memorandum of Agreement
MPC	measurement performance criteria
MPPEH	material potentially presenting an explosive hazard
MQO	measurement quality objective
MRA	Munitions Response Area
MRS	Munitions Response Site
MS/MS	tandem mass spectrometry
MS/MSD	matrix spike/matrix spike duplicate
MSD	minimum separation distance
mV	millivolt
NAD	North American Datum
NBA	No Benchmark Available
NCP	National Oil and Hazardous Substances Contingency Plan
NEW	net explosive weight
NFA	No Further Action
NHPA	National Historic Preservation Act of 1966
NIST	National Institute for Standards and Technology
NMRD	non-munitions related debris
NOAA	National Oceanic and Atmospheric Administration
NSWCPCD	Naval Surface Warfare Center, Panama City Division
NTP	Notice to Proceed
NYSDEC	New York State Department of Environmental Conservation
NYSDOH	New York State Department of Health
OESS	Ordnance and Explosives Safety Specialist
OSHA	Occupational Safety and Health Administration
P.E.	Professional Engineer
P.G.	Professional Geologist
PA	Preliminary Assessment
PAL	project action limit

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

PARCCS	precision, accuracy, representativeness, comparability, completeness, and sensitivity
pdf	portable document format
PDT	Project Delivery Team
PE	Performance Evaluation
PETN	pentaerythritol tetranitrate
PI	Principal Investigator
PM	Project Manager
PMP	Project Management Plan
PNNL	Pacific Northwest National Laboratory
PRG	preliminary remediation goal
PT	proficiency testing
PWS	performance work statement
QA	quality assurance
QAPP	Quality Assurance Project Plan
QAR	Quality Assurance Review
QASP	Quality Assurance Surveillance Plan
QC	quality control
QL	quantitation limit
QSM	Quality System Manual
RAGS	Risk Assessment Guidance for Superfund
RCA	root cause analysis
RCRA	Resource Conservation and Recovery Act
RDX	cyclotrimethylenetrinitramine
RI	Remedial Investigation
ROV	remotely operated vehicle
RPD	relative percent difference
RSD	relative standard deviation
RSL	Regional Screening Level
RTK	real-time kinematic
SARA	Superfund Amendments and Reauthorization Act
SAS	synthetic aperture sonar

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

SAV	submerged aquatic vehicle
SCO	soil cleanup objective
SDG	Sample Delivery Group
SDWA	Safe Drinking Water Act
SEM	simultaneously extracted metals
SHPO	State Historic Preservation Officer
SI	Site Inspection
SLERA	Screening Level ERA
SNR	signal to noise ratio
SOP	standard operating procedure
SRM	solid reference material
SSA	surface supplied air
SSS	side scan sonar
SUXOS	Senior UXO Supervisor
TAL	target analyte list
TBD	to be determined
TCLP	toxicity characteristic leaching procedure
TD	transferred
TDS	total dissolved solids
TEC	threshold effect concentration
THPO	Tribal Historic Preservation Officer
THQ	target hazard quotient
TLI	TLI Solutions, Inc.
TNT	trinitrotoluene
TOC	total organic carbon
TP	Technical Paper
TPC	Third-Party Certification
TPP	Technical Project Planning
TSA	technical system audit
TVG	Transverse Marine Gradiometer
U.S.	United States
UFP-QAPP	Uniform Federal Policy-Quality Assurance Project Plan

LIST OF ACRONYMS AND ABBREVIATIONS (CONTINUED)

USACE	U.S. Army Corps of Engineers
USAEC	US. Army Environmental Command
USBL	ultra-short baseline
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTL	upper tolerance limit
UTM	Universal Transverse Mercator
UUV	unmanned underwater vehicle
UXO	unexploded ordnance
UXOQCS	Unexploded Ordnance Quality Control Specialist
UXOSO	Unexploded Ordnance Safety Officer
VRS	Virtual Reference Station
VSP	visual sample plan
West Point	U.S. Army Garrison West Point
WESTON®	Weston Solutions, Inc.

INTRODUCTION

The Optimized Uniform Federal Policy-Quality Assurance Project Plan (referred to as the UFP-QAPP) has been prepared by Weston Solutions, Inc. (WESTON®) in accordance with the Performance Work Statement (PWS) Rev 2, dated 17 April 2017, for the Military Munitions Response Program (MMRP) for environmental services for two Munitions Response Sites (MRSs) at U.S. Army Garrison West Point (West Point), West Point, NY. The work is being conducted for the United States (U.S.) Army Corps of Engineers (USACE), Baltimore District (CENAB) Multiple Award Military Munitions Services (MAMMS) Contract W912DR-15-D-0022. A copy of the PWS is provided in **Appendix A**.

West Point environmental restoration activities, including munitions responses, are being performed under the MMRP, which follows the Comprehensive Environmental Restoration, Compensation and Liability Act (CERCLA), 42 U.S.C. §9601 et seq. (1980), as amended by the Superfund Amendments and Reauthorization Act (SARA); National Oil and Hazardous Substances Contingency Plan (NCP), 40 Code of Federal Regulations (CFR), Part 300; the Resource Conservation and Recovery Act (RCRA), 42 U.S.C. §6901 et seq. and its implementing regulations at 40 CFR Parts 240-282. The activities are being conducted with regulatory coordination, as appropriate, with the New York State Department of Environmental Conservation (NYSDEC), New York State Department of Health (NYSDOH), and the United States Environmental Protection Agency (EPA) Region 2.

The UFP-QAPP has been prepared for the Remedial Investigation (RI), including munitions response services and environmental sampling, if necessary, at two MRSs designated as Siege Battery–Transferred (TD) River (WSTPT-016-R-01) and Battery Knox–TD River (WSTPT-004-R-01). Two additional areas (Area A and Area B) outside the MRS boundaries, but have been incorporated into the RI because there is a potential for military munitions from the Siege Battery-TD River and Battery Knox-TD River MRSs to have migrated into Area A or Area B, based on tidal fluctuations and currents. Therefore, the exposure pathways for Area A and B are assumed to be the same as Siege Battery-TD River and Battery Knox-TD River MRS. The Siege Battery – TD River MRS, Battery Knox – TD River MRS, Area A, and Area B will be collectively referred to as the Investigation Area throughout the UFP-QAPP.

The Investigation Area consists of the portion of the Hudson River that was overlapped by the range fans for a series of batteries that were used for artillery training at the West Point Army Garrison and Cold Spring Foundry. The series of batteries were operational throughout the Revolutionary War and some continued to be in operation until World War II. The ranges for the series of batteries overlapped. Military munition items may be present within the Investigation Area from activities at the multiple ranges consisting of shooting at targets on barges in the Hudson River, undershooting targets on Constitution Island, and/or overshooting and undershooting Crows Nest.

The UFP-QAPP will primarily serve as the work plan for the collection and analysis of geophysical data, geophysical anomaly identification and excavation, and munitions constituents (MC) sample collection and analysis in the event that a concentrated munitions use area (CMUA) is identified. The UFP-QAPP also includes a contingency sediment sampling plan in the event of visual evidence of MC contamination, i.e., sediment at the location of observed

MEC and/or material potentially posing an explosive hazard (MPPEH) that shows signs of damage or heavy corrosion (outer casing failure) and visible signs of a munitions constituent (MC) release (sediment staining). If visual evidence exists, MC sampling will first be conducted to determine whether a release of MC has occurred. If MC is found at concentrations exceeding screening criteria, additional samples will be collected to determine the nature and extent of contamination. The UFP-QAPP includes the testing, handling, removal, and disposal of MPPEH. However, the UFP-QAPP does not cover the testing, handling, removal, or disposal of chemical warfare materiel (CWM) as there is no historical or current evidence of CWM use associated with either of the MRSs or Areas A and B.

The UFP-QAPP follows the format of the Intergovernmental Data Quality Task Force (IDQTF) Uniform Federal Policy for Quality Assurance Project Plans Manual (UFP-QAPP) (IDQTF, 2005) and the UFP-QAPP optimized worksheets (IDQTF, 2012).

The UFP-QAPP provides a process for obtaining data of sufficient quality and quantity to satisfy project needs. It describes the functional activities, data quality objectives (DQOs), and measures necessary to obtain adequate data for a given purpose. Data acquisition, reporting, and evaluation will be completed in accordance with the UFP-QAPP. As any new procedures are required, addenda to the document will be issued.

All staff participating in project/field efforts are required to read and become familiar with the procedures and implementation plan presented in the UFP-QAPP to ensure that project measurement quality objectives (MQOs) are met consistently.

WORKSHEETS #1 & 2: TITLE AND APPROVAL PAGE

1. Project Identifying Information:
    a. Site Name/ Project Name: Siege Battery–TD River MRS (WSTPT-016-R-01) and Battery Knox–TD River MRS (WSTPT-004-R-01) and Areas A and B/U.S. Army Garrison West Point Water MRSs
    b. Site Location/Number: Hudson River
    c. Lead Organization: United States Army Corps of Engineers (USACE), Baltimore District (CENAB)
    d. Contractor: Weston Solutions, Inc. (WESTON)
    e. Contract Number: Multiple Award Military Munitions Services II (MAMMS II) Contract W912DR 15-D-0022, Delivery Order (DO) W912DR17F0131

2. Lead Organization: CENAB
    a. USACE CENAB PM

Kim Gross, PMP®, USACE — Date

3. Contractor: WESTON
    a. Contractor PM

8 June 2018
Gretchen Tabano, PMP®, P.E., Project Manager, WESTON — Date

b. Contractor Senior Geophysicist

2 March 2018
Ryan Steigerwalt, P.G., WESTON — Date

c. Contractor Corporate QC Manager

Stacie Popp-Young
2 March 2018
Stacie Popp-Young, P.E., WESTON — Date

4. U.S. Military Academy West Point
    a. West Point PM

Jeff Sanborn, Project Manager, West Point — Date

5. State Regulatory Agency: New York State Department of Environmental Conservation (NYSDEC) and New York State Department of Health (NYSDOH)

David Crosby, NYSDEC PM	Date
Steven Karpinski, NYSDOH PM	Date

6. Other Stakeholders: County Agencies, Local Communities, Tribal Groups

7. Plans and reports from previous investigations relevant to the project:

    - Naval Surface Warfare Center, Panama City Division (NSWCPCD). 2016. Report for Underwater Munitions Response Site (MRS) Survey Conducted at the West Point Military Academy – West Point, NY. WSTPT-004-R-01 – Battery Knox–TD River, WSTPT-016-R-01 – Siege Battery–TD River. Prepared for the Department of the Army. Prepared by the Naval Surface Warfare Center, Panama City Division, Panama City, Florida 32407-7001. 08 November 2016.

    - Malcolm Pirnie. 2004. Final Closed/Transferred/Transferring Range Inventory Report, U.S. Military Academy, West Point, New York. August 2004.

    - TLI (TLI Solutions, Inc.). 2006. Final Historical Records Review, United States Military Academy, West Point, New York. Prepared for the U.S. Army Corps of Engineers (USACE), Baltimore District. March 2006.

    - TLI (TLI Solutions, Inc.). 2007. Final Site Inspection Report, United States Military Academy, West Point, New York. Prepared for the U.S. Army Corps of Engineers (USACE), Baltimore District. January 2007.

    - URS. 2016. Final Remedial Investigation Report, Crow's Nest Impact Area, Military Munitions Response Program, Munitions Response Site WSTPT-023-R-01. West Point Military Reservation. West Point, New York. Prepared for the U.S. Army Corps of Engineers, Baltimore District. December 2016.

    - WESTON (Weston Solutions, Inc.). 2011. Final Work Plan Military Munitions Response Program, Remedial Investigations, U.S. Army Garrison – West Point, West Point, NY. Prepared for the U.S. Army Corps of Engineers, Baltimore District. April 2011.

    - WESTON (Weston Solutions, Inc.). 2014a. Final Remedial Investigation Report Battery Knox TD–Land Munitions Response Site, U.S. Army Garrison West Point. Prepared for the U.S. Army Corps of Engineers, Baltimore District. June 2014.

    - WESTON (Weston Solutions, Inc.). 2014b. Final Remedial Investigation Report for Seacoast Battery Munitions Response Site, U.S. Army Garrison West Point. Prepared for the U.S. Army Corps of Engineers, Baltimore District. June 2014.

- WESTON (Weston Solutions, Inc.). 2015. Final Remedial Investigation Report for Fort Clinton West Munitions Response Site, Siege Battery Munitions Response Site, Lusk Reservoir Munitions Response Site, Artillery Firing Range Munitions Response Site, U.S. Army Garrison West Point. Prepared for the U.S. Army Corps of Engineers, Baltimore District. March 2015.

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WORKSHEETS #3 & #5: PROJECT ORGANIZATION AND QAPP DISTRIBUTION (CONTINUED)

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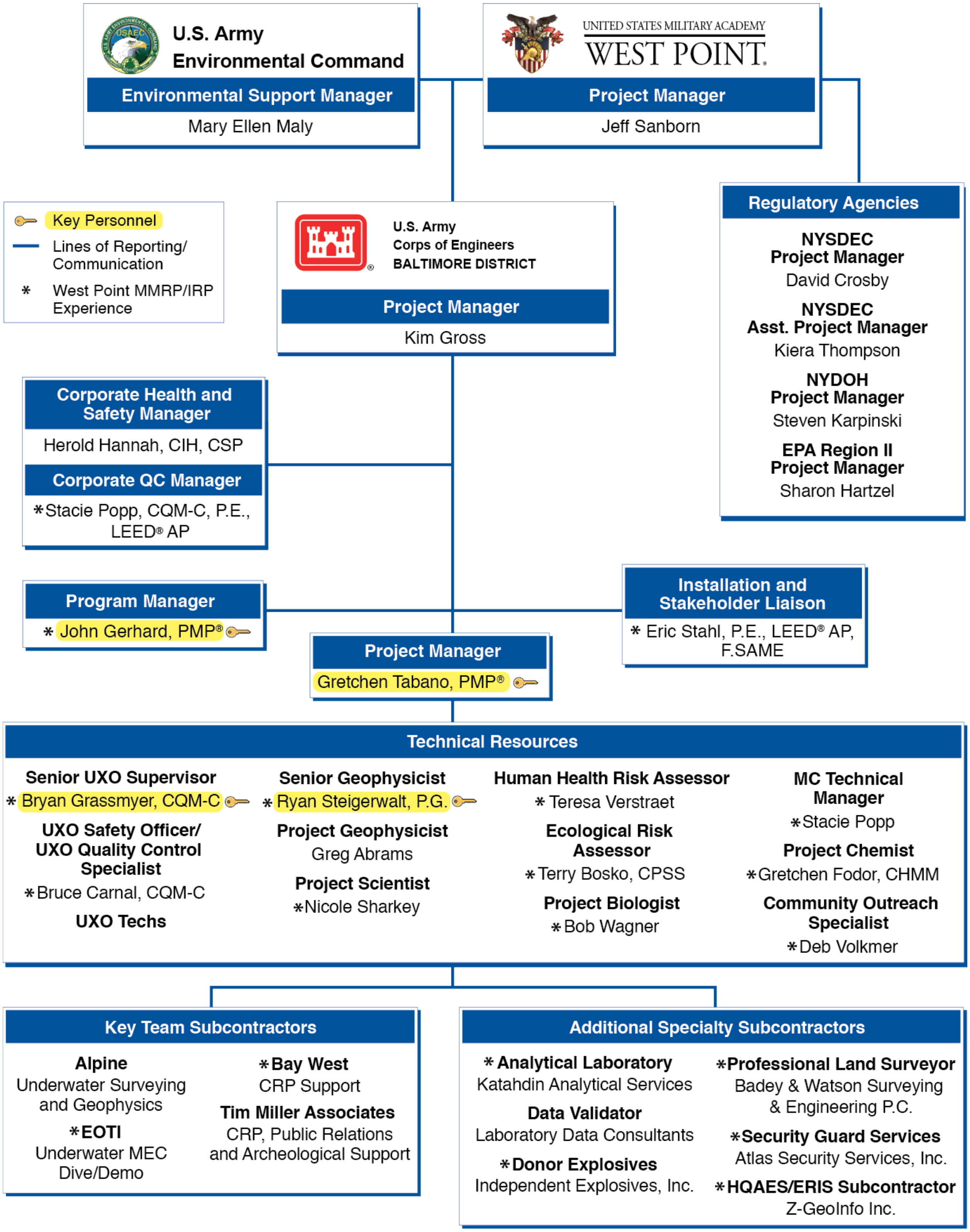
Laura Soeten	Data Validator	Laboratory Data Consultants	1 electronic	(760) 817-1101	lsoeten@lab-data.com

Project Organizational Chart



U.S. Army Environmental Command
Environmental Support Manager
Mary Ellen Maly

UNITED STATES MILITARY ACADEMY WEST POINT
Project Manager
Jeff Sanborn

🔑 Key Personnel
— Lines of Reporting/ Communication
* West Point MMRP/IRP Experience

U.S. Army Corps of Engineers BALTIMORE DISTRICT
Project Manager
Kim Gross

Regulatory Agencies

NYSDEC Project Manager
David Crosby

NYSDEC Asst. Project Manager
Kiera Thompson

NYDOH Project Manager
Steven Karpinski

EPA Region II Project Manager
Sharon Hartzel

Corporate Health and Safety Manager
Herold Hannah, CIH, CSP

Corporate QC Manager
*Stacie Popp, CQM-C, P.E., LEED® AP

Program Manager
* John Gerhard, PMP® 🔑

Installation and Stakeholder Liaison
* Eric Stahl, P.E., LEED® AP, F.SAME

Project Manager
Gretchen Tabano, PMP® 🔑

Technical Resources

Senior UXO Supervisor
* Bryan Grassmyer, CQM-C 🔑

UXO Safety Officer/ UXO Quality Control Specialist
*Bruce Carnal, CQM-C

UXO Techs

Senior Geophysicist
* Ryan Steigerwalt, P.G. 🔑

Project Geophysicist
Greg Abrams

Project Scientist
*Nicole Sharkey

Human Health Risk Assessor
* Teresa Verstraet

Ecological Risk Assessor
*Terry Bosko, CPSS

Project Biologist
* Bob Wagner

MC Technical Manager
*Stacie Popp

Project Chemist
*Gretchen Fodor, CHMM

Community Outreach Specialist
*Deb Volkmer

Key Team Subcontractors

Alpine
Underwater Surveying and Geophysics

***EOTI**
Underwater MEC Dive/Demo

***Bay West**
CRP Support

Tim Miller Associates
CRP, Public Relations and Archeological Support

Additional Specialty Subcontractors

***Analytical Laboratory**
Katahdin Analytical Services

Data Validator
Laboratory Data Consultants

***Donor Explosives**
Independent Explosives, Inc.

***Professional Land Surveyor**
Badey & Watson Surveying & Engineering P.C.

***Security Guard Services**
Atlas Security Services, Inc.

***HQAES/ERIS Subcontractor**
Z-GeoInfo Inc.

17P-0128-2a

WORKSHEETS #4, #7, & #8: PERSONNEL QUALIFICATIONS AND SIGN-OFF SHEET

Name, Organization	Project Title/Role	Education/Experience	Specialized Training/Certifications[1]	Signature/Date[2]
John Gerhard, PMP® WESTON	Program Manager	B.S., Environmental Resource Management; 15 years of project management experience and 20 years of MMRP experience, including previous West Point, NY, work.	Project Management Professional	
Gretchen Tabano, PMP®, P.E., WESTON	Project Manager	B.S., Engineering Science and Mechanics, 20 years of experience in managing and executing projects as part of MMR and installation restoration programs.	Project Management Professional, Professional Engineer	
Ryan Steigerwalt, P.G., WESTON	Senior Geophysicist	M.S., Geology/Geophysics, B.S. Geology 15 years of munitions response experience. Experienced Principal Investigator (PI) on Environmental Security Technology Certification Program (ESTCP) demonstrations in underwater environments.	Professional Geologist	
Stacie Popp-Young, P.E., WESTON	MC Technical Manager Corporate QC Manager	B.S., Chemical Engineering; M.S., Chemical Engineering; 32 years of experience in environmental assessment and CERCLA hazardous waste site investigation and cleanup, including field laboratory method development, data quality reviews, QAPP preparation, and laboratory coordination.	Professional Engineer	
Gretchen Fodor, WESTON	Project Chemist	B.S., Chemistry; M.S., Environmental Studies; more than 24 years of experience in environmental chemistry under various EPA and DoD programs (CERCLA, Clean Water Act [CWA], Safe Drinking Water Act [SDWA], U.S. Army Corps and Air Force Civil Engineer Center).		

WORKSHEETS #4, #7, & #8: PERSONNEL QUALIFICATIONS AND SIGN-OFF SHEET (CONTINUED)

Name, Organization	Project Title/Role	Education/Experience	Specialized Training/Certifications[1]	Signature/Date[2]
Greg Abrams, WESTON	QC Project Geophysicist	B.S., Physics 10 years of MMRP geophysical experience. Experienced in collection and analysis of advanced electromagnetic induction (EMI) sensor data. Experienced in collection and analysis of Hydrographic, side scan sonar (SSS), and marine magnetometer sensor data.	Oasis Montaj Geophysical Data Processing for UXO 3 day UXAnalyze instruction by ESTCP	
Brian Grassmyer, CQM-C WESTON	Senior UXO Supervisor	Graduate of U.S. Navy Basic Explosive Ordnance Disposal (EOD) School including Navy Diver Classes; U.S. Navy Advanced EOD Course; over 25 years of experience supervising UXO technicians conducting MEC/EOD removal and disposal operations.	Construction Quality Management for Contractors (CQM-C)	

Notes:

[1] All unexploded ordnance (UXO) personnel will meet the requirements set forth in Department of defense Explosives Safety Board (DDESB) Technical Paper (TP) 18, Minimum Qualifications for Personnel Conducting Munitions and Explosives of Concern-Related Activities (DDESB, 2016). All field team personnel will complete the Occupational Safety and Health Administration (OSHA) 40-hour training course for hazardous waste site workers as required by the specific task. Additional site-specific training, in accordance with 29 Code of Federal Regulations (CFR) 1910.120 and Engineer Manual (EM) 385-1-1 (USACE, 2014), and the UFP-QAPP will be provided to all personnel upon their initial mobilization. A medical surveillance program will be in place for each member of the field team, with the most recent exam for each member having occurred within the last 12 months.

[2] Signatures indicate personnel have read and agreed to implement the UFP-QAPP as written.

WORKSHEET #6: COMMUNICATION PATHWAYS AND PROCEDURES

Communication Driver	Initiator (role)(1) (2)	Recipient(s) (role)(1)	Procedure(3)
General communication between USACE and other Project Delivery Team (PDT) members	USACE Project Manager (PM) or designee	Appropriate PDT member(s)	Communicates directly as needed (verbally and/or in writing). No documentation of this is required, but important outcomes of the communication may be documented in meeting minutes or summarized in emails to the project team members as warranted to document decisions made.
Regulatory interface	West Point PM or designee	EPA Region II PM NYSDEC PM NYSDOH PM	Project materials and information will be forwarded as deliverables are generated and as warranted in order to effectively execute the task order to the PMs for USACE, EPA, NYSDEC, and NYSDOH by the West Point PM or designee, or by the WESTON PM with permission from the West Point PM. The materials will be sent in hard copy or electronic copy in accordance with the approved Project Management Plan (PMP). Copies of transmittal letters and/or emails will be retained to document the communication.
Regulatory oversight	EPA Region II PM NYSDEC PM NYSDOH PM	West Point PM	Communicates directly as needed (verbally and/or in writing). No documentation of this is required, but important outcomes of the communication will be sent via email to the project team members as warranted to document decisions made.
Project management, task order administration, and logistics	WESTON PM	USACE PM	Communicates directly as needed (verbally and/or in writing). The WESTON PM will communicate project-related issues, including changes in schedule or scope of fieldwork, to the USACE PM by phone or e-mail by close of business next business day. The WESTON PM will also provide project information to the USACE PM through monthly progress reports, e-mail updates, teleconference calls, and meetings. Any deviations from the UFP-QAPP, including those resulting in corrective action (CA), will be documented in a memorandum to the USACE PM within five business days of notification of the change.

WORKSHEET #6: COMMUNICATION PATHWAYS AND PROCEDURES (CONTINUED)

Communication Driver	Initiator (role)(1) (2)	Recipient(s) (role)(1)	Procedure(3)
Daily Reports	WESTON Senior UXO Supervisor (SUXOS) or designee	WESTON PM and WESTON technical personnel, USACE PM, West Point PM	Documents progress in daily report and submits to WESTON PM for onward distribution to PDT. Daily reports will be submitted to USACE PM and West Point PM within 24 hours of work completion that day whenever possible. Field progress reports will vary based on objectives of each definable feature of work (DFW). Examples of these reports are geophysical surveying, intrusive investigation, and daily production reports. The Daily SUXOS report template is included in **Appendix B**.
Stop work due to safety issues	WESTON Unexploded Ordnance Safety Officer (UXOSO) or CENAB Ordnance and Explosives Safety Specialist (OESS)	WESTON SUXOS and other field personnel, USACE OESS	If unsafe work conditions are noted, the UXOSO or OESS will stop work immediately and notify the WESTON SUXOS. Work will not resume until the unsafe condition is corrected. The UXOSO will also notify WESTON Corporate Health and Safety (H&S) Officer immediately when a stop work situation is encountered. The SUXOS and WESTON PM, in collaboration with the UXOSO, will evaluate the need for field CAs. In naturally occurring cases, such as inclement weather (for example, lightning), no CA is required. Work may resume when the UXOSO and OESS agree that conditions allow.
	WESTON SUXOS	WESTON field personnel, WESTON PM, USACE PM, West Point PM	As soon as possible following discovery, the WESTON SUXOS informs the WESTON PM by phone of critical safety issues and generates follow-up Stop Work Memorandum. The WESTON PM will notify the USACE PM and West Point PM verbally or via e-mail as soon as possible, but within one hour, after work stoppage. Changes in the field will be documented in the daily progress reports or memoranda to the WESTON PM. The SUXOS and WESTON PM, in collaboration with the UXOSO, will evaluate the need for field CAs. CAs will be documented in the daily reports and in memoranda to the USACE and West Point PMs. Work may resume when the SUXOS, UXOSO, and OESS agree that the situation has been corrected. The SUXOS will notify the WESTON PM prior to resuming field work. The WESTON PM will notify the USACE PM and West Point PM when conditions have been resolved prior to resuming field work.

WORKSHEET #6: COMMUNICATION PATHWAYS AND PROCEDURES (CONTINUED)

Communication Driver	Initiator (role)[(1)] [(2)]	Recipient(s) (role)[(1)]	Procedure[(3)]
UFP-QAPP changes before fieldwork	WESTON PM	USACE PM	If errors or changed conditions require modifications of the UFP-QAPP before fieldwork begins, the WESTON PM will coordinate preparation of revised text for submittal to the USACE PM and other members of the PDT within 14 days of identifying the change. All changes to the UFP-QAPP require final approval from USACE, West Point, and regulatory agencies prior to implementation.
UFP-QAPP changes during project execution related to geophysics	WESTON SUXOS WESTON PM WESTON Senior Geophysicist	USACE PM, West Point PM, regulatory agencies	The SUXOS and sample team will notify the USACE PM of field deviations from the UFP-QAPP within 2 business days and provide rationale for changes. The WESTON Senior Geophysicist will notify the WESTON PM of field deviations from the UFP-QAPP within 2 business days and provide rationale for changes. Changes in the field will be documented in the daily progress reports and memoranda to the WESTON PM. The SUXOS and WESTON PM, in collaboration with the Senior Geophysicist, will evaluate the need for field CAs. CAs will be documented in the daily reports or in memoranda to USACE and the West Point PMs. All changes to the UFP-QAPP will require final approval from USACE, West Point, and regulatory agencies.
UFP-QAPP changes in the field related to MC; Field CA	MC Technical Manager WESTON PM WESTON Project Chemist	WESTON Project Chemist, WESTON PM, WESTON Project Scientist, USACE PM, West Point PM, regulatory agencies	The MC Technical Manager will notify the WESTON PM and WESTON Project Chemist of changes to UFP-QAPP in the field (related to MC) within 2 business days and provide rationale for changes. Changes in the field will be documented in the daily progress reports or memoranda to the WESTON PM. The MC Technical Manager and WESTON PM, in collaboration with the WESTON Project Chemist and Project Scientist, will evaluate the need for field CAs. CAs will be documented in the daily reports and in memoranda to the USACE and West Point PMs. All changes to the UFP-QAPP will require final approval from USACE, West Point, and regulatory agencies.

WORKSHEET #6: COMMUNICATION PATHWAYS AND PROCEDURES (CONTINUED)

Communication Driver	Initiator (role)[(1) (2)]	Recipient(s) (role)[(1)]	Procedure[(3)]
Geophysical quality control (QC) variances	WESTON PM WESTON Senior Geophysicist	WESTON Project Geophysicist, WESTON Senior Geophysicist, and WESTON PM, USACE PM, West Point PM, regulatory agencies	WESTON Senior Geophysicist notifies WESTON Project Geophysicist and WESTON PM immediately by phone or e-mail. The Senior Geophysicist will also notify the WESTON PM of changes to the UFP-QAPP in the field (related to geophysics) within 2 business days and provide rationale for changes. Changes in the field will be documented in the daily progress reports or memoranda to the WESTON PM. The Project Geophysicist and WESTON PM, in collaboration with the Senior Geophysicist, will evaluate the need for field CAs. CAs will be documented in the daily reports and in memoranda to the USACE and West Point PMs. All changes to the UFP-QAPP will require final approval from USACE, West Point, and regulatory agencies.
Geophysical quality assurance (QA) concerns	USACE Geophysicist	WESTON PM, WESTON Senior Geophysicist, USACE PM, West Point PM, regulatory agencies	The USACE Geophysicist will communicate QA concerns to the WESTON Senior Geophysicist in writing (e-mail or other written communication). WESTON responds to geophysical QA concerns within 24 hours with a CA plan.
Discovery of MEC item(s)	WESTON SUXOS WESTON PM USACE PM	WESTON PM, USACE OESS, USACE PM, West Point PM	WESTON SUXOS verbally notifies WESTON PM and USACE OESS immediately and then awaits permission to respond and/or conduct disposal operation. The WESTON PM notifies the West Point PM and USACE PM verbally or via e-mail daily.
Field team ready to conduct MEC disposal operations	WESTON SUXOS or designee	WESTON PM, and personnel listed in the Explosives Management Plan (EMP) Call Tree	Once the detonation is set up but prior to performing the demolition, the WESTON SUXOS or his designee notifies the WESTON PM and personnel listed in the EMP (**Appendix H**) and other members of the PDT as necessary.

WORKSHEET #6: COMMUNICATION PATHWAYS AND PROCEDURES (CONTINUED)

Communication Driver	Initiator (role)[(1)] [(2)]	Recipient(s) (role)[(1)]	Procedure[(3)]
Field CAs	WESTON UXOQCS	WESTON SUXOS, WESTON PM, USACE PM, West Point PM, regulatory agencies	CA resulting from either failure to follow UFP-QAPP requirements or due to changes in site conditions will be documented by the WESTON UXOQCS and provided immediately to the WESTON SUXOS. The WESTON SUXOS may initiate interim CAs in the field subject to the final approval of the WESTON PM and the WESTON Senior Geophysicist and/or MC Technical Manager. Changes in the field will be documented in the daily progress reports or memoranda to the WESTON PM. The SUXOS and WESTON PM, in collaboration with the UXOQCS, will evaluate the need for field CAs. CAs will be documented in the daily reports and in memoranda to the USACE and West Point PMs. All changes to the UFP-QAPP will require final approval from USACE, West Point, and regulatory agencies.
Reporting Laboratory Data Quality Issues	Laboratory Project Manager	WESTON Project Chemist and MC Technical Manager	All QA/QC issues with project field samples will be reported by the laboratory to the WESTON Project Chemist and MC Technical Manager.
Laboratory Analytical Corrective Actions	WESTON Project Chemist Laboratory Project Manager	WESTON PM and USACE PM	Need for laboratory CAs will be determined by the Project Chemist and/or laboratory Project Manager or Technical Manager and will be documented in memoranda to WESTON and USACE PM.
Data Tracking and Management, Release of Analytical Data, QAPP Amendments	WESTON Project Chemist	WESTON MC Technical Manager and WESTON PM	WESTON Project Chemist or her delegated representative will track data from collection of samples through login at laboratory to delivery by technical report/sample data group and electronic data delivery into database. Final analytical data cannot be released until validation is complete and Project Chemist has approved release.

WORKSHEET #6: COMMUNICATION PATHWAYS AND PROCEDURES (CONTINUED)

Communication Driver	Initiator (role)[(1)] [(2)]	Recipient(s) (role)[(1)]	Procedure[(3)]
Identification of item with potential cultural/historical significance	WESTON SUXOS	WESTON PM, USACE PM, West Point PM, State Historic Preservation Officer (SHPO), NYSDEC Cultural Resource Manager, U.S. Military Academy West Point Cultural Resource Manager, and/or local Museum Conservators	The WESTON SUXOS will notify the WESTON PM via e-mail within 2 hours of identification. The WESTON PM will notify the USACE and West Point PMs weekly via e-mail with a compilation of items identified during the week. The West Point PM will contact via e-mail the SHPO, NYSDEC Cultural Resource Manager, U.S. Military Academy West Point Cultural Resource Manager, and/or local Museum Conservators, if needed.

Notes:

[1] Names and contact information for personnel are provided on Worksheets #3 and 5.

[2] The initiator may designate another qualified individual to communicate with the recipient(s); however, the initiator shown is responsible for the communication being made.

[3] If not specified, communication pathways may occur in the form of electronic mail, in-person meetings, teleconference, or via telephone or best available method.

WORKSHEET #9: PROJECT PLANNING SESSION SUMMARY

Project Name: U.S. Army Garrison West Point Water MRSs **Projected Date(s) of Field Activities:** March 2018 – July 2018 **PM:** John Gerhard, PMP, WESTON	**Site Name:** Siege Battery–TD River and Battery Knox–TD River MRSs and Areas A and B **Site Location:** West Point, New York

Date of Planning Session: 27 September 2017
Location: West Point
Purpose: Technical Project Planning (TPP) 1
Participants:

Name	Organization	Title/Role	Email/Phone #
Kim Gross	USACE, CENAB	PM	Kimberly.u.gross@usace.army.mil (410) 962-3457
Deborah McKinley*	USACE, CENAB	Environmental Engineer	deborah.k.mckinley@usace.army.mil (410) 962-6730
Paul Greene*	USACE	Munitions and Explosives Safety Chief	Paul.E.Greene@usace.army.mil (410) 962-6741
Cliff Opdyke*	USACE	Risk Assessor	Clifford.A.Opdyke@usace.army.mil (410) 963-6765
Tom Colozza*	USACE	Geophysicist	Thomas.S.Colozza@usace.army.mil (410) 962-6647
Mary Ellen Maly*	U.S. Army Environmental Command (USAEC)	Environmental Support Manager	mary.e.maly.civ@mail.mil (210) 466-1870
Jeff Sanborn	U.S. Army Garrison West Point, Department of Public Works (DPW)-Environmental Management Division (EMD)	MMRP Manager	jeffrey.sanborn@us.army.mil (845)-938-5041
Karl H. Weed	DPW-EMD		Karl.weed@usma.edu (845) 938-2116
Brian O. Anderson	DPW-EMD		(954) 687-4687
David Crosby	New York State Department of Environmental Conservation (NYSDEC)	PM	David.crosby@dec.ny.gov (518) 402-9662

WORKSHEET #9: PROJECT PLANNING SESSION SUMMARY (CONTINUED)

Name	Organization	Title/Role	Email/Phone #
Steven Karpinski	New York State Department of Health (NYSDOH)	PM	Steven.karpinski@health.ny.gov (518) 402-7860
Sharon Hartzel	EPA	Remedial Project Manager	Hartzell.sharon@epa.gov (212) 637-4132
John Gerhard	WESTON	PM	j.gerhard@westonsolutions.com (610) 701-3793
Ryan Steigerwalt	WESTON	Technical Manager	ryan.steigerwalt@westonsolutions.com (267) 258-2672
Nicole Sharkey*	WESTON	Project Leader	Nicole.sharkey@westonsolutions.com (610) 701 3425

*Attended on the phone.

Copies of the September 27, 2017 TPP 1 Meeting Minutes and Sign-In Sheet are provided in **Appendix C**.

WORKSHEET #9: PROJECT PLANNING SESSION SUMMARY (CONTINUED)

Project Name: U.S. Army Garrison West Point Water MRSs **Projected Date(s) of Field Activities:** June 2018 – August 2018 **PM:** Gretchen Tabano, PE, PMP, WESTON	**Site Name:** Siege Battery–TD River and Battery Knox–TD River MRSs and Areas A and B **Site Location:** West Point, New York

Date of Planning Session: 26 April 2018
Location: West Point
Purpose: Technical Project Planning (TPP) 2
Participants:

Name	Organization / Title	Email	Telephone Number
Mary Ellen Maly	USAEC- Environmental Support Manager	mary.e.maly.civ@mail.mil	210-466-1870
Kim Gross	USACE -Project Manager	Kimberly.u.gross@usace.army.mil	410-962-3457
Debbie McKinley*	USACE - Environmental Engineer	deborah.k.mckinley@usace.army.mil	410-962-6730
Paul Greene*	USACE - Munitions and Explosives Safety Chief	Paul.E.Greene@usace.army.mil	410-962-6741
Cliff Opdyke*	USACE - Risk Assessor	Clifford.A.Opdyke@usace.army.mil	410-962-6765
Tom Colozza*	USACE - Geophysicist	Thomas.S.Colozza@usace.army.mil	410-962-6647
Jeff Sanborn	Department of Public Works (DPW)-Environmental Management Division (EMD) - MMRP Manager	jeffrey.sanborn@us.army.mil	845-938-5041
Karl H. Weed	DPW-Environmental Management Division	Karl.weed@usma.edu	845-938-2116
David Crosby	NYSDEC - Project Manager	David.crosby@dec.ny.gov	518-402-9662
Kiera Thompson	NYSDEC - Future Project Manager	Kiera.thompson@dec.ny.gov	518-402-9663

WORKSHEET #9: PROJECT PLANNING SESSION SUMMARY (CONTINUED)

Project Name: U.S. Army Garrison West Point Water MRSs **Projected Date(s) of Field Activities:** June 2018 – August 2018 **PM:** Gretchen Tabano, PE, PMP, WESTON	**Site Name:** Siege Battery–TD River and Battery Knox–TD River MRSs and Areas A and B **Site Location:** West Point, New York

Date of Planning Session: 26 April 2018
Location: West Point
Purpose: Technical Project Planning (TPP) 2
Participants:

Name	Organization / Title	Email	Telephone Number
Charles Vandrei	NYSDEC – Cultural Resources	Charles.vandrei@dec.ny.gov	518-402-9428
John Petronella*	NYSDEC – Regional Permit Administrator		
Rebecca Quail*	NYSDEC – Ecological Risk Assessment		
Steven Karpinski	NYSDOH Project Manager	Steven.karpinski@health.ny.gov	518-402-7860
William Rottner	Alpine Ocean Seismic Surveys	wrottner@alpineocean.com	201-397-3164
John Gerhard	WESTON -Program Manager	j.gerhard@westonsolutions.com	610-701-3793
Ryan Steigerwalt	WESTON -Technical Manager	ryan.steigerwalt@westonsolutions.com	267-258-2672
Gretchen Tabano	WESTON -Project Manager	Gretchen.tabano@westonsolutions.com	443-299-6863

*Attended on the phone.

Copies of the April 26, 2018 TPP 2 Meeting Minutes and Sign-In Sheet are provided in **Appendix C**.

WORKSHEET #10: CONCEPTUAL SITE MODEL

10.1 OVERVIEW

The primary purpose of the worksheet is to describe the conceptual site model (CSM) for the U.S. Army Garrison West Point Water MRSs. The two MRS are designated as Siege Battery–TD River MRS (WSTPT-016-R-01) and Battery Knox–TD River MRS (WSTPT-004-R-01). Two additional areas (Area A and Area B) outside the MRS boundaries, have been incorporated into the RI because there is a potential for military munitions from the Siege Battery-TD River and Battery Knox-TD River MRSs to have migrated into Area A or Area B, based on tidal fluctuations and currents. Therefore, the exposure pathways for Area A and B are assumed to be the same as Siege Battery-TD River and Battery Knox-TD River MRS. To provide the basis for the Conceptual Site Model (CSM), Worksheet #10 also provides a summary of observations from previous investigations, secondary data, information from site reports, and other relevant supporting information.

10.2 SITE DESCRIPTION AND BACKGROUND

10.2.1 Installation Setting and Site Description

West Point is located in Orange and Putnam Counties, New York, on the west bank of the Hudson River. West Point is approximately 50 miles north of New York City and approximately 13 miles south of Newburgh (see **Figure 10-1**) (figures are presented at the end of this worksheet). The 15,974 acres of land encompassing West Point have been designated as two areas: the Main Post or campus (2,530 acres) and the Military Reservation (13,444 acres). The Main Post comprises the majority of the academic, residential, and support facilities. The Military Reservation is largely undeveloped and contains such operational training facilities as firing ranges and bivouac areas, which are used during the summer to house and train cadets.

Of the nearly 16,000-acre reservation, 14,101 acres are classified as operational range. The Phase 3 Range Inventory identified 10 closed ranges and 2 transferred areas, totaling approximately 1,564 acres. The MRSs identified in the Range Inventory included a series of batteries that fired artillery during training throughout the Revolutionary War and continued to do so until World War II. The firing from these batteries was mainly directed toward Crows Nest and Target Hill, which were also impact zones for artillery fired from the West Point Foundry at Cold Spring, NY, in the mid to late 1800s. In addition to the batteries, the Range Inventory MRSs included artillery ranges and small arms ranges. West Point has been occupied by the U.S. Army since 27 January 1778 and is the oldest occupied military post in America to have continuously flown the nation’s flag.

The Siege Battery–TD River and Battery Knox–TD River MRSs and Area A and Area B, which are the subject of the UFP-QAPP, are referred to as the Investigation Area. The Investigation Area is located east of West Point, within the Hudson River. The Investigation Area includes the portion of the Hudson River that was targeted by a series of batteries firing artillery during training throughout the Revolutionary War. Artillery firing at barges in the river during training continued until World War II. The batteries overlapped and military munition items may be present within the Investigation Area from the multiple ranges targeting barges in the Hudson

River, undershots from targeting Constitution Island, as well as overshots and undershots from targeting Crows Nest.

The Siege Battery–TD River and Battery Knox–TD River MRS boundaries were determined by the northern extent of the Siege Battery range fan within the Hudson River and by the southern extent of the Battery Knox range fan within the Hudson River. Area A and Area B consist of the areas between the ranges within the Hudson River that may potentially be impacted by military munitions. The eastern and western extents of the Investigation Area are the mean high tide of the Hudson River (see **Figure 10-1**).

10.2.2 Site Background

10.2.2.1 Siege Battery–TD River (WSTPT-016-R-01)

The Siege Battery–TD River MRS encompasses 848 acres within the Hudson River as shown in **Figure 10-2**. The MRS is the portion of the Siege Battery firing fan that falls within the Hudson River. The Siege Battery was constructed in approximately 1845 on the site of Battery Sherburne at what is now called Trophy Point. Battery Sherburne was built in 1778 and contained two iron six-pounder cannons (i.e., six-pounders) on garrison carriages and eight iron six-pounders on stocked or field carriages. Six-pounders fired solid metal artillery munitions that did not contain any explosive material. Activities that took place on U.S. Army Garrison West Point that are associated with the Siege Battery included live firing conducted from the Siege Battery and ammunition storage area toward potential targets located in the Hudson River and on Crows Nest. Projectiles that overshot the targets located in the river may have impacted the shore of the Hudson River to the north of the Village of Cold Spring. During the latter part of the 19th century, the Siege Battery was renamed Battery Schofield and was used for training with Parrott rifles. Various munitions were used at the Siege Battery, including 4.5-inch rifled gun, 30-pounder Parrott guns, 10-inch smooth bore siege mortars, 8-inch smooth bore siege mortars, 5-inch steel breech-loading guns, 7-inch steel breech-loading howitzers, 7-inch steel breech-loading mortars, and 3.2-inch guns. The targets for the guns used at the Siege Battery were on Crows Nest, approximately 2,000 yards distant. Full charges were not used in any of the guns. The targets for the mortars were anchored in the Hudson River. Use of the Siege Battery ended between 1906 and 1910, when Battery Schofield came into service. A map from 1939 indicates that the Siege Battery and Battery Schofield had been replaced by an amphitheater (TLI, 2007). A site inspection (SI) was completed in 2007 and the MRS was recommended for further investigation for the presence of munitions and explosives of concern (MEC) and munitions constituents (MC) (TLI, 2007). In addition, the following two areas are being investigated under the Siege Battery–TD River MRS acreage: Area A (63 acres) and Area B (154 acres) as shown in **Figure 10-2**.

10.2.2.2 Battery Knox–TD River (WSTPT-004-R-01)

The Battery Knox–TD River MRS encompasses 73 acres on the Hudson River as shown in **Figure 10-2**. The MRS is the portion of the Battery Knox range fan that falls within the Hudson River. Battery Knox contained six gun positions and ammunition magazines. The battery was established sometime between 1836 and 1850. In 1874, the battery was redesigned, with modifications made to the armament and the orientation of the guns to improve their defensibility and their ability to cover the river with firepower.

By 1892, Battery Knox was armed with one 100-pounder Parrott 6.4-inch caliber rifle, one 300-pounder Parrott 10-inch caliber rifle, one 8-inch converted rifle, and four 10-inch Rodman rifles. Firing from the battery was conducted to the east towards targets that were placed in the Hudson River. The battery was demolished during the World War II era. An SI was completed in 2007, and the site was recommended for further investigation for the presence of MEC and MC.

10.2.3 Topography

The topography of West Point is best described as having moderately steep hills and numerous escarpments. Slopes from 10 to 60% are common on the installation. The entire Investigation Area (Siege Battery–TD River MRS, Battery Knox–TD River MRS, Area A, and Area B) is located within the Hudson River. The river depth varies from very shallow (1 to 4 feet [ft]) near the shorelines to an average depth of 60 ft in the Siege Battery–TD River MRS main channel and 90 ft average depth in the main channel of the Battery Knox–TD River MRS. Within the Investigation Area, the Hudson River has a maximum sounding at mean lower low water of approximately 175 ft according to the National Oceanic and Atmospheric Administration (NOAA) nautical chart. The deepest portion of the river is located south of Constitution Island near Gees Point in Area B. Refer to **Figure 10-3** for regional topography and river depth as identified during the 2016 NSWCPCD bathymetry survey (NSWCPCD, 2016).

10.2.4 Vegetation

Submersed aquatic vegetation (SAV) is an important habitat in the tidal freshwater Hudson River. The most predominant SAV species is native water celery (*Vallisneria americana*), but other species can be present, including clasping leaved pondweed (*Potamogeton perfoliatus*), and such non-native plants as curly pondweed (*Potamogeton crispus*) and Eurasian water milfoil (*Myriophyllum spicatum*). A very common invasive species impacting SAV is water chestnut (*Trapa natans*), which can be seen in almost every freshwater, slow moving area of the Hudson River in the summertime (NYSDEC, 2017a).

10.2.5 Geology

West Point, New York, lies in the Hudson Highlands, a low, rugged mountain range that forms a zone of folded and faulted metamorphic and igneous rocks subjected to extensive weathering and erosion. Precambrian-age granite, diorite, gneiss, and schist compose the majority of the crystalline bedrock underlying West Point. Granite, the most prevalent rock type in the bedrock, is typically medium-grained and composed of quartz, feldspar, and mica. Granite and pegmatite are igneous rocks and occur as dikes and sills within the gneiss. Igneous rocks on the installation consist of plagioclase feldspar, hornblende, pyroxene, and biotite mica and quartz (Tetra Tech, Inc., 2010).

The metamorphic rocks of West Point exist in sequences. These sequences are composed of a hard, layered, banded rock gneiss, which is sometimes intruded by igneous rocks. Marble, quartzite, schist, and amphibolite are other metamorphic rocks present in the Highlands area. The metamorphic rocks were deposited as marine sediments, volcanic ashes, and volcanic rocks. During the Precambrian period, these sediments and rocks were possibly subject to three phases of folding, extensive regional metamorphism, partial melting, and magmatic intrusion. The cantonment area, which is bounded by the Hudson River, is underlain by exposed bedrock and glacial alluvium (Tetra Tech, Inc., 2010).

There are three fault zones through the Hudson Highlands. These faults were active during the Precambrian period and were reactivated during the period of Taconic mountain building. During the latter, some new faults became active. Shear zones are also common at West Point. According to the New York State Geological Survey, historically, there have not been any major seismic activities in this area (Tetra Tech, Inc., 2010).

At some time during their formation, vast magnetite (Fe_3O_3) deposits were emplaced along fissures in the Highlands rocks. The plentiful magnetite with its high (50-60%) iron content created local ore deposits. The last operating mine in the region, the Forest of Dean Mine in Orange County, NY, ran until 1931 (Johnson and Gellasch, 2004).

10.2.6 Sediment

The sediment environment within the Hudson River varies between depositional areas, dynamic areas and areas of erosion. Within the Investigation Area, the thickness of sediment varies from bedrock to thick depositional areas. The sediment within the Battery Knox–TD River MRS and Area B consists of mud and sandy mud. The sediment within Area A consists of mud, and the sediment within the Siege Battery–TD River MRS consists of mud and sandy mud, with a small sand and gravel area extending outside the northern MRS boundary (NYSDEC, 2006a).

Based on the geology of the area, which includes the presence of rocks with a highly oxidized iron content, it is assumed that the level of iron in the sediment is the result of local geologic conditions and runoff from the soils in the watershed area to the river. The iron-containing soil would migrate through natural processes to be deposited within the Hudson River sediments. Precipitation and the resulting stormwater runoff facilitate the transport of iron from surface soil in the watershed area via overland runoff through soil erosion. Background data regarding the naturally occurring level of iron in the soil were not available from West Point.

10.2.7 Hydrology

The entire Investigation Area is located within a portion of the Hudson River. The Hudson River is a 315-mile (507 kilometer [km]) river that flows from north to south. The river originates in the Adirondack Mountains of Upstate New York, flows through the Hudson Valley, and eventually drains into the Atlantic Ocean, between New York City and Jersey City. The portion of the river containing the Investigation Area consists of a tidal estuary with tidal influence extending as far north as the Federal Dam in Troy, New York.

10.2.8 Endangered Species and Sensitive Habitats

The portion of the Hudson River where the Investigation Area is located is classified as an Estuarine and Marine Deepwater wetland.

The NYSDEC New York Nature Explorer Interactive Online Tool (NYSDEC, 2017b) identified several species of concern that could potentially be present within the Investigation Area boundary. Several plant and animal species were also identified with habitats that occur along the shoreline. The Investigation Area is located entirely within the river; therefore, all species with habitats entirely outside the mean high tide were excluded. The species of concern are listed in **Table 10-1**.

Table 10-1 Identified Species of Concern

Species	State Conservation/ (Protection) Status	Federal Protection Status
Fish		
Atlantic Silverside (*Menidia menidia*)	S2S3	None
Atlantic Sturgeon (*Acipenser oxyrinchus*)	S1 (Protected)	Endangered
Shortnose Sturgeon (*Acipenser brevirostrum*)	S1 (Endangered)	Endangered
Dragonflies and Damselflies		
Needham's Skimmer (*Libellula needhami*)	S3	None
Tiger Spiketail (*Cordulegaster erronea*)	S1	None
Plants		
Long's Bittercress (*Cardamine longii*)	S2 (Threatened)	None
Saltmarsh Aster (*Symphyotrichum subulatum var. subulatum*)	S2 (Threatened)	None
Slender Marsh-pink (*Sabatia campanulata*)	S1 (Endangered)	None
Smooth Bur-marigold (*Bidens laevis*)	S2 (Threatened)	None
Spongy Arrowhead (*Sagittaria montevidensis var. spongiosa*)	S2 (Threatened)	S2 (Threatened)
Tidal Spikerush (*Eleocharis aestuum*)	S1 (Endangered)	None
Water Pigmyweed (*Crassula aquatica*)	S1 (Endangered)	None
Birds		
Bald Eagle (*Haliaeetus leucocephalus*)	Threatened	Least Concern

Notes:
S1 - Critically Imperiled
S2 - Imperiled
S3 – Vulnerable

The U.S. Fish and Wildlife Service (USFWS) Information, Planning, and Consultation System (IPaC) tool identified the dwarf wedgemussel (*Alasmidonta heterodon*), an Endangered species, as potentially being affected by activities in the Investigation Area. The IPaC tool also identified the Indiana bat (*Myotis sodalis*) and Northern long-eared bat (*Myotis septentrionalis*). However, because the Investigation Area is located entirely within the Hudson River, no habitat for either bat is present. In addition, the dwarf wedgemussel occurs only in the Delaware River Watershed and is not present within the Investigation Area.

While not present within the MRS, a bald eagle (*Haliaeetus leucocephalus)* nest is located to the east of the MRS on Constitution Marsh, which could be impacted by the noise of detonation. To avoid impacting the nesting area, per the National Bald Eagle Management Guidelines (USFWS, 2017), all detonations will occur at locations greater than ½ mile away from the nest, and efforts will be made to avoid performing detonation during peak feeding times (early to mid-morning and later afternoon).

The Project Biologist will create and provide training materials for field personnel to identify any species of concern and other regulated fish species (sport fish) and waterfowl utilizing habitats within the project area to ensure minimization of project-related impacts on biological resources. Prior to removing any MEC items encountered, visual examinations of the immediate vicinity will be made to determine whether mussel beds are present and to assess potential impacts associated with MEC removal. All activities will be conducted in accordance with SOP 1 Natural and Cultural Resources Monitoring (**Appendix D**). Any sensitive habitat observed will be marked, documented, and avoided to minimize potential impacts. WESTON and its subcontractors will avoid working in (including vessel anchoring) any areas containing the identified plant species of concern. Divers will take all necessary precautions to avoid contact with submerged aquatic vegetation. If boat vessel anchoring is required, submerged aquatic vegetation will be avoided, anchoring in soft substrate only using divers to assist with locating appropriate anchoring sites. On-shore detonations will be carried out using the Buried Explosion Module (detailed in Worksheet 17), which will minimize the impact to aquatic receptors.

10.2.9 Historical or Cultural Resources

Historically significant features and cultural resources present in and/or near the Investigation Area consist of Revolutionary War- and Civil War-era ranges and fortifications that existed in and along the river and throughout Constitution Island, shipwrecks in the river, and former West Point Foundry remnants as shown in **Figure 10-3**.

A Section 106 consultation with the State Historic Preservation Officer and tribal communities commenced in June 2018. The WESTON field team will follow the statutes, policies, and procedures that protect our Nation’s cultural and historic resources. The following list is a summary of the components of the Section 106 regulatory process that needs to be considered, as applicable (36 CFR 800, Protection of Historic Properties (incorporating amendments effective August 5, 2004)):

- Initiate Section 106 process – If historic properties exist within the area of intended work, the federal agency will inform the appropriate SHPO/Tribal Historic Preservation Officer (THPO) prior to conducting any activities within the area of concern.

- Identify historic properties – Through the identification of existing or potential future historic properties, a determination of the level of impact on these historic properties can be conducted.

- Assess adverse effects – Once the West Point Cultural Resources Manager assesses if there are any adverse effects, the SHPO/THPO will comment on the assessment and the effects on the historic properties.

- Resolve adverse effects – All adverse effects must be resolved through communications with the SHPO/THPO and the Advisory Council on Historic Preservation (ACHP), if required. A Memorandum of Agreement (MOA) is used to state all agreed-upon measures that will be conducted in the preservation of historic properties.

- Implementation – The federal agency will follow the instructions set forth within the MOA.

- Failure to resolve adverse effects – Consultation may be discontinued by any of the following entities, the federal agency, SHPO, THPO, and/or ACHP if consultation proves to be unproductive.

- Tribes, Native Hawaiians, and the public – Public involvement is a key ingredient in successful Section 106 consultation, and views of Tribes, Native Hawaiian organizations, and the public should be solicited and considered throughout the process.

In accordance with 36 CFR Part 800 – Protection of Historic Properties and Section 106 of the National Historic Preservation Act of 1966 (NHPA), West Point will be required to take into account the effects of their undertakings on historic properties. Since federal funds will be used to undertake this investigation and any subsequent remediation efforts, Section 106 applies and will require consultation with the New York SHPO. In order to initiate the Section 106 process, West Point will submit Form “Request to Initiate Consultation in Compliance with the State History Code and Section 106 of the National Historic Preservation Act.” WESTON, in coordination with USACE, will prepare this form and the necessary supporting documentation for the West Point to initiate consultation with the New York Bureau for Historic Sites. The content of this documentation will also serve as the basis for West Point to initiate government-to-government consultation with the appropriate Native American tribes. It is anticipated that the following Native American tribes will be consulted to acquire their input on tribal affiliation to, or any interests in, lands in the project area and its vicinity:

- Stockbridge-Munsee Band of the Mohican Nation
- Delaware Nation
- Delaware Tribe

The review process established by Bureau for Historic Sites requires two parallel processes: "(a) review for effect on historic standing structures and (b) review for effect on prehistoric and historic archaeological resources." The first step in this review process is the submission of the project documentation through Form "Request to Initiate Consultation in Compliance with the State History Code and Section 106 of the National Historic Preservation Act" (Form). USACE, WESTON and the West Point Cultural Resources Manager will establish an Area of Potential Effect (APE). The West Point Cultural Resources Manager will coordinate with the SHPO/ Bureau for Historic Sites for necessary consultation and approvals. USACE, with support from WESTON, will prepare the Form for West Point to submit to SHPO/Bureau for Historic Sites. The Form includes, but is not limited to, the following data:

- Applicant Information
- Contact Person
- Project Information
- Project Type
- Agency Office to Receive Response
- Required Project Information for SHPO/Bureau for Historic Sites Review
- Map Location - showing boundary of APE
- Project Description Narrative – WESTON will provide a detailed project description describing the project, any ground disturbance, any previous land use, and age of all affected buildings in the project area.
- Measures that will be taken to identify consulting parties including Native Americans.
- Measures that will be taken to notify and involve the public.

The review of project documentation will result in one of three responses by the Bureau for Historic Sites to West Point:

1. No recorded sites occur within the project area and none would be expected.
2. Recorded sites occur within the project area and other unrecorded sites may be expected to exist.
3. No recorded sites exist in the project area, but the area has not been surveyed and there is a high probability that sites exist.

If the Bureau for Historic Sites has concluded that there will be an effect on known resources or that there may be an effect on unrecorded resources, the Bureau for Historic Sites may recommend that an archaeological survey be performed to develop an inventory of archaeological resources (prehistoric and historic) within the project area.

The project team would exclude intrusive operations in identified areas of known resources from the investigation and evaluate the use of the underwater mapping, side scan sonar, and DGM to determine potential subsurface anomalies if data from the surrounding MRS indicate potential presence of munitions. WESTON will coordinate boundaries of these areas with the West Point Cultural Resources Manager along with the SHPO/Bureau for Historic Sites to ensure these areas are not impacted. If an inadvertent discovery of cultural artifacts is made during the project, in accordance with state and federal law, intrusive activities shall stop until the West Point Cultural Resources Manager is contacted, and consultation with SHPO/Bureau for Historic Sites and NYSDEC Cultural Resource Manager is accomplished. A determination will be made about the significance of the find and what, if any, special disposition of the find should be made.

On-site personnel will be briefed at the beginning of the project on potential historical, archaeological, and cultural resources that may be encountered during the course of the investigation and will comply with the MOA.

10.3 CURRENT AND PROJECTED LAND USE

West of the Investigation Area is the West Point and Storm King State Park. East of the Investigation Area is Village of Cold Spring, New York, as well as several recreational areas such as Constitution Island. The Hudson River is used for maritime trade, recreation, and underwater utilities. CSX and Metro-North Railroad lines completely skirt the west and east shores of the river adjacent to the Investigation Area. It is reported that a high-voltage, direct-current underwater and underground transmission line will be routed in and along the Hudson River in the future.

10.4 PREVIOUS INVESTIGATIONS

10.4.1 2004 Closed, Transferring, and Transferred Ranges Inventory Report

The closed, transferring, and transferred (CTT) Range Inventory Report for West Point (also known as the Phase 3 Range Inventory), was completed in August 2004, and marked the completion of the Preliminary Assessment (PA) phase of work under CERCLA. A total of 12 (10 closed and two transferred) ranges and munitions sites were identified during the inventory at the U.S. Military Academy West Point. The munitions sites included 10 closed munitions sites within the installation and two transferred ranges that consisted of the range fans for a series of batteries used from the Revolutionary War until World War II. The two transferred ranges extended to the north and east of West Point and across the Hudson River into Putnam County, New York. The transferred ranges are the Siege Battery–TD and Battery Knox–TD MRSs.

The Siege Battery–TD MRS (WSPT-016-R-01) consists of approximately 1,014 acres located north of West Point, including the Hudson River and a portion of land north of the Village of Cold Spring. The portion of the MRS within the Hudson River is approximately 848 acres. The remaining 166 acres are located on the eastern bank of the river.

The Battery Knox–TD MRS (WSPT-004-R-01) comprises approximately 214 acres extending from the Battery Knox–TD MRS to the east over the Hudson River into Putman County. The portion of the MRS within the Hudson River is approximately 73 acres. The remaining 141 acres are located on the eastern bank of the Hudson River (TLI, 2007).

10.4.2 2007 Site Inspection Report, United States Military Academy, West Point, New York

The 2007 SI was planned and performed to evaluate the potential presence of MEC and MC at the munitions sites identified during the CTT. The SI was completed in two phases. The Historical Records Review (HRR) was the initial step in the MMRP SI process. The primary goal of the HRR was to perform a records search to document historical and other known information for the MRSs at West Point in order to supplement the information developed during the CTT. The second phase of the SI was the completion of field activities from April 24 through May 11, 2006, with a supplemental investigation performed in early September 2006. Activities included visual surveys, surface soil and sediment samples, and geophysical surveys, as appropriate.

The summary and conclusions from the SI (TLI, 2007) for the two transferred ranges that are semi-applicable to the Investigation Area are listed below.

Battery Knox-TD MRS

The following field work activities were conducted at the Battery Knox–TD MRS:

- The SI field activities conducted at the Battery Knox–TD MRS included approximately 22 line miles of visual surveys and collection of surface soil and sediment samples.
- The water portion of the site, which is approximately 73 acres contained within the Hudson River, was not addressed during the SI.
- The Battery Knox–TD MRS comprises 11 parcels of privately owned land. Visual surveys were conducted over seven parcels in May 2006 and two parcels in September 2006. It was determined during the field work that the remaining two parcels would not be surveyed because extensive fill work and landscaping had previously been conducted on these parcels.
- No evidence of military munitions was observed during the visual survey.
- Five sediment and six surface soil samples (including one quality assurance [QA] and one quality control [QC] sample) were collected from within the Battery Knox–TD MRS. Samples were collected within each of the nine parcels that were included in the visual survey.
- Analytical results for metals indicate iron levels exceeding the EPA Region 9 preliminary remediation goal (PRG) existed in one sample collected from Parcel 10 within the Battery Knox–TD MRS. The elevated levels of iron are believed to be naturally occurring

in the soils at the MRS. Based on the geology of the area, which includes rocks with a highly oxidized iron content, it is assumed that the level of iron in the soils is the result of the local geologic conditions. Background data regarding the naturally occurring level of iron in the soil were not available.

- Analytical results for explosives indicate trace amounts in numerous samples; however, the results were well below the screening criteria.

- Based on the results of the field work conducted at Battery Knox–TD, it was recommended that the site be identified as a munitions response area (MRA) with two MRSs. The Battery Knox–TD River MRS (WSPT-004-R-01) consists of 73 acres and encompasses the area contained within the Hudson River. The Battery Knox–TD Land MRS (WSPT-004-R-02) consists of 141 acres and encompasses the area on the eastern shore of the Hudson River within Putnam County. Although both MRSs were being recommended for further investigation as discussed below, the work to be conducted at each MRS is so distinct that the MRS should be considered separately in order to address site-specific issues.

- The Battery Knox–TD River MRS was not included in the SI field activities. Therefore, the MRS was recommended for further investigation for MEC and MC.

- During the SI, no evidence of military activities, including MEC, was identified in the Battery Knox–TD Land MRS nor were any MC identified in the samples at levels above the screening criteria. However, trace amount of explosives were identified in the samples. Because no explanation for the presence of these trace explosives can currently be determined, the Stakeholders had requested that further investigation of the Battery Knox–TD Land MRS be performed, including additional soil sampling and possible geophysical investigation.

Siege Battery–TD MRS

The following field work activities were conducted at the Siege Battery–TD MRS during the SI:

- A visual survey of approximately 28 line miles was performed, and one surface soil sample and one sediment sample were collected.

- No activities were conducted within the water portion of the Siege Battery–TD MRS during the SI field work.

- No evidence of military munitions was observed at the Siege Battery–TD MRS during the visual survey.

- The analytical results for metals indicate that all sample concentrations are below the screening criteria.

- No explosives were detected in the samples.

- Based on the results of the field work conducted at the Siege Battery–TD MRS, it was recommended that the MRS be identified as an MRA with two MRSs. The Siege Battery–TD River MRS (WSPT-016-R-01) consists of approximately 848 acres and extends from the North Dock area of West Point to the north up the Hudson River. The Siege Battery–TD Land MRS (WSPT-016- R-02) comprises approximately 166 acres and encompasses a portion of the Village of Cold Spring and land in Hudson Highlands State Park.

- The Siege Battery–TD River MRS was not included in the SI field activities. Therefore, the MRS was recommended for further investigation.

- Because no MEC was identified during the visual survey and because the analytical results reflected no MC, the Siege Battery–TD Land MRS was recommended for No Further Action (NFA).

10.4.3 2016 Report for Underwater Munitions Response Site (MRS) Survey Conducted at the West Point Military Academy

A marine SI was conducted for West Point Military Academy in the Hudson River basin, from December 8 to 17, 2014, November 2 to 6, 2015, and May 3 to 5, 2016. The Naval Surface Warfare Center, Panama City Division (NSWCPCD) conducted the series of marine SIs in the Hudson River basin at West Point, NY, at the Battery Knox–TD River MRS (WSTPT-004-R-01) and the Siege Battery–TD River MRS (WSTPT-016-R-01). The preliminary SIs were conducted to explore the presence or absence of unexploded ordnance (UXO) in the center channel of the Hudson River and to provide data for follow-on efforts. The SIs consisted of a series of surveys that employed a variety of unmanned underwater vehicles (UUV) equipped with advanced prototype acoustic and magnetic sensors.

NSWCPCD acoustically surveyed 1,093 acres of the Hudson River basin with the high resolution synthetic aperture sonar (SAS) system and magnetically surveyed 87 acres with the sensitive magnetic gradiometer (MAG) system. The focus of the survey was the center of the channel. NSWCPCD conducted an analysis of the data collected from areas of interest north of the Siege Battery–TD River MRS extending south of the Battery Knox–TD River MRS to characterize densities of anomalies resembling cylinders and potential targets of concern.

Based on the findings reported from the SAS analysis, it was projected that the density of potential targets resembling UXO, proud or partially buried, will be on the order of 0.2 per acre over significant portions of the river basin. A greater anomaly density was reported for the MAG sensor, roughly 3.2 per acre, but the number also includes buried anomalies not visible to the acoustic systems. Approximately 24.7% of the magnetic targets are classified as cylinders, whereas roughly 5.8% fit the magnetic description of potential military munitions.

Approximately 80 features of interest were identified from the SAS and MAG results by NSWCPCD. Three areas were identified for further investigation as potential areas of interest where anomalies resembling military munitions were identified. Refer to **Figure 10-4** for the marine SI survey results. Based on the marine SI results, it was suggested that additional CERCLA investigations are required for the MRSs.

10.5 CONCEPTUAL SITE MODEL PATHWAYS ANALYSIS

The pathway analysis portion of a CSM identifies all complete, potentially complete, or incomplete pathways for both current and reasonably anticipated future land uses for a site. Each pathway must include a source, a receptor, and the interaction between them (access and activity).

Sources are those areas where MEC and/or MC have entered the site. A receptor is an organism (human or ecological) that contacts the source. Interaction describes access and activities that facilitate receptors coming into contact with a source. For sites, such as the Investigation Area, where both MEC hazards and MC risk must be considered, the CSMs are typically separated into MEC-based or MC-based scenarios, reflecting the key differences between the types of risks or hazards that may be present. For the UFP-QAPP, the MEC-based CSM is the most relevant, as discussed below.

The CSM Pathway Analyses for the Siege Battery–TD River and Battery Knox–TD River MRSs are summarized in **Table 10-2** and **Table 10-3**. There is a potential for military munitions from the Siege Battery-TD River and Battery Knox-TD River MRSs to have migrated into Area A or Area B, based on tidal fluctuations and currents. Therefore, the exposure pathways for Areas A and B are assumed to be the same as Siege Battery-TD River and Battery Knox-TD River MRS. The tables describe the known or suspected contamination sources, potential/suspected location and distribution of contamination, contamination source or exposure medium, current and future receptors, and potentially complete exposure pathways. The CSM is a “living document” based on existing knowledge and will be updated as more information becomes available.

The MEC CSMs for the Siege Battery–TD River and Battery Knox–TD River MRSs are based on the historical West Point Army Garrison and Cold Spring Foundry activities where multiple artillery range fans overlap. The range fans associated with the Artillery Firing Range, Seacoast Battery, Lusk Reservoir, and Redoubt No. 2 MRSs, and the Cold Spring Foundry Artillery Range overlap the Siege Battery–TD River MRS. Artillery from Battery Knox were fired at targets on barges within the Hudson River. Artillery at Siege Battery were fired at Crows Nest as well as potentially target barges within the river. However, because several artillery range fans overlapped, military munition items may be present within the Investigation Area from the multiple ranges either targeting barges in the Hudson River, as undershots from targeting Constitution Island, and/or as overshots and undershots from targeting Crows Nest. There is also the potential for migration of military munitions between the separate MRSs and Areas A and B from tidal fluctuation and currents.

Table 10-2 lists the weapons systems used at the various ranges overlapping the MRSs. Based on the time of usage and incomplete records, a complete list of potential military munitions is not available. Without knowing the Ordnance Engineers that designed the munition configurations, there are hundreds to thousands of possible caliber configurations with different fuze designs.

Table 10-2 MEC Conceptual Site Model Pathway Analysis

Site Details	Known or Suspected Contamination Source	Potential/Suspected Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Potentially Complete Exposure Pathway
Name: Siege Battery–TD River MRS **Acreage:** 848 **Suspected Past DoD Activities *(release mechanism)*:** Live firing from multiple artillery ranges targeting barges in the Hudson River, undershots from targeting Constitution Island, as well as overshots and undershots from targeting Crows Nest. **Current and Future Land Use:** The Hudson River is used for maritime trade, recreation, and underwater utilities.	MEC from 4.5-inch rifled gun, 30-pounder Parrott guns, 10-inch smooth bore siege mortars, 8-inch smooth bore siege mortars, 5-inch steel breech loading guns, 7-inch steel breech-loading howitzers, 7-inch steel breech loading mortars, 3.2-inch guns, 15-inch Rodman smoothbores, and 13-inch muzzle-loading seacoast mortars	No known MEC has been identified to date within the Hudson River. However, military munitions have been identified within approximately 100 ft of the coast on both sides of the river. MEC have been identified on Constitution Island, and MEC have been identified within the Crow’s Nest Impact Area near River Road (**Figure 10-5**). Approximately 80 features of interest were identified by NSWCPCD marine SI results. Based on the marine SI results, MEC may be exposed on the river bottom as well as buried in sediment.	MEC in surface sediment (0-0.5 ft bgs) and in subsurface sediment (>0.5 ft bgs).	Current and future site workers (utility workers and West Point workers, commercial maritime workers, railroad workers, maintenance workers, and/or construction workers performing dock installation/ maintenance and/or upkeep of the shoreline [inspections, embankment maintenance, cleanups, etc.]) and recreational users (e.g., fishing, boating, diving, wading, and/or swimming).	Exposure of human receptors to surface and/or subsurface MEC. Exposure pathways are incomplete for recreational users at water depths below 120 ft but are potentially complete for site workers.
Name: Battery Knox–TD River MRS **Acreage:** 73 **Suspected Past DoD Activities *(release mechanism)*:** Same as Siege Battery–TD River MRS **Current and Future Land Use:** Same as Siege Battery–TD River MRS	MEC from a 100-pounder Parrott 6.4-inch caliber rifle, a 300-pounder Parrott 10-inch caliber rifle, 8-inch converted rifle, and 10-inch Rodman rifles	Same as Siege Battery–TD River MRS	Same as Siege Battery–TD River MRS	Same as Siege Battery–TD River MRS	Same as Siege Battery–TD River MRS

Table 10-2 MEC Conceptual Site Model Pathway Analysis (Continued)

Site Details	Known or Suspected Contamination Source	Potential/Suspected Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Potentially Complete Exposure Pathway
Name: Area A and Area B **Acreage:** 63 and 154 respectively **Suspected Past DoD Activities *(release mechanism)*:** There is a potential for military munitions from the Siege Battery-TD River and Battery Knox-TD River MRSs to have migrated into Area A or Area B, based on tidal fluctuations and currents. **Current and Future Land Use:** The Hudson River is used for maritime trade, recreation, and underwater utilities.	Same as Siege Battery-TD River and Battery Knox-TD River MRSs.	Same as Siege Battery-TD River and Battery Knox-TD River MRSs.	Same as Siege Battery-TD River and Battery Knox-TD River MRSs.	Same as Siege Battery-TD River and Battery Knox-TD River MRSs.	Same as Siege Battery-TD River and Battery Knox-TD River MRSs.

Note: Anomaly densities are based on the 2016 NSWCPCD Marine SI Report (NSWCPD, 2016).

Table 10-3 MC Conceptual Site Model Pathway Analysis

Site Details	Known or Suspected Contamination Source	Potential/Suspected Location and Distribution	Source or Exposure Medium	Current and Future Receptors	Potentially Complete Exposure Pathway
Name: Siege Battery–TD River MRS, Battery Knox–TD River MRS, Area A, and Area B **Acreage:** 848, 73, 63, and 154 respectively **Suspected Past DoD Activities *(release mechanism)*:** Live firing from multiple artillery ranges targeting barges in the Hudson River, undershots from targeting Constitution Island, as well as overshots and undershots from targeting Crows Nest. **Current and Future Land Use:** The Hudson River is used for maritime trade, recreation, and underwater utilities.	Metals: ▪ Copper ▪ Iron ▪ Lead ▪ Mercury ▪ Zinc Explosives: ▪ Nitroglycerin ▪ Pentaerythritol tetranitrate (PETN) ▪ Cyclotrimethylenetrinitramine (RDX) ▪ 2,4,6-Trinitrotoluene (TNT) ▪ 2,4-Dinitrotoluene (2,4-DNT) ▪ 2,6-Dinitrotoluene (2,6-DNT) ▪ 2-Amino-4,6-dinitrotoluene ▪ 4-Amino-2,6-dinitrotoluene	Within potential CMUAs and Where damaged and/or heavily corroded (outer casing failure) individual MEC items are discovered with visible signs of an MC release (e.g., stained sediment under MEC) or in low visibility scenarios, tactile signs of a potential MC release (e.g., cracks, holes).	MC in surface sediment (0-0.5 ft bgs) and/or subsurface (>0.5 ft bgs) sediment. Depth will vary because the thickness of sediment varies from none (exposed bedrock) to thick depositional areas.	Current and future site workers (utility workers and West Point workers, commercial maritime workers, railroad workers, maintenance workers, and/or construction workers performing dock installation/maintenance and/or upkeep of the shoreline [inspections, embankment maintenance, cleanups, etc.]) and recreational users (e.g., fishing, boating, diving, wading, and/or swimming). Potential ecological receptors are listed in **Table 10-1.**	Exposure of human receptors to surface and/or subsurface MC in sediment. Exposure pathways are incomplete for recreational users at water depths below 120 ft but are potentially complete for site workers. Exposure of ecological receptors to surface (0-0.5 ft bgs) MC in sediment.

Note: The entire Investigation Area will be evaluated for the same MC analytes because of the potential for sediment migration between the separate MRSs and Areas A and B from tidal fluctuation.

However, the basic characteristics (diameter, length, and weight) for the munitions are known based upon the weapons system and time of use. Refer to the Worksheet #10 Attachment, which is presented at the end of this worksheet, for a listing of basic characteristics for munitions used with the known weapons systems and notes for military munitions that have been identified on the land MRSs and can be associated with the weapons systems.

The MEC CSM also includes information from previous investigations conducted within the MRS boundaries (e.g., NSWCPCD marine SI), and within the appropriate Land-MRS counterparts. Refer to **Figure 10-5** for the CSM Source Areas with the locations of the previous military munitions that have been identified in vicinity of the Investigation Area, during previous investigations. The Siege Battery-TD River MRS boundary was developed based on the extent of the Siege Battery range fan within the Hudson River, as delineated in the 2007 SI (TLI, 2007). The Battery Knox–TD River MRS boundary was developed based on the extent of the Battery Knox range fan within the Hudson River, as delineated in the 2007 SI (TLI, 2007).

The interaction of receptor and source is a function of whether the source can be accessed and whether an activity is intrusive or non-intrusive. The MEC CSM pathway analysis indicates that a potentially complete pathway exists for a site worker (e.g., utility workers and West Point workers, commercial maritime workers, railroad workers, maintenance workers, and/or construction workers performing dock installation/maintenance and/or upkeep of the shoreline [inspections, embankment maintenance, cleanups]) or recreational users (e.g., fishing, boating, diving, wading, and/or swimming) to encounter MEC on the surface (0-0.5 ft bgs) or in the subsurface (>0.5 ft bgs) sediment through intrusive activity in areas where MEC is present (preliminarily identified as “Potential MEC Areas” on **Figure 10-5**). The user pathway is incomplete for recreational users at river depths greater than 120 ft, because DoD Manual (DoDM) 4715.20 – Defense Environmental Restoration Program (DERP) Management states that for areas of the MRS with water depths greater than 120 ft, it will be assumed that a physical constraint/barrier exists to prevent exposure to human receptors. However, workers may be required, and appropriately trained, to descend to greater depths. Therefore, the pathway for specific workers (e.g., utility workers, commercial maritime workers, and/or maintenance workers) is potentially complete at depths below 120 ft. Ecological receptors are not typically evaluated for MEC hazards because ecological receptors typically do not engage in activities that expose them to MEC hazards and are not included as MEC receptors. Humans are typically considered the only receptor to MEC, per the Engineer Manual 200-1-12 - Conceptual Site Models (USACE, 2012).A MEC release may be a potential release point for MC (copper, iron, lead, mercury, zinc, and select explosives) to Investigation Area sediment. Significant quantities of munitions, such as a concentrated munitions use area (CMUA), may be a potential release point for metals to environmental media. The failure of a munition to function properly or the deterioration of munitions can result in the presence of explosive residues. After direct release to sediment in contact with MEC, multiple transport processes can affect the overall fate of MC within the sediment of the Hudson River.

For iron, it should be noted that iron is associated with munitions used at the majority of the MRSs associated with West Point. However, iron will not be included in the MC analysis for the MRSs because iron is known to occur naturally in the soils and sediments throughout the West Point area. According to the Geologic Map of New York, 1970 compiled by the New York State

Museum and Science Services, the soils in the vicinity of West Point are primarily derived from biotite-hornblende granite, granite gneiss, and rusty and gray biotite-quartzfeldspar gneisses[1]. These bedrocks are known to be high in iron content; therefore, soils and sediments derived from these rocks would also be high in iron. Therefore, evaluation of iron will not be performed for the RI (WESTON, 2011).

Current potential receptors will be evaluated using an exposure interval of 0 to 2 ft below ground surface (bgs) to represent recreational activities (e.g., fishing, boating, diving) and work activities (e.g., utility installation/maintenance, dock installation/maintenance). The sediment exposure interval for future potential receptors is expected to be the same as the exposure interval for current receptors. Ecological species contact sediment primarily within 0 to 2 ft bgs. Sediment exposure pathways include incidental sediment ingestion, dermal contact, and ingestion of fish. Therefore, the ecological exposure pathways are potentially complete. However, the ingestion of fish exposure route is contingent upon a determination that bioaccumulative MC are present at concentrations in sediment that may result in food chain accumulation. Current and future human receptors include recreational users (adult and child [e.g., fishing, boating, diving, wading, and/or swimming]) and site workers (utility workers and West Point workers, commercial maritime workers, railroad workers, maintenance workers, and/or construction workers performing dock installation/maintenance and/or upkeep of the shoreline [inspections, embankment maintenance, cleanups, etc.]). However, the user pathway is incomplete for recreational users at river depths greater than 120 ft. Potential ecological receptors are listed in **Table 10-1**. The exposure pathways for ecological receptors are assumed to be potentially complete.

The anticipated MC constituents were determined based on time of use (late 1700s to early 1900s) and potential munitions as identified for the various range fans overlapping the Investigation Area. During the Remedial Investigations (RIs) for the Siege Battery–Land MRS and the Battery Knox–Land MRS, the munitions potentially present in the MRSs as a result of military munitions use at these former ranges were evaluated for anticipated MC constituents. The rationale was detailed in an MC Sampling Rationale Memorandum included as Appendix G of the Final RI Work Plan (WESTON, 2011).

The potential MC at Siege Battery–TD River MRS and Battery Knox–TD River MRS was evaluated based on artillery training from the Siege Battery and Battery Knox. The evaluation also considered the portions of the range fans associated with the Artillery Firing Range, Seacoast Battery, Lusk Reservoir, and Redoubt No. 2 MRSs, and the Cold Spring Foundry Artillery Range that overlap the Siege Battery–TD River MRS. The entire Investigation Area will be evaluated for the same MC analytes as a result of the potential for sediment migration between the separate MRSs and Areas A and B from tidal fluctuation. Based on the munition item evaluation, metal analytes that will be evaluated consist of copper, lead, mercury, and zinc. Explosive analytes consist of nitroglycerin, pentaerythritol tetranitrate (PETN),

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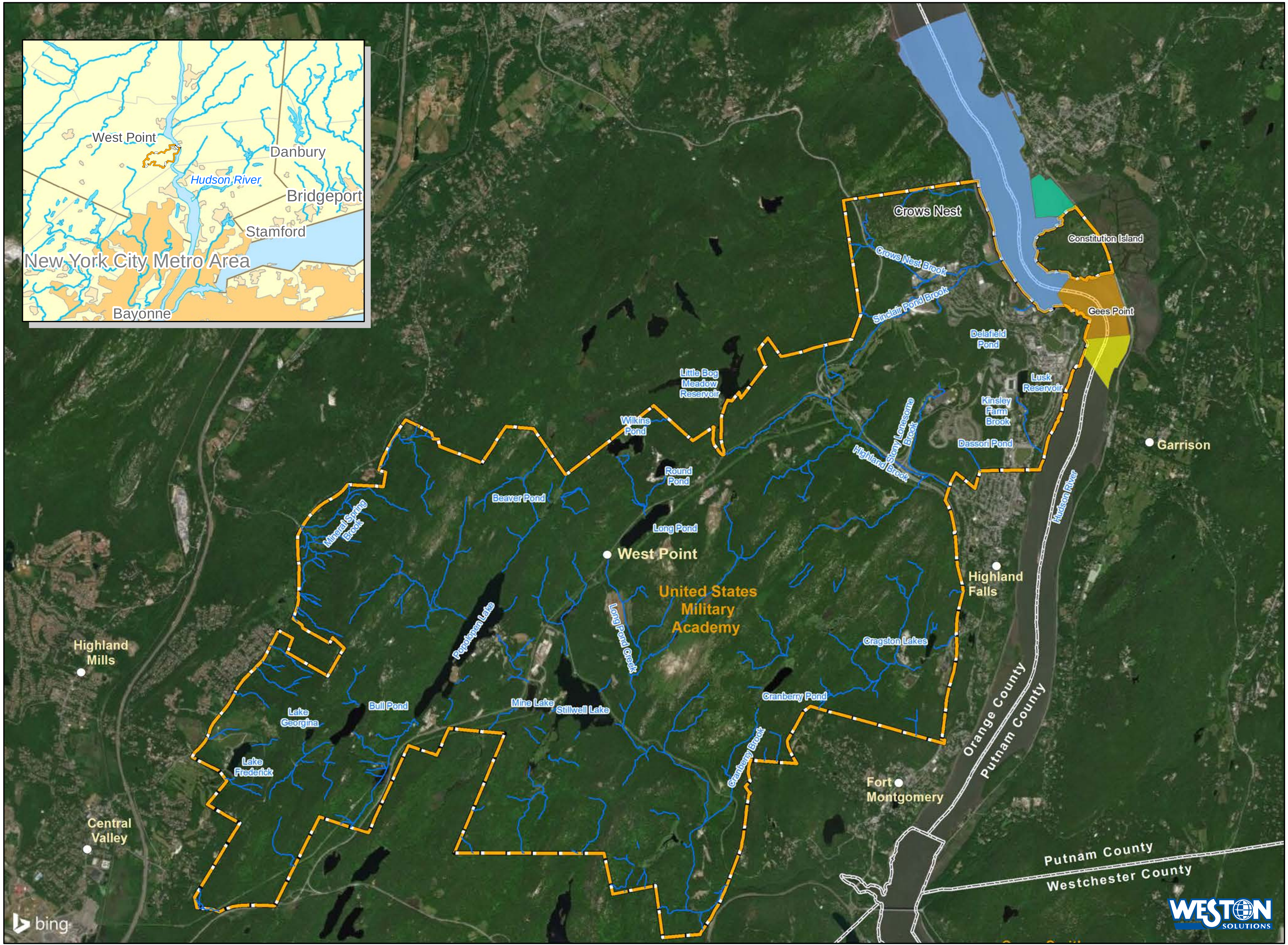
[1] New York State Museum and Science Serves in cooperation with the U.S. Geological Survey and the University of the State of New York, Geologic Map of New York (New York State Museum, 1970 and reprinted 1995).

cyclotrimethylenetrinitramine (RDX), 2,4,6-trinitrotoluene (TNT), 2,4-dinitrotoluene (2,4-DNT), 2,6-dinitrotoluene (2,6-DNT), 2-amino-4,6-dinitrotoluene, and 4-amino-2,6-dinitrotoluene (WESTON, 2011).

TNT was used as a projectile filler for artillery between 1912 and 1940, and nitroglycerin was used as a propellant with artillery after 1906. TNT and nitroglycerin are associated with the time frame and the military munitions used at Battery Knox and Siege Battery artillery ranges. Therefore, TNT, its breakdown products (2,4-DNT, 2,6-DNT, 2-amino-4,6-dinitrotoluene, and 4-amino-2,6-dinitrotoluene), and nitroglycerin will be evaluated during the RI for the Investigation Area (WESTON, 2011).

Iron and lead were primary components in munition casings during the late 1700s to early 1900s. Primer material for artillery fuzes contained lead and mercury, in addition to mercury fulminate as an energetic component in fuzes after 1905. Iron, copper, and zinc were associated with the casings for munitions used at the Siege Battery MRS and the concentration of iron in one soil sample collected on the Siege Battery–Land MRS during the 2007 SI was above the project screening level. The sample was a biased sample collected in proximity to a cast iron fragment. Based on a review of soil and geological data for the area, as discussed in Sections 10.2.5 and 10.2.6, it has been determined that iron occurs naturally in the soils and correspondingly in sediment due to transportation of soil particles containing iron via stormwater runoff to Hudson River sediments. Precipitation and the resulting stormwater runoff facilitate the transport of iron from surface soil in the watershed area via overland runoff through soil erosion. It is not anticipated that iron from munitions would result in levels higher or pose any greater risk than those that occur naturally. Therefore, analysis for iron will not be conducted (WESTON, 2011).

PETN and RDX are not associated with the military munitions used at Battery Knox or Siege Battery. These explosives were not being used by the Army during the time period when the MRSs were in use. Trace amounts of these explosives, however, were detected during the 2007 SI in soil samples collected within the Land MRSs. They were further evaluated during the RI for the Land MRSs. PETN and RDX are associated with the military munitions used at Artillery Firing Range, Lusk Reservoir, and Redoubt No. 2 ranges, which overlap the Investigation Area. Therefore, PETN and RDX will be evaluated during the RI for the Investigation Area (WESTON, 2011).



Legend

- ▭ Installation Boundary
- — Streams
- 🟩 Area A
- 🟧 Area B
- 🟨 Battery Knox - TD River
- 🟦 Siege Battery - TD River

Imagery Source: ESRI, World Imagery
USAD FSA, NAIP 2009

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Figure 10-1
Regional Location Map
U.S. Army Garrison West Point

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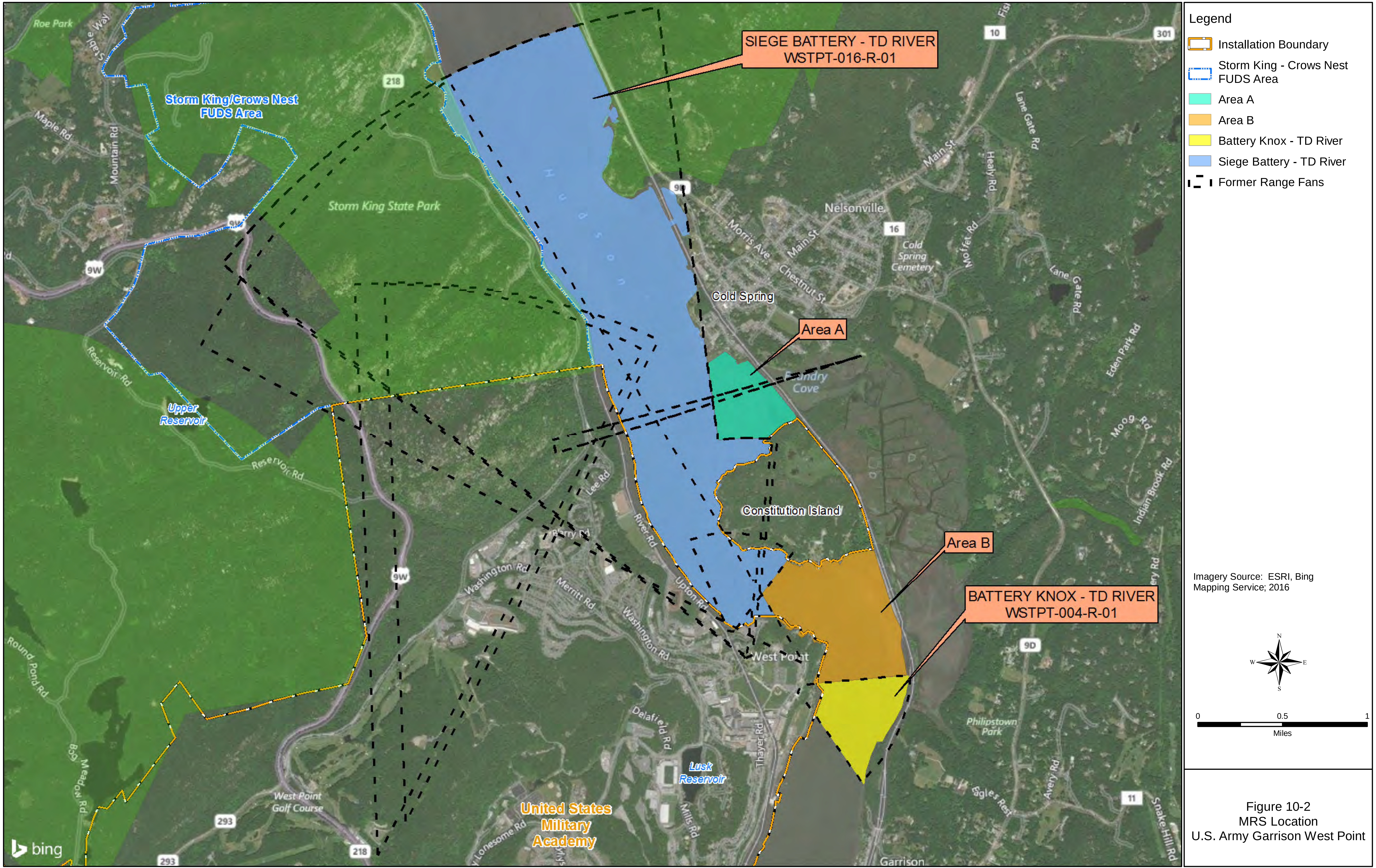

Figure 10-2
MRS Location
U.S. Army Garrison West Point

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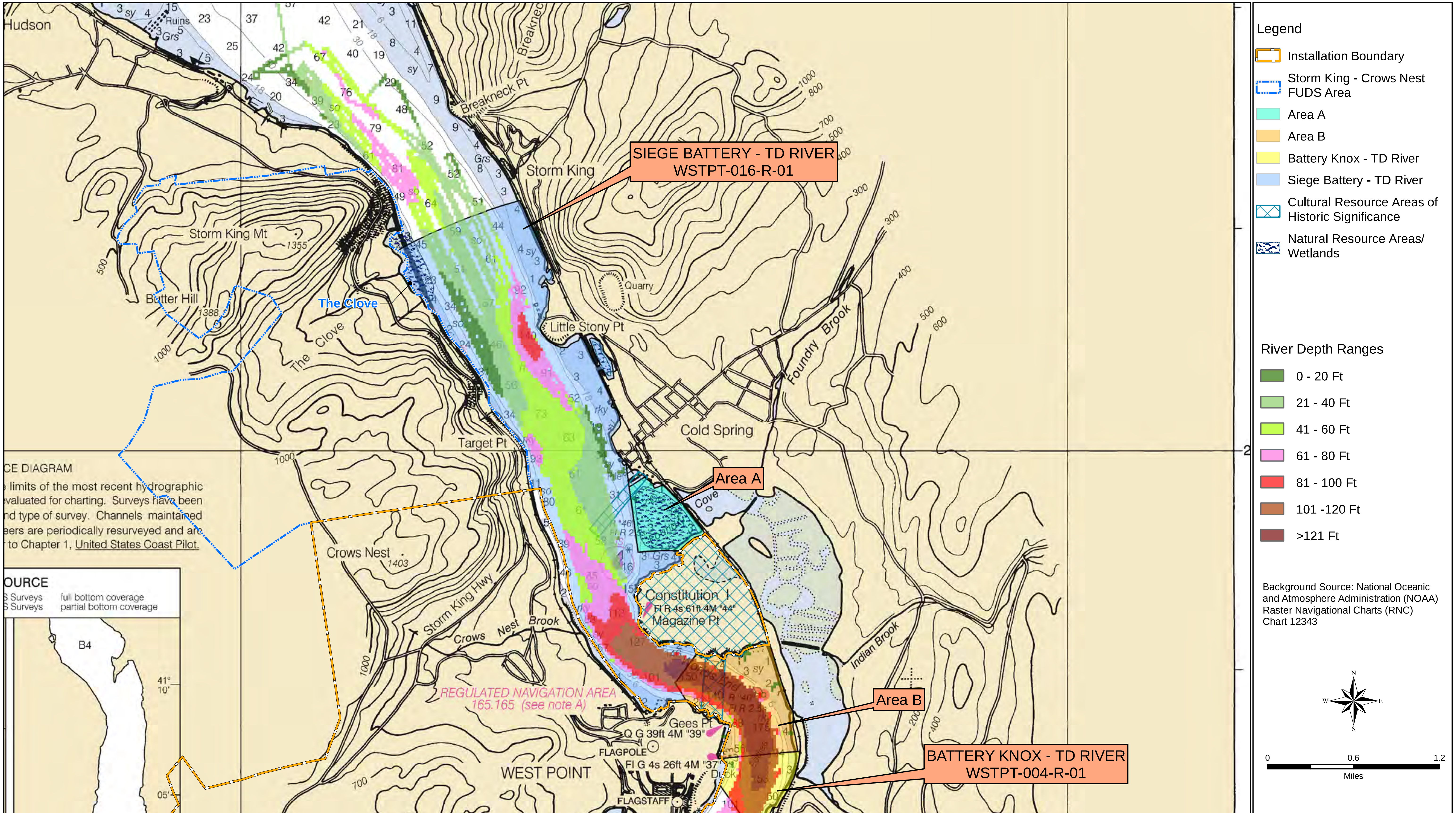
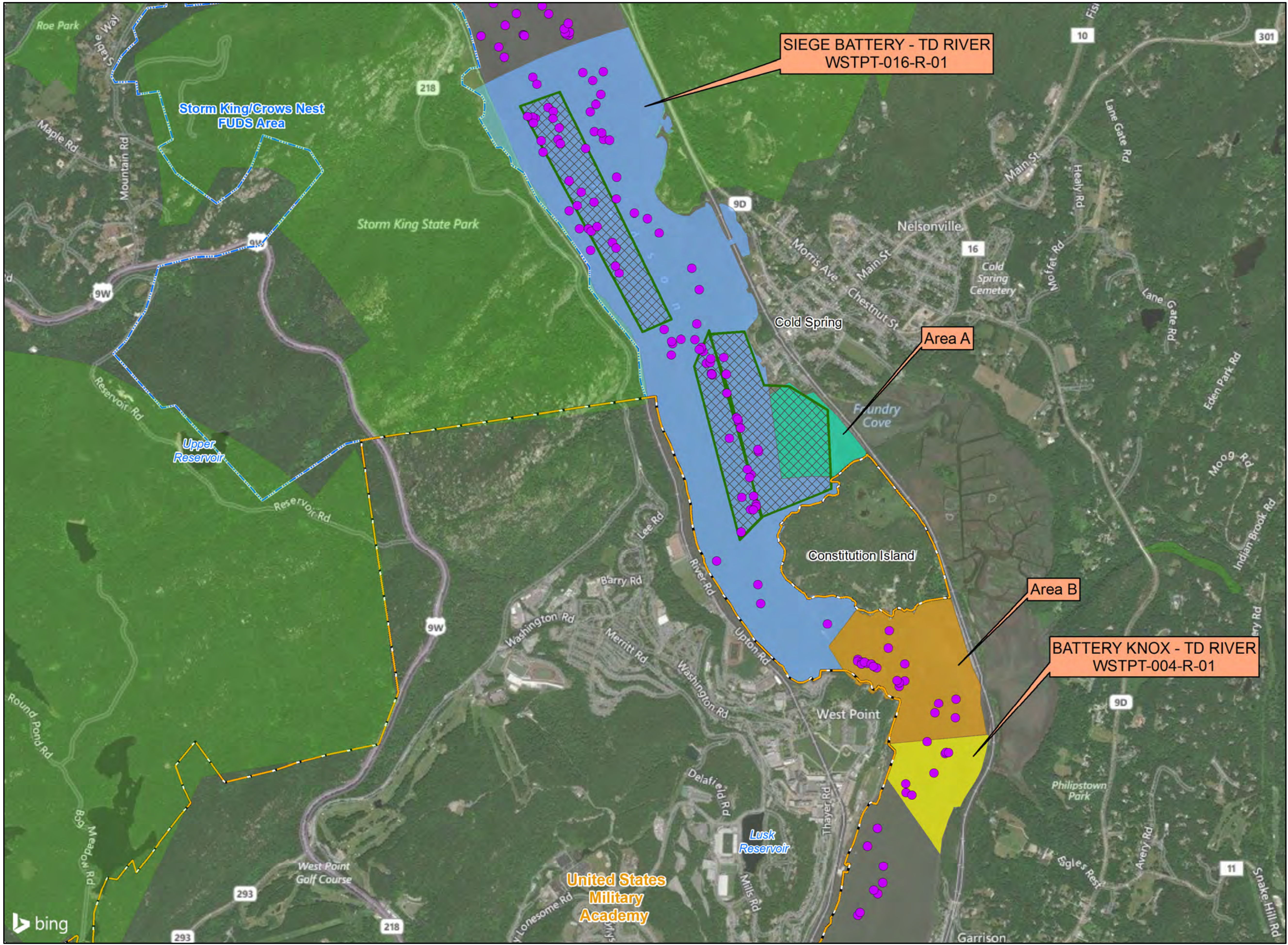


Figure 10-3
Topography and
Hudson River Depth
U.S. Army Garrison West Point



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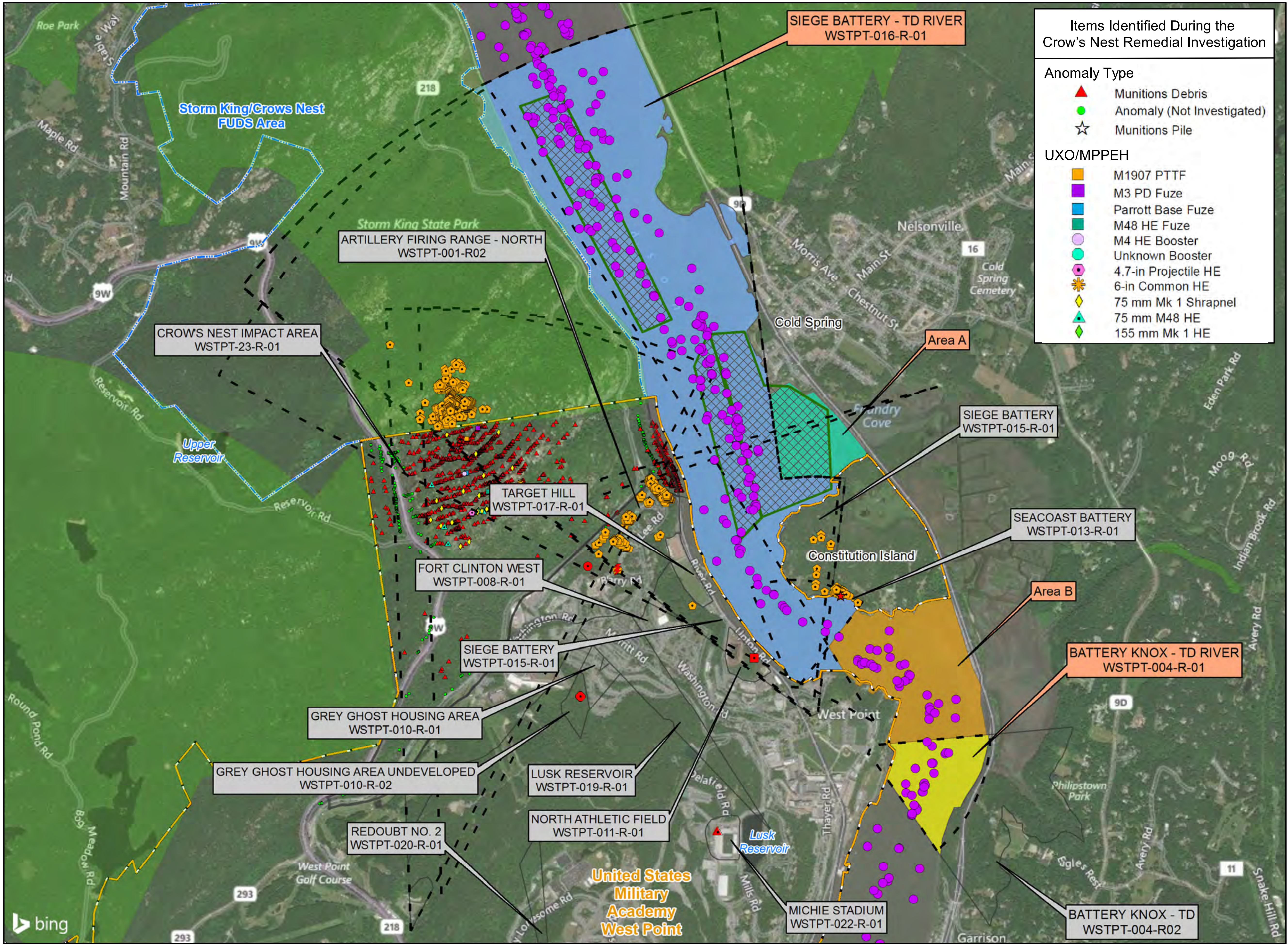
Legend

- ▭ Installation Boundary
- ▭ Storm King - Crows Nest FUDS Area
- 🟩 Area A
- 🟧 Area B
- 🟨 Battery Knox - TD River
- 🟦 Siege Battery - TD River
- ▨ Areas of Interest
- ● Navy Side Scan Items

Imagery Source: ESRI, Bing Mapping Service; 2016

Figure 10-4
NSWCPCD
Marine SI Survey Results
U.S. Army Garrison West Point



Legend

- ▭ Installation Boundary
- ⬚ Storm King - Crows Nest FUDS Area
- 🟩 Area A
- 🟧 Area B
- 🟨 Battery Knox - TD River
- 🟦 Siege Battery - TD River
- ☐ MRS Boundary
- ⌐ ⌐ Former Range Fans
- ▨ Areas of Interest Identified by NSWCPCD
- ● Navy Side Scan Items

MEC MD / UXO Items from Prior Investigations

- ▲ 3" Stokes Mortar(UXO)
- ● 3" Stokes Mortar (UXO) (sand filled, fuzed)
- ★ 37mm Projectile
- ● 8" Butler Projectile(UXO)
- ■ 8" Cannonball (case shot)(UXO)
- ⚡ MKII Hand Grenade
- ⬟ MEC MD Items

Imagery Source: ESRI, Bing Mapping Service; 2016

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Figure 10-5
Conceptual Site Model
MEC Source Areas
U.S. Army Garrison West Point

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WORKSHEET #10 ATTACHMENT: MILITARY MUNITION CHARACTERISTICS

Listed below are the military munition characteristics, by weapons system, that may potentially be identified within the West Point Water MRSs Investigation Area.

Type	Gun	Diameter	Length	Weight	Construction	Sabot	Fuzing[4]
Civil War Ordnance - Rifled Projectiles							
Butler	3-inch wrought iron (ordnance) rifle[1]	2.96 inches	8 1/2 inches	9 pounds (lb) 14 ounces (oz)	Shell	Brass ring, Butler's patent	Threaded time fuze plug (missing).
Hotchkiss	30-pounder Parrott Rifle, 4.2-inch caliber	4.1 inches	10 3/4 inches	About 25 lb	Common Shell	Lead Ring	West Point style percussion or percussion, brass
	4.5-inch Siege Rifle	4.4 inches	10 inches	About 19 lb, sabot missing	Common shell	Lead ring (missing)	Hotchkiss fuze plug
	Rifled 12-pounder Smoothbore, 4.62-inch caliber	4.5 inches	About 9 1/8 inches	About 17 lb, base and sabot missing	Common shell	Lead ring (missing)	Hotchkiss percussion
Read-Parrott	10-pounder Parrott rifle, 2.9-inch caliber or 3-inch Parrott rifle	2.86 inches	8 7/8 inches	8 lb 15 oz	Shell	Wrought iron ring	Parrott percussion, zinc, and paper time fuze
	20-pounder Parrott rifle, 3.62-inch caliber	3.63 inches	10 1/8 inches	18 lb 1 oz	Shell	Brass ring	Parrott zinc fuze plug, paper time fuze
Schenkl	3-inch wrought iron (ordnance) rifle	2.92 inches	9 3/16 inches	8 lb	Shell	Papier-mâché	Schenkl percussion, brass
	20-pounder Parrott rifle, 3.67-inch caliber	3.60 inches	11 3/16 inches	15 lb 6 oz	Shell	Papier-mâché (missing)	Schenkl percussion, brass
Whitworth	12-pounder Whitworth rifle, 2.75-inch caliber	2.71 inches across flats	9 inches	8 lb 8 oz	Case shot - iron segmented interior	None	Threaded fuze missing

WORKSHEET #10 ATTACHMENT: MILITARY MUNITION CHARACTERISTICS

Type	Gun	Diameter	Length	Weight	Construction	Sabot	Fuzing[4]
Civil War Ordnance – Smoothbore Projectiles							
	6-pounder smoothbore, 3.67-inch caliber - cannon	3.56 inches		5 lb 7 oz	Shell	Wooden cup	Confederate copy of the Bormann time fuze
	12-pounder smoothbore, 4.62-inch caliber (i.e., cannon)	4.52 inches		9 lb 4 oz	Shell	Wooden cup (missing)	Bormann time fuze
	24-pounder smoothbore, 5.82-inch caliber - cannon	5.67 inches	Approximately 7 1/4 inches including sabot	20 lb 3 oz	Shell	Wooden cup	Bormann time fuze
	24-pounder Coehorn mortar, 5.82-inch caliber[2]	5.65 inches		16 lb 13 oz	Shell	None	Wooden fuze plug, paper time fuze
Rodman Guns	8-inch, mortar			50 lb			
	10-inch, mortar			102 lb			
	13-inch, mortar			218 lb			
	15-inch, mortar[3]			352 lb			
	20-inch, mortar			750 lb			

Notes:

[1] 8-inch Butler projectile was located near elementary school on West Point. MD in the form of an 8-inch Butler Projectile fragment was also identified south of Storm King Highway, approximately 1000 ft from the Hudson River.

[2] 8-inch Coehorn mortar was located at West Point North Athletic Field near Hudson River.

[3] 15-inch mortar located in training athletic field near Hudson River (West Point).

[4] Fuzes contain trace concentrations of mercury fulminate.

Other Civil War Ordnance – Smoothbore Projectiles

Parrott Guns

Parrott Guns by Size and Munition Size

Model	Length	Weight	Munition	Charge size
2.9-in (10-lb) Army Parrott	73 in	890 lb (400 kg)	10 lb (4.5 kg) shell	1 lb (0.45 kg)
3.0-in (10-lb) Army Parrott	74 in	890 lb (400 kg)	10 lb (4.5 kg) shell	1 lb (0.45 kg)
3.67-in (20-lb) Army Parrott	79 in	1,795 lb (814 kg)	19 lb (8.6 kg) shell	2 lb (0.91 kg)
3.67-in (20-lb) Naval Parrott	81 in	1,795 lb (814 kg)	19 lb (8.6 kg) shell	2 lb (0.91 kg)
4.2-in (30-lb) Army Parrott	126 in	4,200 lb (1,900 kg)	29 lb (13 kg) shell	3.25 lb (1.47 kg)
4.2-in (30-lb) Naval Parrott	102 in	3,550 lb (1,610 kg)	29 lb (13 kg) shell	3.25 lb (1.47 kg)
5.3-in (60-lb) Naval Parrott	111 in	5,430 lb (2,460 kg)	50 lb (23 kg) or 60 lb (27 kg) shell	6 lb (2.7 kg)
5.3-in (60-lb) Naval Parrott (breechload)	111 in	5,242 lb (2,378 kg)	50-lb or 60 lb (27 kg) shell	6 lb (2.7 kg)
6.4-in (100-lb) Naval Parrott	138 in	9,727 lb (4,412 kg)	80 lb (36 kg) or 100 lb (45 kg) shell	10 lb (4.5 kg)
6.4-in (100-lb) Naval Parrott (breechload)	138 in	10,266 lb (4,657 kg)	80 lb (36 kg) or 100 lb (45 kg) shell	10 lb (4.5 kg)
8-in (150-lb) Naval Parrott	146 in	16,500 lb (7,500 kg)	150 lb (68 kg) shell	16 lb (7.3 kg)
8-in (200-lb) Army Parrott	146 in	16,500 lb (7,500 kg)	200 lb (91 kg) shell	16 lb (7.3 kg)
10-in (300-lb) Army Parrott	156 in	26,900 lb (12,200 kg)	300 lb (140 kg) shell	26 lb (12 kg)

Note: MD consisting of a 5.3-inch Parrott Type bottle top and a 10-inch Parrott Type Bottle Top were located south of Storm King Highway, approximately 1000 ft from the Hudson River. MD consisting of a 4.6-inch Parrott Round (Empty) was identified near the West Point Middle School.

Civil War Ordnance – Solid Shot Projectiles (Munition Debris)

Solid shot projectiles (cannonballs) that included no explosive charge could be associated with the majority of weapons systems, and would have the same listed diameter; however, they would be classified as munition debris.

Note: 4.5-inch cannonball (solid shot) and 6-inch cannonball (solid shot) was identified at West Point North Athletic Field near Hudson River. 3.5-inch cannonball (solid shot) and 6-inch cannonball (solid shot) were located south of Storm King Highway, approximately 1000 ft from the Hudson River.

WORKSHEET #11: PROJECT/DATA QUALITY OBJECTIVES

Worksheet #11 is used to document DQOs, which are developed during technical project planning (TPP) sessions. The project DQOs were developed in accordance with the *Guidance on Systematic Planning Using the Data Quality Objectives Process* (EPA QA/G-4) (EPA, 2006a).

11.1 DATA QUALITY OBJECTIVES

DQO Element	DQO Activity Description
1. State the Problem	Site-specific problem statement: Military munitions and MC-related contamination may be present in the Hudson River as a result of live firing activities that occurred from the late 1700s to the early 1900s toward targets in the Hudson River or in surrounding MRSs. Unacceptable risks may be present due to encounters with military munitions in surface and/or subsurface sediment by West Point utility, railroad, maintenance, construction, and maritime workers and recreational users. MC-related contamination in surface and/or subsurface sediment may also present an unacceptable risk to West Point, utility, railroad, maintenance, construction, and maritime workers, recreational users, and ecological receptors.
2. Identify the Goal of the Study	Identify the principal study goal: The goal of the RI is to determine for the separate portions of the Investigation Area the nature and extent of MEC and MC in sediment. The nature of MEC is to be determined through geophysical and follow-on intrusive investigations to identify the specific military munitions present within the Investigation Area. The extent of MEC is to be determined though geophysical surveys and intrusive investigations to achieve a 95% confidence of an extent of 0.5 MEC per acre in the CMUAs and non-CMUAs (based upon anomaly density). The nature and extent of MC will be determined through sediment sampling for select metals (copper, lead, mercury, and zinc) and select explosives (listed in Worksheet #15) at the identified CMUA(s) and at the location of damaged and/or heavily corroded (outer casing failure) individual MEC with visible signs of an MC release (e.g., stained sediment under MEC) or in low visibility scenarios, tactile signs of a potential MC release (e.g., cracks, holes). Sufficient samples will be collected to delineate areas where MC is present higher than both ecological and human screening levels (presented in Worksheet #15) and site-specific background values (to be collected and determined during the RI as described in Section 17.10.2). Post-detonation samples will be collected to confirm whether a release of explosives during detonation events occurred. Once the nature and extent is identified, it must then be determined whether an acceptable or unacceptable risk is present for human receptors from the presence of MEC and whether an acceptable or unacceptable risk is present for human and ecological receptors from the presence of MC (related to munitions activities) in sediment. Additional goals are to collect sufficient data to support a feasibility study (FS), if needed, based upon the investigation results and to update the CSM for each MRS as appropriate based upon the data collected. The FS will be completed once the RI Report is finalized. State how the MEC investigation data will be used in solving the problem: The extent of MEC will be determined by inputting data acquired from combining the NSWCPCD marine SI results, mapping survey results, and geophysical survey results into Visual Sample Plan (VSP) to determine anomaly densities and cluster locations (CMUAs). The nature of MEC will be confirmed during intrusive investigations, based on the type of military munitions identified during the RI. The determination of whether an acceptable or unacceptable risk is present from MEC will be made by identifying and delineating CMUA(s) and determining MEC concentrations within CMUAs and MEC density in non-CMUAs within the Investigation Area.

DQO Element	DQO Activity Description
	State how the MC investigation data will be used in solving the problem: The evaluation of whether an acceptable or unacceptable risk is present from MC (related to military munitions activities) in sediment will be made by determining reference concentrations of metal analytes for comparison with site-specific samples and determining the nature and extent of MC in sediment in any potential CMUA and at the location of damaged and/or heavily corroded (outer casing failure) individual MEC with visible signs of an MC release (e.g., stained sediment under MEC) or in low visibility scenarios, tactile signs of a potential MC release (cracks, holes, etc.). If sample concentrations of analytes exceed the reference concentrations and project action limits (PALs) identified in Worksheet #15 then the sampling area will be expanded, if needed, to determine extent, as detailed in Worksheet #17. To support a potential FS, additional physical characteristics will be analyzed in sediment, including pH, grain size, total organic carbon (TOC), and acid volatile sulfide-simultaneously extracted metals (AVS-SEM) for cadmium, copper, lead, mercury, nickel, silver, and zinc, if needed, to assess bioavailability of lead if ecological PALs are exceeded. It is noted that given that MC impacts are not anticipated, performing additional Baseline Ecological Risk Assessment sampling is not part of the current scope of work. In the unlikely event that environmental impacts are identified, additional sampling would be scoped as part of a separate investigation, which would be scoped in coordination with the NYSDEC.
3. Identify Information Inputs	Updated CSM based on previous studies: RI objectives, site histories/uses, Investigation Area boundaries, types/quantities of munitions, MEC distribution, MEC incident reports, topography/geology/vegetation, and current and future use/receptors/exposure/access (see Worksheet #10). NSWCPCD marine SI results: SAS- and MAG-identified anomaly locations and densities. Mapping survey results, including: ▪ Multibeam bathymetry results ▪ Side Scan Sonar (SSS) surveys to supplement the marine SI results Digital Geophysical Mapping (DGM) survey results, including: ▪ Areas covered ▪ System QC test results ▪ Instrument Verification Strip (IVS) results ▪ Anomaly detections and responses Data synthesis results, including: ▪ Anomaly density/cluster maps ▪ Locations of CMUAs and non-CMUAs ▪ Anomaly locations selected for intrusive investigation ▪ Unique anomaly identification numbers Intrusive investigation results, including: ▪ Excavation results (database) ▪ MEC sensitivity ▪ Photos ▪ Disposal records ▪ Results of the MEC Risk Assessment using the MEC Risk Management Matrices ▪ Final MEC CSM MC Sediment Sampling Plan Inputs, including: ▪ PALS identified in Worksheet #15. ▪ NYSDEC Screening and Assessment of Contaminated Sediment guidance (NYSDEC, 2014) ▪ DoD Environmental Field Sampling Handbook, Revision 1.0, April 2013 (DoD, 2013)

DQO Element	DQO Activity Description
	MC sediment sampling results, including: ▪ Laboratory and analytical results for potential MC: select explosives and select metals (copper, lead, mercury, and zinc) using laboratory analytical methods shown in Worksheet #12. ▪ Descriptive statistics, reference area upper tolerance limits, and hypothesis testing outcomes. ▪ Laboratory and analytical results for physical characteristic sampling (pH, grain size, TOC), and AVS-SEM) using laboratory and analytical methods shown in Worksheet #23. ▪ Results of a human health risk assessment and a screening level ecological risk assessment. ▪ Final MC CSM
4. Define the Boundaries of the Study	Target population: The initial **MEC target population** for MEC is the entire Investigation Area, which is defined as Siege Battery–TD River MRS, Battery Knox–TD River MRS, Area A, and Area B. The characteristics of the MEC types anticipated based on review of historical records and previous investigations are listed in the Worksheet #10 Attachment. Based on this target population, the smallest military munition anticipated will be based on a 3-inch projectile, and the military munition with the greatest fragmentation radius is the 15-inch cannonball. MEC is most readily accessible in surface (0-0.5 ft bgs) sediments, but intrusive activities may cause contact with MEC below this depth, if present. The MEC types and horizontal extent is to be determined through geophysical surveys and intrusive investigations to achieve desired confidence levels. The vertical extent of MEC is to be determined through geophysical surveys and confirmed during the intrusive investigation. Intrusive investigations may be supported by using a remotely operated vehicle (ROV) and other existing data. Investigations will not be conducted below 120 ft bgs in accordance with DoDM 4715.20. Geophysical survey MEC data will be collected from evenly spaced transects that cover the initial MEC target population (entire Investigation Area) determined using VSP. The data will be merged into one dataset and evaluated to identify CMUAs. The subsequent MEC target populations will consist of each potential CMUA, plus the balance of the Investigation Area (non-CMUA area). Each CMUA and the non-CMUA area will be evaluated using ROV/side-scan sonar and intrusive investigation to determine the nature and extent of MEC. During the investigation, if it is determined that MEC extends outside the Investigation Area, the investigation will continue outside of the Investigation Area footprint to determine the extent of contamination. The final dataset will be evaluated to make decisions for each target population. The MC associated with the munitions used in the Investigation Area include copper, lead, mercury, zinc, 2-amino-4,6-dinitrotoluene (2-Am-DNT), 4-amino-2,6-dinitrotoluene (4-Am-DNT), 2,4-dinitrotoluene (2,4-DNT), 2,4,6-trinitrotoluene (2,4,6-TNT), 2,6-dinitrotoluene (2,6-DNT), RDX, PETN, and nitroglycerin. **Target populations for MC** are identified horizontally as the CMUA(s) extent, and vertically as separate populations at depths of 0-0.5 ft bgs, and 0.5-1 ft bgs. Decisions will be made on each CMUA based on sampling described in Worksheet 17.10. 3. In addition, the non-CMUA area will consist of target populations at each reacquired anomaly where a damaged and/or heavily corroded MEC item with visible or tactile signs of an MC release is identified from intrusive activities. Decisions will be made on the non-CMUA area based on each of these damaged items and the results of biased sampling to determine horizontal extent and vertical extent as separate populations from 0 – 0.5 ft bgs, and 0.5-1 ft bgs. The need for collection of sediment samples from depths below 1.0 ft bgs for CMUAs and non-CMUA individual damaged MEC and/or MPPEH, if MC concentrations are detected

DQO Element	DQO Activity Description
	higher than reference concentrations and higher than the PALs, will be discussed with USACE, USAEC, West Point, and NYSDEC. An MC technical memorandum will be drafted, if needed, to detail the additional sampling that may be required. If sampling below 1 ft bgs is performed, this will be considered subsurface sediment and will be combined with the 0.5 to 1 ft bgs dataset. Another **target population will be the reference area** to determine background concentrations of metals in the river sediment, including data from 0 to 0.5 ft bgs (and 0.5 to 1 ft bgs and 1 to 2 ft bgs, if needed and if possible based on the thickness of the sediments) and an 8.85-acre sampling grid area (see Worksheet 17.10.2 for more details). The MC data for each CMUA and the non-CMUA area (where sampling is performed) will be evaluated by comparison to background and PALs as well as a risk assessment, and the results of the evaluation will be used for recommendations of no further action or for evaluation in an FS for each target population. 7-point composite samples will be collected from 0-0.5 ft bgs in detonation area and analyzed for explosives. The maximum concentration detected will be compared to the ecological and human health screening levels in Worksheet #15. Characteristics of interest: The characteristics of interest are features indicative of individual military munitions, clusters of items, target debris (e.g., target barges), and any other feature potentially related to past military munition usage. Of interest is also the density of munition-related items for the determination of CMUA or non-CMUA and the sensitivity of military munitions as an input for the MEC Risk Assessment. Spatial and temporal boundaries: The total Investigation Area is approximately 1,138 acres within the Hudson River. The horizontal boundaries of the Investigation Area are the extent of the Siege Battery and Battery Knox range fan boundaries within the mean high tide of the Hudson River as shown on **Figure 10-2.** The total study area will extend beyond the Investigation Area boundary, in order to determine the extent of MEC and MC, as detailed in Worksheet #17. The vertical depth boundary will be at depth within the Hudson River, but less than 120 ft per DoDM 4715.20. The sediment depth will vary based upon the estuary environment of the Hudson River consisting of depositional areas, dynamic areas and areas of erosion. Within erosional/scouring areas, military munitions may be detected on bedrock/sediment surface. Whereas within depositional areas, military munitions may be detected at a depth of several ft within the sediment. The vertical depth boundary within sediment will be constrained by the detection depth of the underwater handheld magnetometer utilized by the divers and the potential intrusive penetration depth within sediment. The horizontal extent of a CMUA MC sampling area will depend upon the size of any potential CMUA and will vary based upon the extent of potential contamination that might require step-out sampling. The extent of the reference area will be 69 yard by 69 yards (63 x 63 meters). The sediment sample locations will be sampled from 0 to 2 ft depth interval to determine vertical extent. The sediment core will be subsampled from the 0 to 0.5 ft, 0.5 to 1 ft, and 1 to 2 ft intervals (if possible based on the thickness of the sediments). If the 1 to 2 ft interval sample concentrations exceed the reference concentrations and the PALs, then an MC technical memorandum will be drafted, if needed, to detail the additional sampling that may be required to determine vertical extent.

DQO Element	DQO Activity Description
5. Develop the Project Data Collection and Analysis Approach	VSP software was used to support the investigation strategy and design survey transects. Mapping surveys utilizing the pre-planned transects and consisting of multibeam bathymetry and SSS will be conducted to provide topography and morphology of the riverbed to safely and effectively plan the underwater DGM surveys. DGM surveys utilizing the pre-planned transects and consisting of the Transverse Marine Gradiometer (TVG) will be conducted to provide the data density necessary for detection of CMUAs and non-CMUAs. The results from NSWCPCD marine SI, mapping survey results, and DGM survey will be combined to identify anomalies. Ten percent (%) of the features of interest identified in the combined NSWCPCD marine SI and SSS dataset will be identified for reacquisition and investigation. A selection of the anomalies identified as being located within a CMUA and non-CMUA (based upon anomaly density) will be intrusively investigated to achieve a 95% confidence of less than 0.5 MEC per acre in the CMUAs and non-CMUA. Selected anomalies will be reacquired and intrusively investigated during dive operations or assessed by a remotely operated vehicle (ROV), depending on water depth and river conditions. Sediment sample locations will be selected based up whether a CMUA is present and whether individual MEC or MPPEH item(s) are identified as damaged and/or heavily corroded (outer casing failure) with visible signs of an MC release (e.g., stained sediment under MEC) or in low visibility scenarios, tactile signs of a potential MC release (cracks, holes, etc.). The selected sediment samples will be analyzed for select metals (copper, lead, mercury, and zinc) and select explosives physical characteristic sampling (pH, grain size, TOC), and AVS-SEM, if needed, to assess bioavailability of lead if ecological PALs are exceeded. Statistical analyses will be conducted consisting of summary descriptive statistics, graphical examination of box plots and quantile-quantile plots, distribution goodness-of-fit tests, and estimation of 95% upper tolerance limits. Also, reference datasets may be used in hypothesis testing to determine whether potentially affected site median concentrations are statistically significantly different from reference area median concentrations. Comparisons of central tendency or position and hypothesis tests, such as Student's-t test, Mann-Whitney (Wilcoxon Rank Sum), or Kruskal-Wallis tests, may be conducted. The project approach involves several primary components: mapping survey, DGM detection surveys, data synthesis and anomaly investigation (dive operations or ROV), as well as MC sampling. Decision rules for these components are listed as follows: Parameters of interest: Measurements with a response amplitude and a signal-to-noise ratio (SNR) as identified in the IVS Report. Type of inference: Measurements meeting the criteria noted above will be considered to be potentially munition related and selected as anomalies for further evaluation during the anomaly investigation. MEC decision rules: ▪ IF CMUAs are likely present within the Investigation Area, THEN implement a SSS, multibeam bathymetry, and DGM-based transect approach at 250-ft spacing designed by VSP to traverse and detect a target area/CMUA based on a 3-inch projectile or larger at a 95% probability of detection. ▪ IF anomaly clusters are present based on VSP analysis, THEN selected anomalies along the DGM transect surveys, within the anomaly cluster, will be chosen for investigation to determine if they are munitions related and represent a CMUA.

DQO Element	DQO Activity Description
	▪ IF CMUAs are detected and delineated, THEN CMUAs and non-CMUAs will be characterized to determine if there are less than or equal to 0.5 MEC/acre at a 95% confidence level. ▪ IF CMUAs are identified, THEN the nature of MEC will be evaluated through intrusive investigation and inspection. This information will be used to update the CSM(s) for the potential source areas. ▪ In accordance with the PWS and DoDM 4715.20IF, investigations will not be conducted below 120 ft bgs. IF depths greater than 120 ft are encountered, THEN work will stop and the transect will be picked up once the depth is 120 ft or less. Data will be extrapolated from transects surrounding the area with depths greater than 120 ft. ▪ IF MEC is recovered, THEN it will be documented, photographed, and disposed. ▪ IF MEC is identified, THEN a MEC Risk Assessment using the MEC Risk Management Matrices will be performed to determine if the CMUA and/or non-CMUA has an acceptable or unacceptable risk to human receptors. The 3 January 2017 "Trial Period for Risk Management Methodology at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects" Memorandum is included in **Appendix E.** MC decision rules: ▪ IF a CMUA is identified, THEN MC sampling at 0 to 0.5, 0.5 to 1 ft, and 1 to 2 ft intervals (and in 1 ft bgs increments as required to delineate the vertical extent of contamination) will be conducted at the locations of anomalies identified for intrusive investigation to determine the nature and extent of potential contamination in sediment related to past military munition activities, including all items identified as damaged and/or heavily corroded (outer casing failure) with visible signs of an MC release (e.g., stained sediment under MEC), or in low visibility scenarios, tactile signs of a potential MC release (e.g., cracks, holes). The nature and extent of contamination will be defined based on the concentration of analytes exceeding both the PALs and the reference UTL concentrations presented in Worksheet #15. IF both the PALs and the reference UTL concentrations are exceeded, THEN a statistical evaluation of the results against the reference concentrations based on Student's-t test, Mann-Whitney (Wilcoxon Rank Sum), or Kruskal-Wallis tests as appropriate may be performed. ▪ IF an individual MEC or MPPEH item is identified in a non-CMUA area as damaged and/or heavily corroded (outer casing failure) with visible signs of an MC release (e.g., stained sediment under MEC), or in low visibility scenarios, tactile signs of a potential MC release (e.g., cracks, holes), THEN sampling will be conducted at 0 to 0.5, 0.5 to 1 ft, and 1 to 2 ft intervals to determine the nature and extent of potential contamination in sediment related to past military munition activities. Nature and extent of contamination will be defined based upon concentration of analytes exceeding both the PALs and of the reference UTL concentrations presented in Worksheet #15. IF the PALs and reference UTL concentrations are exceeded, a statistical evaluation of the results against the reference concentrations based on Student's-t test, Mann-Whitney (Wilcoxon Rank Sum), or Kruskal-Wallis tests as appropriate may be performed. ▪ IF sample concentrations from the 0 to 0.5 ft interval are determined to exceed both the PALs and the reference UTL concentrations and are statistically evaluated and found to be higher than reference concentrations, THEN samples from the 0.5 to 1 ft interval will be analyzed for select metals and explosives. ▪ IF sample concentrations, within the CMUA or for individual MEC in non-CMUA, are determined to exceed both the PALs and the reference UTL concentrations and are statistically evaluated and found to be higher than reference concentrations, it will be concluded that an MC or MEC release to the environment has occurred and THEN step-out sampling may be conducted, if needed, to determine extent (both vertical and horizontal). The need for step-out sampling will be discussed with USACE, USAEC, West Point, and NYSDEC. An MC technical memorandum will be drafted, if needed, to detail the

DQO Element	DQO Activity Description
	additional sampling that may be required. ▪ IF sample concentrations, within the CMUA or for an individual MEC, are detected less than the PALs and reference UTL concentrations or are confirmed to not statistically exceed reference concentrations, THEN the CMUA or individual MEC location will not be identified as an MC or MEC release to the environment. ▪ IF lead significantly exceeds both background and ecological PALs, THEN sediment samples will be submitted for AVS-SEM analyses, to be selected based on sample lead concentrations and sediment characteristics results. Additional volume of sediment required for AVS-SEM analysis will be collected at the same time as the sample aliquots for physical parameters (TOC, pH and grain size) and held pending lead analysis results. ▪ IF sample concentrations exceed both the PALs and the reference UTL concentrations or are confirmed to not statistically exceed reference concentrations, THEN a risk assessment (Human Health and Screening Level Ecological) will be performed to determine if the MC risk is acceptable or unacceptable. ▪ IF an unacceptable risk related to MC identified, THEN an FS will be recommended for the extent of the area presenting an unacceptable risk. ▪ IF concentrations of explosives in the post-detonation area samples are greater than the human health or ecological screening levels in Worksheet #15, THEN the soils/sediments will be removed and a confirmation sample collected. This process will be repeated until the concentrations are below the screening levels. ▪ IF the concentrations of explosives in the post-detonation area samples are less than the human health or ecological screening levels in Worksheet #15, THEN no further action for the detonation areas is required.
6. Specify Performance or Acceptance Criteria	Project-specific Measurement Performance Criteria (MPCs) are presented in Worksheet #12. Project-specific MPCs are the criteria that collected data must meet to satisfy the DQOs. Failure to achieve the MPCs may have an adverse effect on end uses of the data. Military Munitions Investigation MPCs: ▪ Specific MPCs are presented in Worksheet #12A. ▪ Updates to MPCs may be made based on IVS results. MC Investigation MPCs: ▪ Overall, the baseline condition for MC during the RI is “MC is present at concentrations that present and unacceptable risk to receptors” that is characteristic of the types of munitions historically used at the MRSs, whereas the alternative condition is “MC is not present and/or not present at levels representative of adverse risk.” The vertical and horizontal extent of all suspected MC as necessary based on the presence of a CMUA or MEC items found to be damaged and/or heavily corroded or associated sediment staining will be determined prior to rejecting the baseline condition. If MC is present at concentrations higher than reference concentrations and the PALs, additional sampling will be performed as necessary to determine the vertical and horizontal extent of contamination. ▪ Conclusive data indicating that no MC is present at concentrations that present an unacceptable risk will be obtained prior to rejecting the baseline condition. ▪ If MC is present at levels higher than site-specific PALs and reference concentrations, then a risk assessment (human health and ecological) will occur. ▪ MC characterization performance and acceptance criteria during sample collection and analytical data processing will rely on the DoD QSM acceptance criteria for analytical samples, and high-quality objectives for precision, accuracy, representativeness, comparability, completeness and sensitivity detailed in Worksheet #37. Chemical data will be compared to site-specific reference concentrations and the PALs listed in in Worksheet #15. The laboratory reporting limits will be sufficiently low to achieve the PALS as shown in the tables in Worksheet #15.

DQO Element	DQO Activity Description
	Laboratory analytical data will be generated by a DoD Environmental Laboratory Accreditation Program (ELAP) laboratory using EPA test methods. Laboratory Standard Operating Procedure (SOPs) are summarized in Worksheet #23 and are presented in **Appendix I**. Laboratory certifications are presented in **Appendix I.** Laboratory Data Consultants will provide electronic data deliverables (EDDs). WESTON will provide an EDD deliverable to USACE at the completion of the project. Specifically, the null hypothesis (H_0) is: Sediment sample concentrations for select metals and explosives at the West Point MRSs exceed the PALs and/or reference concentrations and warrant further evaluation. The alternative hypothesis (H_a) is as follows: Sediment sample concentrations for small arms metals and explosives at the West Point MRSs do not exceed the PALs and reference concentrations and do not warrant further evaluation. The false positive decision error occurs when H_0 is erroneously rejected corresponding to decision error I. The false negative decision error occurs when H_a is erroneously accepted corresponding to decision error II. Project-specific Type I and II error rates are 0.05 and 0.2, respectively.
7. Develop the Plan for Obtaining Data	<u>Design for collection of data that will meet project-specific MPCs</u>: Steps 1 through 5 of the DQO process were used to determine the overall project design and the MPCs developed during Step 6. The MPCs determined during Step 6 (see Worksheet #12) were used to develop the MEC investigation design, which is described in Worksheet #17 and the MC sampling design, which is described in Worksheets #17 and 18. The MC sampling design and assessment parameters will be based on MEC investigation findings, and the analytical results will be compared to project screening levels, set equivalent to the PALs listed in Worksheet #15 and reference concentrations. The investigation design is broken down into a series of specific processes and data collection steps, termed DFWs.

WORKSHEET #12A: MEASUREMENT PERFORMANCE CRITERIA FOR MEC-RELATED TASKS

Measurement Performance Activity (or DFW)	Data Quality Indicator	Specification	Activity Used to Assess Performance
Instrument Verification Survey (IVS)	Accuracy/ Completeness	Derived target positions are within 0.25 meters (m) of the underwater truth location.	Initial and ongoing function tests and IVS surveys, IVS SOP
Mapping Survey (Bathymetry and SSS)	Accuracy/ Completeness	100% of the accessible portions of the MRS is mapped by the transect survey.	Verification of conformance to MQOs for transect spacing and coverage
Detection Survey (DGM)	Completeness	100% of the accessible portions of the MRS is surveyed.	Verification of conformance to MQOs for transect spacing and coverage
Detection Survey (DGM)	Sensitivity	The Geometrics Transverse Marine Gradiometer (TVG) preliminary detection threshold will be set to detect a 3-inch projectile at a depth of 2 ft bgs. The detection threshold will be determined in the IVS Report.	Initial and ongoing function tests and IVS surveys, analysis of background variability across the Investigation Area
Detection Survey (DGM)	Completeness/ Comparability	Complete data processing and create target lists.	Data verification/data validation
Intrusive Investigation	Accuracy	100% reacquiring of anomalies identified for investigation (from mapping survey or detection survey target list).	Visual inspection of recovered items
MEC/MPPEH Management	Accuracy	If MPPEH is encountered, only UXO-qualified personnel (UXO Technician II or above) will perform identification of the item and ascertain its condition. The SUXOS and UXOSO must be in agreement on the nature and condition of a MEC item before any action is taken.	Joint SUXOS and UXOSO determination that a MEC item is acceptable to move. After determining an item is acceptable to move, the SUXOS and UXOSO will determine the most expeditious route for safe movement of the MEC item to the disposal point. UXOQCS verifies that MDAS is properly documented in a DoD Form 1348-1A.
Material Documented as Safe (MDAS) Management	Accuracy	If MDAS is encountered, only UXO-qualified personnel (UXO Technician II or above) will perform identification of the item and ascertain its condition. The SUXOS and UXOSO must be in agreement on the nature and condition of a MDAS item before any action is taken.	UXOQCS verifies in a DoD Form 1348-1A that MDAS is properly documented and disposed of.

WORKSHEET #12B: MEASUREMENT PERFORMANCE CRITERIA FOR MC-RELATED TASKS

Measurement Performance Criteria (MPC) for field QC sampling results are used to evaluate project Data Quality Indicators (DQIs) such as accuracy/bias and precision. The intent of the UFP-QAPP is to provide a definition for the different laboratory and field blanks that will be used as QC measures to evaluate the DQIs. In addition, field QC samples and the DQIs to be used for the MC sediment sampling to support the RI within the Investigation Area are summarized in Worksheet 12-1.

12.1 EQUIPMENT RINSATE BLANKS

An equipment rinsate blank (i.e., “decontamination rinsate” or “equipment rinsate”) consists of a sample of deionized water poured over or through decontaminated field sampling equipment that is considered ready to collect or process an additional sample. Equipment rinsate blanks will be collected from non-dedicated sampling equipment to assess the adequacy of the decontamination process.

The only non-dedicated sampling equipment is the Wildco® corer used for the sediment sampling. The Wildco® corer will be fitted with a disposable polycarbonate liner and secured by the nosepiece at each sampling location. However, the nosepiece and barrel will be decontaminated between sampling areas (i.e., CMUA or reference area) by washing with a bottle brush using a Liquinox/water solution and rinsing with deionized water. Equipment rinsate blanks will be collected after the full equipment decontamination between discrete sampling areas and at a frequency of one per 20 samples collected using the coring device.

Samples collected directly with a polycarbonate liner without the use of the Wildco® corer will not be included in the count tracking the required equipment rinsate blank sampling frequency.

To collect an equipment rinsate blank sample, the source water will be poured over and/or through the decontaminated sampling equipment. The runoff water will be collected into the sample containers directly or with the use of a funnel, if necessary. Results of equipment rinsate blank samples will be used to evaluate whether equipment decontamination was effective.

At a minimum, equipment rinsate blank samples will be collected at a rate of one per each sampling event or one per 20 samples collected with non-dedicated sampling equipment, whichever is more frequent. The equipment rinsate blank samples will be analyzed for the same parameters as the field samples that were collected using that piece of equipment. If analytes pertinent to the project are detected in the equipment rinsate blanks, then the frequency of equipment rinsate blank samples may be increased after decontamination procedures have been modified to further evaluate the effectiveness of the decontamination procedure. Equipment blanks should not contain concentrations greater than one-half the Limit of Quantitation (LOQ) for analytes of interest. Detections in the equipment blank and their possible impacts on the investigation are evaluated on a site-specific basis.

When disposable or dedicated sampling equipment is used, equipment rinsate blank samples do not need to be collected (i.e., disposable polycarbonate liners for sample collection by itself without the Wildco® corer, disposable paint tray liners, plastic scoops).

12.2 TEMPERATURE BLANK

A temperature blank is a container of water that is packed and shipped to the laboratory with the field samples requiring preservation by cooling to ≤ 6 degrees Celsius (°C). Upon arrival of the samples, the laboratory measures the temperature of the blank. The temperature reading is used to represent the conditions of the field samples during shipment to the laboratory. The information is used by both the laboratory and by the data validator. One temperature blank will be included with each cooler shipped to the laboratory. If the temperature blank exceeds the criterion of less than 2°C or greater than 6°C, then the laboratory must notify the WESTON MC Technical Manager or Project Chemist immediately for guidance. Samples received by the laboratory on the same day as collection may not have adequate time to achieve ideal preservation temperatures. However, by providing the laboratory notes as evidence that the preservation process is underway during sample receipt, e.g., solid ice remaining in the cooler, data quality will not be impacted.

12.3 FIELD DUPLICATES

A field duplicate is a generic term for two field samples collected at the same time in the same location. They are intended to represent the same population and progress through the steps of the analytical preparation and analysis process in an identical manner to provide precise information concerning the data collection activity. There are two categories of field duplicate samples defined by the collection method: co-located field duplicates and subsample field duplicates. Co-located field duplicates are independent samples collected from side-by-side locations at the same point in time and space so as to be considered identical. Co-locates are samples collected from adjacent locations or liners (e.g., laterally or vertically, in separate containers) at the same time that have not been homogenized. Subsample field duplicate samples are obtained from one sample collection at one sample location.

Sediment duplicate samples for the program will consist of subsample field duplicates that will be homogenized and subsampled in the field to form an original and duplicate sample. Field duplicates will be collected at a rate of 10% (1 per 10) of field samples.

12.4 ANALYTICAL METHOD BLANK

The analytical method blank is an analyte-free matrix in which reagents are added in the same volumes or proportions as used in sample processing, and the sample is carried through the complete sample preparation and analytical process. The purpose of the sample is to document contamination resulting from the analytical process. A method blank shall be included in every analytical batch.

The detection of analytes in a method blank must not exceed the limits of detection (LOD). A CA shall be performed to eliminate the source of contamination prior to proceeding with analysis. After the source of contamination has been eliminated, the samples in the preparation batch shall be re-prepared and re-analyzed. Analytical data are *not* corrected for the presence of analytes in blanks. When an analyte is detected in the method blank and in the associated samples and CAs are not performed or are ineffective, the appropriate validation qualifier shall be applied to the sample results.

12.5 LABORATORY CONTROL SAMPLE/LABORATORY CONTROL SAMPLE DUPLICATE

Laboratory control samples (LCSs) and laboratory control sample duplicates (LCSDs) are analyte-free water (for aqueous analyses) or reagents and glassware only (for sediment analysis) spiked with the target analytes of interest for each analytical method. The LCS and LCSD are analyzed to assess general method performance through the laboratory's ability to recover analytes from a control matrix. The spiking level must be greater than the lowest concentration standard used for calibration and less than or equal to the midpoint of the linear range calibrated. The LCS/LCSD results are evaluated in conjunction with other related QC information to determine the acceptability of the data generated for the associated samples.

The LCS/LCSD shall be carried through the complete sample preparation and analysis process. The LCS/LCSD cannot be used as the continuing calibration verification (CCV). One LCS/LCSD shall be included in every analytical batch. The performance of the LCS and LCSD is evaluated against the QC acceptance limits provided in the DoD *Quality Systems Manual (QSM) for Environmental Laboratories,* Version 5.1, January 2017. Whenever an analyte in an LCS/LCSD is outside the acceptance limit, a CA will be performed. After the system problems have been resolved and system control has been reestablished, the samples in the analytical batch shall be re-analyzed for only the out-of-control analyte(s). When an analyte in an LCS/LCSD exceeds the upper or lower control limit, and no CA is performed or the CA was ineffective, the appropriate validation qualifier will be applied to the affected results.

12.5.1 Laboratory Duplicate Samples

Laboratory duplicates are repeated but independent determinations of the same sample, by the same analyst, at essentially the same time, and under the same conditions. Duplicate samples are obtained by splitting a field sample into two separate aliquots and performing two separate analyses on the aliquots. The analysis of laboratory duplicate samples monitors precision; however, it may be affected by sample inhomogeneity, particularly in the case of nonaqueous samples. Laboratory duplicates will be run and reported for inorganic analyses only. A laboratory duplicate will be run for every 20 (or less) field samples. Laboratory duplicate analyses are not performed for analytical methods that have matrix spike/matrix spike duplicate (MS/MSD) results.

12.6 MATRIX SPIKES/MATRIX SPIKE DUPLICATES

The MS and MSD are used to access the performance of the method as applied to a particular matrix. MS/MSDs are aliquots of samples spiked with known amounts of target analytes. The spiking occurs in the laboratory prior to sample preparation and analysis. The spiking level must be greater than the lowest concentration standard used for calibration and less than or equal to the midpoint of the linear range calibration.

A minimum of one MS sample and one MSD sample will be collected per 20 site samples per matrix collected. Sampling locations selected for the purpose of assigning an MS/MSD should be in an area anticipated to be free from contamination or with low concentrations of targeted analytes. During the acquisition of sediment MS/MSD samples, field personnel will avoid areas that are stained or known to have high levels of targeted materials.

Only site-specific samples shall be used for spiking. The MS/MSD is designated on the chain-of-custody (COC). The MS/MSD is used to document the bias of a method due to sample matrix. The sample results are not used to control the analytical process. The acceptance criteria for the MS and MSD are evaluated against the QC acceptance limits developed during the DQO development process. If performance is not being confirmed by the MS/MSD samples, then the analytical procedures and methods must be re-evaluated for appropriateness and correctness. For example, clean-up procedures may be needed to remove matrix interferences. The results of the matrix spike analyses are used in conjunction with the LCS analyses to assess laboratory accuracy.

12.7 SURROGATE SPIKES

Surrogates are organic compounds similar to the target analyte(s) in structure and chemical behavior in the analytical process, but that are not normally detected in environmental samples. The surrogate results are used to evaluate accuracy, method performance, and extraction efficiency. The surrogate compounds are spiked in environmental samples, control samples, and blank samples in accordance with the method requirements. The surrogate should be spiked at a concentration less than or equal to the midpoint of the linear range calibrated.

When the acceptance criterion of a surrogate recovery is not met, CA must be performed. After the system problems have been resolved and system control has been re-established, the sample is re-prepared and re-analyzed. If CAs are not performed or are ineffective, then the appropriate validation qualifier shall be applied to the sample results.

12.8 INTERNAL STANDARDS

Internal Standards are known amounts of specific compounds added after preparation or extraction of a sample. The compounds are used in an Internal Standard calibration method to correct sample results affected by column injection losses, purging losses, or viscosity effects. Internal Standards can also be used to correct for elemental or inorganic matrix interferences for inductively coupled plasma-mass spectrometry (ICP-MS) (metals) or high performance liquid chromatography (HPLC) tandem MS (MS/MS). Internal Standards will be added to environmental samples, control samples, and blanks in accordance with the method requirements.

When the Internal Standard results are outside of the acceptance limits, CAs will be performed. After the system problems have been resolved and system control has been reestablished, the samples analyzed while the system was malfunctioning shall be re-analyzed. If CAs are not performed or are ineffective, then the appropriate validation qualifier shall be applied to the sample results.

12.9 INTERFERENCE CHECK SAMPLE

The interference check sample (ICS), used in inductively coupled plasma (ICP) analyses only, contains both interfering and analyte elements of known concentrations. The ICS is used to verify background and inter-element correction factors and is run at the beginning and end of each run sequence.

When the ICS results are outside the acceptance limits as prescribed in the method, CA will be performed. After the system problems have been resolved and system control has been re-established, the ICS will be re-analyzed. If the ICS result is acceptable, then the affected samples will be re-analyzed. If CA is not performed or the CA was ineffective, then the appropriate validation qualifier shall be applied to the affected results.

12.10 DATA QUALITY

QC procedures are employed during chemical analysis to support and document the attainment of established method quality objectives. Whether or not the QC procedures support an assessment of general batch control or matrix-specific application, documentation includes calculating DQIs to verify data usability and contract compliance. DQIs (also referred to as parameters of precision, accuracy, representativeness, comparability, completeness, and sensitivity [PARCCS]) are established during the DQO development process. The basis for assessing each of the elements of data quality is discussed in the following sections.

12.10.1 Precision

Precision is the degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves. Precision is usually expressed as standard deviation, variance, percent difference (%D), or range, in either absolute or relative terms. Precision data indicate how consistent and reproducible the field sampling or analytical procedures have been.

Field duplicate precision is evaluated by calculating a relative percent difference (RPD) using the following equation:

$$RPD = |(D1-D2)/\{1/2(D1+D2)\}| \times 100$$

Where:

D1 = original sample concentration
D2 = duplicate sample concentration

The RPD measurement criteria are provided in Worksheet #12B.

If more than two field duplicate samples are collected from adjacent locations and analyzed, then they are referred to as co-located field replicates. If two or more aliquots of the same sample are prepared and analyzed by the laboratory, then these are referred to as laboratory replicates. Precision of replicate samples is evaluated by calculating the relative standard deviation (RSD) using the following equation:

$$\%\text{RSD} = \frac{\sqrt{\dfrac{\sum_{i=1}^{i=n}\left|D_i - \overline{D}\right|^2}{n}}}{\overline{D}}$$

Where:

D_i = the individual sample concentrations
D = the mean of n values
n = the total number of values

Possible causes of poor precision include sample heterogeneity, improper sample collection or handling, inconsistent sample preparation, and/or poor instrument stability.

12.10.2 Accuracy

Accuracy is the degree of agreement of a measurement, or average of measurements, with an accepted reference or “true” value, and is a measure of bias in the system. The accuracy of measurement data will be assessed and controlled through the use of LCSs and LCS duplicates (LCSDs), surrogate spikes, Performance Evaluation (PE) samples, and site-specific MS/MSD samples.

Results for LCS and surrogate spikes will be the primary indicators of accuracy. The results will be used to control accuracy within acceptable limits for definitive-level data. PE samples will provide information on how accurately the laboratory can analyze for a specific analyte using a selected method. Field-designated MS/MSD samples will be employed for applicable methods to identify matrix-associated analytical influences or interferences that may affect the accuracy of the analytical data. As spiked samples are analyzed, spike recoveries will be calculated and compared to pre-established acceptance limits.

Accuracy/bias is:

$$\text{MS \% recovery} = \frac{\mathit{conc.\ of\ sample\ plus\ spike} - \mathit{conc.\ of\ unspiked\ sample}}{\mathit{value\ of\ spike\ added}}\, x\, 100$$

$$\text{LCS target / surrogate \% recovery} = \frac{\mathit{measured\ concentration}}{\mathit{true\ concentration}}\, x\, 100$$

Trip blanks, field blanks, and equipment blanks will be used to monitor accuracy/bias by detecting concentrations of analytes in sediment samples and equipment blank rinsate samples that were originally contaminant-free and comparing the concentrations to the field sample results.

12.10.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

The following factors were developed to ensure representativeness for the MC dataset.

- The degree of homogeneity of the sediment across the Investigation Area and reference area will be assessed as determined by analysis of physical parameters (grain size, TOC) and physical observations recorded during sampling (e.g., sediment color; presence of fines, rocks, non-munition related debris [NMRD], and/or organic materials noted). Homogeneity will also be assessed by review of the precision criteria, specifically the RPD results of replicate MC results for replicate sediment samples. Accuracy criteria will also be used, specifically the MS/MSD recovery data, since these recovery data identifies matrix-associated analytical influences. Homogeneity will also be assesses by evaluating the spread of the data (e.g., maximum, minimum, standard deviations) obtained from calculating the statistics of the target population datasets.
- Physical observations will also be used to evaluate whether the results are representative of military munitions activities or whether other factors were present that may have impacted the results.
- Consistency will be maintained in applying field and sampling procedures to ensure representativeness. For example, the Wildco® corer and corer sleeves will be of consistent width and depth, and sampling procedures will be reviewed by the sampling team prior to mobilization in the field, and sampling will be performed by experienced and trained personnel. Geophysical procedures will be performed by trained and experienced personnel and will follow the project procedures and specific QC steps. In addition, any necessary changes to field procedures and differences in sample recoveries will be recorded and assessed.
- To represent a characteristic of the population, sediment samples will be collected from beneath the different MEC types identified during the investigation, to the extent different types are identified. Sediment sampling locations are selected to represent the areas potentially impacted by MEC for each target population (CMUA and non-CMUA, as described in Worksheet 11), and based on the presence of damaged and/or heavily corroded (outer casing failure) individual MEC items with visible signs of an MC release (e.g., stained sediment under MEC), or in low visibility scenarios, tactile signs of a potential MC release (e.g., cracks, holes). In addition, a sufficient number of samples are to be collected in each target population (see Worksheet 11 and 17.10) to ensure representativeness.

- To maximize representativeness of the data, sampling techniques, sample size, and sample locations within the reference area (Worksheet 17.10.2) are carefully selected to produce samples that are representative of the conditions within each target population.

Sediment samples are generally less homogeneous than water samples; therefore, the sampler and analyst will exercise good judgment when collecting sediment samples or preparing sediment samples for analysis. Samples exhibiting stratification, lithologic changes, or obvious lack of homogeneity will not be used as duplicates. At the laboratory, measures shall be taken to collect aliquots for analysis that are representative of the whole sample. The measures include premixing the sample and discarding large stones or debris from sediment samples.

12.10.4 Comparability

Comparability is the degree to which one dataset can be compared to another dataset measuring the same property. Comparability is assured through the use of established and approved sample collection techniques and analytical methods, consistency in the basis of analysis (dry weight, volume), consistency in reporting units, and analysis of standard reference materials.

Data comparability will be achieved by using standard units of measure (i.e., mg/kg for lead in sediment samples). Sediment sample results will be reported on a dry weight basis, with percent solids or percent moisture reported for each sample. The use of approved or standard laboratory methods to analyze samples (i.e., ASTM International [ASTM] and EPA methods), along with laboratory instruments calibrated in accordance with Worksheet 24, including against National Institute for Standards and Technology (NIST) traceable standards, will also help maintain comparability. Use of standard and consistently applied sampling methods will support maintaining comparability. The specific method used to collect the sediment samples is described in Worksheet 17, Section 17.10, and in WESTON SOP 6, *Sampling Procedures*. Following these procedures and using the Wildco® corer with the nose cone will ensure that sample recoveries and volumes are consistent to the extent possible. The field sampling equipment requires no calibration but will be inspected as noted in Worksheet 22A-4. Comparability of reference data to CMUA data will be ensured by the adherence to the collection of a statistically-based number of samples for the reference area and CMUA. Comparability will also be assessed by way of implementing standard sampling procedure provided in the UFP-QAPP and evaluating field deviations.

In addition, comparability will be assessed by comparing overall precision and bias among datasets for each matrix and analytical fraction, including RPD of duplicate samples, field and laboratory blank sample results, and surrogate and MS/MSD recoveries.

Dataset statistics, such as number of data points, maximum, minimum, standard deviations, upper tolerance levels, Mann-Whitney tests, will be used to assess comparability of the reference area data to the MC data from the target populations (CMUAs and non-CMUA, as described in Worksheet 11). The selection of the size and the number of samples for the reference area are statistically based, and the size is based on the grid size determined as described in Worksheet 17.10.2.

12.10.5 Completeness

Completeness is a measure of the amount of adequate data obtained from the actual performance of measurement procedures compared to the amount expected to be obtained from error-free performance of the same measurement procedures under normal conditions. Completeness measures the extent to which the database resulting from a measurement effort fulfills objectives for the amount of data required. Completeness is defined as the valid data percentage of the total tests requested.

$$\text{Completeness}\,(\%) = \frac{\textit{number of valid analyses per analyte in a matrix}}{\textit{number of requested analyses per analyte for that matrix}}\; x\,100$$

Complete project data involve both satisfactory performance and documentation of field and laboratory procedures. Valid analyses are defined as those where the sample arrives at the laboratory intact, properly preserved, in sufficient quantity to perform the requested analyses, and accompanied by a completed COC. Furthermore, the sample must be analyzed within the specified holding time and in such a manner that analytical QC acceptance are met, with the following exception: data qualified as estimated as a result of data validation are considered valid and counted towards completeness if still suitable for the intended use of the data. Such data require evaluation to determine suitability for decision-making purposes. Rejected data are not valid data. Completeness for the entire project also involves completeness of field and laboratory documentation, whether the samples and analyses specified in the site-specific Work Plan have been processed, and whether the procedures specified in the laboratory Standard Operating Procedure (SOPs) have been followed.

The completeness goal for the Investigation Area RI sediment sampling as a whole is 90%. The completeness goal for the analytical laboratory portion for each project is 90%. Failure to achieve the project completeness goal may necessitate re-sampling and re-analysis or re-evaluation of DQOs.

12.10.6 Sensitivity

Sensitivity is the ability of an analytical method or instrument to discriminate between measurement responses representing different concentrations. PALs were selected based on EPA and NYSDEC risk assessment guidance to evaluate risks to human health and the environment. Analytical methods were selected such that the LOQ, LOD, and detection limits (DL) for each analyte were sufficiently low to be able to compare the MC data to the PALs. In all cases, the LOQs, LODs, and DLs were lower than the PALs, thus the methods were confirmed to meet the sensitivity requirements. However, the LOQs for mercury, RDX, and nitroglycerin and the LOD for RDX were higher than the ecological PALs. These instances will be addressed as discussed in the footnotes in Worksheet 15 tables. Sensitivity will be addressed in the data usability section of the RI Report. Sensitivity is important to enable detection of the target analytes at the levels of interest. Sensitivity requirements include the establishment of various limits such as calibration requirements, instrument detection limits (IDLs), LODs, and site-specific LOQs. Both the IDLs and LODs are normally based on an interference-free matrix (i.e., reagent water or purified solid), which do not take into account matrix effects and may not be achievable for each environmental sample.

The UFP-QAPP requires laboratory service providers to provide laboratory SOPs that include acceptable precision and accuracy/bias ranges based on maintained records of precision and accuracy/bias trends for QC samples. Routine laboratory method performance in combination with published method precision and accuracy/bias ranges based on method validation studies will assist in defining technically feasible measurement performance.

WORKSHEET 12B.1: MEASUREMENT PERFORMANCE CRITERIA TABLE—TOTAL METALS (COPPER, LEAD, AND ZINC) BY INDUCTIVELY COUPLED PLASMA-ATOMIC EMISSION SPECTROSCOPY (ICP-AES) AND MERCURY BY COLD VAPOR ATOMIC ABSORPTION (CVAA)

Matrix: Sediment and Water Equipment Blanks

Analytical Group/Method: Total Metals (Copper, Lead, and Zinc) SW6010C (ICP-AES); Mercury SW7471B (sediment) and SW7470A (water)

Concentration Level: Low

Data Quality Indicators (DQIs)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision - Overall	Field Duplicates (sediment only)	RPD ≤ 50% for analytes detected ≥ Limit of Quantitation (LOQ)
Precision - Laboratory	MS/MSD (sediment only) Laboratory Duplicate (sediment only)* LCS/LCSD**	RPD ≤ 20% for analytes detected ≥ LOQ
Accuracy/Bias - Laboratory	LCS LCSD**	Solid: Recovery acceptance criteria, as specified by DoD QSM 5.1 Appendix C Table C-3, Mercury C-11.[1] Water: Recovery acceptance criteria[1] as specified by DoD QSM 5.1 Appendix C Table C-4, Mercury C-12.
Accuracy/Bias - Laboratory (matrix interference)	MS/MSD (sediment only)	Recovery acceptance criteria[1], as specified by DoD QSM 5.1 Appendix C Table C-3, Mercury C-11
Accuracy/Bias - Laboratory (Contamination)	Method Blanks	No target analytes > ½ LOQ or greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater)
Sensitivity	Quarterly limit of detection (LOD) verification standards	Signal-to-noise (S/N) ratio at least 3, and results must meet all method requirements for analyte identification.
Data Completeness	See Worksheet #34	See Worksheet #34

[1] Worksheet 15 lists the QSM 5.1 limits for solid samples. If water equipment blanks are submitted for analysis, only method blanks and LCS samples will be required; no field duplicates, MS/MSD, or laboratory duplicates will be required for water samples.

* Matrix accuracy/precision may be assessed either through laboratory duplicates or through MS/MSD performed on a project sample. If insufficient sample is provided to perform MS/MSD then a laboratory duplicate is acceptable.

** LCSD is necessary only if the batch does not include MS/MSDs (the LCSD is needed to assess precision).

WORKSHEET 12B.2: MEASUREMENT PERFORMANCE CRITERIA TABLE—EXPLOSIVES BY HIGH-PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC)

Matrix: Sediment and Water Equipment Blanks
Analytical Group/Method: Explosives (HPLC)/SW8330B
Concentration Level: Low

Data Quality Indicators (DQIs)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision - Overall	Field Duplicates (sediment only)	RPD ≤ 50% for analytes detected ≥ LOQ
Precision – Laboratory	MS/MSD (sediment only) Laboratory Duplicate (discrete sediment samples only)*	RPD ≤ 20% for analytes detected ≥ LOQ
Accuracy/Bias - Laboratory	LCS (solid reference material [SRM] required for sediment) LCSD**	Solid LCS recoveries must meet QSM 5.1 Appendix C Table C-37 control limits. Water LCS recoveries must meet QSM 5.1 Appendix C Table C-36 control limits.
Accuracy/Bias - Laboratory (matrix interference)	MS/MSD (sediment only)	Recovery limits same as LCS in QSM 5.1 Appendix C Table C-37 control limits.[1]
Accuracy/Bias - Laboratory (Contamination)	Method Blanks	No target analytes > ½ LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater).
Accuracy/Bias - Laboratory	Surrogate Recoveries (1,2-dinitrobenzene)	Solid samples: 78-119 percent recovery (%R) Water samples: 83-119 %R
Sensitivity	Quarterly limit of detection (LOD) verification standards	Signal-to-noise (S/N) ratio at least 3, and results must meet all method requirements for analyte identification.
Data Completeness	See Worksheet #34	See Worksheet #34

[1] Worksheet 15 lists the QSM 5.1 limits for solid samples. If water equipment blanks are submitted for analysis, only method blanks and LCS samples will be required; no field duplicates, MS/MSD, or laboratory duplicates will be required for water samples.

* Matrix accuracy/precision may be assessed either through laboratory duplicates or through MS/MSD performed on a project sample. If insufficient sample is provided to perform MS/MSD, then a laboratory duplicate is acceptable.

** LCSD is necessary only if the batch does not include MS/MSDs (the LCSD is needed to assess precision).

WORKSHEET 12B.3: MEASUREMENT PERFORMANCE CRITERIA TABLE—pH

Matrix: Sediment
Analytical Group/Method: pH/EPA 9045D
Concentration Level: Low

Data Quality Indicators (DQIs)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision - Laboratory	Laboratory Duplicate (sediment only) * or LCS/LCSD**	RPD ≤ 20% for analytes detected ≥ LOQ
Accuracy/Bias - Laboratory	LCS LCSD**	Recovery within ±0.05 pH units of true value.
Data Completeness	See Worksheet 34	See Worksheet 34

* Batch accuracy and precision may be assessed either through laboratory duplicates or through analysis of an LCS/LCSD. The laboratory is not required to select a project sample for laboratory duplicate analysis; however, the QC acceptance criteria listed above will be used by the laboratory.

** LCSD is necessary only if the batch does not include a laboratory duplicate.

WORKSHEET 12B.4: MEASUREMENT PERFORMANCE CRITERIA TABLE—TOTAL ORGANIC CARBON (TOC)

Matrix: Sediment
Analytical Group/Method: TOC/Determination of Total Organic Carbon in Sediment (Lloyd Kahn Method, EPA Region II)
Concentration Level: Low

Data Quality Indicators (DQIs)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision - Laboratory	Laboratory Quadruplicate *	RPD ≤ 30% if analyte is detected > 3 times the Practical Quantitation Limit (PQL) or RPD < 100% if analyte concentration is < 3 times the PQL.
Accuracy/Bias - Laboratory	LCS	Recovery 80-120%R
Accuracy/Bias - Laboratory (matrix interference)	MS*	Recovery 75-125%R
Accuracy/Bias - Laboratory (Contamination)	Method Blank	No target analyte detected > LOQ.
Data Completeness	See Worksheet 34	See Worksheet 34

* Batch accuracy will be assessed through LCS and MS analysis. Batch precision will be assessed through laboratory quadruplicates. The laboratory is not required to select a project sample for laboratory quadruplicate analysis or MS; however, the QC acceptance criteria listed above will be used by the laboratory to assess accuracy and precision for the batch.

WORKSHEET 12B.5: MEASUREMENT PERFORMANCE CRITERIA TABLE—ACID VOLATILE SULFIDE / SIMULTANEOUSLY EXTRACTED METALS (AVS/SEM)

Matrix: Sediment
Analytical Group/Method: AVS/SEM / Draft Method EPA 821/R-91-100
Concentration Level: Low

Data Quality Indicators (DQIs)	QC Sample or Measurement Performance Activity	Measurement Performance Criteria
Precision - Laboratory	Laboratory Duplicate *	RPD ≤ 20%
Accuracy/Bias - Laboratory	LCS	Recovery 80-120%R
Accuracy/Bias - Laboratory (matrix interference)	MS*	Recovery 75-125%R
Accuracy/Bias - Laboratory (Contamination)	Method Blank	No target analyte detected > LOQ
Data Completeness	See Worksheet 34	See Worksheet 34

* Batch accuracy will be assessed through LCS and MS analysis. Batch precision will be assessed through laboratory duplicates. The laboratory is not required to select a project sample for laboratory duplicate analysis or MS; however, the QC acceptance criteria listed above will be used by the laboratory to assess accuracy and precision for the batch.

AVS/SEM is extracted using 10 grams of sediment. Upon addition of acid, hydrogen sulfide that is given off is collected in a buffer solution and analyzed and reported as acid volatile sulfide. The acid slurry is filtered, and the filtrate is analyzed for the method-specified metals by ICP-AES (EPA 6010C) and mercury (EPA 7470A).

WORKSHEET #13: SECONDARY DATA USES AND LIMITATIONS

Information on secondary (existing) data that will be used for the project, the data source, and how the secondary data will be used is provided in the worksheet. If the secondary data do not meet the same quality objectives as the current investigation, limitations for use of the data are discussed.

Data Type	Source	Data Uses Relative to Current Project	Factors Affecting the Reliability of Data and Limitations on Data Use
Meteorological	National Weather Service	Current and historical meteorological conditions provide important constraints on possible pathways for MEC movement and exposure and on safe field operations. When historical weather patterns indicate periods of time when weather would impede safe or efficient field operations, or when severe weather is predicted during field operations, field schedules can be adjusted to enable safe and efficient operations.	Published data are available for past 20 years. No known limitations.
Topographic maps, digital elevation models, and navigational charts.	U.S. Geological Survey (USGS) NOAA nautical charts	Analog and digital topographic maps provide indications of features that can mobilize MEC and can be integrated with geophysical maps to support interpretation and validation. Historical topographic maps and aerial photographs provide evidence of terrain modifications, and these are reviewed in the range history assessments. Such alternations can affect the depth of detection or can provide evidence of the extent of historical MEC removal actions.	Dates data were collected. Gaps in survey.
Range history, munitions use, and munitions identified within the land portion of the ranges.	CTT, SI Report, and RI Reports for the land MRSs.	Required for identification of potential military munitions and Investigation Area boundary.	Some uncertainty associated with potential military munitions used for the overlapping ranges (all may not be present).
Anomaly locations	NSWCPCD Marine SI	Data collected during the RI will be analyzed in conjunction with data previously collected during the NSWCPCD marine SI.	Anomalies may have migrated.
Ecological habitats and endangered species present.	NYSDEC and USFWS	Current habitats and locations of endangered species provide important constraints on field operations, including locations where operations can be performed.	Because species can move, and site conditions can change, the species listed for the Investigation Area are not guaranteed to be found on or near the project area.

WORKSHEETS #14 & #16: PROJECT TASKS AND SCHEDULE

The activities to be conducted on the Investigation Area to achieve the project DQOs (Worksheet #11) comprise the following four primary components: mapping survey, detection survey, intrusive investigation, and MC sampling. Although these four primary components are the focus of the project, the field operations involve multiple elements, or DFWs (**Table 14-1**) that will be required to achieve the project goals. The subchapter provides a summary of these DFWs and the associated component tasks. A detailed discussion of each of the primary project components and the related DFWs is included on Worksheet #17, and the specific field procedures to be used for the activities described in the summary are included in the various standard operating procedures (SOPs) included in **Appendix D**. The project schedule is included in **Appendix F**.

Table 14-1 Definable Features of Work and Associated Tasks

DFW (Activity)	Associated Tasks	Responsible Party[(1)]	Planned Duration[(2)]	Related SOP(s) (see Worksheet #21)	Deliverable(s)	Deliverable Due Date[(2)]
DFW 1: Mobilization	Establish site, finalize dig permits/approvals	Project Manager	2 days	All SOPs	Not Applicable	Not Applicable
DFW 2: Professional Survey	Install site control	Project Manager, Project Geophysicist	2 days	Worksheet #17	Civil Survey Report	7 days after completion
DFW 3: Geophysical System Verification	IVS Installation	Field Geophysicist	2 days	Alpine IVS UXO-SOP	IVS Technical Memorandum	7 days after completion
DFW 4: Mapping Survey	Multibeam and SSS Assembly and Initial Function Test	Field or Project Geophysicist	4 days	Alpine Multibeam Hydrography SOP Alpine Side Scan Sonar Survey SOP	Sensor System Assembly QC Checklist	7 days after completion
	Data Processing and Target Selection	Data Analyst			Processed Data, Target List, QC Results	7 days after completion

Table 14-1 Definable Features of Work and Associated Tasks (Continued)

DFW (Activity)	Associated Tasks	Responsible Party(1)	Planned Duration(2)	Related SOP(s) (see Worksheet #21)	Deliverable(s)	Deliverable Due Date(2)
DFW 5: DGM Survey	TVG Assembly and Initial Function Test	Field or Project Geophysicist	7 days	Alpine Magnetometer UXO SOP	Preparatory TVG Sensor System Assembly QC Checklist	7 days after completion
	DGM Data Collection. Full coverage survey over accessible area using TVG	Project Geophysicist		Alpine Magnetometer UXO SOP	Raw Data, Weekly Reports, QC Results	Weekly during DGM data collection
	DGM Data Processing	Data Analyst			Processed Data	7 days after completion
DFW 6: Data Synthesis	DGM Data Processing and Target Selection	Project Geophysicist and Data Analyst	7 days	Worksheet #17	Processed Data, Target List, QC Results	7 days after completion
DFW 7: Intrusive Investigation	Reacquisition and intrusive investigation of selected anomalies	SUXOS	18 days	Explosive Ordnance Technologies, Inc. (EOTI) SOP 01, EOTI SOP 02, EOTI SOP 05, EOTI SOP 06,	SUXOS Daily Report, and Intrusive Results, Photographs, Weekly Reports	Daily and weekly during intrusive activities
DFW 8: MPPEH/MEC Handling	Identification, Removal, and Disposal	SUXOS/ UXOQCS	As needed	EOTI SOP 03, EOTI SOP 04	Daily Report, photographs	Daily during intrusive activities
DFW 9: MC Sampling	Discrete sediment sample collection using a Wilco® corer 7-pt composite sampling of detonation locations (post-detonation)	Weston Technical Lead	Concurrent with DFW 7	Worksheet #17 WESTON SOP 6	Daily Report, photographs	Daily during sampling activities

Table 14-1 Definable Features of Work and Associated Tasks (Continued)

DFW (Activity)	Associated Tasks	Responsible Party[1]	Planned Duration[2]	Related SOP(s) (see Worksheet #21)	Deliverable(s)	Deliverable Due Date[2]
DFW 10: Site Restoration	If post-detonation samples are not contaminated, spread sand from demo activities at site	SUXOS/ UXOQCS	As needed	Worksheet #17	Daily Report, photographs	Daily during site restoration activities
DFW 11: Laboratory Analysis	MC Sediment Sample Analysis	Katahdin	As needed	Worksheet #23	Laboratory Report and EDD	30 calendar days after receipt of last sample
DFW 12: Data Validation	MC Sediment Sample Data Validation	Laboratory Data Consultants	As needed	Worksheet #36	Data validation report	30 calendar days after receiving lab data
DFW 13: Risk Evaluation	HHRA and SLERA	Risk Assessor(s)	As needed	Worksheet #17	HHRA and SLERA Reports	30 calendar days after receiving data validation report
	MEC Risk Assessment	Project Scientist	As needed	Worksheet #17	MEC Risk Assessment Matrices	Due with RI Report
DFW 14: Demobilization	Documenting completion of other DFWs; leave site	SUXOS/ UXOQCS	1 day	Worksheet #17	Daily Report, MPPEH/Explosives Records Assessment	Not Applicable

Notes:

[1] Responsible party may not be physically present on-site for the entire project duration.

[2] Refer to the detailed project schedule included in **Appendix F**. The schedule will be updated as the project progresses.

WORKSHEET #15: PROJECT ACTION LIMITS AND LABORATORY-SPECIFIC DETECTION LIMITS/QUANTITATION LIMITS

WORKSHEET 15.1: METALS INCLUDING MERCURY (SEDIMENT)

Matrix: Sediment
Preparatory Method: EPA 3050B (Metals) and Mercury/EPA 7471B
Analytical Group/Method: Metals/EPA 6010C and Mercury/EPA 7471B
Laboratory: Katahdin Analytical Services
Concentration Level: Low

Analyte	CAS Number	Units	Carcinogen Status	Human Health Screening Levels[1]		Project Human Health Screening Levels [1]	Ecological Screening Level [2]				Project Ecological Screening Level [2]	Achievable Laboratory Limits[3,4]			Recovery Limits for LCS, MS, and MSD (%R)	
				EPA RSL Residential	NY Unrestricted / Residential Use Soil Cleanup Objectives		NY Freshwater/Saltwater Sediment Screening Values	Consensus Based Freshwater TEC	EPA Region 3 BTAG - Freshwater / Marine Sediment	LANL ECORISK - No Effect ESL		LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)	LCS MS/MSD	%RPD
Copper	7440-50-8	mg/kg	N	310	50	50	32 / 34	31.6/ 18.7	31.6 / 18.7	23	18.7	2.5	1.0	0.16	81-117	20
Lead	7439-92-1	mg/kg	--	400	200 / 400	400	36 / 47	35.8	35.8 / 30.2	26	26	0.5	0.4	0.09	81-112	20
Mercury	7439-97-6	mg/kg	N	1.1	0.81 / 0.81	0.81	0.2 / 0.15	0.18	0.18 / 0.13	0.017	0.017	***0.033***[4]	0.017	0.0052	80-124	20
Zinc	7440-66-6	mg/kg	N	2300	109	109	120 / 150	121	121 / 124	63	63	***25***	10	0.73	82-113	20

General Notes:

A. The laboratory will use QSM 5.1 QC limits for this project.

B. Quantitation limits highlighted in ***BOLD ITALIC*** exceed the selected ecological screening level.

C. Sediment samples for metals analysis will be either discrete or 7-point composite samples. The laboratory will air dry the sediment and sieve the dry sediment using a 10-mesh sieve. The fraction of sediment passing through the sieve will be spread out on a flat pan, and 30 incremental subsamples will be collected to produce a 2-gram aliquot for ICP metals (copper, lead, and zinc) and a 0.6-gram aliquot for mercury analysis. The remaining dried sediment will then be processed for explosives analysis.

WORKSHEET 15.1: METALS INCLUDING MERCURY (SEDIMENT) (CONTINUED)

Screening Levels:

[1] Minimum human health risk sediment screening levels were obtained from EPA May 2018 Regional Screening Levels (RSLs) for residential soil (EPA, 2018) and New York Unrestricted Soil Cleanup Objectives (SCO) (NYSDEC, 2006), where noncarcinogenic endpoint screening levels were selected to assess a target hazard quotient (THQ) of 0.1 to account for potential occurrence of adverse health effects due to exposure to multiple chemicals (screening levels for noncarcinogens may be adjusted upward during risk assessment, if warranted).

[2] Minimum ecological risk sediment screening levels were obtained from the following: (1) NYSDEC, 2014 Sediment Screening Values; (2) EPA, 2000 TEC; (3) BTAG R3; (4) Los Alamos National Laboratory (LANL) (2017) ECORISK Database (Version 4.1). The most conservative benchmark available was selected.

[3] Achievable LODs/LOQs listed in this table are from Katahdin at the time of this writing. As part of their ELAP accreditation under the Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (QSM), all laboratories perform LOD/LOQ determinations and have quarterly LOD/LOQ verifications (DoD QSM 5.1 Module 4 Section 1.5.2). LODs and LOQs shown are based upon dilution factor of one and dry weight basis. Actual sample LOD/LOQs may be adjusted based on sample amount, moisture content, and dilution factor. EPA SW-846 considers any determinate value less than low level of quantitation (i.e., DoD QSM LOQ) to have a degree of uncertainty; therefore, all detected data are qualified as estimated “J.” Given this fact, the condition where the project screening level is below the laboratory LOQ (i.e., estimated range) must be evaluated. Katahdin was consulted regarding options to lower to the LOQ. It was decided that the best option was to continue to use Method SW-846 6010C to achieve the lowest practical reporting (for example, Method 6020A would yield higher reporting limits for sediment as compared to 6010C). In addition, the LOQs are low enough to be able to provide quantitative data less than the respective background values. Because the best available method is being employed, the uncertainty is accepted, but this situation will be evaluated in the uncertainty discussion in the risk assessment.

[4] Project screening level is below the laboratory LOQ, but above the LOD. Non-detect results will be reported at the LOD, which does meet the screening level. Positive detections between the LOQ and the LOD will be reported as estimated with a “J” flag. Values above the LOD have a 99% probability of being properly reported as detected, and a 1% chance of being misreported as a non-detect. Although this situation adds a level of uncertainty to the risk evaluation, using J-qualified values for risk assessment is consistent with the allowable use of J-qualified data, as discussed in the Guidance for Data Useability for Risk Assessment (Part A) (EPA, 1992), and given that the uncertainty will be very low, these results will meet the DQOs for the project. Use of estimated data will be discussed in the risk assessment uncertainty analysis.

WORKSHEET 15.2: METALS INCLUDING MERCURY (WATER)

Matrix: Water
Preparatory Method: EPA 3010 (Metals) and Mercury/EPA 7470A
Analytical Group/Method: Metals/EPA 6010C and Mercury/EPA 7470A
Laboratory: Katahdin Analytical Services
Concentration Level: Low

Analyte	CAS Number	Units	Project Quantitation Goal[1]	Achievable Laboratory Limits			Recovery Limits for LCS (%R)	
				LOQ (µg/L)	LOD (µg/L)	DL (µg/L)	LCS	%RPD
Copper	7440-50-8	µg/L	25	25	10	0.63	86-114	20
Lead	7439-92-1	µg/L	5.0	5.0	4.0	1.1	86-113	20
Mercury	7439-97-6	µg/L	0.2	0.2	0.1	0.013	82-119	20
Zinc	7440-66-6	µg/L	20	20	10	0.73	87-115	20

[1] The only water samples to be analyzed for metals and mercury are equipment blanks. There are no applicable regulatory limits or Project Action Limit (PAL) for equipment blank samples, so a Project Quantitation Goal has been provided in lieu of the PAL.

General Notes:

A. The laboratory will use QSM 5.1 QC limits for this project.

B. An LCS will be required for laboratory accuracy. If an LCSD is analyzed, the precision will be assessed by the %RPD noted in the table above.

WORKSHEET 15.3: EXPLOSIVES (SEDIMENT)

Matrix: Sediment
Preparatory Method: EPA 8330B
Analytical Group/Method: EPA 8330B
Laboratory: Katahdin Analytical Services
Concentration Level: Low

Analyte	CAS Number	Units	Carcinogen Status	Human Health Screening Levels[1]		Project Human Health Screening Levels [1]	Ecological Screening Level [2]				Project Ecological Screening Level [2]	Achievable Laboratory Limits[3,4,5]			Recovery Limits for LCS, MS, and MSD (%R)	
				EPA RSL Residential	NY Unrestricted / Residential Use Soil Cleanup Objectives		NY Freshwater/Saltwater Sediment Screening Values	Consensus Based TEC	EPA Region 3 BTAG - Freshwater / Marine Sediment	LANL ECORISK - No Effect ESL		LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)	LCS MS/MSD	%RPD
2-amino-4,6-dinitrotoluene (2-Am-DNT)	35572-78-	mg/kg	n	15	NBA	15	NBA	NBA	NBA	17	17	0.1	0.05	0.0063	71-123	20
4-amino-2,6-dinitrotoluene (4-Am-DNT)	19406-51-	mg/kg	n	15	NBA	15	NBA	NBA	NBA	14	14	0.1	0.05	0.0010	64-127	20
2,4-dinitrotoluene (2,4-DNT)	121-14-2	mg/kg	c	1.7	NBA	1.7	NBA	NBA	NBA	0.29	0.29	0.1	0.05	0.0073	75-121	20
2,4,6-trinitrotoluene (2,4,6-TNT)	118-96-7	mg/kg	n	3.6	NBA	3.6	NBA	NBA	NBA	25	25	0.1	0.05	0.0094	71-120	20
2,6-dinitrotoluene (2,6-DNT)	606-20-2	mg/kg	c	0.36	NBA	0.36	NBA	NBA	NBA	8.6	8.6	0.1	0.05	0.0076	79-117	20
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	mg/kg	c	6.1	NBA	6.1	NBA	NBA	0.013 / NBA	3.2	0.013	***0.1***[5]	***0.05***[5]	0.0082	67-129	20
Pentaerythritol tetranitrate (PETN)	78-11-5	mg/kg	n	13	NBA	13	NBA	NBA	NBA	1,300	1,300	0.8	0.4	0.079	72-128	20
Nitroglycerin	55-63-0	mg/kg	n	0.63	NBA	0.63	NBA	NBA	NBA	1,500	1,500	***0.8***[4]	0.4	0.010	73-124	20

WORKSHEET 15.3: EXPLOSIVES (SEDIMENT) (CONTINUED)

Legend:

%RPD = relative percent difference
BTAG = Biological Technical Assistance Group
CAS = Chemical Abstract Service
DL = detection limit
ESL = ecological screening level
LANL = Los Alamos National Laboratory
LCS = laboratory control sample
LOD = limit of detection
LOQ = limit of quantitation
mg/kg = milligrams per kilogram
MS/MSD = matrix spike/matrix spike duplicate
NBA = No benchmark available
RSL = Regional Screening Level
TEC = threshold effect concentration

General Notes:

A. The laboratory will use QSM 5.1 QC limits for this project.
B. Quantitation limits highlighted in ***BOLD ITALIC*** exceed the selected human health and/or ecological screening level.
C. Sediment samples for explosives analysis will be either discrete or 7-point composite samples. The laboratory will air dry the sediment and sieve the dry sediment using a 10-mesh sieve. The fraction of sediment passing through the sieve will be spread out on a flat pan and 30 incremental subsamples will be collected first for the metals analyses. The remaining dried sediment will be processed for explosives analysis by grinding in a puck mill and spreading out on a flat pan. A minimum of 30 incremental subsamples will be collected to obtain a 10-gram aliquot for explosives extraction. If there is insufficient sample to grind in the puck mill (250 grams minimum), then a mortar and pestle will be used to grind the dried sediment.

Screening Levels:

[1] Minimum human health risk sediment screening levels were obtained from EPA May 2018 Regional Screening Levels (RSLs) for residential soil (EPA, 2018) and New York Unrestricted Soil Cleanup Objectives (SCO) (NYSDEC, 2006), where noncarcinogenic endpoint screening levels were selected to assess a target hazard quotient (THQ) of 0.1 to account for potential occurrence of adverse health effects due to exposure to multiple chemicals (screening levels for noncarcinogens may be adjusted upward during risk assessment, if warranted).

[2] Minimum ecological risk sediment screening levels were obtained from the following: (1) NYSDEC, 2014 Sediment Screening Values; (2) EPA, 2000 TEC; (3) BTAG R3; (4) Los Alamos National Laboratory (LANL) (2017) ECORISK Database (Version 4.1). The most conservative benchmark available was selected.

[3] Achievable LODs/LOQs listed in this table are Katahdin LODs/LOQs at the time of this writing. As part of their ELAP accreditation under the Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (QSM), all laboratories perform LOD/LOQ determinations and have quarterly LOD/LOQ verifications (DoD QSM 5.1 Module 4 Section 1.5.2). LODs and LOQs shown are based upon a dilution factor of one and dry weight basis. Actual sample LOD/LOQs may be adjusted based on sample amount, moisture content, and dilution factor. EPA SW-846 considers any determinate value less than low level of quantitation (i.e., DoD QSM LOQ) to have a degree of uncertainty; therefore, all detected data are qualified as estimated “J.” Given this fact, the condition where project screening level is below the laboratory LOQ (i.e., estimated range) must be evaluated. For explosive compounds, the laboratory is currently using the SW846-8330B methodology to achieve lowest practical explosive sensitivity levels. This method was evaluated and no modifications could be made to reduce the LOQ because concentrating any final extracts from the procedure with an inert gas runs the risk of

WORKSHEET 15.3: EXPLOSIVES (SEDIMENT) (CONTINUED)

losing target explosive compounds (e.g., nitrotoluenes). The best available method is being employed; therefore, the uncertainty is accepted, but this situation will be evaluated in the uncertainty discussion in the risk assessment.

[4] Project screening level is below the laboratory LOQ, but above the LOD. Non-detect results will be reported at the LOD, which does meet the screening level. Positive detections between the LOQ and the LOD will be reported as estimated with a “J” flag. Values above the LOD have a 99% probability of being properly reported as detected, and a 1% chance of being misreported as a non-detect. Although this situation adds a level of uncertainty to the risk evaluation, using J-qualified values for risk assessment is consistent with the allowable use of J-qualified data, as discussed in the Guidance for Data Useability for Risk Assessment (Part A) (EPA, 1992), and given that the uncertainty will be very low, these results will meet the DQOs for the project. Use of estimated data will be discussed in the risk assessment uncertainty analysis.

[5] The ecological screening level is shown below the LOQ and LOD. Positive detections between the LOQ and method DL will be reported as estimated with a “J” flag. The potential for a false negative value being reported at the LOD is 1% and increases to 99% at the method DL, indicating uncertainty associated with these results. Values above the LOD have a 99% probability of being properly reported as detected, and a 1% chance of being misreported as a non-detect. Uncertainty will be qualified based on the overall results for each sample because it is expected that several MC would be present as a result of a munitions-source. Additional factors, such as refined exposure assumptions, will further be used to address the level of uncertainty associated with estimated and non-detect results during risk assessment. Although the use of estimated data adds some level of uncertainty to the risk evaluation, it will be limited, and using J-qualified values for risk assessment is consistent with the allowable use of J-qualified data as discussed in the Guidance for Data Useability for Risk Assessment (Part A) (EPA, 1992). Use of estimated data will be discussed in the risk assessment uncertainty analysis. No project-related decisions will be made solely on the basis of estimated data below the LOD. If new analytical methods become available with lower detection limits, they will be reviewed and employed as needed to assess lower concentrations with less uncertainty.

WORKSHEET 15.4: EXPLOSIVES (SOIL)

Matrix: Soil
Preparatory Method: EPA 8330B
Analytical Group/Method: EPA 8330B
Laboratory: Katahdin Analytical Services
Concentration Level: Low

Analyte	CAS Number	Units	Carcinogen Status	Human Health Screening Levels[1]		Project Human Health Screening Levels [1]	Ecological Screening Level [2]				Project Ecological Screening Level [2]	Achievable Laboratory Limits[3,4,5]			Recovery Limits for LCS, MS, and MSD (%R)	
				EPA RSL Residential	NY Unrestricted / Residential Use Soil Cleanup Objectives			LANL ECORISK – No Effect ESL				LOQ (mg/kg)	LOD (mg/kg)	DL (mg/kg)	LCS MS/MSD	%RPD
2-amino-4,6-dinitrotoluene (2-Am-DNT)	35572-78-	mg/kg	n	15	NBA			14			14	0.1	0.05	0.0063	71-123	20
4-amino-2,6-dinitrotoluene (4-Am-DNT)	19406-51-	mg/kg	n	15	NBA	15		12			12	0.1	0.05	0.0010	64-127	20
2,4-dinitrotoluene (2,4-DNT)	121-14-2	mg/kg	c	1.7	NBA	1.7		6.0			6.0	0.1	0.05	0.0073	75-121	20
2,4,6-trinitrotoluene (2,4,6-TNT)	118-96-7	mg/kg	n	3.6	NBA	3.6		7.5			7.5	0.1	0.05	0.0094	71-120	20
2,6-dinitrotoluene (2,6-DNT)	606-20-2	mg/kg	c	0.36	NBA	0.36		4.0			4.0	0.1	0.05	0.0076	79-117	20
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	mg/kg	c	6.1	NBA	6.1		2.3			2.3	***0.1***[5]	***0.05***[5]	0.0082	37-129	20
Pentaerythritol tetranitrate (PETN)	78-11-5	mg/kg	n	13	NBA	13		100			100	0.8	0.4	0.079	72-128	20
Nitroglycerin	55-63-0	mg/kg	n	0.63	NBA	0.63		13			13	***0.8***[4]	0.4	0.010	73-124	20

WORKSHEET 15.4: EXPLOSIVES (SOIL) (CONTINUED)

Legend:

%RPD = relative percent difference
BTAG = Biological Technical Assistance Group
CAS = Chemical Abstract Service
DL = detection limit
ESL = ecological screening level
LANL = Los Alamos National Laboratory
LCS = laboratory control sample
LOD = limit of detection
LOQ = limit of quantitation
mg/kg = milligrams per kilogram
MS/MSD = matrix spike/matrix spike duplicate
NBA = No benchmark available
RSL = Regional Screening Level
TEC = threshold effect concentration

General Notes:

A. The laboratory will use QSM 5.1 QC limits for this project.
B. Quantitation limits highlighted in BOLD ITALIC exceed the selected human health and/or ecological screening level
C. The laboratory will process samples in accordance with EPA method 8330B.

Screening Levels:

[1] Minimum human health risk soil screening levels were obtained from EPA May 2018 Regional Screening Levels (RSLs) for residential soil (EPA, 2018) and New York Unrestricted Soil Cleanup Objectives (SCO) (NYSDEC, 2006), where noncarcinogenic endpoint screening levels were selected to assess a target hazard quotient (THQ) of 0.1 to account for potential occurrence of adverse health effects due to exposure to multiple chemicals (screening levels for noncarcinogens may be adjusted upward during risk assessment, if warranted).

[2] Ecological risk soil screening levels were obtained from Los Alamos National Laboratory (LANL) (2017) ECORISK Database, No Effect Level for Soil (Version 4.1).

[3] Achievable LODs/LOQs listed in this table are Katahdin LODs/LOQs at the time of this writing. As part of their ELAP accreditation under the Department of Defense (DoD) Quality Systems Manual for Environmental Laboratories (QSM), all laboratories perform LOD/LOQ determinations and have quarterly LOD/LOQ verifications (DoD QSM 5.1 Module 4 Section 1.5.2). LODs and LOQs shown are based upon a dilution factor of one and dry weight basis. Actual sample LOD/LOQs may be adjusted based on sample amount, moisture content, and dilution factor. EPA SW-846 considers any determinate value less than low level of quantitation (i.e., DoD QSM LOQ) to have a degree of uncertainty; therefore, all detected data are qualified as estimated “J.” Given this fact, the condition where project screening level is below the laboratory LOQ (i.e., estimated range) must be evaluated. For explosive compounds, the laboratory is currently using the SW846-8330B methodology to achieve lowest practical explosive sensitivity levels. This method was evaluated and no modifications could be made to reduce the LOQ because concentrating any final extracts from the procedure with an inert gas runs the risk of losing target explosive compounds (e.g., nitrotoluenes). The best available method is being employed; therefore, the uncertainty is accepted, but this situation will be evaluated in the uncertainty discussion in the risk assessment.

[4] Project screening level is below the laboratory LOQ, but above the LOD. Non-detect results will be reported at the LOD, which does meet the screening level. Positive detections between the LOQ and the LOD will be reported as estimated with a “J” flag. Values above the LOD have a 99% probability of being properly reported as detected, and a 1% chance of being misreported as a non-detect. Although this situation adds a level of uncertainty to the risk evaluation, using J-qualified values for risk assessment is consistent with the allowable use of J-qualified data, as discussed in the Guidance for Data Useability for Risk Assessment (Part A) (EPA, 1992), and given that the uncertainty will be very low, these results will meet the DQOs for the project. Use of estimated data will be discussed in the risk assessment uncertainty analysis.

WORKSHEET 15.4: EXPLOSIVES (SOIL) (CONTINUED)

[5] The ecological screening level is shown below the LOQ and LOD. Positive detections between the LOQ and method DL will be reported as estimated with a “J” flag. The potential for a false negative value being reported at the LOD is 1% and increases to 99% at the method DL, indicating uncertainty associated with these results. Values above the LOD have a 99% probability of being properly reported as detected, and a 1% chance of being misreported as a non-detect. Uncertainty will be qualified based on the overall results for each sample because it is expected that several MC would be present as a result of a munitions-source, and the presence of lead alone is unlikely. Additional factors, such as background levels and refined exposure assumptions, will further be used to address the level of uncertainty associated with estimated and non-detect results during risk assessment. Background levels of metals are also higher than screening levels and laboratory limits, reducing the uncertainty associated with estimated and non-detect results during risk assessment. Although the use of estimated data adds some level of uncertainty to the risk evaluation, it will be limited, and using J-qualified values for risk assessment is consistent with the allowable use of J-qualified data as discussed in the Guidance for Data Useability for Risk Assessment (Part A) (EPA, 1992). Use of estimated data will be discussed in the risk assessment uncertainty analysis. No project-related decisions will be made solely on the basis of estimated data below the LOD. If new analytical methods become available with lower detection limits, they will be reviewed and employed as needed to assess lower concentrations with less uncertainty.

WORKSHEET 15.5: EXPLOSIVES (WATER)

Matrix: Water
Preparatory Method: EPA 8330B
Analytical Group/Method: EPA 8330B
Laboratory: Katahdin Analytical Services
Concentration Level: Low

Analyte	CAS Number	Units	Project Quantitation Goal [1]	Achievable Laboratory Limits			Recovery Limits for LCS (%R)	
				LOQ (µg/L)	LOD (µg/L)	DL (µg/L)	LCS	%RPD
2-amino-4,6-dinitrotoluene (2-Am-DNT)	35572-78-2	µg/L	0.25	0.25	0.125	0.044	79-120	20
4-amino-2,6-dinitrotoluene (4-Am-DNT)	19406-51-0	µg/L	0.25	0.25	0.125	0.075	76-125	20
2,4-dinitrotoluene (2,4-DNT)	121-14-2	µg/L	0.25	0.25	0.125	0.040	78-120	20
2,4,6-trinitrotoluene (2,4,6-TNT)	118-96-7	µg/L	0.25	0.25	0.125	0.053	71-123	20
2,6-dinitrotoluene (2,6-DNT)	606-20-2	µg/L	0.25	0.25	0.125	0.076	77-127	20
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)	121-82-4	µg/L	0.25	0.25	0.125	0.055	68-130	20
Pentaerythritol tetranitrate (PETN)	78-11-5	µg/L	4.0	4.0	2.0	0.16	73-127	20
Nitroglycerin	55-63-0	µg/L	4.0	4.0	2.0	0.77	74-127	20

[1] The only water samples to be analyzed for explosives are equipment blanks. There are no applicable regulatory limits or Project Action Limit (PAL) for equipment blank samples, so a Project Quantitation Goal has been provided in lieu of the PAL.

General Notes:

A. The laboratory will use QSM 5.1 QC limits for this project.
B. An LCS will be required for laboratory accuracy. If an LCSD is analyzed, the precision will be assessed by the %RPD noted in the table above.

WORKSHEET 15.6: WET CHEMISTRY PARAMETERS

Matrix: Sediment
Analytical Group/Method: Wet Chemistry / varies (see below)
Laboratory: Katahdin Analytical Services
Concentration Level: Low

Analyte	Method	Units	Project Quantitation Goal [1]	Achievable Laboratory Limits			Recovery Limits for LCS and MS (%R)	
				LOQ	LOD	DL	LCS / MS	%RPD
Total Organic Carbon (TOC)	Lloyd Kahn	mg/kg	400	400	300	84.8	80-120/ 75-125	30
pH	EPA 9045D	pH units	NA	NA	NA	NA	NA	NA
Grain Size	ASTM D422	NA	NA	NA	NA	NA	NA	NA
Acid Volatile Sulfide / Simultaneously Extracted Metals								
Acid Volatile Sulfide	EPA 821/R-91-100	µmoles/g	0.00131	0.00131	0.00082	0.00019	80-120/ 75-125	20
SEM: cadmium	EPA 821/R-91-100	µmoles/g	0.00089	0.00089	0.00053	0.000014	80-120/ 75-125	20
SEM: copper	EPA 821/R-91-100	µmoles/g	0.007868	0.007868	0.003147	0.00073	80-120/ 75-125	20
SEM: lead	EPA 821/R-91-100	µmoles/g	0.000483	0.000483	0.000386	0.00015	80-120/ 75-125	20
SEM: mercury	EPA 821/R-91-100	µmoles/g	0.000020	0.000020	0.000018	0.000016	80-120/ 75-125	20
SEM: nickel	EPA 821/R-91-100	µmoles/g	0.00341	0.00341	0.001363	0.00022	80-120/ 75-125	20
SEM: silver	EPA 821/R-91-100	µmoles/g	0.00185	0.00185	0.000742	0.00010	80-120/ 75-125	20
SEM: zinc	EPA 821/R-91-100	µmoles/g	0.00612	0.00612	0.00306	0.00110	80-120/ 75-125	20

NA = Not Applicable

General Note: An LCS and MS will be required for laboratory accuracy for most wet chemistry parameters.

[1] Sediment samples for Wet Chemistry parameters are being analyzed for physical characteristics. There are no applicable regulatory limits or Project Action Limit (PAL) for these parameters, so a Project Quantitation Goal is provided in lieu of the PAL.

WORKSHEET #17: SURVEY DESIGN AND PROJECT WORK FLOW

The worksheet describes the project design and the tasks that will be required to successfully complete field operations during the project and achieve the DQOs described on Worksheet #11.

The following subsections specify WESTON's technical approach, broken down into a series of DFWs for MEC and MPPEH removal and for MC sampling.

17.1 THREE-PHASE INSPECTION PROCESS

Prior to and during execution of field activities, WESTON will ensure quality through utilization of the Three-Phase Inspection Process described in the following subsections. Forms and checklists associated with completion of the preparatory, initial, and follow-up phase activities are included in **Appendix B**.

17.1.1 Preparatory Phase

The preparatory phase will be completed before beginning each DFW. A meeting will be scheduled in advance of each work activity, if deemed necessary by the PDT to facilitate coordination of project activities. The following activities will be completed during the phase:

- Review specifications, references, and plans.
- Verify field equipment to ensure readiness for intended use.
- Assign responsibilities and ensure field staff have the necessary knowledge, training, expertise, and information to perform jobs.
- Verify arrangements for support services.
- Inspect work area to verify that required preliminary work has been completed.
- Review appropriate activity hazard analyses (AHAs).
- Ensure that applicable processes and procedures have been approved by the COR.

The UFP-QAPP and SOPs will be reviewed by the MC Technical Manager, UXO Quality Control Specialist (UXOQCS), and Senior Geophysicist during the preparatory phase to ensure that they describe prequalifying requirements or conditions, equipment, materials, methodology, and QC provisions. Discrepancies between existing conditions and approved plans and procedures will be resolved, or CAs will be taken for unsatisfactory and nonconforming conditions identified during a preparatory phase inspection. The resolution will be verified by the MC Technical Manager, UXOQCS or their designee, as appropriate, before approval to begin work is granted.

The UXOSO or Site Safety and Health Officer will review the Accident Prevention Plan (APP) (submitted under a separate cover) and the appropriate AHAs to ensure that applicable safety requirements have been achieved. Preparation phase inspection results will be documented using the Preparatory Phase Checklist and will be summarized in the Daily QC Report. The personnel qualifications checklist will be used to ensure that personnel meet or exceed the training standards outlined by DoD, USACE, and OSHA, including applicable hazardous waste operator training.

17.1.2 Initial Phase

The initial phase will be performed when the fieldwork has been initiated for a given DFW. The purpose of this phase will be to accomplish the following:

- Inspect the work in progress for compliance with QC requirements.
- Verify adequacy of QC controls to ensure full contract compliance.
- Establish an acceptable level of workmanship.
- Review field operations for compliance with appropriate SOPs.
- Verify that documentation related to field activities is complete.
- Verify that required PPE and other safety procedures are in compliance with the QC specifications included in the APP and AHAs.
- Resolve differences of interpretation that may affect the quality of work.

Additional preparatory and initial phases may be conducted on the same work being performed if (1) the quality of ongoing work is unacceptable, (2) there are changes in the on-site production supervision or work crew, (3) work is resumed after a substantial period of inactivity (2 weeks or more), or (4) other problems develop.

The MC Technical Manager, UXOQCS, and/or Senior Geophysicist will be responsible for ensuring that all discrepancies between site practices and approved plan specifications are identified, documented, and resolved. CAs for unsatisfactory conditions or practices will be verified by the MC Technical Manager, UXOQCS or their designee, as appropriate, before granting approval to proceed. Initial phase results will be documented on the Initial Phase Checklist and summarized in the Daily QC Report.

17.1.3 Follow-Up Phase

The phase will be conducted for each DFW until it has been completed. The purpose of the phase is to ensure compliance with the UFP-QAPP, contract requirements, and it will include the following activities:

- Verify that the work has been completed in compliance with the UFP-QAPP, contract requirements, and any standards that apply to this work and are referenced in this QAPP.
- Ensure that the quality of workmanship was maintained and achieved.

- Validate all fieldwork to ensure that no data gaps exist and schedule additional field activities to address any existing data gaps.
- Verify that all safety and quality inspections were performed and verify that all field performance audits were conducted.

The UXOQCS, Senior Geophysicist, MC Technical Manager, or designee in the field is responsible for on-site monitoring of the practices and operations taking place and for verifying continued compliance with the UFP-QAPP, the specification and requirements of the contract, approved project plans (ESP and EMP), and procedures (SOPs). The UXOQCS and MC Technical Manager or designee in the field will oversee and observe activities as specified in the initial inspection and will verify that CAs for unsatisfactory or nonconforming conditions have been taken before granting approval to continue work. Final follow-up phase checks will be conducted and all deficiencies corrected before starting additional DFWs. Final follow-up checks will be documented and summarized in the Daily QC Report.

17.2 DFW 1: MOBILIZATION

The PM will conduct a readiness review with technical staff to ensure that the team has the proper tools, equipment, and safety gear to complete field tasks in accordance with the UFP-QAPP and associated plans and procedures (SOP 2 Mobilization and Demobilization, **Appendix D**). Following completeness of the readiness review, and following the official Notice to Proceed (NTP), WESTON will mobilize initial personnel and equipment to begin site setup operations. The initial field team will consist of a Site Safety and Health Officer and field geoscientist to support equipment delivery, and survey contractors.

During the intrusive investigation project set-up activities, the SUXOS and UXOSO will mobilize, and WESTON will develop a site operations holding area where MPPEH processing will be conducted. Additionally, the area will serve as command for all field operations and will house equipment and medical and heat triage stations. An office trailer and equipment storage facilities will potentially be sited at a West Point-approved laydown area. Marine equipment staging will be accomplished at the Cold Spring Boat Club/Marina to prevent interference with West Point activities near South Dock. The UXOSO will be dual-hatted as UXOSO/UXOQCS.

17.3 DFW 2: PROFESSIONAL SURVEY

Surveying services will be provided by Badey & Watson Surveying & Engineering, P.C., a New York-licensed land surveyor. Survey operations will be performed prior to the mapping survey and will be performed in compliance with EM 200-1-15. Survey operations will consist of installing a control point(s) for use during the subsequent mapping survey, DGM survey, and intrusive investigation. The potential control point locations are identified on **Figure 17-1**, and the final location will be selected in the field based upon accessibility.

The surveyor will install 4-ft-long, weather-resistant wooden stakes next to survey pins at each control point for visibility after moderate vegetation regrowth, labeled with North American Datum (NAD) 83 Universal Transverse Mercator (UTM) Zone 18 North meter coordinates. Flagging will be placed at the top of each stake. The surveyor will maintain a field logbook detailing all field activities, including daily entries of the personnel on-site, time of day work started and ended, weather conditions, delays, survey data, equipment used, and field sketches. Survey data points will be input into MS Excel format.

Control cards for all benchmarks used during and established for the project will be submitted and will also be included in the RI Final Report and entered in the Geographic Information System (GIS) data. The control point will be incorporated into the overall project Geospatial Data Submission (GDS).

17.4 DFW 3: GEOPHYSICAL SYSTEM VERIFICATION

The TVG will be assembled as described in Alpine IVS UXO - SOP (**Appendix D**). Following assembly and operation verification, a geophysical system verification (GSV) approach will be utilized to verify and monitor the TVG functionality during field investigations.

A single IVS will be constructed adjacent to the MRS for the RI in accordance with Alpine IVS UXO - SOP (**Appendix D**). The IVS will include Small, Medium, and Large industry standard objects (ISO) items.

To test the TVG and verify that it is functioning correctly, initial IVS surveys will be performed as described in Alpine IVS UXO - SOP. During the DGM data acquisition phase, two daily surveys of the IVS will be conducted with the TVG to confirm the continued proper operation of the system. Results from these tests will be monitored against the MQOs in Worksheet #22, which are designed to verify that the system is capable of achieving the stated detection goals. Static background and static spike data will be recorded in addition to IVS testing to ensure equipment is functioning as expected.

MQOs for the IVS tests include:

- Sensor altitude measurements are within project specifications.
- In-line data spacing is within 0.25 m for greater than 98% of the dataset.
- Derived target positions are within 0.5 m of the average of previous locations (confirms positioning precision).

After completing the initial IVS testing, an IVS Technical Memorandum will be prepared detailing the IVS setup, surveys, and results, including documentation and compliance with the IVS MQOs provided in Worksheet #22. The IVS Technical Memorandum will be provided to the project team for review and concurrence. Target selection threshold/methodology will be documented in the Memorandum.

17.5 DFW 4: MAPPING SURVEY

Mapping surveys will be conducted across the accessible portions of the entire 1,138-acre Investigation Area (Siege Battery–TD River MRS, Battery Knox–TD River MRS, Area A, and Area B) on **Figure 10-2**. The NSWCPCD marine SI survey identified several anomalies outside the Investigation Area boundary. Therefore, step-out areas within the Hudson River were identified for additional investigation and will be surveyed in conjunction with the Investigation Area.

The transect spacing was developed for the geophysical surveys and the same transect locations will be used for the Mapping Surveys. The geophysical transect survey will be performed across the Investigation Area and within the step-outs to traverse, detect, and delineate potential CMUAs at a high degree of confidence. Visual Sample Plan (VSP) software was used to support the investigation strategy design. A VSP-designed approach is used when the locations of CMUAs at an MRS are unknown. The "Transect Spacing Needed to Locate a UXO Target Area" module in VSP was used to develop the transect approach. VSP uses the term "target area" to reference a CMUA as defined in the UFP-QAPP.

The technical paper titled, *Simplified Target Sizing Model for Visual Sample Plan* (PNNL, 2013) documents the methods used by VSP software to define the conservative radius used to establish the size of a munition-specific impact area (CMUA). The study developed fragmentation distances for specific munitions items to use in VSP as a means for transect spacing determinations and subsequent MRS characterization. A 3-inch projectile was chosen for VSP calculations to be conservative because it has the shortest fragmentation distance of the items likely to have been fired and impacted within the Investigation Area. The generated VSP calculations based on a 3-inch HE projectile require a transect spacing of 250 ft to ensure a 95% probability of traversing and detecting any CMUAs with a 422-ft radius and an average density of 40 anomalies per acre above the background anomaly density of 6 anomalies per acre.

The VSP calculations indicate a transect spacing of greater than 300 ft would be acceptable for the anticipated munitions. However, based on the information available regarding the type of munitions anticipated (HE, black powder and practice), a 250-ft transect spacing for DGM surveys (3-ft swath width) is more conservative and would provide a higher quality dataset. The 250-ft transect spacing would achieve a greater than 95% probability of traversing and detecting a CMUA, based on a 3-inch projectile or military munition with a greater fragmentation radius.

Approximately 45 miles (16.3 acres) of transects are planned for the Investigation Area and step-outs. Refer to **Figure 17-1** for the locations of the planned survey transects within the Investigation Area and step-outs.

The VSP parameters for the proposed surveys are presented below:

Transect Spacing	Target Radius	Probability of detection	Background/Target Density
250 ft	422 ft	>95%	6/40 anomalies per acre

Multibeam and SSS mapping surveys will be conducted over pre-planned transects across the entire 1,138-acre Investigation Area and within the step-out areas North and South of the Investigation Area.

The mapping surveys will be conducted to provide topography and morphology of the riverbed to safely and effectively plan the underwater DGM surveys. During the course of the survey digital depth soundings output by the sounder will be merged in real-time with navigation data by means of the data-logging and navigation control computer software package QPS QINSy. Post processing for the multibeam and SSS mapping surveys will be completed using Caris HIPS software package.

The mapping survey will be used to:

- Identify obstructions, utilities, or potential culturally-significant areas that should be avoided during subsequent work phases including dive operations.
- Identify optimal locations for the IVS install.
- Identify areas of natural deposition where objects and debris may collect on the river bottom.
- Detect additional features of interest that lie proud on the river bottom that may be munitions related (i.e., ships, barges, individual munitions items).
- Identify submerged aquatic vegetation beds within the survey area.
- Determine whether there has been migration of items by comparing newly collected data with overlapping NSWCPCD marine SI results.

17.6 DFW 5: DGM SURVEY

Following the mapping survey described in Section 17.5, DGM surveys will be performed over areas accessible to the boats in the Investigation Area and step-outs.

DGM operations will be performed in accordance with the USACE Performance Requirements for Geophysical Investigation as presented in EM 200-1-15.

A TVG using an 882 cesium vapor magnetometer coupled with a Sonardyne Scout ultra-short baseline (USBL) for underwater acoustic positioning (if needed), will be used for the DGM surveys. The detection survey will be conducted using transects across accessible portions of the Investigation Area and step-outs in accordance with the Alpine Magnetometer UXO - SOP.

A Real-Time Kinematic (RTK) Differential Global Positioning System (DGPS) will be integrated with the TVG sensor for accurate data positioning. RTK inputs will be supplied via a Virtual Reference Station (VRS) network subscription service (KeyNet GPS, NYSDOT or other) acquired in real-time using a cellular interface. The combination provides reliable, high-precision positioning and navigation. Positioning and tracking will be conducted using Applanix POS MV system in accordance with the Alpine Magnetometer UXO – SOP.

The same planned transect locations used for the Mapping Surveys will be used for the DGM surveys. Data will be collected at a 250-ft transect spacing and a 3-ft swath width of the TVG to provide the data density necessary for detection of CMUAs. The data will be collected at the speed demonstrated at the IVS to ensure that along-line spacing between data points is less than 0.25 m. Transect spacing will be maintained by DGPS for the boat pilot to follow.

In water deeper than approximately 8 ft, the TVG will be tethered and towed by a support vessel, such as Alpine's Research Vessel, Henry Hudson. A float system for the TVG will be used in more shallow water along the shorelines, such as the eastern side of the Metro-North Railroad tracks near Little Stony Point. The float system allows the sensor altitude to be adjusted based on water depth. Data acquisition for both deployment systems will take place at approximately 2 knots and adjusted to meet the MQOs.

TVG data will be stored by the supplied data acquisition system on a hard disk and downloaded to the field processing computer via portable digital media (e.g., thumb drives). The DGM data will be processed using HYPACK® MAX as described in the Alpine Magnetometer UXO - SOP. The processing flow will include review of offsets, heading, and navigation. Navigation will be recomputed with sensor offsets applied. Each line will be reviewed for data quality. All corrections and offsets to the raw data will be applied in HYPACK® MAX and Oasis Montaj during post-processing.

Anomalies will be identified based on a site-specific response threshold that will be established during initial IVS testing. The Data Analyst will assess the data to identify any possible CMUAs where the anomaly density is elevated above background levels.

17.7 DFW 6: DATA SYNTHESIS

Data collected during the RI will be analyzed in conjunction with data previously collected during the NSWCPCD marine SI. The combined dataset will update the current CSM providing robust anomaly density information and assessments of object mobility on the river bed.

Ten SSS anomalies will be selected from the combined dataset and intrusively investigated during the RI. A statistical assessment will be used if more anomalies are identified. The robust SSS dataset will also be used to evaluate the targets of interest identified during the DGM transect survey.

Anomaly locations identified during TVG surveys will be analyzed using VSP to identify possible CMUAs and non-CMUA for follow-on intrusive investigation to determine the nature of the selected anomalies and delineate the extent of MEC. Magnetometer data collected during the NSWCPCD marine SI will be assessed to update the CSM, however, no individual anomalies identified during the NSWCPCD marine SI will be considered for intrusive investigation.

Anomaly cluster locations or potential CMUAs will be identified using the Locate and Mark Target Areas and Geostatistical Mapping functions of VSP. Anomaly density maps will be generated and locations where anomaly clusters are identified will be denoted for subsequent dive work.

The Target of Interest Rate Estimation/ Comparison module in VSP and the USACE developed UXO Estimator software were both used to calculate the amount of acreage within the CMUAs and non-CMUA that need to be investigated. Investigation acreages will be calculated for CMUAs and non-CMUAs separately in order to demonstrate with 95% confidence that there is less than or equal to 0.5 MEC/acre. Based on the anticipated acreage of CMUAs within the Investigation Area, WESTON expects to perform intrusive investigations over 2.4 acres of CMUAs and 5.7 acres in the non-CMUA.

All intrusive assessment coverage will be randomly selected along the DGM transects using VSP. TVG DGM anomalies within randomly selected transect segments will be selected based on the site-specific instrument detection threshold, as identified during the IVS tests and historical information for the Investigation Area.

17.8 DFW 7: INTRUSIVE INVESTIGATION

All anomalies that are selected as targets of interest will be reacquired using RTK GPS for intrusive work. The SUXOS and UXOSO/UXOQCS will oversee and assist the reacquisition team.

A combination of UXO Technician divers and ROV investigations are planned for the intrusive investigation. UXO-qualified divers will be deployed from a diving support vessel to commence the intrusive investigation of the selected targets of interest. To minimize the risks associated with dive operations deeper than 90 ft where dive decompression safety issues must be considered, where river depths are between 90 ft and 120 ft (approximately 5% of the Investigation Area), ROV technology will be used in place of divers.

A Sirio Inspection Class ROV positioned with Sonardyne USBL will be used to investigate anomalies at depth. The ROV will be equipped with a Blue View live sonar system, which can search for potential anomalies in high currents and turbid waters where regular video will not suffice. Once on target, a sonar image (similar to multibeam) will be taken from various angles to offer the best possible image of the item. The ROV investigation will be conducted in accordance with the Alpine UXO – ROV Sonar Inspection SOP.

The ROV investigations will be used to:

- Accurately provide information on item type such as MEC, target debris, or non-munitions-related debris.
- Safely extract information at anomaly locations within the deepest portions of the river channel greater than 90 ft.
- Allow divers to focus on items that are covered by sediment or cannot be resolved by SSS imagery.

All dive operations will be conducted by two qualified boat operators, a Dive Supervisor, a Dive Tender, a Standby Diver, and a Diver. Site management ashore will be provided by a SUXOS, UXOQCS/UXOSO. All UXO Technicians will meet or exceed DDESB TP 18 requirements for their respective positions. In accordance with EM 385-1-1 30.A.03, surface supplied air (SSA) will be used for dive operations in the Investigation Area. SSA is the safest method for use in the

Hudson River due to the expected depth variations where SSA cannot be used. SSA conforms to USACE and OSHA 29 CFR Part 1910, Subpart T regulations. EM 385-1-1 30.C.01.c states SSA operations shall not be conducted against currents exceeding 1 knot.

The SSA Dive Station will be located on the dive platform in a barge configuration or dive boat anchored in place during anomaly reacquisition and investigation. Divers will also use snorkels in shallow water along the shoreline to maximize productivity while adhering to safety and accuracy in reporting.

Once the target of interest has been located by RTK GPS coordinates, the target will be marked by carefully lowering a weighted marker buoy as close to the fix as possible. The dive support vessel will be anchored in place to ensure precise locating. Due to anticipated positioning challenges at depth in the Hudson River, a 10-ft search radius will be used at each anomaly location.

The initial search is performed with an underwater magnetometer, a Fisher Aquanaut 1280x or the Minelab Excalibur II (or equivalent). Once the anomaly's signature is detected and pinpointed, tactile searching techniques will be used to investigate the outside edges. The use of hand tools may be needed to assist in exposing an edge or end of the object, making sure not to dig on top of the item. Dialogue and direction from the topside Dive Supervisor to the diver are maintained through in-water voice communications during all dives. Once the item is uncovered and properly characterized, the item is removed or left in place depending on the disposition of the anomaly discovered. Sediment samples will be collected by the divers at each reacquired anomaly location. In addition, if MEC/MPPEH item(s) are found to be damaged and/or heavily corroded via visible or tactile indications, sediment samples will be collected from 0 to 0.5 ft and 0.5 to 1 ft intervals below the item and surrounding the item at distances of 5 ft to the north, south, east, and west as detailed in Section 17.10.

If an item is located with potential cultural/historical significance the PDT, SHPO, NYSDEC Cultural Resource Manager, U.S. Military Academy West Point Cultural Resource Manager, and/or Museum Conservators will be consulted to determine whether the item(s) has cultural/historical significance and should be managed by and turned over to the appropriate authorities.

17.9 DFW 8: MPPEH/MEC HANDLING, CERTIFICATION, AND DISPOSAL

17.9.1 On-Shore Detonation Events

If acceptable to move, items will be brought to the water surface and transported on shore, to a location outside the tidal area, within the Seacoast Battery MRS, for treatment by detonation to render them safe. The anticipated demolition location is shown in **Figure 17-2**. An exclusion zone (EZ) will be set up around the detonation site. The detonations will be conducted at a safe distance from cultural features and threatened and endangered species habitats if located in the vicinity. If necessary, river traffic may be intermittently stopped from entering the area by a safety boat to keep other boats away. Recreational traffic/users on Constitution Island may be intermittently stopped from entering the EZ, following procedures in SOP 3 Traffic Control (**Appendix D**). The railroad schedule will be monitored to ensure that detonation is not occurring when a train is using the nearby tracks. MPPEH may be stored overnight under constant surveillance for later detonation, following procedures in SOP 4 MPPEH Storage (**Appendix D**). The buried explosion module (BEM) will be used to determine the appropriate mitigation procedures for detonations in order to contain the controlled detonation. BEM is an authorized DoD engineering control to prevent fragmentation from traveling great distance, to reduce the exclusion zone, and to reduce the noise of detonation.

All disposition activities will rely on the Explosives Site Plan (ESP) as guidance (**Appendix G)**. The disposition of MEC items by WESTON will be in accordance with the SOP 5 Demolition Operations (On-Shore) in **Appendix D** describing the procedures and communication chain for use upon the discovery of MEC items requiring demolition procedures. The anticipated method for disposition is demolition. Demolition activities will follow the requirements of the Explosives Management Plan (EMP) (**Appendix H**) and ESP (USACE, 2017), as well as EM 385-1-97 (USACE, 2013), and applicable Bureau of Alcohol, Tobacco, Firearms and Explosives, Federal, State, and local regulations.

MEC items will be guarded until disposal can be accomplished. A remote firing device will be used to ensure a controlled demolition shot for personnel safety during demolition operations. WESTON will coordinate with all agencies on notification roster prior to demolition activities and will not begin until all parties have been notified. The Demolition Notification Roster is presented in Attachment 2 of the EMP provided in **Appendix H**.

Transportation of items that are acceptable to move may be completed using small lift balloons and/or lifting lines. Consolidated shots may be performed, and multiple single shots also will be allowed. The maximum net explosive weight (NEW) at a collection point will be limited such that the K40 overpressure distance for the total NEW does not exceed the hazard fragment distance (HFD) for the area.

The SUXOS (or his designated assistant) will make the appropriate notifications for the demolition operations. The composition of the demolition team will be determined by the SUXOS and additional demolition team members may be added at the discretion of the SUXOS, if there are large quantities of MEC to detonate. Other non-demolition UXO personnel will provide EZ security to ensure the site is clear of all non-essential personnel or remain working if outside of EZ.

Only the demolition team, SUXOS, UXOSO/UXOQCS, and the OESS will be permitted in the area where demolition operations are being conducted.

All demolition materials will be accounted for on a Demolition Material Accountability Form (**Appendix B**). Only the estimated amount needed to complete the day’s demolition operations will be ordered from a local vender and transported to the work area. Prior to and after firing of the shot, a UXO-qualified technician will take photographs of demolition sites using a digital camera for presentation in the RI Final Report. At a minimum, the detonation points and general demolition site will be inspected by the UXOSO after each detonation, to ensure complete detonation of the item(s) and explosives to ensure that a misfire, low order, or kick-out has not occurred. The area where demolition operations are being conducted will remain secured until the demolition team leader or SUXOS gives the “all clear.”

A Data Quality Control Report (DQCR) will be completed daily by the UXOQCS and will cover all on-site tasks. SOP 5 Demolition Operations (On-Shore) (**Appendix D**) presents complete procedures and the Notification Call Tree.

17.9.2 Underwater Detonation Events

Based on the age, length of immersion, and sensitivity of the expected munition items, it is unlikely that an item will be deemed unsafe to move and require underwater detonation. However, based upon the determination that a military munition is unsafe to move and underwater detonations are deemed necessary, USACE, West Point, and NYSDEC will be notified upon discovery and confirmation that the item is unacceptable to move. If NYSDEC does not concur with the underwater detonation at the location or seasonal timing, this will be reported to USACE and West Point, who will work with NYSDEC to develop an appropriate course of action. A flowchart showing the detonation notification process is presented as **Figure 17-3**.

17.9.3 Munitions and Explosives of Concern Storage

In accordance with the ESP, explosives must be delivered on an on-call basis instead of being stored within a sited magazine. It is anticipated that temporary overnight storage of MPPEH awaiting treatment may be required during the project.

The procedures to be followed when overnight storage of MPPEH is needed are provided in SOP 4 in **Appendix D**.

17.9.4 MPPEH Management

All encountered material other than NMRD is initially classified as MPPEH. MPPEH procedures will follow DoD Instruction (DoDI) 4140.62 (DoD, 2015), EM 385-1-97 Chapter 11 (USACE, 2013), and EM 200-1-15 (USACE, 2015). The SUXOS and UXOSO/UXOQCS will be notified, and the UXO Technician III will begin a preliminary assessment. MPPEH will be assessed and its explosives safety status determined and documented prior to transfer within the DoD or release from DoD control. Prior to release to the public, MPPEH will be documented by authorized and technically qualified personnel as material documented as safe (MDAS) after a 100% inspection by the team leader and an independent 100% re-inspection by the SUXOS or UXOQCS to determine that it is safe from an explosives safety perspective.

17.9.4.1 MPPEH Documentation

The SUXOS will certify and the USACE OESS or UXOQCS will verify that debris is free of explosive hazards. If the OESS is not available, the UXOQCS will sign as the verifier. DD Form 1348-1A will be used as the certification/verification documentation. All DD 1348-1A forms will clearly show the typed or printed names of the SUXOS and OESS/UXOQCS, as well as the organization, signature, and home and field office telephone numbers for the persons certifying and verifying that the debris is free of explosive hazards. The form will state the following if only MD is being processed:

> *This certifies and verifies that the munitions debris listed has been 100 percent properly inspected and, to the best of our knowledge and belief, is inert and/or free of explosive hazards.*

If range-related debris is processed with MD, the form will state the following:

> *This certifies that the material listed has been 100 percent properly inspected and, to the best of our knowledge and belief, free of explosive hazards, engine fluids, illuminating dials, and other visible (HTRW) materials.*

The container will be closed and clearly labeled on the outside with the following information. The first container will be labeled with a unique identification that will start with USACE/Installation Name/Contractor Name/001/Seal Unique Identification information. Subsequent containers will be labeled sequentially. The SUXOS will ensure that a DD Form 1348-1A is completed for each container prior to transfer. The form will contain the following information:

- Location where material was obtained
- Basic material content (type of metal; for example, steel or mixed)
- Estimated weight
- Unique identification number of each container
- Seal identification number

In addition to the DD Form 1348-1A, MDAS shipments will be transferred to the recycler under a chain-of-custody (COC).

All material will be accounted for in the daily and weekly reports. After a military munition is certified as MDAS, the PDT, SHPO, NYSDEC Cultural Resource Manager, U.S. Military Academy West Point Cultural Resource Manager, and/or Museum Conservators will be consulted to determine whether the item(s) has cultural/historical significance and should be managed by and turned over to the appropriate authorities.

All MDAS, not deemed of cultural significance, will be disposed of at a recycler, where it will be processed through a smelter prior to resale or release in accordance with all governing regulations. If it is discovered during the material transfer and shipping process that a seal has been broken or the CoC of the material cannot be verified, the material in question will be subject to re-inspection following the established MPPEH process. The MDAS subcontractor will provide the following two documents:

1. CoC: Upon receiving the unopened labeled containers, each with its unique identified and unbroken seal ensuring a continued CoC, and after reviewing and concurring with all provided supporting documentation, the MDAS recycler will sign for having received and agreed with the provided documentation that the sealed containers contained no explosive hazards when received. The document will be signed on company letterhead and state that the contents of sealed containers will not be sold, traded, or otherwise given to another party until the contents have been smelted and are only identifiable by their basic content.

2. Certification of Destruction Letter: The MDAS recycler will send notification and supporting documentation verifying that the sealed containers have been smelted and are, therefore, only identifiable by their basic content. The documentation will be submitted as an appendix to the RI Final Report.

17.10 DFW 9: MC SAMPLING

The MC investigation is intended to determine whether sediment contains explosives or has elevated concentrations of selected metals relative to reference conditions that are associated with MEC and/or MPPEH items located within CMUAs and/or within non-CMUAs at MEC and/or MPPEH items that show signs of damage or heavy corrosion (outer casing failure) and visible signs of an MC release, or in low visibility scenarios, tactile signs of a potential MC release (e.g., cracks, holes). MC samples will be collected by divers using an Ogeechee slide hammer setup from Wildco® (or comparable) with support and close coordination with the Project Scientist or designee in the field in the dive support vessel. In addition, post-detonation samples will be collected. This will include one post-detonation sample collected from each of the land-based detonation areas at the conclusion of the field effort using 7-point composite sampling techniques with disposable sampling equipment. In addition, 7-pt composite samples will be collected from underwater detonation areas post-detonation.

17.10.1 Sediment Sampling Approach

Sediment core samples will be collected from 0 to 2 ft bgs by divers using an Ogeechee slide hammer setup from Wildco® (or comparable) equipped with a polycarbonate liner or, if conditions permit, with a polycarbonate liner alone. The 0 to 2 ft core will be used for collection of 0 to 0.5 ft, 0.5 to 1 ft, and 1 ft to 2 ft as specified below in Subsections 17.10.2 to 17.10.4. Core samplers are compact devices that can be reliably operated by divers and are capable of collecting representative samples across discrete intervals.

While ponar or other grab samplers are frequently used for surface sediment sampling, they are unwieldy, collect samples that contain more sediment from the upper horizon than the lower horizon, and are not capable of reliably sampling deeper intervals. If the sediments are fine-grained and do not offer resistance that would require the use of the Wildco® corer to achieve the target sampling depth interval, a polycarbonate liner may be used to collect samples by manually pressing the liner to the requisite depth, placing a cap on the top, and withdrawing the liner.

If unconsolidated sediment or flowing sands are not recovered with the corer or polycarbonate liner, a disposable core catcher will be used for adequate recovery. After collecting each sediment sample, the dive team will remove the polycarbonate liner from the corer (if used), apply end caps pre-labeled with sample identification and core orientation information, and place the sediment core in a basket for subsequent transfer to the surface and sample processing. The sediment cores will be stored and transported upright to minimize disturbance of the sediment.

During sample processing, the core sample will be subdivided, and subsamples of the 0 to 0.5 ft, 0.5 to 1 ft, and 1 to 2 ft intervals will be placed in polypropylene-lined paint trays for thorough mixing, using dedicated disposable scoops prior to transfer to pre-cleaned and labeled sample containers. Detailed descriptions of the sediment sampling equipment and step by step sampling procedures are provided in the SOP 6 Sampling Procedures (**Appendix D)**.

The Wildco® corer will be fitted with a disposable polycarbonate liner and secured by the nosepiece at each sampling location. However, the nosepiece and barrel will be decontaminated between sampling areas by washing with a bottle brush using a Liquinox/water solution and rinsing with deionized water. Because of logistical constraints associated with deep water sampling activities, decontamination of the Wildco® corer barrel and nosepiece between individual sampling locations within a discrete sampling area (i.e., CMUA or reference area) will be performed in situ by scrubbing the barrel and nosepiece with a bottle brush and rinsing in ambient river water before redeployment.

A flowchart showing the steps of the MC Sampling Approach is provided as **Figure 17-4,** and the steps are described in further detail below. It is noted that **Figure 17-4** does not include the post-detonation area sampling. These samples are described in Section 17.10.5.

17.10.2 Reference Area Sampling Methodology

Sediment core samples will be collected in a non-munitions impacted area upstream of the MRS to establish site-specific metal reference values for surface sediments. The reference dataset is intended to provide a basis for comparisons with metals data developed from sampling in the non-CMUA and CMUA(s) to establish whether elevated concentrations exist beneath or surrounding MEC or MPPEH items. An approximate location of the reference sampling area is provided on **Figure 17-5**. The reference area sampling grid is aligned perpendicular to the direction of river flow to span the range of expected sediment types expected to be encountered in the CMUA and non-CMUA areas based on a review of NYSDEC Hudson Estuary Program GIS mapping of sediment types and sediment environments within and immediately above the Investigation Area. Twenty (20) reference sediment samples will be collected from a depth of 0 to 2.0 ft below sediment surface at a reference area established upstream of the Investigation Area.

Although tidal flow could result in upstream transport and subsequent deposition of contaminated sediment, the predominant direction of any contaminated sediment migration from the site would be downstream of any CMUA(s). The proposed location of the reference area at approximately 0.5 mile above the northernmost MRS was selected to represent proximate sediment characteristics and reflect any metals loads associated with any point or non-point sources in Newburgh, NY. The proposed location of the reference area and grid configuration was selected to characterize variability associated with differing sediment composition types. Selection of a representative reference sampling area is complicated because the locations of any CMUAs within the project area are unknown. Therefore, the currently proposed locations will be re-evaluated after the intrusive investigation is completed, should MEC be found north of the MRS boundary, within or upgradient of the step-out area, indicating potential metals impacts. Therefore, the reference samples will be collected after the anomalies in the northern portion of the investigation area are resolved and the northern extent of the MRSs delineated. If a change to the reference locations is proposed, this information will be provided to USACE, West Point, and NYSDEC along with the rationale for the change.

The reference area sediment cores will be subsampled into discrete samples representing the 0 to 0.5 ft, 0.5 to 1.0 ft, and 1 to 2 ft depth intervals, if possible based on the thickness of the sediments. The 0 to 0.5 ft surface sediment interval is expected to be representative of current river sediment conditions at the most biologically relevant depth and samples from the surface sediment will be analyzed for metals. The deeper 0.5 to 1.0 ft and 1 to 2.0 ft interval samples will be archived pending decisions on the need for analysis. If CMUA and non-CMUA samples from the 0 to 0.5 ft depth beneath MEC or MPPEH items contain metals at concentrations exceeding both PALs and reference area metals UTLs for the surface (0 to 0.5 ft depth) sediments and the deeper samples require analysis, the archived 0.5 to 1.0 ft depth interval reference area sediment samples will also be designated for analysis. Should this interval also be contaminated, the archived 1.0 to 2.0 ft depth interval will be designated for analysis.

The number of sediment samples will be sufficient to establish a statistically-based reference value for the target metals.

Reference sediment samples will be analyzed for the metals listed in Worksheet #15. Surface sediment samples (0 to 0.5 ft depth interval) will also be collected from the reference area for analysis of the ancillary parameters (TOC, pH, and grain size) to support the evaluation of contaminant fate and transport, bioavailability related to risk assessment, and handling/treatment issues for the feasibility study, if necessary. Three sediment samples will be collected from the reference area for TOC, pH, and grain size analysis. Selection of sample locations for ancillary parameter analyses will be based on visual examination of sediments obtained from the reference area with the intent of characterizing the range of conditions encountered (i.e., sandy to silt/clay muds and mineral to organic).

Balduck's method, described in Appendix F of the *Screening and Assessment of Contaminated Sediment* guidance document (NYSDEC, 2014), will be used to determine the minimum number of samples required to characterize sediment contamination in any CMUAs identified in the Investigation Area. Balduck's method is the accepted Division of Fish, Wildlife, and Marine Resources (DFWMR) approach for screening and classifying sediments and assessing whether contaminants present in sediments at a given site have the potential to pose a risk to aquatic life. A dredging factor (Df) of 2, which is appropriate for sites with no previous sediment data but where there is a likelihood of contamination, will be used to estimate the minimum sample count necessary to characterize each CMUA. The size of the reference area and grid spacing will also be established based on Balduck's method (Df = 2) and a sample count of 20. A linear grid of nine (9) cells each measuring 69 yards x 69 yards (63 x 63 meters) and located perpendicular to river flow direction will be established as the reference area (42,829 square yards = 8.85 acres). By aligning the grid perpendicular to river flow, the reference area is expected to span differing erosional/depositional regimes present in the vicinity of the study area.

Prior to collecting sediment samples from the reference area, the starting corner of the grid will be located by RTK GPS coordinates, and the first sampling point (grid node) will be marked by carefully lowering a weighted marker buoy as close to the fix as possible. Then each sample /grid location will be determined by the diver measuring to the next point or by locating each location with the GPS and repeating the weighted buoy method, with close coordination between the boat and the diver. Sample collection procedures are described in Subsection 17.10.3 and in the SOP 6 (**Appendix D**).

Statistical evaluation of analytical results on sediment metals concentrations will include calculation of descriptive statistics, graphical examination by box plots, histograms, and quantile-quantile plots, and estimation of 95% upper tolerance limits (UTLs). If sediment metals concentrations within a CMUA exceed project screening levels, the dataset may also be used for comparisons of central tendency or position between CMUA dataset(s) and the reference area by hypothesis tests such as Student's-t test (if data are normally distributed) or the nonparametric Mann-Whitney (Wilcoxon Rank Sum) or Kruskal-Wallis tests.

17.10.3 CMUA Sampling Methodology

The size of the CMUA will initially be defined by using VSP to determine the extent of high density areas (potential CMUA). The final size determination of the CMUA will be defined by the diving operations (i.e., extent of identified MEC or MPPEH). In areas characterized as CMUAs, a transect-based sampling approach matching the geophysics transects with locations of anomalies identified as MEC or MPPEH items will be utilized to characterize the nature and extent of explosives and metals contamination and to make a decision on a CMUA-wide basis. The sampling approach will include collection of a sufficient number of samples to support statistical calculations. The dataset(s) developed from sampling in the CMUA(s) are intended for comparisons with PALs and reference area sediment concentrations to establish whether elevated concentrations exist beneath MEC or MPPEH items and to support the calculation of exposure point concentrations for use in the ecological and human health risk assessment.

The area of each CMUA will be used to determine the total number of samples needed to characterize the sediment conditions and support statistical evaluations in accordance with Balduck's method (NYSDEC, 2014). A dredging factor (Df) of 2 appropriate for sites with no previous sediment data but where there is a likelihood of contamination will be used to estimate the minimum sample count necessary to characterize each CMUA.

As described in Section 17.7, each anomaly identified within the randomly selected transect segments within a potential CMUA will be investigated by divers or ROV. Anomalies investigated by divers and determined to be MEC or MPPEH will be removed, and sediment core samples will be collected from 0 to 2 ft bgs beneath each of the removed items (to be split into to 0.5 ft, 0.5 to 1 ft, and 1 ft to 2 ft subsamples, if possible based on the thickness of the sediments). The determination that an item is MEC or MPPEH (as opposed to non-MEC items) may need to be done at the water surface due to potential poor visibility conditions. In this case, the sample will be collected for a decision to be made above water. Samples collected for single MEC and/or MPPEH items that show signs of damage or heavy corrosion (outer casing failure) and visible signs of an MC release will be considered in the spatial analysis and included in the total count of samples to represent the CMUA.

Samples collected from 0 to 0.5 ft beneath all MEC and/or MPPEH items that show signs of damage or heavy corrosion (outer casing failure) and visible signs of an MC release will be identified for MC analysis. Samples collected from beneath intact MEC items will be archived prior to selection of a subset for analysis. Selection of samples for analysis will be based on their spatial distribution within the boundaries of the CMUA to obtain a dataset representative of conditions within the CMUA. It is anticipated that samples collected from intact MEC/MPPEH or MEC and/or MPPEH items that show signs of damage or heavy corrosion (outer casing failure) and visible signs of an MC release will provide a sufficient number of samples to ensure the adequate spatial distribution within the CMUA.

The following samples will be submitted for analysis for the explosives and select metals listed in Worksheet #15:

- Samples collected from the 0 to 0.5 ft interval from beneath the selected intact MEC and/or MPPEH item locations.

- Samples from 0 to 0.5 ft interval beneath all MEC and/or MPPEH items that show signs of damage or heavy corrosion (outer casing failure) and visible signs of an MC release.

Subsurface samples from the 0.5 to 1 ft and 1 ft to 2 ft interval below anomalies collected for vertical delineation of contamination will be sent to the laboratory and archived (or extracted and held) for potential metals and explosives analysis if the 0 to 0.5 ft interval sediment samples contain explosives higher than PALs or metals at concentrations exceeding PALs and reference area UTLs.

If divers/ROV observe MEC and/or MPPEH items that show signs of damage or heavy corrosion (outer casing failure) and visible signs of an MC release or in low visibility scenarios, tactile signs of a potential MC release (e.g., cracks, holes), four additional 0 to 2 ft depth sediment cores (for 0 to 0.5, 0.5 to 1 ft, and 1 ft to 2 ft subsamples) will be collected if possible based on the thickness of the sediments in addition to the sediment core below the MEC item. These four samples will be collected from locations at distances of 5 ft to the north, south, east, and west of the damaged MEC item location. These samples will be archived and held for analysis pending the results of the samples collected underneath the items (or extracted and held) for potential metals and explosives analysis if sediment samples collected below the damaged MEC item contain explosives or metals at concentrations exceeding both PALs and reference area metals UTLs. MC results from these samples will be considered a separate dataset for potential evaluation of dataset outliers or to further evaluate the magnitude of releases from leaking items.

Data on the ancillary parameters (TOC, pH, and grain size) will also be collected within the CMUA(s) and the reference area to support the evaluation of contaminant fate and transport, bioavailability related to risk assessment, and handling/treatment issues for the feasibility study, if necessary. Three sediment samples from the 0 to 0.5 ft depth interval within each CMUA will be analyzed for TOC, pH, and grain size analysis. Selection of sample locations for ancillary parameter analyses will be based on the visual examination of sediments obtained from the CMUA with the intent of characterizing the range of conditions encountered (i.e., sandy to silt/clay muds and mineral to organic). In the event that MEC and/or MPPEH items showing signs of damage or heavy corrosion (outer casing failure) and visible signs of an MC release are encountered within a CMUA, samples from the 0-0.5 ft interval beneath the item(s) will be prioritized for ancillary parameter analyses.

If lead significantly exceeds both background and ecological PALs, then sediment samples will be submitted for AVS-SEM analyses, to be selected based on sample lead concentrations and sediment characteristics results. The additional volume of sediment required for AVS-SEM analysis will be collected at the same time as the sample aliquots for physical parameters (TOC, pH and grain size) and held pending lead analysis results. For sediment samples collected for analysis for physical parameters and AVS-SEM, additional volume will be necessary. This will be accomplished by two side-by-side cores. Laboratory analysis for AVS-SEM to assess bioavailability of lead will be considered if ecological PALs are exceeded, and analyses will be conducted in accordance with analytical SOP CA-738-03.

Data from initial analysis of selected sediment samples and any subsequent analysis of surrounding or deeper interval samples within the CMUA(s) will be compared with PALs and reference area UTLs (metals only) to support decisions regarding recommendations for the CMUA and further sampling if necessary. In addition, hypothesis tests for statistically significant differences in mean or median concentrations between CMUA(s) and the reference area may be performed if sediment metals concentrations within the CMUA(s) exceed project screening levels. Mean or median concentrations greater than the project screening levels would be considered elevated if the mean or median concentrations for the CMUA(s) are statistically significantly different (higher) than their respective reference area metrics based on the outcomes of hypothesis testing.

If MC is present within the CMUA at concentrations exceeding both PALs and reference area metals UTLs, and elevated concentrations within the CMUA(s) pose potential risk to human or ecological receptors, additional samples may be collected, as needed to support decisions for the CMUA. Proposed numbers and locations of additional samples will be based on the existing data and exposure pathways and will be presented in an MC sampling technical memorandum to West Point, USACE, USAEC, and NYSDEC for review.

17.10.4 Non-CMUA Sampling Methodology

In the Investigation Area not characterized as CMUAs, a subset of anomalies identified within the selected transect segments will be investigated by divers or ROV. Anomalies investigated by divers and determined to be MEC or MPPEH will be removed. Sediment samples will not be collected under intact MEC items encountered within the non-CMUA areas.

If divers/ROV observe MEC and/or MPPEH items that show signs of damage or heavy corrosion (outer casing failure) and visible signs of an MC release, or in low visibility scenarios, tactile signs of a potential MC release (e.g., cracks, holes), then a sediment core will be collected below the MEC and/or MPPEH item (for 0 to 0.5 and 0.5 to 1 ft interval samples), and four additional 0 to 2 ft depth sediment cores if possible based on the thickness of the sediments (for 0 to 0.5, 0.5 to 1 ft, and 1 to 2 ft interval samples) will be collected from locations at distances of 5 ft to the north, south, east, and west of the damaged MEC item location.

Samples collected from 0 to 0.5 ft interval beneath the damaged MEC and/or MPPEH items will be submitted for analysis for the explosives and select metals listed in Worksheet #15. Subsamples of the 0.5 to 1 ft and 1 ft to 2 ft interval beneath the damaged MEC and/or MPPEH items and the 0 to 0.5 ft, 0.5 to 1 ft, and 1 ft to 2 ft intervals from the surrounding four coring locations will be archived (or extracted and held) for potential metals and explosives analysis. If sediment subsamples of the 0 to 0.5 ft interval collected below the damaged MEC item contain explosives or metals at concentrations exceeding both PALs and reference area metals UTLs, then these additional samples will be analyzed for MC analytes that exceeded as detailed in Section 17.10.3.

The dataset(s) developed from sampling in non-CMUA(s) are intended for comparisons with PALs and reference area sediment concentrations to establish whether elevated concentrations exist beneath or surrounding damaged, corroded, or leaking MEC or MPPEH items and for use in assessing potential ecological and/or human health risks. Mean or median concentrations greater than the project screening levels would be considered elevated if the mean or median concentrations for the CMUA(s) are statistically significantly different from (higher than) their respective reference area metrics based on the outcomes of hypothesis testing.

The MC data for each MEC and/or MPPEH item that show signs of damage or heavy corrosion (outer casing failure) and visible signs of an MC release, or in low visibility scenarios, tactile signs of a potential MC release (e.g., cracks, holes) will be used collectively to make a decision for the non-CMUA area.

Data from the initial analysis of selected sediment samples and any subsequent analysis of surrounding or deeper interval samples will be compared with PALs and reference area UTLs (metals only) to support decisions regarding recommendations for the CMUA and further sampling if necessary. In the event that mean or median concentrations pose a potential risk to human or ecological receptors, the proposed numbers and locations of additional samples will be based on the existing data and exposure pathways and will be presented in an MC sampling technical memorandum to West Point, USACE, USAEC, and NYSDEC for review.

17.10.5 Post-Detonation Sampling Methodology

Composite sampling will be performed after completion of demolition operations, including underwater BIPs. Based on the use of engineering controls during the land demolitions and the presence of water over the underwater detonations (which is an effective engineering control), it is not anticipated that the distribution of MC from the detonation will exceed approximately one (1) meter in diameter. Therefore, the collection of a composite sample will adequately evaluate the distribution of MC.

Collection of composite samples will be performed using the seven (7)-point spoke and hub method consistent with Special Report 96-15 (Cold Regions Research Engineering Laboratory [CRREL], 1996). A central aliquot will be collected from center of the detonation area at a depth of 0-0.5 ft bgs. Six (6) additional aliquots will be collected at depths of 0-0.5 ft bgs in a radial distribution around the central aliquot. The distribution of the composite sample aliquots in the spoke and hub layout will be adjusted as necessary to account for irregular dispersion of MC. Samples will be analyzed for explosives as listed in Worksheet #15. Detailed descriptions of the composite sampling equipment and step by step sampling procedures are provided in the SOP 6 Sampling Procedures (**Appendix D)**.

Should explosives be detected above the screening levels in Worksheet #15, the impacted sediments/soils will be removed. A confirmation 7-pt composite sample will be collected to confirm that explosives remaining are below screening levels. If needed, the confirmation composite samples will be collected after the impacted sediment/soil are removed using the same seven (7)-point spoke and hub method as the initial composite sample. This process will be repeated until concentrations are below the screening levels in Worksheet #15.

17.10.6 Field Quality Control Samples

Field QC samples will be collected and will include field duplicates, MS/MSD samples, and equipment rinsate blanks. Field duplicates are collected to support assessment of variability in sediment concentrations associated with medium heterogeneity or sampling procedures. Equipment rinsate blanks are collected to demonstrate the effectiveness of decontamination procedures in preventing cross-contamination between sampling locations associated with non-disposable sampling equipment.

- **Field Duplicates** – Field duplicates will be collected from each of the sampling areas at a frequency of 1 per 10 samples submitted for laboratory analyses.
- **MS/MSD** – MS/MSD samples will be designated on the COC at a frequency of 1 per 20 samples submitted for laboratory analyses.
- **Equipment Rinsate Blanks** – Equipment rinsate blanks will be collected from the full decontamination of the Wildco® corer between sampling areas (CMUA(s) and reference area) using a Liquinox wash solution and deionized water rinse solution. Equipment rinsate blanks will be submitted for laboratory analysis of explosives, copper, lead, mercury, and zinc.

17.10.7 Investigation-Derived Waste

Investigation-derived waste (IDW) associated with sampling will include disposable scoops, paint tray liners, core liners and caps, and liquid generated by decontamination operations. Decontamination liquids will include a Liquinox/distilled water wash solution and a reagent grade water rinse solution generated during decontamination of the Wildco® corer between uses in different sampling areas. IDW procedures are detailed in SOP 7 IDW (**Appendix D)**. Waste streams may also include MDAS and sediment potentially impacted by detonations.

17.11 DFW 10: SITE RESTORATION

The majority of the field work will occur within the Hudson River, and no restoration of the Hudson River sediments is required for the intrusive investigation. However, should detonation in the water occur, restoration requirements will be coordinated with NYSDEC. On land, site restoration is limited to Constitution Island. Areas of the island that may be impacted included the detonation area(s), equipment/material staging areas, and roads/paths used to bring explosives or other materials to the site and used to access the demolition location. Site restoration will commence after the post-detonation sample results are received and evaluated. If explosives are below the screening levels in Worksheet #15, the sand used for engineering controls during the detonation activities will be spread around the site in a manner such that it matches with the surrounding grade and soils and does not impact vegetation growth if approved by West Point and the Constitution Island Caretaker. If explosives are above screening levels or if West Point directs the sand be removed from the, the sand will be transported off-site for disposal at an appropriate RCRA disposal facility. Constitution Island will be inspected for areas where damage from equipment or detonations may have occurred and these areas will be restored to their pre-RI conditions.

17.12 DFW 11: LABORATORY ANALYSIS

Laboratory analysis will be conducted according to the UFP-QAPP and all applicable SOPs listed in Worksheet #23.

17.13 DFW 12: DATA VALIDATION

Data validation procedures are detailed in Worksheet #36.

17.14 DFW 13: RISK EVALUATION

Risks from MC will be evaluated in accordance with EPA guidance. The evaluation will begin at the screening level with a point-by-point comparison of results from each sample to conservative screening levels selected to assess exposure risks (see Worksheet #15). Human health risks will be assessed in accordance with the December 1989, Interim Final *Risk Assessment Guidance for Superfund, Volume I, Human Health Evaluation Manual (Part A)* document (EPA 540-1-89-002). Ecological risks will be assessed in accordance with the June 1997 Interim Final *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessment* document (EPA 540-R-97-006/OSWER 9285.7-25).

Evaluation and selection of MRS-related chemicals of potential concern (COPCs) for human health and chemicals of potential ecological concern (COPECs) for ecological receptors will be performed during the initial screening to identify potential release areas that require further delineation of the extent of MC contamination. The MC observed at concentrations higher than risk screening levels will be identified as MRS-related COPC or COPEC for further quantitative assessment in accordance with EPA guidance.

17.14.1 Human Health Risk Assessment

To establish baseline risks to human health from MC detected during the RI, for the separate portions of the Investigation Area, a quantitative risk assessment will be performed and described in the RI Report. The Human Health Risk Assessment (HHRA) will be conducted in accordance with *EPA Risk Assessment Guidance for Superfund (RAGS) Volume I Part A* (EPA, 1989). The first step in evaluating human health concerns will be to identify COPCs through a comparison of the maximum detected chemical concentration to conservative project screening levels and reference area concentrations. An uncertainty analysis will be reported with the results of the human health evaluation. Consideration will be given to Investigation Area-specific reference concentrations of naturally occurring metals that are also MC associated with munitions to assist in appropriate management of identified risks.

The following general steps will be performed for the HHRA:

- Identify human receptors and hazards.
- Perform a toxicity assessment.
- Perform an exposure assessment.
- Estimate cancer risks and non-cancer hazards.

Potential human receptor(s) incorporated into the HHRA will be based on the interim CSM developed for the MRS (see Worksheet #10) and any further refinements that can be made based on RI observations and findings. Both current and reasonable foreseeable future activities/uses within the MRS will be considered and included in the HHRA. This information will serve as the basis for identifying the exposure points for COPCs and the exposure pathways to be quantitatively evaluated in the HHRA.

Discrete samples will be subject to a statistically-based analysis to calculate the 95% UCL (ProUCL 5.0.00 software [EPA, 2013a]) on the arithmetic mean of the sample population. The lower of the 95% UCL or the maximum concentration in the dataset will be used as the reasonable maximum exposure point concentration in determining risk. Both potential cancer risks and non-cancer risks to human health will be assessed. Cumulative cancer risks and, as appropriate, cumulative non-cancer hazards, will be calculated using the exposure parameters, toxicity values, and equations developed in the EPA RAGS documents and/or using the EPA's Integrated Risk Information System. Lead results will be evaluated using EPA's Integrated Exposure Uptake Biokinetic Child Lead Model and Adult Lead Model to estimate blood lead concentrations, rather than using toxicity values, and compared with the EPA-recognized target blood lead level of 10 micrograms per deciliter. (Note: The Centers for Disease Control target blood lead level was adjusted to 5 micrograms per deciliter in 2012; however, EPA has not yet adopted this value). Quantitative risk assessment information will be presented following EPA RAGS Part D format (EPA, 2001a). The Part D format provides a standardized approach for organizing and presenting HHRA information.

17.14.2 Ecological Risk Assessment

To determine whether adverse ecological effects are present within the separate portions of the Investigation Area as a result of MC detected during the RI, a quantitative Ecological Risk Assessment (ERA) will be performed, and the results presented in the RI Report. The ERA will be conducted in accordance with EPA *Ecological Risk Assessment Guidance for Superfund* (EPA, 1997) and *Environmental Quality - Risk Assessment Handbook Volume II: Environmental Evaluation* (USACE, EM 200-1-4, 31 December 2010). During the RI, observations regarding the environmental setting of the MRS will be used to verify potential receptors and exposure pathways assumed present and potentially complete as described in Worksheet #10. The screening-level assessment for evaluating ecological concerns will begin with a point-by-point comparison of detected chemical concentrations to project ESLs selected from conservative benchmarks (see Worksheet #15 for project screening levels). For aquatic habitat, the ESLs will include both literature-based and published screening levels for sediment, including threshold effect concentrations for sediment.

If none of the chemical concentrations in sediment samples exceeds the benchmark values, then it will be concluded that there is no significant risk to ecological receptors and no further investigation or action is required. The initial screening level evaluation for ecological risk will be used to identify COPECs. Review and reporting on the specific fate and transport dynamics at the Investigation Area based on the COPECs and complete exposure pathways identified to verify the assessment endpoints and CSMs for the portions of the Investigation Area will be included in the ecological evaluation. This portion of the ERA process is commonly referred to as Step 1 and Step 2, or a Screening Level ERA (SLERA). However, should any of the selected screening values be exceeded, then RI activities will proceed with a quantitative analysis as follows.

If necessary, a refinement step (Step 3a) will be incorporated in the SLERA, following Army (Tri-Service Environmental Risk Assessment Working Group. 2008. *A Guide to Screening Level Ecological Risk Assessment.* TSERAWG TG-090801) guidance and EPA (*The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments*. EPA 540/F-01/014. June 2001b) guidance that will further reduce the hazard quotients (HQ) generated using realistic exposure assumptions. This will be done before an ERA (Steps 3b through 7) will be proposed.

The list of COPECs will be refined, if warranted, based on chemical toxicity information and in consideration of the conservative assumptions (e.g., mean rather than maximum exposure concentrations, and low effect benchmarks, etc.) used during the screening level evaluation. Consideration will be given to Investigation Area-specific reference concentrations of metals that are also MC associated with military munitions to assist in appropriate management of identified risks. The Step 3a ecological evaluation will also include calculation of upper bound HQs using lowest observed adverse effect level (LOAEL) toxicity values. An HQ greater than 1.0 using a LOAEL-based toxicity value represents a dose that is expected to produce adverse population effects. For sediment, ecological HQs will be calculated using probable effect benchmarks to assess impacts to benthic invertebrates. This quantitative analysis will be used to identify adverse risks for further assessment or conclude with a finding of negligible ecological risk for the MRS. An uncertainty analysis will be reported with the results of the ecological evaluation.

A finding of known or suspected adverse ecological risks following completion of the screening-level evaluation will initiate a baseline ERA (Steps 3b through 7). If further baseline assessment of ecological risks is warranted, additional data collection will be planned during problem formulation (Step 3). Because the nature and extent of ecological risks are unknown, a Work Plan addendum will be prepared to detail additional data collection required, update the CSM, identify assessment end points, and state the hypotheses that will be used to complete the baseline ERA.

17.14.3 MEC Risk Assessment

If MEC is identified within the Investigation Area, a MEC Risk Assessment using the MEC Risk Management Matrices will be performed, to determine if the CMUA and/or non-CMUA has an acceptable or unacceptable risk to human receptors. The MEC Risk Assessment will be reported in the RI Report. The 3 January 2017 "Trial Period for Risk Management Methodology at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects" Memorandum is included in **Appendix E.**

17.15 DFW 14: DEMOBILIZATION

When the SUXOS and UXOQCS have documented that all intrusive investigation is complete, the UXOQCS will conduct a MPPEH/Explosives Records Assessment to ensure that all MPPEH and donor explosives are accounted for. MDAS will be properly documented and shipped off-site. Following successful completion of the records assessment and the site restoration activities (if needed), the tools, equipment, and safety gear will be shipped from the Investigation Area and personnel will demobilize. MC sampling will be conducted concurrently with the intrusive investigation dive work. However, if additional samples are needed, the dive team will remobilize, with the details to be included in an MC Technical Memorandum for approval by USACE, USAEC, West Point, and NYSDEC.

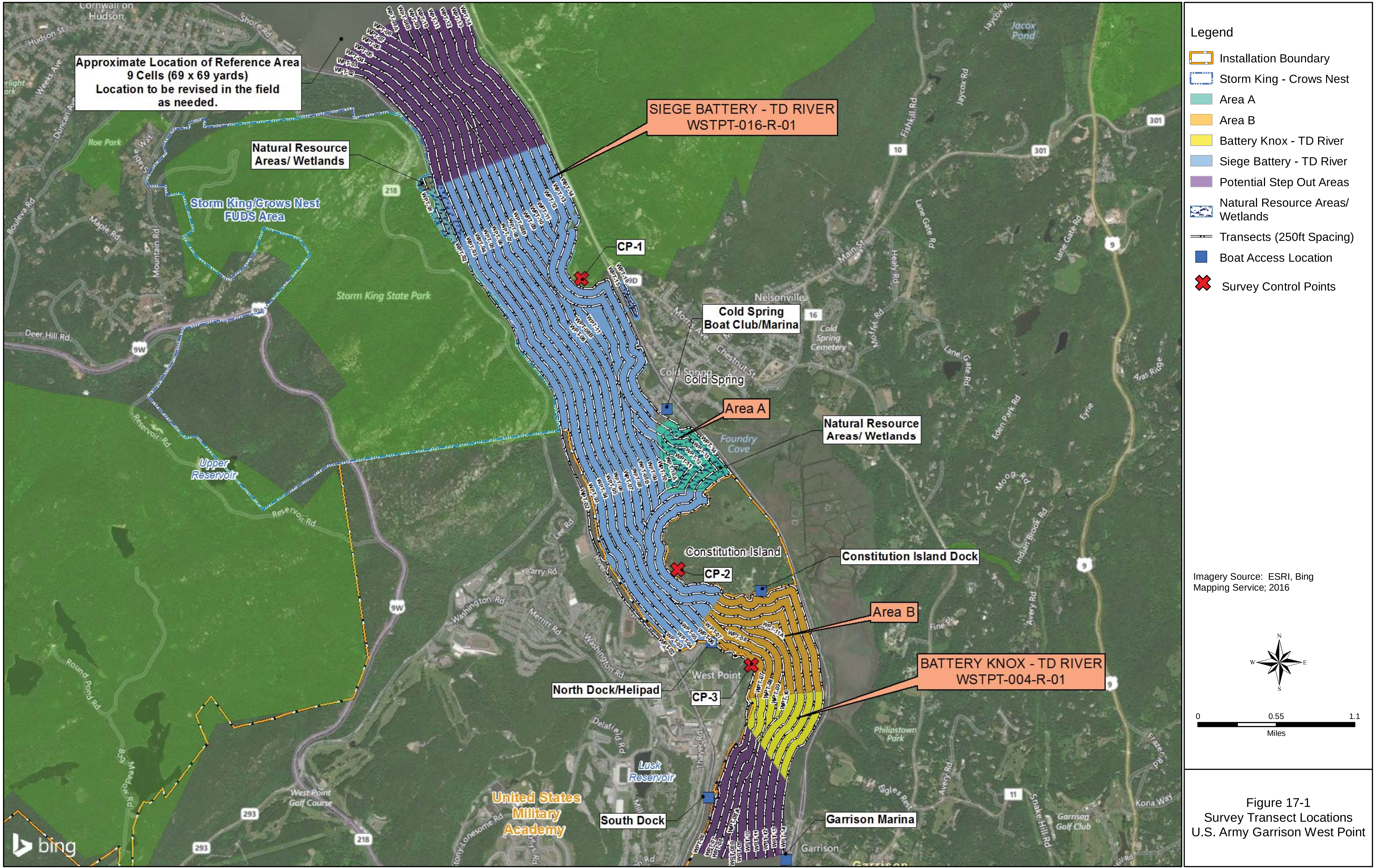

Figure 17-1
Survey Transect Locations
U.S. Army Garrison West Point

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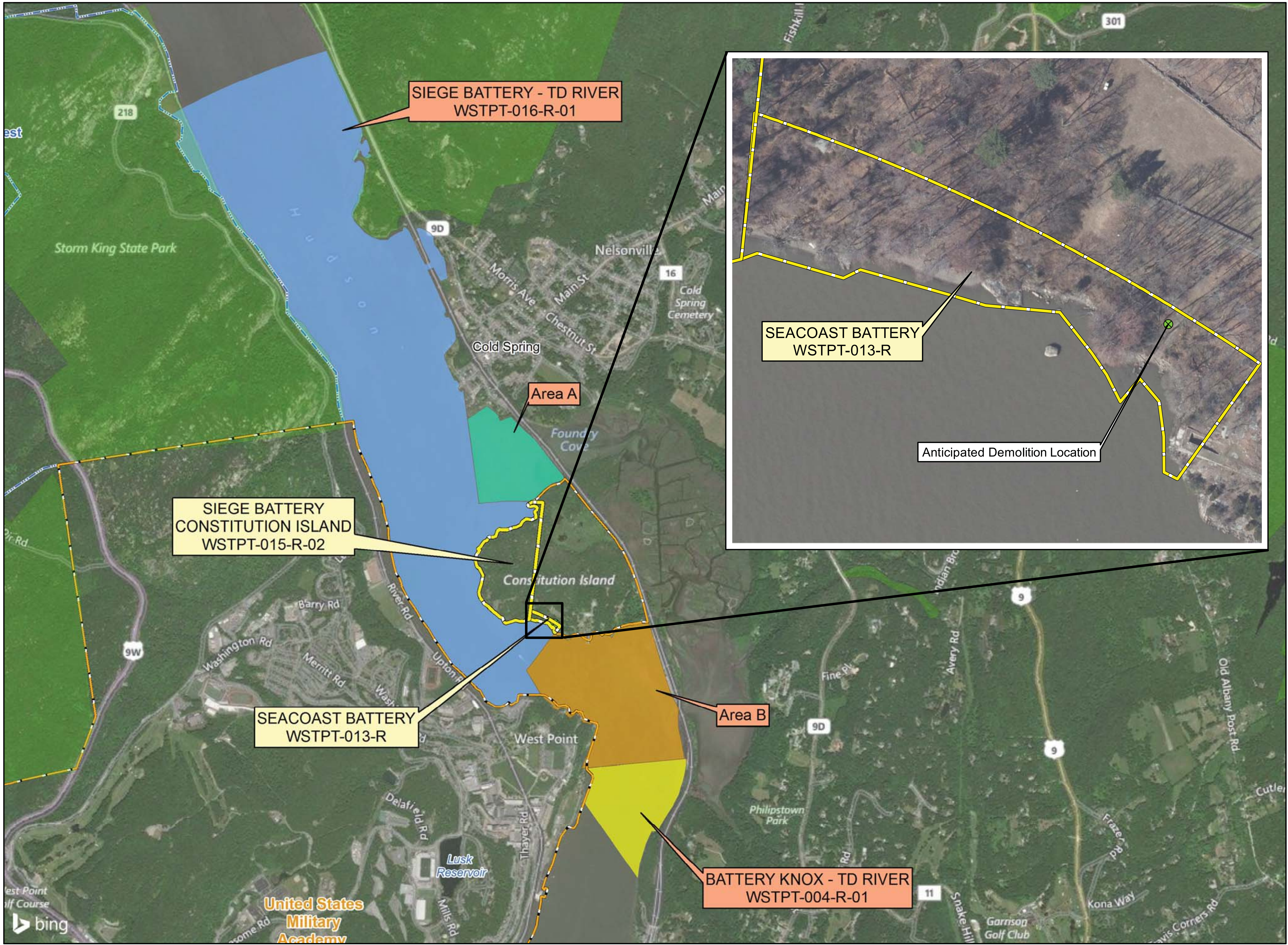

Legend

- Installation Boundary
- MRS Boundary
- Storm King - Crows Nest FUDS Area
- Area A
- Area B
- Battery Knox - TD River
- Siege Battery - TD River
- ⊗ Anticipated Demolition Location

Imagery Source: ESRI, Bing Mapping Service; 2016

N
W E
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0 0.5 1
Miles

Figure 17-2
Anticipated Demolition Location
U.S. Army Garrison West Point

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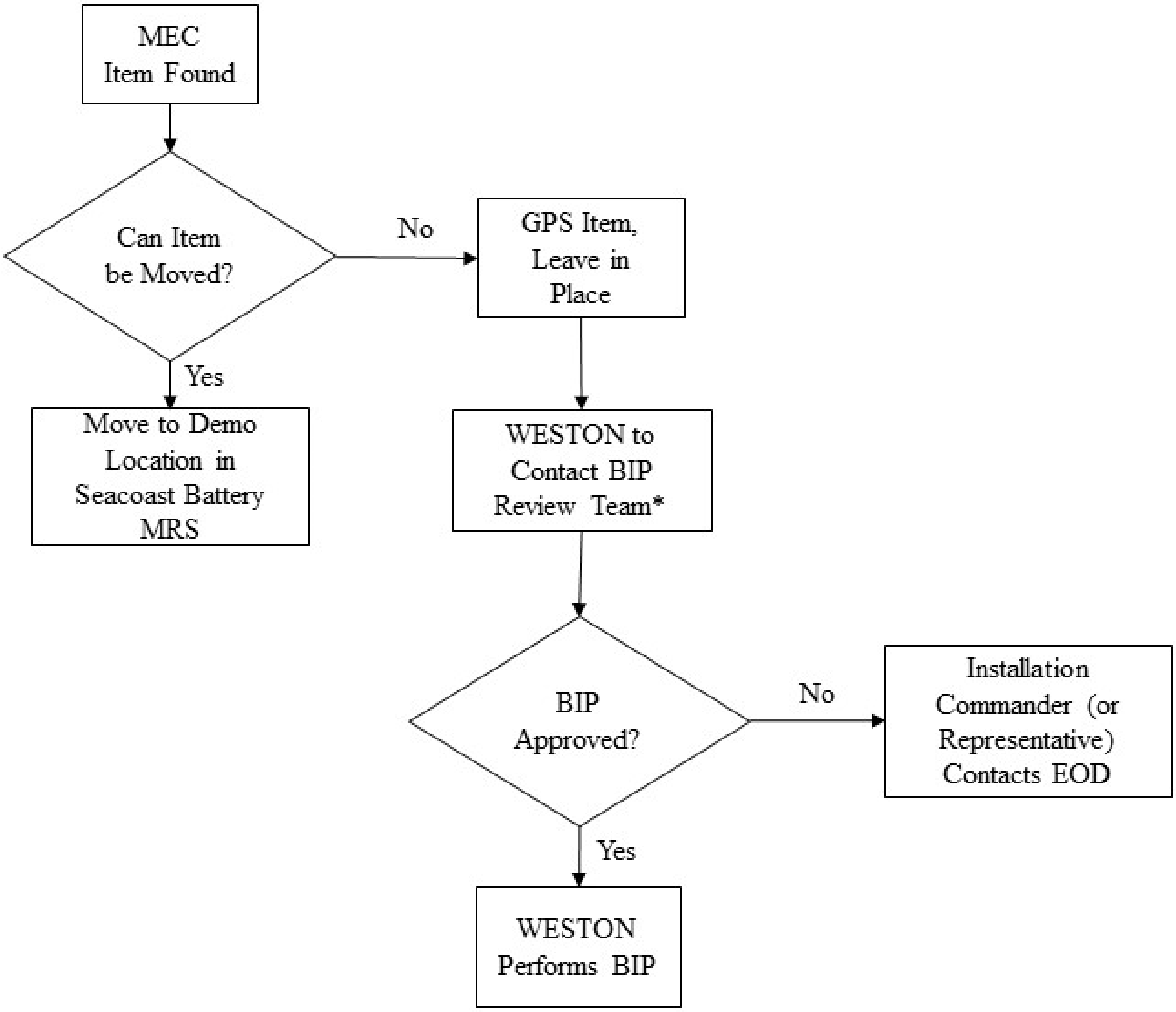
Figure 17-3 MEC Blow-in-Place Notification Flowchart



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Jeff Sanborn, West Point, 845-938-5041
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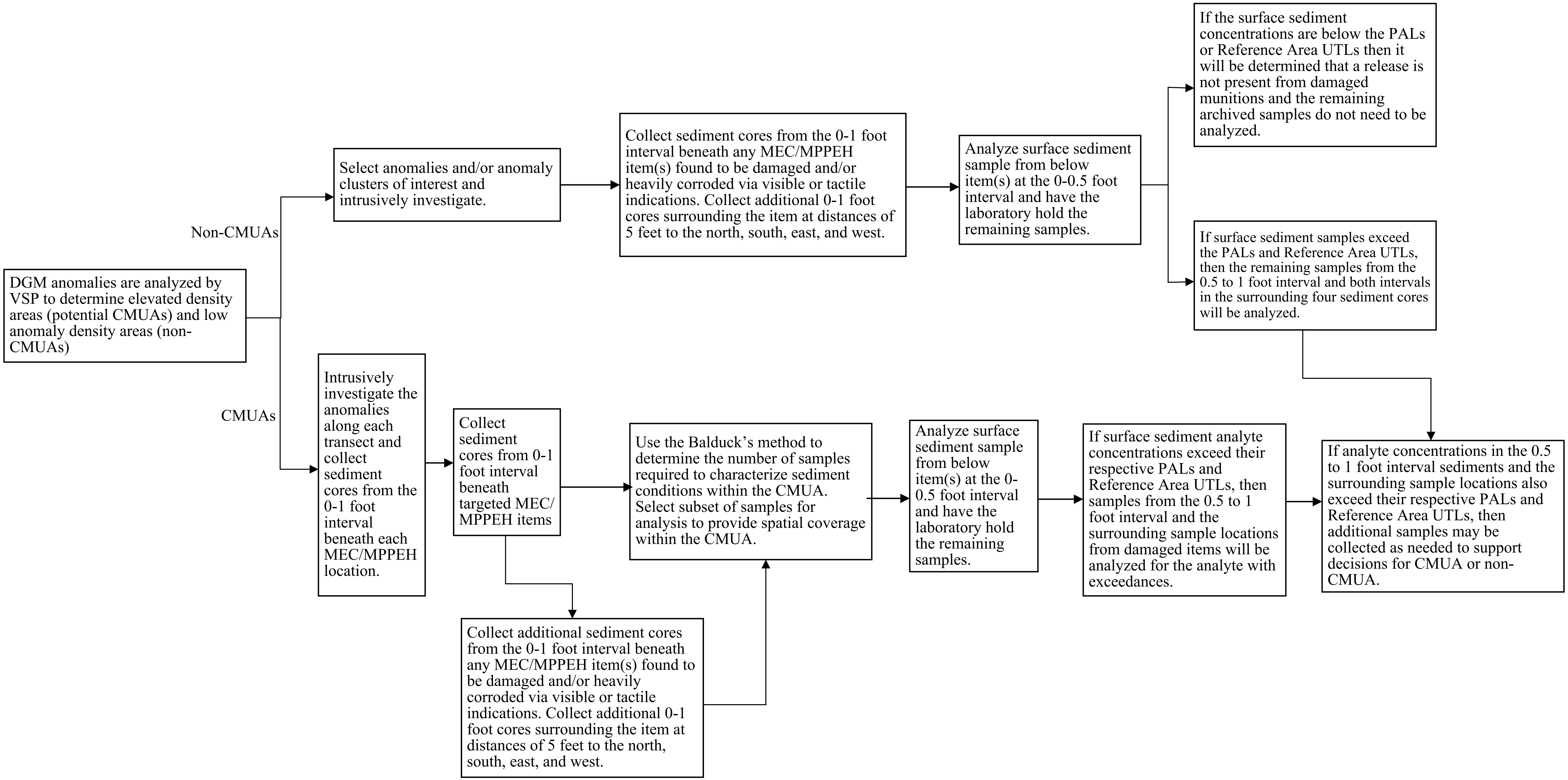
Dave Crosby, NYSDEC, 518-402-9662

Figure 17-4
MC Sampling Approach Flowchart



DGM anomalies are analyzed by VSP to determine elevated density areas (potential CMUAs) and low anomaly density areas (non-CMUAs)

Select anomalies and/or anomaly clusters of interest and intrusively investigate.

Collect sediment cores from the 0-1 foot interval beneath any MEC/MPPEH item(s) found to be damaged and/or heavily corroded via visible or tactile indications. Collect additional 0-1 foot cores surrounding the item at distances of 5 feet to the north, south, east, and west.

Analyze surface sediment sample from below item(s) at the 0-0.5 foot interval and have the laboratory hold the remaining samples.

If the surface sediment concentrations are below the PALs or Reference Area UTLs then it will be determined that a release is not present from damaged munitions and the remaining archived samples do not need to be analyzed.

If surface sediment samples exceed the PALs and Reference Area UTLs, then the remaining samples from the 0.5 to 1 foot interval and both intervals in the surrounding four sediment cores will be analyzed.

Intrusively investigate the anomalies along each transect and collect sediment cores from the 0-1 foot interval beneath each MEC/MPPEH location.

Collect sediment cores from 0-1 foot interval beneath targeted MEC/ MPPEH items

Collect additional sediment cores from the 0-1 foot interval beneath any MEC/MPPEH item(s) found to be damaged and/or heavily corroded via visible or tactile indications. Collect additional 0-1 foot cores surrounding the item at distances of 5 feet to the north, south, east, and west.

Use the Balduck's method to determine the number of samples required to characterize sediment conditions within the CMUA. Select subset of samples for analysis to provide spatial coverage within the CMUA.

Analyze surface sediment sample from below item(s) at the 0-0.5 foot interval and have the laboratory hold the remaining samples.

If surface sediment analyte concentrations exceed their respective PALs and Reference Area UTLs, then samples from the 0.5 to 1 foot interval and the surrounding sample locations from damaged items will be analyzed for the analyte with exceedances.

If analyte concentrations in the 0.5 to 1 foot interval sediments and the surrounding sample locations also exceed their respective PALs and Reference Area UTLs, then additional samples may be collected as needed to support decisions for CMUA or non-CMUA.

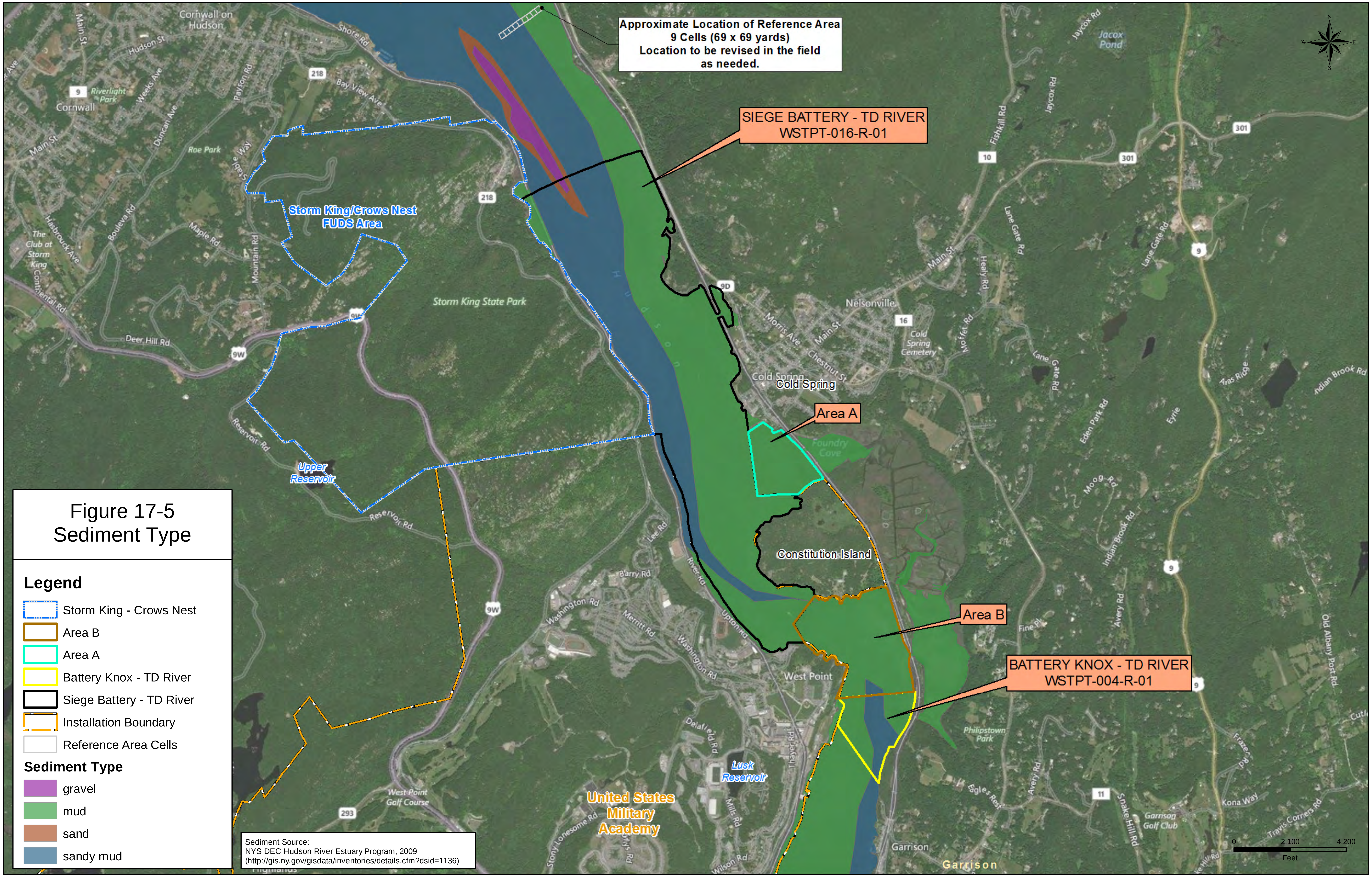


Figure 17-5
Sediment Type

Legend

- ⬚ Storm King - Crows Nest
- ⬚ Area B
- ⬚ Area A
- ⬚ Battery Knox - TD River
- ⬚ Siege Battery - TD River
- ⬚ Installation Boundary
- ⬚ Reference Area Cells

Sediment Type

- 🟪 gravel
- 🟩 mud
- 🟫 sand
- 🟦 sandy mud

Sediment Source:
NYS DEC Hudson River Estuary Program, 2009
(http://gis.ny.gov/gisdata/inventories/details.cfm?dsid=1136)

File: Y:\West_Point\mxd\WaterMRSs\Sediment_Type.mxd, 6/8/2018 11:11:08 AM, johna

WORKSHEET #18: SAMPLING LOCATIONS AND METHODS/SOP REQUIREMENTS TABLE

None of the Investigation Area sediment sample locations have been pre-determined. Sample locations will be determined based on whether a CMUA is identified or if an individual MEC item is identified with evidence of sediment contamination (sediment staining or leaking munition). **Table 18-1** presents the proposed types of samples, which will be determined based on site conditions.

Table 18-1 Soil/Sediment Sampling Information

Site Location	Example Sampling Location / ID Number (depth)	Matrix	Depths (inches bgs)	Analytical Group	Sample Type	Sampling SOP Reference	Rationale for Sampling Location
West Point: Siege Battery – TD River MRS	WP-SB-CMA001-SS06-00	Sediment	0-0.5 and 0.5-1.0. Deeper depths sampled on an as-needed basis	Metals, explosives, and physical characteristics (pH, grain size, TOC) and AVS/SEM	Laboratory sample	SOP 6	Identify MC sediment concentrations associated with CMUA
West Point: Battery Knox– TD River MRS	WP-BK-MEC001-SS06-00	Sediment	0-0.5 and 0.5-1.0. Deeper depths sampled on an as-needed basis	Metals, explosives, and physical characteristics (pH, grain size, TOC) and AVS/SEM	Laboratory sample	SOP 6	Identify MC sediment concentrations associated with MEC and sediment staining
West Point: Area A	WP-AA-MEC001-SS06-00	Sediment	0-0.5 and 0.5-1.0. Deeper depths sampled on an as-needed basis	Metals, explosives, and physical characteristics (pH, grain size, TOC) and AVS/SEM	Laboratory sample	SOP 6	Identify MC sediment concentrations associated with MEC and sediment staining

Table 18-1 Soil/Sediment Sampling Information (Continued)

Site Location	Example Sampling Location / ID Number (depth)	Matrix	Depths (inches bgs)	Analytical Group	Sample Type	Sampling SOP Reference	Rationale for Sampling Location
West Point: Area B	WP-AB-MEC001-SS06-00	Sediment	0-0.5 and 0.5-1.0. Deeper depths sampled on an as-needed basis	Metals, explosives, and physical characteristics (pH, grain size, TOC) and AVS/SEM	Laboratory sample	SOP 6	Identify MC sediment concentrations associated with MEC and sediment staining
West Point: Reference Area	WP-REF-REF001-SS06-00	Sediment	0-0.5 and 0.5-1.0. Deeper depths sampled on an as-needed basis	Metals and physical characteristics (pH, grain size, TOC)	Laboratory sample	SOP 6	Identify MC sediment concentrations associated with MEC and sediment staining
West Point: Post Detonation Areas (BIP)	WP-DET-MEC001-SS01-00	Sediment	0-0.5	Explosives	Laboratory sample	SOP 6	Confirm whether detonation activities have released explosives to the environment
West Point: Post Detonation Areas (Land-based Detonation Area)	WP-DET-DEMO001-SS01-00	Soil	0-0.5	Explosives	Laboratory sample	SOP 6	Confirm whether detonation activities have released explosives to the environment

The purpose of the field sample identifier (ID) is to provide additional information about the sample to end users of the data. It is expected that the approach will add supplemental value for users who are evaluating data in tabular form, without the benefit of any other spatial reference. Sample labels are required to properly identify samples and targets of interest. All samples and targets must be properly labeled with the field sample ID in accordance with SOP 8 COC (**Appendix D**). The sample IDs will be recorded in the site logbook, the chain-of-custody, and the shipment documents in accordance with relevant SOPs.

Table 18-1 Soil/Sediment Sampling Information (Continued)

The sample ID will be composed of five components:

[__ _] [_ _] [___] [_ _] [_ _]

1 2 3 4 5

Component 1 – Defines the project and program the work relates to:

WP – West Point

Component 2 – Defines the remediation area or property:

SB – Siege Battery

BK – Battery Knox

AA – Area A

AB – Area B

REF – Reference Area

DET – Post-Detonation Sample

Note: If any of the samples overlap areas, then the component 2 will be consistently used for the majority of samples

Component 3 – Defines the sample or target location type and number (starting at 001):

CMA001 – Concentrated Munitions Use Area

MEC001 – Individual MEC

REF001 – Reference Area

RDW001 – Investigation Derived Waste container

DET001 – Land-based Detonation Area

Component 4 – Defines the sample type, depth, or date of sample collection:

SS01 = surface sediment, 0 to 0.5 ft depth

SB02 = subsurface sediment, 0.5 to 1.0 ft depth

Table 18-1 Sediment Sampling Information (Continued)

Component 5 – Defines the Quality Assurance sample type:

00 = primary sample no. 1

01 = field duplicate sample

02 = equipment blank, submitted as EB01-MMDDYY-01 (where “01” can increase sequentially if more than 1 blank per day is used and “MMDDYY” indicates the date submitted)

An example of typical sample ID nomenclature is WP-SB-CMA001-SS01-00. The “WP” indicates a sample collected for West Point. The “SB” indicates a sample or target of interest at the Siege Battery–TD River MRS. The “CMA001” indicates that it is concentrated munitions use area location number 1 at that MRS. The “SS01” indicates that it is surface sediment collected from between 0 and 6 inches bgs. The “00” identifies the sample as a primary sample.

WORKSHEETS #19 & 30: SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES

Primary Laboratory: Katahdin Analytical Services, LLC, 600 Technology Way, Scarborough, ME 04074. Phone number: 207-874-2400
Accreditations/Certifications: DoD Environmental Laboratory Accreditation Program (ELAP) (Laboratory Certificate No. L2223; expiration date 2/1/2019)

Sample Delivery Method: FedEx or Other Overnight Carrier

Matrix	Analytical Group[1]	Analytical and Preparation Method/SOP Reference[2]	Containers (number, size, and type)	Sample Volume[3] (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[4] (preparation/ analysis)
Sediment or Soil	Explosives	SW846 8330B/CA-548 (preparation) and CA-402 (analysis)	Two 8-oz wide-mouth jars	10 g	Cool to ≤ 6 °C	14 days to extraction, 40 days to analysis
	Metals	SW846 3050B (preparation), 6010C (analysis)/ CA-605, CA-608		2 g	None	6 months to analysis
	Mercury	SW846 7471B/ CA-611		0.6 g	Cool to ≤ 6 °C	28 days to analysis
	Total Organic Carbon (TOC)	Determination of Total Organic Carbon in Sediment (Lloyd Kahn Method), EPA Region II/ CA-741	2-oz wide-mouth jar	0.5 g	Cool to ≤ 6 ° C	14 days to analysis
	Acid Volatile Sulfide-Simultaneously Extracted Metals (AVS-SEM)	USEPA Draft Analytical Method for Determination of Acid Volatile Sulfide in Sediment, 821-R-91-100/CA-738	2-oz wide-mouth jar	10g	Minimize headspace to protect sample from oxygen, Cool to ≤ 6 ° C	14 days to analysis
	Grain Size	ASTM D422/CA-551	8-oz wide-mouth jar	200 g	Cool to ≤ 6 ° C	None
	pH	SW846 9045D/CA-709	4-oz wide-mouth jar	25g	Cool to ≤ 6 ° C	28 days to analysis

WORKSHEETS #19 & 30: SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES (CONTINUED)

Matrix	Analytical Group[1]	Analytical and Preparation Method/SOP Reference[2]	Containers (number, size, and type)	Sample Volume[3] (units)	Preservation Requirements (chemical, temperature, light protected)	Maximum Holding Time[4] (preparation/ analysis)
Water (Equipment Blanks)	Explosives	SW846 8330B/ CA-548 (preparation) and CA-402 (analysis)	Two 1-liter amber glass	1 L	Cool to ≤ 6 °C	7 days to extraction, 40 days to analysis
	Metals	SW846 3010 (preparation), 6010C (analysis)/CA-604, CA-608	250-mL HDPE bottle	50 mL	HNO_3 to pH <2, Cool to ≤ 6 °C	180 days
	Mercury	SW846 7470A/CA-615		25 mL		28 days

Notes:
[1] Refer to Worksheet #15 for specific target analytes.
[2] Refer to the Analytical SOP References table (Worksheet #23).
[3] Minimum sample volume requirement.
[4] Maximum holding time is calculated from the time the sample is collected to the time the sample is extracted, digested, or analyzed.

WORKSHEET #20: FIELD QUALITY CONTROL SAMPLE SUMMARY TABLE

Matrix	Analytical Group[1]	Analytical and Preparation Method/ SOP Reference[2]	No. of Samples	No. of Field Duplicates	No. of MS/MSD	No. of Field Blanks	No. of Equipment Blanks[3]	No. of Trip Blanks	Other[4]	Total No. of Analyses
Sediment	Metals	SW-846 6010C/7471B	TBD[1]	One per 10 samples per event	One per 20 samples	One per 20 samples per event	TBD	0	0	TBD
Sediment or Soil	Explosives	SW-846 8330B	TBD[1]	One per 10 samples per event	One per 20 samples	One per 20 samples per event	TBD	0	0	TBD

Notes:

[1] QC samples are not required for physical characteristics (pH, grain size, TOC), AVS/SEM, or equipment blanks.

[2] The number of samples is estimated and may be less than or greater than the numbers shown above. The actual number will be determined from conditions and results observed in the field (for example, stained sediment under confirmed anomaly or confirmed MEC item) and analytical results of initial sediment samples, for example if step out samples are necessary or if sediment removal is warranted and confirmation samples need to be collected.

[3] Equipment blanks will only be collected if non-disposable material is used. Equipment rinsate blanks will be collected from the full decontamination of the Wildco® corer between sampling areas (CMUA(s) and reference area) using a Liquinox wash solution and deionized water rinse solution

[4] Proficiency testing (PT) samples are not planned at this time unless requested by EPA or USACE.

WORKSHEET #21: FIELD STANDARD OPERATING PROCEDURES

Reference Number	Title, Revision Date and/or Revision Number	SOP Originating Organization	Related Equipment Types	Modified for Project? (Y/N)	Comments
Alpine-SOP-1	IVS Installation and Use, Rev 0.0	Alpine	TVG. ISOs. Analog geophysical instrument (such as a Fisher Aquanaut 1280x or the Minelab Excalibur II).	N	
Alpine-SOP-2	Multibeam Hydrographic Surveys, 12 Oct 2017, Rev 1.0	Alpine	Marine Multibeam sensor	N	
Alpine-SOP-3	UXO - Marine Magnetometer Surveys, 14 Oct 2017, Rev 1.0	Alpine	TVG	N	
Alpine-SOP-4	UXO – ROV Sonar Inspection	Alpine	Sirio Inspection Class ROV	N	
Alpine-SOP-5	Side Scan Sonar Surveys, 14 March 2016, Rev 0.0	Alpine	Side Scan Sonar	N	
EOTI-SOP-1	Underwater Data Collection for UXO	EOTI	Underwater digital camera. GPS. All-metals detector.	N	
EOTI-SOP-2	Defibrillator Usage	EOTI	Automated External Defibrillator.	N	
EOTI-SOP-3	MPPEH Management	EOTI	MDAS containers (e.g., 55-gallon drums), container handling equipment as required, seals, logbook and/or PDA for recording data, camera, communications equipment.	N	
EOTI-SOP-4	Safe to Move Procedures for UXO	EOTI	Individual dive gear, diver through water communications system, GPS, MineLab Excalibur II underwater all-metals detectors (or comparable), support boats, Pelican floats (or equivalent), log book, approved hand tools for excavation.	N	

WORKSHEET #21: FIELD STANDARD OPERATING PROCEDURES (CONTINUED)

Reference Number	Title, Revision Date and/or Revision Number	SOP Originating Organization	Related Equipment Types	Modified for Project? (Y/N)	Comments
EOTI-SOP-5	Tethered Diving	EOTI	Individual dive gear, diver through water communications system, GPS, MineLab Excalibur II underwater all-metals detectors (or comparable), support boats, Pelican floats (or equivalent), log book, approved hand tools for excavation.	N	
EOTI-SOP-6	Underwater Magnetometer Operations Verification for UXO	EOTI	FISHER 1280-X AQUANAUT underwater all-metals detector, log book, indelible pen, IVS	N	
WESTON-SOP-1	Natural and Cultural Resource Monitoring	WESTON	Camera. GPS log book, indelible pen	N	
WESTON-SOP-2	Mobilization/Demobilization	WESTON	Field camera, Log book, Level D PPE, Planning Documents,	N	
WESTON-SOP-3	Traffic Control	WESTON	Two hand-held stop signs, Two “Road Work Ahead” signs, Two “Be Prepared to Stop” signs, Two “End Road Work” signs, Two traffic flagger signs, reflective vests, Two-way radios (cell phones will be used for backup communication), Camera, Log Book, Safety Boat for river traffic.	N	
WESTON-SOP-4	Overnight MPPEH Storage	WESTON	Radio and/or cellular phone, Flashlight, Megaphone, Camera, Log Book, Level D PPE	N	

WORKSHEET #21: FIELD STANDARD OPERATING PROCEDURES (CONTINUED)

Reference Number	Title, Revision Date and/or Revision Number	SOP Originating Organization	Related Equipment Types	Modified for Project? (Y/N)	Comments
WESTON-SOP-5	Demolition Operations (On-Shore)	WESTON	Level D PPE – no nylon, Log Book, Remote Firing Device, Donor Explosives.	N	
WESTON-SOP-6	Sampling Procedures	WESTON	Wildco® core sampler with polycarbonate liners, polycarbonate tube (liner) sampler.	N	
WESTON-SOP-6	Sampling Procedures	WESTON	Disposable trowels	N	
WESTON-SOP-7	IDW Management	WESTON	UN-certified and DOT-authorized drums or other containers, Funnels, 5-gallon buckets, Labeling material, Sampling materials (i.e., scoops/trowels, containers, labels, cooler and shipping supplies), Logbook	N	
WESTON-SOP-8	Chain-of-Custody	WESTON	Chain-of-custody forms, Custody seals, Sample labels, Pen, Markers, Tape, Scissors, Fiber strapping tape, Ice, Waterproof cooler, Waterproof plastic resealable bags, Garbage bags, Paper towels, Bubble wrap, “peanuts”, or other inert packing material, Air bills, Up arrows, Dangerous Goods Shipping, Paperwork (if applicable), Temperature blank (if applicable).	N	

WORKSHEET #22: EQUIPMENT TESTING, INSPECTION, AND QUALITY CONTROL

The worksheet documents procedures for performing testing, inspections, and quality control for all field data collection activities.

WORKSHEET 22A-1: MAPPING SURVEY (INSTRUMENT: MULTIBEAM AND SSS)

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified By	Acceptance Criteria	Failure Response
Verify correct assembly	Alpine-SOP-2, Multibeam Hydrographic Surveys Alpine-SOP-4, UXO – ROV Sonar Inspection Alpine-SOP-5, UXO – Side Scan Sonar Surveys	Once following assembly	Field Geophysicist / Project Geophysicist	As specified in applicable SOPs	Root Cause Analysis/ Corrective Action (RCA/CA): Make necessary adjustments and re-verify.
In-line measurement spacing	Alpine-SOP-2, Multibeam Hydrographic Surveys Alpine-SOP-5, UXO – Side Scan Sonar Surveys	Verified for each survey unit using Caris HIPS and SIPS geospatial software	Project Geophysicist/ running QC summary/Senior Geophysicist	98% ≤ 0.25 m between successive measurements	RCA/CA
Survey speed	Alpine-SOP-2, Multibeam Hydrographic Surveys Alpine-SOP-5, UXO – Side Scan Sonar Surveys	Verified for each survey unit using Caris HIPS and SIPS	Project Geophysicist/ running QC summary/Senior Geophysicist	95% within maximum project design speed or demonstrated speed	

WORKSHEET 22A-2: DGM SURVEY (INSTRUMENT: TVG)

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
Verify correct assembly	Alpine-SOP-1, IVS Installation and Use Alpine-SOP-2, Multibeam Hydrographic Surveys Alpine-SOP-3, UXO - Marine Magnetometer Surveys Alpine-SOP-4, UXO – ROV Sonar Inspection Alpine-SOP-5, UXO – Side Scan Sonar Surveys	Once following assembly	Field Geophysicist/ Project Geophysicist	As specified in applicable SOPs	RCA/CA: Make necessary adjustments and re-verify.
Initial sensor function test	Alpine-SOP-3, UXO - Marine Magnetometer Surveys Alpine-SOP-4, UXO – ROV Sonar Inspection	Once following assembly	Field Geophysicist/ Project Geophysicist	As specified in applicable SOPs	RCA/CA: Make necessary adjustments and re-verify.
Initial detection survey positioning accuracy (IVS)	Alpine-SOP-1, IVS Installation and Use	Once prior to start of dynamic detection survey data acquisition	Project Geophysicist/IVS Memorandum/Senior Geophysicist	Along line derived positions of IVS target(s) are within 0.5 meters of the ground truth locations	RCA/CA: Make necessary adjustments and re-verify.
Ongoing instrument function test	Alpine-SOP-1, IVS Installation and Use	Beginning and end of each day and each time instrument is turned on	Field Geophysicist/ Running QC Summary/ Project or Senior Geophysicist	As specified in applicable SOPs	RCA/CA: Make necessary adjustments and re-verify.

WORKSHEET 22A-2: DGM SURVEY (INSTRUMENT: TVG) (CONTINUED)

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/Report Method/Verified by	Acceptance Criteria	Failure Response
Ongoing positioning precision (IVS)	Alpine-SOP-1, IVS Installation and Use	Beginning and end of each day	Project Geophysicist/ Running QC Summary /Senior Geophysicist	Along line derived positions of IVS target(s) within 0.5 meters of the average locations	RCA/CA
In-line measurement spacing	Alpine-SOP-3, UXO - Marine Magnetometer Surveys	Verified for each survey unit using Geosoft Sample Separation QC tool	Project Geophysicist/ Running QC Summary/ Senior Geophysicist	98% ≤ 0.25 m between successive measurements	RCA/CA
Sensor Altitude	Alpine-SOP-3, UXO – Marine Magnetometer Surveys	Verified for each survey unit	Project Geophysicist/ Running QC Summary/ Senior Geophysicist	Determined during initial IVS testing	RCA/CA
Survey Speed	Alpine-SOP-3, UXO - Marine Magnetometer Surveys	Verified for each survey unit using Geosoft Sample Velocity QC tool	Project Geophysicist/ Running QC Summary/ Senior Geophysicist t	95% within maximum project design speed or demonstrated speed	
Coverage	Alpine-SOP-3, UXO - Marine Magnetometer Surveys	Verified for each survey unit using Geosoft Foot Print Coverage QC tool	Project Geophysicist/ Running QC Summary/ Senior Geophysicist	90% within project designed cross-track measurement spacing (excluding site-specific access limitations, e.g., obstacles, unsafe terrain)	RCA/CA
DGM detection survey performance	Alpine-SOP-3, UXO - Marine Magnetometer Surveys	Evaluated by survey unit	Project Geophysicist/ Running QC Summary/ Senior Geophysicist	All blind QC seeds must be detected and positioned within 0.5m (+/-1% of water depth) down-line of ground truth	RCA/CA

WORKSHEET 22A-3: INTRUSIVE INVESTIGATION

Measurement Quality Objective	DFW/SOP Reference	Frequency	Responsible Person/ Report Method/ Verified By:	Acceptance Criteria	Failure Response
Verify correct assembly	DFW 6/EOTI SOP 06	Once following assembly	Field Geophysicist/ Project Geophysicist	As specified in applicable SOPs	RCA/CA: Make necessary adjustments and re-verify.
Initial sensor function test	DFW 6/EOTI SOP 06	Once following assembly	Field Geophysicist/ Project Geophysicist	As specified in applicable SOPs	RCA/CA: Make necessary adjustments and re-verify.
Ongoing instrument function test	DFW 6/EOTI SOP 06	Beginning and end of each day and each time instrument is turned on	Field Geophysicist/ Running QC Summary/ Project or Senior Geophysicist	As specified in applicable SOPs	RCA/CA: Make necessary adjustments and re-verify.

WORKSHEET 22A-4: MC SAMPLING

Field Equipment	Maintenance Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference
Sampling Tools (Wildco Corer)	NA	Check for obvious defects or broken parts	Prior to use	NA	Replace	Field personnel	Worksheet #17; SOP 6 Sampling Procedures
Mixing containers with Disposable liners	Check liners for tears/holes.	Visually inspect for cleanliness	Prior to use	NA	Decontaminate prior to re-use. Replace liner	Field personnel	Worksheet #17; SOP 6 Sampling Procedures
Sampling Tools (disposable trowels)	NA	Visually inspect for cleanliness	Prior to use	NA	Replace	Field personnel	Worksheet #17; SOP 6 Sampling Procedures

WORKSHEET #23: ANALYTICAL SOP REFERENCES TABLE

Katahdin SOP Number	Title, Revision Date, and Number[1]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work?[2] (Y/N)
CA-402	Determination of Nitroaromatics and Nitramines by HPLC Method 8330, 03/17, Revision 10.	Definitive	Sediment / Explosives	High-performance liquid chromatography (HPLC)	No Variance	N
CA-548	Preparation of Aqueous and Solid Samples for Explosive Analysis by Method 8330, 10/17, Revision 4.	Definitive (Preparation)	Sediment and Water / Explosives	Not applicable	No Variance	N
CA-551	Grain Size Analysis, 09/17, Revision 1.	Definitive	Sediment/ Grain Size	Sieves	No Variance	N
CA-604	Acid Digestion of Aqueous Samples by EPA Method 3010 for ICP and ICP-MS Analysis of Total or Dissolved Metals, 09/17, Revision 8.	Definitive (Preparation)	Water / Metals	Not applicable	No Variance	N
CA-605	Acid Digestion of Solid Samples by EPA Method 3050 For Metals Analysis By ICP-AES, ICP-MS, 09/17, Revision 7.	Definitive	Sediment / TAL Metals	Not applicable (digestion)	No Variance	N
CA-608	Trace Metals Analysis By ICP-AES Using EPA Method 6010, 09/17, Revision 18.	Definitive	Sediment / TAL Metals	Inductively Coupled Plasma (ICP) – Atomic Emission Spectroscopy (AES)	No Variance	N
CA-611	Digestion and Analysis of Solid Samples for Mercury by EPA Method 7471, 10/17, Revision 11.	Definitive	Sediment / Mercury	Mercury Analyzer	No Variance	N
CA-615	Digestion and Analysis of Aqueous Samples for Mercury by EPA Method 7470, 09/17, Revision 9.	Definitive	Water / Mercury	Mercury Analyzer	No Variance	N
CA-709	pH Concentration Measurements in Soil Matrices – SW 846 Method 9045, 08/16, Revision 11.	Definitive	Sediment / pH	pH Meter	No Variance	N

WORKSHEET #23: ANALYTICAL SOP REFERENCES TABLE (CONTINUED)

Katahdin SOP Number	Title, Revision Date, and Number[1]	Definitive or Screening Data	Matrix and Analytical Group	Instrument	Variance to QSM	Modified for Project Work?[2] (Y/N)
CA-738	Determination of Acid Volatile Sulfide and Simultaneously Extractable Metals in Sediments, 05/12, Revision 3. (Reviewed 03/17)	Definitive	Sediment / Acid Volatile Sulfide and Simultaneously Extractable Metals	Buret – Acid Volatile sulfides ICP – Simultaneously Extractable Metals	No Variance	N
CA-741	Determination of Total Organic Carbon in Solids using the EPA Region II Lloyd Kahn Method, 05/16, Revision 6. (Reviewed 03/17)	Definitive	Sediment / Total Organic Carbon (TOC)	TOC Analyzer	No Variance	N
SD-902	Sample Receipt and Internal Control, 09/17, Revision 12.	NA	NA	NA	NA	N
SD-903	Sample Disposal, 09/17, Revision 6.	NA	NA	NA	NA	N

[1] SOPs are reviewed/revised as needed. The current version will be followed at the time of sample receipt.

[2] If yes, then specify the modification that has been made. Note that any analytical SOP modification made relative to project specific needs must be reviewed and approved by the USACE.

HPLC = high performance liquid chromatography
ICP-AES = Inductively Coupled plasma atomic emission spectroscopy
SOP = standard operating procedure
TAL = Target Analyte List
TOC = Total Organic Carbon
QSM = Quality Systems Manual
EPA = U.S. Environmental Protection Agency

WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for CA	SOP Reference[1]
HPLC Explosives	Initial calibration (ICAL) - 7-point calibration of all explosives	At instrument set-up, major instrument change, when ICV does not meet criteria.	7 point calibration – correlation coefficient $r^2 \geq 0.99$ for linear least squares regression or non-linear least square regression (quadratic). Alternatively, RSD for each analyte ≤ 15%.	Repeat Initial calibration and/or perform necessary equipment maintenance. Check calibration standards. Reanalyze affected samples.	Analyst, Department Manager	CA-402
	ICV	Once after initial calibration.	%R within 80%-120% for all project compounds.	Identify source of problem, correct, repeat ICAL, rerun samples.	Analyst, Department Manager	
	CCV	Before sample analysis, after every 10 field samples, and at the end of the analytical sequence.	%D must be ± 20% of true value for all project compounds.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since the last CCV. Alternately, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst, Department Manager	

WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for CA	SOP Reference[1]
ICP-AES – Copper, Lead, and Zinc	ICAL - 1-point calibration plus blank	Daily ICAL prior to sample analysis.	One-point calibration plus a blank per manufacturer's guidelines.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards.	Analyst, Department Manager	CA-608
	ICV	Once after each ICAL, prior to beginning a sample run.	%R must be within 90-110% for all project analytes.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Analyst, Department Manager	
	Calibration Blanks: Initial Calibration Blank (ICB) Continuing Calibration Blank (CCB)	Before beginning a sample sequence, after every 10 samples and at end of the analysis sequence.	The absolute values of all analytes must be < ½ LOQ or < 1/10th the amount measured in any sample.	ICB: Correct problem and repeat ICV/ICB analysis. If that fails, rerun ICAL. All samples following the last acceptable calibration blank must be reanalyzed. CCBs may not be re-analyzed without re-analysis of the associated samples and CCVs.	Analyst, Department Manager	
	CCV	After every 10 field samples and at the end of each run sequence.	%R must be within 90-110% for all project analytes.	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since the last CCV. Alternately, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst, Department Manager	

WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for CA	SOP Reference[1]
	Low-level Calibration Check Standard (if using one-point ICAL)	Daily after one-point ICAL.	%R must within 80%-120% for all project analytes.	Correct problem, then reanalyze.	Analyst, Department Manager	
	ICS - ICSA & ICSAB	Daily, before sample injections	ICSA: Absolute value of concentration for all non-spiked project analytes < ½ LOQ (unless they are a verified trace impurity from one of the spiked analytes). ICSAB: %Rs must be within 80-120%.	Terminate analysis; locate and correct the problem, reanalyze ICS, reanalyze all samples.	Analyst, Department Manager	
Mercury analyzer	ICAL - 5 points plus a calibration blank	Daily ICAL prior to sample analysis.	Correlation coefficient $r^2 \geq 0.99$.	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards.	Analyst, Department Manager	CA-611
	ICV	Once after each ICAL, prior to beginning a sample run.	%R must be within 90-110%	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Analyst, Department Manager	
	Low-level Calibration Check Standard (LLCCV)	Daily after ICAL.	%R must within 80%-120% for all project analytes.	Correct problem, then repeat ICAL No samples shall be analyzed without a valid LLCCV.	Analyst, Department Manager	

WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for CA	SOP Reference[1]
	CCV	After every 10 field samples and at the end of the analysis sequence.	%R must be within 90-110%	Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails or if two consecutive CCVs cannot be run, perform corrective action(s) and repeat CCV and all associated samples since the last CCV. Alternately, recalibrate if necessary; then reanalyze all associated samples since the last acceptable CCV. If reanalysis cannot be performed, data must be qualified and explained in the case narrative.	Analyst, Department Manager	
	Calibration Blanks: ICB and CCB	Immediately after the ICV and immediately after every CCV.	The absolute value of analyte must be < ½ LOQ or < 1/10th the amount measured in any sample.	ICB: Correct problem and repeat ICV/ICB analysis. If that fails, rerun ICAL. All samples following the last acceptable calibration blank must be reanalyzed. CCBs may not be re-analyzed without re-analysis of the associated samples and CCVs.	Analyst, Department Manager	

WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for CA	SOP Reference[1]
Total Organic Carbon Analyzer / Total Organic Carbon	ICAL – Minimum of a 5-point calibration curve plus a blank is prepared.	Initially, when the daily CCV does not pass, but, no longer than every 3 months.	Correlation coefficient ≤ 0.995	Recalibrate and/or perform necessary equipment maintenance. Check calibration standards	Analyst, Department Manager	CA-741
	ICV	Once after each ICAL, prior to beginning a sample run.	Lloyd Kahn: %R must be within 80%-120%	If the ICV fails high, report samples that are non-detected and reanalyze samples with detections.	Analyst, Department Manager	
	CCV	After every 10 field samples and at the end of the analytical run	Lloyd Kahn: %R must within 80%-120%	If the CCV fails high, report samples that are non-detected. Recalibrate and/or reanalyze samples analyzed after the last acceptable CCV.	Analyst, Department Manager	
Spectrophotometer / AVS	ICAL – Minimum of a 5-point calibration curve plus a blank is prepared.	Prior to sample analysis	Linear Regression Correlation Coefficient ≥ 0.995	Investigate source of problem, Recalibrate	Analyst, Department Manager	CA-738
	ICV	One of each per prep batch	Recovery within 80-120 %R	Recalibrate and reanalyze sample batch	Analyst, Department Manager	
	CCV	At beginning of run, after every 10 samples and at the end of the run	Recovery within 80-120 %R	Reanalyze all samples back to last acceptable CCV recovery	Analyst, Department Manager	

WORKSHEET #24: ANALYTICAL INSTRUMENT CALIBRATION TABLE (CONTINUED)

Instrument	Calibration Procedure	Frequency of Calibration	Acceptance Criteria	Corrective Action (CA)	Title/Position Responsible for CA	SOP Reference[1]
pH Meter (pH)	Initial calibration (ICAL)	Daily ICAL to consist of 3- to 5-point calibration with pH buffers	N/A	N/A	Analyst, Department Manager	CA-709
	Continuing calibration	At beginning of run, after every 10 samples and at end of run.	Recovery within 90% - 110%	Recalibrate and reanalyze samples back to last acceptable continuing calibration.	Analyst, Department Manager	
Grain Size	Sieve – Visual inspection	Every use	No clogging or tears in mesh	Remove from service	Analyst, Department Manager	CA-551

[1] SOPs are reviewed/revised as needed. The current version will be followed at the time of sample receipt.

NA = not available/not applicable

WORKSHEET #25: ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
HPLC - Explosives	Check and sonicate pump valves as needed. Backflush column as needed. Replace analytical column or guard column as needed. Sonicate and replace solvent with every use. Replace the UV lamp as needed. Check and replace seal-pak as needed.	Explosives	Column flow, pressure	Prior to initial calibration and/or as necessary.	Acceptable calibration or CV	Correct the problem and repeat calibration or CV	Analyst, Department Manager	CA-402
Sieves	Cleaning	Grain Size	Visual inspection for clogs or tears	Each use	N/A	Remove from service	Analyst, Department Manager	CA-551
ICP-AES	Clean torch assembly and spray chamber when discolored or when degradation in data quality is observed. Clean nebulizer, check argon, replace peristaltic pump tubing as needed. Other maintenance specified in lab Equipment Maintenance SOP.	Metals	Torch, nebulizer chamber, pump, pump tubing.	Prior to ICAL and as necessary.	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-608
Mercury Analyzer	Replace peristaltic pump tubing, replace mercury lamp, replace drying tube, clean optical cell and/or clean liquid/gas separator as needed. Other maintenance specified in lab Equipment Maintenance SOP.	Mercury	Tubing, sample probe, optical cell.	Prior to ICAL and as necessary	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-611
Spectrophoto-meter	Clear cuvettes and lenses as necessary. Outside calibration annually.	Acid Volatile Sulfide	Cuvettes, cuvette holder, lenses	As necessary	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-738

WORKSHEET #25: ANALYTICAL INSTRUMENT AND EQUIPMENT MAINTENANCE, TESTING, AND INSPECTION TABLE (CONTINUED)

Instrument/ Equipment	Maintenance Activity	Testing Activity	Inspection Activity	Frequency	Acceptance Criteria	Corrective Action	Responsible Person	SOP Reference[1]
Probe - pH	Clean, drain, and refill reference electrode as needed.	pH	Reference electrode for white crystals, Inspect electrode for damage.	Before use	pH 7 ± 0.05 pH units (pH)	Correct problem and repeat calibration.	Analyst, Department Manager	CA-709
TOC Combustion Analyzer	Check level of dilution water, drain vessel water, humidifier water, auto sampler rinse water and phosphoric acid vessel and fill as needed. Replace oxygen cylinder.	Total Organic Carbon	Tubing, sample boat, syringe, humidifier, rinse reservoir, phosphoric acid vessel, oxygen pressure	Prior to initial calibration and as necessary	Acceptable calibration or CCV	Correct the problem and repeat calibration or CCV	Analyst, Department Manager	CA-741

[1] SOPs are reviewed/revised as needed. The current version will be followed at the time of sample receipt.

WORKSHEETS #26 & 27: SAMPLE HANDLING, CUSTODY, AND DISPOSAL

Sampling Organization: WESTON
Laboratory: Katahdin Analytical Services, LLC
Method of sample delivery (shipper/carrier): FedEx or other overnight carrier
Number of days from reporting until sample disposal: 45 days (30 days TA)

Activity	Organization and Title/ Position of Person Responsible for the Activity	SOP Reference[1]
Sample labeling	WESTON – Project Scientist or designee in the field	SOP 8
Sample chain-of-custody form completion	WESTON – Project Scientist or designee in the field	SOP 8
Sample packaging and shipping coordination	WESTON – Project Scientist or designee in the field	SOP 8
Sample receipt, inspection, and log-in	Katahdin - Analyst, Department Manager	SD-902
Sample custody and storage	Katahdin - Analyst, Department Manager	SD-902
Sample Disposal	Katahdin - Analyst, Department Manager	SD-903

[1] SOPs are reviewed/revised according to each organization's schedule. The current version will be followed at the time of sample receipt.

WORKSHEET #27: SAMPLE CUSTODY REQUIREMENTS

27.1 FIELD SAMPLE CUSTODY PROCEDURES — SAMPLE COLLECTION, PACKAGING, SHIPMENT, AND DELIVERY TO THE LABORATORY

To maintain a record of sample collection, transfer between personnel, shipment, and receipt by the laboratory, a COC record (see SOP 8, **Appendix D)** will be completed for each sample shipment by the field team. The COC, which may be more than one page long, will list each sample in a shipping container (cooler). The COC will be placed in a resealable plastic bag and taped to the inside lid of the container. Each time the samples are transferred, the signatures of the persons relinquishing and receiving the samples, as well as the date and time of transfer, will be documented. The transfer from the field team to the shipper and from the shipper to the laboratory will be documented by the airbill instead of the COC. The laboratory is required to maintain a copy of the COC and airbill as part of the laboratory's project records.

Custody seals (see SOP 8) are used to determine whether any tampering has occurred during transport of samples. The signed and dated seals will be fastened to the right and left sides of each shipping cooler by the person responsible for packaging for both on-site and off-site sample analyses. If the coolers are opened before receipt at the laboratory, the seals will not be intact.

WESTON expects to ship samples in batches. Samples will be shipped immediately upon completion of the collection of the sediment samples of one batch. Prior to shipping the samples, the field team will store the samples in refrigerators designated for sample storage in coolers. If the samples are stored in coolers and the sample preservation requirements include refrigeration, ice or the equivalent will be used to keep the samples cold. The coolers or refrigerators will be secured in either a locked room or compartment or otherwise sealed to prevent tampering until the samples are transferred to the shipping service.

Unless previous screening results, site knowledge, or other information indicates the samples are hazardous, the samples collected and shipped for analysis will be treated as environmental samples. Samples, whether classified as hazardous or as environmental samples, will be shipped in compliance with the applicable regulations. The United States Department of Transportation (DOT) and the International Air Transport Association (IATA) have established specific regulations governing the packaging of hazardous and environmental samples for shipment. The regulations include specifications for packing materials, shipping containers, and shipping labels. The samples will be shipped in accordance with the regulations based on the best available knowledge of the samples being collected.

27.2 ELECTRONIC SAMPLE TRACKING

The electronic sample tracking process is initiated with the receipt of the hard copy COC and the associated sample attribute forms. The field sample coordinator is responsible for emailing the documents to WESTON's Project Chemist when a shipment has been released to the shipping vendor. The receipt date is stamped on the documents and an analytical batch file is created for storage of the hard copy documentation related to the specific batch. WESTON's data management sample coordinator compares the COC and the laboratory confirmation for discrepancies. Any issues are documented and reconciled.

27.3 SAMPLE IDENTIFICATION PROCEDURES

Samples collected at the Investigation Area must be uniquely labeled with the Site Identification, Site Area Identification, Sample Type, and Sequential Sample Number. Sample identification is described in Worksheet #18. The samples will be identified with a label attached directly to the container (See SOP 8). Sample label information will be completed using waterproof black marker. The labels will contain the following information:

- Sample ID.
- Time and date of collection.
- Project name.
- Analysis requested.
- Preservative (if any).
- Sample source/location.
- Sampler's initials.

From a data management perspective, the key requirement for the field sample identifier is that it is a unique name. In addition, for sample tracking purposes, the identifier has implicit coding of sample information, including site, location ID, sample type, sample depth, or date collected.

27.4 LABORATORY SAMPLE CUSTODY PROCEDURES — RECEIPT OF SAMPLES, ARCHIVING, AND DISPOSAL

The designated sample custodian(s) and staff are responsible for samples received at the laboratory. In addition to receiving samples, the sample receipt staff is also responsible for documentation of sample receipt and storage before and after sample analysis. Summaries of the minimal laboratory receipt procedures are as follows:

- Upon receipt, sign, date, and document the time of sample receipt on the airbills or other shipping manifests received from the couriers.

- Sign the COC assuming custody of the samples. If a COC is not received with a set of samples, the laboratory will immediately notify the WESTON Project Manager.

- Inspect the sample cooler for integrity and then document the following information:

  - Type of courier and whether the samples were shipped or hand delivered (copies of the airbills are maintained).

  - Availability and condition of custody information.

  - Sample temperature ambient or chilled.

  - Actual temperature of the temperature blank.

  - Presence of leaking or broken containers and indication of sample preservation.

- Verify the holding time has not been exceeded. If a sample has exceeded holding time, then the WESTON Project Chemist will be notified.

- Match the sample container information (e.g., sample tag/label), COC records, and the pertinent information associated with the sample. The sample custodian then verifies sample identity to ensure that the information is correct. Any inconsistencies are resolved with WESTON through the Laboratory Project Manager and CA measures are documented before sample analysis proceeds.

- Samples submitted to off-site laboratories will be stored at 4 to 6°C for a minimum of 60 days following the completion of analyses and/or issue of final reports. If needed, the samples can be held for reanalysis up to 6 months for metals. Laboratories are also responsible for the proper management and disposal of the sample residuals and extracts, following the applicable federal, state, and local laws, rules, and regulations.

WORKSHEET #28: ANALYTICAL QUALITY CONTROL AND CORRECTIVE ACTION

WORKSHEET 28.1: METALS

Matrix: Sediment and Water[1]
Analytical Group: Metals (copper, lead, and zinc)
Analytical Method/ SOP: SW-846 6010C/ CA-608

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample.	Correct problem. If required, re-prep and reanalyze method blank and all samples processed with the contaminated blank.	Analyst, Laboratory Department Manager	Accuracy/Bias (Contamination)	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
LCS	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified.	Correct problem, then re-prep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst, Laboratory Department Manager	Accuracy/Bias	QSM 5.1 LCS recovery for sediment: copper (81-117%R) lead (81-112%R) zinc (82-113%R) QSM 5.1 LCS recovery for water: cooper (86-114%R) lead (86-113%R) zinc (87-115%R)
Matrix Spike	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified.	Examine the project-specific requirements. Contact the client regarding additional measures to be taken.	Analyst, Laboratory Department Manager	Accuracy/Bias	QSM 5.1 MS recovery limits for sediment same as for LCS above.

WORKSHEET 28.1: METALS (CONTINUED)

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. MSD or MD: RPD ≤ 20% (between MS and MSD or sample and MD)	Examine the project- specific requirements. Contact the client as to additional measures to be taken.	Analyst, Laboratory Department Manager	Accuracy/Bias	QSM 5.1 MSD recovery limits for sediment same as for LCS above MSD or MD: RPD ≤ 20%
Post-Digestion Spike	One per preparatory batch if the MS or MSD fails (using the same sample as used for the MS/MSD if possible)	Recovery within 80-120%.	If PDS recovery is outside control limits, then J-flag the result in the parent sample and explain in the case narrative.	Analyst, Laboratory Department Manager	Accuracy/Bias (matrix interference)	Recovery within 80-120%.
ICP Serial Dilution	One per preparatory batch if MS or MSD fails	Five-fold dilution must agree within ± 10% of the original measurement.	If PDS recovery is outside control limits, then J-flag the result in the parent sample and explain in the case narrative.	Analyst, Laboratory Department Manager	Accuracy/Bias (matrix interference)	Five-fold dilution must agree within ± 10% of the original measurement. If analyte concentration > 50 LOQ (prior to dilution).
Results between DL and LOQ	NA	Apply “J” qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager	Accuracy	Apply “J” qualifier to results between DL and LOQ.

[1] The only water samples to be collected are equipment rinsate blanks; required QC samples applicable to equipment blanks are method blanks and LCS results. The laboratory will not prepare MS/MSD, PDS, or serial dilution samples from any equipment blank samples.

WORKSHEET 28.2: MERCURY

Matrix: Sediment and Water[1]
Analytical Group: Metals (mercury)
Analytical Method/ SOP: SW-846 7471B and 7470A/CA-611 (solid) and CA-615 (water)

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per preparatory batch.	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample.	Correct problem. If required, re-prep and re-analyze MB and all samples processed with the contaminated blank.	Analyst, Laboratory Department Manager	Accuracy/Bias (Contamination)	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
LCS	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified.	Correct problem. If required, re-prep and re-analyze MB and all samples processed with the contaminated blank.	Analyst, Laboratory Department Manager	Accuracy/Bias	QSM 5.1 LCS recovery for mercury in solids: 80-124%R QSM 5.1 LCS recovery for mercury in water: 82-119%R
MS/MSD	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. RPD ≤ 20% (between MS and MSD)	Examine the project- specific requirements. Contact the client as to additional measures to be taken.	Analyst, Laboratory Department Manager	Accuracy/Bias (matrix interference)	QSM 5.1 MS and MSD recovery for mercury: 80-124%R QSM 5.1 RPD ≤ 20%
Results between DL and LOQ	NA	Apply “J” qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager	Accuracy	Apply “J” qualifier to results between DL and LOQ.

[1] The only water samples to be collected are equipment rinsate blanks; required QC samples applicable to equipment blanks are method blanks and LCS results. The laboratory will not prepare MS/MSD samples from any equipment blank samples.

WORKSHEET 28.3: EXPLOSIVES

Matrix: Sediment and Soil and Water[1]
Analytical Group: Explosives
Analytical Method/SOP: SW846 8330B/CA-402

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Method Blank	One per batch of 20 or less	No target compounds > ½ LOQ or > 1/10 the amount measured in any sample.	Investigate source of contamination Evaluate the samples and associated QC: i.e., the blank results are above the LOQ, report sample results that are <LOQ or > 10X the blank concentration. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Supervisor	Accuracy/Bias (Contamination)	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.
LCS	One per batch of 20 or less	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	Analyst, Laboratory Supervisor	Accuracy/Bias	QSM 5.1 LCS recovery acceptance limits as specified in Worksheet 15.2.
MS/MSD	One per SDG or every 20 samples.	%R should be within the same limits as for the LCS. RPD should be ≤ 20%.	Evaluate the samples and associated QC: i.e., If the LCS results are acceptable, narrate. If both the LCS and MS/MSD are unacceptable, reprep the samples and QC.	Analyst, Laboratory Supervisor	Precision/ Accuracy/ Bias (matrix interference)	QSM 5.1 LCS recovery acceptance limits as specified in Worksheet 15.2 for MS and MSD recoveries. RPD ≤ 20%
Surrogate	Spiked into each sample, standard and QC sample	Laboratory must use the QSM 5.1 Appendix C Limits for surrogate recovery (1,2-dinitrobenzene).	If surrogate recovers above the high limit and sample is < LOQ, no CA taken. If surrogate recovers lower than the low limit, the affected samples are re-extracted and reanalyzed.	Analyst, Laboratory Supervisor	Accuracy/Bias	QSM 5.1 surrogate recovery limits: 78-119%

WORKSHEET 28.3: EXPLOSIVES (CONTINUED)

QC Sample:	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria
Second Column Confirmation	All positive results must be confirmed	RPD between primary and second column concentrations must be ≤ 40%.	Apply qualifier if RPD >40% and discuss in the case narrative. The higher of the two results will be reported unless matrix interference is apparent.	Analyst, Laboratory Department Manager	Precision	RPD between primary and second column concentrations must be ≤ 40%.
Results between DL and LOQ	NA	Apply “J” qualifier to results between DL and LOQ.	NA	Analyst, Laboratory Department Manager	Accuracy	Apply “J” qualifier to results between DL and LOQ.

[1] The only water samples to be collected are equipment rinsate blanks; required QC samples applicable to equipment blanks are method blanks and LCS results; reporting of surrogate recoveries and second column confirmation is required. The laboratory will not prepare MS/MSD samples from any equipment blank samples.

WORKSHEET 28.4: pH

Matrix: Sediment
Analytical Group: pH
Analytical Method/SOP: SW846 9045D/ CA-709

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 0.05 pH units of true value.	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <PQL, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate[1]	One sample duplicate per 10 samples.	RPD $\leq$20	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >20, report original result with notation or narration.	Analyst, Laboratory Department Manager	Precision	Same as Method/SOP QC Acceptance Limits.

[1] Laboratory duplicates will not be required for project samples; however, if a project sample is selected for laboratory quality control (QC), the laboratory will use the acceptance limits in the table above to evaluate the data.

WORKSHEET 28.5: TOTAL ORGANIC CARBON

Matrix: Sediment
Analytical Group: Total Organic Carbon (TOC)
Analytical Method/SOP: Determination of Total Organic Carbon in Sediment (Lloyd Kahn Method, EPA Region II) /CA-741

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
Method Blank	One per analytical batch of 20 or fewer samples.	No target analytes > LOQ or > 1/10 the amount measured in any sample.	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Re-prepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	Analyst, Laboratory Department Manager	Accuracy/Bias (Contamination)	Same as Method/SOP QC Acceptance Limits.
LCS	One per analytical batch of 20 or fewer samples.	%R must be within 80-120	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <PQL, narrate. Otherwise, reprep a blank and the remaining samples.	Analyst, Laboratory Department Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS[1]	One for every set 10 samples	%R must be within 75-125%	(1) Evaluate the samples and associated QC: i.e., If the LCS results are acceptable, narrate. (2) If both the LCS and MS are unacceptable, reprep and reanalyze the samples and QC. (3) Notate sample result in raw data if matrix interference suspected.	Analyst, Laboratory Department Manager	Accuracy/Bias (matrix interference)	Same as Method/SOP QC Acceptance Limits.
Laboratory Quadruplicate[1]	One sample quadruplicate per 20 samples.	RPD ≤30% for samples >3X the PQL, <100% RPD for samples <3X the PQL.	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD still >30%, report original result with notation or narration.	Analyst, Laboratory Department Manager	Precision	Same as Method/SOP QC Acceptance Limits.

[1] Matrix Spike (MS) and Laboratory Quadruplicates will not be required for project samples; however, if a project sample is selected for laboratory quality control (QC), the laboratory will use the acceptance limits in the table above to evaluate the data.

WORKSHEET 28.6: ACID VOLATILE SULFIDE/SIMULTANEOUSLY EXTRACTED METALS (AVS/SEM)

Matrix: Sediment
Analytical Group: AVS/SEM
Analytical Method/SOP: EPA 821/R-91-100/ CA-738.03

QC Sample	Frequency/ Number	Method/SOP QC Acceptance Limits	Corrective Action	Person(s) Responsible for Corrective Action	Data Quality Indicator (DQI)	Measurement Performance Criteria (MPC)
Method Blank	One per prep batch of 20 or fewer samples	No analyte detected > LOQ	Investigate source of contamination. Reprep and analyze method blank and all samples processed with the contaminated blank	Analyst, Laboratory Department Manager	Accuracy/Bias (Contamination)	Same as Method/SOP QC Acceptance Limits.
LCS	One of each per prep batch	80-120 %R	Recalibrate and reanalyze sample batch	Analyst, Laboratory Department Manager	Accuracy/Bias	Same as Method/SOP QC Acceptance Limits.
MS[1]	One for every set of 10 samples	75-125 %R	Notate sample result in raw data with Notation I-1	Analyst, Laboratory Department Manager	Accuracy/bias (matrix interference)	Same as Method/SOP QC Acceptance Limits.
Laboratory Duplicate[1]	One sample duplicate per twenty samples or per batch	RPD ≤ 20%	If lab QC are within criteria and matrix interference suspected in laboratory duplicate, flag data. Else, reanalyze.	Analyst, Laboratory Department Manager	Precision	Same as Method/SOP QC Acceptance Limits.

[1] Matrix spike (MS) and laboratory duplicates will not be required for project samples; however, if a project sample is selected for laboratory quality control (QC), the laboratory will use the acceptance limits in the table above to evaluate the data.

WORKSHEET #29: PROJECT DOCUMENTS AND RECORDS TABLE

Worksheet #29 provides the following information: (1) minimum specifications for all data management tasks and deliverables and (2) procedures for controlling project documents, records, and databases. The following subsections list records to be used and maintained for the RA as well as the personnel responsible for generating and verifying the records. All records should be maintained in the WESTON project files for a minimum of 5 years.

The WESTON PM will establish a document control and records management system (project database). All project personnel will be made aware of the proper use of and access to the project database. The system will be accessible to field personnel to post records during the field activities, will include a minimum file structure as shown below, and will be maintained throughout the execution of the field activities. Files (hard copies and electronic) will be transferred to Project File upon completion of the project. All final document files, including reports, figures, and tables, will be submitted in electronic format. Any document files, logs, reports, figures, and tables will be made available to the on-site USACE OESS upon request.

A project-specific GIS will be used to store and manage relevant geospatial-related data and information. WESTON will manage and maintain project data in GIS. The final GIS deliverable will include all documentation, reports, meeting minutes, and databases created, developed, or modified under the TO in original and PDF format.

All geophysical, target, and intrusive results and QC data will be managed by the Project Geophysicist, who will coordinate transfers of data to project staff and will facilitate QC review of UXO and geophysical data as appropriate. Target data will be recorded in logbooks or on electronic devices, downloaded, backed up daily, and stored in a manner to secure data in the event of a computer failure. The Project Geophysicist or the SUXOS (if intrusive investigation data) will review each day's inputs for inconsistencies and ensure the completeness of the records. QC personnel will conduct an audit of the database and document the results in the Daily QC Reports and appropriate SOP checklists. The results of the database audit will be provided to the WESTON PM and Senior Geophysicist.

DGM data files will be delivered in accordance with the requirements in Data Item Description (DID) WERS-004.01 Attachment C. It is expected that all DGM sensor data transfer will be accomplished via ftp site. If the large size of the advanced DGM sensor data files makes the process cumbersome, the data will be transferred onto an external hard drive.

Initial QC checks for all data, with the exception of coverage, will be performed by date. Coverage QC will be performed for entire survey units. Daily QC files (i.e., IVS, static, and function checks) and DGM sensor background files will be stored in separate databases and folders from the production data, although they will also be named and organized by date in their respective folders.

Geophysicists will use the latest version of UXAnalyze for processing and interpreting DGM sensor data.

The projects documents and records are presented in **Table 29-1**, **Table 29-2**, and **Table 29-3**.

Table 29-1 Minimum Required Documents and Records for MEC

Document/Record	Purpose	Completion/Update Frequency	Format/Storage Location/ Archive Requirements
SUXOS Log	Document daily activities during UXO operations	Daily	Hard copy or electronic/field office, project file/archived electronically
Verification Plan	Document the IVS requirements	Before mobilization	Electronic/QAPP, project file/archived electronically
Daily Status Reports	Document daily activities during geophysics operations	Daily	Hard copy or electronic/field office, project file/archived electronically
Daily QC Reports	Document QC activities performed in the field	Daily	Hard copy/field office/archived electronically
Daily Geophysical QC Report	Document geophysical QC results	Daily	Electronic/project file/archived electronically
Team Leader Log(s)	Provide record of UXO Dive Team's activities (clearance, MEC/MD/other debris identified, targets excavated)	Daily	Hard copy/field office/archived electronically
Root Cause Analysis	Required for MQO failures and Non-Conformance Reports	When required	Electronic/project file/archived electronically
Instrument Verification Strip (IVS) Technical Memorandum	Report establishing the millivolt (mV)/amp threshold for target detection, demonstrating geophysical systems are operational and capable of performing the work, and defining the expected response for daily IVS checks	Completed following initial IVS data collection and submitted to client for approval and with final report	Electronic/project file/archived electronically
Daily Quality Control Checklists (IVS, Function Check Area [FCA])	Document daily QC procedures	Daily	Hard copy or electronic/field office and project file/archived electronically
Final Amplitude Response Anomaly List	Document detected/selected anomalies	After detection survey is complete	Electronic/project file/archived electronically

Table 29-1 Minimum Required Documents and Records for MEC (Continued)

Document/Record	Purpose	Completion/Update Frequency	Format/Storage Location/ Archive Requirements
QC Database	Document MQO results	Weekly	Electronic/project file/archived electronically
Intrusive Investigation Results	Document intrusive investigation results	Weekly	Electronic/project file/archived electronically

The following project records (**Table 29-2**) will be stored in the project files and assessed in accordance with Worksheets #31, 32, and 33.

Table 29-2 Project Documents and Records for MC

Record	Generation	Verification	Storage Location/Archival
Sample Collection Documents and Field Records			
Field Notebooks	Field Project Scientist or designee	Delegated QA Manager	Project File
Daily Quality Control Report	UXOQCS	Delegated QA Manager	Project File
Site Maps	Field Project Scientist or designee	Delegated QA Manager	Project File
COC Forms	Field Project Scientist or designee	Delegated QA Manager	Project File
Custody Seals	Field Project Scientist or designee	Delegated QA Manager	Project File
Air Bills	Field Project Scientist or designee	Delegated QA Manager	Project File
On-Site Analysis Documents and Records			
Daily observations and notes, personnel on site, samples collected, date, time, communications, tailgate safety meeting items, unusual incidents/events, etc.	Field Project Scientist or designee	Delegated QA Manager	Project File
Documenting sample points, notations of site conditions	Field Project Scientist or designee	Delegated QA Manager	Project File
Sediment classification, sample depth, sample numbers, nos. of containers, requested analyses, preservation	Field Project Scientist or designee	Delegated QA Manager	Project File
Data Assessment Documents and Records			
Project QAPP	Project Staff	PM	Project Files
Validation reports on applicable samples	Project Staff	PM	Project Files
Laboratory Records			
Data validation reports	Delegated QA Manager	PM	Project File
Sample receipt, sample condition, custody, and internal tracking records	Laboratory Sample Receiving	Laboratory PM/Delegated QA Manager	Laboratory and Project File

Table 29-2 Project Documents and Records for MC (Continued)

Record	Generation	Verification	Storage Location/Archival
Laboratory Information Management System (LIMS) login	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Run logs – sample chronology	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Standard traceability logs	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Calibration logs	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
QC sample identification (blanks, duplicates, LCS, MS/MSD)	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Laboratory data qualifiers	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Instrument calibration logs	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Instrument maintenance logs	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Electronic data deliverables	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Case narrative	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Laboratory sample identification	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Quality assurance/quality control forms	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
DL/LOQ Studies	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File

Table 29-2 Project Documents and Records for MC (Continued)

Record	Generation	Verification	Storage Location/Archival
Laboratory Accreditation Certificates	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Quality Assurance Manual	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Analytical SOPs	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File
Sample disposal records	Laboratory Technician/Laboratory QA Manager	Laboratory PM/Delegated QA Manager	Laboratory and Project File

Table 29-3 Project Documents for Analytical Laboratory Data Deliverables

Laboratory Data Deliverables			
Record	**Metals**	**Explosives**	**Other**
Narrative	X	X	X
Chain-of-custody	X	X	X
Summary Results	X	X	X
QC Results	X	X	X
Chromatograms		X	

WORKSHEETS #31, 32, & 33: ASSESSMENTS AND CORRECTIVE ACTION

WORKSHEET 31.A: GEOPHYSICAL ASSESSMENTS

The worksheet is used to document responsibilities and procedures for conducting project assessments, documenting assessments, responding to assessment findings, and implementing corrective action. The type, frequency, and responsible parties of planned assessment activities to be performed for the project are summarized in the table below.

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
Fieldwork Readiness Review	Once before mobilization	Internal	WESTON	WESTON Program Manager	WESTON Project Manager	WESTON Project Manager	WESTON Program Manager
Health and Safety Assessment	Once during field activities	Internal	WESTON	WESTON Project H&S Manager, or designee	WESTON UXOSO or Site Safety and Health Officer	WESTON UXOSO or Site Safety and Health Officer	WESTON Project H&S Manager and SUXOS
Site Preparation Assessment	Following completion of IVS installation	Internal	WESTON	WESTON Project Geophysicist (transect locations) and Site Geophysicist	WESTON SUXOS	WESTON SUXOS	WESTON Site Geophysicist
DGM Data Deliverable Assessment	Weekly	Internal	WESTON	WESTON Senior Geophysicist	WESTON Project Geophysicist	WESTON Project Geophysicist	WESTON Senior Geophysicist
Intrusive Results Assessment	Weekly	Internal	WESTON	WESTON QC or Project Geophysicist	WESTON SUXOS	WESTON SUXOS	WESTON Senior or Project Geophysicist

WORKSHEET 31.A: GEOPHYSICAL ASSESSMENTS (CONTINUED)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing Corrective Actions	Person(s) Responsible for Monitoring Effectiveness of Corrective Actions
MPPEH/ Explosives Records Assessment	Once prior to demobilization	Internal	WESTON	WESTON SUXOS	WESTON SUXOS	WESTON SUXOS	WESTON UXOQCS
Review Geospatial Data	For each GIS data submittal	External (see Quality Assurance Surveillance Plan (QASP)	USACE	Applicable USACE PDT Members	WESTON GIS Manager	WESTON GIS Manager	WESTON Senior Geophysicist
Field Activities	See QASP	External (see QASP)	USACE	Applicable USACE PDT Members	WESTON PM and relevant personnel	WESTON SUXOS and other relevant personnel	WESTON UXOQCS and Senior Geophysicist
Geophysical Surveys	See QASP	External (see QASP)	USACE	USACE Project Geophysicist	WESTON Senior Geophysicist, and Project Geophysicist	WESTON Project Geophysicist	WESTON Senior Geophysicist
Review RI Report	For each submittal	External (see QASP)	USACE	Applicable USACE PDT Members	WESTON PM	WESTON PM and relevant personnel	WESTON PM

Geophysical Corrective Action

Based on the findings of project assessments above, corrective action may be required. A CA is defined as an action taken by a project team to eliminate the cause(s) of nonconformity in order to prevent recurrence. For assessment findings that require corrective action, deficiencies will be documented and communicated to the appropriate project personnel. CA will then be implemented and a follow-up assessment will be performed to verify the results of the CA. Procedures for handling UFP-QAPP deviations during each type of assessment are summarized in the table below.

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Time Frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Time Frame for Response
Fieldwork Readiness Review	Internal e-mail	WESTON Project Manager	3-5 business days	Internal e-mail	WESTON Program Manager	3-5 business days
Preparatory, Initial, and Follow-up Inspections	Internal e-mail	WESTON Project Manager, WESTON SUXOS	1-3 business days	Follow-up inspection	WESTON Project Manager, WESTON SUXOS	24 hours after notification
Health and Safety Assessment	Written assessment report	WESTON SUXOS, WESTON PM, UXOSO	3-5 business days	Letter or memo	WESTON Project H&S Manager	24 hours after notification
QAPP Compliance and MEC Operations Assessment	Written assessment report	WESTON PM, WESTON SUXOS, WESTON UXOQCS	3-5 business days	Letter or memo	WESTON MEC Operations Manager, WESTON Corporate QC Manager	3-5 business days
Site Preparation Assessment	Internal e-mail	WESTON SUXOS	1-3 business days	Internal e-mail	WESTON Site Geophysicist and Project Geophysicist	24 hours after notification

Geophysical Corrective Action (Continued)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Time Frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Time Frame for Response
DGM Data Deliverable Assessment	Internal e-mail, SOP checklist(s) noting deficiency	WESTON Site Geophysicist and Project Geophysicist	1-5 business days	Internal e-mail and/or RCA	WESTON Senior Geophysicist	24 hours after notification
Classification Assessment	Internal e-mail	WESTON Project Geophysicist	1-2 business days	Internal e-mail and/or RCA	WESTON Senior Geophysicist	1-2 business days
Anomaly Resolution Assessment	Internal e-mail	WESTON SUXOS	24 hours	Internal e-mail and/or RCA	WESTON QC or Project Geophysicist	24 hours
Intrusive Results Assessment	Internal e-mail	WESTON SUXOS	1-5 business days	Internal e-mail and/or RCA	WESTON UXOQCS	1-2 business days
MPPEH/ Explosives Records Assessment	Internal e-mail	WESTON SUXOS	24 hours	Internal e-mail	WESTON UXOQCS	24 hours
Review Geospatial Data	Electronic submittal QA Form, Geospatial QA Form	WESTON Senior Geophysicist and WESTON GIS Manager	14 calendar days	E-mail or appropriate QA Form with responses	Lead Organization and Design Center PMs	10 business days
Field Activities	Corrective Action Request (CAR), Quality Assurance Review (QAR), HNC-948, Memorandum for Record	WESTON PM and SUXOS (and other technical personnel if appropriate)	1-5 business days (immediately if serious deficiency)	E-mail or appropriate QA Form with responses	Lead Organization and Design Center PMs	1-2 business days

Geophysical Corrective Action (Continued)

Assessment Type	Nature of Deficiencies Documentation	Individual(s) Notified of Findings	Time Frame of Notification	Nature of Corrective Action Response Documentation	Individual(s) Receiving Corrective Action Response	Time Frame for Response
Geophysical Surveys	CAR	WESTON Senior Geophysicist and Project Geophysicist	1-5 business days (immediately if serious deficiency)	E-mail or appropriate QA Form with responses	Lead Organization and Design Center PMs and USACE Project Geophysicist	1-2 business days
Review Final Report	United States Army Engineering Support Center, Huntsville (CEHNC) Form 7, KO Transmittal Memo	WESTON PM	14 calendar days	CEHNC Form 7 with completed responses	Lead Organization and Design Center PMs	10 business days

WORKSHEET 31.B: MC ASSESSMENTS

Generalized planned project assessments are discussed below. **Table 31B-1**, presented immediately after the worksheets, provides general guidance for planned project assessments and their frequencies.

The worksheet details the different types of assessments for evaluating project activities. Examples include, but are not limited to, laboratory assessments, field audits, and field documentation review. Field investigations should include at least one field technical system audit (TSA) at the start of field activities. An audit may be an internal or external Contractor audit or a government oversight audit.

Field Audits

Daily Quality Control Audits

Daily quality control audits are daily assessments of field documentation activities. Daily quality control audits will be performed by the Project Scientist or designee in the field and will be documented in a DQCR. The auditor will summarize daily activities and assess whether appropriate project documentation procedures are being followed. The audit may cover technical performance and effectiveness. The findings of each audit will be conveyed to each field team member during daily pre-work conferences so that adjustments can be made, if warranted. If, during the audit, a procedure is determined as being performed in a manner that may cause severe harm to the field crew or render the data unusable, then the field auditor has the authority to stop work until the issue is adequately resolved.

Information to be provided in the daily reports is as follows:

- Project and delivery order numbers.
- Date.
- Project name and location.
- Temperature range.
- Wind conditions.
- Personnel on-site
- Summary of site activities.
- Level of health and safety protection.
- Instruments used (including serial numbers).
- Calibrations performed.
- Instrument problems.
- CAs.
- Samples collected.
- Summary of sample collection methods.
- QC samples collected.
- Additional remarks.

DQCRs will be compiled and filed on a daily basis. The reports will be reproduced and sent to the West Point PM and USACE PM or designees, assuming that no problems arise or deviations from the schedule or field activities occur. The submittals may be hard copy or electronic via email. In the event that problems arise, the WESTON PM will notify the West Point PM and USACE PM immediately.

Field Technical System Audits (TSAs)

Field TSAs are independent assessments. Field TSAs currently are not planned for the project. Should a Field TSA be deemed necessary, a field audit may be performed by the USACE PM or designee, or a senior technical person who is independent of the project. The number of audits depends on the size and complexity of the project and the experience of field personnel. The auditor will check that the appropriate project-planning documents are being followed and that each appropriate procedure is being followed. The audit will cover technical performance and effectiveness. Pre- and post-audit conferences with appropriate project personnel will be conducted to make clear the purpose and findings of the audit. The findings of each field audit will be summarized and submitted to West Point, USACE, USAEC, NYSDEC, and WESTON PMs, if they are not the individuals performing the audit.

The auditor, West Point, USACE, and NYSDEC PMs will review the response to the audit findings to determine whether the responses are adequate. If, during the audit, a procedure is determined as being performed in a manner that may cause severe harm to the field crew or render the data unusable, then the field auditor has the authority to stop work until the issue is adequately resolved.

Field Performance Audits for MC

Field performance audits are self-assessments. Performance audits will be conducted by the Project Scientist or designee in the field, MC Technical Manager (if not an auditor as described above), or Project Chemist who is independent of the sampling. The Project Scientist or designee in the field will not be directly involved with the sampling but will supervise the divers performing the sampling activities. The auditor will check that the appropriate project-planning documents are being followed and that each appropriate procedure is being followed. The audit will include a check of the following:

- The sampling activities to ensure they are being conducted in accordance with SOP 6 Sampling Procedures.
- The COC forms and determine if the correct analytical methods were requested.
- The correct number of field QC samples was collected.

The findings of the audit will be summarized and submitted to the MC Technical Manager or Project Chemist, if they are not the individuals performing the audit. The MC Technical Manager or Project Chemist will review the response to the audit findings to determine whether the responses are adequate. If, during the audit, a procedure is determined as being performed in a manner that may cause severe harm to the field crew or render the data unusable, then the field auditor has the authority to stop work until the issue is adequately resolved. The audit findings and responses will be included in the RI Report.

Laboratory Audits

Laboratory System Audits

Laboratories performing work for the West Point Investigation Area must have successfully completed an assessment under the DoD ELAP.

At least one off-site laboratory audit will be performed prior to the start of the field sampling activities so that effective CA measures can be implemented to mitigate the extent and impact of identified non-conformances. The audit may consist of evaluating the laboratory’s Quality Manual, SOPs, and current accreditations.

Laboratory Performance Assessments

Laboratory performance audits will be performed as needed based on CAs during the contract. The audits may consist of the following tasks:

- Internal laboratory oversight by the laboratory QA Manager.
- Chemistry support coordinator conference calls, correspondence, and questions.
- Data validation.

Evaluation Data Audits for MC

Data audits are required to verify the accuracy of data collection, storage, and management systems. Data review audits are discussed below.

Data Review Audits

A thorough review of the complete data review process, including a review of the sampling and analysis verification, sampling and analysis validation, and data usability assessment (DUA) steps, will be performed to confirm that the process conforms to the procedures specified. The data review audit may also include an audit of the performance of the data reviewer.

Data Performance Audits

Data performance audits will be performed as part of data validation steps IIa and IIb (see Worksheet 36) to verify the integrity of electronic and hard copy data. The following are required tasks:

- Screen electronic data deliverables (EDDs) for reasonableness. The check will consist of reviewing data, such as verifying that numbers are delivered in fields designed for numbers, text in fields designed for text.

- Verify that units are milligrams per liter (mg/L), micrograms per liter (µg/L), milligrams per kilogram (mg/kg), or micrograms per kilogram (µg/kg); confirm that values less than 0 are not reported.

- Verify that the analytes specified in the laboratory statement of work are presented in the laboratory report for each sample collected.

- Verify that each sample requested is returned by the laboratory.

- When shortcomings of the data are noted during inspection of the EDD, notify the laboratory, the WESTON PM, West Point PM, and USACE PMs promptly.

A generalized Worksheet #31 is shown in **Table 31B-1** and provides most of the types of assessments that will be required and conducted at the Investigation Area. Additional/fewer assessments may be required, and Worksheet #31 will be modified as appropriate.

Worksheet #31 also describes the activities for identifying and correcting problems encountered during the project that have the potential to impact data quality (e.g., sampling error). For each type of assessment, the procedures for handling site-specific deviations and CAs are detailed. The following table provides general guidance for the types and frequencies of assessment findings and CA responses. Additional project assessments and CA responses may be required on a site-specific basis.

CAs will be required if the audits identify noncompliance problems with the laboratory, field procedures, or the data. Specifically, CAs for field nonconformance issues will require addressing the audit findings as described above. Depending on the severity of the finding, a follow-up audit may be performed to verify the CA has been successfully implemented.

CAs for laboratory issues identified as a result of performance audits will require the following actions:

- Document the nonconformance issues on a laboratory nonconformance form.
- Record the cause of the nonconformance.
- Document the CAs taken.
- Verify the CAs taken were sufficient to address the concern.

CAs for database issues identified as a result of data performance audits will require the Database Manager to consult with the Project Chemist, Program Manager, Data Validator, or laboratory to develop CAs. If the issues identified are laboratory-based, then the laboratory will be contacted in writing by the Project Chemist, Database Manager, or Data Validator of the required CAs to be taken (typically a resubmittal of the pertinent data package).

A generalized Worksheet #31 is shown in **Table 31B-1** for MC and General Remediation Tasks and provides some of the types of assessments that will be required and conducted for the Investigation Area. Additional assessments may be required, and Worksheet #31 will be modified as appropriate. This will be determined by the Project Chemist and communicated to the WESTON PM, who will discuss the proposed changes as required by Worksheet #6.

Table 31B-1 Planned Project Assessments Table for MC and General Remediation Tasks

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Daily QC audit	Daily	Internal	WESTON	Project Scientist or designee in the field	PM	Project Manager/ Project Scientist or designee in the field	Project Scientist or designee in the field
Review of field notes/logbook	Weekly	Internal	WESTON	Project Scientist or designee in the field / Field QC Coordinator	Program Manager	Project Scientist or designee in the field	Program Manager
Review of field instrument calibration sheets	Daily	Internal	WESTON	Project Scientist or designee in the field or Project Chemist	Program Manager	Project Scientist or designee in the field	Program Manager
Review of COC forms	Daily	Internal	WESTON	Project Scientist or designee in the field, MC Technical Manager, or Project Chemist	Project Chemist	Program Manager	Program Manager
Field TSA	Once during each field event	External	USACE	USACE PM	MC Technical Manager or WESTON PM	Project Scientist or designee in the field or MC Technical Manager	WESTON PM/ MC Technical Manager
Field performance audit	At least once during each field event	Internal	WESTON	Project Scientist or designee in the field	PM	PM/ Project Scientist or designee in the field or MC Technical Manager	WESTON PM/ MC Technical Manager
Laboratory system audit	Once prior to start of field activities	External/ Internal	WESTON	MC Technical Manager/Project Chemist	Laboratory	Laboratory Technical Manager/Project Chemist	Laboratory Technical Manager /Program Manager

Table 31B-1 Planned Project Assessments Table for MC and General Remediation Tasks (Continued)

Assessment Type	Frequency	Internal or External	Organization Performing Assessment	Person(s) Responsible for Performing Assessment	Person(s) Responsible for Responding to Assessment Findings	Person(s) Responsible for Identifying and Implementing CA	Person(s) Responsible for Monitoring Effectiveness of CA
Laboratory performance assessment	Once during the course of the project	External/ Internal	WESTON	MC Technical Manager/Project Chemist	Laboratory Technical Manager/Project Chemist	Laboratory Technical Manager/Project Chemist	Laboratory Program Manager/Site Technical Manager/Technical Manager
Laboratory data review audit	Once per Sample Delivery Group (SDG)	External/ Internal	WESTON	Third-Party Data Validator/Project Chemist	Laboratory	Laboratory Technical Manager/Project Chemist	Laboratory Program Manager/ Technical Manager
Laboratory data performance audit	Each laboratory report/EDD received	Internal	WESTON	Project Chemist	To Be Determined (TBD)	TBD	TBD

WORKSHEET #34A: DATA VERIFICATION, VALIDATION, AND USABILITY INPUTS FOR MEC-RELATED TASKS

The worksheet presents the inputs that will be used during data verification, validation, and usability assessment. Inputs include planning documents and field records.

Requirements/Specifications:

Item	Description	Verification (Completeness)	Validation (Conformance to Specifications)	Usability (Achievement of DQOs and MPCs)
Field Records				
1	Field Logbooks (Digital)	X		
2	IVS Checklists	X	X	
3	FCA Checklists			
4	TPC Checklists	X	X	X
5	Daily QC Reports	X		
6	Weekly Status Reports	X		
7	Daily/Weekly SUXOS Reports	X		
8	Sensor Function Test Results	X	X	
Electronic Data				
9	Raw Data Files (SSS, multibeam, DGM, and GPS)	X		
10	Converted Data Files	X	X	
11	Data Processing Checklists	X		
12	QC Database	X	X	X
13	Amplitude Response Anomaly List	X	X	X
14	Final Data Archive (for each delivered area subset)	X	X	X
Interim and Final Reports/Deliverables				
15	IVS Technical Memorandum	X	X	X
16	Dig List	X	X	X
17	Final Report			X

WORKSHEET #34B: DATA VERIFICATION AND VALIDATION INPUTS TABLE FOR MC DATA AND SEDIMENT REMEDIATION

Item	Description	Verification (completeness)	Validation (conformance to specifications)
Planning Documents/Records			
1	Approved QAPP	X	
2	Contract	X	
3	Field SOPs	X	
4	Laboratory SOPs/QA Manual/Certifications	X	
Field Records			
5	Field logbooks/daily reports	X	X
6	Equipment calibration records	X	X
7	COC forms	X	X
8	Sampling diagrams/surveys	X	X
9	Sample/boring logs	X	X
10	Sample location verification	X	X
11	Relevant correspondence	X	X
12	Change orders/deviations	X	X
13	Field audit reports	X	X
14	Field corrective action reports	X	X
Analytical Data Package			
15	Cover sheet (laboratory identifying information)	X	X
16	Case narrative	X	X
17	Internal laboratory COC	NA	NA
18	Sample receipt records	X	X
19	Sample chronology (i.e., dates/times of receipt, preparation, and analysis)	X	X
20	Communication records	X	X
21	Project-specific PT sample results	NA	NA
22	LOD/LOQ establishment and verification	X	X

WORKSHEET #34B: DATA VERIFICATION AND VALIDATION INPUTS TABLE FOR MC DATA AND SEDIMENT REMEDIATION (CONTINUED)

Item	Description	Verification (completeness)	Validation (conformance to specifications)
23	Standards traceability	X	X
24	Instrument calibration records	X	X
25	Definition of laboratory qualifiers	X	X
26	Results reporting forms	X	X
27	QC sample results	X	X
28	Corrective action reports	X	X
29	Raw data	X	X
30	Electronic data deliverable	X	X

WORKSHEET #35A: DATA VERIFICATION AND VALIDATION PROCEDURES FOR MEC-RELATED TASKS

Activity and Records Reviewed	Requirements/ Specifications	Process Description/Frequency	Responsible Person	Documentation
General MEC Field Documentation	UFP-QAPP	Verification only, confirm documentation is complete for each day of field activities and any required signatures are included.	UXOQCS	UXOQCS Daily QC Report
			SUXOS	Daily Status Reports
			SUXOS	Team Leader Logbook(s)
			SUXOS	Field Change Request Form
			UXOQCS/ WESTON Project Geophysicist	RCA
			UXOQCS	Photographic Log
		Verification; confirm documentation is complete for each day of field activities and any required signatures are included. Validation; ensure the results of all relevant MPCs are attained and correctly documented in the deliverable.	UXOQCS	Daily QC Report
General Geophysics Documentation	UFP-QAPP	Verification only; confirm documentation is complete for each day of field activities and required signatures are included.	WESTON Project Geophysicist	Field logbooks
		Verification; confirm Weekly Geophysical QC Reports on file cover entire duration of field effort. Validation; ensure the results of all relevant MQOs are attained and correctly documented in the deliverable.	WESTON Project Geophysicist (verification), Senior Geophysicist (validation)	Weekly Geophysical QC Report Final Data Archive (for each delivered survey unit)

WORKSHEET #35A: DATA VERIFICATION AND VALIDATION PROCEDURES FOR MEC-RELATED TASKS (CONTINUED)

Activity and Records Reviewed	Requirements/ Specifications	Process Description/Frequency	Responsible Person	Documentation
Detection Survey - IVS	UFP-QAPP, Alpine IVS UXO SOP	Verification; confirm documentation is complete, including dates and applicable signatures. Validation; initial IVS surveys have been conducted according to the SOP. All specifications have been achieved or exceptions noted. If appropriate, CAs have been completed.	WESTON Senior Geophysicist	IVS Technical Memorandum
Mapping Data Collection	UFP-QAPP, Alpine Multibeam Hydrography SOP	Verification; confirm documentation is complete, including dates and applicable signatures.	WESTON Project Geophysicist	Weekly Geophysical QC Report
		Validation; MQOs have been achieved, with any exceptions noted. If appropriate, CAs have been completed.	WESTON Project Geophysicist	Mapping data
Detection Data Collection	UFP-QAPP, Alpine Magnetometer UXO SOP	Verification only; confirm documentation is complete for all processing steps.	WESTON Project Geophysicist	Weekly Geophysical QC Report
		Verification; confirm documentation is complete, including dates and applicable signatures. Validation; MQOs have been achieved, with any exceptions noted. If appropriate, CAs have been completed.	WESTON Project Geophysicist	DGM data
Detection Data Processing	UFP-QAPP, Alpine Magnetometer UXO SOP	Verification; confirm documentation is complete, including dates and applicable signatures. Validation; Sensor Function Test Results meet project MQOs and processing has been completed according to SOP, as appropriate. MQOs have been achieved, with any exceptions noted. If appropriate, CAs have been completed.	WESTON Project Geophysicist	Sensor Function Test Results (detection survey)

WORKSHEET #35A: DATA VERIFICATION AND VALIDATION PROCEDURES FOR MEC-RELATED TASKS (CONTINUED)

Activity and Records Reviewed	Requirements/ Specifications	Process Description/Frequency	Responsible Person	Documentation
Intrusive work at selected anomalies	UFP-QAPP, EOTI SOP 01, EOTI SOP 05, EOTI SOP 06	Verification; confirm that intrusive results are on file listing items recovered from all investigated anomalies. Validation; ensure dig sheet data are complete and adequately describe the reacquisition results and dig results, including the correct item type, MEC type, nomenclature, description, and quantity, for all listed items; ensure that items "left in place" are clearly noted and described; ensure that anomalies not investigated are clearly noted and explained.	WESTON UXOQCS/ Project Geophysicist	Intrusive results
Analog Removal	UFP-QAPP, EOTI SOP 01, EOTI SOP 03, EOTI SOP 04, EOTI SOP 05, EOTI SOP 06	Verification; verify that all magnetometer/metal detector test data, analog removal records, and analog transect status sheet are on file spanning the duration of the project. Validation; ensure the results of all relevant MPCs are attained and correctly documented in the deliverable.	WESTON UXOQCS	Daily Instrument Test Report, Analog Removal Records
Explosives Storage and Transport	UFP-QAPP, EOTI SOP 03, EOTI SOP 04, WESTON SOP 06, WESTON SOP 08, WESTON SOP 09	Verification; confirm that DD Form 1348-1As are on file spanning the duration of the project. Validation; ensure all MDAS handled and transported off-site is accounted for and that the CoC for those transfers is correctly documented.	WESTON SUXOS and UXOQCS	DD Form 1348-1A
		Verification; verify that Explosives Usage Records are on file for all demolition operations conducted during the project. Validation; ensure the record of each demolition event agrees with the related Magazine Data Card entries.	WESTON SUXOS	Explosive Usage Record

WORKSHEET #35A: DATA VERIFICATION AND VALIDATION PROCEDURES FOR MEC-RELATED TASKS (CONTINUED)

Activity and Records Reviewed	Requirements/ Specifications	Process Description/Frequency	Responsible Person	Documentation
		Verification; verify that the inventory records are on file for all magazines spanning the duration of the project. Validation; ensure the record of each demolition event agrees with the related Explosive Usage Records; ensure that there is no remaining inventory of donor explosives.	WESTON SUXOS	Magazine Data Card
Demolition Operations	UFP-QAPP, EMP, WESTON SOP 5	Verification; verify that Demolition Summary Sheet is on file for demolition operations conducted during the project. Validation; ensure all MEC destroyed by demolition and all demolition events are listed.	WESTON SUXOS	Demolition Summary Report
		Verification; verify that the shot records are on file for all demolition operations conducted over the duration of the project. Validation; ensure the record of each demolition event agrees with the related dig sheet or Magazine Data Card entries.	WESTON SUXOS	Demolition Shot Record
MPPEH Handling	UFP-QAPP, EOTI SOP 03, WESTON SOP 4, WESTON SOP 5	Verification; verify that all MDAS Disposal Documentation has been received and are on file for all MDAS shipped off-site during the project. Validation; ensure disposal documents account for all shipments of MDAS transported off-site and they certify the disposal of the material in accordance with project requirements.	WESTON SUXOS	MDAS Disposal Documentation

WORKSHEET #35B: DATA VERIFICATION PROCEDURES FOR MC

Worksheet 35B describes how each item for MC data will be verified, when the activity will occur, what documentation is necessary, and the identity of the person responsible. "Internal" or "external" is in relation to the data generator. The purpose of the assessment (Worksheets 31 and 32) is to evaluate the effectiveness of project activities to verify that the resulting data quality is adequate for its intended use, whereas MC data verification (Worksheet 35B) is to confirm that the specified requirements (sampling and analytical) have been completed. Verification inputs for the worksheet include items such as those listed in Table 9 on Page 112 of the *UFP-QAPP Manual* (EPA505-B-04-900A, IDQTF, Version 1, 2005, and March 2012 Optimized UFP-QAPP Worksheets). The description will detail how each item will be verified, when the activity will occur, and what documentation is necessary.

Data verification records may include a narrative that identifies the technical non-compliance issues or the shortcomings of the data produced during field or laboratory activities. If data verification identifies non-compliance issues, then the narrative will identify the records involved and indicate CAs taken in response. The records routinely produced during field activities and at the analytical laboratory (commonly referred to as a data package) and other documentation, such as checklists, handwritten notes, or tables, will also be included as part of the data verification records. Definitions and supporting documentation for laboratory qualifiers assigned will also be included.

A generalized Worksheet 35 for MC data is shown in **Table 35B-1** and provides most of the data deliverables and verification aspects to be implemented for the tasks related to MC sampling and analysis for the Investigation Area. Additional/fewer data deliverables may be required and Worksheet 35B will be modified as appropriate.

Table 35B-1 Data Verification (Step I) Process Table

Verification Input	Description	Internal/External	Responsible for Verification
Planning Documents (UFP-QAPP)	Evidence of required approval of plans.	Internal	WESTON PM and MC Technical Manager
Review of field procedures	Determine whether field procedures are performed in accordance with the UFP-QAPP and prescribed procedures.	Internal	Project Scientist or designee in the field and MC Technical Manager
COC forms	COC forms will be reviewed upon completion and verified against the packed sample coolers they represent. A copy of each COC will be placed in the project files, and the original will be taped inside the cooler for shipment or courier pickup.	Internal	Project Scientist or designee in the field
Field notes	Field notes will be reviewed internally and placed in the project file.	Internal	Project Scientist or designee in the field
Laboratory data package	Verify that data results meet the required turnaround time and data packages are complete. One hundred percent of data packages will be verified for sample and QC sample completeness. Verification activities include a check of the elements presented in Table 9 of the UFP-QAPP Manual (EPA505-B-04-900A, IDQTF, Version 1, 2005 and March 2012 Optimized UFP-QAPP Worksheets) that are applicable to the level of data package received to confirm that field sampling and analytical procedures have met the specified requirements.	External	Project Chemist and/or Data Validator[1]
Laboratory data package	Laboratory data packages will be verified internally by the laboratory performing the work for completeness data package and electronic deliverable and technical accuracy prior to submittal. Laboratory data package will include detailed case narrative, QC summary report, sediment sample results in dry weight, and an electronic data deliverable.	Internal	Laboratory Project Manager
Audit Reports, Corrective Action Reports	Verify that all planned audits were conducted. Examine audit reports. For any deficiencies noted, verify that corrective action was implemented according to plan.	Internal	WESTON PM and MC Technical Manager

[1] Laboratory Data Consultants, 2701 Loker Ave. West, Suite 220 Carlsbad, CA 92010. http://www.lab-data.com

WORKSHEET #36: MC DATA VALIDATION PROCEDURES

Data Validator: Laboratory Data Consultants

Analytical Group/Method	Explosives/SW 8330B Metals/SW 6010C and 7471B
Data deliverable requirements:	EnviroData 2012 EDD or equivalent EDD in MS Excel or ASCII file
Analytical specifications:	WS 28
Measurement performance criteria:	WS 12
Percent of data packages to be validated:	100%
Percent of raw data to be reviewed:	10%
Percent of results to be recalculated:	10%
Validation procedure:	Primary Criteria: ▪ QSM 5.1 acceptance criteria (incorporated into the UFP-QAPP Secondary Criteria: ▪ *National Functional Guidelines for Organic Superfund Methods Data Review* (EPA, 2017a) ▪ *National Functional Guidelines for Inorganic Superfund Methods Data Review* (EPA, 2017b). ▪ *EPA Region II SOP HW-16, Validation of Data, Nitroaromatics and Nitroamines by HPLC*, SW-846, Method 8330A (Revision 2) (EPA, 2006b). ▪ Method acceptance criteria
Validation code	S2BVEM (Stage 2B Validation Manual for metals) and S4VEM (Stage 4 Validation Manual for explosives) in accordance with EPA-540-R-2017-001 and EPA-540-R-2017-002. Data for remaining wet chemistry parameters will not be validated.
Electronic validation program/version:	None

The following data qualifiers will be applied during data validation by a third party. Potential impacts on project-specific data quality objectives will be discussed in the data validation report, which will be included as part of the final report.

WORKSHEET #36: MC DATA VALIDATION PROCEDURES (CONTINUED)

Data Validation Qualifier	Data Qualifier Definitions
U	The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
J	The result is an estimated quantity. The associated numerical value is the approximate concentration of the analyte in the sample.
J+	The result is an estimated quantity, but the result may be biased high.
J-	The result is an estimated quantity, but the result may be biased low.
R	The data are unusable. The sample results are rejected due to serious deficiencies in meeting Quality Control (QC) criteria. The analyte may or may not be present in the sample.
UJ	The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

WORKSHEET #37: DATA USABILITY ASSESSMENT FOR MC

The data usability assessment worksheet outlines the approach that will be employed while processing and reviewing RI analytical data to ensure the data are of good quality and usable to make the decisions identified in Worksheet #11 with the confidence levels established in this UFP-QAPP.

37.1 DATA QUALITY

The data usability evaluation will include an evaluation of the performance criteria for each of the PARCCS, described in detail in Worksheet 12B, Section 12.10.1 through 12.10.6.

37.2 ASSESSMENT OF DATA USABILITY

Assessment of data usability will be performed as the initial step of the data interpretation phase. In addition, data assessment is considered the final step in the data evaluation process and can be performed only on data of known and documented quality. As described in Worksheet 36, data generated for this project will undergo a formalized data validation process following the concepts presented in the EPA Inorganic and Organic National Functional Guidelines protocol.

All data will be assessed for usability, and the results will be presented in a data usability evaluation report provided as part of the RI Report. The data usability evaluation report will be prepared by the Project Scientist with assistance from the Project Chemist. The data usability evaluation report will consist of the following:

- Assessment of field and sampling and analysis activities compared to the scope in UFP-QAPP, including deviations (and effects on data quality);
- Summary of data verification and validation, including qualified data;
- Summary of evaluation of field, geophysics, and analytical data quality as compared to achievement of DQOs, including evaluation of DQIs and PARCCS parameters, and effects on the usability of data;
- Application and validity of statistical tests; and
- Overall data usability statement, including any data gaps identified due to data quality issues or gaps in the CSM.

Any corrective action (CA) memoranda submitted to the CENAB PM will also be included in the RI Report.

Data usability goes beyond validation because the achievement of the DQOs are evaluated, based on the comparison of the project DQIs and individual study-specific work plans with the obtained results. The results of the data usability assessment, and particularly any changes to the DQOs necessitated by the data not meeting usability criteria, will be included in each final report. Primarily, the assessment of the usability will follow procedures described in appropriate

EPA guidance documents, particularly *Guidance for Data Useability in Risk Assessment* (Publication No. 9285.7-05FS, September 1992), and will be conducted according to the process outlined in the following subsections.

37.3 SAMPLING AND ANALYSIS ACTIVITIES EVALUATION

The first step of the data usability evaluation will include a review of the sampling and analysis activities in comparison to project-specific DQIs and study-specific work plans. Specific limitations to the data, i.e., results that are qualified as estimated (J/UJ), or rejected, will be determined and documented in the database. The data acquisition and evaluation process consists of a series of procedures designed to maximize final data quality.

37.4 ACHIEVEMENT OF DQIs

The second part of data usability pertains to the achievement of the specific DQIs. The Project Scientist will compare the performance achieved for each data quality criterion against the expected and planned performance. In general, the comparison will follow from the DQIs used to define each DQO. The comparison is the most critical component of the assessment process. Any deviation from planned performance will be documented and evaluated to determine whether CA is advisable. Potential CAs will range from resampling and/or reanalysis of data to qualification or exclusion of the data for use in the data interpretation. In the event that CA is not possible, the limitations, if any, of the data with regard to achieving the DQOs will be noted.

In conjunction with the DQI achievement review, the Project Scientist or MC Technical Manager will need to make decisions regarding the use of qualified values, which are a consequence of the formalized evaluation/validation process. Data qualifiers will be applied to individual data results. Data usability decisions will be made based on the assessment of the usability of each of the results for the intended purpose. Evaluation will describe the uncertainty (i.e., bias, imprecision) of the qualified results. Cumulative QC exceedances from the DQIs may require technical judgment to determine the overall effect on the usability of the data. Decisions about the usability of qualified data for use in risk assessment will be based on the EPA document mentioned, which allows the use of estimated values. Finally, data users may choose to determine final data usability qualifiers as a result of the overall examination and decision process.

37.5 ACHIEVEMENT OF DQOs

The third step in the data usability process concerns achievement of the DQOs. After the dataset has been assessed to be of known quality, data limitations have been documented, and overall result applicability/usability for its intended purpose has been determined, the final data assessment can be initiated by considering the answers to the following questions:

- Are the data adequate to determine the presence of MC contaminated sediment if leaking or damaged MEC is identified?

- Do the data collected adequately characterize the nature and extent of potential MC if a CMUA is identified?

The project team (as defined in Worksheet 7), will need to formulate solutions if data gaps are found as a result of problems, biases, or trends in the analytical data, or if conditions exist that were not anticipated in the development of the DQOs. It is particularly important that each data usability evaluation specifically address any limitations on the use of the data that may result from a failure to achieve the stipulated DQO.

If the project scope changes, the DQOs will be expanded. The project team will re-evaluate the existing DQOs and determine what additional DQOs are needed. The additional DQOs will address the specific action limits and measurable performance criteria necessary to make appropriate decisions regarding the analytical data. The results of the data usability assessment, and particularly any changes to the DQOs necessitated by the data not meeting usability criteria, will be included in the final report.

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APPENDICES

APPENDIX A
PERFORMANCE WORK STATEMENT

Munitions Response Services at the U.S. Army Garrison West Point
West Point, NY
PERFORMANCE WORK STATEMENT

Date: 17 April 2017
REV: 2

1.0 Introduction and Background

The Contractor shall assume calendar days for all scheduling requirements unless otherwise stated.

This requirement is for environmental services for two (2) Munitions Response Sites (MRSs) at U.S. Army Garrison West Point, West Point, NY. This is a performance-based, firm-fixed price task order. Munitions response services included in this Performance Work Statement (PWS) are as follows:

- Achieve Remedial Investigation / Feasibility Study (RI/FS) through Decision Document for Siege Battery-TD River (WSTPT-016-R-01) MRS. **This MRS is a water range.**
- Achieve Remedial Investigation / Feasibility Study (RI/FS) through Decision Document for Battery Knox-TD River (WSTPT-004-R-01) MRS. **This MRS is a water range.**

The U.S. Army Garrison West Point, West Point, NY (the "Installation") is located in Orange and Putnam Counties, New York, on the west back of the Hudson River. The Installation is approximately 50 miles north of New York City and approximately 13 miles south of Newburgh. The 15,974 acres of land encompassing the Installation has been designated as two areas: the Main Post or campus (2,530 acres) and the Military Reservation (13,444 acres). The Main Post contains the majority of the academic, residential, and support facilities. The Military Reservation is largely undeveloped and contains operational training facilities such as firing ranges and bivouac areas used during the summer to house and train cadets.

The Closed, Transferred, and Transferring (CTT) Range Inventory identified 10 closed ranges and 2 transferred areas, totaling approximately 1,564 acres. The MRSs identified in the Range Inventory included a series of batteries and artillery ranges, which fired artillery during training throughout the Revolutionary War and continued to do so until World War II (WWII). The firing from these batteries was mostly directed toward Crow's Nest, which were also impact zones for artillery fired from the West Point Foundry at Cold Spring, NY in the mid to late1800's. In addition to batteries, the Range Inventory MRSs included artillery ranges and small arms ranges. The Installation has been occupied by the U.S. Army since January 27, 1778, and is the oldest occupied military post in America to have continuously flown the nation's flag.

1.1 MRS Background

Siege Battery – TD River (WSTPT-016-R-01) - The Siege Battery-TD River MRS encompasses 848 acres within the Hudson River. The MRS is the portion of the Siege Battery firing fan that falls within the Hudson River. Activities that took place on the Installation that are associated with the Siege Battery included live firing conducted from the Siege Battery and ammunition storage. There are no known impact areas within the Siege Battery MRS; however, projectiles that overshot the targets located in the Hudson River may have impacted into the Constitution Island portion of the MRS. In addition, target butts for a 1,000-yard Rifle Range were also located within the Siege Battery MRS. Projectiles that overshot the targets located in the river may have impacted the shore of the Hudson River to the north of the Village of Cold Spring. During the latter part of the 19th century, the Siege Battery was renamed Battery Schofield and was used for training with Parrott rifles. Various munitions were used at the Siege Battery including a 4½ - inch rifled gun, 30-pounder Parrott guns, 10-inch smooth bore siege mortars, 8-inch smooth bore siege mortars, 5-inch steel breech-loading guns, 7-inch steel breech-loading howitzers, 7- inch steel breech-loading mortars, and 3.2-inch guns. The targets for the guns used at the Siege Battery were on Crow’s Nest, approximately 2,000 yards distant. Full charges were not used in any of the guns. The targets for the mortars were anchored in the Hudson River. Use of the Siege Battery ended between 1906 and 1910, when Battery Schofield came into service. A map from 1939 indicates the Siege Battery and Battery Schofield had been replaced by an amphitheater. An SI was completed in 2007 and recommended the site for further investigation for the presence of Munitions and Explosive of Concern (MEC) and Munitions Constituents (MC).

Battery Knox – TD River (WSTPT-04-R-01) - The Battery Knox-TD River MRS encompasses 73 acres on the Hudson River. The MRS is the portion of the Battery Knox firing fan that falls within the Hudson River. Battery Knox contained six gun positions and ammunition magazines. The battery was established sometime between 1836 and 1850. In 1874, the battery was redesigned, with modifications made to the armament and the orientation of the guns to improve their defensibility and their ability to cover the river with firepower. By 1892, Battery Knox was armed with one 100-pounder Parrott 6.4-inch caliber rifle, one 300- pounder Parrott 10-inch caliber rifle, one 8-inch converted rifle, and four 10-inch Rodman rifles. Firing from the battery was conducted to the east towards targets that were placed in the Hudson River. The battery was demolished during the WWII era. An SI was completed in 2007 and recommended the site for further investigation for the presence of MEC and MC.

2.0 Requirements

The Contractor shall be responsible for fully executing the Firm Fixed Price Remediation (FFPR) approach under a Performance-Based Acquisition (PBA) by: conducting required environmental investigative and restoration services for which the United States Department of the Army (the “Army”) is statutorily responsible; addressing any and all unforeseen environmental, explosive safety, scheduling, and regulatory issues; and, assuming contractual liability and responsibility for the achievement of the performance objectives for the MMRP sites at the U.S. Army Garrison West Point identified in this Performance Work Statement (PWS), including any sites with off-installation contamination for which the Army is responsible.

The Contractor must possess all the required expertise, knowledge, equipment and tools required to meet or exceed the government’s objectives identified in this PWS in accordance with established industry standards. The Contractor must have the capability and experience to perform, or provide investigative and restoration services required for hazardous substance and waste sites and MEC.

Work will include one or more of the following: Remedial Investigation/Feasibility Study (RI/FS), Proposed Plan (PP), and Decision Document (DD).

Under this task order, the Contractor shall perform munitions response actions for military munitions (MM) and MC. Activities may involve MEC which includes Unexploded Ordnance (UXO), Discarded Military Munitions (DMM), and MC if found in high enough concentrations to cause an explosive hazard, Material Potentially Presenting an Explosive Hazard (MPPEH), and non-explosive concentrations of MC and incidental contaminants not related to MM. All activities involving work in areas potentially containing MEC hazards will be conducted in full compliance with DoD, Department of the Army and United States Army Corps of Engineers (USACE) safety regulations.

It is the Contractor's responsibility to comply with all applicable federal, state and local laws and regulations and to fulfill the performance objectives of this PWS in a manner that is consistent with any applicable orders or permits, all existing and future cleanup agreements or guidance for the Installation, and relevant DoD and Army policy, for the duration of the contract.

All environmental services will comply with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended by the Superfund Amendments and Reauthorization Act (SARA), and National Oil and Hazardous Substances Contingency Plan (NCP) in coordination with the New York State Department of Environmental Conservation (NYSDEC), New York State Department of Health (NYSDOH) and the United States Environmental Protection Agency (EPA) Region 2 requirements as applicable.

To perform munitions responses, the DoD primarily uses CERCLA. However, CERCLA has no special provisions for dealing with explosive safety. Activities may involve MEC, which includes UXO, DMM, and MC if found in high enough concentrations to cause an explosive threat, non-explosive concentrations of MC and incidental contaminants not related to MM. Specific requirements concerning explosives safety under the Active MMRP are further clarified in DoDM 6055.09M, ER 385-1-95, EM 385-1-97. Munitions Response Actions – Minimum Separation Distances (Relative to Impulse Water Pressure) from Underwater Detonations Memorandum dated 16 Sep 2013 provides additional information.

Certain pollutants or contaminants (P/C) may be an issue at sites covered by this PWS. Cleanup of P/C may be warranted if the P/C present an imminent and substantial endangerment to the public health or welfare that result in an unacceptable risk. P/C, as defined in CERCLA, typically does not have a federally promulgated maximum contaminant limit (MCL). For any such P/C, or any other chemical, that does not have a federally promulgated MCL, but does have a finalized reference dose (RfD) or slope factor listed in USEPA's Integrated Risk Information System (IRIS) database, that RfD or slope factor should be incorporated in the NCP risk assessment process. Funding will not be provided for responses that are not in full compliance with CERCLA, the DERP, and DoD and Army policy. Additionally, state standards will only be analyzed through the CERCLA applicable or relevant and appropriate requirement (ARAR) process.

3.0 Types of Services Required

This PWS includes the following types of services as authorized in the basic contract:

- CERCLA Studies and Reports
- Remedial Investigation of MEC/MC
- Feasibility Study for MEC/MC
- Proposed Plan for MEC/MC
- Decision Document for MEC/MC

4.0 Task Order Type

This is a firm fixed-price task order without environmental insurance. The period of performance on this Task Order is sixty (60) months from NTP, inclusive of all options.

5.0 Performance Objectives and Standards

The Contractor shall be required to furnish all plant, labor, materials and equipment necessary to meet the performance objectives and standards identified in Table 1 below. The current status of the remediation efforts for each site can be found in documents provided in data disks (**Attachment A**) for this Task Order. The information in **Section 1.1** is provided for background information only.

Table 1: Performance Requirements Summary

Performance Objectives	Performance Measure
Approved Project Management Plan (PMP): • Draft PMP within 30 days of contract award. • Final PMP within 15 days of receipt of COR comments on the draft. • The Contractor should assume that updates will be required as options are exercised and modifications are made.	• Army approval through the Contracting Officer's Representative (COR).
Approved Uniform Federal Policy - Quality Assurance Project Plan (UFP-QAPP) within 18 months of NTP for the following sites: • Siege Battery-TD River (WSTPT-016-R-01) • Battery Knox-TD River (WSTPT-004-R-01)	• Army approval through the COR. • Regulator concurrence (e.g., receipt of documentation confirming approval of UFP-QAPP).

OPTION: Achieve Remedial Investigation / Feasibility Study (RI/FS) at the following sites within 30 months of award of option: • Siege Battery-TD River (WSTPT-016-R-01) • Battery Knox-TD River (WSTPT-004-R-01)	• Army approval through the COR. • Regulator concurrence (e.g., receipt of documentation confirming approval of Remedial Investigation Report/Feasibility Study Report). • Compliance with the Government provided, DDESB approved Explosives Site Plan (ESP).
OPTION: Achieve Proposed Plan (PP)/Decision Document (DD) at the following sites within 24 months of award of option: • Siege Battery-TD River (WSTPT-016-R-01) • Battery Knox-TD River (WSTPT-004-R-01)	• Army approval through the COR. • Regulator concurrence (e.g., receipt of documentation confirming approval of Proposed Plan/Decision Document).
OPTION: Achieve an Accepted DERP Restoration Advisory Board (RAB) Public Interest Survey Report (Survey 1) within 12 months of award of option.	• Army approval through the COR.
OPTION: Achieve an Accepted DERP Restoration Advisory Board (RAB) Public Interest Survey Report (Survey 2) within 12 months of award of option.	• Army approval through the COR.

The Contractor shall assume the following:

- With the exception of the PMP and UFP-QAPP, stand-alone documents will be generated for each MRS.
- Per DoDM 4715.20, for areas of the MRS with water depths greater than 120 feet, it will be assumed that a physical constraint/barrier exists to prevent exposure to human receptors.
- As part of this investigation, the Siege Battery-TD River (WSTPT-016-R-01) MRS will be expanded to include Area A (63 acres) and Area B (154 acres) as illustrated in **Attachment D**.
- The Government will provide a DDESB-approved ESP for this work.
- All “acceptable to move” MEC will be disposed of within the boundaries of the MRS on the western shore of the river and Constitution Island.

6.0 Project Management

The PBA approach requires careful coordination of project activities to ensure that all stakeholders are kept informed of the project status, existing or potential problems, and any changes required to prudently manage the project and meet the needs of the Installation's project stakeholders and decision-makers. The Contractor shall be responsible for the following project management activities:

6.1 Project Management Plan and Schedule

The Contractor shall develop and maintain a detailed Project Management Plan (PMP). The PMP, based on the schedule prepared as part of the Contractor proposal, shall specify the schedule, technical approach, and resources required for the planning, execution, and completion of the performance objectives. The first draft of the PMP will be due within thirty (30) days of contract award. The draft PMP and subsequent revisions shall be subject to Army review and approval through the Contracting Officer's Representative (COR). The final PMP shall be due within fifteen (15) days of comments received from the COR. A payment milestone will be established for Army approval of the final PMP through the COR.

As part of the PMP, the Contractor shall develop and maintain an activity-based schedule that fully supports the technical approach and outlines the due dates for all milestones and payable deliverables. A payment plan shall be included with the schedule that allows for payments to the Contractor based on successful completion of interim milestones proposed by the Contractor. It is the Army's intent to make all payments after verification of progress in accordance with this schedule. The Contractor shall coordinate activities with the COR to ensure that the proposed project schedule does not conflict with other contractor activities on site, or interrupt Installation mission activities.

As part of the PMP, the Contractor shall identify and implement a means for providing project status reports to the COR. The PMP shall address the frequency and content of status reports.

6.2 Milestone Presentations

Milestone presentations shall be made to the COR at the completion of each milestone below to provide analysis and lessons learned, and to present approaches for completion of future milestones. At the COR's request, the Contractor may also make milestone presentations to the other project stakeholders, consistent with the applicable regulatory drivers listed in **Section 2.0** of this PWS, to show achievement of the performance objectives. This includes participation in annual Installation Action Plan (IAP) meetings, if requested by the COR.

The Contractor may propose a revision of the milestones below to reflect their PMP and provide for interim milestones. Interim milestones will only be accepted if they represent significant progress toward milestone completion, and completion of these interim steps can be measured and demonstrated. Payments will be tied to the successful completion major milestones listed below or an interim milestone plan approved by the Army, through the COR. To that end, all proposed interim milestones should be associated with easily demonstrated metrics tied to performance measurements (e.g., resolution of comments on a draft, acceptance of a final report, or acceptance of a data submittal or meeting minutes). All milestones must have a defined means for demonstrating completion in order to facilitate certification and approval (see **Section 8.3**, Certification and Approval of Project Milestones and Deliverables).

Major Milestones

- Approval of the Project Management Plan

- Approval of (acceptance/approval of) Final UFP-QAPP
- Approval of (acceptance/approval of) Final Remedial Investigation Report
- Approval of (acceptance/approval of) Final Feasibility Study
- Approval of (acceptance/approval of) Final Proposed Plan
- Approval of (acceptance/approval of) Final Decision Document
- Approval of (acceptance/approval of) Final Community Relations Plan (CRP)
- Approval of (acceptance/approval of) DERP RAB Public Interest Survey Report (Survey 1)
- Approval of (acceptance/approval of) DERP RAB Public Interest Survey Report (Survey 2)

6.3 Environmental Requirements

The Contractor shall perform contract tasks in areas which potentially contain MEC hazards and shall comply with all applicable federal, state and local laws and regulations; and applicable site-specific orders, agreements, or rules; as well as Army and DOD requirements, such as those established by the DoD Explosive Safety Board; while performing these contract tasks. The Contractor shall ensure that all activities performed by its personnel, subcontractors and suppliers are executed in accordance with these requirements. Any incident of non-compliance noted by the Contractor shall immediately be brought to the attention of the COR telephonically and then by written notice. Nothing in this contract shall relieve the Contractor of its responsibility to comply with applicable laws and regulations. The Contractor will obtain all approvals and permits (i.e., excavation, wetlands, National Pollutant Discharge Elimination System (NPDES), cultural resources, etc.), necessary to accomplish the work. When the work to be performed requires facility clearances, the Contractor will obtain them prior to any work and coordinate all work with that point of contact (POC) prior to initiation. Contractors are required to perform their own utility checks. The Contractor shall comply with all site-specific time and procedural requirements (federal, state, and local) described in the permits obtained. The Army technical experts will also independently review Contractor work to ensure compliance with all applicable requirements.

The Contractor shall be required to review and adhere to significant aspects /impacts related to environmental policy.

The Army is in the process of establishing a Geographic Information System (GIS)-based tracking system to ensure the Land Use Controls (LUCs) are enforced. The LUCs will/have been incorporated into the Master Plan and compliance with LUCs will/shall be reported in the inspection and annual reports and 5 year reviews for each site. The LUC policy applies to all units and activities, Military and Civilian Support Activities, tenant organizations and agencies and Government and Civilian Contractors.

The Contractor shall review and fully understand "Executive Order 13423 -- Strengthening Federal Environmental, Energy, and Transportation Management," in particular those requirements pertaining to environmental management system (EMS). The Contractor shall also be required to review and adhere to the Installation's environmental management system, including the environmental policy and significant aspects / impacts.

The Contractor shall consider and implement green response/remediation strategies and applications to maximize sustainability, reduce energy and water usage, promote carbon neutrality, promote industrial materials reuse and recycling, and protect and preserve land resources, consistent with DOD's Policy on Consideration of Green and Sustainable Remediation Practices in the Defense Environmental Restoration Program. The contractor shall present green remediation options and approaches in its work plans, maintain records of "green-related" activities, and report this information to the COR in its project status reports.

6.4 Munitions and Explosives of Concern Related Guidance

MEC includes: UXO, as defined in 10 U.S.C. 101(e)(5); DMM, as defined in 10 U.S.C. 2710(e)(2); or Munitions Constituents (MC), as defined in 10 U.S.C. 2710(e)(3), present in high enough concentrations to pose an explosive hazard.

MEC distinguishes specific categories of military munitions that may pose unique explosives safety risks. Because MEC that is being actively managed may be determined to be hazardous wastes, 29 Code of Federal Regulations (CFR), Hazardous Waste Operations and Emergency Response, Section 1910.120 may apply.

The Contractor shall comply with all Installation or site-specific time and procedural requirements (federal, state, and local) described in the approvals obtained.

UXO qualified personnel shall be responsible for determining the explosive safety status of any material recovered that may pose an explosive hazard (i.e., MPPEH).

Should MEC be encountered during this response, UXO-qualified personnel shall evaluate the explosive hazard and remove and or mitigate the hazard. This response will be conducted per the CERCLA and the NCP, applicable state and federal regulations, and applicable DOD, U.S. Army, and USACE guidance.

6.5 Health and Safety Requirements

Upon receipt of notice to proceed the Contractor shall conduct a site specific hazard evaluation as defined in paragraph 06.A.02 of EM 385-1-1. The hazard evaluation shall not be limited to potential exposure to hazardous and/or toxic agents but will include all potential hazards which workers may encounter on the site. This evaluation shall be documented in a written report and provided for review and acceptance by the Government Designated Authority (GDA) prior to submission of the Accident Prevention Plan (APP). Prior to beginning any fieldwork, the Contractor shall implement a written Safety and Health Program compliant with federal, state, and local laws and regulations and approved by the COR. The Contractor shall develop and ensure that its subcontractors, suppliers and support personnel comply with the approved APP and Site Safety and Health Plan (SSHP) per the guidance established in EM 385-1-1. The Army reserves the right to immediately stop work under this contract for observed safety concerns which may expose site personnel to an immediate hazard or any violations of the SSHP at no additional cost to the Army. Once the Army verifies through the COR that the violation has been corrected, the Contractor shall be allowed to continue work. The APP/SSHP shall contain the minimum elements required for compliance with EM 385-1-1 guidance. In addition to compliance with the approved APP/SSHP the Contractor will be responsible for conducting all work in accordance with the approved ESP provided by USACE. Additionally, the Contractor must adhere to all DoD and Department of the Army (DA) and USACE policies, procedures and regulations for munitions response.

Personnel involved in certain munitions response activities will, as required, meet the qualifications of Department of Defense Explosives Safety Board (DDESB), Technical Paper (TP) 18, Minimum Qualifications for UXO Technicians and UXO-Qualified Personnel. Per EP 1110-1-18, the Contractor will propose a workweek schedule for each project. The proposed schedule will be submitted to the Contracting Officer (KO) for approval. The KO will seek the concurrence of the project development team (PDT) and resolve any other comments before making the decision to accept or reject the schedule. If the schedule is rejected, the Contractor will propose a new schedule and the same process will be repeated until an acceptable schedule is approved.

The sites are not suspected to contain chemical warfare material (CWM); however, if suspect CWM or unknown munition is encountered during any phase of site activities the Contractor shall immediately halt operations and contact the COR for assistance and guidance.

All activities involving work in areas potentially containing MEC hazards shall be conducted in full compliance with Department of Army, state, and local requirements regarding personnel, equipment and procedures, and DoD Standard Operating Procedures and safety regulations.

6.6 Quality Management

The Contractor must ensure that the quality of all work performed or produced under this contract meets Army approval. Quality control/assurance plans must be prepared and approved by the COR prior to performance of physical work.

Since the technical approach for this PBA shall be developed by the Contractor, the Contractor shall also develop a strategy for Army Quality Assurance (QA), to be submitted with the PMP. The QA strategy should highlight key quality control activities or events the COR will use to determine when Army (Contracting Officer (KO) or COR) inspections can be conducted to assess progress toward milestones. Activities identified in the QA strategy should be appropriately coded in the project schedule to allow for planning of QA inspections. These activities will be incorporated into the Quality Assurance Surveillance Plan (QASP) that will be developed and implemented by the COR to determine when Army (COR) inspections can be conducted to assess progress toward and/or completion of milestones. The QASP will be made final within fifteen (15) calendar days of the final approved PMP.

6.7 Quality Control

Quality Control shall be provided whenever sampling or analysis for chemical constituents is required in order to achieve milestones. Quality control for traditional soils or geotechnical testing shall also be included. Effective October 1, 2009, laboratory(ies) to be used by the Contractor to perform testing in support of the DoD environmental restoration programs and that do not hold an unexpired DoD Component (Army) approval need to be accredited in accordance with DoD Environmental Laboratory Accreditation Program (ELAP). Laboratories that have DoD Component approvals in place prior to this date will be subject to DoD ELAP requirements when those approvals expire or when additions or modifications to their scope of approval are required. The Contractor may establish an on-site testing laboratory at the project site if determined necessary by the Contractor. However, on-site testing shall meet the requirements of USEPA, specific state regulator requirements, and all requirements of the most recently approved DoD Quality Systems Manual (QSM).

Following task order award and during project implementation, the Contractor shall develop and submit documentation of project-specific quality assurance (QA) and QC activities prepared in accordance with the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP). The Government will review and return the quality systems documentation, with comments, indicating acceptance or rejection. If necessary, the Contractor shall revise the documentation to address all comments and shall submit the revised documentation to the Government for acceptance. In addition, the Contractor shall develop and submit Quality Control Summary Reports to summarize the quality control details of the task order project. The problems and successes of the work done to control the quality of the chemical measuring activities and other chemically related cleanup activities shall be included in the summary reports.

6.8 Project Repository and Administrative Record

The Contractor shall update at least monthly a multimedia (i.e., both paper and electronic format) project repository of all project-related information to ensure that pertinent documentation and data are available for project reviews, and to provide a clear record of the PBA approach to support final decisions and remediation completion. This repository is the property of the Army and available to the Army upon request by the COR or KO. A project repository is currently maintained at the Highland Falls Library, 298 Main Street, Highland Falls NY 10928. Documents provided to the library are on CD. "Project-related information" includes all previous environmental restoration documentation of a technical nature developed by the Army and previous Army contractors for the sites specified in this PWS, and all the documentation developed by the Contractor in order to achieve the performance objectives specified in this PWS. Documents generated prior to the PBA are not expected to be stored in electronic format; however, all documents generated by the Contractor shall be maintained in multi-media form.

The Contractor shall also update the Administrative Record File for CERCLA activities. The project repository and Administrative Record File shall be updated by the Contractor, and made available to the public, for the duration of the contract. Final electronic document files must be in text-searchable portable document format (PDF) and be accompanied by defined metadata for use by the Installation.

6.9 Army Environmental Database and Environmental Restoration Information System

The Contractor shall be responsible for providing the COR with the data and documentation necessary for each site in the Headquarters Army Environmental System (HQAES). In addition, the Contractor shall upload all generated analytical data into the Environmental Restoration

Information System (ERIS) on a quarterly basis. The Army, through the COR, will provide data specifications for HQAES and ERIS to the Contractor. The Contractor shall comply with all applicable requirements for data validation and submission.

6.10 Additional Site Plans

Prior to beginning any field work, the Contractor shall prepare any additional plans or documents (e.g., sampling and analysis plans, quality assurance project plan, waste minimization plans, health and safety plans) consistent with Section C of the basic contract, the applicable regulatory drivers listed in **Section 2.0** of this Task Order, and any other agreements, orders, or regulations that apply to the Installation and sites. These plans and documents shall be subject to Army review and approval, through the COR.

6.11 Waste Minimization Plans

The Contractor shall provide, and upon Army approval through the COR, implement a Waste Minimization Plan. A Draft and Final Waste Minimization Plan shall be submitted with the PMP deliverables in accordance with Table 1. The plan shall identify waste streams and projected volumes to be generated to achieve the performance objectives identified in the PWS.

6.12 Installation Action Plan Meetings

Contractors currently do not participate in the Installation Action Planning Meetings (IAPs). If requested by the Installation, the Contractor will provide site information to support the IAP process, participate in the IAP meetings, and provide input and comments on the draft IAP, as appropriate.

6.13 Protection of Property

If it is necessary to access private property or other property outside the control of the Army, the Contractor will submit a written request to the COR a minimum of 60 calendar days in advance of the proposed entry date stating that a Right of Entry will be needed. The Contractor will not enter any property not under the control of the Army without an approved Right of Entry and will be required to comply with all conditions specified in the Right of Entry. If the Government is unable to obtain the Right of Entry within 120 calendar days from the date of notification from the Contractor, the Contractor will make best efforts to complete the requirements of this PWS without entering such property.

The Contractor will be responsible for any damage that may be caused to property of the United States (Federal property) or any other property owned by others during the activities of the Contractor under this contract and will exercise due diligence in the protection of all property located on the premises against fire or damage from any and all other causes. Any property of the United States or owned by others damaged or destroyed by the Contractor incident to the exercise of the privileges herein granted will be promptly repaired or replaced by the Contractor to a condition satisfactory to the COR or reimbursement is made by the Contractor sufficient to restore or replace the property to a condition satisfactory to the COR in accordance with Federal Acquisition Regulation (FAR) Clause 52.245-2.

6.14 Project Stakeholders

For the purposes of this PWS, project stakeholders will include but are not limited to:
- the Army;
- the NYSDEC;
- the NYSDOH;
- the U.S. Environmental Protection Agency (USEPA) Region II;
- the U.S. Army Garrison West Point RAB (if formed);
- Storm King State Park;
- and, potentially, local communities such as the Town of Phillipstown, Garrison and Cold Spring.

Specific Army stakeholders include the following: Installation staffs, Installation Management Command (IMCOM) as the Installation's parent organization, Department of Defense Explosives Safety Board (DDESB), U.S. Army Technical Center for Explosive Safety (USATCES), U.S. Army Public Health Center, U.S. Army Environmental Command, and U.S. Army Corps of Engineers –Baltimore District.

The Contractor shall be responsible for obtaining comments with appropriate approval on project deliverables consistent with applicable regulatory drivers and agreements for each site. The Contractor shall use EM 200-1-2 [Technical Project Planning (TPP) Process] as a reference.

6.15 Regulatory Involvement

All regulatory coordination shall be approved by the Army through the COR. The Contractor shall provide the necessary support to initiate, schedule, and address all regulatory aspects of the project (e.g., organizing discussions with regulators concerning site response objectives and completion requirements, attending meetings with regulators, obtaining regulator comments on site documents and appropriately addressing them, and obtaining written documentation of remediation completion from the regulators for all of the sites identified in this PWS). The COR, or designee, will attend and represent the Army at all meetings with the regulators. With approval of the COR, the Contractor may also informally discuss remediation issues with regulators and provide an after-action report back to the COR. The Army will be the signature authority for all regulatory agreements and remediation documentation.

6.16 Public Involvement

All public participation coordination shall be approved by the Army through the KO. The Contractor shall provide the necessary support to initiate, schedule, and address all public participation aspects of the project (e.g., preparation of briefings, presentations, fact sheets, newsletters, articles/public notices to news media, etc). The Contractor shall be responsible for requesting and addressing all public comments consistent with the applicable regulatory drivers listed in **Section 1.0** of this PWS. The COR, or designee, will attend and represent the Army at all meetings with the public.

At this time, there is not sufficient community interest to establish and sustain a Restoration Advisory Board (RAB) or Technical Review Committee (TRC). The Contractor will conduct public interest surveys, if optional tasks are awarded. If the surveys indicate adequate public interest exists, the Installation will establish a RAB. Should a RAB be formed, the Contractor will be required to provide the necessary support (e.g., preparation of briefings, presentations, fact sheets, newsletters, and notifications to RAB members) for the sites listed in this PWS. Activities required to support public meetings are included in this effort. The Contractor will be required to participate and provide presentations on sites listed in this PWS. The Installation will provide detailed information concerning the RAB's organization.

The Contractor is responsible for developing an approved IRP and MMRP Community Relations Plan (CRP) to address both the IRP and MMRP projects at the Installation that is consistent with the Installation’s current Community Relations Plan.

6.17 Communications

The Contractor shall not make available or publicly disclose any data or report generated under this contract unless specifically authorized by the KO through the COR. If any person or entity requests information from the Contractor about the subject of this scope of work or work being conducted hereunder, the Contractor shall refer them to the COR. All reports and other information generated under this scope of work shall become the property of the Government, and distribution to any other source by the Contractor is prohibited unless authorized by the KO.

6.18 Deliverable Requirements

All documents must be produced in draft, draft-final, and final versions in both hard copy and electronic (PDF) format. Raw data files, such as MS Word documents or Excel tables, may be requested to assist in submittal reviews. The electronic format must have optical character recognition per the USAEC READ requirements. The Contractor will provide a sufficient number of copies of each submittal as requested by the various project stakeholders. The COR will provide consolidated Army comments on draft documents to the Contractor within thirty (30) days. Once initial comments are addressed, the Army will review draft-final documents before submission to appropriate regulatory agencies. The Contractor shall ensure that review periods are consistent with the applicable regulatory drivers noted in **Section 2** of this PWS. All documents shall be identified as draft-final until completion of stakeholder coordination, when they will be signed and finalized. One copy of the final document shall be placed in both the project repository and Administrative Record (for CERCLA documents). The Contractor should also use EM 200-1-15 and MMRP Data Item Descriptions (DIDS) as a reference.

The Contractor will conform to U.S. Army Corp of Engineers (USACE) requirements or a similar approach that addresses all subject matter areas prescribed in the USACE requirements, which can be found at: http://www.hnd.usace.army.mil/oew/CX_refdocs.aspx and http://140.194.76.129/publications/. Additionally, if versions of Engineer publications, Data Item

Description (DID), etc. are updated, the substantive requirements of the most recently approved version will apply.

The Munitions Response Site Prioritization Protocol (MRSPP) requirements in 32 CFR Section 179 require the DoD in consultation with representatives of the states and Indian tribes, to assign each MRS a relative priority for response actions. These MRSPP scores must be reviewed annually and must be revised whenever new data are obtained. Pursuant to this requirement, the Contractor shall annually review, revise MRSPP scores based on new information, and submit to the Army. In addition, the Contractor shall also include any information that may have influenced the MRS priority or MRS sequencing decision in the Administrative Record. Furthermore, the FY02 Defense Authorization Act creating the MMRP requires DoD to develop and maintain an inventory of defense sites that are known or suspected to contain UXO, DMM or MC. Pursuant to this requirement, the Contractor shall submit annual updates to the Installation Munitions Response (MR) map that reflect changes to the location, boundaries and/or extent of the MMRP sites in .pdf format. Note that these two annual deliverables will not be accepted as interim payment milestones.

The Contractor shall propose deliverables and payment milestones as part of its proposal, and if approved by the Army, included as part of the PMP. Final decisions regarding the adequacy of milestone and deliverable completion resides with the COR (see ***Section 6.2***, *Milestone Presentations*) and will be based on the appropriate acceptance and approval of required documentation by Regulatory Agencies, consistent with CERCLA and the NCP.

6.19 Geographic Information System

The Contractor shall adhere to all applicable federal, DoD, and Army geospatial data standards for tasks and deliverables in this PWS. Spatial data must be compliant with the Spatial Data Standards for Facilities, Infrastructure, and Environment v3.1 Army Adaptation. Spatial data must meet the requirements of the associated Quality Assurance Plan (QAP), available via the Installation Geospatial Information & Services AKO Page at https://www.us.army.mil/suite/page/421538, or will be provided to the Contractor by the Government upon request. If the attribute data being collected as part of the PWS does not match one of the required columns listed in Table 4 of the QAP, then a separate business table with the custom data may be created, using the data layer primary key as the join attribute. If no QAP exists for the data layers developed, the Contractor shall meet the minimum requirements listed in Attachment E. Each geospatial data set shall be accompanied by metadata conforming to the Metadata Requirements for Army IGI&S Geospatial Data (https://www.us.army.mil/suite/doc/44217993). The horizontal accuracy of any geospatial data created by the Contractor shall be tested and reported in accordance with the National Standard for Spatial Data Accuracy (NSSDA) and the results shall be recorded in the metadata. All data must have a datum of WGS84 and a defined projection. All GIS data will be provided to the Installation upon completion of the performance objectives as established in Table 1 of this PWS, or as requested by the Installation.

Army technical experts will independently review Contractor work to ensure compliance with all spatial data requirements. Installation subject matter experts will review Contractor work and validate geospatial data. Validated data will be submitted to the OACSIM geospatial database of record.

6.20 Contractor Manpower Reporting

The Office of the Assistant Secretary of the Army (Manpower & Reserve Affairs) operates and maintains a secure Army data collection site where the Contractor will report ALL contractor manpower (including subcontractor manpower) required for performance of this contract. The Contractor is required to completely fill in all the information in the format using the following web address https://cmra.army.mil. The required information includes:

(1) Contracting Office, Contracting Officer, Contracting Officer's Technical Representative;
(2) Contract number, including task and delivery order number;
(3) Beginning and ending dates covered by reporting period;
(4) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;
(5) Estimated direct labor hours (including sub-contractor);
(6) Estimated direct labor dollars paid this reporting period (including sub-contractor);
(7) Total payments (including subcontractor);
(8) Predominant Federal Service Code (FSC) reflecting services provided by contractor (and separate predominant FSC for each sub-contractor if different);
(9) Organizational title associated with the Unit Identification Code (UIC) for the Army Requiring Activity (the Army Requiring Activity is responsible for providing the contractor with its UIC for the purposes of reporting this information);
(10) Locations where contractor and sub-contractors perform the work (specified by zip code in the United States and nearest City, Country, when in an overseas location, using standardized nomenclature provided on website);
(11) Presence of deployment or contingency contract language, and,
(12) Number of contractor and sub-contractor employees deployed in theater this reporting period (by country).

As part of its submission, the Contractor will also provide the estimated total cost (if any) incurred to comply with this reporting requirement. Reporting period will be the period of performance not to exceed twelve (12) months ending September 30 of each government fiscal year and must be reported by 31 October of each calendar year.

6.21 Monthly Progress Reports

The Contractor shall submit by the 10th day of each month a monthly progress report summarizing activities of the preceding month (if at least fifteen (15) days of contract performance occurred in that month) and planned activities for the following month. The report shall be a concise summary and include at a minimum, the following information:

(1) Contracting Office, Contracting Officer, Contracting Officer's Representative;
(2) Contract number, including task and delivery order number;
(3) Beginning and ending dates covered by the report;
(4) Date of the report;
(5) Contract completion date and list of all CLIN period of performance dates;
(6) Contractor name, address, phone number, e-mail address, identity of contractor employee entering data;

(7) Summary of accomplishments for the report month and planned accomplishments for the following month;
(8) Safety reporting including field exposure hours and recordable and/or reportable accidents;
(9) Record of deliverables submitted;
(10) Record of communication, correspondence, and invoices;
(11) Estimate of percentage complete for each task and overall percentage complete;
(12) Personnel changes,
(13) Green remediation practices/process,
(14) Date of last submittal to the Contractor Manpower Reporting System,
(15) If applicable progress on meeting small business goals and,
(16) If applicable an updated network analysis schedule.

Reports shall be submitted to the COR in hard copy as well as via email. Email attachments, if any, shall be in Adobe pdf or MS Word format only. Email submittals shall include the project manager and emdc.admin@usace.army.mil on the cc line. The subject of the email shall be the contract number with task order followed by "Monthly Progress Report" followed by the year and month of the report (for example "W912DR-99-D-9999 9999 Monthly Progress Report YYYY MM").

7.0 Expertise and Necessary Personnel

The Contractor shall provide the necessary personnel and equipment to execute this PWS successfully. The Contractor shall be responsible for determining the requirements for licensed professionals and certifications.

The Contractor shall furnish all plant, labor, materials and equipment necessary to meet the performance objectives. The Contractor shall provide personnel trained as required by the Occupational Safety and Health Administration (OSHA) and all other applicable federal and state regulations. The Contractor shall provide all support activities necessary to ensure the safe and effective accomplishment of all work. For all work performed under this contract, the Contractor shall also develop and implement quality control measures consistent with all applicable federal and state regulatory requirements and standards.

7.1 Key Personnel

The Army requires that the following positions, at a minimum, be designated as "key personnel", subject to the terms and conditions for such set forth in the basic contract. The Contractor shall notify the COR of any changes in key personnel. The change of key personnel is subject to approval by the KO, although such approval will not be unreasonably withheld provided replacement personnel are of the same quality as originally proposed.

- Program Manager
- Project Manager
- Senior Geophysicist
- Senior UXO Supervisor

8.0 Additional Requirements

8.1 Resources

8.1.1 Army Furnished Resources

The Army will provide the following resources to the Contractor:

- Access to Army-maintained records, reports, data, analyses, and information, in their current format (e.g., paper copy, electronic, tape, disks, CDs), as related to the MMRP Munitions Response Sites (MRSs).
- Access to DoD and Army policy and guidance documents.
- All Army owned property used for Remedial Investigation purposes must be maintained by the Contractor in accordance with applicable maintenance requirements, and may not be replaced by the Army should new equipment be required.
- GIS database resources from the MMRP Reports will be provided by the COR following task order award.
- Access to personnel to conduct interviews on Installation operations and activities.
- All ROEs will be executed by a Government Real Property Officer.

8.1.2 Contractor Furnished Resources

The Contractor shall be responsible for the following:

- Coordination with the Army and the Installation in order to get access to the Installation, as required for execution of this PWS and by doing so, will follow the procedures described during the Contractors' meeting at the Installation.
- Coordination with the Army and the Installation in order to gain access to available infrastructure (e.g., buildings, roadways, waste management units, other Installation facilities) and utilities (e.g., electric power and telephone lines, natural gas and water supply distribution pipelines, and wastewater discharge conveyances), as required for execution of this PWS.
- The Contractor is responsible for disposal of all investigation derived waste generated under this contract including removal and disposal of munitions related debris, detonation and disposal of MEC.
- Site air monitoring for hazardous chemicals during intrusive activities.
- Any other necessary resources needed to achieve the defined performance objectives of this PWS.

8.2 Contractor's Guarantee

For the purposes of this PWS, the following definitions apply. The "Project Price" for each site identified in this PWS will be equal to the approved proposed price for completion of performance objectives, the payment of which will be tied to one or more project milestones. The Contractor guarantees to complete and meet all of the performance objectives outlined in this PWS for all sites on the installation at the Project Price.

8.3 Certification and Approval of Project Milestones and Deliverables

The COR will perform contract management, inspection, oversight, review, and approval activities. Certification and approval of project milestones by the COR is necessary before distribution of financing payments. Certification by the Army is also contingent upon the Contractor performing in accordance with the terms and conditions of the contract for this work, this PWS, and all amendments.

Representatives of the Army and the Contractor will have a conference with the COR in a manner and at a time agreed to by all parties after receipt of each status report to:

- Formally review the quantity and quality of services;
- Inspect work for compliance with this PWS, the associated Contractor's final proposal, and project documentation;
- Accept or reject milestones and deliverables completed since the previous review;
- Modify the PMP and work plan as required to identify those project planning changes, milestone payments, and project schedule.

8.4 Government Rights

The Army has unlimited rights to all documents/material produced under this contract. All documents and materials, to include the source codes of any software, produced under this contract shall be Army owned and are the property of the Army with all rights and privileges of ownership/copyright belonging exclusively to the Army. These documents and materials cannot be used or sold by the Contractor without written permission from the KO. All materials supplied to the Army shall be the sole property of the Army and cannot be used for any other purpose. This right does not abrogate any other Army rights under the applicable Data Rights clause(s).

8.5 Stop Work

Government personnel have the authority and responsibility to stop work immediately if the work is considered to be a serious threat to the safety or health of workers, other personnel, or to the environment. Authorized Government personnel include, but are not limited to, Government OE Safety Specialists, Installation safety officers, Installation Environmental Division personnel, and command personnel with responsibility for overall Installation operations. When work is stopped due to a hazard/threat to worker safety, health, or the environment, the situation and resolution must be documented and submitted to the KO. Work must be stopped whenever chemical and biological warfare agents or radiological materials are discovered. In addition, the KO has the authority to temporarily stop work on a project following a 24-hour (one working day) written notification to the Contractor. Stop work notices may be related to nonconformance to project specifications, lack of performance by the Contractor, financial considerations, funding considerations, and other circumstances outlined in the contract. Stop work notices may also be related to security levels that could prevent access to the Installation during a time of national crisis.

8.6 Environmental Responsibility Considerations

The Army will retain responsibility for any assessed natural resource damages that are attributed to historic releases of hazardous substances (prior to contract with the Contractor) and any injuries that are necessary and incidental to the reasonable implementation of a selected response or remedial action. The Contractor shall be responsible for any/all additional natural resource injuries and associated Natural Resource Damages claims brought as a result of its actions (e.g. release of hazardous substance or unreasonable disturbance of natural resources as a result of construction activities).

The Army will retain all responsibility for third party liability for CWM or radiological material that are either targeted for or may be discovered during the course of remediation. Response cost claims, property damage and personal injury claims brought due to contamination and hazardous substance releases that have occurred historically (prior to contract with the Contractor) and are not due to Contractor remediation activities are excluded from Contractor responsibility. The Contractor shall be responsible for and indemnify the Army for:

- Any response cost claims for any environmental remediation services which the Contractor has assumed responsibility for under this PWS;
- All costs associated with correction of a failure of any remedy implemented or operated and maintained by the Contractor to the extent such failure was caused by the willful or negligent acts or omissions of the Contractor in the course of performing the environmental services;
- All personal injury or property damage claims to the extent caused by the acts or omissions of the Contractor in the course of performing the environmental services;
- All natural resource damages pursuant to 42 U.S.C. Section 9607(a)(4)(C), to the extent that such damages were caused or contributed to by the actions of the Contractor or its successors in interest; and
- All costs associated with or arising from any negligent acts or omissions or willful misconduct of the Contractor in the course of performing the environmental services or implementing remedial actions.

8.7 Inspections

The Army technical experts will independently review Contractor work to ensure compliance with all applicable requirements.

Any service or submittal performed that does not meet Task Order requirements shall be corrected or re-performed by the Contractor and at no additional cost to the Government. Corrective action must be certified and approved by the COR. If the contractor performs any task unsatisfactorily and all defects are not corrected, the Government reserves the right to terminate the Task Order for default. In addition, the Government reserves the rights under FAR clause 52.246-4, Inspection of Services – Fixed Price, for further remedies concerning a Contractor’s failure to perform in conformance with contract requirements.

8.8 Organizational Conflicts of Interest

8.8.1 Disclosure

The Contractor shall provide a disclosure statement with its proposal, which concisely describes all relevant facts concerning any past or present organizational conflicts of interest relating to the work in each PWS. In the same statement, the Contractor shall provide the information required in the following paragraph to assure the Government that the conflicts of interest have been mitigated and/or neutralized to the maximum extent possible. If a conflict of interest is discovered after contract award, the Contracting Officer will make a decision whether to terminate or rescind the PWS and/or contract at that time.

8.8.2 Potential Conflicts of Interest

In order to avoid any organizational conflicts of interest, or even the appearance of any organizational conflicts of interest, the Contractor performing environmental and/or related MMRP services work at the Site(s) under this PWS will need to avoid, neutralize and/or mitigate - prior to task order award - significant potential conflicts of interest that may prejudice effective competition. The KO has determined that at a minimum Contractors will ensure that all data pertaining to contamination at the sites shall be made available to all land owners in a timely fashion.

8.9 AT/OPSEC Requirements

<u>Access and General Protection/Security Policy and Procedures:</u> Contractor and all associated sub-contractors employees shall provide all information required for background checks to meet Installation access requirements to be accomplished by Installation Provost Marshal Office, Director of Emergency Services or Security Office. Contractor workforce must comply with all personal identity verification requirements (FAR clause S2.204-9, Personal Identity Verification of Contractor Personnel) as directed by DOD, HQDA and/or local policy. In addition to the changes otherwise authorized by the changes clause of the is contract, should the Force Protection Condition (FPCON) at any individual facility or installation change, the Government may require changes in contractor security matters or processes.

For contractors that do not require CAC, but require access to a DoD facility or installation. Contractor and all associated sub-contractors employees shall comply with adjudication standards and procedures using the National Crime Information Center Interstate Identification Index (NCIC-III) and Terrorist Screening Database (TSDB) (Army Directive 2014-05/AR 190-13), for all employees who will be entering Army-controlled installations or facilities (central area/Restricted area). Applicable installation, facility and area commander installation/facility access and local security policies and procedures (provided by government representative). Documentation of these checks will be made available to the COR and security personnel upon request.

The Contractor and all associated sub-contractors employees will provide to the Visitor Control Center, ten days in advance of the event, names, Date of Birth, and Social Security numbers of all employees who will be entering Army-controlled installations or facilities.

The Contractor and all associated sub-contractors employees will ensure that its employees entering Army-controlled installations or facilities have obtained access badges and passes (if required) in accordance with facility regulations and that these badges and passes are obtained in advance so as not to delay the accomplishment of contracted services.

The Contractor and all associated sub-contractors employees will return all issued U.S. Government Common Access Cards, Installation badges, and/or access passes to the COR when the contract is completed or when a contractor employee no longer requires access to the Installation or facility.

iWatch Training: The Contractor and all associated sub-contractors shall brief all employees on the local iWATCH program (training standards provided by the requiring activity ATO). This locally developed training will be used to inform employees of the types of behavior to watch for and instruct employees to report suspicious activity to the COR. This training shall be completed within 30 calendar days of contract award and within 05 calendar days of new employees commencing performance with the results reported to the COR NLT 30 calendar days after contract award.

Force Protection Conditions (FPCON's): During higher Force Protection Conditions (FPCON's) contract personnel are required to comply with all Antiterrorism policies and procedures while on the Installation. Contract personnel may be directed to enter the Installation through certain access control points where they can best be identified and searched. Contractor personnel may be prohibited from certain portions of the Installation during exercises and actual emergencies.

Contractors will comply with parking restrictions and will not park in unauthorized parking areas or within 82 feet of an inhabited building when directed.

Access control roster (personnel and vehicles) must be provided. Names/vehicles verified by the Contractor and received background screening. Substitutes receive same vetting process prior to work.

All contractor personnel and vehicles are subject to search while on the installation.

In the event of an identified restricted/exclusion area, the contractor personnel will not be authorized without specific permission or an escort.

Access may be denied during increased readiness or Force Protection Conditions (FPCON's).

Alien Employment: The Contractor shall not employ any alien who does not have a valid US Immigration I-551 or I-94. The Contractor shall provide valid social security numbers and citizenship status of all employees to the Government, upon request.

E -Verify: E-Verify is an Internet based system operated by the Department of Homeland Security (DHS) in partnership with the Social Security Administration (SSA) that allows participating employers to electronically verify the employment eligibility of their newly hired employees. E-Verify is currently free to employers and is available in all 50 states. E-Verify provides an automated link to federal databases to help employers determine employment eligibility of new hires and the validity of their Social Security numbers. E-Verify are the best means for determining employment eligibility of new hires and the validity of their Social Security numbers.

Contractors shall use E-Verify on all employees that will be working on this Installation, under this contract. This shall be done prior to the employee starting work on the Installation. For E-Verify information: www.dhs.gov/E-Verify 1-888-464-4218.

Human Trafficking: The United States Government has adopted a zero tolerance policy regarding trafficking in persons. Additional information about trafficking in persons may be found at the website for the Department of State's Office to Monitor and Combat Trafficking in Persons' at http://www.state.gov/g/tip. Government contracts shall —

(a) Prohibit contractors, contractor employees, subcontractors, and subcontractor employees from —

- (1) Engaging in severe forms of trafficking in persons during the period of performance of the contract;
- (2) Procuring commercial sex acts during the period of performance of the contract; or
- (3) Using forced labor in the performance of the contract;

(b) Require contractors and subcontractors to notify employees of the prohibited activities described in paragraph (a) of this section and the actions that may be taken against them for violations; and

(c) Impose suitable remedies, including termination, on contractors that fail to comply with the requirements of paragraphs (a) and (b) of this section.

Contractor Vehicles: The Contractor shall comply with the parking policy dated 12 August 2015 (or latest policy). Under no circumstances will Contractors park in Central Parking Area (CPA) Lots.

The local general, visitor, and government designated parking areas SHALL NOT be used by the Contractor. No general Contractor or subcontractor employee parking is available near the immediate site. The Contractor will need to identify and locate parking facilities for general and subcontractors off of West Point and provide a means for shuttling workers to the site. West Point shuttle services will not be used for transporting workers to the site.

Contractors and construction vehicles can only park in pre-approved designated staging areas or as identified in their contract. Central Area Parking is reserved for Staff and Faculty and requires a special pass. In accordance with AR 190-5, persons who operate a motor vehicle on West Point shall be deemed to have given consent for the removal and temporary impoundment of the privately owned vehicle (POV) and construction equipment when it is:

(1) Parked illegally
(2) Interfering with operations
(3) Creating a safety hazard
(4) Left unattended in a restricted or controlled area
(5) Parked in a Central Parking Area (CPA) lot without the proper CPA Pass
(6) Parked in a reserved space authorized by the Installation Commander

The Installation Point of Contact will review and coordinate all contractor pass requests.

8.10 Travel

Travel to/from the Installation and to other CONUS locations (locations within the continental United States) for such purposes as to attend meetings, briefings and/or presentations may be required incidental to this remedial action, the costs for which shall be included in the total price for the PWS.

8.11 Performance and Payment Bonds

In accordance with the base contract, the Contractor:
☒ is NOT required to furnish Performance and Payment Bonds on this PWS.
☐ is required to furnish Performance and Payment Bonds on this PWS in accordance with the following:

8.12 Warranty

In accordance with the base contract, the Contractor:
☒ is NOT required to provide a 5-year warranty for each site as specified in this PWS.
☐ is required to provide a 5-year warranty for each site as specified in this PWS.

9.0 Contracting Officer's Representative

The Contracting Officer's Representative contact information will be provided after award.

Attachment A: Reference Documents

The Army believes that this documentation provided with the solicitation represents the most recent and appropriate documentation available for the Installation and sites identified in this Task Order. However, if there is a conflict between this information and other site documentation (the existing reports), the Contractor is solely responsible for reviewing all available information and forming their independent, professional conclusions/interpretation of site conditions and requirements to meet the objectives of this PWS. This information is not intended as a substitute for complete analysis of technical data available, nor is it intended to be a guide on how the Contractor should address achievement of the performance objectives/standards.

Specific documents may be made available following a request to the Contracting Officer, if the documentation can be distributed in a timely manner. Electronic format is not guaranteed.

Title	Author	Date
Unexploded Ordnance Site Survey Report for Crow’s Nest	Human Factors Applications, Inc.	May 1994
Site Specific Final Report, Volume 1, Time Critical Removal Action and OE Construction Support, Crow’s Nest Area/Palisades Park/FUDS/Cold Springs Near USMA, West Point, NY	Environmental Hazards Specialist International, Inc.	December 2000
Archive Search Report for the Former West Point/Cold Spring Foundry, Putnam and Orange Counties, New York, Project Number C02NY112701		June 2001
Engineering Evaluation/Cost Analysis Storm King Site, Orange County, New York	Parsons	July 2002
Final Removal Action Report, Military Munitions Response Program for Storm King, Orange County, New York	American Technologies, Inc.	January 2006

Final Historical Records Review, United States Military Academy, West Point, New York	TechLaw	March 2006
Final Site Inspection Report, Volume 1, United State Military Academy, West Point, New York	TLI Solutions	January 2007
Final Remedial Investigation Report, Battery Knox-TD Land MRS, U.S. Army Garrison West Point, West Point, New York	Weston	June 2014
Final Remedial Investigation Report, North Atlantic Field MRS, U.S. Army Garrison West Point, West Point, New York	Weston	June 2014
Final Remedial Investigation Report, Seacoast Battery MRS, U.S. Army Garrison West Point, West Point, New York	Weston	June 2014
Final Remedial Investigation Report, Target Hill MRS, U.S. Army Garrison West Point, West Point, New York	Weston	June 2014
Final Remedial Investigation Report, Fort Clinton West, Siege Battery, Lusk Reservoir and Artillery Firing Range MRS, U.S. Army Garrison West Point, West Point, New York	Weston	March 2015

Final Site Inspection Report, Crow's Nest Impact Area and Training Areas C1, C2 and J1, Munitions Response Site WSTPT-023-R-01, Military Munitions Response Program, West Point Military Reservation, West Point, New York	URS	September 2015
Final Remedial Investigation Report, Crow's Nest Impact Area and Training Areas C1, C2 and J1, Munitions Response Site WSTPT-023-R-01, Military Munitions Response Program, West Point Military Reservation, West Point, New York	URS	December 2016
Report for Underwater Munitions Response Site (MRS), Survey Conducted at West Point Military Academy – West Point NY (WSTPT-004-R-01 – Battery Knox-TD-River, WSTPT-016-R-01 – Siege Battery-TD-River) and Data Disk (Bathymetry, GIS, Sonar Data)	Naval Surface Warfare Center, Panama City Division	November 2016
Community Involvement Plan for 14 Munitions Response Sites, MMRP, U.S. Army Garrison, West Point, New York	Plexus/PARS JV	February 2016
Draft Explosives Site Plan	USACE, Baltimore District	January 2017
Munitions Response Actions – Minimum Separation Distances (Relative to Impulse Water Pressure) from Underwater Detonations Memorandum		September 16, 2013
GIS Files (Battery Knox TD River MRS, Siege Battery TD River MRS, Area A and Area B)		

iWatch Training Presentation	West Point	
USMA Application for Local Area Badge	West Point	
West Point Parking Policy dated August 2015	West Point	
GIS Files, Munitions Response Sites, West Point	West Point	

Attachment B: List of Acronyms

AOC	Area of Concern
CAIS	Chemical Agent Identification Set
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
COR	Contracting Officer's Representative
CTT	Closed, Transferred, and Transferring
CWM	Chemical Warfare Materiel
DDESB	Department of Defense Explosives Safety Board
DMM	Discarded Military Munitions
DOD	Department of Defense
DPW	Department of Public Works
DQO	Data Quality Objective
ERIS	Environmental Restoration Information System
ESP	Explosive Site Plans
ESS	Explosive Safety Submission
FAR	Federal Acquisition Regulation
GDA	Government Designated Authority
GIS	Geographic Information System
HRR	Historical Records Review
IRA	Interim Removal Action
KO	Contracting Officer
LTM	Long-Term Management
MC	Munitions Constituents
MEC	Munitions and Explosives of Concern
MMRP	Military Munitions Response Program
MR	Munitions Response
NCP	National Oil and Hazardous Substances Contingency Plan
NELAP	National Environmental Laboratory Accreditation Program
OSHA	Occupational Safety and Health Administration
PBA	Performance-Based Acquisition
PMP	Project Management Plan
POC	Point of Contact
PPE	Personal Protective Equipment
PWS	Performance Work Statement
QA	Quality Assurance
QIPR	Quarterly In Progress Review
RAB	Restoration Advisory Board
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
SARA	Superfund Amendments and Reauthorization Act
SC	Site Close out
SI	Site Inspection
SSHP	Site Safety and Health Plan
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Center
USATCES	U.S. Army Technical Center for Explosives Safety
USDA	United States Department of Agriculture
USEPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance

Attachment C: Definitions

Activity-Based Schedule: Activities and milestones defined at the detail level and logically sequenced to support, and manage completion of the performance objectives.

Contractor's Project Costs: Costs incurred by the Contractor (including costs covered by insurance and the PMP) in executing the work required to achieve the performance objectives identified in the PWS for all sites identified in this contract/task order.

Chemical Warfare Materiel (CWM): An item configured as a munitions containing a chemical substance that is intended to kill, seriously injure, or incapacitate a person through its physiological effects. CWM also includes V- and G- services nerve agent, H-series blister agent, and lewisite in other than munitions configurations. Due to their hazards, prevalence, and military-unique application, Chemical Agent Identification Sets (CAIS) are also considered CWM. CWM does not include riot control agency, chemical herbicides, smoke and flame producing items, or soil, water, debris, or other media contaminated with chemical agent.

Deliverables: Documentation or data that support the completion of milestones or achievement of the performance objectives identified in this PWS.

Discarded Military Munitions (DMM): Military munitions that have been abandoned without proper disposal or removed from storage in a military magazine or other storage area for the purpose of disposal. The term does not include unexploded ordnance, military munitions that are being held for future use or planned disposal, or military munitions that have been properly disposed of consistent with applicable environmental laws and regulations.

Explosive Ordnance Disposal (EOD): The detection, identification, on-site evaluation, rendering safe, recovery, and final disposal of unexploded explosive ordnance. It may also include explosive ordnance that has become hazardous by damage or deterioration.

Government Designated Authority: The senior person in charge or his/her appointed representative for the operation or activity being conducted/considered.

Milestones: Significant events or activities that occur in the course of the Contractor achieving the performance objectives identified in this PWS.

Military Munitions (MM): All ammunition products and components produced or used by or for the DoD or the U.S. Armed Services for national defense and security, including MM under the control of the DoD, the U.S. Coast Guard, the U.S. Department of Energy, and National Guard personnel. The term military munitions includes: confined gaseous, liquid, and solid propellants, explosives, pyrotechnics, chemical and riot control agents, smokes, and incendiaries used by DoD components, including bulk explosives and chemical warfare agents, chemical munitions, rockets, guided and ballistic missiles, bombs, warheads, mortar rounds, artillery ammunition, small arms ammunition, grenades, mines, torpedoes, depth charges, cluster munitions and dispensers, demolition charges, and devices and components thereof. MM do not include wholly inert items, improvised explosive devices, and nuclear weapons, nuclear devices, and nuclear components thereof. However, the term does include non-nuclear components of nuclear devices, managed under DOE's nuclear weapons program, after all required sanitization operations under the Atomic Energy Act of 1954, as amended, have been completed.

Munitions Constituents (MC): Any materials originating from unexploded ordnance, DMM, or other military munitions, including explosive and non-explosive materials, and emission, degradation, or breakdown elements of such ordnance or munitions.

Munitions Debris (MD): Remnants of munitions (e.g., fragments, penetrators, projectiles, shell casings, links, fins) remaining after munitions use, demilitarization, or disposal.

Munitions and Explosives of Concern (MEC): This term, which distinguishes specific categories of military munitions that may pose unique explosives safety risks, means UXO, as defined in 10 .SC 101(e)(5)(A) through (C); DMM, as defined in 10 USC 2710(e)(2); or MC (e.g., TNT, RDX), as defined in 10 USC 2710(e)(3), present in high enough concentrations to pose an explosive hazard.

Munitions response: A response action, including investigation, removal actions, and remedial actions, to address the explosives safety, human health, and/or environmental risks presented by munitions and explosives of concern (MEC) and/or MC.

Material Potentially Posing an Explosive Hazard (MPPEH): Material that, prior to determination of its explosives safety status, potentially contains explosives or munitions (e.g., munitions containers and packaging material; munitions debris remaining after munitions use, demilitarization, or disposal; and range-related debris); or potentially contains a high enough concentration of explosives such that the material presents an explosive hazard (e.g., equipment, drainage systems, holding tanks, piping, or ventilation ducts that were associated with munitions production, demilitarization or disposal operations). Excluded from MPPEH are munitions within the DoD established munitions management system and other hazardous items that may present explosion hazards (e.g., gasoline cans, compressed gas cylinders) that are not munitions and are not intended for use as munitions.

PMP Documents: The original PMP (including project schedule), revisions, and status reports.

Project Documents (CERCLA): Documentation and data required by CERCLA remediation and RA(O) and/or LTM activities. These documents include the additional site plans referenced in **Section 6.0** of this PWS.

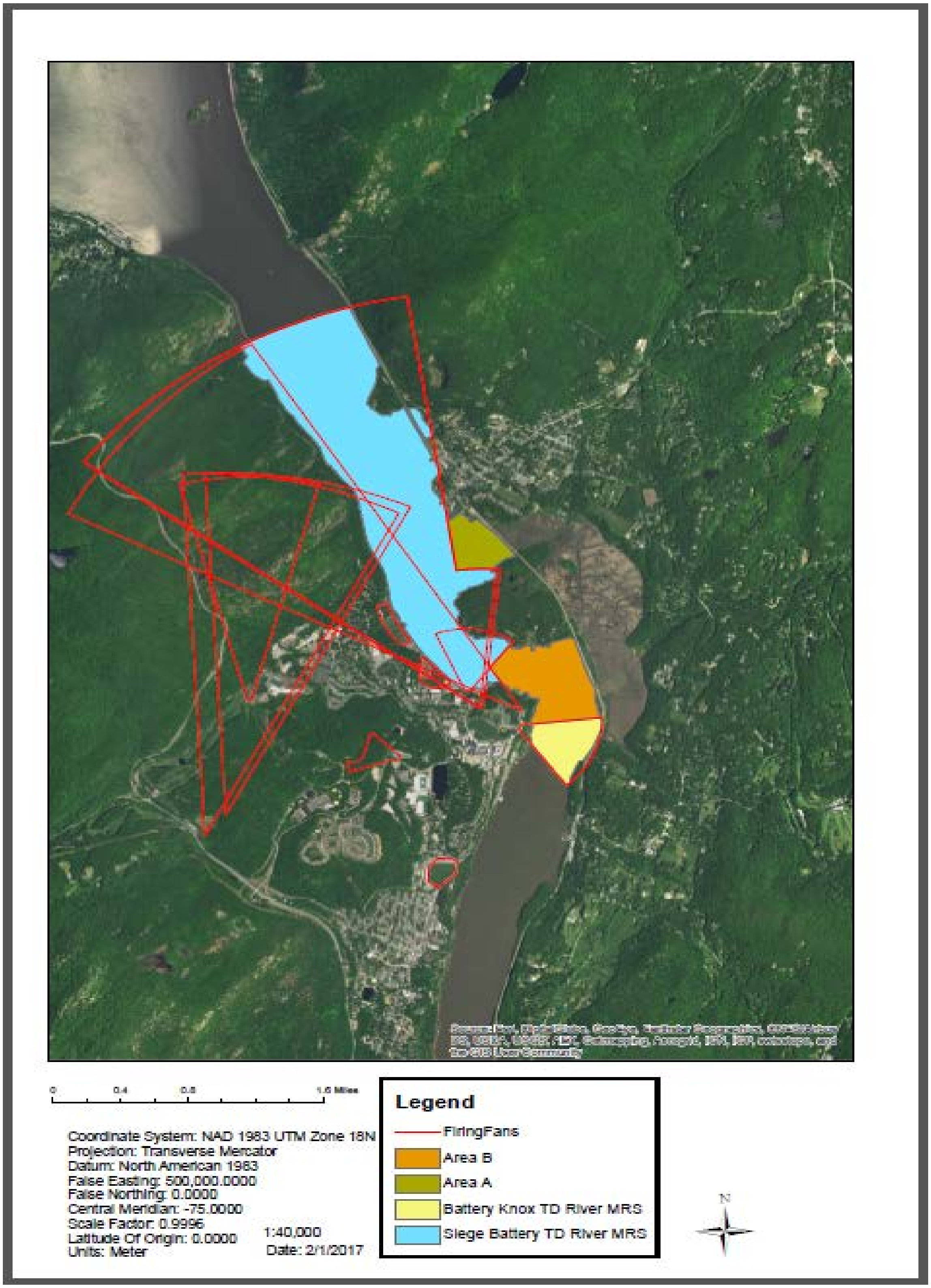
Project Price: The approved proposed price for achieving completion of remediation services in accordance with the PWS, the payment of which will be tied to one or more project milestones. The Project Price does not include the cost of the PMP, insurance premiums or surplus line taxes, if applicable.

Project-related information: All previous environmental restoration documentation of a technical nature developed by the Army and previous Army contractors and subcontractors during their work at the sites specified in this PWS, and all the documentation developed by the Contractor in order to achieve the performance objectives specified in this PWS.

Unforeseen environmental issues: include unknown and/or varied concentrations of contaminants at cleanup sites (off-installation areas included) identified in this PWS, but not unknown sites (e.g., sites not identified in this PWS). For sites addressed under the MMRP, unknown contaminants will be limited to MC and those chemicals reasonable associated with the identified munitions and munitions related activities.

Unexploded ordnance (UXO): Military munitions that have been primed, fuzed, armed, or otherwise prepared for action; have been fired, dropped, launched, projected, or placed in such a manner as to constitute a hazard to operations, installations, personnel, or material; and remain unexploded either by malfunction, design, or any other cause.

Attachment D: MRS Map with Additional Investigation Areas A and B



Attachment E: Minimum Requirements for Data Layers Without An Established Quality Assurance Plan

- Installation geospatial data shall be provided in a personal geodatabase compliant with the Spatial Data Standards for Facilities, Infrastructure, and Environment (SDSFIE), version 3.1 Army Adaptation.

- If a geospatial data layer contains a discriminator per SDSFIE v3.1, the discriminator must be populated

- All features shall be attributed with the Installation Code from the Headquarters Installation Information System (HQIIS)

- Each data layer shall be accompanied by metadata conforming to the Metadata Requirements for Army IGI&S Geospatial Data (https://www.us.army.mil/suite/doc/44217993)

- The FGDC National Standard for Spatial Data Accuracy (NSSDA) shall be used to evaluate and report the positional accuracy of all data layers submitted

- All data shall be provided with a defined projection and must have a datum of WGS84

- All data shall be topologically sound and geometrically correct. This includes no null or empty features, no non-simple features and no duplicate features.

- All data shall meet the basic topology rule set for Installation geospatial data. Exceptions to the topology rules are possible. In case of an exception, a justification must be provided in the data layer documentation.

- Point features
  - Must be located inside polygons of parent feature class

- Line features
  - Must not self overlap
  - Must not self intersect
  - Must be single part
  - Must not have pseudo-nodes
  - Must not have dangles

- Polygon features
  - Must not overlap
  - Must not have gaps

APPENDIX B
FIELD FORMS

Title/Description of Form

- Daily Quality Control Report
- Site Visitors Log
- Safety Meeting Attendance Log
- Safety Inspection Log
- Weekly Vehicle Safety Checklist
- Daily UXO SUXOS Site Report
- Demolition Material Accountability Form
- DD Form 1348-1A
- ATF Form 5400.5
- Demolition Shot Record
- EN 6048
- Corrective Action Request

Daily Quality Control Report
MMRP RI

West Point Water MRSs

CONTRACT NO./D.O. NO.: W912DR-15-D-0022/ W912DR17F0131	**WORK ORDER NO.:** 03886.552.131	**DATE / TIME ON AND OFF SITE**

WEATHER/TEMPERATURE:

WORK LOCATION: West Point, NY
Subcontractor(s) On-Site: ☐ ____________ ☐ ____________ ☐ _____________

<u>WORK COMPLETED</u>:

- ☐ Survey Activities
- ☐ Mapping activities (transects)
- ☐ DGM activities (transects)
- ☐ Reacquire/Investigate Anomalies
- ☐ Open Detonation
- ☐ Grid QC List (List completed grids).
- ☐ Grid QA (List completed grids).
- ☐ Munitions Constituent Sampling.
- ☐ UXO Technician Escort activities.
- ☐ Equipment Transport (mob/demob to/from site-List).
- ☐ Equipment Maintenance
- ☐ Equipment Issues (List below).
- ☐ ____________________________
- ☐ Safety Briefing Given

Comments:

QUALITY INSPECTIONS PERFORMED: *(PP – Prep Phase; IP – Initial Phase; FP – Follow On Phase)*

<u>Phase:</u>	**<u>DFW:</u>**	**<u>FQCY</u>**	**<u>Audit(s) Performed:</u>**	**<u>Pass</u>**	**<u>Fail</u>**
Phase of TPI for DFW	Task inspected	When task was and is being check, weekly/daily		☐ ☐ ☐ ☐	☐ ☐ ☐ ☐

<u>Findings/Comments</u>:

<u>Grids/Anomalies QC'd/QA'd and disposition:</u>

Returned for Rework:

Grid/Anomalies passed QC inspection:

<u>MATERIALS DELIVERED (Amount, Condition, and Purpose):</u>

PROBLEMS/RESOLUTIONS:	
DATA TRACKING:	
Comments:	
FURTHER DISCUSSION (List Topic and Comment):	
PREPARED BY:	**SIGNATURE:**

Environmental Samples

Level of Health & Safety Protection: Level D

Exposure Hours (WESTON): ______

Exposure Hours (Subcontractors): ______

Exposure Monitoring[i]: Noise: ______ Chemical: ______

Exposure Mileage[ii]: WESTON: Subcontractor(s):

Instrumentation Used:

Calibration(s) Performed:

Instrument Problems/Remedies:

Summary of Site Activities (Including problems encountered, corrective actions taken, and a summary of any instructions received from Government personnel):

Sample Collection Method(s):

Samples Collected[iii]:

Quality Control Samples:

Signature: ______ Title: ______

---

[i] Indicate the low and high readings from monitoring equipment. Attach tabulated readings.
[ii] Estimate vehicle mileage traveled during working hours.
[iii] Indicate 1) Sample Media: Groundwater, Surface Water, Soil or Sediment, 2) Sample Type: Composite, Grab, Duplicate, Incremental, Rinsate, and 3) Sample ID Numbers.

Site Visitors Log

Contract No.: W912DR-15-D-0022		**DO: W912DR17F0131**	**Location: West Point, New York**				
Date	Name	Company	Telephone Number	Safety Briefing Received	Time		Escort Required
					In	Out	

Safety Meeting Attendance Log

Date:		Time:		Contract Number:	W912DR-15-D-0022
Task Order Number:	W912DR17F0131	Location:	West Point, NY		
Weather Conditions:					
I. Safety Meeting Topic (Briefly describe):					
II. Attendees:					

Name (Print)	Signature	Company

Name (Print)	Signature	Company

III. Verification:

I certify that the personnel listed on this roster received the briefing described above. Site personnel not attending this meeting will be briefed before beginning their assigned duties.

Site Safety Officer

Date

WESTON SOLUTIONS

Safety Inspection Log

Date: ____________ Time: ____________ Work Order #: 03886.552.131

Contract #: W912DR-15-D-0022 DO: W912DR17F0131 Location: West Point, New York

Weather Conditions: ____________

Type of Inspections: Daily ________ Weekly ________ Special ________ Reinspection ________

Location inspected: (List by grid number, coordinates, or description) ____________

Activity: ____________

II. Inspection Requirement	Satisfactory	Unsatisfactory	N/A
EM and Dig Transect Survey			
EM and Dig Grids			
Evacuation Technique			
Personal Protection Equipment			
Work Practices			
Site Control			
First Aid Equipment			
Fire Fighting Equipment			
Explosives Transportation			
Explosives Storage			
Disposal Operations			

Overall Inspection Results: Satisfactory ____________ Unsatisfactory ____________

III. Comments: ____________

____

Work stopped due to safety violation: Yes ____________ No ____________

Safety violations noted: ____________

Corrective Measures ____________

Reinspection required Yes ____________ No ____________

IV. Signatures: I acknowledge that I have been briefed on the results of this inspection and will take corrective actions (if necessary).

____
Site Safety Officer

____
Sr. UXO Supervisor/Project Manager

WESTON Weekly Vehicle Safety Checklist

Operator	Location of Vehicle use West Point, New York		Home Office location		
Year and make of Vehicle License Plate	Date of Inspection	Odometer Reading	Was vehicle driven during Safety Check?	Yes ☐	No ☐

Safety Minded Drivers have Safe Equipment	Satisfactory	Unsafe	Corrected
Seat Belt (Accessible/condition)	☐	☐	☐
Lights: Headlights	☐	☐	☐
Turn Indicators	☐	☐	☐
Brake Lights	☐	☐	☐
Tail Lights	☐	☐	☐
Backup Light	☐	☐	☐
Flashers	☐	☐	☐
Instrument Panel	☐	☐	☐
Dome/inside	☐	☐	☐
Steering	☐	☐	☐
Horn	☐	☐	☐
Brakes	☐	☐	☐
Parking Brake	☐	☐	☐
Muffler (noisy)	☐	☐	☐
Tires (tread, cuts, inflated properly)	☐	☐	☐
First Aid Kit (Serviceable)	☐	☐	☐
Fire Extinguisher (Serviceable)	☐	☐	☐

Condition of Vehicle (Note items that indicate previous damage and/or represent safety hazard)

Inside: ____

Outside: ____

Other Items:

1. ____
2. ____
3. ____
4. ____
5. ____

Safety Checked: __________ By: ____

Date: Name and Signature

Daily UXO SUXOS Site Report

CONTRACT NO. / D.O.: - W912DR-15-D-0022/ W912DR17F0131

DATE:

WORK LOCATION: U.S. Army Garrison West Point Water MRSs

WORK COMPLETED:

☐ Survey Activities.
☐ Mapping activities (transects)
☐ DGM activities (transects)
☐ Reacquire/Investigate Anomalies.
☐ Grid QC List.
☐ Grid QA

☐ Munitions Constituents Sampling
☐ UXO Technician Escort activities.
☐ Magazine secured.
☐ Equipment Maintenance.
☐ Equipment Issues (List Below)
☐ ____
☐ Safety briefing given

Comments:

PROBLEMS/RESOLUTIONS:

DAILY ACTIVITIES:

Total Number/Line miles completed:

MD, NMRD, MEC/MPPEH:	**Team2:**	**Team 3:**

UXO items located:

UXO Daily Total:

Remarks: SUXOS ___________, UXOSO/QCS ________________

Geophysical Teams:

Team 1:

Team 2:

Demo Team:

Sample Team:

PREPARED BY:	**SIGNATURE:**

Weston Solutions, Inc.

Demolition Material Accountability Form

1. Project Name: West Point Water MRSs 2. Project Location: West Point, New York 3. Project No. 03886.552.131

4. Explosive Description:____ 5. Marks and Identification:____

6. Manufacturer:____ 7. Storage Location: ____

8. Date Received	9. Quantity In	10. Unit of Issue	11. Quantity Out	12. Balance	13. Date Expended	14. Printed Name and Initials

DD Form 1348-1A Issue Release/Receipt Document

1 2 3	4 5 6	7	23 24	25 26 27 28 29		45	46 47 48 49 50	51	52 53	54 55 56	57 58 59	60 61	62 63 64	65 66	67 68 69 70 71 72 73	74 75 76 77 78 79 80
DOC IDENT	RI FROM	M & S	U/I	QUANTITY		**SER**	**SUPPLE-MENTARY ADDRESS**	**SIG**	**FUND**	DIS-TRI-BU-TION	PRO-JECT	PRI	RDD EEA QLT DE	ADV		UNIT PRICE DOLLARS CTS

1. TOTAL PRICE
DOLLARS CTS

2. SHIP FROM

SHIP TO

4. MARK FOR

Munitions Debris (MD) turned in as;
Materials Documented as Safe (MDAS)

5. DOCDATE	6. NMFC	7. FRT RATE	8. TYPE CARG0	9. PS

10. QTY. REC'D	11. UP	12. UNIT WEIGHT	13. UNIT CUBE	14. UFC	15. SL

16. FREIGHT CLASSIFICATION NOMENCLATURE

17. ITEM NOMENCLATURE

Munitions Debris

18. TYCONT	19. NO CONT	20. TOTAL WEIGHT	21. TOTAL CUBE

22. RECEIVED BY	23. DATE RECEIVED

NUMBER & SUFFIX (30-44)

I acknowledge that all items listed above must be shredded and or melted before resale.

Signature:____

NUMBER & ADD (8-22)

26

1 This certifies and verifies that the material listed has been 100% inspected and to the best of our knowledge and belief is inert and/or free of explosives or related materials.

2 We Certify that the MD scrap materials were demilitarized in accordance with Appendix 4, Category III, Para 6a, that were compiled with in the DOD 4160.21-M-1 and other applicable regulations.

3 Each piece of MD scrap metal has been inspected by (3) separate Senior qualified UXO Tech's (Unexploded Ordnance Technicians).

27. ADDITIONAL DATA

Signature: Title: Senior UXO Supervisor, Weston Solutions Inc. Date:

Signature: Title: Quality Control Officer, Weston Solutions Inc. Date:

DD FORM 1348-1A, JUL 91 **S/N 0102-LF-016-4100**

OMB No. 1140-0026 (07/31/2014)

U.S. Department of Justice
Bureau of Alcohol, Tobacco, Firearms and Explosives

Report of Theft or Loss-Explosive Materials

For ATF Use Only

Date Received	Date Faxed to JSOC & Field Division	Unique Identifier
		Case Number

To Be Completed By Person Making Report

Upon discovery of any theft or loss of any of your explosive materials:

- First, contact ATF toll free at 1-800-461-8841 between 8:00 a.m. - 5:00 p.m. EST or after hours and weekends contact ATF at 1-800-800-3855 to report the theft or loss;
- Second, contact your local law enforcement office to report the theft or loss to obtain a police report; and
- Third, complete this form and attach any additional reports, sheets or invoices necessary to provide the required information, and fax the form with additional material(s) to the ATF U.S. Bomb Data Center (USBDC) at 866-927-4570 or email to USBDC@atf.gov.

1. Date

2. Type of Report *(Check one)*: ☐ Theft ☐ Loss ☐ Attempted Theft/Suspicious Activity ☐ Supplement

3. Full Name of Person Making the Report *(Last, First, Middle)*

4a. Licensee or Permittee Name

4b. Federal Explosives License or Permit Number

5a. Office Address *(Street Address, City, State, and Zip Code)*

5b. Telephone Number

5c. E-mail Address

6. Actual Location of Theft or Loss *(If different from item 5a)*

7. Theft or Loss	Date	Time
a. Discovered		
b. When Was the Magazine Last Checked		
c. Occurred *(Show approximate if exact not known)*		
d. Reported to ATF by Telephone		
e. Reported to Local Authorities		

8. Name of Local Law Enforcement Officer to Whom Reported

9. Name and Address of Local Authority to Whom Reported

10. Telephone Number

11. Police Report Number

12. Explosive Materials Lost or Stolen *(Attach invoices or additional sheets, if necessary)*

a. Manufacturer and/or Importer	b. Brand Name	c. Date Shift Code	d. Size *(Length & Diameter)*	e. Quantity *(Pounds of Explosives, Number of Dets)*	f. Type and Description *(Dynamite, Blasting Agents, Detonators, etc. Include for each type, size, MS delay or length of legwire, as applicable)*

ATF Form 5400.5
Revised July 2012

13. Theft or Loss Occurred from *(Check applicable box on each row)*

a. Magazine Type:

☐ 1 ☐ 2 ☐ 2 Det. Box ☐ 3 Day Box ☐ 4 ☐ 5

☐ Outdoor ☐ Indoor

☐ Permanent ☐ Portable ☐ Mobile Truck ☐ Mobile Trailer

☐ Overnight Storage ☐ Day Storage

b. Types of Locks *(Check all that apply)*:

☐ Padlock ☐ Mortise ☐ 3-Point ☐ Puck Lock ☐ Other *(Explain)* ______________

c. Location Description/Type:

☐ Licensed/Permitted Premises ☐ Remote Storage ☐ Work Site ☐ In Transit ☐ During Operations

14. Method of Entry:

☐ Door

Was a Key Used? ☐ Yes ☐ No

Suspected Employee-Involved Theft? ☐ Yes ☐ No

☐ Wall(s) ☐ Roof ☐ Floor/Bottom

Lock(s) Defeated? *(If yes, check additional appropriate boxes)* ☐ Yes ☐ No

☐ Lock Shackle Cut *(How?)* ______________________________

☐ Lock Left Unlocked

☐ Keyway Drilled Out

☐ Other *(Explain)* ______________________________

☐ Lock Pried, Twisted or Levered

☐ Lock Picked or Shimmed

☐ Lock Body Drilled Out or Cut

Manufacturer and Model of Lock:	Location of Magazine Keys: ☐ Office ☐ Employee ☐ Other *(Address)* ______________________________	Are All Keys Accounted For? ☐ Yes ☐ No

15. Hood Defeated? *(If yes, check all applicable)* ☐ Yes ☐ No

☐ Hood Cut

☐ Other *(Explain)* ______________________________

☐ Hood Removed

☐ Hood Broken

Hood Width *(Inches)* ______________________

Hood Length (Inches) ______________________

Hood Depth *(Inches)* ______________________

Hood Thickness (Inches) ______________________

16. Other Information Pertinent to the Theft, Loss or Suspicious Activity *(Any details you can provide)*

16a. Was Theft or Loss Disclosed During an ATF Inspection or Being Reported as a Result of Inspection? ☐ Yes ☐ No

16b. Additional Security Measures in Place?

☐ Alarm ☐ Security System/Service ☐ Fencing ☐ Lighting ☐ Other *(Explain)* ______________________

17. Signature and Title of Person Making Report	18. Date

Reporting Instructions

Email or fax this completed form to the ATF address listed below or call if no fax is available:

Bureau of Alcohol, Tobacco, Firearms and Explosives
U.S. Bomb Data Center
99 New York Ave., N.E. 8.S-295
Washington, DC 20226
Toll Free Fax: 1-866-927-4570
Email Address: USBDC@atf.gov

Questions regarding the completion of this form should be referred to the U.S. Bomb Data Center toll free at 1-800-461-8841.

Privacy Act Information

The following information is provided pursuant to section 3 of the Privacy Act of 1974 (5 U.S.C. § 522a(e)(3).

1. **Authority.** Solicitation of this information is made pursuant to Title XI of the Organized Crime Control Act of 1970 (18 U.S.C. Chapter 40). Disclosure of a theft or loss of explosive materials is mandatory pursuant to 18 U.S.C. § 842(k) for any person who has knowledge of such theft or loss from his stock.

2. **Purpose.** The purpose for the collection of this information is to give ATF notice of the theft or loss of explosive materials, and to furnish ATF with the pertinent facts surrounding such theft or loss. In addition, the information is used to confirm and verify prior notification of this theft or loss of explosive materials.

3. **Routine Uses.** The information will be used by ATF to aid in the administration of laws within its jurisdiction concerning the regulation of explosive materials and other related areas. In addition, the information may be disclosed to other Federal, State, foreign, and local law enforcement of laws within their jurisdiction. System of records notice Justice/ATF-008 Regulatory Enforcement Record System FR Vol.68 No.16 Page 3558 dated January 24, 2003.

4. **Effects of not supplying information requested.** 18 U.S.C. § 842(k) makes it unlawful for any person, who has knowledge of the theft or loss of explosive materials from his stock, to fail to report such theft or loss within twenty-four hours of discovery thereof, to the Secretary and to appropriate local authorities. The penalty for violation of this section is a fine of not more than $1,000 or imprisonment for not more than one year, or both. 18 U.S.C. § 844(b).

Paperwork Reduction Act Notice

This request in accordance with the Paperwork Reduction Act of 1995. The purpose of this information collection is to report the theft or loss of explosive materials. The information is used for investigative purposes by ATF officials. This information is mandatory by statute. (18 U.S.C. § 842)

The estimated average burden associated with this collection of information is 1 hour and 48 minutes per respondent or recordkeeper, depending on individual circumstances. Comments concerning the accuracy of this burden estimate and suggestions for reducing this burden should be addressed to Reports Management Officer, Document Services, Bureau of Alcohol, Tobacco, Firearms and Explosives, Washington, DC 20226.

An agency may not conduct or sponsor, and a person is not required to respond to, a collection of information unless it displays a currently valid OMB control number.

Demolition Shot Record

DATE/TIME: ________ TRACKING NUMBER: __

LOCATION: ______________________

1. ITEMS REMOVED FROM GRID (**YES**/NO)

4. ITEMS DESTROYED ONSITE (**YES**/NO**)**

5. WHO DESTROYED ITEM(S)?

Name: __________________ Organization: WESTON

Time of Detonation:______________

6. MEC ITEMS ENCOUNTERED:

TYPE	QTY	CONDITION	DISPOSITION

7. Demolition notifications made by: ________________________

8. COMMENTS:

____
WESTON UXO Representative (Signature)

____
WESTON UXO Representative (Print Name)

US ARMY CORPS OF ENGINEERS (USACE)
MUNITIONS RESPONSE
QUALITY ASSURANCE REPORT (QAR) FORM
The proponent agency is CESO. *See instructions on page 2.*

1. REPORT NO. *(1,2,3, etc., for the Task Order (T.O.))*

2. USACE REPRESENTATIVE'S NAME

3. DATE ACTIVITY COMPLETED

4. PROJECT NAME

5. PROJECT LOCATION

6. WEATHER CONDITIONS

7. CONTRACTOR

8. CONTRACT NUMBER

9. T.O. NUMBER

10. DISTRIBUTED TO (*check boxes and insert individual's name*)

☐ a. District Program/Project Manager

☐ b. Design Center

☐ c. Remedial Action District TM

☐ d. Contractor

11. RESPONSE DUE DATE (*Based on type of nonconformance, IF REQUIRED)*

12. TYPE OF ACTIVITY CONDUCTED (*Include types of inspections/audits conducted, operations observed, etc.)*

13. RESULTS AND OBSERVATIONS

14. DEFICIENCY TYPE (*select one*) ☐ a. Not Applicable ☐ b. Critical ☐ c. Major ☐ d. Minor

☐ e. Other, *Specify*

15. DATE

16. USACE REPRESENTATIVE'S SIGNATURE

17. CONTRACTOR REPRESENTATIVE'S NAME

18. DATE

19. CONTRACTOR REPRESENTATIVE'S SIGNATURE (*indicating receipt of the QAR*)

20. **The Contractor will provide the following information to the Contract Specialist by the "Response Due" date above.**
Please contact the Contracting Officer's Representative (COR) or Project Manager if you have any questions.

a. Contractor Response as to Cause and Actions Taken to Correct Current Condition and to Prevent Recurrence (*cite applicable quality control procedures or changes in plans, procedures, or practices*).

b. Contractor Representative's Authentication (*form must be signed before returning*)

(1) Printed Name	(2) Title	(3) Date Signed	(4) Signature

c. Government Evaluation (*acceptance, partial acceptance, etc.*)

d. Government Actions (*reduced payment, cure notice, show cause, other*)

e. Close Out	Name	Title	Date (*YYYY-MM-DD*)	Signature
(1) Contractor Notified				
(2) USACE PDT Representative				
(3) Contracting Officer or COR				

INSTRUCTIONS FOR ENG FORM 6048

Block 1. Report number.

Block 2. Name of USACE representative conducting the quality assurance (QA) activity.

Block 3. Date QA Activity completed.

Block 4. Project Name, i.e., "Camp Swampy (MRS-02).

Block 5. Project Location, i.e., "Smithville, Alaska".

Block 6. Weather conditions, if applicable.

Block 7. Contractor and/or subcontractor executing the work.

Block 8. Contract number.

Block 9. Task Order number.

Block 10. List by name all official recipients of the QAR. At a minimum, the District Program/Project Manager must be selected.

Block 11. Enter the date that the contractor is to respond, if applicable.

Block 12. List all QA-related activities, inspections, audits conducted, operations observed, etc. Include specific references to applicable government quality requirements, i.e., Quality Assurance Surveillance Plans, Department of Defense, Army, and/or USACE requirements, policy, guidance, etc., requiring the inspection/audit being conducted. For example: "Spot-checked inventory of demolition explosives as required by the project QASP and approved Explosives Safety Submission (ESS)."

Block 13. Describe results and observations of each QA activity conducted. Attach discipline-specific checklists/documentation used. All deficiencies noted must include reference to the specific regulation or requirement that was violated. For example: "Demolition explosives stored on site were not inventoried weekly in accordance with ESS paragraph 4.2 and Work Plan paragraph 5.4. Last inventory was conducted 3 weeks ago on xx Feb 2013."

Block 14. Select the type of deficiency, if any, observed. Use contract-specific definitions if available, or use the following general definitions:

a. Check the appropriate box.

b. Critical: A deficiency that is likely to result in hazardous or unsafe conditions for individuals using, maintaining, or depending upon the supplies or services; or is likely to prevent performance of a vital agency mission.

c. Major: A deficiency, other than critical, that is likely to result in failure of the supplies or services, or to materially reduce the usability of the supplies or services for their intended purpose.

d. Minor: A deficiency that is not likely to materially reduce the usability of the supplies or services for their intended purpose or is a departure from established standards having little bearing on the effective use or operation of the supplies or services.

Block 15. Date the USACE Representative signs.

Block 16. QA representative's signature.

Block 17. Contractor Representative's printed name.

Block 18. Date Contractor Representative signs.

Block 19. Contractor representative signature. Signature does not indicate concurrence with stated findings, only that contractor has received the report.

Block 20a. Contractor indicates action(s) taken to determine cause of the deficiency, action taken to correct immediate deficiency, and action taken to prevent a recurrence of the deficiency. Include dates of actions taken and a schedule for completion of planned actions.

Block 20b. Contractor representative's printed name, title, date signed, and signature.

Block 20c. Indicate government acceptance of contractor's actions to correct identified deficiencies.

Block 20d. Indicate negative government actions taken as a result of the deficiency.

Block 20e. Signature of contractor, PDT representative and contracting officer or COR indicating close out for all deficiencies indicated.

Corrective Action Request (CAR)

Corrective Action Request I No. (*1, 2, 3, etc. for the T.O.*)

USACE Representative:
Date Issued:
Issued to: (*Contractor*)
Response Due: (*Based on type of nonconformance*)
Contract # and T.O. #
Project Name/Location:

Nonconformance Type (circle one): Critical Major Minor

Description of Condition Found:

Apparent Cause:

(The Contractor will provide the following information to the Contracting Officer and USACE PM by the "Response Due" date above. Please contact USACE Representative listed above if you have any questions)

Actual Cause: (Contractor will investigate and determine cause of condition reported above. Actual cause should be stated as specifically as possible)

Action Taken to Correct Condition: (Corrective Action should address root cause, not the symptom)

Action Taken to Prevent Recurrence:

Action Taken to Monitor Effectiveness of Corrective Action: (Generate data as proof. State the monitoring method put into place and who is responsible for reviewing data.)

Contractor Representative Signature/Title/Date Signed: (Form must be signed before returning)

(*USACE Project Team Use Only*)
Review of Corrective Action:

1) Has condition improved? ___ Yes ___ No
2) Additional corrective action required? ___ Yes ___ No

Comments:

Completed form provided to Contracting Officer: (Date)

APPENDIX C
TECHNICAL PROJECT PLANNING (TPP)
MEETING MINUTES

DEPARTMENT OF THE ARMY
UNITED STATES ARMY ENVIRONMENTAL COMMAND
UNITED STATES ARMY CORPS OF ENGINEERS
UNITED STATES ARMY GARRISON – WEST POINT

Technical Project Planning Meeting 1
Military Munitions Response Program
U.S. Army Garrison – West Point

27 September 2017

Project:	**Military Munitions Response Program Water Munitions Response Sites U.S. Army Garrison – West Point**
Points of Contact:	U.S. Army Garrison – West Point, MMRP Manager: Jeff Sanborn/ 845-938-5041 USACE – Project Manager: Kim Gross/ 410-962-3457 Contractor, Weston Solutions, Inc. (WESTON), Project Manager: John Gerhard/ 610-701-3793

On 27 September 2017, the representatives from the stakeholder organizations listed below attended the Technical Project Planning Meeting 1 at the West Point Department of Public Works (DPW) Conference Room, Bldg 667. This meeting was conducted as part of the Technical Project Planning (TPP) process. The purpose of the meeting was to discuss project goals and specific execution strategies with the following stakeholders: U.S. Army Garrison West Point, U.S. Army Corps of Engineers (USACE), U.S. Army Environmental Command (USAEC), New York State Department of Environmental Conservation (NYSDEC), New York State Department of Health (NYDOH), and U.S. Environmental Protection Agency (EPA) Region 2. This discussion was held in order to reach consensus on the approach to successfully complete the Military Munitions Response Program (MMRP) Remedial Investigation (RI) of the water munitions response sites (MRSs): Siege Battery - TD River MRS and Battery Knox - TD River MRS.

MEETING ATTENDEES:

Name	Organization / Title	Email	Telephone Number
Kim Gross	USACE Project Manager	Kimberly.u.gross@usace.army.mil	410-962-3457
Debbie McKinley*	USACE Environmental Engineer	deborah.k.mckinley@usace.army.mil	410-962-6730
Paul Greene*	USACE Munitions and Explosives Safety Chief	Paul.E.Greene@usace.army.mil	410-962-6741
Cliff Opdyke*	USACE Risk Assessor	Clifford.A.Opdyke@usace.army.mil	410-962-6765
Tom Colozza*	USACE Geophysicist	Thomas.S.Colozza@usace.army.mil	410-962-6647
Mary Ellen Maly*	U.S. Army Environmental Command Environmental Support Manager	mary.e.maly.civ@mail.mil	210-466-1870
Jeff Sanborn	DPW-Environmental Management Division (EMD)/MMRP Manager	jeffrey.sanborn@us.army.mil	845-938-5041
Karl H. Weed	DPW-Environmental Management Division	Karl.weed@usma.edu	845-938-2116
Brian O. Anderson	DPW-Environmental Management Division		954-687-4687
David Crosby	New York State Department of Environmental Conservation (NYSDEC) Project Manager	David.crosby@dec.ny.gov	518-402-9662
Steven Karpinski	New York State Department of Health (NYSDOH) Project Manager	Steven.karpinski@health.ny.gov	518-402-7860
Sharon Hartzel	U.S. Environmental Protection Agency (EPA)/Remedial Project Manager	Hartzell.sharon@epa.gov	212-637-4132
John Gerhard	WESTON/Project Manger	j.gerhard@westonsolutions.com	610-701-3793
Ryan Steigerwalt	WESTON /Technical Manager	ryan.steigerwalt@westonsolutions.com	410-612-5900
Nicole Sharkey*	WESTON /Project Leader	Nicole.sharkey@westonsolutions.com	610-701-3425

*On the phone

Key discussion points and results of the TPP Meeting 1 are presented below.

- Attendee introductions (all)
- West Point MMRP RI TPP presentation (Mr. John Gerhard and Mr. Ryan Steigerwalt – WESTON)
  - NYSDEC asked about the rationale for including Area A and Area B in the investigation. WESTON responded that the Navy survey identified anomalies in the gaps between the range fans of the Siege Battery - TD River and Battery Knox - TD River MRSs. Therefore, the Areas were included in the RI and will be investigated at the same time as the two MRSs. Area A is located within an area of interest as identified by the Navy survey. Area B is located in an area where military munitions may have moved between the two MRSs due to tidal fluctuations. USACE clarified that the existing MRSs may be expanded to include Area A and/or B based upon the RI results. The conceptual site model (CSM) for Area A and Area B is similar to what is expected for the Siege Battery-TD River MRS.
  - NYSDEC asked for clarification on Activity #3 listed on slide 28: the rationale for the 0.5 MEC per acre standard. WESTON replied that the 0.5 MEC per acre was taken from a statistical model developed by USACE. The land use and goals of the investigation are taken into account within the module and the MEC per acre standard will vary per site. 0.1 MEC per acre is standard for a residential developed area and 1.0 MEC per acre is typically used for a remote undeveloped area where intrusive activity is unlikely. The MEC per acre assumption also takes into account the predicted amount of residual MEC that may be expected at the MRS based on the CSM.
  - NYSDEC asked about the procedure for a potential shipwreck to be identified in the Hudson. WESTON responded that they are aware of the archeological sensitivity of shipwrecks. Protocols will be developed during the project planning process for when archeological and cultural resources are encountered. WESTON inquired if NYSDEC has a cultural resource manager to coordinate findings or if just the State Historic Preservation Office (SHPO) should be contacted. NYSDEC responded that they can provide a point of contact (POC) of someone who usually coordinates with the SHPO (**Action Item**).
  - NYSDEC asked if any shipwrecks are known to exist within the investigation area boundary. West Point responded that, as shown in an image on a previous slide, a barge was identified by the Navy survey. NYSDEC asked what is the procedure if any MEC are identified on/under/near a shipwreck. WESTON responded that the surveys would not be able to identify any military munitions under a ship due to interference from metal on the ship itself. However, if any military munition was identified on or near a shipwreck, a decision would have to be made from the project team (USACE, USAEC, West Point, and WESTON) on whether the munition could be moved without impacting the shipwreck or if the area of the shipwreck should be excluded from the investigation area.
  - NYSEC asked where the reference sample locations in support of the munitions constituent (MC) sampling may be located and how many. WESTON responded that, at a minimum, one reference location would be placed upstream and outside of the MRS boundary. However, areas still have to be evaluated for characteristics that would be similar to within the investigation area for comparability.
- After the Presentation WESTON had several questions for NYSDEC

1) WESTON asked whether a right-of-entry was required for performing the investigative work in the Hudson River. NYSDEC responded that they would have to check, but that approval of the Work Plan should be sufficient (**Action Item**).
2) WESTON asked for clarification on the boundary of the Hudson River. WESTON understands that the high water line was the boundary but wanted to confirm. NYSDEC responded that Mean High Tide is the boundary.
3) WESTON asked for a NYSDEC cultural resource manager POC. NYSDEC stated they would provide a POC and asked if the presentation could be provided to the POC for informational purposes (**Action Item**). West Point responded that a condensed summary was asked to be provided by WESTON before the meeting, for relaying to project stakeholders (**Action Item**).
4) WESTON asked how NYSDEC or SHPO would want the recovered items (munitions determined to be safe and non-munition items) handled and disposed of after the investigation is complete. West Point responded that NYSDEC has priority of any military munitions identified within the Hudson River. USACE clarified that any military munition identified is Department of Defense (DoD) property until certified and verified as a material documented as safe (MDAS). WESTON stated that they will work with the State and West Point when military munitions, that are certified and verified as MDAS, will be transferred to determine if cultural resources professionals are interested in the items. All non-munitions cultural items will also be stored for assessment if specialists would like to inventory or keep for historical purposes.
5) WESTON asked if NYSDEC has a POC that should be consulted for biological issues because activities such as demolition would potentially adversely affect protected species. NYSDEC asked if demolition has to occur in the water. WESTON responded that, if military munitions are deemed unacceptable to move, they would have to be blown-in-place. However, the current plan is to move the munitions to a shallow water area near the shoreline during low tide to minimize potential adverse effects. The demolition would then occur in the area between low and high tide. Per the explosive safety plan (ESP) and DoD regulations, munitions cannot be moved outside the MRS boundary by a contractor. USACE clarified that only Explosive Ordnance Disposal (EOD) units can move a munition outside the MRS boundary. NYDEC asked if Article 27 USACE permits were required to conduct activities within the river. USACE clarified that, under CERCLA, permits are not required, but substantive requirements should be met. NYSDEC and USACE replied that they would both inquire with their permit people (**Action Item**).
6) WESTON asked if typical reviews times for documents are 30 or 45 days. NYSDEC responded that 30 days is standard; however, the cultural and biological POC's would have to be asked as they may require additional time.

- EPA had several general questions for the project team
    1) EPA asked how the step-out areas were determined. WESTON responded that the step-out transect areas were determined based on the boundaries of the Navy survey.
    2) EPA had a general question about whether capping is a viable option for underwater munition sites. USACE responded that capping is a viable technology for underwater

munitions sites depending on the CSM. Capping would be viable in a relatively quiescent location such as a lake, but not in a location with a scouring water flow. WESTON clarified that it would also depend on if a pathway was complete. For example, human receptors would not interact with military munitions within sediment of the Hudson River at locations deeper than 120 feet, thus resulting in an incomplete pathway.

3) EPA asked if fishing and recreation is allowed within the Hudson River within the investigation area and if military munitions within the river could present a risk to people fishing. West Point responded that the investigation areas are used heavily for recreation, especially during the summer months. However, there is no historical evidence of anyone interacting with military munitions in the water. USACE clarified that munitions from the time period of use are not very sensitive, especially due to the presence of water. USACE further clarified that it is very unlikely for an accidental underwater detonation, but it is possible for people to accidentally “hook” a military munition and bring it to the surface.

ACTION ITEMS

Item	Responsible Party	Due Date
Provide NYSDEC cultural resource manager POC	NYSDEC	11/4/2017
Determine if a ROE is needed	NYSDEC	11/4/2017
Provide NYSDEC biological POC	NYSDEC	11/4/2017
Provide fact sheet/summary of activities to be conducted within the investigation area boundary.	WESTON	11/4/2017
Determine if permits are required within the Hudson River	NYSDEC and USACE	11/4/2017

WESTON SOLUTIONS

SHEET ____ **of** ____

CLIENT/SUBJECT USACE - West Point, NY - Water MRS. **W.O. NO.** ______

TASK DESCRIPTION TPP 1 - 9/27/17 **TASK NO.** ______

PREPARED BY ______ **DEPT** ______ **DATE** ______

MATH CHECK BY ______ **DEPT** ______ **DATE** ______

METHOD REV. BY ______ **DEPT** ______ **DATE** ______

APPROVED BY ______

DEPT ______ **DATE** ______

NAME	ORGANIZATION	PHONE	EMAIL
John Gerhard	Weston Solutions, Inc.	610-701-3793	J.Gerhard@weston solutions.com
Kim Gross	USACE, Balt District	410-962-3457	Kimberly.u.gross@usace.army.mil
Jeff Sanborn	DPW West Point	845 938 5041	Jeff.sanborn@usma.edu
Steve Karpinski	NYSDOH	518 402 7853	steven.karpinski@health.ny.gov
David Crosby	NYSDEC	518-402-9642	david.crosby@dec.ny.gov
Karl H. WEED	USMA	(845)938-2116	Karl.Weed@USMA.edu
RYAN STEIGERWALT	WESTON SOLUTIONS	(267)258-2672	RYAN.STEIGERWALT@WESTONSOLUTIONS.COM
Sharon Hartzell	US EPA	212-637-4132	hartzell.sharon@epa.gov
BRIAN O. ANDERSON	DPW, Westpoint.	(954) 687.4687.	

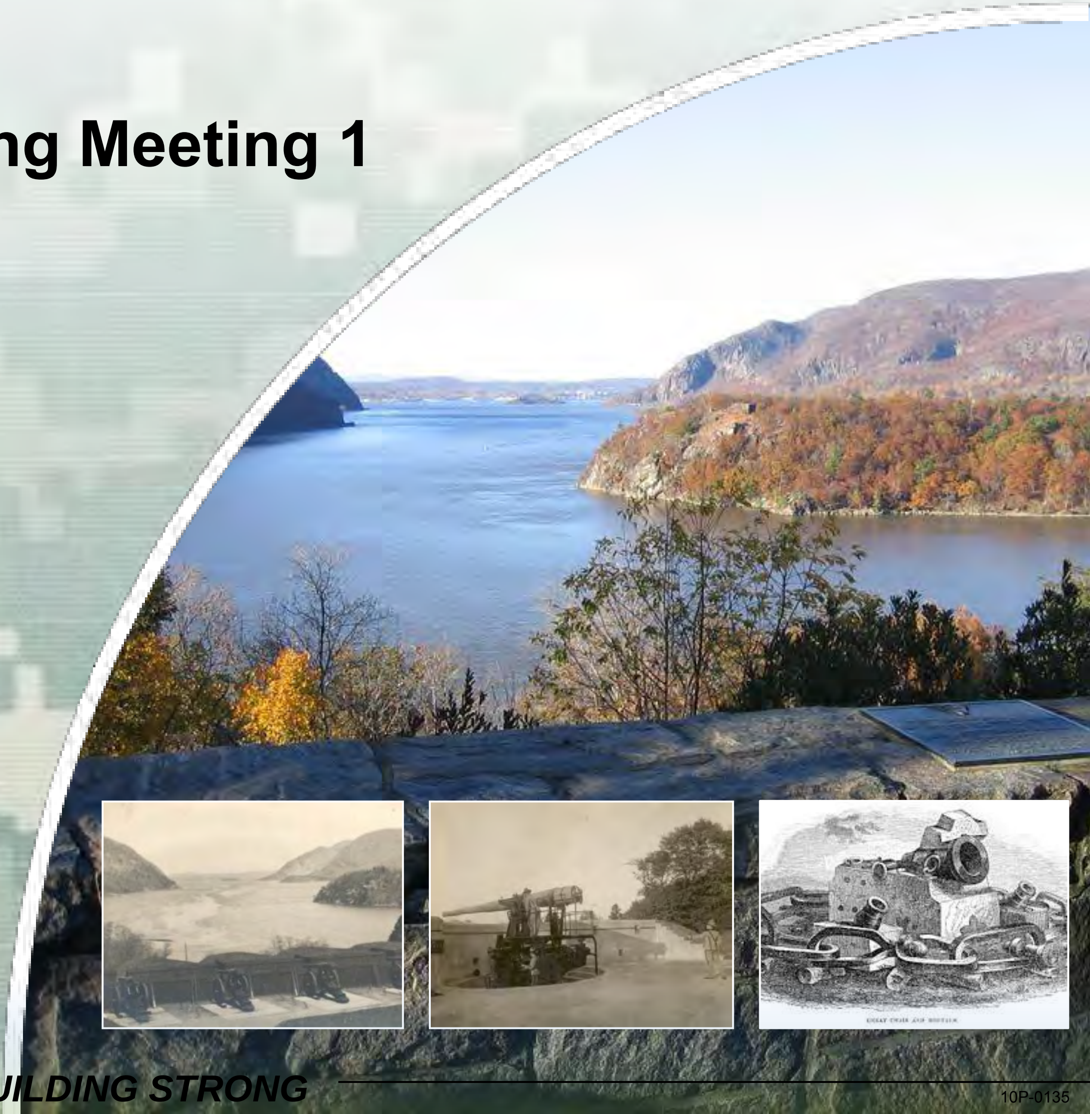
Military Munitions Response Program

Water Munitions Response Sites

West Point, NY

Technical Project Planning Meeting 1

27 September 2017



US Army Corps of Engineers
BUILDING STRONG®

Agenda

- Introductions
- Terminology
- Performance Work Statement
- Technical Project Planning
- Planning and Data Quality Objectives
- Reporting

Introductions

- **U.S. Army Garrison West Point**
  - Jeff Sanborn, MMRP Lead
- **U.S. Army Environmental Command**
  - Mary Ellen Maly, Environmental Support Manager
- **U.S. Army Corps of Engineers, Baltimore District**
  - Travis McCoun, Contracting Officer’s Representative
  - Paul Greene, Munitions and Explosives Safety Chief
  - Kim Gross, Project Manager
  - Deborah McKinley, Environmental Engineer
  - Tom Colozza, Geophysicist
  - David King, Geophysicist
  - Cliff Opdyke, Risk Assessor
  - Alan Warminski, Chemist

Introductions

- **New York State Department of Environmental Conservation (NYSDEC)**
  - David Crosby, Project Manager
- **New York State Department of Health (NYSDOH)**
  - Steven Karpinski, Project Manager
- **U.S. Environmental Protection Agency (EPA)**
  - Sharon Hartzel, Remedial Project Manager

Introductions

- **Weston Solutions, Inc.**
  - Eric Stahl, Client Service Manager
  - John Gerhard, Program and Project Manager
  - Ryan Steigerwalt, Technical Manager
  - Brian Grassmyer, Senior UXO Supervisor
  - Greg Abrams, Project Geophysicist
  - Nicole Sharkey, Project Leader
  - Bryan Hnetinka, Project Engineer
  - Deb Volkmer, Community Outreach

Terminology

- **COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT (CERCLA)**
  - Passed in 1980, CERCLA imposes strict joint and several liability for cleaning up environmentally contaminated land
- **DEFENSE ENVIRONMENTAL RESOTRATION PROGRAM (DERP)**
  - DoD environmental restoration activities at active installations, Formerly Used Defense Sites, and Base Realignment and Closure locations
- **NATIONAL OIL AND HAZARDOUS SUBSTANCES POLLUTION CONTINGENCY PLAN (NCP)**
  - Federal government's framework for responding to both oil spills and hazardous waste releases
- **MILITARY MUNITIONS RESPONSE PROGRAM (MMRP)**
  - DoD program begun in 2001 and addresses the potential explosives safety, health, and environmental issues resulting from past munitions use at current and former military training lands.

Terminology

- **SITE INSPECTION (SI)**
  - The objective of the SI is to eliminate, from further consideration, those sites that pose no significant threat to public health or the environment (i.e., determine whether a release has occurred), and/or collect data to help characterize the release for effective initiation of the Remedial Investigation (RI)
- **REMEDIAL INVESTIGATION/FEASIBILITY STUDY (RI/FS)**
  - Mechanism for collecting data to characterize nature and extent of contamination, assess risk to human health and the environment, and conduct treatability testing to evaluate the potential performance and cost of the treatment technologies that are being considered
- **MUNITIONS AND EXPLOSIVES OF CONCERN (MEC)**
  - Unexploded Ordnance (UXO) – military munitions that were primed, fused, armed, or prepared for action; fired, dropped, launched, projected, or placed; and remain unexploded by malfunction, design, or any other cause
  - Discarded Military Munitions (DMM) – munitions abandoned without proper disposal or removed from storage for the purpose of disposal
  - Munitions constituents in high enough concentrations to pose an explosive hazard

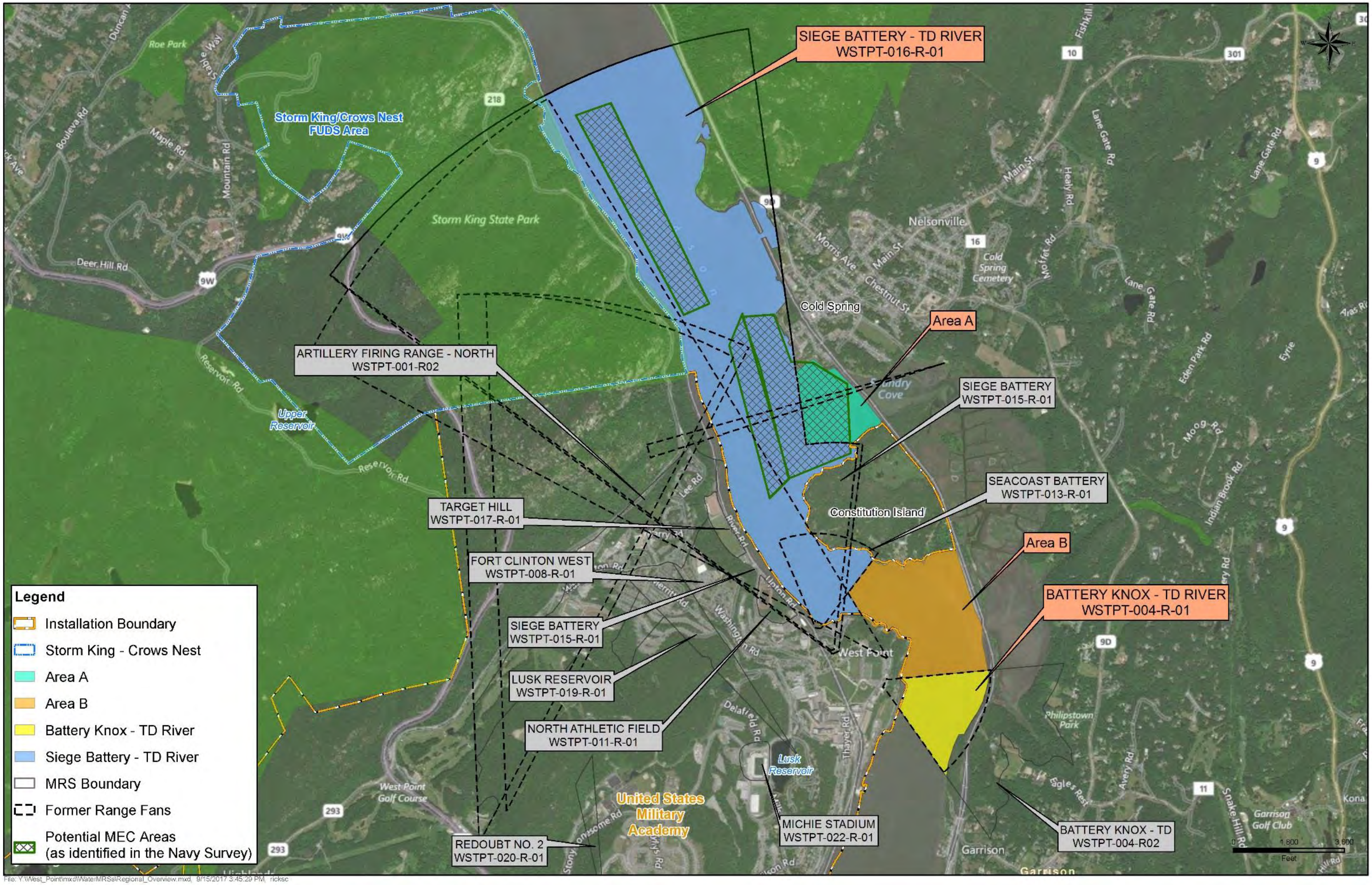
Terminology

- **MUNITIONS CONSTITUENTS (MC)**
  - Explosives and non-explosive materials originating from military munitions, including emissions, degradation, or breakdown elements of such munitions
- **MATERIAL POTENTIALLY PRESENTING AN EXPLOSIVE HAZARD (MPPEH)**
  - Material that prior to determination of its explosive safety status, potentially contains explosives, munitions, or a high enough concentration of explosives that the material presents an explosive hazard. Material Documented as Safe (MDAS) is MPPEH that has been assessed and documented as not presenting an explosive hazard. Material documented as an explosive hazard (MDEH) is MPPEH that cannot be documented as MDAS, that has been assessed and documented as to the maximum explosive hazards the material is known or suspected to present.
- **MUNITION DEBRIS (MD)**
  - A military munition or components thereof that does not contain explosives or pyrotechnics. Includes, Practice munitions without spotting charges, inert training munitions, expended ejection munitions, and fragments that do not contain explosives or pyrotechnics.

Performance Work Statement

- Munitions Response Sites (MRS)
  - Siege Battery-Transferred (TD) River (WSTPT-016-R-01)/ Area A and Area B
  - Battery Knox-TD River (WSTPT-004-R-01)
- Uniform Federal Policy – Quality Assurance Project Plan (UFP-QAPP) within 18 months of notice to proceed
- Option – Achieve Remedial Investigation / Feasibility Study (RI/FS) within 30 months of award of option
- Option – Achieve Proposed Plan/ Decision Document within 24 months of award of option
- Community Relations Plan for Installation Restoration Program and MMRP within 12 months of notice to proceed
- Option - Achieve an accepted DERP Restoration Advisory Board (RAB) Public Interest Survey Report (Survey 1 & 2) within 12 months of award of each option

Regional Overview



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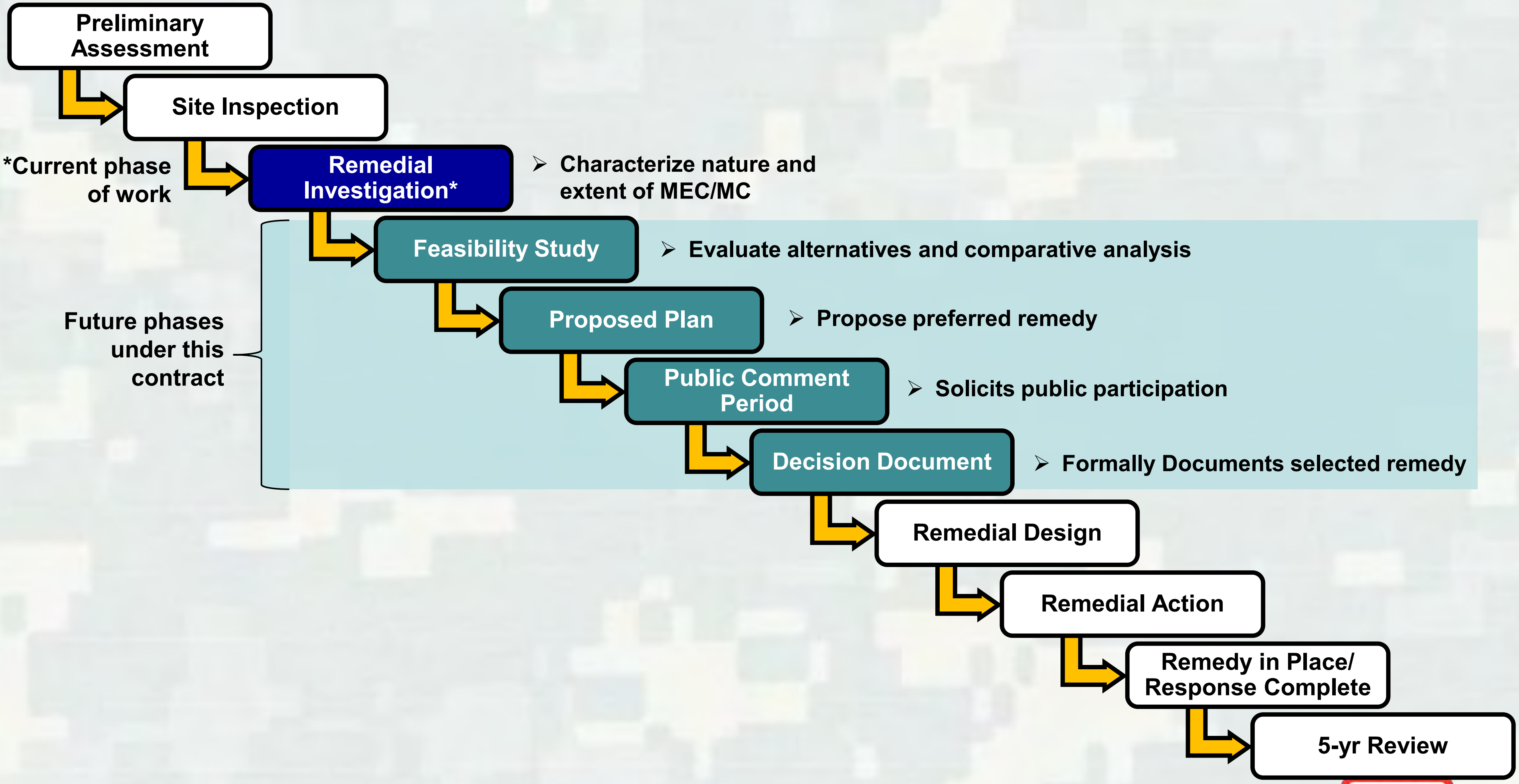
CERCLA Phases



Preliminary Assessment

Site Inspection

*Current phase of work

Remedial Investigation*

- Characterize nature and extent of MEC/MC

Future phases under this contract

Feasibility Study

- Evaluate alternatives and comparative analysis

Proposed Plan

- Propose preferred remedy

Public Comment Period

- Solicits public participation

Decision Document

- Formally Documents selected remedy

Remedial Design

Remedial Action

Remedy in Place/ Response Complete

5-yr Review

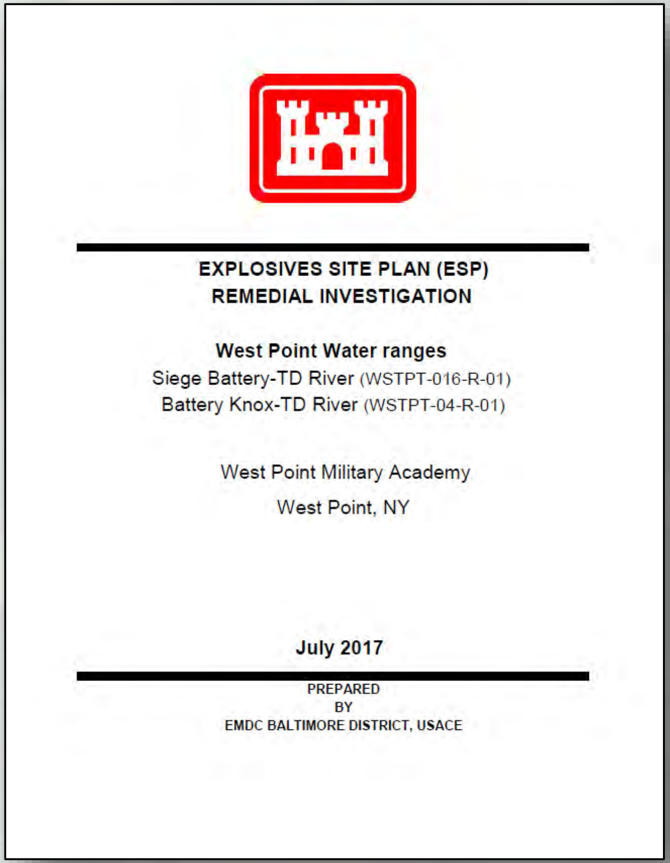
BUILDING STRONG®

Technical Project Planning (TPP)

- **TPP is a four phase process:**
  - Phase 1 – Project Objectives are identified
  - Phase 2 – Determine data needs to satisfy Data Quality Objectives
  - Phase 3 – Develop data collection options to satisfy Phase 2
  - Phase 4 – Finalize a data collection program to meet short/long term goals
- **Meetings**
  - ***1st Meeting held prior to development of the planning documents***
  - 2nd Meeting held prior to finalization of RI/FS Work Plans and field work
  - Additional Meetings:
    - Following field work and stakeholder review of the Draft-Final Remedial Investigation
    - Following stakeholder review of the Draft-Final Feasibility Study
    - Following stakeholder review of the Draft-Final Decision Document

RI Planning

- Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP)
  - Conceptual Site Model (CSM)
  - Data Quality Objectives (DQOs)
  - Covers MEC and MC characterization activities
- Accident Prevention Plan (APP)/ Site Safety and Health Plan (SSHP)
- Dive Safety Plan
- Explosives Site Plan (ESP) – USACE prepared
- Community Relations Plan (CRP)



EXPLOSIVES SITE PLAN (ESP)
REMEDIAL INVESTIGATION

West Point Water ranges
Siege Battery-TD River (WSTPT-016-R-01)
Battery Knox-TD River (WSTPT-04-R-01)

West Point Military Academy
West Point, NY

July 2017

PREPARED
BY
EMDC BALTIMORE DISTRICT, USACE

Data Quality Objectives

- Follows EPA 7-step process to develop DQOs
    1. State the Problem
    2. Identify the Goal of the Study
    3. Identify Information Inputs
    4. Define Boundaries of the Study
    5. Develop the Project Data Collection and Analysis Approach
    6. Specify Performance and Acceptance Criteria
    7. Develop the Plan for Obtaining Data
- Subsequent slides focus on decisions and approaches to achieve the MMRP RI at the Siege Battery – TD River, Area A, Area B and Battery Knox – TD River

Conceptual Site Model

- West Point is located in Orange and Putnam Counties, New York
  - 50 miles north of New York City
  - 13 miles south of Newburgh
- Occupied by the U.S. Army since January 27, 1778, and is the oldest occupied military post in America to have continuously flown the nation's flag
- Primary Mission: "To educate, train, and inspire the Corps of Cadets so that each graduate is a commissioned leader of character committed to the values of Duty, Honor, Country and prepared for a career of professional excellence and service to the Nation as an officer in the United States Army"

Conceptual Site Model

- Adjacent to West Point, the Hudson River is used for maritime trade, recreation, and underwater utilities
- CSX and Metro-North Railroad lines completely skirt the west and east shores of river
- A parking area at Cold Spring Station, Cold Spring public works facilities, state roadways, and several recreation areas are close to the river edge
- In the future, a high voltage direct current underwater and underground transmission line will be routed in and along the Hudson River

Conceptual Site Model

- The Range Inventory Report identified 10 closed ranges and two transferred areas that were used for artillery training throughout the Revolutionary War and into World War II
- Transferred areas include Siege Battery and Battery Knox
- Siege Battery – TD River MRS includes multiple artillery range fans including Artillery Firing Range, Fort Clinton, Seacoast Battery, Siege Battery and Cold Spring Foundry
  - Siege Battery – TD River MRS includes the potential for munitions from the multiple ranges, targeting barges in the Hudson River, undershots targeting Constitution Island, as well as over and undershots
- Battery Knox – TD River MRS was used for defense of the Hudson River and for training cadets. Weapons at the battery were directed east and downward from the bluff, targeting barges placed within the Hudson River
- Area A and Area B are not included within the range fans but are assumed to have a similar CSM as Siege Battery – TD River MRS

Data Quality Objectives

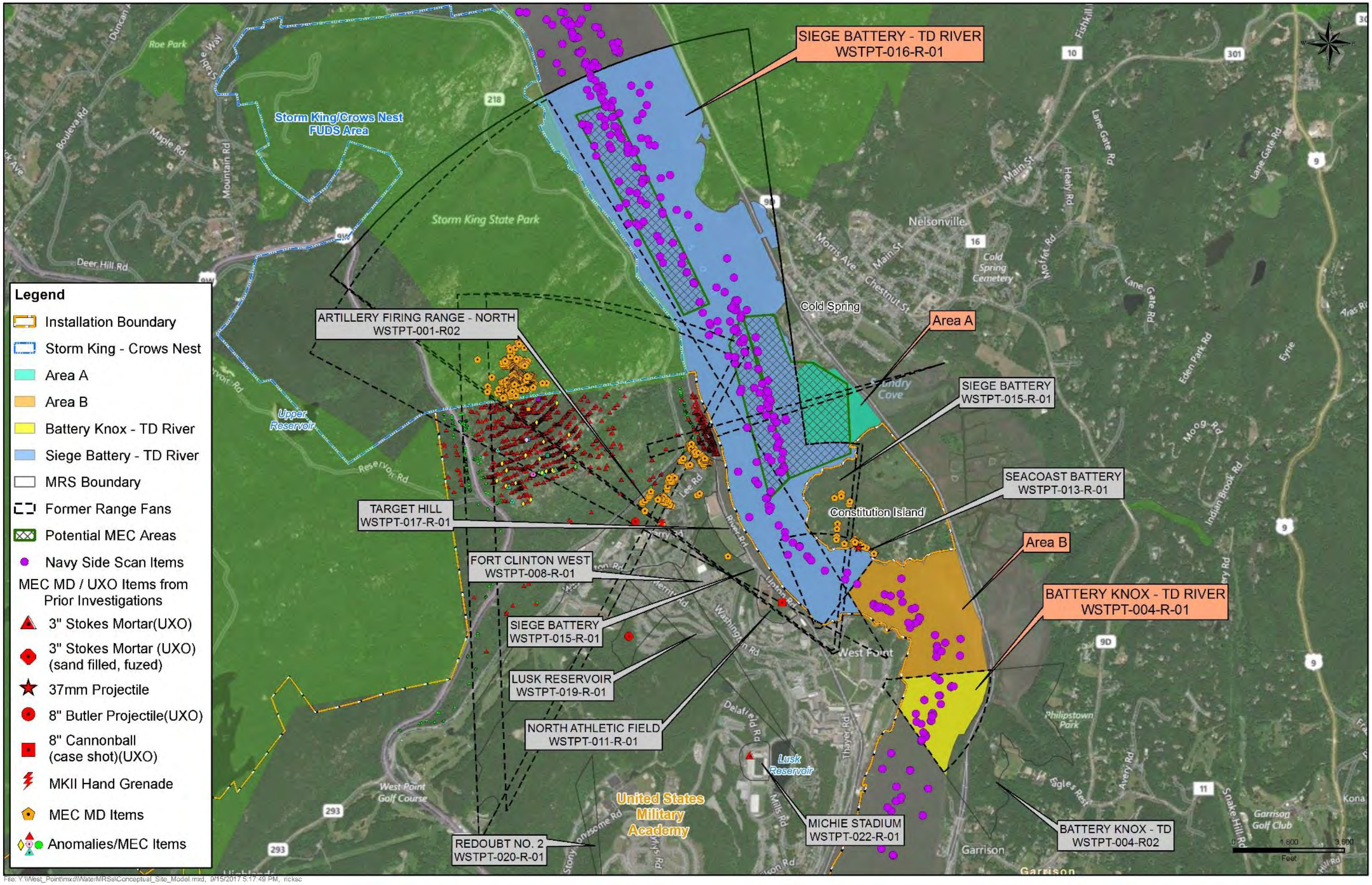
Step 1 - State the Problem

- Due to past training, MEC and munition debris (MD) have been recovered along the shoreline of the Hudson River near the Crow's Nest impact area and on Constitution Island
- Underwater surveys documented areas of concern within the Hudson River that may be munitions related features
- Based on these findings, MEC and MC may be present within the Siege Battery – TD River, Area A, Area B and Battery Knox – TD River

The nature and extent of MEC and MC at these MRSs are unknown

- **MEC may be proud on the river bottom or buried in sediment**
- **MC may be present in sediment depending on conditions and concentrations of potential MEC and MD**

Conceptual Site Model



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Data Quality Objectives

Step 2 – Identify the Goal of the Study

- Delineate the nature and extent of MEC
  - Traverse, detect and delineate concentrated munitions use areas (CMUAs)
  - Determine type and concentration of MEC where CMUAs are encountered
  - Assess the remaining MEC density in non-CMUAs
  - Determine if an acceptable or unacceptable risk is present, for human receptors from the presence of MEC

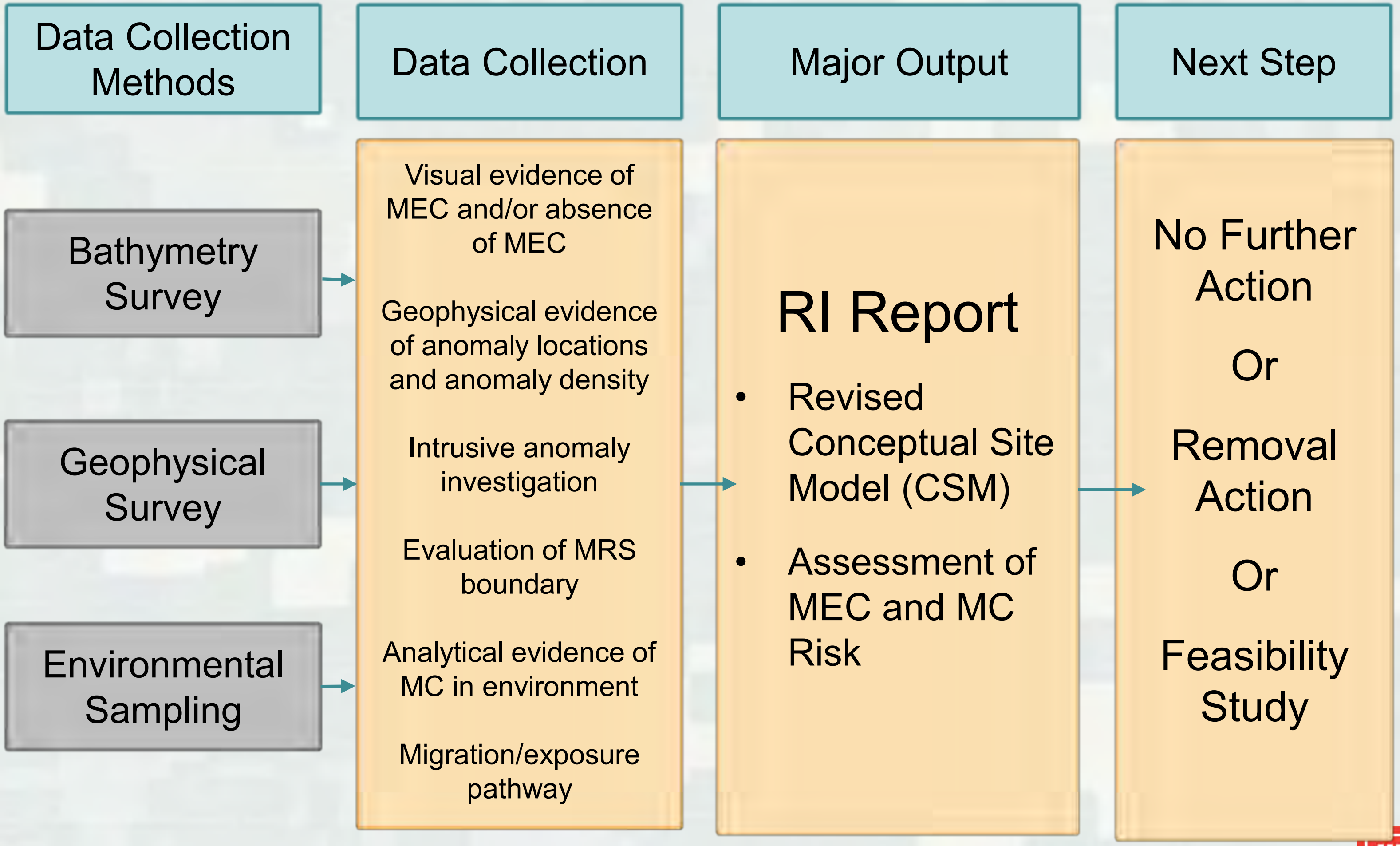
Data Quality Objectives

Step 2 – Identify the Goal of the Study

- Delineate the nature and extent of MC
  - Determine reference concentrations of metals in sediment in areas unrelated to munition related activities
  - Determine if there is a MC release in sediment due to high densities of MEC and MD where CMUAs are encountered
  - Determine vertical and horizontal extent of MC release in sediment where CMUAs are encountered
  - Conclude if MC is present in sediment at observed MEC and/or MPPEH that show signs of damage or heavy corrosion (outer casing failure) and visible signs of a MC release
  - Determine vertical and horizontal extent of MC release in sediment where individual MEC and/or MPPEH individual items damaged and/or heavy corroded (outer casing failure) with visible signs of a MC release
  - Determine if MC are present at concentrations that pose an unacceptable risk, for current or future human receptors and for ecological receptors

Data Quality Objectives

Step 2 – Identify the Goal of the Study



Data Collection Methods

- Bathymetry Survey
- Geophysical Survey
- Environmental Sampling

Data Collection

Visual evidence of MEC and/or absence of MEC

Geophysical evidence of anomaly locations and anomaly density

Intrusive anomaly investigation

Evaluation of MRS boundary

Analytical evidence of MC in environment

Migration/exposure pathway

Major Output

RI Report

- Revised Conceptual Site Model (CSM)
- Assessment of MEC and MC Risk

Next Step

No Further Action

Or

Removal Action

Or

Feasibility Study

Data Quality Objectives

Step 3 – Identify Information Inputs

- **Past Studies**
  - Closed, Transferred and Transferring Ranges Inventory, 2004
    - Identification of off-post ranges for Siege Battery and Battery Knox
  - Historical Records Review, 2006
    - Collection and analysis of historical information pertaining to munitions related activities
  - Site Inspection, 2007
    - Delineation of between land and water potions of the transferred ranges
  - Nature and extent of MEC and MD on land adjacent to river MRSs
    - RI Report – Siege Battery, 2015
    - RI Report – Battery Knox, 2014
    - RI Report – Seacoast Battery, 2014; FS – Seacoast Battery
    - RI Report – Crow’s Nest, 2016; FS – Crow’s Nest
  - Navy Underwater Study, 2016
    - Sonar, magnetometer and sub-bottom profiling surveys of more than 1,000 acres of the Hudson River

Data Quality Objectives

Step 3 – Identify Information Inputs

- **Future work**
  - Pre-digital geophysical mapping (DGM) river bottom mapping
    - Topography, water depth, features of interest on river bottom
  - DGM surveys
    - Anomaly locations
  - Remotely Operated Vehicle (ROV) reconnaissance
    - High resolution scans of features on river bottom
  - Investigations using divers
    - Anomaly investigation, subsurface results
  - Environmental media sampling for MC
    - Concentrations of metals and explosives related to military munitions and metals in reference areas

Data Quality Objectives

Step 4 – Define the Boundaries of the Study

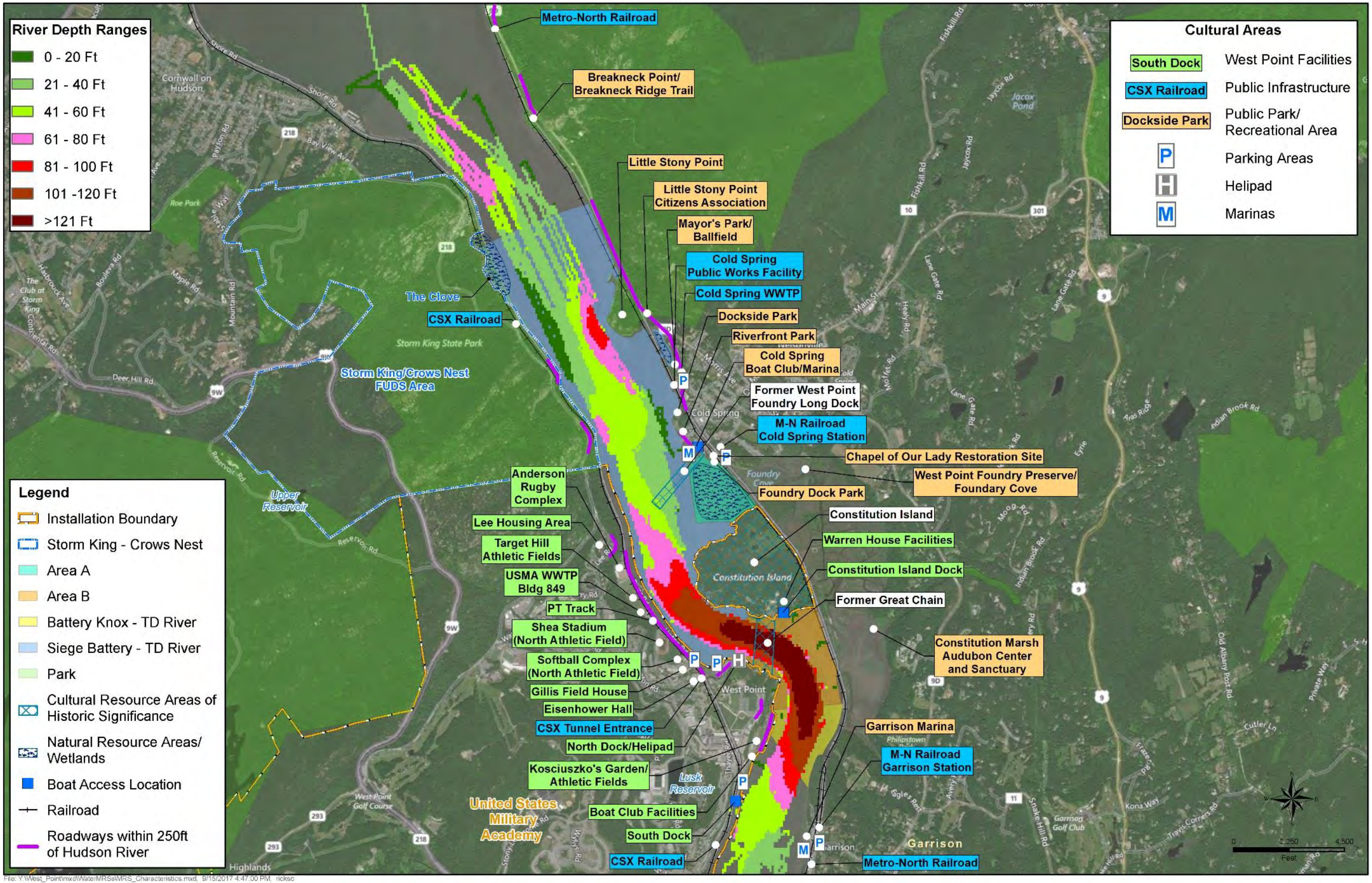
- **Study Area boundaries**
  - Siege Battery – TD River: 848 acres
  - Area A: 63 acres
  - Area B: 154 acres
  - Battery Knox – TD River: 73 acres
  - Step-outs north and south based on Navy Survey results
- **Horizontal boundaries**
  - Hudson River shoreline to mean high tide
  - MC sampling boundary will vary based upon size of CMUA and individual items damaged and/or heavy corroded (outer casing failure) with visible signs of a MC release
- **Vertical boundaries**
  - MEC may be proud on river bottom surface or below sediment
  - Maximum water depth for investigation is 120 ft deep
  - MC Sediment sampling from 0-6 inches below ground surface

Data Quality Objectives

Step 4 – Define the Boundaries of the Study

- **Anticipated weapons systems used**
  - Siege Battery: 4½-inch rifled gun, 30-pounder Parrott guns, 10-inch smooth bore siege mortars, 8-inch smooth bore siege mortars, 5-inch steel breech-loading guns, 7-inch steel breech-loading howitzers, 7-inch steel breech-loading mortars, and 3.2-inch guns
  - Battery Knox: one 100-pounder Parrott 6.4-inch caliber rifle, one 300-pounder Parrott 10-inch caliber rifle, one 8-inch converted rifle, and four 10-inch Rodman rifles
- Anticipated MC constituents
  - Determined based on time of use (late 1700's to early 1900's) and potential MEC as identified for the land portion of the various range fans overlapping the study area boundaries consisting of select metals and explosives.

MRS Characteristics to be Evaluated In CSM



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Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

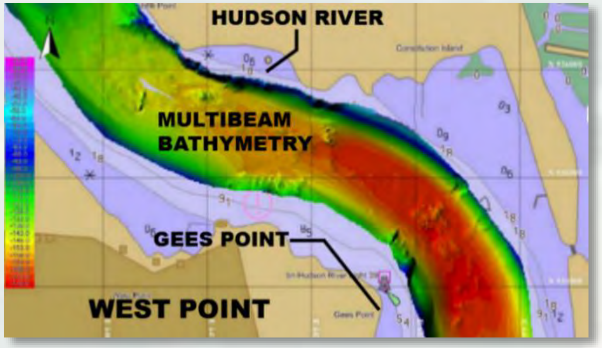
- Overall characterization strategy for MEC and MC

Activity	Performance Standard
1. Pre-DGM river bottom mapping	Evaluate river bottom topography/ morphology as a DGM planning guide and to identify features of interest for further investigation
2. Traverse and detect CMUAs at a high level of confidence	Demonstrate a 95% probability of traversing and detecting any CMUAs; Use Visual Sample Plan (VSP) to determine appropriate design to achieve metrics
3. Determine NCMUAs are characterized	Demonstrate that NCMUAs are characterized to show with at least 95% confidence they have less than or equal to 0.5 MEC per acre
4. Step-out investigations	Based on characterization results, additional work may be needed outside of MRS boundaries
5. MC characterization	Determine nature and extent of MC where CMUAs are identified and where damaged and/or heavily corroded (outer casing failure) MEC are discovered with visible signs of a MC release.

Data Quality Objectives

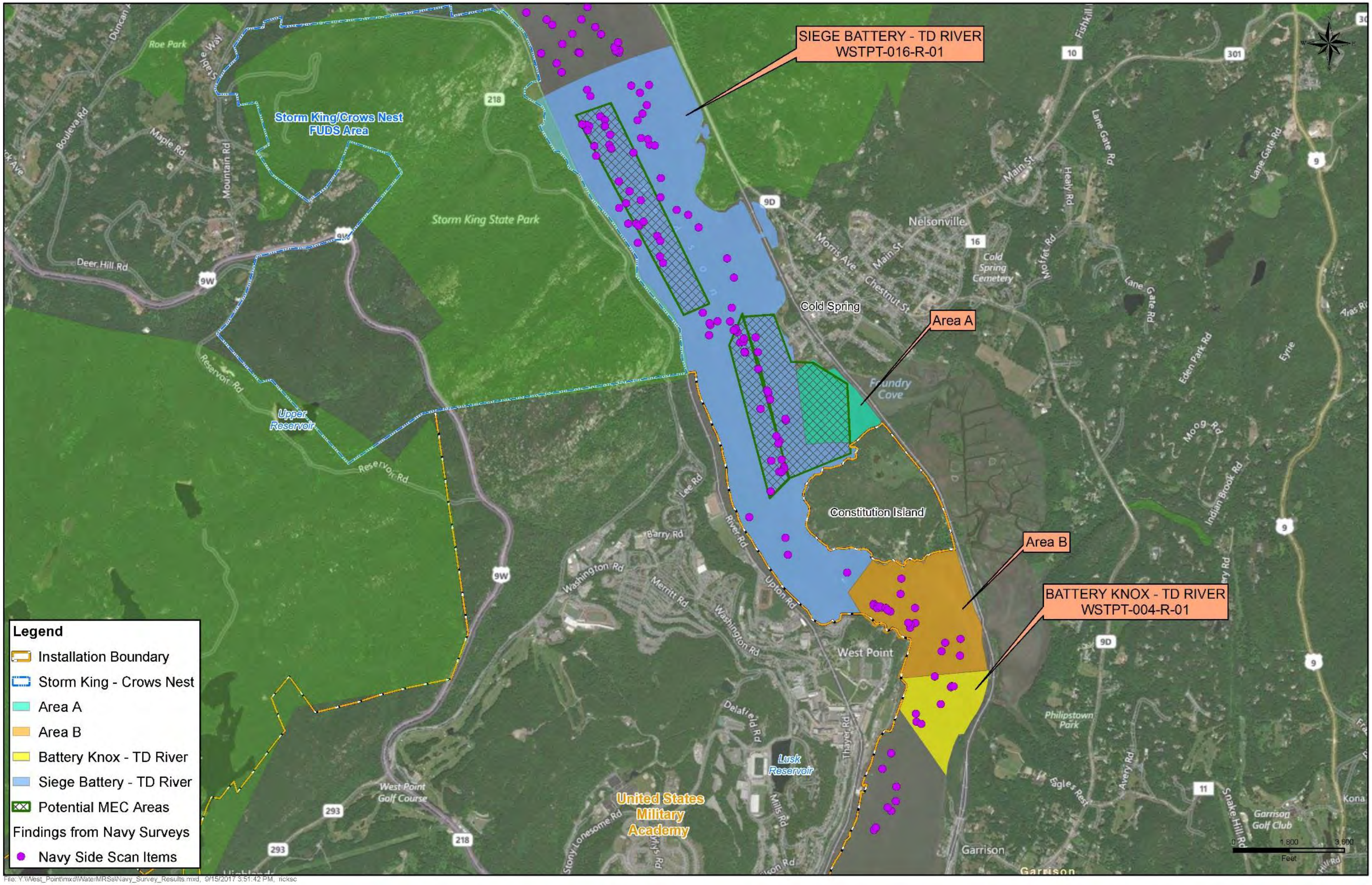
Step 5 – Develop the Project Data Collection and Analysis Approach

- **Pre-DGM river bottom mapping**
  - Perform multibeam bathymetry and side scan sonar surveys to supplement the existing Navy dataset, focusing on shallow areas of river
  - Provides topography and morphology of the riverbed to safely and effectively plan the underwater DGM surveys



  - Identify obstructions, utilities, or potential culturally-significant areas that should be avoided during subsequent work phases including dive operations
  - Detect additional features of interest that lie proud on the river bottom that may be munitions related
  - Determine if there has been migration of items by comparing newly collected data with overlapping Navy results
  - Identify optimal locations for the Instrument Verification Strip (IVS) install and demolition operations

Navy Survey Results



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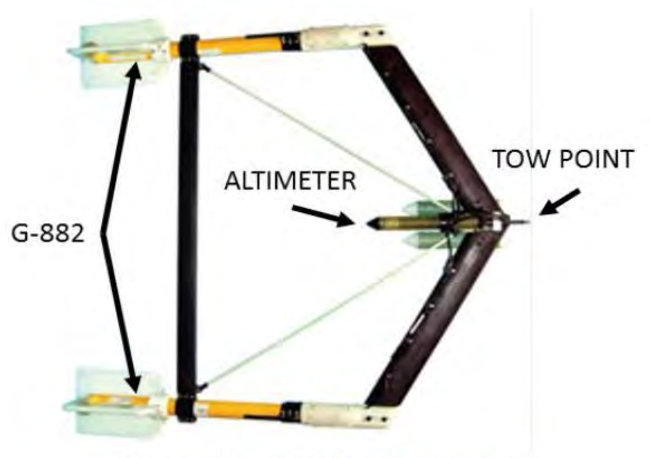
Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

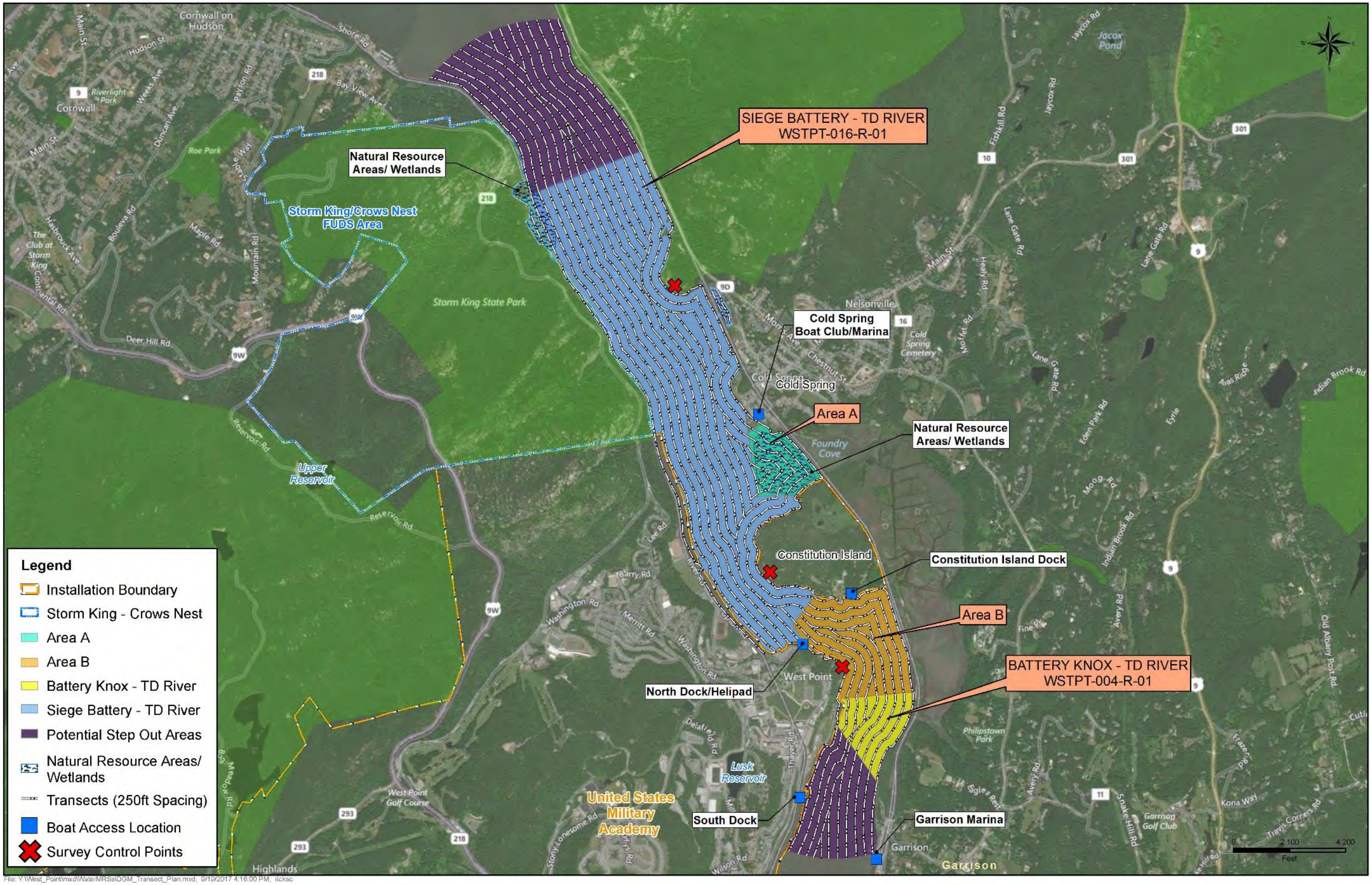
- **CMUA traversal and detection**
  - Use VSP's *Transect Spacing to Locate a MEC Target Area Module* to calculate the appropriate transect spacing to detect anomaly clusters exhibiting characteristics of potential CMUAs
  - Achieve a 95% probability of traversing and detecting a CMUA based on a 3-inch projectile or munition with a greater fragmentation radius
  - Requires a 250 ft transect spacing for DGM surveys



Geometrics TVG planned for DGM transect surveys.

  - Transects will be conducted using the Geometrics Transverse Marine Gradiometer (TVG)
  - Secondary method to be used closer to shore in shallow water where the TVG may not be effective.
  - Follows side scan sonar transects and adjusted away from obstacles

DGM Transect Plan



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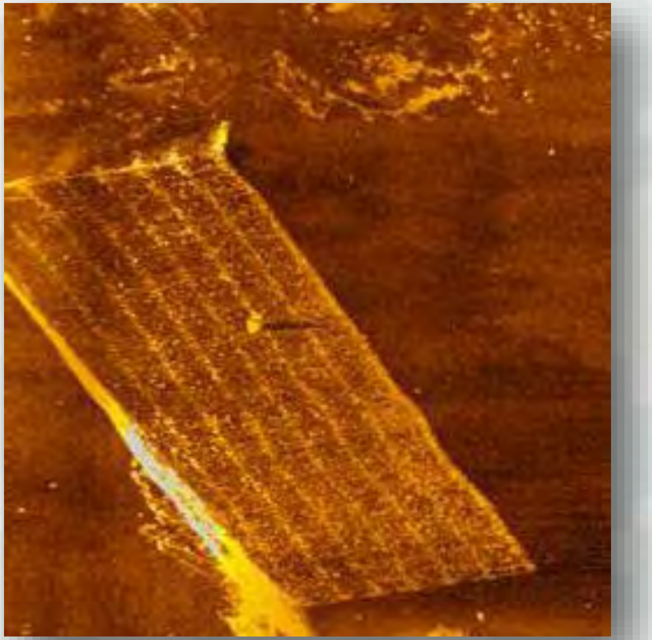
Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **Data assessment**
  - Potential CMUAs will be identified using the *Locate and Mark Target Areas and Geostatistical Mapping* functions of VSP to develop anomaly concentration maps
  - Anomalies along transects within potential CMUAs will be selected for further investigation
  - The selected anomalies and features of interest detected during the surveys will be synthesized with the multibeam surveys, magnetometry, and Navy results to determine if items are co-located
  - Several features of interest such as munitions-like items, potential targets or other munitions related items identified by the Navy and in newly collected multibeam and side scan sonar data will be selected for further investigation



Barge feature detected during Navy side scan sonar survey

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **NCMUA assessment**
  - There is a statistical potential that individual MEC may be present outside of CMUAs
  - Assess portions of the MRSs outside of CMUAs to determine remaining MEC density
  - Be 95% confident there is less than or equal to 0.5 MEC per acre (parameter used where there is generally low recreational/ industrial use by human receptors)
  - Utilize magnetometer transect data to calculate appropriate coverage and select anomalies for investigation

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **Anomaly investigation**
  - Approach needs to be multifaceted due to current, tidal fluctuation, river bottom topography, morphology, obstacles, water depth and personnel safety
  - Combination of UXO Technician divers and ROV investigations are planned
  - An ROV will be deployed as a preferred approach where data analysis suggests items are exposed on the river bottom and in locations not accessible to divers
    - ROV provides a high resolution sonar scan
    - Accurately provides information on item type such as MEC, target debris or non-munition related debris (NMRD)
  - UXO Technician divers will also be used in areas where we find the river to be more depositional which could mean MEC is buried in sediment

Example ROV planned for use during RI

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **Anomaly investigation**
  - UXO Technician divers will also be used in areas where we find the river to be more depositional which could mean MEC is buried in sediment
  - Support vessels will need to be anchored at multiple points to support reacquisition needs
  - Due to depths and currents a large search radius will be employed to confirm the diver is on target
  - Analog metal detectors will support reacquisition
  - Manual investigation methods including hand tools and tactile searching techniques are used for items within the sediment until the item is uncovered and properly characterized

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **MEC and MPPEH management**
  - Acceptable to move MEC and MPPEH will be brought to shore for demolition
  - The preferred consolidation point will be between high and low tide river conditions
  - Constitution Island's shoreline is ideally situated for demolition operations
  - MEC and MPPEH unacceptable to move will be blown-in-place if permitted
  - Non-hazardous items that are culturally-sensitive will be managed separately to allow the West Point Cultural Resources Manager, Museum Conservators, and others to be consulted

Items turned over to the West Point Museum During the RI:


Historical Artifacts


3.5 inch solid shot cannonball


15 Inch Rodman Solid shot Cannonball

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **Step-out investigations**
  - Anomalies were identified by the Navy outside of the MRS boundaries
  - Transects were expanded outside the study area boundaries to confirm Navy anomalies.
  - If munitions related material is discovered near the northern and southern MRS boundaries during the RI then additional step-outs may be required
  - Existing Navy data may be used for investigation purposes based on the comparative analysis performed with newly collected data

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **MC Characterization**
  - Reference area sampling for sediment:
    - Initiate collection of samples from reference area(s) using randomly placed grid to provide context for any observed screening level exceedances in MRS areas.
    - Locations to be established in non-munitions impacted areas upstream of the MRS based on available data such as bathymetry, sediment types, tidal flow/tidelines, and/or known areas of upstream contamination/releases.
    - Minimum of ten sediment samples will be collected and analyzed for target metals to support statistical evaluation of reference area conditions.
    - Statistical analysis will consist of summary descriptive statistics, graphical examination of box plots and Q-Q plots, distribution goodness-of-fit tests, and estimation of 95% upper tolerance limits.
    - Reference datasets may be used in hypothesis testing to determine whether potentially impacted site median concentrations are statistically significantly different than reference area median concentrations.

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **MC Characterization**
  - Sediment samples will be collected during dive related operations
  - Sediment samples will be collected using a Wildco® corer
  - Analysis for select constituents based on potential munitions identified for the study boundary will include:
    - Metals:
      - Lead and Mercury
    - Explosives:
      - Nitroglycerin
      - Pentaerythritol tetranitrate (PETN)
      - Cyclotrimethylenetrinitramine (RDX)
      - 2,4,6-Trinitrotoluene (TNT)
      - 2,4-Dinitrotoluene (2,4-DNT)
      - 2,6-Dinitrotoluene (2,6-DNT)
      - 2-Amino-4,6-dinitrotoluene
      - 4-Amino-2,6-dinitrotoluene

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **MC Characterization For CMUA**
  - Sediment in locations where CMUAs are discovered based on concentrations of MEC and MD will be assessed using a probabilistic gridded sediment sampling approach
  - Extent of MC for CMUAs will be determined using gridded step-out sampling where there are exceedances of the screening levels and reference concentrations
- **MC Characterization For Individual MEC**
  - Sediment where damaged and/or heavily corroded (outer casing failure) MEC are discovered with visible signs of a MC release, will be assessed using a biased discrete sediment sampling approach
  - Extent of MC for single items will be determined using step-out sampling where there are exceedances of the screening levels and reference concentrations

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **MC Risk Assessments**
  - Verify and validate analytical data
  - Human Health Risk Assessment (HHRA) following Risk Assessment Guidance for Superfund (RAGS).
  - HHRA includes 4 basic steps in addition to the initial planning and scoping process:
    - Step 1 Hazard Identification
    - Step 2 Dose-Response Assessment
    - Step 3 Exposure Assessment
    - Step 4 Risk Characterization
  - Human health screening levels will be conservatively adopted from latest EPA Residential Screening Levels for residential exposure
    - Cancer effects will be assessed using a target risk of 1.0E-6
    - Risks from noncarcinogens will be assessed using a target hazard quotient of 0.1 to account for potential additive risk

Data Quality Objectives

Step 5 – Develop the Project Data Collection and Analysis Approach

- **MC Risk Assessments**
  - Screening Level Ecological Risk Assessment (SLERA) following the Ecological Risk Assessment Guidance for Superfund (ERAGS)
  - SLERA includes 3 basic phases in addition to the initial planning and scoping process :
    - Phase 1 Problem Formulation
    - Phase 2 Analysis
    - Phase 3 Risk Characterization
  - Ecological screening levels will be published ecological benchmarks that will be researched and selected from various sources for MC analytes/compounds

Data Quality Objectives

Step 6 – Specify Performance and Acceptance Criteria

- **Measurement performance criteria**
  - Specific operating specifications for each phase of work will be documented in the UFP-QAPP
  - Measurement performance criteria (MPCs) may include not to exceed transect spacing, sample density for DGM data collection, reacquisition tolerance, laboratory limits of detection, and PARCC parameters.
- **Quality control**
  - Work activities will be measured against MPCs
  - An instrument verification strip will be installed with industry standard objects for daily checkout of the magnetometer system
    - Located between the Cold Spring Boat Club/Marina and Constitution Island
  - Multiple control points will be established to confirm GPS positional accuracy
  - Collection and analysis of field and lab quality control samples in accordance with the UFP-QAPP

Data Quality Objectives

Step 7 – Develop the Plan for Obtaining Data

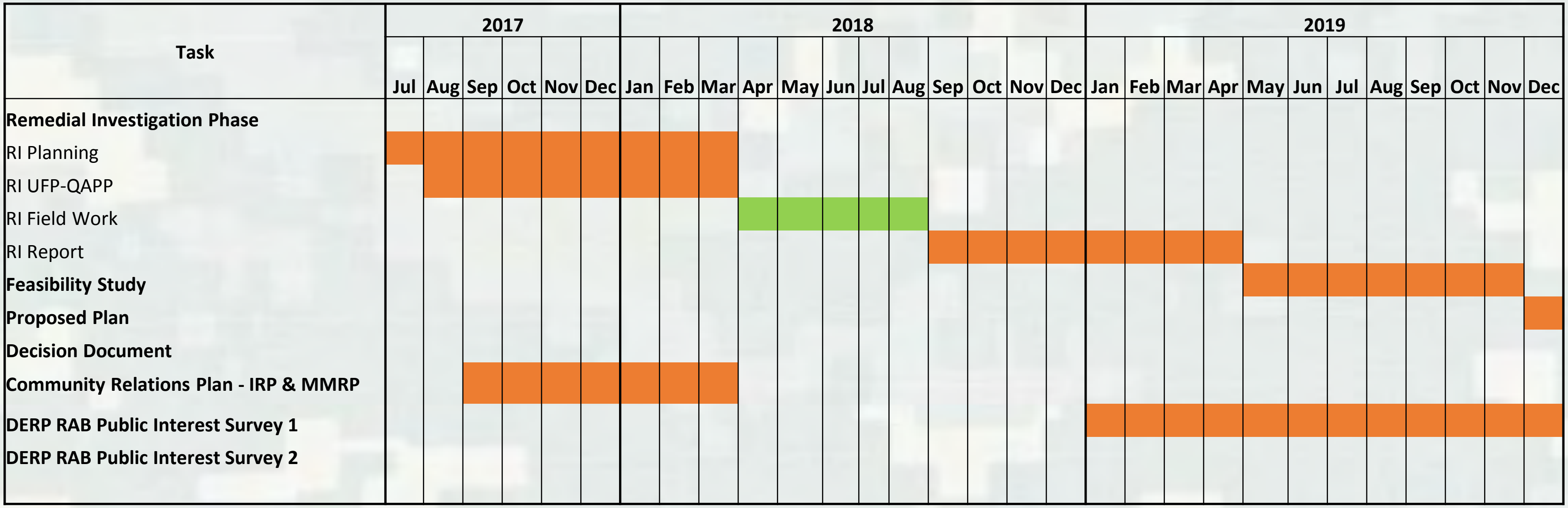
Key Stakeholders/Community Interest Groups:

- State and County Agencies:
  - Orange County
  - Putnam County
  - NYSDEC
  - NYS Department of Health
  - NYS Department of State
  - Orange County Department of Health
- Federal Agencies:
  - EPA-Region 2
- Tribal Groups:
  - Stockbridge-Munsee Mohican Tribal Historic Preservation
- Local Communities:
  - Town of Philipstown
  - Town of Cold Spring
  - Village of Garrison
  - Town of Highlands
  - Village of Highland Falls
- Other Interested Parties:
  - Scenic Hudson Inc.
  - Hudson Highlands Land Trust
  - Hudson River Keeper
  - Putnam County Historical Society
  - Bascobel Restoration Inc.
  - Hudson River Valley Greenway Communities Council
  - Chapel of Our Lady Restoration Inc.

Data Quality Objectives

Step 7 – Develop the Plan for Obtaining Data

PROJECT SCHEDULE



Task	2017						2018												2019											
	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Remedial Investigation Phase																														
RI Planning	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧																					
RI UFP-QAPP		🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧																					
RI Field Work										🟩	🟩	🟩	🟩	🟩																
RI Report															🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧								
Feasibility Study																							🟧	🟧	🟧	🟧	🟧	🟧	🟧	
Proposed Plan																														🟧
Decision Document																														
Community Relations Plan - IRP & MMRP			🟧	🟧	🟧	🟧	🟧	🟧	🟧																					
DERP RAB Public Interest Survey 1																			🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧	🟧
DERP RAB Public Interest Survey 2																														

- RI through Decision documents for both MRSs
- Green - Fieldwork

RI Reporting

- MEC Investigation Methodologies and Results
- MC Investigation Methodologies and Results
- Data Usability Assessment
- Revised CSM
- Fate and Transport for MEC and MC
- MEC Risk Management Methodology
- MC Risk Assessments
- Conclusions

Acronym List

APP	Accident Prevention Plan	MD	Munitions Debris
CERCLA	Comprehensive Environmental Response, Compensation Liability Act	MDAS	Material Designated as Safe
CMUA	Concentrated Munitions Use Area	MDEH	Material Designated as an Explosive Hazard
COPC	Contaminant of Potential Concern	MEC	Munitions and Explosives of Concern
COPEC	Contaminant of Potential Ecological Concern	MMRP	Military Munitions Response Program
CSM	Conceptual Site Model	MPC	Measurement performance criteria
CRP	Community Relations Plan	MPPEH	Material Potentially Presenting an Explosive Hazard
DERP	Defense Environmental Restoration Program	MRS	Munitions Response Site
DGM	Digital Geophysical Mapping	MRSPP	Munitions Response Site Prioritization Protocol
DMM	Discarded Military Munitions	NCMUA	Non-Concentrated Munitions Use Area
DQOs	Data Quality Objectives	NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ERAGS	Ecological Risk Assessment Guidance for Superfund	NMRD	Non-Munition Related Debris
ESP	Explosives Site Plan	NYS DEC	New York State Department of Environmental Conservation
FS	Feasibility Study	NYS DOH	New York State Department of Health
GPS	Global Positioning System	PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
HHRS	Human Health Risk Assessment	RAB	Restoration Advisory Board
HRR	Historical Records Review	RAGS	Risk Assessment Guidance for Superfund
HTRW	Hazardous, Toxic, and Radioactive Waste	RI	Remedial Investigation
IVS	Instrument Verification Strip	ROV	Remotely Operated Vehicle
MC	Munitions Constituents	SLERA	Screening Level Ecological Risk Assessment

Acronym List

SI	Site Inspection
SSHP	Site Specific Safety and Health Plan
TD	Transferred
TPP	Technical Project Planning
TVG	Transverse Marine Gradiometer
UFP-QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USACE	United States Army Corps of Engineers
USAEC	United States Army Environmental Command
USEPA	United States Environmental Protection Agency
UXO	Unexploded Ordnance
VSP	Visual Sample Plan

UNITED STATES MILITARY ACADEMY
WEST POINT

DEPARTMENT OF THE ARMY
UNITED STATES ARMY ENVIRONMENTAL COMMAND
UNITED STATES ARMY CORPS OF ENGINEERS
UNITED STATES ARMY GARRISON – WEST POINT

Technical Project Planning Meeting 2
Military Munitions Response Program
U.S. Army Garrison – West Point

26 April 2018

Project:	**Military Munitions Response Program Water Munitions Response Sites (MRSs)** **U.S. Army Garrison – West Point**
Points of Contact:	U.S. Army Garrison – West Point, MMRP Manager: Jeff Sanborn/ 845-938-5041 USACE – Project Manager: Kim Gross/ 410-962-3457 Contractor, Weston Solutions, Inc. (WESTON), Project Manager: Gretchen Tabano/ 443-299-6863

On 26 April 2018, a Technical Project Planning (TPP) Meeting 2 was held in support of the Remedial Investigation (RI) field effort planned for the Water MRSs in the summer of 2018. The meeting was attended by representatives from U.S. Army Corps of Engineers (USACE), U.S. Army Garrison West Point, U.S. Army Environmental Command (USAEC), New York State Department of Environmental Conservation (NYSDEC), New York State Department of Health (NYDOH), and WESTON at the West Point Department of Public Works (DPW) Conference Room, Bldg 667.

This meeting was conducted as part of the TPP process. The purpose of the meeting was to discuss project goals and specific execution strategies with the following stakeholders: U.S. Army Garrison West Point, USACE, USAEC, NYSDEC, and NYDOH. This discussion was held in order to finalize the approach presented in the Uniform Federal Policy for Quality Assurance Project Plans (UFP-QAPP) for the RI field effort and discuss any concerns the Stakeholders have with the approach presented for the Military Munitions Response Program (MMRP) RI of the water MRSs: Siege Battery - Transferred (TD) River MRS and Battery Knox - TD River MRS.

TPP #2 MEETING ATTENDEES:

Name	Organization / Title	Email	Telephone Number
Mary Ellen Maly	USAEC- Environmental Support Manager	mary.e.maly.civ@mail.mil	210-466-1870
Kim Gross	USACE -Project Manager	Kimberly.u.gross@usace.army.mil	410-962-3457
Debbie McKinley*	USACE - Environmental Engineer	deborah.k.mckinley@usace.army.mil	410-962-6730
Paul Greene*	USACE - Munitions and Explosives Safety Chief	Paul.E.Greene@usace.army.mil	410-962-6741
Cliff Opdyke*	USACE - Risk Assessor	Clifford.A.Opdyke@usace.army.mil	410-962-6765
Tom Colozza*	USACE - Geophysicist	Thomas.S.Colozza@usace.army.mil	410-962-6647
Jeff Sanborn	Department of Public Works (DPW)- Environmental Management Division (EMD) - MMRP Manager	jeffrey.sanborn@us.army.mil	845-938-5041
Karl H. Weed	DPW-Environmental Management Division	Karl.weed@usma.edu	845-938-2116
David Crosby	NYSDEC - Project Manager	David.crosby@dec.ny.gov	518-402-9662
Kiera Thompson	NYSDEC - Future Project Manager	Kiera.thompson@dec.ny.gov	518-402-9663
Charles Vandrei	NYSDEC – Cultural Resources	Charles.vandrei@dec.ny.gov	518-402-9428
John Petronella*	NYSDEC – Regional Permit Administrator		
Rebecca Quail*	NYSDEC – Ecological Risk Assessment		
Steven Karpinski	NYSDOH Project Manager	Steven.karpinski@health.ny.gov	518-402-7860
William Rottner	Alpine Ocean Seismic Surveys	wrottner@alpineocean.com	201-397-3164
John Gerhard	WESTON -Program Manger	j.gerhard@westonsolutions.com	610-701-3793
Ryan Steigerwalt	WESTON -Technical Manager	ryan.steigerwalt@westonsolutions.com	267-258-2672
Gretchen Tabano	WESTON -Project Manager	Gretchen.tabano@westonsolutions.com	443-299-6863

*On the phone

Key discussion points and results of the TPP Meeting 2 are presented below.

- Attendee introductions (all)
- West Point MMRP RI TPP presentation (Mr. John Gerhard, Ms. Gretchen Tabano, and Mr. Ryan Steigerwalt – WESTON). The WESTON team went through the attached presentation. Specific questions/comments are noted below:
    - Slide 14 – NYSDEC asked what TD stood for. USAEC explained this acronym for Transferred (TD) and was developed during SI phase. It means the MRS is not on property that is Army owned property.
    - Slide 14 – NYSDEC asked if the Army owned Constitution Island. The project team confirmed the Army owns Constitution Island.
    - Slide 23 – NYSDEC asked for clarification on how concentrated munitions use areas (CMUAs) and non-concentrated munitions use areas (NCMUAs) (defined on Slide 7 of the TPP Meeting 2 presentation) would be determined. Ryan Steigerwalt clarified that the MEC/munitions debris (MD) distribution for impact areas typically followed a bell-shaped curve. The CMUA would include the entire bell-shaped curve and the NCMUA would include the remainder of the area. NYSDEC followed up to ask if the investigative approach developed for this work was West Point, New York specific. The project team explained the investigative approaches are general in nature. The specific transect spacing for the digital geophysical mapping (DGM) phase of the work is munitions specific based on West Point and generated using a statistical tool called Visual Sample Plan.
    - Slide #25 – NYSDEC asked what the acronym DGM stood for. The project team explained it as digital geophysical mapping, which will entail use of magnetometers to locate metallic objects on the surface and in the subsurface sediments within the Hudson River for this project.
    - NYSDEC questioned why we are restricting work to underwater areas less than 120 feet deep. The project team responded this was a DOD restriction based on requirements specified in Department of Defense Manual (DoDM) 4715.20. The 120 ft is based on the depth at which recreational diving is typically performed without use of specialized gases and decompression requirements. Therefore, recreational exposures are anticipated to be limited at depths greater than 120 ft.
    - Slide #34 – NYSDEC requested the project team to describe the shallow water mag surveys. The project team indicated this would be a floated marine magnetometer.
    - Slide #35 – NYSDEC asked if transect data would be collected in depths of water greater than 120 ft. The project team did confirm this. However, anomalies at this depth would not be investigated with divers.
    - Slide #44 - NYSDEC asked about the planned munitions constituent (MC) reference samples. The question was whether the samples were located far enough to the north of the site such that they could be considered to be non-MRS impacted areas. WESTON clarified that the step-out transects shown in purple highlight on Slide 35 of the TPP Meeting 2 presentation were being collected to ensure that the extent of MEC was determined during the field effort. The reference samples are located approximately one mile upstream of the current MRS boundary. NYSDEC suggested that a grid system be used that evaluated different water depths and sources. WESTON requested these suggestions be included in NYSDEC comments on the UFP-QAPP so the Army could review and address them appropriately.

- Slide #47 – NYSDEC questioned how the team would sample for MC based on visual evidence. The project team clarified visual evidence would be where cracked or leaking munitions were discovered. It would not be based on staining as this would be observations of sediment staining were unlikely in the murky, underwater environment anticipated in the Hudson River.
- NYDOH questioned the depth of the sediment surface horizon currently planned from 0-6”. They typically use 0-2” for surface soils to assess risk to human health. However, it was also indicated that NYDOH was not sure if this requirement should pertain to sediments as it does to soil. Human interaction with sediments in the Hudson River is limited due to water depths and general minimal opportunity to interact with sediments. NYSDEC had concerns with making the first sampling interval 0-2” due to ecological interactions and that 0-6” should be the minimum range to consider. After discussion, it was agreed that NYDOH would discuss this issue internally with the NYDOH technical experts. If there are concerns with the proposed approach, this will be provided in writing as a comment on the UFP-QAPP.
- NYSDEC brought up their concerns with the risk assessment approach proposed. NYSDEC’s position is that their screening levels are promulgated in New York and they do not support the U.S. Environmental Protection Agency’s (USEPA’s) risk assessment approach. Remediation, per NYSDEC protocols is required based on exceedances of screening levels, regardless of documented risks. For sediment, the levels used are the Class A Sediment Criteria, which are based on ecological receptors. There are no screening levels for sediment specific to human health. The NYSDEC utilizes surface soil criteria for human health evaluations and they also consider the NYDOH criteria for human health sediment evaluations. USAEC responded that the Army’s lawyers have evaluated this comment and due to the provisions and requirements of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), further remedial action is only to be taken in the event that an unacceptable risk to human health or the environment is documented.
- NYSDEC does not agree with the background assessment approach presented for MC. The NYSDEC suggests use of the 75th percentile of the reference value. A minimum of 20 samples should be used. If outliers are observed in the dataset and removed, the 90th percentile is then to be used. The site sample results should then be compared to the calculated reference values in a straight comparison. No averaging of the site results should occur and statistical comparison of the results to the reference values is not accepted. The NYSDEC will evaluate the UFP-QAPP and make formal comments on the reference sampling program after review.
- NYSDEC was concerned with the proposed detonation location The shoreline along Constitution Island was identified as the preferred location to perform detonation. The proposed location was originally located between the low and high tide line. This is within the waters of the State on State owned land. They do not want the detonations to occur on State property, but want the Army to move the items to Army (West Point) property to perform the demolition. USACE was consulted and agreed to determine if land demolition would be a possibility. WESTON is to provide the proposed location for the demolitions to USACE for approval once site reconnaissance of the area is performed.
- There is a small chance that an unexpected munitions item may be encountered that cannot be fully identified or the configuration of the item cannot be ascertained. In this situation, the item would be typically blown-in-place within the water. NYSDEC was also concerned with performing blow-in-place operations in the Hudson River due to environmental and cultural

resource issues. If an item is discovered and needs to be blown-in-place, the team discussed that possibility of Navy Explosive Ordnance Disposal (EOD) divers, responding to the call. It was speculated that sometimes Navy EOD has the ability to perform render safe procedures on MEC items, which Contractors are not allowed to perform. However, the team did not know for certain whether this was the case. The process to get Navy EOD to respond and whether this is a possibility will be vetted for the project. Formal notification procedures will be developed in the UFP-QAPP to engage with stakeholders and receive direction on how to proceed if an item is encountered that is not acceptable to move. The NYSDEC is to provide a point of contact (POC) should this situation occur.

- NYSDEC indicated that the area of the RI had been previously mapped for cultural resources by the State University of New York (SUNY) Stony Brook, Lamont Doherty and NYSDEC in 2005 using vessels loaned by National Oceanic and Atmospheric Administration (NOAA). This has resulted in a large database of side scan sonar data. Some of the area/data has been evaluated for cultural resources and some has not. However, the NYSDEC indicated that the currently planned effort will generate a dataset using side-scan sonar and geophysical survey data that should supplement the previous dataset as it uses more current technology. As part of the RI, WESTON will interpret the newly collected side scan sonar data at locations where dive operations are planned. The dataset will be evaluated to determine if potential cultural resources are present that should be avoided for investigation. NYSDEC will also consult with the State Historical Preservation Office (SHPO) office based on side scan sonar results. This process is anticipated to take 1-2 weeks so should not impact the planned intrusive field effort.
- USACE asked when the NYSDEC anticipated completing their review of the UFP-QAPP. They felt the review would be complete in approximately 2-3 weeks. It was asked if the State had any comments on the non-intrusive field tasks (set up the IVS, perform side-scan sonar, morphology studies, DGM) and the NYSDEC responded they did not. The NYSDEC indicated that if they were sent a letter/email requesting that those field tasks be approved such that they could be completed while review of the other tasks in the UFP-QAPP be completed, they would approve it.
- NYSDEC asked whether a fact sheet has been released. West Point indicated that one was generated but it has only been used to communicate with West Point groups (fire, security, etc.) and has never been released to the public. NYSDEC supports the distribution of the fact sheet to the public, but wants to be notified prior to distribution so they are aware and can communicate the information to their management and public affairs office. West Point informed NYSDEC that a meeting with the Community Engagement Council is scheduled for 3 May 2018. West Point will provide a copy of the fact sheet and meeting materials for the Community Engagement Council meeting.

ACTION ITEMS

Item	Responsible Party	Due Date
Provide comments on UFP-QAPP	NYSDEC and NYDOH	5/17/2018
Provide comment on the surface horizon sediment sampling depths	NYDOH	5/17/2018
Plot the proposed demolition location on a figure and send to USACE for review/approval	WESTON	Provided to USACE on 5/3/2018

Determine the process and potential for Navy EOD to respond to items found in the Hudson that are determined unacceptable to move	USACE	Completed on 5/7/2018
Develop a letter/email requesting for NYSDEC approval of the non-intrusive field tasks	WESTON	Email sent on 5/4/2018
Develop a process for how an item that cannot be moved will be handled	WESTON/USACE	Email sent on 5/7/2018 to NYSDEC
Provide POC that should be contacted in the event that detonations (BIP or items moved to selected demolition location) are planned	NYSDEC	5/17/2018
Provide the fact sheet and Community Engagement Council meeting materials to NYSDEC	West Point	Provided on 4/26/2018

APPENDIX D
FIELD STANDARD OPERATING PROCEDURES (SOPs)

APPENDIX D
ALPINE FIELD STANDARD OPERATING PROCEDURES (SOPs)

Alpine-SOP 1	Instrument Verification Strip (IVS) Installation & Use Rev. 1.0
Alpine -SOP 2	Multibeam Hydrographic Surveys Rev. 1.0
Alpine -SOP 3	UXO – Marine Magnetometer Surveys Rev. 1.0
Alpine -SOP 4	UXO – ROV Sonar Inspection Rev. 1.0
Alpine -SOP 5	Side Scan Sonar Surveys Rev. 0

ALPINE-SOP 1
INSTRUMENT VERIFICATION STRIP (IVS) INSTALLATION & USE
REV. 1.0

Alpine
A GARDLINE COMPANY

Alpine Standard Operating Procedure For:

Instrument Verification Strip (IVS) Installation & Use

Prepared by: Mark L Kosakowski Date: 10/20/2017

Signature
Mark L Kosakowski,
Senior Project Manager

Approved by: ______________________ Date: 10/20/2017

Signature
Robert Mecarini, President
Certified Hydrographer

Record of Revisions		
Revision	**Section**	**Description**
0	All	New Procedure

I. Scope and Application

This Standard Operating Procedure (SOP) is applicable to all Instrument Verification Strips (IVS) that will be performed to support UXO surveys. This SOP describes the procedures that Alpine Ocean Seismic Survey, Inc. (Alpine) will use to install an IVS. The primary objective of the IVS is to verify the UXO survey platform/sensor is functioning properly for anomaly detection and positioning of sensor responses.

II. Objectives

The objective of the IVS is to collect georeferenced sensor responses of known Industry Standard Objects which have been seeded in an anomaly cleared area. The IVS will be designed based on each MRS, expected anomalies, sensor type (Magnetic or Electromagetic), geology and survey platform.

III. Equipment & Supplies

Equipment and supplies needed for the IVS installation include:

- Survey vessel
- RTK GPS navigation equipment
- Horizontal Control Check Points
- Marine communications equipment
- Marine Magnetics/Electromagnetics system
- Side Scan Sonar system
- Single Beam (SB) or Multibeam (MB) Bathymetry system
- Electronic data acquisition equipment
- Electronic data storage equipment
- Electronic data post processing equipment
- Industry Standard Objects (ISO's)
- Mooring components (anchors, line and buoys)
- Survey rod with level

Survey Vessel

The IVS will be installed using the survey vessel, equipped as appropriate to perform the pre-mapping, installation and post-lay operations.

To conduct the pre and post lay operations, the survey vessel will be outfitted with a side scan sonar, a bathymetric survey system (SB or MB), an electromagnetic or cesium marine magnetometer system and an RTK GPS positioning and navigation system. The survey vessel will meet all required local, state and USCG safety regulations and be equipped with all required safety gear.

For IVS deployment and recovery, the survey vessel will equipped with appropriate mooring/line handling gear including a davit and cathead and/or winch.

IV. IVS Installation Procedures

Chart review and planning

Alpine and client will review MRS and identify areas in or outside of MRS that have the correct water depth and location to install the IVS.

Pre-Deployment Operations

1. Alpine will collect bathymetric and side scan sonar imagery of the proposed IVS sites. This is typically done during the MRS pre-survey of proposed transects for efficiency. Pre-surveys provide general knowledge of the bottom type, depth and potential obstructions in a given area.

2. Once the pre-survey data is processed Alpine will make recommendations for the IVS location based on proximity to MRS, access with vessel, depth, bottom contours and lack of obstacles.

3. Two potential areas will be chosen. Alpine will conduct a magnetometer or Electromagnetic sensor survey of these two sites to assess background signal (noise) and anomaly responses for the respective sensor. The goal is to have the quietest background noise and no magnetic (MAG) or electromagnetic (EM) responses. If no anomalies are found the area will be deemed “clean”. In the case anomalies are found in multiple sites Alpine will assess the areas to find a usable section/path or we will continue looking for another site and repeat previous steps.

Deployment Operations

1. After a suitable area is identified the appropriate simulants, in most cases ISO’s, will be seeded. NOTE; ISO’s are determined by matching response signature of the ISO to the expected Munitions of Explosive Concern (MEC) signatures.

2. The items to be used as simulants will be attached to an appropriate mooring/deployment line which will allow easy installation into the water and onto the bottom while also allowing sufficient “non-mobility” and the capacity to recover safely and easily.

3. Small simulants will be attached to synthetic line at minimum 15-foot intervals. No more than 4 simulants will be attached to the same line. These simulants will be anchored to the bottom using non-magnetic/non-metallic dead weight anchors constructed of cement. The anchor weights will be based on the potential buoyancy and hydrodynamic drag potential. Two anchor weights will be used, one prior to the first simulant and a second on the trailing edge after the last simulant. At least 30 feet of lead in will be allowed for the weights. In addition, each weight will have a sufficient length of line attached to allow easy lowering of the weight to the bottom. This line will have a marked buoy

attached for identification of the bottom obstructions position.

4. To install the IVS the distal weight will be lowered to the bottom in the appropriate location. Once on the bottom a navigational fix will be recorded. The survey vessel will then slowly move along the intended IVS transect, lowering the prepared line as it becomes taut. When the last simulant is in the water the anchor weight remaining on deck will be slowly lowered to the bottom using a taut line. When on the bottom, a second navigational fix will be recorded and the lifting/recovery line, with the buoy attached, released. The two navigational/position fixes will be recorded in the logs.

5. Once the ISO's have been placed, Alpine will conduct an "IVS As-Built" survey which will be used as the baseline of QAQC for the project.

IVS As-Built

1. The IVS As-Built will consist of surveying in the ISO's with a MAG or EM sensor, and a USBL beacon for geospatial correction or a survey pole and RTK GPS.

2. After the ISO's are surveyed in Alpine will conduct multiple passes with the MAG or EM survey gear to assess detection distances and geospatial positioning accuracy.

3. All data will be logged and referenced for the Data Quality Objectives (DQO's).

Recovery Operations

1. To recover the deployed IVS, the survey vessel will navigate to each buoy marked anchor. Using a boat hook the buoy will be recovered and the attached line fed through the davit to the cathead winch.

2. Using the cathead, the anchor weight will be recovered to the deck. When secured on deck the remaining attached line will be slowly raised and each simulant recovered to the vessel. The last anchor weight will then be raised using the cathead.

3. Once the full mooring assembly is onboard the vessel will move to the next deployment site.

V. Health and Safety

Refer to the Alpine Health and Safety Plan (HASP).

ALPINE-SOP 2
MULTIBEAM HYDROGRAPHIC SURVEYS REV. 1.0

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Standard Operating Procedure
Multibeam Hydrographic Surveys

Prepared by: Mark L Kosakowski   Date: 10/12/2017

Signature
Mark L Kosakowski,
Senior Project Manager

Approved by: ________________________   Date: 10/12/2017

Signature
Robert Mecarini, President
Certified Hydrographer

Record of Revisions		
Revision	**Section**	**Description**
1	All	Updated procedures

I. Scope and Application

This Standard Operating Procedure (SOP) is applicable to multibeam hydrographic surveys planned for the US Army Corps of Engineers. This SOP describes procedures that Alpine Ocean Seismic Survey, Inc. (Alpine) will use to acquire hydrographic data utilizing a multibeam echosounder over a series of pre-planned profile transects within the confines of the project.

The hydrographic survey will be conducted in accordance with the US Army Corps of Engineers' "***Engineering Manual EM 1110-2-1003 for Hydrographic Surveys***".

II. Objectives

The objective of this hydrographic survey is to collect geo-referenced water depth information (soundings) along pre-planned cross-sectional transects. The hydrographic data will be processed and presented as a digital elevation model, contours, and/or cross-sections.

III. Equipment & Supplies

Equipment and supplies needed for the hydrographic survey include:

- Shallow draft hydrographic survey vessel
- RTK GPS navigation and heave, pitch, and roll equipment and control monuments
- Marine communications equipment
- Depth sounding and sound velocity profiling equipment
- Electronic data acquisition equipment
- Electronic data storage equipment
- Electronic data post processing eqiupment

Hydrographic Survey Vessel

Alpine will conduct the hydrographic survey using Alpine's purpose built survey vessels. These vessels have a fully enclosed climate controlled cabin, twin engines and shallow draft capability. All vessels are equipped with a repeatable alignment sonar pole for the hydrographic transducer.

Navigation and Heave, Pitch and Roll Equipment

Navigational data will be acquired using an Applanix POS MV System coupled with RTK GPS input. The Applanix positioning system provides high accuracy heading, heave, pitch and roll correction via an IMU (Inertial Measurement Unit) which is stationed near the center of rotation of the vessel. The Applanix POS MV blends GNSS data with angular rate and acceleration data from an IMU and heading from GNSS Azimuth Measurement System (GAMS) to produce a robust and accurate full six degrees of freedom Position and Orientation solution. The following steps are taken to calibrate the Applanix POS MV:

The GAMS Solution will be calculated as follows:

- GAMS calibration begins when the number of satellites in view exceeds 5 and PDOP less than 3.0.

- The vessel will be maneuvered through moderately aggressive turns (figure eights or S-turns) incorporating changes of speed and direction.
- The operator will then wait for the heading accuracy to be below the threshold value entered (0.5 degree) and for the GAMS Status to read “Ready Offline”.
- Vessel motion is then stopped and the vessel held to a constant heading.
- GAMS calibration will be started.
- Once GAMS calibration is complete the values are saved into the system, and are used for the remainder of the survey.

RTK inputs will be supplied via a Virtual Reference Stations (VRS) network subscription service (KeyNet GPS, NYS DOT or other) acquired in real-time using a cellular interface. This combination provides reliable, high-precision positioning and navigation. The system consists of a GPS receiver, a GPS antenna and cable, an Intuicom RTK Bridge cellular modem with a separate cellular antenna connected to the GPS, and a RS232 interface to the navigational computer. If VRS network coverage is not available the Project Manager will specify which NGS control monuments are to be used with radio telemetry setups. This system configuration has sub-decimeter horizontal and vertical position accuracy.

Fully automated, the Applanix provides means for multiple channel simultaneous satellite tracking with real time display of geodetic position, time, date, and boat track. The Applanix unit along with its IMU is mounted on the survey vessel with the Intuicom receiver. The Applanix accepts the correction factors and applies the RTK differential corrections to obtain continuous, high accuracy, real time position updates. The Applanix system is interfaced to the Alpine navigation system running QPS QINSy software for trackline control.

Digital Depth Sounding and Sound Velocity Profiling Equipment

Multibeam hydrographic data will be acquired using a R2Sonic 2024 Multibeam System. The multibeam data will be acquired at a frequency of 400 kHz (unless otherwise stated in the Project Execution Plan by the Project Manager) to provide the best resolution for the survey data. A CastAway CTD will be cast once every two hours, during each survey day, to collect a speed of sound profile. The speed of sound profiles are used to correct for sound velocity variations in the water column and input during post processing of the data.

The multibeam system is calibrated by running a series of survey lines over a steeply sloping area of seafloor. A grid of lines are then run in opposite directions to measure minor transducer head offsets for pitch (forward/aft), roll (port/starboard) and heading (yaw). The data is also synchronized using a 1 PPS signal provided by the POS MV which eliminates any latency errors.

The R2Sonic multibeam outputs digital depth data to the navigation and data logging computer. During survey operations digital depth data output from the sounder are merged with navigation data via the QINSy software, and saved for post-processing. Relevant supporting information and navigation event marks for each line are automatically annotated on the digital data record via the computer interface.

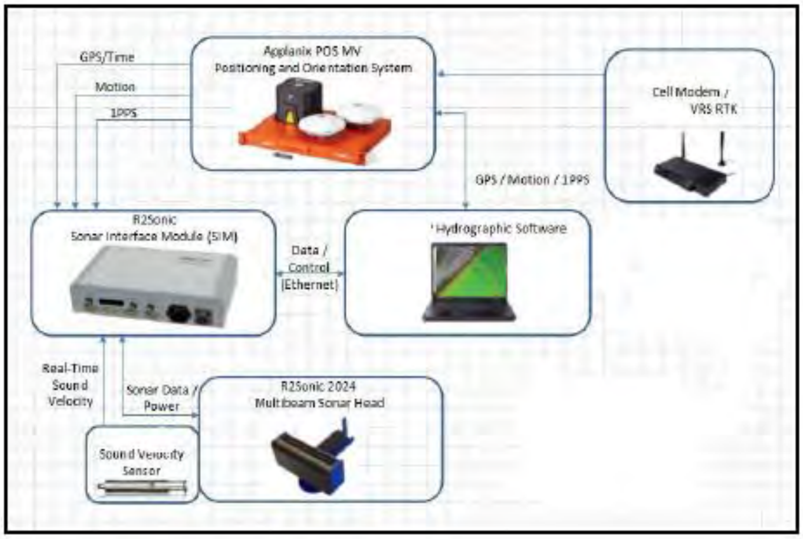
III. Data Acquisition and Processing Equipment

During the course of the survey digital depth soundings output by the sounder will be merged in real-time with navigation data by means of the data-logging and navigation control computer software package QPS QINSy. Caris HIPS software package will be used for post processing the sounding data.

Data acquisition equipment, software, and file formats are summarized in Table 1.

Table 1. Summary of Hydrographic Data Collection/Processing Equipment and Software.

Equipment Type	Manufacturer	Model	Data file format
GPS Receiver/RTK Receiver/Heave Pitch and Roll Sensor	Applanix /Intuicom	POS MV	Logged by QINSy
Navigation Software and Sounding Data Collection Platform	QPS	QINSy	Raw .qpd and .db files, export as XTF
Multibeam Echo Sounder	R2Sonic	2024	Raw file format logged by QINSy
Data Processing Software	Caris	HIPS	QINSy raw XTF file format processed by Caris to generate; XYZ, DXF, TIFF
CAD Software	AutoCAD	2017	DXF, DWG



IV. Survey Procedures

Alpine will conduct the multibeam hydrographic survey within the proposed survey area as described in the Project Execution Plan. A survey boundary and planned transects are provided by the Project Manager.

1. Before leaving dock, the survey crew will check to make sure all navigation and instrument systems are working properly, calibrate and set navigational instruments based on the instrument-specific standard operating procedures, and prepare equipment for start of daily

survey operations including: deployment of 400 kHz transducer into water, measurement/check of survey equipment offsets, daily speed of sound test, bar check, and other required pre-survey activities which will include documentation in a job information summary log (Attachment 1).

2. Prior to starting the project, a navigation field check will be performed. This check will include moving the vessel primary GPS antenna near a supplied horizontal and vertical bench mark and the relative position recorded. The Delta x, Delta y and Delta z will be calculated and must be within the survey specifications prior to beginning survey operations.

3. Once on-site, the vessel will come to a stop and the survey crew will deploy the multibeam transducer into the water. The transducer will be calibrated utilizing a patch test, a bar check and a sound velocity profile will be performed to calibrate the sounder for changes in water mass sound speed.

4. When the multibeam sounding system is determined to be working properly, the vessel will then be navigated to align with the start of a proposed survey line. Data logging will be initiated and the survey transect will be investigated. Once on-line, all relevant information will be recorded in a survey line log (Attachment 2).

5. At the end of each survey line, confirmations will be made on the survey line log (Attachment 2) regarding successful data acquisition and storage of digital data files.

6. Navigation equipment will be prepared for the next survey line and the survey vessel will be navigated to next survey line.

7. Steps 4 through 6 will be repeated to collect multibeam sounding data along all proposed survey lines.

8. All raw survey data will be recorded electronically

9. All acquisition documentation (e.g., field notes, instrumentation frequencies) will be recorded either electronically in the data collection software package or manually in a field notebook.

11. At the end of each survey day, computer data from the hydrographic survey will be checked for error flags. All accepted data will be backed up. Back-up copies will be made for all raw electronic data files and hard copies will be made for all field log entries.

IV. Quality Assurance and Quality Control

Instruments will be operated in accordance with the manufacturer’s procedures. Alpine personnel will follow industry standard acceptable protocols for data transfer and transformation that ensure both the integrity of the original data set and the quality of post-processed data. Wherever possible, the procedures and documentation for the survey will be conducted in accordance with the U. S. Army Corps of Engineers, Engineering and Design Hydrographic Surveying Manual EM 1110-2-1003. Confidence checks will be performed daily, or as needed, to ensure proper equipment functionality and data quality.

Positioning Systems Confidence Checks

Alpine shall initially verify the accuracy of the positioning system by occupying a survey monument set for this project. Once verified to this monument, Alpine shall establish an accessible checkpoint at a location(s) where the vessel will be docked. Using this checkpoint, the positioning system's accuracy will be verified at the beginning and end of each day of field operations. Additionally, data will only be saved if horizontal dilution of position (HDOP) readings are five (5) or less, indicating adequate satellite geometry.

Multibeam Echosounder Confidence Checks

First, bar checks will be conducted, at a minimum, on a daily basis. Second, lead lines are conducted on a daily basis, from the water line to the top of sediment. These lead lines are recorded in the field log with accurate position and time, to be computed as a "sounding" that is checked against the final bathymetry surface. Third sound velocity profiles will be conducted every 2 hours (specifically one will be conducted with the bar check). Third, weather and other site conditions permitting, Alpine surveys "tie" or cross lines on a daily basis.

Depth data collected at the intersection of the transects and cross lines will be assessed during data processing (Section 5) to estimate the overall accuracy of the survey results. This is a standard part of Alpine's data processing procedures. The data processing software has a built in function for querying subsets of depth measurements at intersecting track and crossing lines. Basic statistics are applied to summarize the differences between proximal measurements (mean, variance, range) and to test that the mean difference between transect and crossing line depths is ± 0.5 feet (as per USACE).

V. Data Processing and Reporting

Following the conclusion of the investigation recorded raw multibeam data will be processed and analyzed using Caris HIPS processing software. Multibeam array depths are time-tagged with the positioning and motion sensors, corrected for water velocity refraction, draft, lever arm, and dynamic draft variations. Depth data will be referenced to project datum based on "tide" readings provided by the VRS RTK data. The VRS RTK "tide" data will be checked against a nearby NOAA\NOS CO-OPS real-time water level recording station to insure that there are no "gross" vertical correction or timing errors. If a local gauge is not available, Alpine shall install one prior to the start of survey operations. Processed sounding data will be used to construct the required profiles.

Alpine will use in-house procedures for processing field survey data into useful cross-sections for interpretation. Data processing and review will be accomplished employing Caris HIPS software. The processing flow will include review of attitude, heading, altitude, and navigation data. Each line will be reviewed for data quality.

Depth information gathered during the hydrographic survey will be plotted on the project base sheets using AutoCAD at an appropriate scale and resolution. Alpine will submit the geo-referenced data sets to the project lead within 30 days of the completion of the survey.

Attachment 1 – Job Information Summary Log

Page 1 of 1

Job Number:
Client:
Client Contact:
Type of Survey:
Purpose:
Project Manager:
Surveyors:
Vessel Name:

Location of Survey:
City:
State
Location Name:

Horizontal Datum: **Feet** **Meters**
State Plane NAD 83 ☐ Zone:
State Plane NAD 27 ☐ Zone:
UTM ☐ Zone:

Vertical Datum: **Feet** **Meters**
NGVD 29 ☐
NAVD 88 ☐
MLLW ☐
Other ☐ Name:

Water Level
NOAA Gage ☐ Station Name:
RTK ☐
Micro Gages ☐
Other ☐ Description:

Navigation
Differential ☐ DGPS signal used:
RTK ☐ Base Station name:
NAVD 88 Elevation:
WGS-84 Ellipsoid Height:
Geoid height
Ellipsoid = Geoid + Orthometric height
NAVD88 = Orthormetic height
XY Coordinates:
Base station configuration file name:

Hydrographic
Single Beam ☐ System Used:
Multibeam ☐ Transducer:
Depth Range:
Power setting:

Prepared by: ____________________Date:_______ Reviewed by: _________________ Date: _______

Attachment 2 –Survey Line Log

DATE	Julian Day	UTC Time	Local Time	Run #	Survey Line #	Survey Direction	BOL Event	EOL Event	Event Note #	Navigation File Name	Sounding File Name	Comment/Description

Prepared by: ______________________________________ Date: _____________

Reviewed by: ______________________________________ Date: _____________

ALPINE-SOP 3
UXO - MARINE MAGNETOMETER SURVEYS REV. 1.0

A GARDLINE COMPANY

Alpine Standard Operating Procedure For:

UXO - Marine Magnetometer Surveys

Prepared by: Mark L Kosakowski

Date: 10/13/2017

Signature
Mark L Kosakowski,
Senior Project Manager

Approved by: ________________________

Date: 10/13/2017

Signature
Robert Mecarini, President
Certified Hydrographer

Revision 1 - Date: 14 October 2017
Alpine Document Number: 11648

Record of Revisions		
Revision	**Section**	**Description**
0	All	New Procedure
1	All	Updated Procedures

I. Scope and Application

This Standard Operating Procedure (SOP) is applicable to all magnetometer surveys that will be performed to support UXO surveys. This SOP describes the procedures that Alpine Ocean Seismic Survey, Inc. (Alpine) will use to acquire magnetometer data. The primary objective of the magnetometer survey is to sequentially survey an identified area, lift by lift, to ascertain if suspected unexploded ordnances (UXO) are present. If identified, protocols will be enacted to handle the presence of the munition.

II. Objectives

The objective of the magnetometer survey is to collect georeferenced magnetic profiles along pre-planned cross-sectional transects. The magnetometer data will be processed and presented as contoured lines of magnetic flux.

III. Equipment & Supplies

Equipment and supplies needed for the hydrographic survey include:

- Shallow draft hydrographic survey vessel
- RTK GPS navigation equipment and control monuments
- Marine communications equipment
- Marine Magnetics system
- Electronic data acquisition equipment
- Electronic data storage equipment
- Electronic data post processing equipment

Survey Vessel

Alpine will conduct the magnetic survey using Alpine's purpose built survey vessels. These vessels have a fully enclosed climate controlled cabin, twin engines and shallow draft capability. All vessels are equipped with a side mount, survey winch, and cable block location (davit and/or A-frame).

The survey vessel will be outfitted with a subsurface towed cesium marine magnetometer system. The survey vessel will meet all requirements of the USCG for safety equipment for the vessel, survey crew and any visiting representatives.

Navigation Equipment

Navigational data will be acquired using an Applanix POS MV System coupled with RTK GPS input. The Applanix positioning system provides high accuracy heading, heave, pitch and roll correction via an IMU (Inertial Measurement Unit) which is stationed near the center of rotation of the vessel. The Applanix POS MV blends GNSS data with angular rate and acceleration data from an IMU and heading from GNSS Azimuth Measurement System (GAMS) to produce a robust and accurate full six degrees of freedom Position and Orientation solution. The following steps are taken to calibrate the Applanix POS MV:

The GAMS Solution will be calculated as follows:

- GAMS calibration begins when the number of satellites in view exceeds 5 and PDOP less than 3.0.
- The vessel will be maneuvered through moderately aggressive turns (figure eights or S-turns) incorporating changes of speed and direction.
- The operator will then wait for the heading accuracy to be below the threshold value entered (0.5 degree) and for the GAMS Status to read “Ready Offline”.
- Vessel motion is then stopped and the vessel held to a constant heading.
- GAMS calibration will be started.
- Once GAMS calibration is complete the values are saved into the system, and are used for the remainder of the survey.

RTK inputs will be supplied via a Virtual Reference Stations (VRS) network subscription service (KeyNet GPS, NYS DOT or other) acquired in real-time using a cellular interface. This combination provides reliable, high-precision positioning and navigation. The system consists of a GPS receiver, a GPS antenna and cable, an Intuicom RTK Bridge cellular modem with a separate cellular antenna connected to the GPS, and a RS232 interface to the navigational computer. If VRS network coverage is not available the Project Manager will specify which NGS control monuments are to be used with radio telemetry setups. This system configuration has sub-decimeter horizontal and vertical position accuracy.

Fully automated, the Applanix provides means for multiple channel simultaneous satellite tracking with real time display of geodetic position, time, date, and boat track. The Applanix unit along with its IMU is mounted on the survey vessel with the Intuicom receiver. The Applanix accepts the correction factors and applies the RTK differential corrections to obtain continuous, high accuracy, real time position updates. The Applanix system is interfaced to the Alpine navigation system running QPS QINSy software for trackline control.

Optional Navigation Equipment – Ultra Short Baseline (USBL) subsea acoustic positioning system for towed sensors.

Marine Magnetometer Equipment

Magnetometer data will be acquired using a Geometrics Model G-882 cesium vapor marine magnetometer (or G-882 Transverse Gradiometer - TVG). Depending on water depth, the magnetometer will either be surface towed on a trailing buoy or towed subsurface behind the vessel. Magnetometer data will be collected along survey lines across the project site spaced at intervals specified in the Project Execution Plan provided by the Project Manager. The marine magnetometer shall be interfaced with internal sensors for depth and altitude measurements.

III. Data Acquisition and Processing Equipment

QPS QINSy software package will be used for trackline design, navigation, trackline control, and magnetometer and positioning system data logging. Survey navigation data will be processed using QINSy and AutoCAD software to generate trackline maps. Magnetometer data will be processed using Geometrics MagPick and the digital contouring software Schreiber Instruments QuickSurf (or equivalent) to generate magnetic intensity plots that will be imported to AutoCAD overlays. Data acquisition equipment, software, and file formats are summarized in Table 1.

Table 1 - Summary of Magnetometer Data Collection/Processing Equipment and Software

Equipment Type	Manufacturer	Model	Data file format
GPS Receiver/RTK Receiver/Heave Pitch and Roll Sensor	Applanix /Intuicom	POS MV	Logged by QINSy
Navigation Software and Data Collection Platform	QPS	QINSy	Raw .qpd and .db files, export as ASCII
Magnetometer(TVG)	Geometrics	G-882(2X)	Raw file format logged by QINSy
Data Processing Software	Geometrics	MagPick	XYZ, DXF, TIFF
CAD Software	AutoCAD	2017	DXF, DWG

IV. Survey Procedures

Alpine will conduct the magnetometer survey within all accessible areas of the project site.

1. Before leaving dock, the survey crew will check to make sure all navigation and instrument systems are working properly. The crew will, a) calibrate and set navigation instruments based on the instrument-specific standard operating procedures, and b) prepare survey equipment for start of daily survey operations by measuring survey equipment offsets and conducting other required pre-survey activities.

2. Before beginning survey operations the depth and altimeter sensors scale and bias coefficients will be verified, documented, and recorded in the acquisition software.

3. Navigate to the coordinates of the first transect. QPS QINSy software will be used for trackline design, navigation, trackline control, and RTK GPS data logging.

4. Align survey vessel along longitudinal transect and confirm compass heading and operation. Start data acquisition and commence magnetometer survey

along transect.

5. Note relevant observations and changes in operational procedures to the field log. These may include: coordinates of observed obstructions or artifacts; areas where interferences or other conditions limit survey resolution; and coordinates where adjustments to the magnetometer data acquisition parameters are made.

6. At the end of each transect, confirm successful data acquisition as well as storage, navigation and equipment calibrations and settings. Log time and coordinates at end of each transect line surveyed.

7. Prepare equipment for navigation to next transect; navigate to next transect.

8. Repeat steps 2 to 6 and collect magnetometer data along each transect until representative magnetometer data have been acquired in all survey areas.

9. All raw survey data and information (e.g., field notes, instrumentation frequencies) must be documented electronically or in a field note book. At the end of each day, check daily computer data recordings. Back-up copies of the raw electronic data and make copies of all field log entries.

IV. Quality Assurance and Quality Control

Instruments will be operated in accordance with the manufacturer's procedures. Alpine personnel will follow industry standard acceptable protocols for data transfer and transformation that ensure both the integrity of the original data set and the quality of post-processed data. Wherever possible, the procedures and documentation for this survey will be conducted in accordance with the U. S. Army Corps of Engineers, Engineering and Design Hydrographic Surveying Manual EM 1110-2-1003. Confidence checks using a onsite instrument verification strip (IVS) will be performed daily, or as needed, to ensure proper equipment functionality and data quality.

Positioning Systems Confidence Checks

Alpine shall initially verify the accuracy of the positioning system by occupying a survey monument set for this project. Once verified to this monument, Alpine shall establish an accessible checkpoint at a location(s) where the vessel will be docked. Using this checkpoint, the positioning system's accuracy will be verified at the beginning and end of each day of field operations. Additionally, data will only be saved if horizontal dilution of position (HDOP) readings are five (5) or less, indicating adequate satellite geometry.

A navigational control monument will be established in a shore-side area adjacent to the project site. If no local NGS survey monuments are available in the immediate area, the control monument will be established using acquiring static GPS data, uploaded and processed by NGS NOAA Online Positioning User Service (OPUS). The control point will be verified through checking in to additional control monuments or through the use of Virtual Reference Station (VRS) RTK GPS techniques.

The control monument will be used as the daily navigational check point.

V. Data Processing and Reporting

Following conclusion of the field investigation Alpine will process field survey data into project maps and other survey deliverables. Trackline data processing and initial review of the magnetometer data will be accomplished employing HYPACK® MAX software. The processing flow will include review of offsets, heading, and navigation. Navigation will be recomputed with sensor offsets applied. Each line will be reviewed for data quality. All corrections and offsets to the raw data will be applied in HYPACK® MAX during post-processing.

Following initial processing steps performed utilizing the HYPACK® MAX software, magnetometer/transverse gradiometer data sets will be processed using Schreiber Instruments QuickSurf, Oasis Montaj or Geometrics MagPick (or equivalent).

VI. Health and Safety

Refer to the Alpine Health and Safety Plan (HASP).

Attachment 1 – Job Information Summary Log

Job Number:
Client:
Client Contact:
Type of Survey:
Purpose:
Project Manager:
Surveyors:
Vessel Name:

Location of Survey:
City:
State
Location Name:

Horizontal Datum:			**Feet**	**Meters**
State Plane NAD 83	☐	Zone:		
State Plane NAD 27	☐	Zone:		
UTM	☐	Zone:		

Vertical Datum:			**Feet**	**Meters**
NGVD 29	☐			
NAVD 88	☐			
MLLW	☐			
Other	☐	Name:		

Water Level

NOAA Gage	☐	Station Name:
RTK	☐	
Micro Gages	☐	
Other	☐	Description:

Navigation

Differential	☐	DGPS signal used:
RTK	☐	Base Station name:
		NAVD 88 Elevation:
		WGS-84 Ellipsoid Height:
		Geoid height
Ellipsoid = Geoid + Orthometric height		XY Coordinates:
NAVD88 = Orthormetic height		Base station configuration file name:

Hydrographic

Single Beam	☐	System Used:
Multibeam	☐	Transducer:
		Depth Range:
		Power setting:

Prepared by: ____________________Date:_______ Reviewed by: ________________ Date: _______

Attachment 2 –Survey Line Log

DATE	Julian Day	UTC Time	Local Time	Run #	Survey Line #	Survey Direction	BOL Event	EOL Event	Event Note #	Navigation File Name	Sounding File Name	Comment/Description

Prepared by: ______________________________________ Date: _____________

Reviewed by: ______________________________________ Date: _____________

ALPINE-SOP 4
UXO – ROV SONAR INSPECTION REV. 1.0

Alpine
A GARDLINE COMPANY

Alpine Standard Operating Procedure For:

UXO – ROV Sonar Inspection

Prepared by: Mark L. Kosakowski   Date: 10/20/2017

Signature
Mark L Kosakowski,
Senior Project Manager

Approved by: ______________________________   Date: _10/20/2017

Signature
Robert Mecarini, President
Certified Hydrographer

Record of Revisions		
Revision	**Section**	**Description**
1	All	New Procedure

I. Scope and Application

This Standard Operating Procedure (SOP) is applicable to all Remotely Operated Vehicle (ROV) Surveys that will be performed to support UXO projects. This SOP describes the procedures that Alpine Ocean Seismic Survey, Inc. (Alpine) will use during a survey day utilizing a ROV. The primary objective of ROV inspections is to verify anomalies mapped during geophysical surveys are Munitions of Explosive Concern (MEC). Water turbidity will determine whether sonar or video technologies will be utilized.

II. Objectives

The objective of the ROV visual inspection is to inspect obstructions and anomalies identified during the geophysical survey, using video or high definition sonar. The ROV's camera and sonar systems will be used to identify items that are proud of the bottom, confirm if it is or is not MEC, and further, potentially identify MEC type/class (if present). If possible, the ROV will be used to ensonify or video at least 3 sides of a target and record the resultant imagery/data for each. During no point of the ROV inspection will contact be made with the potential MEC items.

III. Equipment

Equipment and supplies needed for the IVS installation include:

- Shallow draft hydrographic survey vessel with lifting davit or A Frame
- ROV (standard video included)
- Sonar (option)
- ROV power supply- Generator
- RTK GPS navigation equipment and control monuments
- Marine communications equipment
- Electronic data acquisition equipment
- Electronic data storage equipment
- Electronic data post processing equipment

Survey Vessel

The ROV will be installed and setup on one of Alpine's purpose built survey vessels. ROV operations will be supported using a side davit arm and winch system to allow easy deployment and recovery of the ROV over the side. The ROV umbilical will be handled and tether by a deckhand. The ROV pilot and ROV control and data recording equipment will be housed within the vessels fully enclosed climate controlled cabin. ROV operations will only be conducted on an anchored and secured vessel. Live-boating will not be used.

Surface navigation and positioning will be provided by and RTK GPS system while underwater positioning will be performed using a fully integrated Ultrashort Baseline (USBL) Positioning System.

IV. Dockside Pre Departure Procedures

1. Each morning before operations Alpine will conduct a safety/toolbox meeting to discuss safety, previous safety observations, area of work for the day and weather

2. ROV's require up to 2 hours of maintenance a day to stay in good working order. This maintenance will be done at the beginning of each day (or as needed). During no time will preventative maintenance be delayed. Maintenance will include general inspection of the O-rings, connections, thruster function, control responses, video function, USBL beacon and all fasteners.

3. After completion of the ROV Maintenance, QAQC checks will be conducted for RTK GPS against the dockside GPS monument. Results will be recorded.

V. IVS ROV Check

1. Once checks are complete the vessel will depart the dock and travel to the installed IVS site. The geophysical survey's IVS will be utilized to test the functionality of the ROV's visual and acoustic systems.

2. Upon arrival the ROV and Ultra Short Base Line (USBL) survey pole will be deployed and USBL tested.

3. The ROV's camera will be tested first. A test recording will be made and stored.

4. The ROV's Blue View Sonar will be tested next and calibrated as per the manual.

5. After completion of the checks the ROV will be brought aboard and the crew will transit to the first site.

VI. ROV Anomaly Ensonification

1. As current direction can change, knowledge of tides and currents is crucial to successful productive field operations. A local tide chart/plot will be a part of the field equipment for reference. This tide chart will be consulted each morning and before each ROV dive throughout the day.

2. The vessel will be positioned approximately 3-times the water depth downstream of the target area to ensure that the vessel anchor is outside of the area of interest. Positioning the vessel downstream of the area of interest helps the operation by making sure the ROV tether streams aft of the ROV and does not create an obstruction for the forward looking systems.

3. Position the vessel to be slightly port or starboard of the search area to allow the ROV to move laterally in the site. This will help keep any bottom disturbance created by the vessel, anchor, anchor line and ROV from moving directly into the area of interest.

4. The ROV will be first used to conduct a general sweep of the are of interest. Following this the ROV will be piloted back to each anomaly, making a safe and secure closer approach to both visually photograph and ensonify from a downstream position, a port position and a starboard position. The goal is to obtain three perspectives of the item of interest and provide data to confirm it position and, if possible, its identity.

5. The pilot will then move to the next area up stream to sweep the next segment of the search area and repeat the process.

6. When the accessible area is completed the ROV will be piloted back to the vessel and recovered. Once on deck and the umbilical is clear the vessel will be moved to the next search area.

7. At the end of the day the ROV and USBL pole will be retrieved.

8. Prior to completing operations an end of day inspection of the ROV will be conducted, looking for loose fasteners, water intrusion and any damage. If time allows, or if damage from water intrusion is observed, the ROV will be immediately serviced.

As current direction can change, knowledge of tides and currents is crucial to successful productive field operations. A local tide chart/plot will be a part of the field equipment for reference. This tide chart will be consulted each morning and before each ROV dive throughout the day.

ALPINE-SOP 5
SIDE SCAN SONAR SURVEYS REV. 0

Alpine
A GARDLINE COMPANY

Alpine Standard Operating Procedure For:

Side Scan Sonar Surveys

Prepared by: Mark L Kosakowski   Date: 3/14/2016

Signature
Mark L Kosakowski,
Senior Project Manager

Approved by: ______________________________   Date: 3/14/2016

Signature
Robert Mecarini, President
Certified Hydrographer

Revision 0 - Date: 14 March 2016
Alpine Document Number: 11648

Record of Revisions		
Revision	**Section**	**Description**
0	All	New procedure

I. Scope and Application

This Standard Operating Procedure (SOP) is applicable to side scan sonar surveys that will be used to support the Weston Solutions, Inc. UXO survey near West Point, NY along the Hudson River. This SOP describes the procedures that Alpine Ocean Seismic Survey, Inc. (Alpine) will use to acquire side scan sonar imagery.

II. Objectives

The primary objective of the side scan sonar is to provide full coverage ensonification of the area of interest's river bottom to create a mosaic which can be used to map objects proud of the bottom.

III. Equipment & Supplies

Equipment and supplies needed for the side scan sonar survey include:

- Shallow draft survey vessel;
- Navigational charts and permits;
- Global positioning system (GPS) navigation equipment and real-time kinematic (RTK) control monuments;
- Marine communications equipment;
- Electronic data acquisition equipment;
- Electronic data storage equipment;
- Field logs and charting paper;
- Boat supplies (e.g., fuel, safety equipment); and
- Personnel supplies (e.g., protective clothing).

Survey Vessel

Alpine will conduct the survey using a purpose built survey vessel. This vessel has a fully enclosed climate controlled cabin, twin outboard engines and shallow draft capability. The vessel is equipped with a side mount and starboard side davit and winch.

Navigation Equipment

A navigational control monument will be established in a shore-side area adjacent to the project site. The control monument will be established using OPUS or a known monument. The control point will be used as the RTK reference station.

Alpine will employ precision GPS receivers to acquire navigation data based on GPS satellites at the shore-based control monument. Differential correctors determined at the control stations will be transmitted to the survey vessel where they will be used by the onboard receiver using RTK OTF (on-the-fly) software to determine the accurate position of the GPS antenna in both the horizontal and vertical planes. These data will be logged on board at one-second intervals for the duration of the project. Data quality parameters will also be logged and monitored by the onboard navigator with flags put on all data points that do not meet the quality limits set. The specified accuracy for this system is +/- 2 centimeter (cm) when satellite configuration is sufficient. Where coverage is determined by GPS filters and navigational software flags to be insufficient, additional control stations will be added or, if there are only small gaps in coverage, the navigation data will be interpolated between points of adequate coverage based on boat speed and heading.

Side Scan Sonar Equipment

Side scan sonar imagery will be acquired using a Klein side scan sonar system equipped with a dual frequency (100/500 kilohertz (kHz)) towfish. The survey will be conducted along a series of tracklines oriented parallel to the general course of the river. The primary intent of the survey will be to acquire close to 100 percent overlapping side scan sonar coverage of the riverbed within the entire project area. The sonar will be tuned for high-resolution and set at a sweep distance of approximately 50 meters left and right of the sonar towfish.

III. Data Acquisition and Processing Equipment

Hypack Inc.'s software package HYPACK® MAX will be used for trackline design, navigation, trackline control, RTK differential global positioning system (DGPS) data and dual frequency depth sounding logging. Side scan sonar imagery will be logged to a Klein proprietary file formats, which can both be easily converted to industry standard xtf format files. Survey navigation data will be processed using HYPACK® MAX and AutoCAD software to generate trackline maps. Side scan sonar will be processed with Triton Elics International (TEI) ISIS software. Data acquisition equipment, software, and file formats are summarized in Table 1.

Table 1 – Summary of Side Scan Sonar Data Collection/Processing Equipment & Software

Equipment Type	Manufacturer	Model	Data File Format
OTF DGPS Receiver	Trimble	MS750/7400 Msi	Logged by HYPACK
Navigation Software and Data Collection Platform	Hypack, Inc.	HYPACK	HYPACK
Side Scan Sonar data acquisition	Klein	3000	xtf
Data Processing Software	Hypack, Inc.	HYPACK	XYZ, DXF,
Side Scan Sonar Data Processing Software	Chesapeake Technologies	Sonar Wiz	Geo-referenced tif
CAD Software	AutoCAD	Release 2004	DXF, DWG

IV. Survey Procedures

Alpine will conduct the side scan sonar survey within all accessible areas to be investigated at the project site.

1. Before leaving dock, the survey crew will check to make sure all navigation and instrument systems are working properly. The crew will, a) calibrate and set navigation instruments based on the instrument-specific standard operating procedures, and b) prepare survey equipment for start of daily survey operations by measuring survey equipment offsets and conducting other required pre-survey activities.

2. Navigate to the coordinates of the first transect. Hypack Inc.'s HYPACK® MAX software will be used for trackline design, navigation, trackline control, and RTK DGPS data logging.

3. Align survey vessel along the proposed survey transect and confirm compass heading and operation. Start data acquisition and commence side scan sonar surveying. Log side scan sonar imagery data.

4. During the survey, perform periodic manual push probes of the bottom sediments. Note coordinates and results of probing or characterization in the field log. Note coordinates of areas that may require additional confirmatory coring or probing to ground truth the side scan sonar imagery in the field log.

5. Note relevant observations and changes in operational procedures to the field log. These may include: coordinates of observed obstructions or artifacts; areas where interferences or other conditions limit survey resolution; and coordinates where adjustments to the side scan sonar data acquisition parameters had to be made.

6. At the end of each transect, confirm successful data acquisition as well as storage, navigation and equipment calibrations and settings. Log time and coordinates at end of each transect line surveyed.

7. Prepare equipment for navigation to next transect; navigate to next transect.

8. Repeat steps 2 to 7 and collect side scan sonar imagery data along all proposed survey transects.

9. All raw survey data and information (e.g., field notes, instrumentation frequencies) must be documented electronically or in a field note book. At the end of each day, check daily computer data from the HYPACK® MAX and side scan sonar system for error flags. Back-up copies of the raw electronic data and make copies of all field log entries.

IV. Quality Assurance and Quality Control

Alpine personnel will follow industry standard acceptable protocols for data transfer and transformation that ensure both the integrity of the original data set and the quality of post-processed data. Positioning system confidence checks and equipment calibration procedures will be performed daily, or as needed, to ensure proper equipment functionality and data quality. Sonar confidence checks will consist of towing the side scan sonar over previously identified objects, and navigational buoy blocks on the riverbed and along the shore and bridge piers in order to verify the interpretation of the sonar imagery.

V. Data Processing and Reporting

Following conclusion of the field investigation Alpine will process the field survey data into project maps and other survey deliverables. Trackline data processing and review will be accomplished employing HYPACK® software. The processing flow will include review of offsets, heading, and navigation. Navigation will be recomputed with sensor offsets applied. Each line will be reviewed for data quality. All corrections and offsets to the raw data will be applied in HYPACK® during post-processing.

Side scan sonar imagery review will consist of the construction of sonar mosaics for all areas investigated. Once sonar mosaics are constructed the imagery will be reviewed together with the results of marine magnetometer to interpret/map the project site. During this review side scan sonar targets will also be mapped and identified. The results of the mapping/review will be presented on project drawings and summarized in tabular format in the project report.

VI. Health and Safety

Refer to the Alpine Health and Safety Plan (HASP).

Attachment 1 – Job Information Summary Log

Job Number:
Client:
Client Contact:
Type of Survey:
Purpose:
Project Manager:
Surveyors:
Vessel Name:

Location of Survey:
City:
State
Location Name:

Horizontal Datum: Feet Meters
State Plane NAD 83 ☐ Zone:
State Plane NAD 27 ☐ Zone:
UTM ☐ Zone:

Vertical Datum: Feet Meters
NGVD 29 ☐
NAVD 88 ☐
MLLW ☐
Other ☐ Name:

Water Level
NOAA Gage ☐ Station Name:
RTK ☐
Micro Gages ☐
Other ☐ Description:

Navigation
Differential ☐ DGPS signal used:
RTK ☐ Base Station name:
NAVD 88 Elevation:
WGS-84 Ellipsoid Height:
Geoid height
XY Coordinates:
Base station configuration file name:

Ellipsoid = Geoid + Orthometric height
NAVD88 = Orthometric height

Hydrographic
Single Beam ☐ System Used:
Multibeam ☐ Transducer:
Depth Range:
Power setting:

Prepared by: ____________________Date:_______ Reviewed by: ________________ Date: _______

Attachment 2 –Survey Line Log

DATE	Julian Day	UTC Time	Local Time	Run #	Survey Line #	Survey Direction	BOL Event	EOL Event	Event Note #	Navigation File Name	Sounding File Name	Comment/Description

Prepared by: ____ Date: ______________

Reviewed by: ____ Date: ______________

APPENDIX D
EOTI FIELD STANDARD OPERATING PROCEDURES (SOPs)

EOTI-SOP 1	Underwater Data Collection for UXO
EOTI-SOP 2	Defibrillator Usage
EOTI-SOP 3	MPPEH Management
EOTI-SOP 4	Safe to Move Procedures for UXO
EOTI-SOP 5	Tethered Diving
EOTI-SOP 6	Underwater Magnetometer Operations Verification for UXO

EOTI-SOP 1
UNDERWATER DATA COLLECTION FOR UXO

STANDARD OPERATING PROCEDURE 01:

Underwater Data Collection for UXO – Siege Battery – TD River and Battery Knox – TD River MRSs at West Point, NY

Purpose

This standard operating procedure (SOP) provides general guidelines for the collection of munitions-related data for UXO – Siege Battery – TD River and Battery Knox – TD River MRSs at West Point, NY.

Scope

RI data will be collected using manual writing media, digital camera, Global Positioning System (GPS), and an all-metals detector.

Equipment and Materials

- Grease pen and board, writing slate and pencil, magnetic writing board, or other writing media capable of use underwater
- Underwater digital camera
- GPS point collection equipment
- Whites Dual Pro PI underwater all-metals detectors (or comparable)
- Log book
- Indelible pen

Procedures and Guidelines

Underwater Data Collection

A. Procedures for Collecting Underwater Data

1. Data collected may be used to assist future investigations and help make removal/remedial action determinations; therefore, the data will be collected in the following manner outlined in this SOP.
2. Any of the following positioning equipment can be utilized as long as it is designed to provide sub-meter accuracy:
    - A GPS system with acoustic positioning to a surface antennae(s), such as Navimate™ or Pilot ™ Multipurpose Survey and Tracking System
    - A GPS with a surface-tethered antennae such as *The Sound Ocean Systems, Inc. Sea Guide*
    - A buoy floated from the river bottom to the surface with the location marked at the surface using GPS

    NOTE: Systems utilizing a surface tether to either a buoy or an antenna will need to be sub-meter accurate at the river bottom location not at the surface location.
3. A Weston Solutions, Inc. Biologist, working with appropriate regulatory personnel, will review all areas to identify habitats or species of concern prior to any intrusive activities.
4. Underwater all-metals detectors will be used to support the visual survey and to identify sub-river bottom anomalies at the river bottom surface. The metal detector will be tested at least once daily to ensure that it is functional. The functionality test will follow the procedures defined by the manufacturer. Since metal detectors vary from manufacturer to manufacturer, the owner's manual specific to the make and model used will serve as the functionality test SOP.

5. Data will be collected along the approximate transects and anomaly waypoints as specified in the Work Plan as follows:
    - Waypoints will be collected along each transect to map the final transect position. This will include start point and end point (coordinates) of each transect, which will be done using any of the systems described above for position collection. Generally maintaining spacing between transects is necessary, so prepositioning markers will be included as guides depending on the type of positioning system used.
    - Maintaining spacing between anomaly waypoints is necessary, so prepositioning markers will be included as guides depending on the type of positioning system used.
6. Observations relevant to the RI objectives will be noted, including, but not limited to:
    - GPS coordinate of the observed MEC/MPPEH items or items
    - Locations of anomalies that are detected with the metal detector
    - If an anomaly cannot be investigated due to the presence of obstructions or depth below the river bed, the reason for not investigating the anomaly will also be recorded.
    - Photograph when possible of any observed/excavated item
    - Communicate the description of the observed/evacuated item over the primary communication system and logged by the Dive Supervisor/ tender topside.
    - Written description of the observed/excavated item (specifics described below). As a backup to the primary communications above, the description can be written using a grease pen and board, writing slate and pencil, magnetic writing board, or other writing media capable of use underwater and photographed next to the item (if visibility permits).
    - Whether the item is confirmed or suspected to be MEC/MPPEH. All documentation/classifications of MEC/MPPEH must be done by UXO-qualified personnel.
    - Underwater obstructions or obstacles that could impede or impact the current or future investigation/removal actions
7. MEC/MPPEH located during this investigation will be removed from the site, in accordance with the Work Plan and the following procedures
    - Only items that can be safely moved as determined by the SUXOS and UXOSO will be moved.
    - All safe-to-move items requiring explosive treatment will be moved to a designated area onto the shore for treatment/disposal at Constitution Island.
    - If an MEC/MPPEH item is found is deemed unsafe to move, and presents an imminent explosive hazard to persons in the area or potential trespassers, the EOTI Project Manager will be immediately notified and the site will be secured until underwater disposal is authorized and completed by the EOTI Dive team.
    - Items may be marked for disposal/treatment and completed in groups by EOTI Dive team.

B. Information to be included in MEC/MPPEH Item Descriptions and included in the EOTI/Weston munitions response database (if those determinations can be made)

1. Unique, Sequential Identification Number
2. Item Group
3. Item Class
4. Item Category
5. Type/Filler
6. Description/Fuzing
7. Quantity
8. Depth of water
9. Depth of Item in Sediment (approximate)
10. Weight (estimate)
11. Frag
12. Demo Required
13. General Comment for Condition of Item (biological growth on item, etc)
14. General Location
15. Date Found
16. Action Taken
17. Item Moved To (as applicable)
18. X Geographic Coordinate
19. Y Geographic Coordinate
20. Photograph (if conditions permit)

Data Collection

The basic requirements for field log book entries are detailed below.

A. Procedures for Completing Field Log Books

1. Field notes will be kept in bound, hard-cover log books Pages will be water-resistant and notes will be taken with water-proof, non-erasable permanent ink.
2. On the inside cover of the log book the following information will be included:
    - Project name and address
    - Activity or location
    - Project name

- EOTI Project Manager's name
- Phone numbers for EOTI, Weston Solutions, Inc., emergency response, etc.

3. To the extent practical, all lines of all pages will be used to prevent later additions of text. Line(s) not used should be marked through with a line and initialed and dated. Any pages not used should be marked through with a line, the author's signature, the date, and the note "Intentionally Left Blank."
4. If errors are made in the log book, cross a single line through the error and enter the correct information. All corrections shall be initialed and dated by the personnel performing the correction. If possible, all corrections should be made by the individual who made the error.
5. Daily entries will be made chronologically.
6. Information will be recorded directly in the field log book during the work activity. Information will not be written on a separate sheet and then later transcribed into the log book.
7. Each page of the log book will have the date of the work and the note takers initials.
8. The final page of each day's notes will include the note-takers signature as well as the date.
9. Only information relevant to the subject project will be added to the log book.

B. Information to be Included in Field Log Books

1. Entries into the log book will be as detailed and descriptive as possible so that a particular situation can be recalled without reliance on the collector's memory. Entries must be legible and complete.
2. General project information will be recorded at the beginning of each field project. This will include the project title, the project number, and project staff.
3. Scope: Describe the general scope of work to be performed each day.
4. Weather: Record the weather conditions and any significant changes in the weather during the day.
5. Tail Gate Safety Meetings: Record time and location of meeting, who was present, topics discussed, and issues/problems/concerns identified, and corrective actions or adjustments made to address concerns/ problems, and other pertinent information.
6. Standard Health and Safety Procedures: Record level of personal protection being used (e.g., level D PPE) and personnel monitoring information. Also record other required health and safety procedures as specified in the project specific health and safety plan.
7. Instrument Calibration: As applicable, record calibration/functionality information for each piece of health and safety and field equipment.
8. Personnel: Record names of all personnel present during field activities and list their roles and their affiliation. Record when personnel and visitors enter and leave a project site and their level of personal protection.
9. Communications: Record communications with project manager, subcontractors, regulators, facility personnel, and others that impact performance of the project.
10. Time: Keep a running time log explaining field activities as they occur chronologically throughout the day.
11. Deviations from the Work Plan: Record any deviations from the work plan and document why these were required and any communications authorizing these deviations.
12. Health and Safety Incidents: Record any health and safety incidents and immediately report any incidents to the Project Manager.

13. Subcontractor Information: Record name of company, record names and roles of subcontractor personnel, list type of equipment being used and general scope of work. List times of starting and stopping work and quantities of consumable equipment used if it is to be billed to the project.
14. Problems and Corrective Actions: Clearly describe any problems encountered during the field work and the corrective actions taken to address these problems.
15. Technical and Project Information: Describe work being performed each day.
16. Any conditions that might adversely affect the work or any data obtained (e.g., water visibility).

C. Data Review

1. All data entered into the EOTI/Weston Solutions MR database will be reviewed to ensure that:
    - All relevant information about the item has been recorded (as applicable and available) and accurate (based on the field notes, pictures, and discussions with the data collection team)
    - There is appropriate agreement between the various elements of the item description
    - The descriptions of the action taken for the item are accurate
2. Field log books will allow the reviewer to verify:
    - Equipment functional tests are conducted in accordance with manufacturer’s recommendations
    - The rationale for adjusting/terminating transects is recorded
    - Pictures are being taken and logged
    - Relevant details pertaining to the investigation have been/are being recorded

EOTI-SOP 2
DEFIBRILLATOR USAGE

TABLE OF CONTENTS

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide procedures for the use of an automated external defibrillator (AED) on someone who is suspected to be in sudden cardiac arrest (SCA). This SOP is not a stand-alone document and should be used together with the AED manufacturer's documentation; other EOTI procedures; applicable Federal, State, and local regulations; and contract restrictions and guidance.

2.0 DEFINITIONS AND APPLICABILITY

Defibrillation is an electrical shock delivered to the heart designed to terminate a life-threatening arrhythmia or cardiac arrest. The Automated External Defibrillator (AED) is a device capable of automatically detecting a heart rhythm that requires a shock. If someone has sudden cardiac arrest (SCA), an AED can save his/her life.

This SOP applies to EOTI employees and their subcontractors tasked to perform MMRP field activities who have previously received formal emergency response training for CPR (cardiopulmonary resuscitation).

3.0 PROCEDURES

3.1 Preparation

Before using an automated external defibrillator (AED) on someone who is suspected of having sudden cardiac arrest (SCA), check the individual to verify that he/she isn't sleeping. Shout at and/or shake the individual to confirm. If the individual fails to respond or has collapsed and fails to respond, call 9-1-1 or have another team member call 9-1-1. If two rescuers are present, one can provide CPR (cardiopulmonary resuscitation) while the other calls 9–1–1 and secures the AED.

Check the person's breathing and pulse. If breathing and pulse are absent or irregular, prepare to use the AED as soon as possible. (SCA causes death if it's not treated within minutes.)

If no one knows how long the person has been unconscious, or if an AED isn't readily available, do 2 minutes of CPR. Then use the AED (if you have one) to check the person.

After using the AED, or if an AED is not available, give CPR until emergency medical help arrives or until the person begins to move. Try to limit pauses in CPR.

After 2 minutes of CPR, you can use the AED again to check the person's heart rhythm and give another shock, if needed. If a shock isn't needed, continue CPR.

3.2 Using an Automated External Defibrillator (AED) - Overview

AEDs are user-friendly devices that untrained bystanders can use to save the life of someone having SCA.

Before using an AED, check for puddles or water near the victim who is unconscious. Move him or her to a dry area, and stay away from wet or damp areas when delivering shocks (water conducts electricity).

Turn on the AED's power. The device will audibly provide step-by-step instructions. In addition to the audible voice prompts the user should also see prompts on the device’s screen.

Expose the victim’s chest. If the victim's chest is wet, dry it. AEDs have adhesive pads with sensors called electrodes. Apply the pads to the victim's chest as pictured on the AED's instructions.
Place one pad on the right center of the victim's chest above the right nipple. Place the other pad slightly below the left nipple and to the left of the ribcage.

Ensure the adhesive pads have good connection with the skin. If the connection isn't good, the machine may repeat the phrase "check electrodes."

If the victim has a lot of chest hair, you may need to trim it. (AEDs usually come with a kit that includes scissors and/or a razor.) If the victim is wearing a medication patch that's in the way, remove it and clean the medicine from the skin before applying the adhesive pads.

Remove metal necklaces and underwire bras. The metal may conduct electricity and cause burns. You can cut the center of the bra and pull it away from the skin.

Check the victim for implanted medical devices, such as a pacemaker or implantable cardioverter defibrillator. (The outline of these devices is visible under the skin on the chest or abdomen, and the victim may be wearing a medical alert bracelet.) Also check for body piercings.

Move the defibrillator pads at least 1 inch away from implanted devices or piercings so the electric current can flow freely between the pads.

Check that the wires from the electrodes are connected to the AED. Ensure that no one is touching the victim, and then press the AED's "analyze" button. Stay clear while the machine checks the victim's heart rhythm.

If a shock is needed, the AED will let you know when to deliver it. Stand clear of the victim and make sure others are clear before you push the AED's "shock" button.

Start or resume CPR until emergency medical help arrives or until the victim begins to move. Stay with the victim until medical help arrives, and report all known information to the emergency personnel.

3.3 AED Operational Steps

3.3.1 Confirm cardiac arrest

3.3.1 Confirm cardiac arrest. If an individual *appears* to be experiencing an emergency episode, check to ensure that it is a cardiac arrest before using an AED. Ensure the individual is unconscious and not merely sleeping. Verify unconsciousness by shaking the victim, or yelling/clapping near him/her. Check to see if the victim is unable to respond, if he/she is breathing, and has a pulse. Use the ABC method below to verify the victim's condition. If there is no pulse or breathing has stopped, immediately begin CPR.

3.3.1.1 **A**irway: Confirm the victim's airway is open before checking for breathing. Tilt back the victim's head and lift the victim's chin. If an object is visible that is obstructing the airway, remove it.

3.3.1.2 **B**reathing: Lean in closely to listen for breathing. Look to see if the victim's chest is rising and falling.

3.3.1.3 **C**irculation: Feel for a pulse. Signs of circulatory issues include color changes, sweating, and a lower level of consciousness

3.3.2 Seek emergency response help immediately and begin CPR

After establishing a victim is experiencing an emergency episode, call or employ another worker to call 9-1-1 and inform the emergency personnel of the situation including informing them of the access to an AED and the intent of using it.

Initiate CPR. Apply 30 chest compressions followed by 2 rescue breaths. The rescue breaths should be no longer than one second to avoid overventilation and to only provide enough air to see the chest expand. Repeat the cycle keeping the chest compressions to 100 compressions per minute – never exceed 125 compressions per minute. The chest should be compressed 2 inches (5 cm) downward and should be allowed to fully expand upward with as few interruptions as possible.

3.3.3 Ensure the victim is dry

Before using an AED, ensure there is no accumulated water near the victim – move the victim away from water and dry them off if possible.

3.3.4 Turn on the AED

Once the victim is away from water, turn on the AED. The AED unit will provide audible instructions for attaching the cables and adhesive pads to the victim's chest.

3.3.5 Prepare the chest area

Open or cut through the victim's shirt. If the chest contains hair, it should be cut or shaved with the scissors or razor provided with the AED. Check for evidence of implanted devices such as a pacemaker. Remove any metal jewelry or accessories from the victim to avoid electrical shock. This includes removal of a bra in the case of a female victim as the underwire can conduct electricity.

3.3.6 Apply the adhesive pads from the AED

The electrodes for the AED are typically adhesive pads. The AED will advise you to put the electrodes or pads in place. You need to make sure that they are placed correctly so the victim will get the maximum amount of shock necessary. One pad should be placed below the collarbone on the upper right side of the victim's bare chest. The other should be placed below the pectoral or breast on the left, at the bottom of his heart, slightly along his side. Ensure there is no fabric or other objects between the pads and the victim's skin. Any obstruction will make the AED malfunction. If the adhesive pads are applied incorrectly, the AED will audibly notify of the problem. If an implanted device or body piercing exists, ensure the adhesive pads are applied at least 1 inch from the device or piercing.

3.3.7 Allow the AED to analyze the connections

The AED should be equipped with an analyze button/setting to ensure it is properly connected. This procedure will analyze the heart rhythm of the victim. The AED will inform you if the shock is needed or if CPR should continue. If the AED reports that no shock is required, the victim has either regained a pulse or has an un-shockable heart rhythm. If no shock is required, the CPR efforts should continue until emergency workers arrive.

3.3.8 Shock the victim if necessary

If the AED advises to shock the victim, clear any bystanders away from the victim and press the shock button on the AED. The AED will only provide one shock at a time. The shock is short-term and the victim should exhibit movement due to the force of the shock.

3.3.9 Continue CPR

Once a shock has been administered to the victim, continue CPR for an additional 2 minutes. Allow the AED to check for a heart rhythm. Repeat this procedure, following the AED's audible instructions until emergency personnel arrive. CPR should be discontinued if the victim begins to breath on his/her own or if he/she regains consciousness. The AED will also likely remind you when 2 minutes have passed and/or inform you to stop CPR.

3.4 AED Equipment Documentation

Field personnel in possession of an AED should read the literature that comes with their AED and be familiar with its contents so that slight differences in AED manufacturers' operating instructions can be reconciled with this SOP.

Attachment A

OPERATOR AND SERVICE MANUAL

OPERATOR AND SERVICE MANUAL

POWERHEART® AED

G3 PRO 9300P

70-00968-01 F

CARDIAC
science®

AT THE HEART OF SAVING
LIVES®

Trademark Information

Patents

This device is covered by the following U.S. and foreign patents:

5,792,190; 5,999,493; 5,402,884; 5,579,919; 5,749,902; 5,645,571; 6,029,085; 5,984,102; 5,919,212; 5,700,281; 5,891,173; 5,968,080; 6,263,239; 5,797,969; D402,758; D405,754; 6,088,616; 5,897,576; 5,955,956; 6,083,246; 6,038,473; 5,868,794; 6,366,809; 5,474,574; 6,246,907; 6,289,243; 6,411,846; 6,480,734; 6,658,290; 5,850,920; 6,125,298; EP0725751; EP0757912; EP00756878

Other U.S. and foreign patents pending.

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(262)953-3500
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www.cardiacscience.com

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Getting Started 3

Data Management 4

Troubleshooting and Maintenance 5

Technical Data 6

Limited Warranty

Limited Warranty

Cardiac Science Corporation ("Cardiac Science") warrants to the original purchaser that its AEDs and stated battery operating life will be free of any defect in material and workmanship according to the terms and conditions of this Limited Warranty ("Limited Warranty"). For purposes of this Limited Warranty, the original purchaser is deemed to be the original end user of the product purchased. This Limited Warranty is NONTRANSFERABLE and UNASSIGNABLE.

For How Long?

This Limited Warranty covers the following products or parts for the following time periods:

1. Seven (7) years from the date of the original shipment to the original purchaser for Powerheart AED automated external defibrillators. Warranty duration for the pads, batteries and accessories are covered below.
2. Disposable defibrillation pads shall be warranted until the expiration date.
3. Lithium batteries P/N (9145) have a full operational replacement guarantee of one year or 12 hours of use from the point of installation into a Powerheart AED G3 Pro, whichever comes first.
4. One (1) year from the date of original shipment to the original purchaser for Powerheart AED accessories. The terms of the Limited Warranty in effect as of the date of original purchase will apply to any warranty claims.

What You Must Do:

Please complete and submit the Product Registration online at http://www.cardiacscience.com/services-support/product-registration/.

To obtain warranty service for your product:

Inside the US, call us toll free at 800.426.0337 seven days a week, 24 hours a day. Our technical support representative will try to resolve your issue over the phone. If necessary, and at our sole discretion, we will arrange for service or a replacement of our product.

Outside the US, contact your local Cardiac Science representative.

What We Will Do:

If your Cardiac Science product is returned within 30 days of the date it was purchased, at the direction of a technical support representative, we will repair or replace it with a new product of equal value at no charge to you or offer a full refund of the purchase price, provided the warranty applies. Cardiac Science retains the exclusive right to repair or replace the product or offer a full refund of the purchase price at its sole discretion. SUCH REMEDY SHALL BE YOUR SOLE AND EXCLUSIVE REMEDY FOR ANY BREACH OF WARRANTY.

If your Cardiac Science product is returned, at the direction of a technical support representative, after 30 days but within the warranty period, Cardiac Science, at its sole discretion, will repair your product or replace it. The repaired or replacement product will be warranted subject to the terms and conditions of this Limited Warranty for either (a) 90 days or (b) the remainder of the original warranty period, whichever is longer, provided the warranty applies and the warranty period has not expired.

Obligations and Warranty Limits:

Limited Warranty Obligation: Exclusive Remedy

THE FOREGOING LIMITED WARRANTY IS IN LIEU OF AND SPECIFICALLY EXCLUDES AND REPLACES ALL OTHER EXPRESSED OR IMPLIED WARRANTIES INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

Some states do not allow limitations on how long an implied warranty lasts, so this limitation may not apply to you.

NO PERSON (INCLUDING ANY AGENT, DEALER, OR REPRESENTATIVE OF CARDIAC SCIENCE) IS AUTHORIZED TO MAKE ANY REPRESENTATION OR WARRANTY CONCERNING CARDIAC SCIENCE PRODUCTS, EXCEPT TO REFER PURCHASERS TO THIS LIMITED WARRANTY.

YOUR EXCLUSIVE REMEDY WITH RESPECT TO ANY AND ALL LOSSES OR DAMAGES RESULTING FROM ANY CAUSE WHATSOEVER SHALL BE AS SPECIFIED ABOVE. CARDIAC SCIENCE SHALL IN NO EVENT BE LIABLE FOR ANY SPECIAL, PUNITIVE, INDIRECT, CONSEQUENTIAL OR INCIDENTAL DAMAGES OF ANY KIND, INCLUDING, BUT NOT LIMITED TO, EXEMPLARY DAMAGES, COMMERCIAL LOSS FROM ANY CAUSE, BUSINESS INTERRUPTION OF ANY NATURE, LOSS OF PROFITS OR PERSONAL INJURY OR DEATH, EVEN IF CARDIAC SCIENCE HAS BEEN ADVISED OF THE POSSIBILITIES OF SUCH DAMAGES, HOWEVER OCCASIONED, WHETHER BY NEGLIGENCE OR OTHERWISE.

Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above limitation or exclusion may not apply to you.

What This Warranty Does Not Cover:

This Limited Warranty does not cover defects or damages of any sort resulting from, but not limited to, accidents, damage while in transit to our service location, product tampering, unauthorized product alterations, unauthorized service, unauthorized product case opening, failure to follow instructions, improper use, abuse, neglect, fire, flood, war or acts of God. Cardiac Science makes no warranty claim as to the compatibility of Cardiac Science products with any non-Cardiac Science products, parts or accessories.

This Limited Warranty is Void if:

1. Any Cardiac Science product is serviced or repaired by any person or entity other than Cardiac Science unless specifically authorized by Cardiac Science.
2. Any Cardiac Science product case is opened by unauthorized personnel or if a product is used for an unauthorized purpose.
3. Any Cardiac Science product is used in conjunction with incompatible products, parts or accessories, including but not limited to batteries. Products, parts and accessories are not compatible if they are not Cardiac Science products intended for use with the Powerheart AED.

If The Warranty Period has Expired:

If your Cardiac Science product is not covered by our Limited Warranty:

Inside the US, call us toll free at 1.800.426.0337 for advice as to whether we can repair your Powerheart AED, and for other repair information, including charges. Charges for non-warranty repairs will be assessed and are your responsibility. Upon completion of the repair, the terms and conditions of this Limited Warranty shall apply to such repair or replacement product for a period of 90 days.

Outside the US, contact your local Cardiac Science representative.

This warranty gives you specific legal rights, and you may also have other rights, which vary from state to state.

1 Product Information and Safety

Contents

Before Operating the Powerheart G3 AED:

- Become familiar with the various safety alerts in this section.
- Safety alerts identify potential hazards using symbols and words to explain what could potentially harm you, the patient, or the Powerheart G3 AED.

Contact information

Inside the United States:

To order additional Powerheart G3 AEDs or accessories, contact Cardiac Science Customer Care:

- Toll Free (USA): 1.800.426.0337 (option 2)
- Telephone: +1.262.953.3500 (option 2)
- Fax: +1.262.953.3499
- Email: care@cardiacscience.com

Cardiac Science provides 24-hour telephone technical support. You can also contact Technical Support though fax or email.

There is no charge to the customer for a technical support call. Please have the serial and model numbers available when contacting Technical Support. (The serial and model numbers are located on the underside of the AED.)

- Toll Free (USA): 1.800.426.0337 (option 1)
- Telephone: +1.262.953.3500 (option 1)
- Fax: +1.262.798.5236
- Email: techsupport@cardiacscience.com
- Web site: http://www.cardiacscience.com

Outside the United States:

Contact your local Cardiac Science representative to order devices or accessories and to receive technical support for your AED products.

Defibrillator tracking

Defibrillator manufacturers and distributors are required, under the Safe Medical Devices Act of 1990, to track the location of defibrillators they sell. Please notify Cardiac Science Technical Support in the event that your defibrillator is sold, donated, lost, stolen, exported, destroyed or if it was not purchased directly from Cardiac Science or an authorized dealer.

Product models

This manual is for Powerheart G3 Pro model 9300P.

Warranty information

The Powerheart G3 AED *Operator and Service Manual* and any and all information contained herein (except for the *Limited Warranty* chapter) do not constitute any warranty as to the Powerheart G3, Powerheart G3 Automatic or any related products in any manner whatsoever. The *Limited Warranty* chapter in this manual serves as the sole and exclusive warranty provided by Cardiac Science regarding Powerheart G3 AED products.

Safety terms and definitions

The symbols shown below identify potential hazard categories. The definition of each category is as follows:

DANGER

This alert identifies hazards that will cause serious personal injury or death.

WARNING

This alert identifies hazards that may cause serious personal injury or death.

Caution

This alert identifies hazards that may cause minor personal injury, product damage, or property damage.

Safety alert descriptions

The following is a list of Powerheart G3 AED safety alerts that appear in this section and throughout this manual.

Read and understand these safety alerts before operating the AED.

Caution: Read this Operator and Service Manual carefully.

It contains information about your safety and the safety of others. Become familiar with the controls and how to use the AED properly before operating the product.

DANGER! Fire and Explosion Hazard

To avoid possible fire or explosion hazard, do not operate the AED:

- In the presence of flammable gases
- In the presence of concentrated oxygen
- In a hyperbaric chamber

WARNING! Shock Hazard and Possible Equipment Damage

Defibrillation shock current flowing through unwanted pathways is potentially a serious electrical shock hazard and results in potential damage to the equipment. To avoid this hazard during defibrillation abide by all of the following:

- Do not use in standing water or rain. Move patient to dry area
- Do not touch the patient, unless performance of CPR is indicated
- Do not touch metal objects in contact with the patient
- Keep defibrillation pads clear of other pads or metal parts in contact with patient
- Disconnect all non-defibrillator proof equipment from the patient before defibrillation

WARNING! Battery model 9145 is Not Rechargeable.

Do not attempt to recharge the battery. Any attempt to recharge the battery may result in an explosion or fire hazard.

WARNING! Possible Radio Frequency (RF) Susceptibility.

Radio-frequency (RF) interference from devices such as cellular phones and two-way radios can cause improper AED operation. The AED should be used at least 6 feet (2 meters) away from RF devices, as stated in accordance with EN 61000-4-3:2002.

WARNING! Possible Interference with Implanted Pacemaker.

Therapy should not be delayed for patients with implanted pacemakers and a defibrillation attempt should be made if the patient is unconscious and not breathing. The AED has pacemaker detection and rejection, however with some pacemakers the AED may not advise a defibrillation shock. (Cummins, R., ed., Advanced Cardiac Life Support; AHA (1994): Ch. 4)

When placing Pads:

- Do not place the pads directly over an implanted device.
- Place the pad at least one inch from any implanted device.

WARNING! Electromagnetic Compatibility.

Use of accessories or cables other than those specified, with the exception of accessories and cables sold by Cardiac Science Corporation as replacement parts for internal components, may result in increased emissions or decreased immunity of the AED.

WARNING! Improper Equipment Placement.

Position the AED away from other equipment. If it is necessary to use the AED adjacent to or stacked with other equipment, then observe the AED to verify normal operations.

Caution: Restricted Use.

Federal law restricts this device for sale by or on the order of a physician or practitioner licensed by law of the state in which he/she practices.

Caution: Lithium Sulfur Dioxide Battery (model 9145).

Pressurized contents: never recharge, short circuit, puncture, deform, or expose to temperatures above 65°C (149°F). Remove the battery when discharged.

Caution: Battery Disposal.

Recycle or dispose of the lithium battery in accordance with all federal, state and local laws. To avoid fire and explosion hazard, do not burn or incinerate the battery.

Caution: Use only Cardiac Science Approved Equipment.

Using batteries, pads, cables, or optional equipment other than those approved by Cardiac Science may cause the AED to function improperly during a rescue.

Caution: Possible Improper AED Performance.

Using pads that are damaged or expired may result in improper AED performance.

Caution: Moving the Patient During a Rescue.

During a rescue attempt, excessive jostling or moving of the patient may cause AEDs to improperly analyze the patient's cardiac rhythm. Stop all motion or vibration before attempting a rescue.

Caution: Systems Statement.

Equipment connected to the analog and digital interfaces must be certified to the respective IEC standards (i.e. IEC 60950 for data processing equipment and IEC 60601-1 for medical equipment).

Furthermore, all configurations shall comply with the system standard IEC 60601-1-1. Anybody who connects additional equipment to the signal input part or signal output part configures a medical system, and is therefore, responsible that the system complies with the requirements of the system standard IEC 60601-1-1.

Caution: Equipment Malfunction.

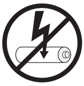
Portable and RF communications equipment may affect the AED. Always observe the recommended separation distances as defined in the EMC declaration tables.

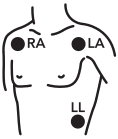
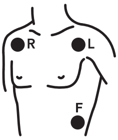
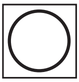
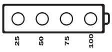
Caution: Equipment Malfunction.

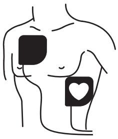
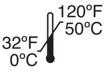
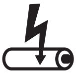
The AED requires special precautions regarding EMC. Use the AED according to the guidelines of the EMC declaration tables.

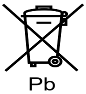
Symbol descriptions

The following symbols may appear in this manual, on the AED, or on its optional components. Some of the symbols represent standards and compliances associated with the AED and its use.

Symbol	Description	Symbol	Description
	Caution. Consult accompanying documentation.		Additional information is provided in the accompanying documentation.
	Dangerous Voltage: The defibrillator output has high voltage and can present a shock hazard. Please read and understand all safety alerts in this manual before attempting to operate the AED.		Defibrillator Proof Type BF Equipment: The AED, when connected to the patient's chest by the pads, can withstand the effects of an externally applied defibrillation shock.
IP24	The AED is protected against the effects of splashing water in accordance with IEC 60529.		Do not recharge battery.
	Classified by CSA International with respect to electric shock, fire and mechanical hazards only in accordance with CAN/CSA C22.2 No.60601-1:08 EN60601-1 and EN60601-2-4. Certified to CAN/CSA Standard C22.2 No. 60601-1:08.		Defibrillation proof type CF applied part.
	When the SHOCK indicator is lit, press this button to deliver a defibrillation shock.		Indicates the AED battery status. The illuminated areas indicate the remaining battery capacity.

Symbol	Description	Symbol	Description
	The Z-Bar provides a relative visual indicator of the total transthoracic impedance between the two defibrillation pads.		Indicates AED requires maintenance by authorized service personnel.
	A red indicator with a BLACK X means the AED requires operator attention or maintenance, and is not Rescue Ready.		A green indicator without a BLACK X means the AED is Rescue Ready.
	Indicates placement of ECG leads and electrodes (AHA).		Indicates placement of ECG leads and electrodes (IEC).
	When pressed and confirmed, activates manual mode.		Indicates that the manual override function has been disabled.
	Symbol for ON. Open the lid to power on the AED.		Test button: Press to view battery capacity.
	Charge LED: Solid yellow indicates battery charging. Blinking yellow indicates charging error.		Battery capacity: Indicates the AED battery status. The illuminated areas indicate the remaining battery capacity when the test button is pressed.
	Date of manufacture: year and month.		Date of factory recertification (R): year and month.

Symbol	Description	Symbol	Description
	Latex free. Not made with natural rubber latex.		Disposable. Single patient use only.
	Tear here to open.		- Position of defibrillation pads on the chest of patient. - When pads on screen are flashing, check defibrillation pads. The defibrillation pads are missing, not connected, or have compromised functionality.
℞ ONLY	For use by or on the order of a Physician, or persons licensed by state law.		Separate one pad from blue liner by peeling from the tabbed corner.
	Do not incinerate or expose to open flame.		
	Upper and lower operating temperature limits.		Use pads by this date.
SN	Serial Number	**REF**	Device model number; battery model number
OPTION	Option number	**LOT**	Lot number
Li-ion	Lithium ion		Rechargeable battery

Symbol	Description	Symbol	Description
LiSO$_2$	Lithium sulfur dioxide	EC REP	Authorized representative in the European Community
CE 0086	CE Mark: This equipment conforms to essential requirements of the Medical Device Directive 93/42/EEC.		Manufacturer
	Waste Electronic Electrical Equipment (WEEE). Separate collection for waste electrical and electronic equipment.		Waste Electronic Electrical Equipment (WEEE) containing lead. Separate collection for waste electrical and electronic equipment.
	Recycle cardboard according to local law.		Dispose of properly in accordance with all state, province, and country regulations.

Electromagnetic emissions standards compliance

Guidance and manufacturer’s declaration—electromagnetic emissions

The AED is intended for use in the electromagnetic environment specified below. The customer or the user of the AED should assure that it is used in such an environment.

Emissions test	Compliance	Electromagnetic environment—guidance
RF emissions CISPR 11	Group 1	The AED uses RF energy only for its internal function. Therefore its RF emissions are very low and are not likely to cause any interference in nearby electronic equipment.

Emissions test	Compliance	Electromagnetic environment—guidance
RF emissions CISPR 11	Class B	The AED is suitable for use in all establishments, including domestic establishments and those directly connected to the public low-voltage power supply network that supplies buildings used for domestic purposes.
Harmonic emissions IEC 61000-3-2	Not applicable	
Voltage fluctuations/flicker emissions IEC 61000-3-3	Not applicable	

Guidance and manufacturer's declaration—electromagnetic immunity

The AED is intended for use in the electromagnetic environment specified below. The customer or the user of the AED should assure that it is used in such an environment.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment—guidance
Electrostatic discharge (ESD) IEC 61000-4-2	±6 kV contact ±8 kV air	±6 kV contact ±8 kV air	Floors should be wood, concrete or ceramic tile. If floors are covered with synthetic material, the relative humidity should be at least 30%
Electrical fast transient/burst IEC 61000-4-4	±2 kV for power supply lines ±1 kV for input/output lines	Not applicable	
Surge IEC 61000-4-5	±1 kV differential mode ±2 kV common mode	Not applicable	

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment—guidance
Voltage dips, short interruptions and voltage variations on power supply input lines 61000-4-11	<5% U_T (>95% dip in U_T) for 0.5 cycle 40% U_T (60% dip in U_T) for 5 cycles 70% U_T(30% dip in U_T) for 25 cycles <5% U_T(>95% dip in U_T) for 5 sec.	Not applicable	
Power frequency (50/60 Hz) magnetic field IEC 61000-4-8	3 A/m	80 A/m	Power frequency magnetic fields should be at levels no higher than those characteristic of a typical location in typical heavy industrial and power plants and the control rooms of H.V. sub-stations.

Note: U_T is the a.c. mains voltage prior to application of the test level.

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment—guidance
Conducted RF	3 Vrms	Not Applicable	
IEC 61000-4-6	150 kHz to 80 MHz outside ISM bands[a] 10 Vrms 150 kHz to 80 MHz in ISM bands[a]	Not Applicable	

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment—guidance
			Portable and mobile RF communications equipment should be used no closer to any part of the AED, including cables, than the recommended separation distance calculated from the equation applicable to the frequency of the transmitter.
Radiated RF IEC 61000-4-3	10 V/m 80 MHz to 2.5 GHz	10 V/m	**Recommended separation distance** $d = 1.2 \sqrt{P}$ 80 MHz to 800 MHz $d = 2.3 \sqrt{P}$ 800 MHz to 2.5 GHz
			where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer and d is the recommended separation distance in meters (m)[b].

Immunity test	IEC 60601 test level	Compliance level	Electromagnetic environment—guidance
			Field strengths from fixed RF transmitters, as determined by an electromagnetic site survey,[c] should be less than the compliance level in each frequency range.[d] Interference may occur in the vicinity of equipment marked with the following symbol: 

NOTE 1 At 80 MHz and 800 MHz, the higher frequency range applies.

NOTE 2 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

a The ISM (industrial, scientific and medical) bands between 150 kHz and 80 MHz are 6.765 MHz to 6.795 MHz; 13.553 MHz to 13.567 MHz; 26.957 MHz to 27.283 MHz; and 40.66 to 40.70 MHz.

b The compliance levels in the ISM frequency bands between 150 kHz and 80 MHz and in the frequency range 80 MHz to 2.5 GHz are intended to decrease the likelihood that mobile/portable communications equipment could cause interference if it is inadvertently brought into patient areas. For this reason, an additional factor of 10/3 is used in calculating the recommended separation distance for transmitters in these frequency ranges.

c Field strengths from fixed transmitters, such as base stations for radio (cellular/cordless) telephones and land mobile radios, amateur radio, AM and FM radio broadcast and TV broadcast cannot be predicted theoretically with accuracy. To assess the electromagnetic environment due to fixed RF transmitters, an electromagnetic site survey should be considered. If the measured field strength in the location in which the AED is used exceeds the applicable RF compliance level above, the AED should be observed to verify normal operation. If abnormal performance is observed, additional measures may be necessary, such as re-orienting or relocating the AED.

d Over the frequency range 150 kHz to 80 MHz, field strengths should be less than 1 V/m.

Recommended separation distances between portable and mobile RF communications equipment and the AED

The AED is intended for use in an electromagnetic environment in which radiated RF disturbances are controlled. The customer or the user of the AED can help prevent electromagnetic interference by maintaining a minimum distance between portable and mobile RF communications equipment (transmitters) and the AED as recommended below, according to the maximum output power of the communications equipment.

Rated maximum output power of transmitter W	Separation distance according to frequency of transmitter m			
	150 kHz to 80 MHz outside ISM bands	150 kHz to 80 MHz in ISM bands	80 MHz to 800 MHz	800 MHz to 2.5 GHz
	$d = 1.2\sqrt{P}$	$d = 1.2\sqrt{P}$	$d = 1.2\sqrt{P}$	$d = 2.3\sqrt{P}$
0.01	0.12	0.12	0.12	0.23
0.1	0.38	0.38	0.38	0.73
1	1.2	1.2	1.2	2.3
10	3.8	3.8	3.8	7.3
100	12	12	12	23

For transmitters rated at a maximum output power not listed above, the recommended separation distance d in meters (m) can be determined using the equation applicable to the frequency of the transmitter, where P is the maximum output power rating of the transmitter in watts (W) according to the transmitter manufacturer.

NOTE 1 At 80 MHz and 800 MHz, the separation distance for the higher frequency range applies.

NOTE 2 The ISM (industrial, scientific and medical) bands between 150 kHz and 80 MHz are 6.765 MHz to 6.795 MHz; 13.553 MHz to 13.567 MHz; 26.957 MHz to 27.283 MHz; and 40.66 to 40.70 MHz.

NOTE 3 An additional factor of 10/3 is used in calculating the recommended separation distance for transmitters in the ISM frequency bands between 150 kHz and 80 MHz and in the frequency range 80 MHz to 2.5 GHz to decrease the likelihood that mobile/portable communications equipment could cause interference if it is inadvertently brought into patient areas.

NOTE 4 These guidelines may not apply in all situations. Electromagnetic propagation is affected by absorption and reflection from structures, objects and people.

2 Introduction

Contents

This section presents information about the AED, its use, and the training requirements for operation.

AED description

The AED is a self-testing, battery-operated automated external defibrillator (AED). After applying the AED's defibrillation pads to the patient's bare chest, the AED automatically analyzes the patient's electrocardiogram (ECG) and advises the operator to press the button and deliver a shock if needed. The AED guides the operator through the rescue using a combination of voice prompts, audible alerts, and visible indicators. At the discretion of Advanced Life Support (ALS) personnel, the AED can be converted to manual override mode, and deliver a shock by pressing the SHOCK button to deliver therapy. The AED can also provide non-diagnostic ECG monitoring.

Indications for use

Powerheart AED G3 Pro

The Powerheart® AED G3 Pro is intended to be used by personnel who have been trained in its operation. The operator should be qualified by training in basic life support, CPR/AED or other physician-authorized emergency medical response. The device is indicated for emergency treatment of victims exhibiting symptoms of sudden cardiac arrest who are unresponsive and not breathing. If the victim is breathing post-resuscitation, the AED should be left attached to allow for acquisition and detection of the ECG rhythm. If a shockable ventricular tachyarrhythmia recurs, the device will charge automatically and advise the operator to deliver therapy; or when in manual override mode, ALS personnel will monitor the ECG display and deliver a shock by pushing the shock button to deliver therapy.

When the patient is a child under 8 years of age or weighs less than 55 lbs (25kg), the AED should be used with the Model 9730 Pediatric Attenuated Defibrillation Electrodes. Therapy should not be delayed to determine the patient’s exact age or weight.

9131 Defibrillation Electrodes

Cardiac Science 9131 Defibrillation Electrodes are single use and intended to be used in conjunction with Cardiac Science automatic external defibrillators (AED) to monitor and deliver defibrillation energy to the patient.

The electrodes are intended for short term use (<8 hours) and must be used before the expiration date listed on the packaging.

The AED electrodes are used for emergency treatment of cardiac arrest patients over 8 years of age or greater than 55 pounds. The user assesses the patient’s condition and confirms that the patient is unconscious, pulseless and is not breathing prior to applying the electrodes to the skin.

9660 Defibrillation Electrodes

Cardiac Science 9660 Defibrillation Electrodes are single use and intended to be used in conjunction with Cardiac Science G3 Pro automated external defibrillators (AED) to monitor and deliver defibrillation energy to the patient.

The electrodes are intended for short term use (<8 hours) and must be used before the expiration date listed on the packaging.

The AED electrodes are used for emergency treatment of cardiac arrest patients over 8 years of age or greater than 55 pounds. The user assesses the patient's condition and confirms that the patient is unconscious, pulseless and is not breathing prior to applying the electrodes to the skin.

RHYTHMx AED ECG analysis algorithm

The RHYTHMx™ AED ECG analysis algorithm provides ECG detection capabilities. The features available with the AED include the following:

- Detection Rate
- Asystole Threshold
- Noise Detection
- Non-Committed Shock
- Synchronized Shock
- Pacemaker Pulse Rejection
- SVT Discriminators
- Supraventricular Tachycardia (SVT) Rate

Detection rate

All ventricular fibrillation (VF) and ventricular tachycardia (VT) rhythms at or above this rate will be classified as shockable. All rhythms below this rate will be classified as non-shockable. This rate is programmable between 120 bpm (beats per minute) and 240 bpm via MDLink Software by the Medical Director. The default Detection Rate is 160 bpm.

Asystole threshold

The asystole baseline-to-peak threshold is set at 0.08 mV. ECG rhythms at or below 0.08 mV will be classified as asystole and will not be shockable.

Noise detection

The AED will detect noise artifacts in the ECG. Noise could be introduced by excessive moving of the patient or electronic noise from external sources like cellular and radiotelephones. When noise is detected, the AED will issue the prompt "ANALYSIS INTERRUPTED. STOP PATIENT MOTION" to warn the operator. The AED will then proceed to reanalyze the rhythm and continue with the rescue.

Non-committed shock

After the AED advises a shock, it continues to monitor the patient ECG rhythm. If the patient's rhythm changes to a non-shockable rhythm before the actual shock is delivered, the AED will advise that the rhythm has changed and issue the prompt "RHYTHM CHANGED. SHOCK CANCELLED." The AED will override the charge.

Synchronized shock

The AED is designed to automatically attempt to synchronize shock delivery on the R-wave if one is present. If delivery cannot be synchronized within one second, a non-synchronized shock will be delivered.

Pacemaker pulse detection

The AED contains pacemaker pulse detection circuitry to detect pulses from an implanted pacemaker.

SVT discriminators

The AED is supplied with the SVT Discriminator enabled and with the default setting "NO THERAPY FOR SVT". With the factory default setting of "NO THERAPY FOR SVT", the AED will not shock an SVT rhythm.

SVT Discriminators are sophisticated filters that analyze the morphology of the ECG waveforms and distinguish VF/VT from SVT and Normal Sinus Rhythms (NSR). The SVT Discriminator will only be applied to rhythms that fall between the Detection Rate and the SVT Rate. The factory default setting for this feature is "NO THERAPY FOR SVT", however the Medical Director can enable this feature using MDLink on the Powerheart AED.

SVT rate

All rhythms with rates between the Detection Rate and SVT Rate will be screened through a number of SVT Discriminators to classify them into VF/VT or SVT. Rhythms classified as SVT between the two set rates are not shockable. All SVT rhythms above the rates will be classified as shockable. The SVT Rate must be greater than the

Detection Rate and is selectable between 160 and 300 bpm or, “NO THERAPY FOR SVT” can be selected via MDLink Software by the Medical Director.

Rescue protocol

The AED rescue protocol is consistent with the guidelines recommended by the AHA/ERC 2010 Guidelines for Resuscitation and Emergency Cardiac Care.

Upon detecting a shockable cardiac rhythm, the AED advises the operator to press the SHOCK button to deliver a defibrillation shock followed by directions to perform 2 minutes of CPR.

STAR® biphasic waveform

The STAR® Biphasic Waveform is designed to measure the patient’s impedance and deliver a customized shock. This allows the delivery of an optimized energy level to each patient. The energy levels for the Powerheart G3 AED are available in three different defibrillation shock levels.

The Ultra-Low Energy (150 VE), Low Energy (200 VE), and High Energy (300 VE) shocks are variable energy. The actual energy is determined by the patient’s impedance. See Table 2-1 on page 2-7, Table 6-2 on page 6-9, Table 6-3 on page 6-9, and Table 6-4 on page 6-10 for additional information.

STAR biphasic energy protocols for Powerheart G3 AEDs

The STAR Biphasic defibrillation waveform will deliver variable escalating energy that is customized to each patient’s needs based upon a patient’s thoracic impedance. This customization adjusts for the unique physical differences between patients. The Powerheart G3 AED comes equipped with five different biphasic energy protocols.

The operator, with guidance, direction, and implementation from the designated AED program Medical Director, may select from one of these five protocols when placing the Powerheart G3 AED into service. The Powerheart G3 AED’s factory default energy protocol is 200-300-300 Joule (J) escalating Variable Energy (VE). The first shock is delivered within the range of 126J-260J. Subsequent shocks are delivered within a range of 170J-351J.

These protocols are selected by using the MDLink software program. The five biphasic energy protocols available are as follows:

Table 2-1: Biphasic Energy Protocols

Energy Protocols	Shock Sequence[1]	Energy Level (VE)	Energy Range[2] (J)
Factory Default	1	200	126-260
	2	300	170-351
	3	300	170-351
Protocol #2	1	200	126-260
	2	200	126-260
	3	300	170-351
Protocol #3	1	150	95-196
	2	200	126-260
	3	200	126-260
Protocol #4	1	150	95-196
	2	150	95-196
	3	200	126-260
Protocol #5	1	200	126-260
	2	200	126-260
	3	200	126-260

[1] The Ultra-Low Energy (150 VE), Low Energy (200 VE) and High Energy (300 VE) shocks are variable energy. The actual energy is determined by the patient's impedance.

[2] Allowable energy range.

Operator training requirements

Persons authorized to operate the AED must have all of the following minimum training:

- Defibrillation training and other training as required by state, province, or country regulations
- Training on operation and use of the AED
- Additional training as required by the physician or Medical Director
- A thorough understanding of the procedures in this manual

Note: Keep valid certificates of training and certification as required by state, province, or country regulations.

3

Getting Started

Contents

AED indicators

The following indicators are located on the AED.

Rescue Ready status indicator

The status indicator is located on the Powerheart G3 AED handle.

When this indicator is green, the AED is Rescue Ready. This means the AED self-tests have verified the following:

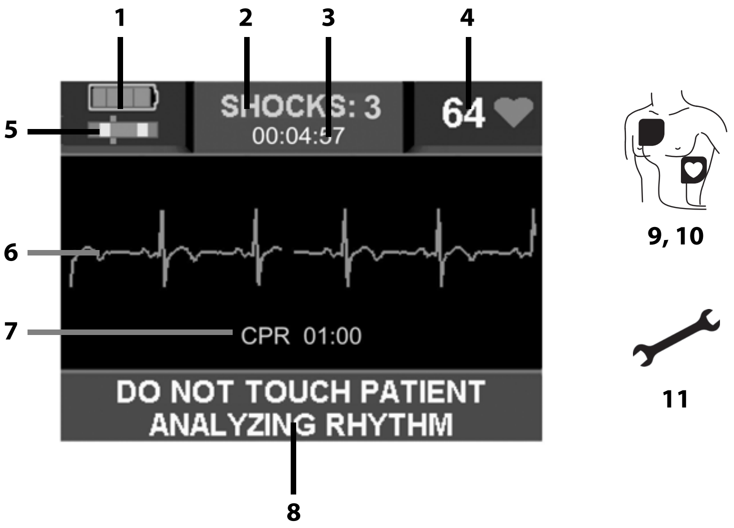
- Battery has an adequate charge
- Pads are properly connected to the AED and functioning
- Integrity of the internal circuitry is good

When the status indicator is red, attention is required.

1. Open the lid of the AED to troubleshoot the issue.
2. The AED may become Rescue Ready (the indicator turns green) after it runs further tests.
3. If the indicator remains red, contact Cardiac Science Technical Support (see *Contact information* on page 1-2) or outside the U.S., your local Cardiac Science representative.

Note: When the status indicator shows not Rescue Ready (the indicator is red) you might hear an intermittent beep. See *Audible maintenance indicator* for troubleshooting information.

Diagnostic panel



	Indicator	**Description**
1	Smartgauge™ battery	Displays the battery capacity. At maximum charge, the battery is GREEN. With use, the GREEN level will gradually go out from right to left as the battery capacity decreases. Once the battery level is depleted, the battery indicator will turn to RED, and the battery should be replaced. **Note:** When the battery indicator is initially RED—upon lid opening or at any time during a rescue—a **BATTERY LOW** prompt will be issued at once. However, the AED is capable of delivering at least nine more defibrillation shocks after the first time a **BATTERY LOW** prompt appears.
2	Number of shocks delivered	Counts and displays the number of shocks delivered.
3	Elapsed rescue time	Times and displays the elapsed rescue time.
4	Heart rate	Displays the patient's heart rate.
5	Z-Bar	provides a relative visual graphical indicator of the total transthoracic impedance between the two defibrillation pads. The Z-Bar is used in the assessment of: • Adequate pad placement • Pad quality and integrity • Pad adhesion to the patient's skin • Proper pad connection to the AED • Provides for quick assessment between pads off and pads shorted For more information, see *Z-Bar Indicator* on page 3-4
6	ECG display	Displays 4.5 seconds of the patient's ECG.
7	CPR counter	During CPR, displays a count-down timer.

	Indicator	Description
8	Text display	With 2 lines of text, it provides the operator with information regarding system initialization, text version of the voice prompts and data during a rescue, and diagnostics.
9	Pad placement	Visually assists the rescuer with pad placement with the directions for use. Appropriate text prompts are also displayed.
10	Pad	When flashing with voice and text prompt indicating "Check Pads", indicates to check pads when pads are: • not properly connected to the AED • not within operational specifications (cold, dried, damaged) • disconnected from the patient during a rescue
11	Service	Indicates that service is required that can only be performed by qualified service personnel.

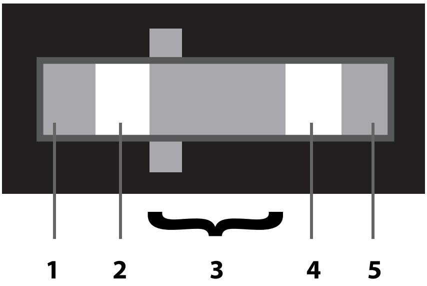
Z-Bar Indicator

The Z-Bar provides a relative visual graphical indicator of the total transthoracic impedance between the two defibrillation pads. The Z-Bar is used in the assessment of:

- Adequate Pad placement
- Pad quality and integrity
- Pad adhesion to the patient's skin
- Proper Pad connection to the AED
- Provides for quick assessment between PADS OFF and PADS SHORTED

Note: The Z-Bar is displayed on all therapy screens with the exception of the ECG MONITORING screen. On the ECG MONITORING screen the Z-Bar will be displayed only if the detection lead is set to Pads.

The Z-Bar is divided into 5 sections. The ideal operating range is section 3 (impedance range from 30 to <150).



Section	Measured impedance range (ohms)	Description	Color fill
1	<20	Lower Limit Alarm—Non-operational range.	Red
2	20- 30	Lower marginal operating range. Indicates potential issue with pad position.	Yellow
3	30 - 150	Normal operating range.	Green
4	150 -180	Upper marginal operating range. Indicates potential Pad degradation in Pad quality or position.	Yellow
5	>180	Upper Limit Alarm—Non-operational range.	Red

Audible maintenance indicator

When the daily, weekly, or monthly self-test determines attention is required, a beep sounds every 30 seconds until the lid is opened or the battery power is depleted. Opening and closing the lid may deactivate the beep. If the error is not corrected by the next automatic self-test, the beep will be reactivated.

Because the beep is a general indicator that the AED is not Rescue Ready, always open the lid first and allow the AED to perform its self test. If the AED provides a voice prompt but does not change the Rescue Ready indicator to green, note the prompt and contact Cardiac Science Technical Support (see *Contact information* on page 1-2) or outside the U.S., your local Cardiac Science representative.

Control buttons

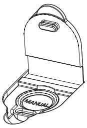
The AED has two buttons.

Shock button

The SHOCK button is located at the far right of the control panel.

Pressing this button delivers a defibrillation shock. The word SHOCK and the shock button indicator LED illuminate RED when the AED is ready to deliver a defibrillation shock to the patient. Note modification to behavior below when in manual mode.

Manual override button



The Manual Override button is located at the far left of the control panel and converts the device from automated mode to manual. This feature should only be used by ALS personnel. The factory default setting for Manual Override functionality is enabled, however the Medical Director can disable/enable this feature via MDLink.

- Lift the cover to access the button.
- Pressing this button converts to manual standby mode when pushed once, a voice prompt “Entering manual mode. Press button again to confirm”, will be heard. Converts to manual mode when MANUAL button is pressed again.
- If the rescuer does not confirm within 30 seconds of the capacitors charging, the AED will revert back to AED Mode.
- If the Medical Director has disabled this feature in MDLink, an icon indicating No MANUAL MODE will appear in the bottom left of the display.

Setting the AED internal clock

For US models, the internal clock is preset to Central Standard Time. You can reset it to your local date and time. To set the clock, you need a Windows XP or newer computer with RescueLink software installed.

To set the clock:

1. Ensure that the computer is set at the correct local time and date.
2. Run the RescueLink software on the computer.
3. Connect the communications cable to the computer.
4. Align the infra-red (IR) port on the AED with the IR port on the communications cable.
5. Open the lid of the AED.
6. In RescueLink:
    a. From the **Communications** menu, select **AED Date and Time**.
    b. Click **Get** to review the current time in the AED.

       The AED prompts, “Communications Mode.”
    c. If the time and date is incorrect, click **Set** to set a new time and date.

   The AED date and time updates to the computer’s time and date.
7. Close the lid of the AED.

Note: Use only the IR communications cable available separately from Cardiac Science. Other IR products may interfere with the transmission and are not for use with the AED.

Voice prompts and text display

The voice prompts activate when the AED lid is opened and help guide the operator through the rescue. The AED text display provides a visual display of most of the audible voice prompts.

The following tables list the voice and text prompts and a description of when the prompts are issued.

Table 3-1: Standard prompts

Voice prompt	Text display	Situation
Note: The AED is shipped from the factory with Traditional CPR defaulted ON. The Medical Director may modify the CPR options in MDLink. Traditional CPR prompts are listed in this table. Except where noted, prompts apply both to compressions-only CPR and traditional CPR (compressions and breaths).		
Tear open package and remove pads.	TEAR OPEN PACKAGE REMOVE PADS	When the lid is opened, this phrase is repeated twice to initiate the rescue sequence.
Peel one pad from plastic liner.	PEEL ONE PAD FROM PLASTIC LINER	Repeats until one pad is peeled off of the liner.
Place one pad on bare upper chest.	PLACE ONE PAD ON BARE UPPER CHEST	Repeats twice while one pad is placed.
Peel second pad and place on bare lower chest as shown.	PEEL SECOND PAD PLACE ON LOWER CHEST	Repeats until both pads are placed on the patient.

Table 3-1: Standard prompts (continued)

Voice prompt	Text display	Situation
Press pads firmly to patient's bare skin.	PRESS PADS TO PATIENT'S BARE SKIN	When better connectivity is required because impedance is too high.
Do not touch patient! Analyzing rhythm.	DO NOT TOUCH PATIENT ANALYZING RHYTHM	When the AED is analyzing the cardiac rhythm of the patient.
Shock advised.	SHOCK ADVISED	When the AED is preparing to deliver a defibrillation shock.
Charging.	CHARGING	Repeats while AED is charging.
Stand clear! Push flashing button to deliver shock.	STAND CLEAR PUSH BUTTON TO SHOCK	After the AED is fully charged and ready to deliver the defibrillation shock. The RED SHOCK indicator flashes and the phrase repeats for 30 seconds or until the SHOCK button is pushed.
Plug in pads connector.	PLUG IN PADS CONNECTOR	When the pad socket does not have defibrillation pads or ECG electrodes connected.
Shock Delivered.	SHOCK DELIVERED	After the AED delivers a defibrillation shock.
Start CPR.	START CPR	After the AED delivers a defibrillation shock. After the AED detects a non-shockable rhythm.
Give 30 compressions. Then Give two breaths.	30 COMPRESSIONS 2 BREATHS	Perform CPR for 2 minutes. **Note:** Prompt for traditional CPR only.

Table 3-1: Standard prompts (continued)

Voice prompt	Text display	Situation
Battery Low.	BATTERY LOW	Occurs once when the battery voltage becomes low, although a rescue can continue for approximately 9 more shocks. When the battery is too low to perform a rescue, the device halts operation and displays “Battery Low” on the Display, the NVI will turn to RED and the Sonalert will beep. No voice prompt is issued. If completely depleted, all AED activity will terminate.
Analysis interrupted. Stop patient motion.	ANALYSIS INTERRUPTED STOP PATIENT MOTION	When the AED detects ECG noise artifact, stop moving or touching the patient.
Open lid to continue rescue.	OPEN LID TO CONTINUE RESCUE	When the lid is inadvertently closed during a rescue, this prompt will repeat for 15 seconds.
Rhythm changed. Shock cancelled.	RHYTHM CHANGED SHOCK CANCELLED	When the device is prepared to shock then detects a change in rhythm and therefore cancels the shock.
ECG monitoring mode	ECG MONITORING MODE	When ECG Patient Cable is inserted into the pad socket. When the Manual Mode button is pressed when in ECG Monitoring Mode.
Communications mode	COMMUNICATIONS MODE	When the lid is open and IR is transmitting the AED.

Table 3-1: Standard prompts (continued)

Voice prompt	Text display	Situation
(Beep) (or) Metronome (30 times at 100/ minute) **Note:** Option is selected in MDLink software.	Not applicable	One “Beep” occurs in 30-second intervals during CPR when enabled by the MDLink software program, “Beep” also occurs when the AED requires maintenance.
Continue CPR	CONTINUE CPR	During CPR mode when enabled, or when a rescue is resumed in CPR mode after being interrupted by the lid closing.
Service required	SERVICE REQUIRED	Occurs after a self-test determines that the AED is not functioning properly. The prompt “SERVICE REQUIRED” will be heard when the lid is opened.

Table 3-2: Advanced prompts

Voice Prompt	Text Display	Situation
Entering manual mode. Press button again to confirm	MANUAL MODE PRESS BUTTON TO CONFIRM	After ALS presses the MANUAL button once to initiate the manual mode.
Manual mode. charging	CHARGING	After ALS presses the MANUAL button again to confirm.

Table 3-2: Advanced prompts (continued)

Voice Prompt	Text Display	Situation
Manual mode not confirmed.	MANUAL MODE NOT CONFIRMED	When the MANUAL button is not pressed a second time within five seconds, the device stays in AED mode.
If rhythm is shockable, press SHOCK button to deliver therapy.	IF SHOCKABLE RHYTHM PRESS SHOCK BUTTON	When in manual mode, prompts ALS personnel to press SHOCK button if ECG indicates a shockable rhythm.
Shockable rhythm. Attach defibrillation pads.	SHOCKABLE RHYTHM ATTACH DEFIBRILLATION PADS	When the device is performing ongoing ECG monitoring via the ECG Patient Cable Kit and detects a shockable rhythm.
(none)	DEVICE WILL DISARM IN :30	Should the rescuer go into manual mode and decide that AED mode is more appropriate, the AED will revert back to AED mode 30 seconds after charging is complete. The seconds will count down from 30 on the display. **Note:** When **Remain in manual mode** has been enabled (Using MDLink software). The AED will disarm but remain in Manual Mode.

4 Data Management

Contents

The AED is designed for ease of data management and review. The data can be downloaded from the AED and displayed on the PC screen using the Rescuelink software.

Recording rescue data

The AED automatically records Rescuelink data and can store up to 60 minutes of ECG monitoring time in its internal memory. Multiple rescues can be stored in the internal memory, allowing the rescuer to administer additional rescues without downloading the data to a PC. Should the internal memory become full, the AED will purge rescues as needed, beginning with the oldest rescue.

When downloading data, Rescuelink will enable the user to select which rescue to download. See the Rescuelink application HELP files for more information.

Reviewing rescue data

You need a Windows XP or newer computer with RescueLink software installed.

To retrieve data from internal memory:

1. Run the RescueLink software on the computer.
2. Connect the communications cable to the computer.
3. Align the infra-red (IR) port on the AED with the IR port on the communications cable.
4. Open the lid of the AED.
5. In RescueLink:
    a. From the **Communications** menu, select **Get Rescue Data**.
    b. Select **Internal Memory of AED**, then click **OK**.

       The AED prompts, “Communications Mode.”
    c. Select a rescue by clicking on the date and clicking **OK**.
    d. Wait for the rescue data to appear in RescueLink.
6. Close the lid of the AED.

Note: Use only the IR communications cable available separately from Cardiac Science. Other IR products may interfere with the transmission and are not for use with the AED.

5 Troubleshooting and Maintenance

Contents

This section presents information about the AED diagnostics self-tests, maintenance, and service indications.

Self-tests

The AED has a comprehensive self-test system that automatically tests the electronics, battery, pads, and high voltage circuitry. Self-tests are also activated every time you open and close the AED lid.

When performing the self-tests, the AED completes the following steps automatically:

1. Turns itself on, and the Status Indicator changes to red.
2. Performs the self-test.
3. If successful, the Status Indicator reverts to green.
4. Turns itself off if the lid is closed.

There are three types of automatic self-tests:

- The daily self-test checks the battery, pads, and the electronic components.
- The weekly self-test completes a partial charge of the high voltage electronics in addition to the items tested in the daily self-test.
- During the monthly self-test, the high voltage electronics are charged to full energy in addition to the items tested in the daily self test.

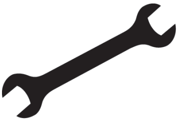
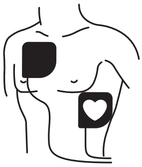
In addition, self-tests will be initiated upon opening the lid and again upon closing the lid.

If the self-test detects an error, the Status Indicator remains red. Upon closing the lid, an audible alert will be issued. The diagnostic panel under the lid indicates the source of the problem according to Table 5-1 on page 5-3.

Indicator troubleshooting table

The following is a troubleshooting table for the AED indicators.

Table 5-1: Indicator Troubleshooting Table

View	Symptom	Solution
	Red Service indicator appears on the screen.	Maintenance by authorized service personnel is required. Contact Cardiac Science Technical Support or, outside the U. S., your local Cardiac Science representative.
	Red Pads indicator (LED) is lit.	Connect the pads or replace with a new pair.
	The last battery indicator (LED) is red and flashing.	The battery is low. Replace with a new battery.
	Rescue Ready Status indicator is red, and no other indicators on the diagnostic panel are lit.	Replace the battery. If the status indicator remains red, contact Cardiac Science Technical Support or, outside the U. S., your local Cardiac Science representative.

⚠ **Caution: Temperature Extremes.**

Exposing the AED to extreme environmental conditions outside of its operating parameters may compromise the ability of the AED to function properly. The Rescue Ready® daily self-test verifies the impact of extreme environmental conditions on the AED. If the daily self-test determines environmental conditions outside of the AED's operating parameters, the Rescue Ready indicator could change to red (not Rescue Ready) and the AED may issue a "SERVICE REQUIRED" alert to prompt the user to move the AED to environmental conditions within the acceptable operating parameters at once. See Chapter 6, *Technical Data*, for acceptable environmental conditions and *Rescue Ready status indicator* on page 3-1 for information about the Rescue Ready indicator.

⚠ **Caution: Not Rescue Ready.**

Issues other than extreme environmental conditions can cause the AED to become not Rescue Ready. For more information, see *Rescue Ready status indicator* on page 3-1.

Scheduled maintenance

Note: Powerheart G3 AEDs perform weekly partial energy and monthly full energy charges of the high voltage circuitry as part of their extensive self testing regimens. Consequently, Cardiac Science does not recommend that users perform any additional energy tests.

Perform the following tests per the schedule indicated:

Daily maintenance

Check the Status Indicator to ensure that it is GREEN. When the indicator is GREEN, the AED is ready for a rescue. If the indicator is RED, refer to the troubleshooting table on page 5-3.

Monthly maintenance

Perform the following procedure each month (28 days):

1. Open the AED lid.
2. Wait for the AED to indicate status: Observe the change of the STATUS INDICATOR to RED. After approximately 5 seconds, verify that the STATUS INDICATOR returns to GREEN.

3. Check the expiration date on the pads.
4. Check that the battery has adequate charge. If the battery indicator is red, replace the battery.
5. Listen for the voice prompts. Additionally, check the display shows text prompts that correspond to the audio.
6. Close the lid and observe the change of the STATUS INDICATOR to RED. After approximately 5 seconds, verify that the STATUS INDICATOR returns to GREEN.

Annual maintenance

Perform the following tests annually to confirm that the diagnostics are functioning properly and to verify the integrity of the case.

Check the integrity of the pads and circuitry:

1. Open the AED lid.
2. Remove the pads.
3. Close the lid.
4. Confirm that the STATUS INDICATOR turns RED.
5. Open the lid and confirm that the pads icon flashes on the screen.
6. Reconnect the pads and close the lid.
7. Make sure the expiration date is visible through the clear window of the lid.
8. Check to make sure that the STATUS INDICATOR is GREEN. If the pads are not installed properly, the pads icon flashes on the screen. Contact Cardiac Science Technical Support (see *Contact information* on page 1-2) or outside the U.S., your local Cardiac Science representative.
9. Open the lid and confirm that no diagnostic indicators are lit.
10. Check the expiration date of the pads; if expired, replace them.
11. Check the pads packaging integrity.
12. Close the lid

Check the Integrity of the Service Indicator (LED) and Circuitry:

1. Immediately after opening the AED lid, press and hold the Shock button and confirm that the Service LED is lit.
2. Release the Shock button.
3. Close the lid.

4. Verify that the STATUS INDICATOR remains RED.
5. Open the lid and confirm that no diagnostic panel indicators are lit.
6. Close the lid.
7. Verify that the STATUS INDICATOR turns GREEN.

Check the integrity of the case:

Examine the molded case of the AED for any visible signs of stress. If the case shows signs of stress, contact Cardiac Science Technical Support (see *Contact information* on page 1-2) or outside the U.S., your local Cardiac Science representative.

Cleaning and care

Use a cloth dampened with an approved cleaning solution to wipe the case. Dry the case with a clean cloth. Do not spray or pour the cleaning solution on the case or submerge the AED.

Approved cleaners

Use one of these solutions to clean the case of the AED: soapy water, ethanol, or 91% isopropyl.

The AED and its accessories cannot be sterilized.

Caution: Equipment Damage.

When cleaning the device, use one of the following: Isopropyl Alcohol, Ethanol, a mild soapy water solution, or a 3% hydrogen peroxide solution.

Caution: Equipment Damage.

Keep all cleaning solutions and moisture away from the inside of all defibrillation pads and cable connector openings.

Authorized repair service

The AED has no user-serviceable internal components. Try to resolve any maintenance issues with the AED by using the Troubleshooting Table presented in this chapter. If you are unable to resolve the problem, contact Cardiac Science Technical Support (see *Contact information* on page 1-2) or outside the U.S., your local Cardiac Science representative.

⚠ **WARNING! Shock Hazard.**

Do not disassemble the AED. Failure to observe this warning can result in personal injury or death. Refer maintenance issues to Cardiac Science authorized service personnel.

Note: The warranty will be void upon unauthorized disassembly or service of the AED.

Frequently Asked Questions

Q: Can I give CPR while the AED is analyzing?

A: No. As with all AEDs, the operator should stop CPR compressions during the analysis phase.

Q: Can I transport the victim while the AED is analyzing?

A: No. Vehicle motion may cause noise artifacts that could interfere with proper cardiac rhythm analysis. Stop the vehicle when cardiac rhythm analysis is necessary.

Q: Is it safe for the AED to provide a shock to a patient lying on a conductive floor, antistatic floor, or a metal surface?

A: Yes, it is safe. Using a Powerheart AED on a patient lying on a conductive floor, antistatic floor, or a metal surface does not create a safety hazard for either the device user or the patient.

Q: Do I need to prepare the chest prior to pad application?

A: Special preparation is not usually necessary. The chest should be as clean, dry, and as oil free as possible. Follow your Medical Director's instruction.

Q: What happens if the battery is low?

A: There are several Battery Low conditions that the AED will detect:

Battery Low detected - AED not in use: If a low battery condition is detected during a self test, the AED will beep once every 30 seconds. Remove the battery and replace with a fresh battery.

Battery Low detected – AED in use: When the red LED initially lights up—upon lid opening or at any time during a rescue—a BATTERY LOW prompt will be issued at once. However, the AED is capable of delivering at least 9 defibrillation shocks after the first BATTERY LOW prompt is issued.

Battery too low to charge AED during rescue: When the AED is not capable of delivering any more shocks, a BATTERY LOW prompt is displayed until the battery is replaced or AED activity ends.

To continue the rescue attempt, leave the lid open and replace the battery. When the battery replacement takes longer than 60 seconds, the first rescue is terminated and the AED begins to record the events from then on as a separate rescue.

Battery is completely depleted—No AED function: All AED activity stops until the battery is replaced with a fresh battery.

Q: How do I set the AED internal clock?

A: Set the clock by using the Rescuelink Software Program and a PC. See *Setting the AED internal clock* on page 3-7.

Q: What happens if I close the lid in the middle of a rescue attempt?

A: If you close the lid during a rescue, you must re-open the lid within 15 seconds to continue the rescue. You will hear the prompt, “Open lid to Continue Rescue.” If the lid remains closed for more than 15 seconds, a new rescue will initiate when the lid is reopened.

Note: If the lid is closed during a rescue while the pads are connected to the patient, the STATUS INDICATOR remains GREEN. When the lid is reopened, however, the STATUS INDICATOR will turn RED and then back to GREEN. The rescue may be continued.

Q: My AED is sounding an audible alert. Why? How do I stop it?

A: The audible alert indicates that the self-test detected a need for maintenance or corrective action. Open the device lid and view the indicator on the diagnostic panel. Determine the maintenance required by using the troubleshooting table on page 5-3.

Q: The AED did not sound an audible alert when I removed the pads and closed the lid. Why?

Note: Ensure the battery is installed. The AED will never beep while battery is removed.

A: The lid-closed pad self-test only activates the STATUS INDICATOR. The AED allows time for replacement of the pads—as removing pads is a normal procedure after a rescue—or a battery during the post rescue procedure.

Q: What if I have to perform a rescue in an isolated area and at subzero temperatures?

A: When travel to a rescue involves exposing the AED to extremely cold temperatures for an extended period of time, keep the pads and the battery warm.

Q: What should I do if I initiate MANUAL MODE but then decide AED MODE is more appropriate?

A: Momentarily closing the lid and opening the lid will always take the device out of MANUAL mode and into AED MODE. Once charging is complete, wait 30 seconds for the AED to revert back to AED MODE. The seconds will count down on the display. If “REMAIN IN MANUAL MODE” has been enabled, momentarily close the AED lid and reopen. This will revert the AED to AED mode.

6 Technical Data

Contents

This section lists the AED parameters and describes the STAR biphasic waveform.

Parameters

Table 6-1: Parameters

Parameter	Detail
Operation	Semi-Automatic (shock advisory) Manual
Audible Alerts	Voice Prompt Maintenance Alert
Visible Indicators	Status Indicator Battery Status Indicator Service Indicator Pads Indicator Text Display
Rescue Data Storage	Internal with 60 minutes ECG data with event annotation
Dimensions	Height: 8 cm (3.3 in) Width: 27 cm (10.6 in) Depth: 31 cm (12.4 in)
Weight (Batteries and Pads)	3.20 kg (7.0 lb)
Environmental Operation and Standby Conditions	Temperature: 0°C to 50°C (32°F to 122°F) Humidity: 5% to 95% (non-condensing) Pressure: 57kPa (+15,000ft) to 103kPa (-500ft)
Shipment and Transport environmental Conditions (for up to 1 week)	Temperature: -30°C to 65°C (-22°F to 149°F) Humidity: 5% to 95% (non-condensing) Pressure: 57kPa (+15,000ft) to 103kPa (-500ft)
Pads	Self-adhesive, disposable defibrillation pads Minimum combined surface area: 228cm^2 Extended length of lead wire: 1.3m

Table 6-1: Parameters (continued)

Parameter	Detail
9144 Rechargeable Lithium Battery Specifications	Output voltage: 11.1VDC Battery is rechargeable Check local regulations for disposal information Operational life: 2.5 years or 300 battery charge/discharge cycles, whichever comes first Standby: 6 months Capacity: 100 shocks typical (60 shocks minimum) or 3 hours minimum of ECG display (6 hours typical) Charge time: 3 hours for stated capacity; 4.5 hours to fully charge depleted battery **Note:** The battery operating life depends on the type of battery, device settings, actual usage, and environmental factors.
9145 Lithium Battery Specifications	Output voltage: 12VDC Batteries are non-rechargeable Lithium content: 9.2g Check local regulations for disposal information Estimated Shelf Life (from date of manufacture): 5 Years Typical Shocks: 290 shocks **Note:** The battery operating life depends on the type of battery, device settings, actual usage, and environmental factors.
Batteries and Capacitor Charge Times	A new battery, after the AED has delivered 15 300VE shocks, typically takes 10 seconds to charge the AED to maximum energy. A battery with reduced capacity will take longer to charge the AED.
Battery charger (for 9144 rechargeable battery)	Power Requirements: 90-132 VAC or 198-264 VAC at 47-63 Hz The charger operates from, and accepts standard IEC mains power cables.

Table 6-1: Parameters (continued)

Parameter	Detail
AED Self test Sequence	Daily: Battery, pads, internal electronics, Shock button, and software. Weekly: Battery, pads, internal electronics, Shock button, software, and partial energy charge cycle. Monthly (every 28 days): Battery under load, pads, internal electronics, full-energy charge cycle, Shock button, and software. Open Lid (when lid is opened): Battery, pads, internal electronics, Shock button, and software. Close Lid (when lid is closed): Battery, pads, internal electronics, Shock button, and software.

Table 6-1: Parameters (continued)

Parameter	Detail
Safety and Performance	Model 9300P The AED has been designed and manufactured to conform to the highest standards of safety and performance including electromagnetic compatibility (EMC). The 9300P and pads conform to the applicable requirements of the following: CSA: Classified by CSA International with respect to electric shock, fire and mechanical hazards only in accordance with CAN/CSA C22.2 No.60601-1:08, EN60601-1 and EN60601-2-4. Certified to CAN/CSA Standard C22.2 No. 60601-1:08. Electrical, Construction, Safety and Performance: IEC 60601-1 IEC 60601-2-4 Electromagnetic Compatibility (EMC): IEC 60601-1-2 IEC 60601-2-4
Emissions	EM: EN 55011/CISPR 11, Group 1, Class B RTCA DO-160D Section 21, Category M

Table 6-1: Parameters (continued)

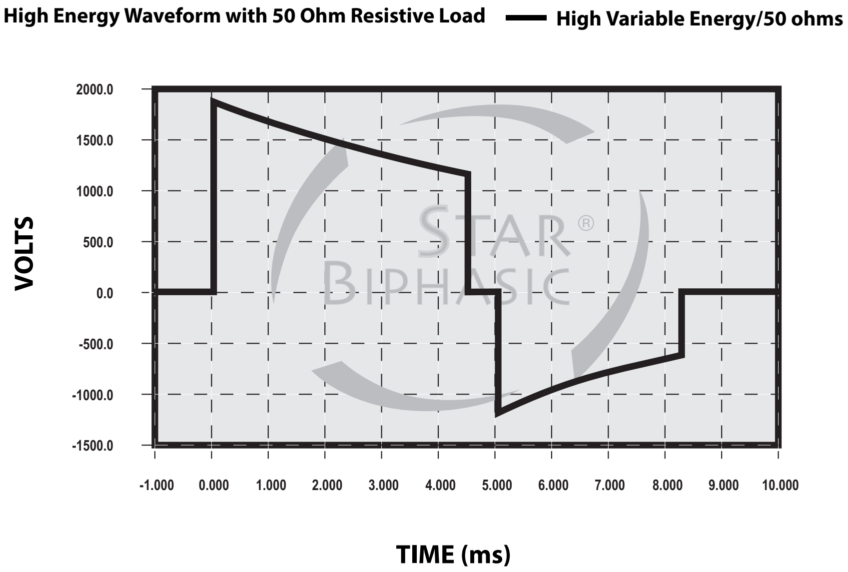
Parameter	Detail
Immunity	EM IEC 61000-4-3, Level X, (20V/m) IEC 60601-2-4, (20V/m) Magnetic IEC 61000-4-8 IEC 60601-2-4 ESD IEC 61000-4-2 IEC 60601-2-4 6kV contact discharge, 8KV air gap discharge
Environmental Conditions	Free Fall Drop: IEC 60068-2-32, 1 meter Bump: IEC 60068-2-29, 40g and 6000 bumps Vibration (Random): IEC 60068-2-64: 10Hz – 2kHz, 0.005 – 0.0012 g^2/Hz Vibration (Sine): IEC 60068-2-6: 10Hz – 60Hz, 0.15 mm and 60Hz – 150Hz, 2g Enclosure Protection: IEC 60529, IP24 Vibration (random): RTCA DO-160D Section 8, category S, curve B Temperature variation: RTCA DO-160D Section 5, category C Temperature/altitude decompression/overpressure: RTCA DO-160D section 4, category A4, operating 0°C to 50°C, ground survival 0°C to 50°C
Shipping and Transportation Conditions	ISTA Procedure 2A
RHYTHMx ECG Analysis Performance	The AED RHYTHMx ECG Analysis system analyzes the patient's ECG and advises you when the AED detects a shockable or non-shockable rhythm. This system makes it possible for a person, with no training in the interpretation of ECG rhythms, to offer defibrillation therapy to victims of sudden cardiac arrest. With a new battery, after the AED has delivered 15 300VE shocks, the maximum time from beginning rhythm analysis until the AED is ready to shock is 17 seconds.

Table 6-1: Parameters (continued)

Parameter	Detail
Cardiac Rhythms Used to Test the Rhythm Recognition Detection System for Powerheart G3 AEDs	Shockable Rhythm – VF: Meets IEC 60601-2-4 requirement and AHA recommendation of Sensitivity of >90% Automatic External Defibrillators for Public Access Defibrillation: Recommendations for Specifying and Reporting Arrhythmia Analysis Algorithm Performance, Incorporating New Waveforms and Enhancing Safety, AHA AED Task Force and approved by the AHA Science Advisory and Coordinating Committee. Circulation, 1997(95), pp 1677-1682 Shockable Rhythm – VT: Meets IEC 60601-2-4 requirement and AHA recommendation of Sensitivity of >75% Non-shockable Rhythm – NSR: Meets IEC 60601-2-4 requirement (>95%) and AHA recommendation (>99%) of Specificity Non-shockable – Asystole: Meets IEC 60601-2-4 requirement and AHA recommendation of Specificity of >95% Non-shockable: Meets IEC 60601-2-4 requirement and AHA recommendation of Specificity – all other rhythms of >95% For detailed information contact Cardiac Science for white papers: P/N 112-2013-005 (Pediatric Defibrillation Instructions for use) P/N 110-0033-001 (RHYTHMx White Paper) P/N MKT-11081-01 (STAR Biphasic White Paper)

STAR biphasic waveform

The waveform generated by the AED is a Biphasic Truncated Exponential waveform. The following is a graph of the waveform voltage as a function of time when the AED is connected to a 50 Ohm resistive load.



The Biphasic Truncated Exponential (BTE) waveform uses variable energy. The actual energy delivered will vary with the patient's impedance and the device will deliver a shock when impedance is between 25-180 Ohms. Energy will be delivered at three different levels referred to as ultra-low variable energy, low variable energy, and high variable energy as shown in the waveform tables on the following pages.

Table 6-2: Ultra-low Variable Energy (150 VE) Powerheart G3 Waveform

	Phase 1		Phase 2		
Patient's Impedance (Ohms)	Voltage* (Volts)	Duration* (MS)	Voltage * (Volts)	Duration* (MS)	Energy** (Joules)
25	1393	3.3	743	3.2	145-196
50	1420	4.5	909	3.2	128-173
75	1430	5.8	973	3.2	116-156
100	1434	7.0	1007	3.2	108-146
125	1437	8.3	1027	3.2	102-138
150	1439	9.5	1040	3.2	98-132
175	1441	10.8	1049	3.2	95-128

Table 6-3: Low Variable Energy (200 VE) Powerheart G3 Waveform

	Phase 1		Phase 2		
Patient's Impedance (Ohms)	Voltage* (Volts)	Duration* (MS)	Voltage* (Volts)	Duration* (MS)	Energy** (Joules)
25	1609	3.3	858	3.2	193-260
50	1640	4.5	1050	3.2	170-230
75	1651	5.8	1124	3.2	155-209
100	1656	7.0	1163	3.2	144-194
125	1660	8.3	1186	3.2	136-184
150	1662	9.5	1201	3.2	130-176
175	1663	10.8	1212	3.2	126-170

Table 6-4: High Variable Energy Powerheart G3 Waveform (all values are typical)

	Phase 1		Phase 2		
Patient's Impedance (Ohms)	**Voltage* (Volts)**	**Duration* (MS)**	**Voltage* (Volts)**	**Duration* (MS)**	**Energy** (Joules)**
25	1869	3.3	997	3.2	260-351
50	1906	4.5	1220	3.2	230-311
75	1918	5.8	1306	3.2	209-283
100	1925	7.0	1351	3.2	195-263
125	1928	8.3	1378	3.2	184-248
150	1931	9.5	1396	3.2	176-238
175	1933	10.8	1408	3.2	170-230

* All values are typical.

**Allowable energy range.

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EOTI-SOP 3
MPPEH MANAGEMENT

MPPEH MANAGEMENT

STANDARD OPERATING PROCEDURES

Prepared By:

Explosive Ordnance Technologies, Inc.

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Knoxville, TN 37923

TABLE OF CONTENTS

1 PROCEDURES

1.1 MDAS COLLECTION DAILY CERTIFICATION AND STORAGE

1.1.1 Purpose

The purpose of this SOP is to provide procedures for the collection, daily certification and storage of MPPEH and its inspection, certification and verification as MDAS during segregation and separation operations.

1.1.2 Scope

This SOP applies to EOTI UXO Technicians accounting for, managing and preparing MDAS for recycling. This SOP is not a stand-alone document and should be used together with other SOPs, the Site Safety and Health Plan (SSHP), applicable Federal, State, local regulations, and contract restrictions and guidance.

1.1.3 Training

Individuals selected have received or will receive MPPEH Training from NOSSA and those UXO technicians fulfill the TP-18 requirements under NAVSEA OP 5, Volume 1, 7th Revision guidance.

1.1.4 Collection, Certification and Storage Procedures

All recovered MPPEH items will undergo a 100% inspection and an independent 100% re-inspection by the SUXOS and UXOSO/QCS to determine and document whether the item is MDAS or material documented as an explosive hazard (MDEH). MDAS is recorded and a brief description is documented in the Comments block of the inspection sheet. Individual weights for MDAS are not required; however, an estimate of the total weight of MDAS is noted on the inspection sheet.

The total MDAS weight by area is documented by the SUXOS at the end of each workday. MDAS will be containerized, locked, and segregated to prevent comingling with MDEH or MPPEH pending categorizing. MDAS will be certified daily to maintain its explosive safety status. MDAS will be prepared for transport to recycler in sealed containers, under a chain of custody that will follow the material until final processing.

1.1.5 MDAS Certification and Containerization

MDAS will be certified explosives free by the SUXOS and recorded in the field log. Only processed material that been certified will be placed in the processed drums and sealed. This sealed container is then locked, weighed, and labeled, and a chain-of-custody (DD Form 1348-1A), with numbered seals, is generated.

The DD Form 1348-1A will contain the following statement to be signed by the SUXOS and the UXOQCS:
"The material listed on this form has been inspected or processed by DDESB-approved means, as required by DOD policy, and to the best of my knowledge and belief does not pose an explosive hazard".

The MDAS will be transferred to AGVIQ under the chain-of-custody procedure. The chain-of--custody will be terminated when the material is smelted or demilitarized by the recycling facility and documentation is returned from the facility attesting to the process.

1.2 QUALITY CONTROL

Any tasks the UXOQCS determines to not meet the quality control standards will be considered deficient or non-conforming. If a deficiency or nonconformance occurs, the UXOQCS will prepare a Nonconformance Report and submit to the SUXOS. The SUXOS will conduct a root cause analysis of the deficiency or nonconformance, prepare and submit a response to the PM and QC within 48 hours.

2 HAZARD ANALYSIS/RISK ASSESSMENT AND HAZARD CONTROL BRIEF

All personnel will attend the tailgate safety briefing given by the SUXOS, on the existing and potential hazards within the MDAS inspection and holding area prior to commencing any MDAS Management or Recycling activities. Personnel will be cognizant of the surroundings and remain observant of their footing at all times. All personnel shall be aware of the signs of heat stress and be able to recognize the onset of heat stress disorders in themselves and their team members. Wear long sleeve clothing and apply insect repellant as warranted to mitigate the impact of biting/stinging insects.

The potential for encountering MDEH comingled with MDAS is very low. Should MDEH be discovered, it will be left in place, the SUXOS and the UXOQCS will be notified to investigate the occurrence and determine the corrective actions.

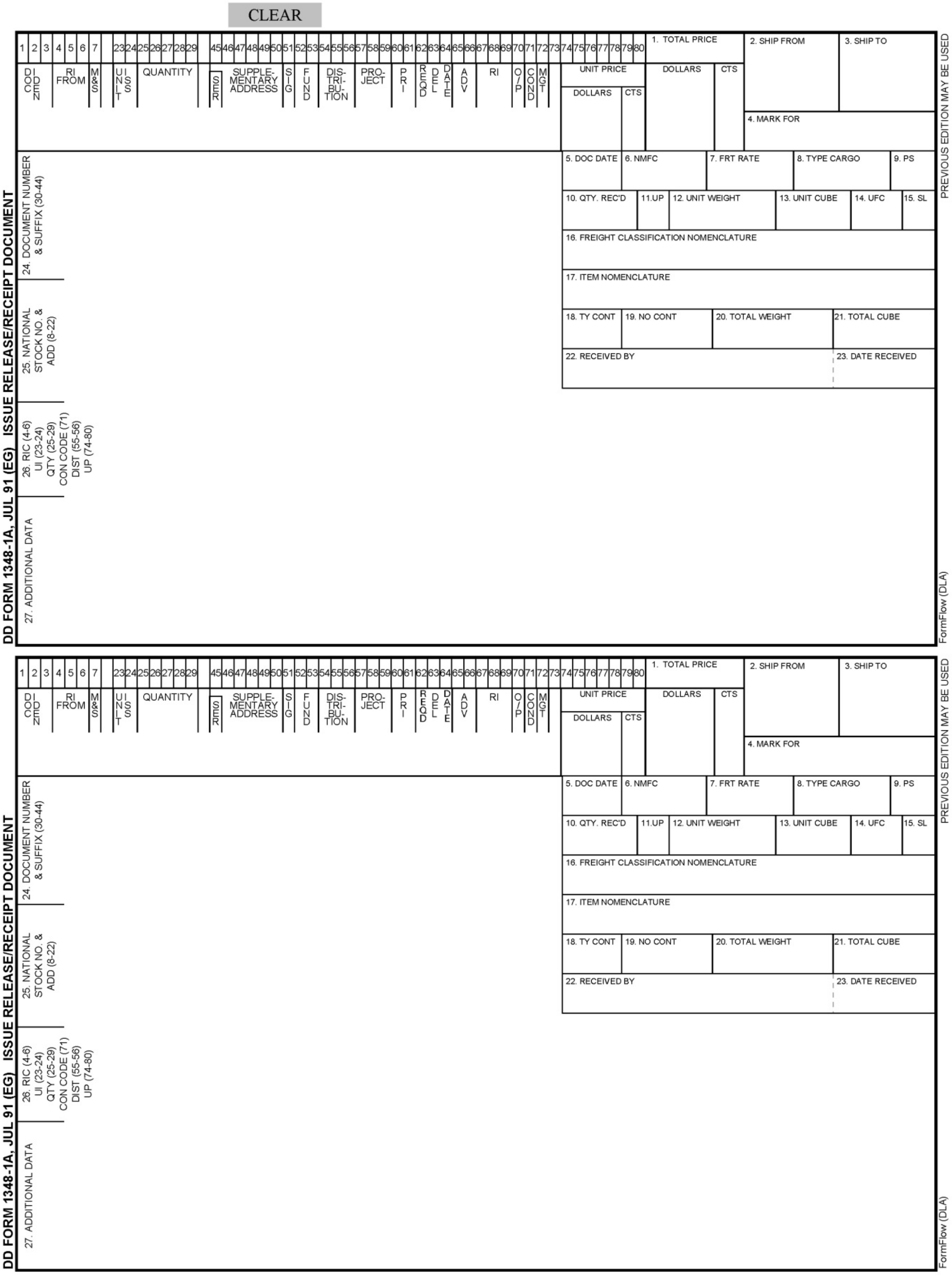
3 DIAGRAMS

Site maps of the work area are located in the construction office/trailer. Teams will be provided maps of the overall project site and evacuation routes.

4 EQUIPMENT

The MDAS Management team will be equipped with the following: MDAS containers provided by AGVIQ (e.g., 55 gallon drums):

- Container handling equipment as required
- Seals
- Logbook and/or PDA for recording data
- Camera
- Communications equipment
- Required safety equipment includes the following:
- First-aid kit
- Level D PPE Inclement weather gear as needed



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7. FRT RATE
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26. RIC (4-6)
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CON CODE (71)
DIST (55-56)
UP (74-80)
27. ADDITIONAL DATA

DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

PREVIOUS EDITION MAY BE USED

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DD FORM 1348-1A, JUL 91 (EG) ISSUE RELEASE/RECEIPT DOCUMENT

PREVIOUS EDITION MAY BE USED

FormFlow (DLA)

EOTI-SOP 4
SAFE TO MOVE PROCEDURES FOR UXO

STANDARD OPERATING PROCEDURE 04:

Safe to Move Procedures for UXO – Siege Battery – TD River and Battery Knox – TD River MRSs at West Point, NY

Purpose

This standard operating procedure (SOP) provides general guidelines for determining the "Safe to Move" procedures for UXO for the Siege Battery – TD River and Battery Knox – TD River MRSs at West Point, NY.

Scope

The determination for MEC that is "Safe to Move" will follow the process outlined below.

Equipment and Materials

- Individual Dive Gear
- Diver through water communications system
- GPS point collection equipment
- MineLab Excalibur II underwater all-metals detectors (or comparable)
- Support Boats
- Pelican floats (or equivalent)
- Log book
- Chart with plotted transects and anomaly waypoints or locations marked
- Prepositioned transects
- Prepositioned waypoints
- Approved hand tools for excavation

Procedures and Guidelines

A. Laying of Waypoints and Search Line Patterns (Transects)

1. Anomaly waypoints transects, ascent/decent lines, and other marker buoys will be set up in advance of the dive operations by Weston Solutions, Inc..

B. General Procedures for Determining if MEC/MPPEH is Safe to Move

1. Diver/divers will enter water at the up-current buoy and descend to the up current end of the anomaly waypoint or transect.
    a. Note: This procedure will be accomplished using a single diver search method.
2. Diver will ensure ordnance locator is on and begin an all metals locator assisted sweep toward the down current end of anomaly waypoint or transect.

   a. For a single diver search the search pattern will consist of a minimum 10 ft. arc (5 ft. on each side of anomaly waypoint or transect).

3. Upon MEC/MPPEH acquisition, diver will notify the diving supervisor of contact type, (either surface or sub-surface), position and distance on anomaly waypoint or transect line. Diver will also deploy an additional marker buoy (if required) to identify the location for a surface GPS mark.

4. If MEC/MPPEH requires intrusive investigation, diver will request permission from the diving supervisor to expose/dig.

   a. If item is embedded in any sensitive area and condition of the item cannot be determined the diver will surface and consult with diving supervisor to discuss further investigation procedures.

5. Upon receipt of permission to expose, diver will investigate contact using proper techniques (Dig from the side of the item).

   a. If the source of an anomaly is found to be deeper than 18 inches, the anomaly identifier and location will be recorded as having a source deeper than 18 inches beneath the river bottom that was not characterized or removed.

6. Once MPPEH/MEC is exposed diver will attempt to identify and obtain the following information:

Unique, Sequential Identification Number
Item Group
Item Class
Item Category
Type/Filler
Description/Fuzing (presence of nose and or base fuse)
Quantity
Depth of water
Depth of Item in Sediment (approximate)
Weight (estimate)
Frag
Demo Required
General Comment for Condition of Item (biological growth on item, etc.)
General Location
Date Found
Action Taken
Item moved to (as applicable)
X Geographic Coordinate
Y Geographic Coordinate
Photograph to include accompanied white board / slate

7. Upon obtaining the above information diver one will be recovered and a second diver will be deployed to confirm the information if a two man search team is used, the second diver will confirm information.

8. Upon confirmation by a second diver, all information will be analyzed by the dive supervisor, SUXOS and UXOSO.

    a. Only items that can be safely moved as determined by both the SUXOS and UXOSO will be moved in accordance with the approved Work Plan and ESS.

9. Upon agreement of both the SUXOS and UXOSO a determination will be made whether the item is safe to move. This agreed upon decision will be documented in the field logbook.

10. Only items which can be manually and safely brought to the surface will be moved.

11. Once brought to the surface MEC / MPPEH deemed as "Safe to Move" will be secured in the support boat using sandbags or a closed metal container and be transported as follows:

    a. If MEC/MPPEH are found and can be moved and moved safely, they will be removed during the SI and consolidated in an approved area for treatment. They will be detonated in accordance with the guidelines as outlined in the ESS.

12. If an MEC/MPPEH item found is deemed unsafe to move, it presents an imminent explosive hazard to persons in the area or potential trespassers, the on-site government representative or OESS will be immediately notified and the site will be secured until a remediation of the item by underwater detonation can be made.

C. If MEC is determined as "Unsafe to Move" for any reason or removal of the item will negatively Impact the environment the following procedures will apply:

1. Item will be marked with a diver deployed buoy and a GPS mark will be taken.

2. Item will be remediated and blown in place (BIP) when approved by the USACE Program manager and the Baltimore District USACE PM.

EOTI-SOP 5
TETHERED DIVING

STANDARD OPERATING PROCEDURE 05:

Tethered Diving – Siege Battery – TD River and Battery Knox – TD River MRSs at West Point, NY

Purpose

This standard operating procedure (SOP) provides general guidelines for utilizing Tethered Diving standard operating procedures for underwater UXO remediation for the Siege Battery – TD River and Battery Knox – TD River MRSs at West Point, NY.

Scope

Tethered diving is a tended diving method where one diver in the water is line tended by surface personnel and directed to perform a variety of underwater tasks, which could include light work or scientific tasks. OSHA also requires that standby divers for working dives be line tended. This method is applicable to SCUBA and surface supplied air (SSA) diving. The typical tethered diving equipment, personnel, and procedure is described below.

Typical Equipment and Materials

- Individual Dive Gear
- Diver through water communications system
- GPS point collection equipment
- MineLab Excalibur II underwater all-metals detectors (or comparable)
- Support Boats
- Pelican floats (or equivalent)
- Log book
- Chart with plotted transects and anomaly waypoints or locations marked
- Approved hand tools for excavation
- Other additional equipment as specified in the project-specific Dive Operations Plan

Equipment utilized for tethered diving nominally includes the standard diver dress, e.g. dry suit, fins, and weight belt, as well as other equipment required to accommodate tethered diving needs. These other items include, at a minimum, a full-face mask with communications, strength member with quick release snap shackle tether, hardwired or wireless communications, and man-rated safety harness for rated for lifting the diver from the water. In addition, a cutting device is recommended for the diver within easy reach, e.g. EMT shears mounted on the harness.

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Procedures and Guidelines

A. Establishment of Target of Interest (TOI) locations

1. For this project, TOI waypoints, transects, ascent/decent lines, and/or marker buoys will be established by Weston Solutions, Inc. prior to the actual dive operations.

B. General Considerations for Supporting Tethered Diving Operations

1 *Full-face mask* - The full-face mask (FFM), allows for hardwired communication and in conjunction with a dry suit with hood, e.g. Viking pro-magnum and dry gloves and will give the diver some protection from polluted water, when using the positive pressure version to minimize leakage. Typically, the mask is used with an ear/microphone attachment, such that the diver may be in constant hardline communication with the surface.

2 *Tether line* - While any kind of line may be used in conjunction with line signals, typically a comm. rope is used to allow for constant communications with the diver. Care must be taken in tending the diver when moving in arc patterns (discussed below), such that the line is not hung up and frayed on sharp underwater objects. The tether should be fitted with a quick release snap-shackle to allow the diver to egress to the surface should the tether become irreconcilably entangled in bottom debris. The tether may also be marked in intervals for measuring distances used in search patterns, for example. Tethers can be made in most any length, though 200 and 300-foot tethers are typical for their dive operations. Generally, the length of tether required must be the distance from the dive platform added to the depth to the dive site multiplied by 1.5 (NOAA, 2009), e.g. 50 feet from the dive site at a 50-foot depth would be 150 feet of tether. A tether longer than 300 foot can present some span of control problems with a dive platform under anchor, in adequately fending off nearby vessel traffic in a timely fashion. The tether should be stowed in a bucket or bag of some kind, with the tender end going in first, diver end last, to keep it from being stepped on and damaged, and to avoid tripping/falling hazards on the dive platform. The container should allow for easy decontamination and segregation of contaminated line from other gear.

3 *Communications Unit* - The communications unit is utilized by the tender while tending the diver's line to maintain constant verbal communication with the diver and standby diver. The tender communications unit allows the tender to talk with the diver via a headset and belt clip communications unit. The tender unit typically uses replaceable batteries, which should be changed out daily to ensure constant communications. The vessel should have one set of batteries per day for the dive operation, plus one spare set. Care should be taken when installing batteries in the unit, as the battery compartment soldering can be quite fragile. Rechargeable batteries are beneficial for this purpose to minimize waste generation from daily dive operations. When connecting the headset to the belt clip unit, a "squeal" should initially be heard as the unit powers on. Absence of this sound can indicate that the batteries are dead, or that the unit is otherwise not functioning. When the unit is not in use, the headset should be disconnected from the belt clip unit to conserve battery power.

4 *Harness* - A diver harness is necessary to connect the diver securing to the tether line. Buoyancy compensation device (BCD) D-rings are inadequate strength members for this task, as they cannot support the diver's entire weight and dynamic load when the tender needs to quickly retrieve the diver. Breakage of a BCD D-ring could result in serious injury to the

diver, as the diver's head is connected to the tether via the communications cable, absent the secure harness connection. The harness is worn underneath the BCD or backpack on top of the wetsuit or dry suit. The harness should be rated to pull the diver from the water, in the event of an emergency on the surface or beneath the water.

5 *Emergency Gas Supply* - An emergency gas supply (EGS) is necessary for tethered diving operations should the primary air supply be exhausted. The EGS may be a pony bottle connected to a larger primary bottle up to a fully redundant SCUBA bottle, depending on diving depth (Barsky, 1999). The EGS bottle is left open for diving, while the manifold block is in the closed position, such that the diver is breathing off the primary surface-supplied air (SSA) supply, but may access the reserve supply by simply turning the manifold knob, as in a surface supplied air configuration. This is different than a non FFM configuration, where the pony bottle is normally left off (e.g. NOAA mouthpiece reserve air supply system) to prevent a free flow from emptying the reserve supply. A 15 or 19 cubic foot EGS may be adequate for shallow diving, while a 30 cubic foot tank should be used at or below 100 feet. The EGS should be mounted upside down such that the diver can reach the tank valve, should it accidentally be left closed. A submersible pressure gauge (SPG) must also be in plain view of the diver so that they may see the internal pressure of their EGS bottle. For example, if the manifold block is bumped, the diver may start breathing off the EGS without their knowledge. Frequent checking of the primary gas supply SPG, bailout block and EGS SPG will help to ensure that the diver is continuously breathing off the primary air supply. Also, as tethered diving is often used for low visibility situations, analog gauges should be used as digital gauges cannot be read when pressing the gauge directly against the FFM in true blackout conditions. For diving with a dry suit, the inflator whip should be connected to the manifold block such that suit inflation may still be achieved when using the EGS.

6 *Diver* - The diver, unlike in the conventional SCUBA diving buddy system, will be diving alone. This takes some adjustment for the diver, and reminders from their divemaster that they will be in constant communication with the surface. Taking the dive slowly and not rushing through tasks is key to avoiding panic, and minimizing air consumption. The tethered SSA diver will need to adjust to not being primarily in control of their dive, i.e. the divemaster will be in constant communication with them, and will instruct the diver what to do, and when to do it. As with all dives, the diver may end the dive for any reason.

7 *Tender* - The tender will assist the diver in dressing in, tending the line, and doffing gear at the end of the dive. The tender should also be a diver prepared to dive each day, especially for deeper dive profiles. Tender responsibilities are the same as generally defined for buddy type SCUBA operations, except that they remain on the surface and can hear the diver throughout the dive, and should be monitoring the diver constantly for signs of anxiety. Breathing rate of the diver is a clue to their mental status. As needed, the tender should ask the diver to stop what they are doing, rest, and breathe (e.g. more deeply or slowly). As with all dives, the tender must remain undistracted such that they can monitor the surface for danger from incoming boat traffic and any other hazards.

8 *Standby Diver* - All tethered diving operations require a standby diver. The standby diver must be ready to get into the water within several minutes, and be dressed in their drysuit either half way, or fully at the divemaster's discretion.

C. Procedures for Supporting Tethered Diving Operations

1 *Dive Team Logistics* - As noted above, the tethered diving operation normally involves ***at least*** three divers. This allows for safe and efficient diving by rotating through the crew of 3 divers, especially for deeper dive profiles. The 3-person rotation allows for ample surface intervals for the diver who has just completed a dive, and then becomes the Tender, the diver who has been out of the water for the duration of the last dive, who becomes the standby diver, and the diver, who has been out of the water for at least two dives worth of time.

2 *Dive Gear Donning, Water Entry, and Descent* - The tender and standby diver both assist the diver in donning gear. Special attention is paid to placement and setting of the manifold block/EGS and verification that the diver can reach the block and EGS valves easily, and without looking, as tethered diving is often used in low visibility environments. The primary and EGS tank pressures are checked and recorded. Comm. checks are performed, and volumes/ear piece placement adjusted as needed. The diver is deployed with an extra loop of line available (to avoid jerking the diver during descent) and the tender arrests their descent into the water via the tether line and holds them at the surface until they can complete a mask check. The tender uses both hands to tend the line, to ensure that the diver is firmly held in place. The tether line is never wound around the tender in any way for two reasons: 1) the line could become contaminated under some conditions which could leave polluted water and sediment on the tender, and 2), the tender could be pulled into the water with the line wound around them. The tender should use gloves to prevent chafing, and these should be covered by disposable gloves if there is any chance of contamination in surface water or sediment. Likewise, the tether should be managed in a portion of the dive platform considered to be the "hot zone" where it can be appropriately decontaminated and otherwise managed without tracking contamination throughout the vessel during tending at contaminated sites. The diver controls the rate of descent, including making requests for the amount and rate of slack given by the surface to ensure too much line is not paid into the water column, resulting in entanglements.

3 *Dive Operations at the pre-planned depth* - Directing the diver is undertaken in a different manner than in buddy type SCUBA operations, where movements are relative to the tethered line itself. For example, the tender may instruct the diver to swim "toward the line," "away from the line," "take a 90 right," "take a 90 left," and so on. The diver trusts that the surface can direct them where they need to go, as in conducting a search pattern, "Hold line tension, and swim with the tether at your left." Surface may ask the diver to conduct search patterns via an arc, sweep, or out and back methods, using these line signals. Based on whether there is visibility on the bottom, this will determine the distance between diver sweeps. (Hendrick, 2000). The surface will regularly ask for pressure checks from the diver, and the diver should also volunteer these to the surface. If asked during a crucial task for a pressure check, the diver should ask the surface to "standby." The surface will hold tension at all times, and release tension only when requested by the diver. Without tension, the surface loses good information on the status of the line, i.e. tangled or untangled, and may actually cause the line to tangle by allowing it to drag on the bottom. Absence of tension also prevents backup communications from happening as discussed in emergency procedures, below. Equipment may be conveyed to a stationary diver nearby the platform via a loop in the line. If this is done, tension should be maintained in the line should verbal communications fail, and once the tool is conveyed, all slack should be removed.

4 *Ascent* - The surface will control the diver's ascent, except when the diver ascends away from the dive platform. Using the tether, the tender will give at least a 2 second count for every foot of line they pull in. When the diver nears the platform, the tender will instruct the diver to put up their hand for the last part of the ascent to protect their head from the hull of the vessel. The tender will remain on comm. until the diver is aboard and decontaminated, as needed. The line will be managed in the dive platform's "hot zone" with gloves such that it can be decontaminated at the end of dive operations, and otherwise managed to avoid material tracking throughout the vessel.

5 *Doffing Dive Gear* - Decontamination, such as a potable water decontamination., will take place as needed before other tasks, focusing on the mask and glove areas when conducting repetitive diving. The tender will ensure that the diver leaves the bottom with sufficient pressure to undergo whatever type of decontamination they deem necessary.

6 *Vessel Operations* - Vessel operations necessitate important tethered diving safety procedures, which include:

a. All boat/ship propellers must be deactivated prior to initiating dive operations.
b. A small boat must be on anchor before deploying the tethered diver.
c. Ships do not need to be on anchor for a ship husbandry dive, e.g. clearing a fouled propeller in deep water.
d. A bow and stern line shall be available. While it is not required to be at a 2 point or greater anchor configuration, sudden wind changes may necessitate a two-point anchoring system to complete a dive safely.
e. If the boat were to swing on its anchor, it is important that sufficient slack is given and/or tension is kept on the diver to ensure they are not swept away in current, or subjected to sudden changes in pressure.
f. When operating near channel, vessel traffic and channel 16 communications should be monitored to determine if large vessels are inbound.

As the dive platform cannot fend off other boat traffic by means of physical presence, care should be given how far channel ward a tethered diver is allowed to travel. Consideration of notice to mariners, broadcast of an encumbered vessel status either via VHF and/or automatic identification system (AIS) could also be considered.

7 *Emergency Procedures* - Before the tethered diver undertakes a working dive, it is important that they have practiced how to free an entangled line, disconnecting from the tether, unconscious diver rescue, and clearing a flooded mask in a training situation. During the dive briefing, backup communication line pull signals must be reviewed and memorized by the dive crew. See the US Navy Revision 6 Table 8-3 line pull signal table below. It is also important that the dive crew review what it sounds like for the communications cable wet connection for the hard line comm. to become disconnected underwater at the diver end. Absence of sound for the diver should indicate that they need to reconnect the plug, and/or begin using line pull signals to communicate their status to the surface. A fresh set of batteries should be on hand topside, in the event of communications loss, to ensure that voice communications can be re-established. A fully redundant tender headset and communications box might be kept on board in the event that these become flooded or cease operating. A diver recall could also kept on hand to supplement line pull signals should hard line communications be lost. The diver must also be prepared to disconnect from the tether, in consultation with the surface. The diver should not disconnect from the tether without first telling the surface, "going off comm." to ensure that the surface

understands that communications will be lost for a period of time. Unplanned loss of communication (voice and line pulls) of the tethered diver should lead to immediate deployment of the standby diver unless the divemaster determines that conditions are too hazardous for rescue to be undertaken. For retrieval of an unconscious diver on the bottom, the standby diver would be deployed on tether, and follow the primary diver's tether to the bottom. Once with the unconscious diver, the victim should be oriented head up, and the surface notified that they may haul the pair up. For trapped diver situations, a "rescue bottle" could be maintained for the standby diver to convey to a trapped primary tethered diver. The rescue bottle could be outfitted with a quick disconnect coupling (female), so that the bottle may be connected underwater to the trapped diver's SCUBA bailout block manifold quick disconnect fitting (male), along with a mouthpiece second stage and SPG.

US Navy Revision 6 Table 8-3 Line Pull Signals

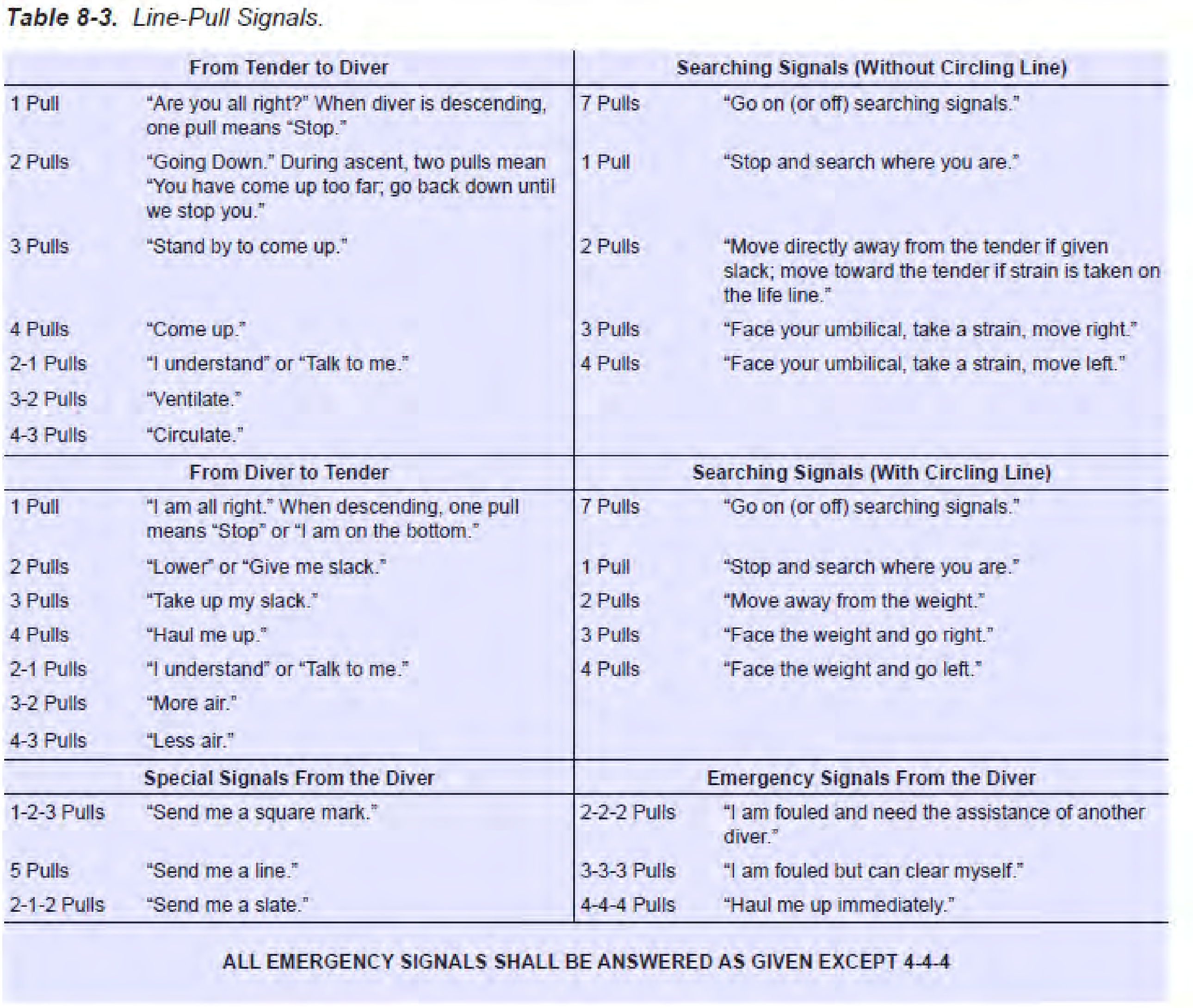

Table 8-3. *Line-Pull Signals.*

From Tender to Diver		Searching Signals (Without Circling Line)	
1 Pull	"Are you all right?" When diver is descending, one pull means "Stop."	7 Pulls	"Go on (or off) searching signals."
2 Pulls	"Going Down." During ascent, two pulls mean "You have come up too far; go back down until we stop you."	1 Pull	"Stop and search where you are."
3 Pulls	"Stand by to come up."	2 Pulls	"Move directly away from the tender if given slack; move toward the tender if strain is taken on the life line."
4 Pulls	"Come up."	3 Pulls	"Face your umbilical, take a strain, move right."
2-1 Pulls	"I understand" or "Talk to me."	4 Pulls	"Face your umbilical, take a strain, move left."
3-2 Pulls	"Ventilate."		
4-3 Pulls	"Circulate."		
From Diver to Tender		**Searching Signals (With Circling Line)**	
1 Pull	"I am all right." When descending, one pull means "Stop" or "I am on the bottom."	7 Pulls	"Go on (or off) searching signals."
2 Pulls	"Lower" or "Give me slack."	1 Pull	"Stop and search where you are."
3 Pulls	"Take up my slack."	2 Pulls	"Move away from the weight."
4 Pulls	"Haul me up."	3 Pulls	"Face the weight and go right."
2-1 Pulls	"I understand" or "Talk to me."	4 Pulls	"Face the weight and go left."
3-2 Pulls	"More air."		
4-3 Pulls	"Less air."		
Special Signals From the Diver		**Emergency Signals From the Diver**	
1-2-3 Pulls	"Send me a square mark."	2-2-2 Pulls	"I am fouled and need the assistance of another diver."
5 Pulls	"Send me a line."	3-3-3 Pulls	"I am fouled but can clear myself."
2-1-2 Pulls	"Send me a slate."	4-4-4 Pulls	"Haul me up immediately."
ALL EMERGENCY SIGNALS SHALL BE ANSWERED AS GIVEN EXCEPT 4-4-4			

EOTI-SOP 6
UNDERWATER MAGNETOMETER OPERATIONS VERIFICATION FOR UXO

STANDARD OPERATING PROCEDURE 06:

Underwater Magnetometer Operations Verification for UXO – Siege Battery – TD River and Battery Knox – TD River MRSs at West Point, NY

Purpose

This standard operating procedure (SOP) provides general guidelines for usage and operation of an underwater magnetometer for the collection of munitions-related data for UXO at the Siege Battery – TD River and Battery Knox – TD River MRSs at West Point, NY. This Standard Operation Procedure summarizes the technical usage, requirements and operational verification of the **FISHER 1280-X AQUANAUT** Underwater Magnetometer (or other similar underwater magnetometer) for use on this project.

Scope

RI data will be collected using manual writing media, digital camera, Global Positioning System (GPS), and an underwater all-metals detector (magnetometer). The **FISHER 1280-X AQUANAUT** Underwater Magnetometer proposed for use on this project, can transmit audible signals to the diver-operator when metal objects are detected within the device's sensor range. When a metallic anomaly is detected, the diver-operator will convey the location of the anomaly as a measured "off-set" from each pre-placed sand bag via the continuous diver-to-tender communications system. Each pre-placed sand bag will have pre-determined GPS coordinates and the new anomaly coordinates will be calculated and recorded by the dive support team based on the observed off-set.

All underwater operations will be performed under the supervision and direction of qualified unexploded ordnance (UXO) personnel in accordance with the procedures included in the Accident Prevention Plan or Site Specific Health and Safety Plan for this project. Once located by the diver-operator, each anomaly will be intrusively investigated as described in the UFP-QAPP (Uniform Federal Policy – Quality Assurance Project Plan) and the EOTI Dive Operations Plan for this project.

Equipment and Materials

- Underwater digital camera
- GPS point collection equipment (data are kept/updated by the dive support team per the work plan)
- **FISHER 1280-X AQUANAUT** underwater all-metals detector/magnetometer w/ batteries and headset
- Log book
- Indelible pen
- Previously prepared Under Water Instrument Verification Strip (IVS) – for instrument operation verification, an underwater linearly seeded test strip of industry standard object (ISOs) or surrogate items will be used to verify the operation of the **FISHER 1280-X AQUANAUT** unit prior to each dive.

Procedures and Guidelines

Underwater Data Collection – Magnetometer Operation Verification for Anomaly Existence/Condition

A. *Rationale for Collecting Underwater Data for Anomaly Classification*

Data collected will be used to confirm the anomaly location and assist in possible future anomaly reacquisitions/investigations/actions as in the location and documentation of Material Potentially Presenting an Explosive Hazard (MPPEH), or for the documentation of Munitions Debris (MD) or Munition Debris Material Designated as Safe (MDAS) removals. Therefore, the operability of the **FISHER 1280-X AQUANAUT** Underwater Magnetometer shall be verified daily prior to its underwater utilization.

B. *Set-Up and Operations of the **FISHER 1280-X AQUANAUT** Underwater Magnetometer*

- Every member of the EOTI Dive Team shall read the entire **FISHER 1280-X AQUANAUT** Underwater Magnetometer Owner's Manual and shall be thoroughly familiar with its contents.
- Ensure that new batteries (or fully re-charged batteries if utilized) are in the **FISHER 1280-X AQUANAUT** Underwater Magnetometer battery compartment and the water-proof battery compartment seal is intact and functional in accordance with the Owner's Manual. This operation shall be performed prior to every dive and at least daily when only one dive will be made.
- Move to a clear area adjacent to the underwater IVS
- Turn on the instrument and position the sensor head away from the body and any metallic dive gear components. In accordance with the Owner's Manual, adjust the sensitivity to screen out background "noise".
- Move to the IVS and pass the sensor over a "seed" item that represents the smallest detectable MEC item. Adjust the sensitivity of the device to provide the diver-operator with an unambiguous response to the surrogate or inert "seed" item. This exercise shall be performed before every dive. Similar procedures shall also be utilized for larger "Seed" items and the audible tone and accuracy of location shall be noted and retained by the operator.
- The sensitivity shall not be re-adjusted from this point forward until the termination of the dive.
- Throughout the dive operation, the UXO Technician III will monitor the operation of the device's performance and shall insure that this procedure is followed with due diligence and attentional to detail.

C. *Applicable References*

- The Project-Specific Work Plan (UFP-QAPP) with its Data Quality Objective (DQO) - established metrics, the EOTI Comprehensive Safe Practices Dive Manual, and the West Point Project-Specific Dive Plan.

APPENDIX D
WESTON FIELD STANDARD OPERATING PROCEDURES (SOPs)

SOP 1	Natural and Cultural Resource Monitoring
SOP 2	Mobilization and Demobilization
SOP 3	Traffic Control
SOP 4	Overnight MPPEH Storage
SOP 5	Demolition Operations (On-Shore)
SOP 6	Sediment Sampling
SOP 7	Management of Investigation Derived Waste (IDW)
SOP 8	Sample Chain of Custody, Labeling, Packing, and Shipping

WESTON-SOP 1
NATURAL AND CULTURAL RESOURCE MONITORING

FIELD STANDARD OPERATING PROCEDURE 1

Natural and Cultural Resource Monitoring

1 SCOPE AND APPLICATION

Instructions presented in this Standard Operating Procedure are for natural and cultural resource monitoring. The natural or cultural resource monitor may be an on-site WESTON employee having received training to recognize the resources documented in the Optimized UFP-QAPP Worksheet #10 and respond according to the procedures in this SOP. The natural resources were documented for the entire Investigation Area; which includes the Siege Battery – TD River MRS, Battery Knox – TD River MRS, Area A and Area B.

Resource	Presence within Work Area
Vegetation	One federally listed threatened or endangered (T&E) plant species was identified as potentially having habitat within the Investigation Area (Saltmarsh Aster). NO designated or proposed critical habitat for T&E plant species was identified within the Investigation Area.
Birds	Native birds potentially occurring near the Investigation Area include both forest birds and pelagic seabirds. Migratory birds have also been observed near Investigation Area. Project activities are not expected to impact any birds with habitat near the Investigation Area.
Fish	Three federally listed T&E fish species were identified within the Investigation Area (Atlantic Silverside, Atlantic Surgeon and Shortnose Sturgeon).
Terrestrial Animals	No terrestrial animals have a habitat within the Investigation Area, because it is strictly aquatic.
Dragonflies and Damselflies	Two federally listed T&E species were identified as potentially having habitat within the Investigation Area (Needham's Skimmer and Tiger Spiketail).
Cultural Areas/Artifacts	Historically significant features and cultural resources present in and/or near the Investigation Area, consist of Revolutionary War- and Civil War-era ranges and fortifications that existed in and along the river and throughout Constitution Island, shipwrecks in the river, and former West Point Foundry remnants.

2 EQUIPMENT

1) Camera.
2) Global Positioning System device.
3) Binoculars, if needed.
4) Level D Personal Protective Equipment.

3 RELATED PROCEDURES

None.

4 PROCEDURES

4.1 AWARENESS TRAINING

Prior to any field work activities commencing, awareness training will be conducted for field staff for recognition of special status plants and aquatic wildlife that may be encountered within the Investigation Area.

On-site personnel will be briefed on potential historical, archaeological, and cultural resources that may be encountered during the course of the remedial investigation.

4.2 INTRUSIVE ACTIVITIES

In order to protect marine resources, WESTON and its subcontractors will avoid working in (including vessel anchoring) any areas containing the identified plant species of concern. Divers will take all necessary precautions to avoid contact with submerged aquatic vegetation.

If, during excavation or other activities, any previously unidentified or unanticipated historical, archaeological, or cultural resources are discovered or found, all activities that may damage or alter such resources will be temporarily suspended.

The following Best Management Practices will be in place to avoid, minimize, and offset adverse effects:

1. Divers will take all necessary precautions to avoid contact with submerged aquatic vegetation. If small boat vessel anchoring is required, submerged aquatic vegetation will be avoided, anchoring in soft substrate only using SCUBA divers to assist with locating appropriate anchoring sites.

2. Boat engines will be shut off when not necessary as much as practicable to avoid potential acoustic impacts.

3. Spill prevention measures will be in place for prompt response in the case of any fuel or oil releases to minimize potential effects to humans and the river environment. Spill response equipment for any in-water hydrocarbon release will be on site and easily accessible and all vessel personnel will be trained in proper spill control and cleanup techniques (See Section 10.0 of the UFP-QAPP).

4.3 ON-SHORE DETONATIONS

Prior to any on-shore detonations, observations will be made around detonation locations to ensure animal species of concern and cultural sites are not present. If either is observed, work in the area will stop until the animal moves away from the work location or the cultural site can be marked and protected in a manner to prevent damage to the cultural site.

4.4 UNDERWATER DETONATIONS

Should underwater detonations be deemed necessary, based upon the determination that a military munition is unsafe to move, then a clear framework plan to avoid, minimize, and offset adverse effects to potentially affected species will be developed with the U.S. Army Corps of Engineers (USACE), New York State Department of Environmental Conservation (NYSDEC), NOAA fisheries, and detailed in an Underwater Detonations Procedures Technical Memorandum.

5 FIELD FORMS

1) Daily Quality Control Report (DQCR)
2) Site Visitor Log.

6 REFERENCES

Worksheet #10 of the Optimized UFP-QAPP.

WESTON-SOP 2
MOBILIZATION AND DEMOBILIZATION REMEDIATION SUPPORT AREA

FIELD STANDARD OPERATING PROCEDURE 2

Mobilization/Demobilization

1 SCOPE AND APPLICATION

Instructions presented in this Standard Operating Procedure are for mobilization and demobilization of personnel, equipment, and materials.

2 EQUIPMENT

1) Field camera
2) Log book
3) Level D PPE
4) Planning Documents
5) Other equipment noted below such as support facilities, flagging tape, stakes, signs etc.

3 RELATED PROCEDURES

None.

4 PROCEDURES

The site manager will oversee and document the following general mobilization activities:

1) Site Access. Obtain access badges and/or keys for entry to the site from the installation or land owner.
2) Support Facilities. Mobilize portable toilets, hand washing facilities, storage containers, trash bins to the site.
3) Delivery and inspection of equipment and materials. Verify that equipment being mobilized to the site is in proper working order. Verify that materials delivered to the site are of the quality and quantity specified in the purchase order. Collect all delivery tickets, sales receipts, or other documentation provided by the vendor. Equipment and materials will be mobilized to the site on an as-needed basis to avoid multiple handling, storage, and transportation costs.
4) Establish Work Zones. Mark areas such as exclusion zones, decontamination zones, decontamination reduction zones, and rest areas. Post signage as needed. Once a site perimeter is established, keep unauthorized personnel out of work zones and document visitors to the site using a visitor log.
5) Obtain Permits. Obtain and keep on site any Right of Entry documents, excavation permits, photo permits, vehicle access permits, or other permits required by the installation or land owner.
6) Keep planning documents on site. Planning documents such as the Work Plan / Quality Assurance Project Plan, Accident Prevention Plan, Site Specific Health and Safety Plan, and others required by EM 200-1-15 are on site for reference.

5 FIELD FORMS

1) Site Visitors Log
2) Daily Quality Control Report (DQCR)

6 REFERENCES

EM 385-1-1.

Visitors Log

Contract: ______________________________ MRS: ______________________________

Name	Organization	Purpose of Visit	Time in	Time out	Signature

WESTON-SOP 3
TRAFFIC CONTROL

FIELD STANDARD OPERATING PROCEDURE 3

Traffic Control

1 SCOPE AND APPLICATION

Instructions presented in this Standard Operating Procedure are for intermittent road closure and river traffic control during material potentially presenting an explosive hazard (MPPEH) movement and treatment events or other events that pose an explosive risk to the public. Traffic control procedures will mitigate risk to human receptors.

Traffic will likely need to be stopped on an as-needed basis only. Traffic will be stopped during operations that involve the following:

1) Movement of MPPEH on the surface within the Hazard Fragment Distance or Maximum Fragment Distance Horizontal, depending on the fuze condition of the MPPEH.
2) Detonation of MPPEH on-shore in an area where the exclusion zone includes river traffic or roads.
3) Detonation of MPPEH in shallower than 6 feet below surface in the river such that the exclusion zone includes river traffic.

Detonations will be scheduled on Fridays; however, detonation or movement of MPPEH on other weekdays may occur if necessary.

2 EQUIPMENT

1) Two hand-held stop signs.
2) Two “Road Work Ahead” signs.
3) Two “Be Prepared to Stop” signs.
4) Two “End Road Work” signs.
5) Two traffic flagger signs.
6) Level D Personal Protective Equipment (PPE) with reflective vests.
7) Two-way radios (cell phones will be used for backup communication).
8) Camera.
9) Log Book.
10) Safety Boat for river traffic.

3 RELATED PROCEDURES

None.

4 GENERAL PROCEDURES

1) Obtain a road closure permit by submitting an application with a traffic control plan to New York State Department of Transportation Highways Division (NYSDOT Highways).
2) Follow 200-foot spacing of signs and flagger personnel and conditions of NYSDOT Highways road closure permit. Flaggers will be stationed at two positions on road and will control incoming traffic.
3) Follow 200-foot spacing of safety boat and any applicable United States Coast Guard conditions.
4) Flaggers will communicate with the unexploded ordnance (UXO) crew by radio so that traffic can be stopped and resumed when necessary.
5) The traffic control points will change locations depending on where operations involving MPPEH are taking place.
6) An off-duty law enforcement officer (Cold Spring Police Department or U.S. Military Academy West Point Military Police) should be present on site to supervise traffic control operations.
7) Traffic should be stopped for the minimum amount of time possible to accomplish the task involving MPPEH.
8) Once traffic has been allowed to resume, traffic should be allowed to move freely until traffic resumes its normal flow before stopping traffic again.

5 SPECIFIC PROCEDURES FOR DETONATIONS

1) Traffic control intervals should be kept to 15 minutes.
2) Stop traffic during movement of MPPEH onto the detonation site (or into the buried explosion module excavation) whenever the exclusion zone overlaps roads or river traffic.
3) Allow traffic to dissipate then stop traffic again.
4) Attach donor charges to the MPPEH item(s) and connect a witness pigtail to the item and arrange it so that it can be seen above the ground surface after burying.
5) Bury the shot.
6) Detonate the shot.

7) Confirm that the witness pigtail has been consumed in the detonation. If it has not, or if smoke can be seen venting from the hole, continue to hold traffic. If it has been consumed and no smoke is observed, follow the next step.

8) Observe 5-minute wait period.

9) Allow traffic to dissipate then stop traffic again.

10) Unbury the shot and confirm high order detonation has occurred.

6 FIELD FORMS

Daily Quality Control Report.

WESTON-SOP 4
OVERNIGHT MPPEH STORAGE

FIELD STANDARD OPERATING PROCEDURE 4

Overnight MPPEH Storage

1 SCOPE AND APPLICATION

Instructions presented in this Standard Operating Procedure are for overnight storage of Material Potentially Presenting an Explosive Hazard (MPPEH) on an as-needed basis.

Delivery must be scheduled at least one day in advance. In accordance with the Explosive Site Plan (ESP), explosives must be delivered on an on-call basis instead of being stored within a sited magazine. It is anticipated that temporary overnight storage of MPPEH awaiting treatment within the U.S. Army Garrison West Point Water Munitions Response Sites (MRSs) will be required during this project.

2 EQUIPMENT

1) Radio and/or cellular phone
2) Flashlight
3) Megaphone
4) Camera
5) Log Book
6) Level D Personal Protective Equipment (PPE)

3 RELATED PROCEDURES

None.

4 PROCEDURES

1) An Unexploded Ordnance (UXO) technician will place MPPEH in an area that can be secured within the MRSs.
2) The on-site MPPEH item must not be left unattended at any time. The hours of the detail will be coordinated by the Senior Unexploded Ordnance Supervisor (SUXOS). One or more personnel must remain at the site and may not leave until relieved the next morning.
3) The personnel will not attempt to move or in any way disturb the MPPEH item.
4) The secured area will be located within the Munitions Response Site (MRS) with which the MPPEH item was initially identified.

5) The personnel will tell any trespassers that the site is off limits and ask them to leave.

6) If necessary, the personnel will call local law enforcement by dialing 911 and notify the SUXOS and Project Manager.

5 FIELD FORMS

1) Daily Quality Control Report.
2) Visitor Log.
3) Tailgate Safety Form.

6 REFERENCES

United States Army Corps of Engineers (USACE). 2017. Explosive Safety Plan (ESP). Remedial Investigation West Point Water Ranges: Siege Battery–TD River (WSTPT-016-R-01), Battery Knox–TD River (WSTPT-004-R0-1). West Point Military Academy, West Point, NY. July 2017.

WESTON-SOP 5
DEMOLITION OPERATIONS (ON-SHORE)

FIELD STANDARD OPERATING PROCEDURE 5

Demolition Operations (On-Shore)

1 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to provide the minimum procedures and safety and health requirements applicable to conducting demolition/disposal operations of unexploded ordnance (UXO)/munitions and explosives of concern (MEC) at the U.S. Army Garrison West Point Water Munitions Response Sites (MRSs).

This SOP applies to all WESTON site personnel, including contractor and subcontractor personnel, involved in conducting UXO/MEC demolition/disposal operations. This SOP is not intended to contain all of the requirements needed to ensure complete compliance and should be used in conjunction with approved project plans and applicable referenced regulations. Consult the documents listed in Section 20 of this SOP for additional compliance issues.

2 RELATED PROCEDURES

Overnight MPPEH Storage

3 EQUIPMENT

1) Level D Personal Protective Equipment (PPE) – no nylon.
2) Log Book
3) Remote Firing Device
4) Donor Explosives

4 RESPONSIBILITIES

4.1 PROJECT MANAGER

The Project Manager (PM) will be responsible for ensuring the availability of the resources needed to implement this SOP and will also ensure that this SOP is incorporated into plans, procedures, and training for sites where this SOP will be implemented.

4.2 SENIOR UXO SUPERVISOR

The Senior UXO Supervisor (SUXOS) will be responsible for assuring that adequate safety measures and housekeeping are performed during site operations, including demolition activities, and will visit site demolition locations, as deemed necessary, to ensure that demolition operations are carried out in a safe, clean, efficient, and economic manner. The demolition activities will then be conducted under the direct control of the SUXOS, who will be responsible for supervising demolition operations within the area.

The SUXOS will be responsible for training on-site UXO personnel on the nature of the materials handled, the hazards involved, and the precautions necessary. The SUXOS will also ensure that the Daily Operational Log, Ordnance Accountability Log, WESTON Demolition Shot Records, and inventory records are properly filled out and accurately depict the demolition events and demolition material consumption for each day's operations. The SUXOS will be present during demolition operations or designate a competent, qualified person to be in charge during any absences.

4.3 UXO SAFETY OFFICER

The UXO Safety Officer (UXOSO) for the site is responsible for ensuring that all demolition operations are being conducted in a safe manner and is required to be present during MEC demolition operations. The UXOSO will ensure the compliance of the demolition team with the above referenced documents that are applicable to the particular task being performed. The UXOSO will be responsible for notifying the Project Manager, United States Army Corps of Engineers (USACE), and Emergency Management Services (EMS)/police in the event of an accident requiring medical attention or the possibility of lost time. The emergency response plan will be used, and first aid, notification, and evacuation will be accomplished as required. The accident site will then be shut down and the scene preserved/secured for the accident investigation team.

4.4 UXO QUALITY CONTROL SPECIALIST

The UXO Quality Control Specialist (UXOQCS) is responsible for ensuring the completeness of demolition operations records and for weekly inspection of the Ordnance Accountability Log, the Daily Operational Log, the WESTON Demolition Shot Record, and the inventory of MEC and demolition material. The UXOQCS, assisted by demolition team personnel, will inspect each demolition pit and an area of appropriate radius after each demolition shot, in accordance with the approved explosive siting plan, to ensure that there are no kick-outs, hazardous UXO/MEC components, or other hazardous items. In addition, the pit may be checked with a magnetometer, and large metal fragments and any hazardous debris will be removed on a per use basis in accordance with the Performance Work Statement (PWS). Any UXO/MEC discovered during the QC check will be properly disposed of using the demolition procedures in the Work Plan. Extreme caution must be exercised when handling UXO/MEC that has been exposed to the forces of detonation. Personnel must adhere to acceptable safe practices and procedures when determining the condition of munitions and fuzes that have not been consumed in the disposal process.

5 GENERAL OPERATIONAL AND SAFETY PROCEDURES

Personnel, including contractor and subcontractor personnel, involved in operations on UXO/MEC-contaminated sites will be familiar with the potential safety and health hazards associated with the conduct of demolition/disposal operations and with the work practices and control techniques used to reduce or eliminate these hazards.

During demolition operations, the general safety provisions listed below will be followed by demolition personnel at all times. Noncompliance with the general safety provisions listed below will result in disciplinary action, which may include termination of employment.

Safety regulations, such as the following, which are applicable to demolition range activities and demolition and MEC materials involved will be complied with:

- Demolition of any kind is prohibited without an approved Explosives Site Plan (ESP) or Explosives Safety Submission (ESS).
- The quantity of UXO/MEC to be destroyed will be determined by the range limit, fragmentation, and K-Factor distance calculations, as specified in the approved ESP. Additional regulations/procedures, such as Demolition SOPs, Army Materiel Command (AMC) Regulation 385-100, and other publications will be used, as required. The team will ensure that the demolition shot does not exceed the net explosive weight (NEW) for the hazard fragmentation distance.
- In the event of an electrical storm, dust storm, or other hazardous meteorological conditions, immediate action will be taken to cease demolition range operations and to evacuate the area.
- In the event of a fire, which does not include explosives or energetic materials, the fire will be put out using the firefighting equipment located at the site.
- The UXOSO is responsible for reporting all injuries and accidents that occur.
- Personnel will not tamper with any safety devices or protective equipment.
- Any defect or unusual condition noted that is not covered by this SOP will be reported immediately to the SUXOS or UXOSO for evaluation and/or correction.
- Methods of demolition will be conducted in accordance with this SOP and approved changes or revisions thereafter.
- Adequate fire protection and first aid equipment will be provided at all times.
- Personnel engaged in the destruction of UXO/MEC will wear clothing made of natural fiber, closely-woven cloth, such as cotton. Synthetic material, such as nylon, is not authorized unless treated with anti-static material.
- Care will be taken to restrict exposure to the smallest number of personnel, for the shortest time, to the least amount of hazard, consistent with safe and efficient operations.
- Work locations will be maintained in a neat and orderly condition.
- Hand tools will be maintained in a good state of repair.
- Each heavy equipment and/or vehicle operator will have a valid operator's permit or license for the equipment being operated.
- Equipment and other lifting devices designed and used for lifting will have the load rating and date of next inspection marked on them. The load rating will not be exceeded and the equipment will not be used without a current inspection date.
- Leather or leather-palmed gloves will be worn when handling wooden boxes, munitions, or UXO/MEC.
- Eye protection will be worn when handling wooden boxes, munitions, or UXO/MEC.

- Lifting and carrying require care. Improper methods cause unnecessary strains. Observe the following preliminaries before attempting to lift or carry:
  - When lifting, keep your arms and back as straight as possible, bend your knees and lift with your leg muscles.
  - Be sure to have good footing and a firm hold on the object, and lift with a smooth, even motion.
- The demolition range will be provided with two forms of communication, capable of contacting appropriate personnel or agencies (i.e., medical response, Quick Response Force [QRF]).
- Motor vehicles and material handling equipment (MHE) used for transporting UXO/MEC or demolition materials must meet the following requirements:
  - New York State Purchase, Own, Possess & Transport Explosives license: https://labor.ny.gov/formsdocs/wp/cr39.pdf
  - NY Blasters requirements: https://labor.ny.gov/stats/olcny/blasters.shtm
  - Exhaust systems will be kept in good mechanical repair at all times.
  - Lighting systems will be an integral part of the vehicle.
  - One Class 10 B:C rated, portable fire extinguisher will be mounted inside the cab, and, if possible, one Class 10B:C fire extinguisher be mounted on the vehicle outside of the cab on the driver's side. If mounting on the vehicle is not possible, the fire extinguisher will be kept in the bed of the truck or in the trunk of the vehicle if it is a sport utility vehicle (SUV).
  - Wheels of carriers must be chocked and brakes set during loading and unloading.
  - No demolition material or UXO/MEC will be loaded into or unloaded from motor vehicles while their motors are running.
- Motor vehicles and MHE used to transport demolition material and UXO/MEC will be inspected prior to use to determine that:
  - Fire extinguishers are filled and in good working order.
  - Electrical wiring is in good condition and properly attached.
  - Vehicles transporting energetics will have the transport area-beds lined with a non-metallic material.
  - Vehicles transporting energetics will have a clean transport area-bed free of debris or combustibles.
  - Fuel tank and piping are secure and not leaking.
  - Brakes, steering, and safety equipment are in good condition.
  - The exhaust system is not exposed to accumulations of grease, oil, gasoline, or other fuels, and has ample clearance from fuel lines and other combustible materials.
- Employees are required to wear leather, or rubber, gloves when handling demolition materials. The type of glove worn is dependent on the type of demolition material.
- A red warning flag, such as an “Active Range Flag” or a wind sock, will be displayed at the entrance to the demolition area during demolition operations when required by local

authority. If applicable, the entrance gate will be locked when demolition work is in process.

- Unless otherwise directed or authorized by the approved ESP, demolition shots will be tamped with an appropriate amount of earth/dirt.
- An observer will be stationed at a location where there is a good view of the air and surface approaches to the demolition range, before material is detonated. It will be the responsibility of the observer to order the SUXOS to suspend firing if any aircraft, vehicles, birds, terrestrial animals, or marine mammals and sea turtles, or personnel are sighted approaching the general demolition area. Demolitions will be coordinated with the Army, the Coast Guard, and local police to keep the required radius free of potential traffic.
- Two-way radios (to include cell phones) will not be operated in proximity to the demolition range during the priming process and while the pit is primed. Radio transmissions will be kept at a minimum of 50 ft from the explosives.
- No demolition operation will be left unattended during the active portion of the operation (i.e., during the burn or once any explosives or UXO/MEC are brought to the range).
- A minimum radius (approximately 50 ft) around the demolition pit will be cleared of dry grass, leaves, and other extraneous combustible materials.
- No demolition activities will be conducted if there is less than a 2,000-ft ceiling.
- Demolition shots must be fired during daylight hours (minimum time after for sunrise and prior to sunset is determined by the firing procedure used (i.e., electric, non-electric, shock tube 30/60/60).
- Notification of the local authorities will be made in accordance with the site requirements.
- No more than two persons will ride in a truck transporting demolition material or UXO/MEC, and no person will be allowed to ride in the trailer/bed.
- Vehicles will not be refueled when carrying demolition material or UXO/MEC and must be 100 ft from magazines or trailers containing such items before refueling.
- Explosive vehicles will be cleaned of visible explosive and other contamination before releasing the vehicles for other tasks.
- After handling demolition material or UXO/MEC and prior to conducting any other task, personnel will wash their faces and hands.

6 SPECIAL REQUIREMENTS FOR DEMOLITION ACTIVITIES

The following safety and operational requirements will be met during demolition range operations. Any deviations from this procedure will be allowed only after receipt of written approval from USACE. Failure to adhere to the requirements and procedures listed in the paragraphs below could result in serious injury or death; therefore, complete compliance with these requirements and procedures will be strictly enforced. Any deviations from the approved ESP will require a request for approval and a change to the ESP prior to implementation. The change will be submitted through appropriate channels—the Project Manager, the USACE Ordnance and Explosives Safety Specialist (OESS), and up to the Department of Defense Explosives Safety Board (DDESB).

7 GENERAL REQUIREMENTS

The general demolition range requirements listed below will be followed at all times:

- The USACE "Procedures for Demolition of Multiple Rounds (Consolidated Shots) on Munitions and Explosives of Concern (MEC) Sites" will be followed when destroying multiple munitions by detonation on-site. This document will be available on-site during site operations. DDESB Technical Paper (TP) 16 and/or the Demolition Tables will be used to calculate the required buried model and protective works.
- White phosphorus (WP) and propellant will be disposed of only in an approved manner and following the guidance for maximum temperature exposure (90 degrees Fahrenheit). If suspected WP is encountered, arrangements will be made through the USACE OESS to designate and document a WP demolition area.
- Material awaiting destruction will be stored at not less than intra-line distance, based on the largest quantity involved, from adjacent explosive materials and from explosives being destroyed. The material will be protected against accidental ignition or explosion from fragments, grass fires, burning embers, or detonating impulses originating in materials being destroyed.
- UXO/MEC or bulk explosives to be destroyed by detonation should be detonated in a pit not less than 3 ft deep and covered with earth which protrudes not less than 2 ft above existing ground level. Requirements may be found in the explosives siting plan or explosive safety submission. TP 16 and or the Demolition Tables will be used to calculate the required buried module and protective works. The components should be placed on their sides or in a position to expose the largest area to the influence of the demolition material. The demolition material should be placed in direct contact with the item to be detonated and held in place by tape or earth packed over the material. The total quantity to be destroyed below ground at one time will not exceed the range limit.
- Detonations will be counted to ensure detonation of the pit. After each series of detonations, a search will be made of the surrounding area for UXO/MEC. Items such as lumps of explosives or unfuzed ammunition may be picked up and prepared for the next shot. Fuzed ammunition, or items that may have internally damaged components, will be detonated in place, if possible.
- All shots will be dual primed with an electrical/remote firing device (RFD) whenever possible.
- Upon completion of the project, disturbed demolition areas will be thoroughly inspected for UXO/MEC. Depending upon the amount of displaced material, the site may have to be backfilled and leveled. If necessary, this will be coordinated with the contractor representative.
- Before and after each shot, the WESTON Demolition Shot Record will be filled out by the SUXOS with all applicable information. This record will be kept with the Ordnance Accountability Log and will reflect each shot.

8 ELECTRIC DETONATOR USE

The following requirements are necessary when using electric detonators and blasting circuits:

- Electric detonators and electric blasting circuits may be energized to dangerous levels from outside sources such as static electricity, induced electric currents, and radio communication equipment. Safety precautions will be taken to reduce the possibility of a premature detonation of the electric detonator and the explosive charges. Radios will not be operated during the priming process or while the pit is primed.
- The shunt will not be removed from the leg wires of the detonator until the continuity check of the detonator is performed.
- When uncoiling or straightening the detonator leg wires, keep the explosive end of the detonator pointing away from the body and away from other personnel. When straightening the leg wires, do not hold the detonator itself; rather, hold the detonator leg wires approximately 1 inch from the detonator body. Straighten the leg wires by hand; do not throw or wave the wires through the air to loosen them.
- Prior to use, the detonators will be tested for continuity. To conduct the test, place the detonators in a pre-bored hole in the ground or place them in a sand bag, and walk facing away from the detonators and stretch the wires to their full length, being sure not to pull the detonators from the hole or sand bag. With the leg wires stretched to their fullest length, test the continuity of the detonators one at a time by un-shunting the leg wires and attaching them to the galvanometer and checking for continuity. After the test, re-shunt the wires by twisting the two ends together. Repeat this process for each detonator until all detonators have been tested. This process will be accomplished at least 50 ft from and downwind of any UXO/MEC or demolition materials and out of the demolition range personnel and vehicle traffic flow pattern. In addition, all personnel on the demolition range will be alerted prior to the test being conducted.

NOTE: When testing the detonator, prior to connecting the detonator to the firing circuit, the leg wires of the detonator must be shunted by twisting the bare ends of the wires together immediately after testing. The wires will remain short circuited until time to connect them to the firing line or RFD receiver.

- At the power source end of the blasting circuit, the ends of the wires will be shorted or twisted together (shunted) at all times, except when actually testing the circuit or firing the charge. The connection between the detonator and the circuit firing wires must not be made unless the power ends of the firing wires are shorted and grounded or the firing panel is off and locked.
- The firing line will be checked using pre-arranged hand signals. If the demolition pit is not visible from the firing point, two-way radios will be used. If radios are used, communication will be accomplished a minimum of 50 ft from the demolition pit and detonators. The firing line will be checked for electrical continuity in both the open and closed positions and will be closed/shunted after the check is completed.
- UXO/MEC to be detonated will be placed in the demolition pit and the demolition material placed/attached in such a manner as to ensure the total detonation of the UXO/MEC. Once the UXO/MEC and demolition material are in place and the shot has been tamped, the detonators will be connected to the detonation cord. Prior to handling any detonators that

are connected to the firing line or RFD, personnel will ensure that they are grounded. The detonators will then be carried to the demolition pit with the end of the detonators pointed away from the individual. The detonators will then be connected to the detonation cord, Non-Electric (NON-EL), etc., ensuring that the detonator is not covered with tamping material to allow for ease of recovery/investigation in the event of a misfire. There is a one hour wait time for misfires.

- Prior to making connections to the blasting machine or RFD transmitter, the firing circuit will be tested for electrical continuity and ohms resistance, or transmitting power (as applicable), to ensure the blasting machine or RFD transmitter (distance) has the capacity to initiate the shot.
- The individual assigned to make the connections at the blasting machine or panel will not complete the circuit at the blasting machine or panel, and will not give the signal for detonation until satisfied that all personnel in the vicinity have been evacuated to a safe distance. When in use, the blasting machine, or its actuating device, will be in the blaster's possession at all times. When using the panel, the switch must be locked in the open position until ready to fire, and the single key must be in the blaster's possession.
- Prior to initiating a demolition shot(s), a warning will be given. The type and duration of such warning will be determined by the prevailing conditions. At a minimum, this should be an audible signal using a siren, air horn, or megaphone, which is sounded for a duration of 1 minute, 5 minutes prior to the shot and again 1 minute prior to the shot.

9 NON-EL USE (SHOCK TUBE)

The following requirements are necessary when using NON-EL (shock tube) systems:

- After cutting a piece of shock tube, either immediately tie a tight overhand knot in one or both cut ends or splice one exposed end and tie the other.
- Always use a sharp knife or razor blade to cut shock tube to prevent the tube from being pinched or otherwise obstructed.
- Always cut shock tube squarely across and make sure the cut is clean.
- Use only the splicing tubes provided by the manufacturer to make splices.
- Every splice in the shock tube reduces the reliability of the priming system; therefore, keep the number of splices to a minimum.
- Always dispose of short, cut-off pieces in accordance with local laws as they relate to flammable material.

The shock tube system is a thin plastic tube of extruded polymer with a layer of pentaerythritol tetranitrate (PETN) coated on its interior surface. The PETN propagates a shock wave, which is normally contained within the plastic tubing. The shock tube offers the controlled instantaneous action of electric initiation without the risk of premature initiation of the detonator by radio transmissions, high-tension power lines, or static electricity discharge. The NON-EL system uses detonators in the bunch blocks and in the detonator assembly, which will be handled in accordance with approved procedures.

The shock tube initiating system is highly reliable because all of the components are sealed and, unlike standard non-electric priming components, cannot be easily degraded by moisture. Cutting the shock tube makes the open end vulnerable to moisture and foreign contamination; therefore, care must be taken to prevent moisture and foreign matter from getting into the exposed ends of the shock tubes.

9.1 SHOCK TUBE DEMOLITION PROCEDURES

WARNING

Although the detonation along the shock tube is normally contained within the plastic tubing, burns may occur if the shock tube is held.

9.1.1 Shock Tube Assembly

The shock tube assembly procedure listed below will be followed at all times:

- Spool out the desired length of shock tube from the firing point to the demolition site and cut it off with a sharp knife or razor blade. Weight down the loose end of the trunk line.
- Immediately seal the shock tube remaining on the spool by tying a tight overhand knot on the cut-off end or use a push-over sealer.
- Using a sharp knife or razor, cut the sealed end off the detonator assembly.
- Push one of the shock tube ends to be spliced firmly into one of the pre-cut splicing tubes provided by the manufacturer at least ¼ inch. Push the other shock tube end firmly into the other end of the splicing tube at least ¼ inch. Secure splice with tape if needed.

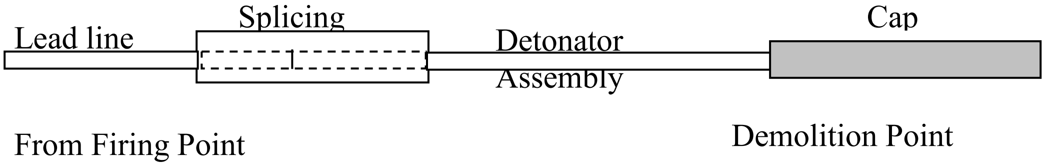

Figure 1 Shock Tube Assembly

9.1.2 Firing Assembly Setup

The firing assembly setup procedure listed below will be followed at all times:

- If there are multiple items to be destroyed, using bunch block(s) supplied by the manufacturer, lay out lead lines at the demolition site to the shot(s) and secure the bunch block with a sandbag or some other item that will keep it from moving.

NOTE: No more than six leads may be used from any one bunch block.

- If the detonator assembly has not been attached yet, use the splicing tube to splice the detonator assembly to the shock tube branch line as explained in the splicing instructions above.

- If this is a non-tamped shot, place the detonator assembly into the demolition material. If the shot is to be tamped, prepare the demolition material with a detonating cord (det cord) lead long enough to stick out of the tamping at least 1 ft.
- Tape the detonator assembly with the cap to the det cord lead as shown in Figure 2.

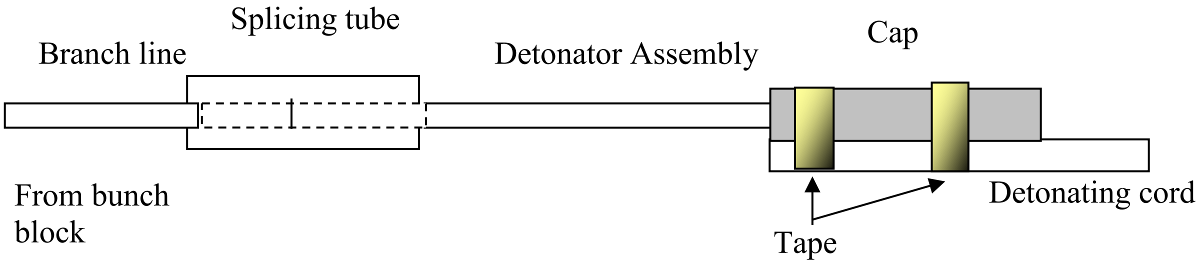

Figure 2 Firing Assembly

- Return to the firing position.
- Cut off the sealed end of the shock tube and proceed to the directions listed in Step 7. If you are using a previously cut piece of shock tube, use a sharp knife or razor blade to cut approximately 18 inches from the previously cut end, whether or not it was knotted in accordance with the above guidance.
- Insert a primer into the firing device and connect the shock tube lead line to the firing device ensuring that the shock tube is properly seated in the firing device.
- Take cover.
- Signal **"fire in the hole"** three times and initiate charge.
- Observe a 5-minute wait time after the detonation.
- Remain in designated safe area until Demolition Supervisor announces **"All Clear."**

10 DETONATING CORD USE

The following procedures are required when using detonating cord (det cord):

- The det cord should be cut using approved crimpers, and only the amount required should be removed from inventory.
- The det cord should be cut outside the magazine.
- For ease of inventory control, remove the det cord only in 1-ft increments.
- The det cord should not be placed in clothing pockets or around the neck, arm, or waist, and should be transported to the demolition location in either an approved “day box;” original container; or a cloth satchel, depending upon the magazine location and proximity to the demolition area.
- The det cord should be placed at least 50 ft away from the detonators and the demolition materials until the det cord is ready to use. To ensure consistent safe handling, each classification of demolition material will be separated by at least 25 ft until ready to use.

- When the det cord is ready to be connected to the demolition materials or the detonator, the det cord will be secured to the UXO/MEC. The cord is then strung out of the hole and secured in place with soil or filled sandbags, leaving a minimum of 6 ft of det cord exposed outside the hole.
- Once the hole is filled, make a loop in the det cord large enough to accommodate the detonator, place the detonator in the loop, and secure it with tape. The detonator's explosive end will face down the det cord toward the demolition material or parallel to the main line.
- Always ensure that there is a minimum of 6 ft of det cord extending out of the hole to make it easier to attach and inspect the detonator and replace it should a misfire occur.
- If the det cord detonators are electric, they will be checked, tied in to the firing line, and shunted prior to being taped to the loop. If the det cord detonators are non-electric, the time/safety fuze will be prepared with the igniter in place prior to taping the detonators to the det cord loop. If the det cord detonators are NON-EL, tape the detonators into the loop as described above.
- In the event that a time/safety fuze is used, an igniter is not available, and a field expedient initiation system is used (i.e., matches), do not split the safety fuze until the detonator is taped into the det cord loop.

11 TIME/SAFETY FUZE USE

The following procedures are required when using a time/safety fuze:

- Prior to each daily use, the burn rate for the time/safety fuze must be tested to ensure the accurate determination of the length of time/safety fuze needed to achieve the minimum burn time of 5 minutes necessary to conduct demolition operations.
- To ensure both ends of the time/safety fuze are moisture free, use approved crimpers to cut 6 inches off the end of the time/safety fuze roll, and place the 6-inch piece in the time/safety fuze container.
- If quantity allows, accurately measure and cut off a 6-ft-long piece of the time/safety fuze from the roll.
- Take the 6-ft section out of the magazine, and attach a fuze igniter.
- In a safe location, removed from demolition materials and UXO/MEC, ignite the time/safety fuze, measure the burn time from the point of initiation to the "spit" at the end, and record the burn time in the SUXOS's Log.
- To measure the burn time, use a watch with a second hand or chronograph.
- To calculate the burn rate in seconds per foot, divide the total burn time (in seconds) by the length (in feet) of the test fuze.
- When using a time/safety fuze for demolition operations, the minimum amount of fuze to be used for each shot will be the amount needed to permit a minimum burn time of 5 minutes.

12 DEMOLITION RANGE INSPECTION SCHEDULE

The schedule for the demolition range inspection will be followed when demolition operations are being conducted. This inspection will be conducted by the UXOSO or UXOQCS and will be documented in the Site Safety or QC Log. If any deficiencies are noted, demolition operations will be suspended and the deficiency will be reported to the SUXOS. Once the deficiencies are corrected, demolition operations may be resumed.

13 METEOROLOGICAL CONDITIONS

To control the effects of demolition operations and to ensure the safety of site personnel, the following meteorological limitations and requirements will apply to demolition operations:

- Demolition operations will not be conducted when the live herbaceous fuel moisture is less than 100%.
- Demolition operations will not be conducted when the Burning Index for that hour of the day is 20 or lower.
- Demolition operations will not be conducted during electrical storms or thunderstorms.
- No demolition operations will be conducted if the surface wind speed is greater than 20 miles per hour.
- Demolition operations will not be conducted during periods of visibility of less than 1 mile caused by, but not limited to, dense fog, blowing snow, rain, sand storms, or dust storms.
- Demolition will not be carried out on extremely overcast days with more than 80% cloud cover, with a ceiling of less than 2,000 ft.
- Demolition operations will not be initiated until an appropriate time after sunrise, and will be secured at an appropriate time prior to sunset (see Section 4).

14 PRE-DEMOLITION/DISPOSAL PROCEDURES

14.1 PRE-DEMO/DISPOSAL OPERATIONAL BRIEFING

WESTON'S philosophy is that a successful operation is dependent upon a thorough briefing, covering all phases of the task, which is presented to all affected personnel. The SUXOS will brief personnel involved in range operations in the following areas:

- Type of UXO/MEC being destroyed.
- Type, placement, and quantity of demolition material being used.
- Method of initiation (electric, non-electric, or NON-EL).
- Means of transporting and packaging UXO/MEC.
- Route to the disposal site.
- Equipment being used (i.e., galvanometer, blasting machine, firing wire).
- Misfire procedures.
- Post-shot clean-up of range.
- Proper tie-down and securing procedures according to explosive transportation requirements.

14.2 PRE-DEMO/DISPOSAL SAFETY BRIEFING

The WESTON SUXOS, Team Leader, or UXOSO will conduct a safety briefing for personnel involved in range operations in the following areas:

- Care and handling of explosive materials.
- Personal hygiene.
- Two man rule and approved exceptions.
- Personnel roles and responsibilities.
- Potential trip/fall hazards.
- Horseplay on the range.
- Staying alert for any explosive hazards on the range.
- Calling a safety stop for hazardous conditions.
- Location of emergency shelter, if available.
- Parking area for vehicles (vehicles must be positioned for immediate departure, with the keys in the ignition).
- Location of range emergency vehicle.
- Location of the assigned paramedic.
- Wind direction (to assess potential toxic fumes).
- Locations of first aid kit and fire extinguisher.
- Route to nearest hospital or emergency aid station.
- Type of communications in the event of an emergency.
- Storage location of demolition materials and UXO/MEC awaiting disposal.
- Demolition schedule.

14.3 TASK ASSIGNMENTS

Individuals with assigned tasks will report the completion of the task to the SUXOS. The types of tasks that may be required are as follows:

- Contact local military authorities and fire response personnel, and get air clearance, as required.
- Contact hospital/emergency response/medevac personnel, if applicable.
- Secure all access roads to the range area.
- Visually check range for any unauthorized personnel.
- Visually check for natural and cultural resources.
- Check firing wire for continuity and shunt.
- Prepare designated pits as required.
- Check continuity of detonators.
- Check time/safety fuze and its burn rate.
- Designate a custodian of the blasting machine, RFD, fuze igniters, or NON-EL initiator.

- Secure detonators in a safe location.
- Place UXO/MEC in pit, and place charge in desired location.

14.4 PREPARING EXPLOSIVE CHARGE FOR INITIATION

To prepare the explosive charge for initiation, the procedures listed below will be followed:

- Ensure firing wire is shunted.
- Connect detonator to the firing wire.
- Isolate or insulate all connections.
- Prime the demolition charge.
- Place demolition charge on UXO/MEC.
- Depart to firing point (if using non-electric firing system, obtain head count, pull igniters, and depart to designated safe area).
- Obtain a head count.
- Give the 1-minute warning signal, using a bullhorn or siren, 5 minutes prior to detonation, and again at 1 minute prior to detonation.
- Check the firing circuit.
- Take cover.
- Signal "**fire in the hole**" three times (or an equivalent warning).
- If using electric firing system, connect firing wires to blasting machine, and initiate charge.
- Remove firing wires from blasting machine and shunt or turn off RFD transmitter.
- Remain in designated safe area until SUXOS announces **"All Clear."** This will occur after a post-shot waiting period of 5 minutes and the SUXOS has inspected the pit(s).

15 POST-DEMOLITION/DISPOSAL PROCEDURES

Do not approach a smoking hole or allow personnel out of the designated safe area until cleared to do so, and follow the procedures listed below:

- After the **"All Clear"** signal, check pit for low orders or kick-outs.
- Examine pit, and remove any large fragmentation, as needed.
- Back fill hole, as necessary.
- Police all equipment.
- Notify military authorities, fire department, etc., that the operation is complete.

16 MISFIRE PROCEDURES

A thorough check of all equipment, firing wire, and detonators will prevent most misfires. However, if a misfire does occur, the procedures outlined below will be followed.

16.1 ELECTRIC MISFIRES

To prevent electric misfires, one technician will be responsible for all electrical wiring in the circuit. If a misfire does occur, it must be cleared with extreme caution, and the responsible technician will investigate and correct the situation, using the steps outlined below:

- Check firing line and blasting machine connections, and make a second initiation attempt.
- If unsuccessful, disconnect and connect to another blasting machine (if available), and attempt to initiate a charge.
- If unsuccessful, commence a 30-minute wait period.
- After the maximum delay predicted for any part of the shot has passed, the designated technician will proceed down range to inspect the firing system, and a safety observer must watch from a protected area.
- Disconnect and shunt the detonator wires, connect a new detonator to the firing circuit, check the replacement detonator for continuity, and prime the charge without disturbing the original detonator.
- Follow normal procedures for effecting initiation of the charge.

16.2 NON-ELECTRIC MISFIRES

Working on a non-electric misfire is the most hazardous of all operations. Occasionally, despite all painstaking efforts, a misfire will occur. Investigation and corrective action should be undertaken only by the technician who placed the charge, using the following procedure:

- If the charge fails to detonate at the determined time, initiate a 60-minute wait period plus the time of the safety fuze, i.e., 5-minute safety fuze plus 60 minutes for a total of 65 minutes.
- After the wait period has expired, a designated technician will proceed down range to inspect the firing system. A safety observer must watch from a protected area.
- Prime the shot with a new non-electric firing system, and install a new fuze igniter.
- Follow normal procedures for initiation of the charge.

16.3 NON-EL MISFIRES

The use of a shock tube for blast initiation can result in misfires, which require the following actions:

- If the charge fails to detonate, it could be the result of the shock tube not firing. Visually inspect the shock tube. If it is not discolored (i.e., slightly black), it has not fired.
- If it has not fired, cut a 1-ft piece off the end of the tube, re-insert the tube into the firing device, and attempt to fire again.
- If the device still does not fire, wait 60 minutes and proceed down range to replace the shock tube in accordance with the instructions outlined below.
- If the tube is slightly black, then a "Black Tube" misfire has occurred, and the shock tube will have to be replaced after observing a 60-minute wait time. When replacing the shock

tube, be sure to remove the tube with the detonator in place. Without removing the detonator from the end of the tube, dispose of by demolition.

16.4 DETONATING CORD MISFIRE

WESTON uses det cord to tie in multiple demolition shots and to ensure that electric detonators are not buried. Because det cord initiation will be either electric, non-electric, or NON-EL, the procedures presented in Sections 16.1, 16.2, or 16.3, as appropriate to the type of detonator used, will be used to clear a det cord misfire. In addition, the following procedures will be conducted:

- If there is no problem with the initiating system, wait the prescribed amount of time, and inspect the connection between the initiator and the cord to ensure that it is properly connected. If the connection was faulty, attach a new initiator, and follow the appropriate procedures for the type of initiator.
- If the initiator detonated, but the cord did not, inspect the cord to determine if the problem is with the det cord and not time fuze. Also, check to ensure that there is PETN in the cord at the connection to the initiator.
- It may be necessary to uncover the det cord and replace it. This must be accomplished carefully, to ensure that the demolition charge and the UXO/MEC item are not disturbed.

17 RECORD-KEEPING REQUIREMENT

To document the demolition operation procedures and the completeness of the demolition of UXO/MEC, the following recordkeeping requirements will be met:

- WESTON (as directed) will obtain and maintain all required permits.
- The SUXOS will ensure that logs are completed accurately, and the SUXOS and UXOQCS will monitor the entries in the log for completeness, accuracy, and compliance with meteorological conditions.
- The SUXOS will enter the appropriate data on the Ordnance Accountability Log and the Demolition Shot Record to reflect the UXO/MEC destroyed and will complete the appropriate information on the Explosives Accountability Log (the Magazine Data Card), which indicates the demolition materials used to destroy the UXO/MEC.
- The quantities of UXO/MEC recovered must match the quantities of UXO/MEC destroyed or disposed.
- WESTON will retain a permanent file of demolition records, including permits, magazine data cards, training and inspection records, waste manifests if applicable, and operating logs.
- Copies of the ATF License and required permits must be made available on site.

18 SAFETY AND PERSONAL PROTECTIVE EQUIPMENT REQUIREMENTS

The following safety measures and personal protective equipment (PPE) will be used in preventing or reducing exposure to the hazards associated with UXO/MEC demolition/disposal operations. These requirements will be implemented unless superseded by site-specific requirements stated in the SSHP:

- Hard hats are required only when working around heavy equipment or when an overhead or head impact hazard exists.
- Composite toe/shank boots in accordance with EM 385-1-1 are required during surface/subsurface location of anomalies.
- Safety glasses will be required whenever an eye hazard exists, for example, when working around flying dirt/debris, handling explosives, and using hand tools. Safety glasses will provide protection from impact hazards and, if necessary, ultraviolet radiation (i.e., sunlight).
- Positive means will be required to secure the PPE and prevent it from falling and causing an accidental detonation.
- Reflective vests will be worn when in proximity to roads or construction equipment (e.g., excavators).

19 FORMS

1) Daily Quality Control Report
2) Visitor Log
3) Demo Shot Record
4) Material Accountability Form

20 REFERENCES

Applicable sections and paragraphs in the documents listed below will be used as references for the conduct of UXO demolition/disposal operations.

Army Materiel Command (AMC) Regulation 385-100. Safety Manual. September 1995.

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WESTON-SOP 6
SEDIMENT SAMPLING

FIELD STANDARD OPERATING PROCEDURE 6

Sampling Procedures

1 SCOPE AND APPLICATION

This Standard Operating Procedure (SOP) is applicable to the collection of sediment and soil samples for explosives, metals, acid volatile sulfide – simultaneously extracted metals (AVS-SEM), total organic carbon (TOC), and grain size analyses from locations on the Hudson River.

Discrete sediment samples will be collected for characterization purposes associated with the presence of munitions and explosives of concern and or material potentially presenting an explosive hazard. Composite soil and/or sediment samples will be performed, for explosives only, after completion of demolition operations, including underwater blow-in-place (BIP). Samples will be collected as described in the Uniform Federal Policy Quality Assurance Project Plan (UFP-QAPP) (WESTON, 2018a)

2 SUMMARY OF METHOD

Sampling devices that will be used depend on a variety of factors including sediment depth, water depth, substrate type, and others. Based on these factors, the samplers to be used for sediment collection may include the following:

1) Wildco® core sampler with polycarbonate liners.

2) Polycarbonate tube (liner) sampler.

The choice of samplers is dictated by the ease of deployment and ability to collect representative sediment core samples of the 0 to 0.5 foot (ft) and 0.5 to 1 ft intervals. Each sampling technique presents various advantages and disadvantages for its application. For example, sample disturbance, sample volume and recovery, and ease of decontamination vary between techniques and will be part of the gear selection decision.

Sampling devices would also include disposable trowels for collection of soil samples at the 0 to 0.5 ft interval for post-detonation sampling conducted above the tide line.

3 HEALTH AND SAFETY ISSUES

1) When working with potentially hazardous materials, follow U.S. Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), and specific health and safety procedures as documented in the Accident Prevention Plan (APP) (WESTON, 2018b).

2) When conducting sampling from a boat in an impoundment or flowing waters, follow appropriate boating safety procedures presented in the APP.

4 INTERFERENCES

Primary potential interferences with sampling are associated with the cross-contamination of samples during the collection process.

Cross-contamination will be avoided by the implementation of equipment decontamination procedures associated with collection. Where feasible, disposable equipment will be used for sampling and/or sample preparation. Decontamination procedures are described in the Optimized UFP-QAPP, Worksheet 12.1 (WESTON, 2018a).

5 PERSONNEL QUALIFICATIONS

The sediment and soil sample collection will be performed by EOTI and Weston Solutions, Inc. (WESTON®) personnel. All field sampling personnel are required to take the 40-hour health and safety training and regular refresher courses prior to engaging in any field effort. At a minimum, all personnel are required to be trained to recognize the hazards associated with field work and, specifically, working from a boat, as well as be fully knowledgeable of the provisions of the APP (WESTON, 2018b).

6 EQUIPMENT AND SUPPLIES

- Personal Protective Equipment (see APP)
- Decontamination items
- Polyethylene sheeting
- Rinse bottles
- Trash bags
- Paper towels
- Field logbook and black ball point pens
- Field data sheets
- Folding ruler marked in tenths of an inch
- Paint trays
- Paint tray liners
- Utility knife
- Polyethylene or propylene scoops and scoopulas
- Shipping supplies
- Ziploc® bags (1 quart and 1 gallon size)
- Sharpies or other permanent marker
- Wildco® corer with polycarbonate core liners, shells (core catchers), and end caps
- Polycarbonate sampling tubes (core liners)
- Disposable trowels
- Approved UFP-QAPP
- Approved APP
- Personal Protective Equipment (PPE) and Other Disposables

7 SAMPLE COLLECTION – PREPARATION

The following preparation steps will be performed prior to sediment or soil sample collection:

1) Determine the extent of the sampling effort, the sampling methods to be employed, minimum sample volume requirements, and the equipment and supplies needed.
2) Obtain necessary sampling and monitoring equipment.
3) Pre-label polycarbonate core liners with the sediment sampling locations identification codes and orientation arrows (sediment sampling only).
4) Pre-label Ziploc bag with soil sampling location identification code (soil sampling only).
5) Decontaminate or pre-clean equipment and ensure that it is in working order.
6) Prior to sampling, all equipment will be thoroughly checked by the team leader to ensure the boat, its motor, diving equipment, sampling equipment, Global Positioning System (GPS) unit, etc. are all in good working condition.
7) All sampling locations have been clearly identified and are free of any obstructions that may preclude their sampling.
8) No unusual conditions have occurred or are expected to occur that may affect the ability to obtain representative samples (e.g., dredging).

8 SAMPLE COLLECTION – SECONDARY PARAMETERS

Sediment and soil characteristics, such as color, odor, and presence of organic material, will be described on the field data sheets or in the sample log book.

9 SAMPLE COLLECTION – METHOD OPTIONS

9.1 WILDCO® CORER AND OTHER SAMPLING DEVICES

The Wildco® corer is a metal tube with a replaceable tapered nosepiece on the bottom and a check valve on top. The check valve allows water to pass through the corer on its descent, but prevents washout during its recovery. If sediment conditions permit, sampling may be performed using only the polycarbonate liner (i.e., without the Wildco® corer). Core samples will be collected manually by divers.

9.2 DISPOSABLE TROWELS

Soil samples will be collected with disposable trowels. One trowel per sample will be utilized.

9.3 SEDIMENT SAMPLING

9.3.1 Sampling Procedure

1) Identify the location of the sediment sample and the type of sediment.

2) If the sediment is sandy or unconsolidated and likely to flow out of the Wildco® corer (or polycarbonate liner) on retrieval, insert a core catcher insert.

3) If a Wildco® corer will be used, insert a polycarbonate liner pre-labeled with the location identification code and orientation arrow into the body of the corer. Affix nose cone to the Wildco® corer to secure the polycarbonate liner.

4) Place the Wildco® corer or polycarbonate liner over the sampling location and press the device vertically downward to a depth of 1 ft.

5) Retrieve the Wildco® corer or polycarbonate liner with a smooth, continuous lifting motion, avoid jerking or bumping the sampler because this type of motion may result in the loss of the sample.

6) Remove the nose cone and slide the core liner out of the Wildco® corer.

7) Apply plastic end caps to the top and bottom of the core liner and place the collected core sample into the basket, maintaining vertical orientation (arrow on core liner pointing upward), for transport to the surface for subsequent sample processing.

8) If the Wildco® corer is used, decontaminate the nose cone between sediment sampling locations within a sampling area with a coarse bottle brush to remove adhered sediment. Between sampling areas, decontaminate the Wildco® corers and nose cones following the procedures in the UFP-QAPP.

9.3.2 Sample Processing

Once samples have been collected and transported to the surface for sampling processing, perform the following steps to prepare the sediment samples for shipment and analysis:

- Allow the sediment cores to settle after transport.
- Measure and mark 0 to 0.5 ft and 0.5 to 1 ft sampling depth intervals on the core liner with a permanent marker.
- Carefully decant standing water above the top of the sediment core to minimize loss of fine sediment.
- Cut liner with utility knife into upper and lower sampling interval subsamples and place them into separate lined paint trays.
- Thoroughly mix samples with a disposable scoop.
- Transfer the sample(s) into suitable prelabeled sample containers.
- Secure the caps tightly and place into a zip-locked bag
- Record all pertinent data in the site logbook and on a field data sheet.

- Place filled sample containers on ice immediately.
- Complete all chain-of-custody documents and field sheets, and record information in the field logbook.

Upon completion of sediment sample processing and transfer to sample containers, all sediment samples will be placed in coolers containing sufficient ice to cover the samples. The samples will be maintained at 0 to 4 degrees Centigrade (°C) until samples are shipped.

9.4 COMPOSITE SAMPLING

9.4.1 Sampling Procedure

Collection of composite samples will be performed using the seven (7)-point spoke and hub method consistent with Special Report 96-15 (Cold Regions Research Engineering Laboratory [CRREL], 1996). A central aliquot will be collected from center of the detonation area at a depth of 0-0.5 ft bgs. Six (6) additional aliquots will be collected at depths of 0-0.5 ft bgs in a radial distribution around the central aliquot. Soil samples will be collected as composite samples post-detonation, if detonation is conducted above the tide line, whereas sediment samples will be collected if detonation is conducted below the tide line (i.e. BIP).

1) Identify the location of the detonation and the medium (soil/sediment).

    - Determine the location of the central #1 aliquot, based upon the detonation location.
    - Seven samples will be placed in a wheel pattern with #1 in the center. Aliquot #2 and #5 will be oriented north-south, and the radius of the wheel will be 1 meter and the aliquot locations will be separated by 1 meter.

2) If the medium is sediment then:

    - If the sediment is sandy or unconsolidated and likely to flow out of the Wildco® corer (or polycarbonate liner) on retrieval, insert a core catcher insert.

    - If a Wildco® corer will be used, insert a polycarbonate liner pre-labeled with the location identification code and orientation arrow into the body of the corer. Affix nose cone to the Wildco® corer to secure the polycarbonate liner.

    - Place the Wildco® corer or polycarbonate liner over the sampling location and press the device vertically downward to a depth of 1 ft.

    - Retrieve the Wildco® corer or polycarbonate liner with a smooth, continuous lifting motion, avoid jerking or bumping the sampler because this type of motion may result in the loss of the sample.

    - Remove the nose cone and slide the core liner out of the Wildco® corer.

- Apply plastic end caps to the top and bottom of the core liner and place the collected core sample into the basket, maintaining vertical orientation (arrow on core liner pointing upward), for transport to the surface for subsequent sample processing.

- If the Wildco® corer is used, decontaminate the nose cone between sediment sampling locations within a sampling area with a coarse bottle brush to remove adhered sediment. Between sampling areas, decontaminate the Wildco® corers and nose cones following the procedures in the UFP-QAPP.

3) If the medium is soil then:

- Pre-label the zip lock bag with the location identification code.
- Remove vegetation, if present.
- Use disposable trowel to collect aliquots into zip lock bag.

9.4.2 Sample Processing

Once samples have been collected and transported to the surface for sampling processing, perform the following steps to prepare the sediment samples for shipment and analysis:

1) Sediment Samples

- Allow the sediment cores to settle after transport.
- Measure and mark 0 to 0.5 ft sampling depth intervals on the core liner with a permanent marker.
- Carefully decant standing water above the top of the sediment core to minimize loss of fine sediment.
- Cut liner with utility knife into sampling interval and place it into a lined paint tray.
- Thoroughly mix samples with a disposable scoop.
- Transfer the sample(s) into suitable prelabeled sample containers.
- Secure the caps tightly and place into a zip-locked bag
- Record all pertinent data in the site logbook and on a field data sheet.
- Place filled sample containers on ice immediately.
- Complete all chain-of-custody documents and field sheets, and record information in the field logbook.

2) Soil Samples

- Empty zip lock bag into a lined paint tray
- Removing large rocks or fragments and break up soil clumps,
- Thoroughly mix samples with a disposable scoop.
- Transfer the sample(s) into suitable prelabeled sample containers.
- Secure the caps tightly and place into a separate zip-locked bag
- Record all pertinent data in the site logbook and on a field data sheet.
- Place filled sample containers on ice immediately.
- Complete all chain-of-custody documents and field sheets, and record information in the field logbook.

Upon completion of composite sample processing and transfer to sample containers, all samples will be placed in coolers containing sufficient ice to cover the samples. The samples will be maintained at 0 to 4 degrees Centigrade (°C) until samples are shipped.

10 DATA AND RECORDS MANAGEMENT

All sample documentation will follow project specific SOPs for field sample ID, data recording, chain of custody, and custody seal procedures. All data and information will be documented in field data logbooks with permanent ink. All entries in field logbooks should be legibly recorded and contain accurate and inclusive documentation of an individual's project activities.

11 DECONTAMINATION

All sampling equipment will be decontaminated as specified in the UFP-QAPP (WESTON, 2018a).

12 FIELD QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

Field quality control (QC) samples will be collected by the sampling team to determine whether data are of suitable quality. They include blanks, duplicates and/or equipment rinsate blanks. All field quality assurance/quality control (QA/QC) procedures will be followed as described in the UFP-QAPP.

13 REFERENCES

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WESTON-SOP 7
MANAGEMENT OF INVESTIGATION DERIVED WASTE (IDW)

FIELD STANDARD OPERATING PROCEDURE 7

Management of Investigation Derived Waste (IDW)

1 SCOPE AND APPLICATION

The purpose of this Standard Operating Procedure (SOP) is to support the requirements for investigation derived waste (IDW) management. The requirements of these procedures are applicable to management for wastes generated as a result of field sampling and characterization activities and not yet characterized by laboratory analysis as hazardous or non-hazardous wastes. The goal of IDW management is to minimize the amount of waste generated while following applicable regulations. Field personnel should review and understand all applicable federal, state, and local regulations regarding IDW. Regulations may prohibit disposal of certain IDW on-site.

Investigation-derived waste is anticipated to be minimal and associated with the collection of samples. Prior to commencing sampling for investigation/remediation and generation of IDW, the Field Team Leader/Engineer will select an area, preferably secure, for IDW storage in consultation with the On-Site Manager.

Any container used for IDW will be United Nations (UN) certified and U.S Department of Transportation (DOT) authorized. Drums will not be stacked on top of each other and will be stored in rows not larger than two drums wide, with labels facing outward for identification. Decontamination fluids and other low-volume fluids may be transported on site in 5-gallon buckets with lids to the drum staged area.

Different residual materials (e.g., soil and water) will not be drummed together, but will be placed in separate drums. Field screening will be used to drum materials with similar levels of contamination together, if possible.

Drums will be staged on pallets in a containment area. The containment area should have 10% capacity of the total capacity of the drums contained in the area should they become punctured or otherwise start to leak. The containment area will be lined with plastic and have bermed sides. Containers not containing solid materials do not need a containment area but should still be staged on pallets off the ground surface.

2 EQUIPMENT

1) UN certified and DOT authorized drums or other containers
2) Funnels
3) 5-gallon buckets
4) Photoionization detector (PID) or other appropriate instrumentation
5) Labeling material
6) Sampling materials (i.e., scoops/trowels, containers, labels, cooler and shipping supplies)
7) Logbook

3 RELATED PROCEDURES

SOP 07	Decontamination
SOP 11	Contaminated Soil Excavation and Disposal

4 IDW MANAGEMENT

Investigation-derived waste is anticipated to be minimal and associated with the collection of samples. The types of IDW generated during geophysical surveys and anomaly investigation are anticipated to consist of trash as described below. The EPA Guide to Management of Investigation-Derived Wastes (January 1992) will be used to assist in management of IDW where necessary.

IDW-filled drums will be transported to the secure staging area at the site in accordance with applicable DOT and U.S. Environmental Protection Agency (EPA) regulations.

Parameters to consider include the volume of IDW, the contaminants present, and the presence of contaminants in the soil at the site. If the contamination is not yet known, the material must be staged until sample results indicate the appropriate disposal method.

The IDW-filled drums must be sampled to determine whether they contain materials classified as Resource Conservation and Recovery Act (RCRA) hazardous wastes, or if the material can be discharged on-site to ground surface. IDW-filled drums containing RCRA hazardous wastes must be shipped off-site within 90 days.

4.1 SOIL

Accumulation of soil IDW is not expected during MC sampling. Excess soil generated during sample collection will be returned to the land surface at the sample collection location. Disposal of soil from remediation excavation activities is discussed in SOP 11 Contaminated Soil Excavation and Disposal.

Soil that cannot be returned to the land must be drummed. The soil will be placed in UN certified and DOT-authorized drums that will be sealed and labeled in accordance with labeling practices. Based upon the results of the characterization, additional soil may be returned to source area immediately after generation or spread around source area, or it may need to be containerized for appropriate off-site disposal or treatment.

4.2 LIQUIDS

Residual liquids will be generated by decontamination (SOP 07) in minimal volumes expected to be less than 5 gallons at a given location.

Liquid such as water from dewatering operations during excavation will be containerized until lab analysis has been completed. Decontamination water must be containerized. It will be placed in a UN certified/DOT-authorized drums or other containers as appropriate (for example, tote tanks). Drums will be sealed and labeled in accordance with labeling procedures. Liquid drums will contain removable bungs. Funnels will be used to prevent spillage when adding liquids to the drums.

4.3 PERSONAL PROTECTIVE EQUIPMENT (PPE) AND OTHER DISPOSABLES

Project-specific provisions should be made prior to disposal of IDW. Do not assume bagged waste can be disposed of in any dumpster. All non-contaminated disposable wastes such as bags, washed gloves, and material scrap, will be kept separate from other wastes. This material will be bagged or otherwise contained and disposed of in the Field Office dumpster or other appropriate and approved location.

Additional disposable wastes may include PPE and sampling equipment. This material will contain minimal residual solids or liquids and is considered nonhazardous. The material will be placed in bags separate from trash and subsequently disposed in a like manner. If conditions are encountered where probability is high for significant MC, then disposable PPE or equipment may be generated that is considered contaminated. This material will be placed in drums or secure boxes unless field screening results of soil and/or waste residuals indicate non-elevated results. The number and types of PPE will be documented in field records prior to disposal.

5 DISPOSAL OPTIONS

Wastes that have been drummed based on field criteria/historical information may be sampled for laboratory analysis to determine the appropriate type of disposal facility. The number of samples collected will depend on the homogeneity of the drummed material, the nature of the source areas, and the requirements of the disposal facility.

IDW characterized or listed as hazardous waste will be managed and disposed of in a manner consistent with local and state guidance, and federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and/or RCRA or Toxic Substances Control Act (TSCA) guidelines.

IDW determined to be non-hazardous waste will be managed and disposed of in accordance with state and/or local guidelines. Uncontaminated PPE and trash will be disposed in designated dumpsters to be picked up by a local vendor for landfill disposal.

5.1 DRUM SAMPLING

The sampling of containerized solid materials is generally accomplished through the use of one of the following samplers:

1) Scoop or trowel
2) Waste pile sampler
3) Sampling trier
4) Grain sampler

Once the container to be sampled is opened, insert the decontaminated sampling device into the center of the material to be sampled. Retrieve the sample and immediately transfer it into the sample bottle. If the sampling device is disposable, it may be left in the container sampled. Otherwise, decontaminate the device thoroughly before collecting the next sample. Each container should be sampled discretely. Depending on the objective of the sampling event (e.g., characterization for disposal) compositing of samples in the laboratory may be permissible. Compositing on a weight/weight or volume/volume basis will be made prior to analysis.

5.2 LABELING

Pending a determination of whether the IDW is hazardous or non-hazardous, containers will be labeled on the side using a weather-resistant paint pen. The following information will be included:

1) Investigation Derived Waste (IDW)
2) Sampling location identification.
3) Sampling area designation.
4) Point of contact with phone number.
5) Type of material:
    - OB—Overburden soil and cuttings
    - GW—Groundwater
    - DW—Decontamination water
    - DS—Disposables
    - SV—Decontamination solvents
6) Water content
    - SAT—Saturated
    - UNSAT—Unsaturated
7) For drums containing liquids, indicate the approximate fill line on the outside of the drum. Do not fill more than two-thirds full with liquids:
    - Range of field screening results and instrument type
    - Date the drum was filled and sealed

Only IDW pending analysis may be labeled. Any wastes known to be RCRA or TSCA wastes based on knowledge of the waste material must be managed as RCRA or TSCA at the point of generation. Upon receipt of analytical results for those IDW containers, the respective containers must immediately be managed appropriately.

6 BIBLIOGRAPHY

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WESTON-SOP 8
SAMPLE CHAIN OF CUSTODY, LABELING, PACKING, AND SHIPPING

FIELD STANDARD OPERATING PROCEDURE 9

Sample Chain of Custody, Labeling, Packing, and Shipping

1 SCOPE AND APPLICATION

This standard operating procedure (SOP) describes procedures for properly documenting, labeling, packaging and shipping environmental and/or hazardous material samples that are to be shipped off-site for laboratory analyses.

The procedures described in this SOP will be initiated by WESTON upon collection of samples and maintained until samples are relinquished to the shipping carrier for delivery to the laboratory. The person overseeing sample shipping is required to have current certification in the Shipping and Transporting Dangerous Goods Course.

2 EQUIPMENT

1) Chain of custody forms
2) Custody seals
3) Sample labels
4) Pen
5) Markers
6) Tape
7) Scissors
8) Fiber strapping tape
9) Ice
10) Waterproof cooler
11) Waterproof plastic resealable bags
12) Garbage bags
13) Paper towels
14) Bubble wrap, “peanuts”, or other inert packing material
15) Air bills
16) Up arrows
17) Dangerous Goods Shipping Paperwork (if applicable)
18) Temperature blank (if applicable)

3 RELATED PROCEDURES

None

4 PROCEDURES

4.1 CHAIN OF CUSTODY RECORDS

All environmental sample sets should be accompanied by a chain of custody (COC) record (Figure 1). This form records each sample and the individuals responsible for sample collection, transfer, shipment, and receipt by the laboratory. The form must also contain pertinent information about the sampling location, date, and times, signature of sampling technician, types and numbers of samples collected and shipped for analysis in each lot and the project name. The COC record serves as a legal record of possession of the sample.

Samples shall be accompanied by an approved and completed COC form during each step of custody, transfer, and shipment. The COC record is initiated with the acquisition of the sample and remains with the sample at all times and bears the name of the person (field sampler) assuming responsibility for the samples.

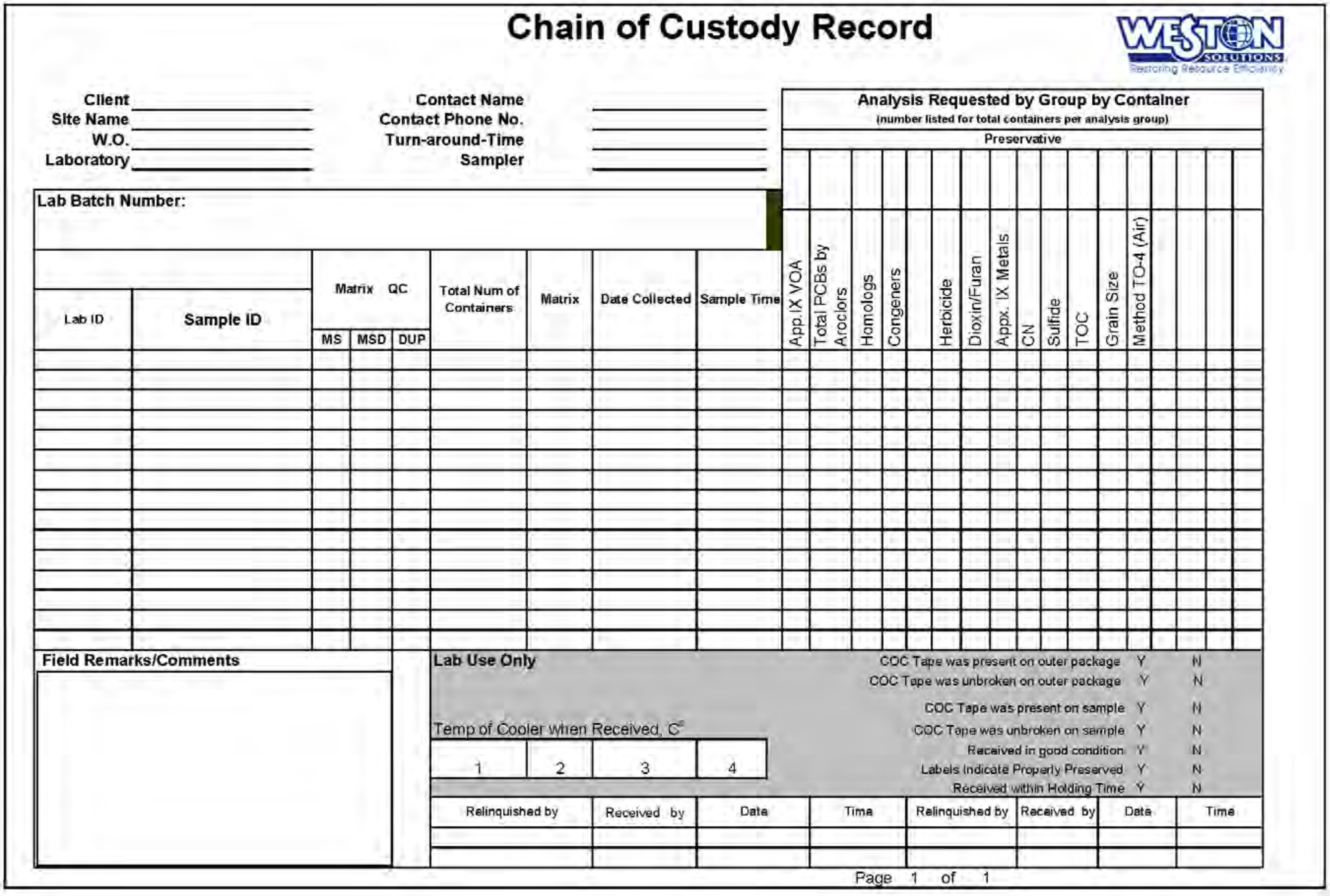
The field sampler is tasked with ensuring secure and appropriate handling of the bottles and samples. To simplify the COC record and eliminate potential litigation problems, as few people as possible should handle the sample or physical evidence during the investigation.

A sample is considered to be under custody if one or more of the following criteria are met:

1) The sample is in the sampler’s possession.
2) The sample is in the sampler’s view after being in possession.
3) The sample was in the sampler’s possession and then was locked up to prevent tampering.
4) The sample is in a designated secure area.

When physical possession of samples is transferred, both the individual relinquishing the samples and the individual receiving the samples should sign, date, and note the time that he/she received the samples on the COC record. This COC record documents transfer of custody of samples from the field investigator to another person, other laboratories, or other organizational units.

If an error is made, a single line should be drawn through the entry, and the entry initialed and dated. The erroneous information should not be obliterated. Any errors found in documentation should be corrected by the person who made the entry.



Chain of Custody Record

WESTON SOLUTIONS
Restoring Resource Efficiency

Client ____________
Site Name ____________
W.O. ____________
Laboratory ____________

Contact Name ____________
Contact Phone No. ____________
Turn-around-Time ____________
Sampler ____________

Lab Batch Number:

Analysis Requested by Group by Container
(number listed for total containers per analysis group)

Preservative

Lab ID	Sample ID	Matrix QC			Total Num of Containers	Matrix	Date Collected	Sample Time	App.IX VOA	Total PCBs by Aroclors	Homologs	Congeners		Herbicide	Dioxin/Furan	Appx. IX Metals	CN	Sulfide	TOC	Grain Size	Method TO-4 (Air)				
		MS	MSD	DUP																					

Field Remarks/Comments

Lab Use Only

Temp of Cooler when Received, C°

1	2	3	4

COC Tape was present on outer package Y N
COC Tape was unbroken on outer package Y N
COC Tape was present on sample Y N
COC Tape was unbroken on sample Y N
Received in good condition Y N
Labels Indicate Properly Preserved Y N
Received within Holding Time Y N

Relinquished by	Received by	Date	Time	Relinquished by	Received by	Date	Time

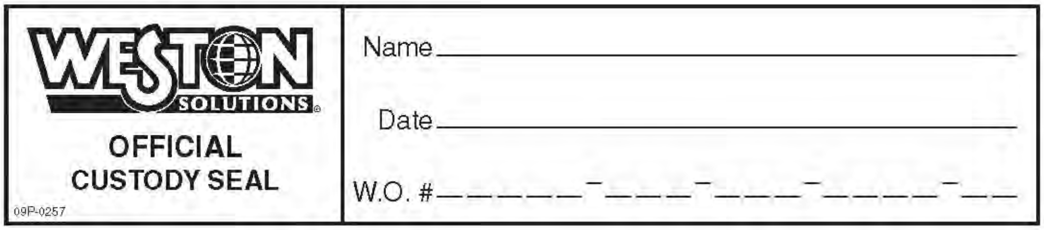
Page 1 of 1

Figure 1 Example Chain-of-Custody Form

4.2 CHAIN OF CUSTODY SEALS

The COC seal is an adhesive seal placed in areas such that if a sealed container is opened, the seal would be broken (Figure 2). The COC seal ensures that no sample tampering occurred between the field and the laboratory analysis.

These signed and dated seals will be placed at the junction between the lid and the jar and on the cooler by the person responsible for packaging. If the coolers or jars are opened before receipt at the laboratory, the seals will not be intact. If the COC seals are not intact, the Laboratory Project Manager will notify the WESTON Analytical Manager within 24 hours of receipt of the container. The WESTON Analytical Manager will then follow the corrective action procedures.



WESTON SOLUTIONS

OFFICIAL
CUSTODY SEAL

09P-0257

Name ______________________

Date ______________________

W.O. # ______-____-____-______-___

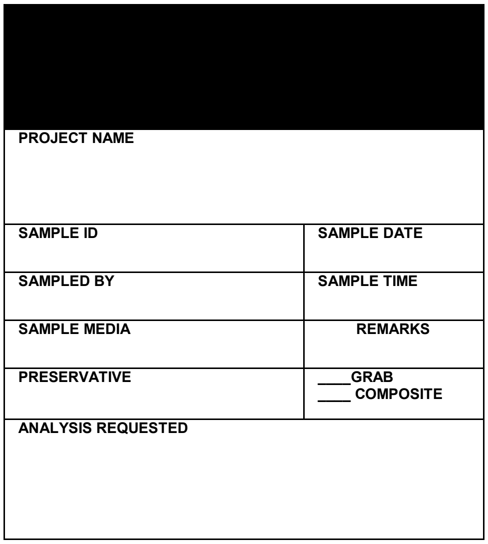
Figure 2 Example Chain-of-Custody Seal

4.3 SAMPLE LABELS

Every sample container will receive a label that summarizes information about the sample collection and preservation. Labels (Figure 3) will be completed using waterproof ink just before or after the sample is collected. The label will include the following information:

1) Project name.
2) Unique sample identification number.
3) Sampling date and time.
4) Initials of sampler.
5) Sample media (soil, groundwater, etc.).
6) Sample collection method (grab or filtered/unfiltered for groundwater).
7) Analysis requested/chemical analysis parameters (analytes and EPA SW-846 method number).
8) Method of sample preservation/conditioning.

If an error is made, a single line should be drawn through the entry and the entry initialed and dated. The erroneous information should not be obliterated. Any errors found in documentation should be corrected by the person who made the entry.



[redacted]

PROJECT NAME	
SAMPLE ID	SAMPLE DATE
SAMPLED BY	SAMPLE TIME
SAMPLE MEDIA	REMARKS
PRESERVATIVE	____GRAB ____ COMPOSITE
ANALYSIS REQUESTED	

Figure 3 Example Jar/Bottle Label

4.4 PACKING SAMPLES FOR SHIPMENT

Environmental samples sent off-site for analysis must be properly packaged for shipment and delivered or shipped to the designated laboratory for analyses. Shipping containers must be secured by using nylon strapping tape, custody seals, and clear packing tape. The custody seals must be placed on the container such that it cannot be opened without breaking the seals. The seal must be signed and dated by the field sampler.

When previously collected samples are split with a facility, state regulatory agency, or other government agency, the agency representative must sign the COC record, if present. All samples should be accompanied by a COC record. The original of the COC record will be placed in a plastic bag taped to the inside lid of the secured shipping container and transmitted to the laboratory along with the samples. One copy of the record will be retained by the field sampler or project leader. This copy will become a part of the project file.

If sent by mail, the package should be registered with return receipt requested. If sent by common carrier, an air bill should be used. Receipts from post offices and air bills should be retained. The air bill number or registered mail serial number should be recorded in the remarks section of the COC record.

Environmental samples should be packaged for shipment as follows (refer to WESTON's *Manual of Procedures for Shipping and Transporting Dangerous Goods* (WESTON, 2016) for additional information as necessary):

1) The sample container is checked to determine that it is adequately identified, and sample labels are compared to the COC.

2) All bottles are checked to ensure that the contents are secured.

3) Glass bottle ware should be wrapped in bubble wrap to prevent breakage. The bottles should be double wrapped in plastic bags that prevent leakage.

4) A waterproof cooler (such as a Coleman or other sturdy cooler comprised of metal or equivalent strength material) is typically used as a shipping container. In preparation for shipping samples, if the cooler has a drain plug, the drain plug is taped shut on the inside and outside. Approximately 3 inches of inert packing material, such as bubble wrap, perlite, or Styrofoam beads or "peanuts," is placed in the bottom of the container.

5) The cooler should be lined with a plastic garbage bag.

6) The bottles are placed upright inside the garbage bag in the cooler in such a way that glass is not touching glass or that they do not touch and will not touch during shipment. Bubble wrap or cardboard separators may be placed between the bottles at the discretion of the shipper.

7) All samples should be shipped to the laboratory on ice and chilled to 4 °C, except for the geotechnical and other samples that do not require shipment with ice.

8) Additional inert packing material is placed in the cooler to partially cover the sample bottles (more than halfway), to ensure they do not shift during transport. If samples are required to be shipped to the laboratory with ice, ice must be double bagged and placed around, among, and on top of the sample bottles. The cooler should then be filled with ice or inert packing material to prevent shifting and breakage of the contents.

9) A temperature blank should be placed in the cooler so that it can be easily found by the laboratory when the cooler is first opened upon receipt.

10) The paperwork going to the laboratory is placed inside a waterproof plastic bag. The bag is sealed and taped to the inside of the cooler lid. The COC form is included in the paperwork sent to the laboratory. The air bill must be filled out before the samples are handed over to the carrier. The contract laboratory should be notified of the shipment along with the estimated time of arrival. If the shipper suspects that the sample contains any substance or elevated air monitoring readings are noted that would require laboratory personnel to take additional safety precautions, this must be noted on the COC and the individual laboratory must be notified. Also, be sure to discuss with the appropriate laboratory whether samples will be accepted by the laboratory on Saturday. If the laboratory isn't open on Saturdays, one shouldn't sample on Friday or would have to drive the samples to the laboratory so that they were received by the laboratory before closing.

11) The cooler is closed and taped shut with strapping tape (filament-type) by wrapping the strapping tape a minimum of three times around the cooler, overlapping it each time.

12) Custody seals are placed on the cooler on the strapping tape. Additional seals may be used if the sampler or shipper thinks more seals are necessary. The cooler is then wrapped once with clear packing tape on top of custody seals and strapping tape.

13) The cooler is transferred to the overnight carrier. A standard air bill is necessary for shipping environmental samples. The shipper should be aware of carrier weight or other policy limitations. “Environmental Samples” may be included on the air bill to indicate the nature of the goods. Be sure to affix “Saturday Delivery” stickers on the cooler and select the “Saturday Delivery” check box on the carrier air bill.

4.5 HAZARDOUS SAMPLES

Hazardous samples are defined as those that are known to or suspected to contain contaminated materials and typically include, but are not limited to, oils (liquid non-aqueous phase liquid [LNAPL] and dense non-aqueous phase liquid [DNAPL]), sludges, discarded products, source area samples, waste profile samples and samples containing a noxious odor. Hazardous samples must be packaged according to International Air Transport Association (IATA) regulations for air transportation and/or U.S. Department of Transportation (DOT) regulations for ground carrier shipments. Personnel with required duties pertaining to the shipment of hazardous samples and/or other dangerous goods, including packaging and/or paperwork preparation, will have completed required WESTON’s Function-Specific Shipping and Transporting Dangerous Goods training course with required refresher training every 2 years.

In accordance with current IATA and DOT regulations, WESTON has prepared a Manual of Procedures for Shipping and Transporting Dangerous Goods to instruct employees on the shipment of routine hazardous samples and dangerous goods. Only those employees who have completed the aforementioned training course are qualified to prepare shipments of dangerous goods in accordance with the provisions provided in the Manual of Procedures for Shipping and Transporting Dangerous Goods. For shipments not considered to be routine and not covered by the manual, a Dangerous Goods Shipping Advisor within WESTON will be contacted for assistance. Dangerous Goods Shipping Advisors have completed initial (24-hour) and refresher training (16-hour) at IATA- and DOT-endorsed training facilities.

Sample shipments that may contain hazardous constituents must be evaluated and comply with instructions within WESTON's Manual of Procedures for Shipping and Transporting Dangerous Goods.

5 BIBLIOGRAPHY

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CFR (Code of Federal Regulations). 49 CFR, Subtitle B, Other Regulations Relating to Transportation, Chapter I, Pipeline and Hazardous Materials Safety Administration, Department of Transportation, Parts 100–185.

IATA (International Air Transport Association). 2017. *Dangerous Goods Regulations*. 58th Edition. Effective from 1 January 2017 through 31 December 2017.

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APPENDIX E
3 JANUARY 2017 "TRIAL PERIOD FOR RISK MANAGEMENT METHODOLOGY AT FORMERLY USED DEFENSE SITES (FUDS) MILITARY MUNITIONS RESPONSE PROGRAM (MMRP) PROJECTS" MEMORANDUM

DEPARTMENT OF DEFENSE
UNITED STATES OF AMERICA

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

JAN 03 2017

CEMP-CED

MEMORANDUM FOR SEE DISTRIBUTION

SUBJECT: Trial Period for Risk Management Methodology at Formerly Used Defense Sites (FUDS) Military Munitions Response Program (MMRP) Projects

1. PURPOSE: This memorandum establishes as guidance and implements a 2-year trial of the process described in the Study Paper: Decision Logic to Assess Risks Associated with Explosive Hazards, and to Develop Remedial Action Objectives (RAOs) for Munitions Response Sites (MRS). (Enclosure 1).

2. APPLICABILITY: This guidance is applicable to all USACE elements engaged in FUDS MMRP projects.

3. REQUIREMENTS: In accordance with 40 CFR Part 300.175(d) (4), *"...the Lead Agency shall conduct a site specific baseline risk assessment to characterize the current and potential threats to human health and the environment..."* For unacceptable risks, and in accordance with 40 CFR Part 300.430(e) (i), the Lead Agency shall *"Establish Remedial Action Objectives (RAOs) specifying contaminants and media of concern, potential exposure pathways, and remediation goals."* The methodology in Enclosure 1 is intended to satisfy the requirement for a risk assessment for FUDS MMRP projects. RAOs are established to define the acceptable end state for a MRS.

4. IMPLEMENTATION: Although application of this risk methodology is first intended for use at the end of Remedial Investigations, it is also intended to support remedy selection decisions and post Remedial Action data assessment.

a. The methodology will be used to:

(1) Provide information to support risk management decisions upon completion of site characterization;

(2) Develop remedial action objectives; and

(3) Provide a basis for assessing achievement of remedial action objectives relative to acceptable end states.

b. Implementation will avoid disruption of service contracts or site remedy implementation, where possible. For circumstances where ongoing work is not able to transition to the new methodology and be conducted in compliance with this Memorandum, efforts will be made to include consideration of the risk assessment criteria discussed in Enclosure 1 and provide feedback to address how other approaches compare to the process described in the Study Paper. This information will be submitted to the EM CX in lieu of Enclosure 2.

5. DATA MANAGEMENT: Information regarding use for this methodology during the 2-year trial will be collected by the EM CX. Project teams will submit the attached Feedback Form (Enclosure 2), at the time draft reports are submitted for EM CX review. The methodology will be assessed at the end of two years from the date of this memorandum. The EM CX, at the end of the trial, will prepare a report of assessment.

6. TRAINING: Project teams are encouraged to enroll in the FUDS training course #428 to learn how to use the methodology, or engage the EM CX to assist in project specific application.

7. EFFECTIVE DATES: The requirements and procedures set forth in this interim guidance are effective immediately. They will remain in effect for 2 years, unless superseded by other policy or regulation.

8. POINT OF CONTACT: For additional information, please contact Mr. Julian Chu, FUDS National Program Manager, at 202-761-1869.

2 Encls
1. Study Paper
2. Feedback Form

KAREN J. BAKER
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Director, Environmental and Munitions Center of Expertise

7 December 2016

Final
Study Paper:
Decision Logic to Assess Risks Associated with Explosive Hazards, and to Develop Remedial Action Objectives (RAOs) for Munitions Response Sites

Abstract

A framework of logic is presented to evaluate hazards at Munitions Response Sites (MRS) such that a systematic assessment of the associated site specific human health risks can be determined, and remedial action objectives (RAOs) can be established. This paper is presented as a consistent methodology for these determinations which depend on site-specific characterization data and specific land use conditions at each MRS. These data are processed similar to the Department of Army Pamphlet for Risk Management (DA Pam 385-30), but the framework utilizes MRS characteristics of Accessibility, Sensitivity and Severity to illustrate site specific conditions, and assign acceptable versus unacceptable scenarios at an MRS. Acceptable end states as presented in Figure A3-1 achieve negligible risk scenarios for an MRS and can be A) Acceptable, where unlimited use unrestricted exposure (UU/UE) is supported, B) Acceptable without additional land use controls (LUCs), where UU/UE may not be supported, or C) Acceptable with LUCs, where UU/UE is not supported.

1 Purpose

The purpose of this paper is to provide U.S. Army Corps of Engineers (USACE) Formerly Used Defense Sites (FUDS) Project Delivery Teams (PDT) with decision logic to differentiate acceptable versus unacceptable site conditions at Munitions Response Sites (MRSs), to establish a systematic approach for developing remedial action objectives (RAOs), and to assist in developing acceptable response alternatives to meet the RAOs. This paper establishes a parallel to the Department of the Army Pamphlet defining the process of Risk Management (DA Pam 385-30), by defining factors more appropriate for Military Munitions Response Program (MMRP), to include specific site conditions and munitions sensitivities. The strength in the Army risk assessment approach is that it is intended to address potentially acute hazard scenarios by factoring real site conditions to establish risk.

- Section 2 provides the applicability of this paper.
- Section 3 introduces CERCLA regulatory requirements for risk assessment and defining remedial action objectives, and limitations to available tools.
- Section 4 addresses the requirement for risk assessment at Munitions Response Sites (MRSs) by providing considerations for site characterization and a framework that allows PDTs to define the current state of an MRS as acceptable or unacceptable based on specific site conditions and information gathered through characterization.
- Section 5 addresses the requirements for developing the RAO by utilizing the framework for MRS risk assessment in Section 4 to identify one or more site scenarios that are

considered acceptable and therefore would constitute a protective end state. These scenarios provide the basis for determining the RAO(s) for the MRS.

- Section 6 presents an exit strategy using post remedy data assessments to evaluate confidence in the remedial action and support achievement of the RAOs for an acceptable end state.

2 Applicability

This study paper methodology may be applied by all USACE organizations conducting FUDS MMRP CERCLA response actions.

3 Background

3.1 NCP Requirement for a Risk Assessment

In accordance with 40 CFR Part 300.175(d)(4), *"...the Lead Agency shall conduct a site specific baseline risk assessment to characterize the current and potential threats to human health and the environment..."* The methodology described in this paper is intended to meet the NCP requirement for a risk assessment, and be consistent with the risk management decision process described in DA Pam 385–30, which establishes a framework for risk management in accordance with Department of Defense Instruction (DODI) 6055.1 and Army Regulation (AR) 385–10.

3.2 NCP Requirement for Remedial Action Objectives

For unacceptable risks, and in accordance with 40 CFR Part 300.430(e)(i), the Lead Agency shall *"Establish Remedial Action Objectives (RAOs) specifying contaminants and media of concern, potential exposure pathways, and remediation goals."*

Similar to a chemical contaminant, defining a measureable and achievable RAO for munitions response sites will be dependent upon a defensible characterization[1] to result in clear identification of the munitions and explosives of concern (MEC), as well as the exposure pathways to receptors. Identification of MEC for a munitions project must first be supported by the nature of the specific munitions known or suspected to exist at a MRS. The specific nature of the munitions present is a significant consideration in defining the presence of a hazard.[2]

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[1] Although there are different goals for cleanup of munitions than for HTRW, CERCLA is generally the regulatory framework that DoD has determined will be used for the MMRP. The term "characterization" is used broadly to foster the iterative development of a robust, high quality Conceptual Site Model (CSM) through investigative response actions, such as the CERCLA Preliminary Assessment (PA), Site Inspection (SI) and Remedial Investigation (RI) phases collectively, but generally irrespective of the regulatory framework under which a project is being conducted. At the end of the RI under CERCLA, the site is "characterized" and data is used for assessment of risk.

[2] Variability in explosive nature (sensitivity) of specific munitions, and variance in the anticipated result of an incident (severity) is acknowledged in determining an acceptable versus unacceptable risk on an MRS (e.g., small spotting charge vs. high explosive, fuzed munitions).

With these considerations applied to the 40 CFR Part 300 requirement for developing a measureable RAO, development of measureable and achievable RAO for a MRS requires:

A

a. Identification of specific munitions and explosives of concern (MEC) and media of concern.
b. Identification of exposure pathways to receptors, and
c. Identification of acceptable remediation goal.

3.3 *Current Tools for Assessment of Explosive Hazards*

Currently, there are tools available to assist in prioritization, and qualitative assessment of hazard reduction for MRSs. These tools have specific programmatic functions, but have limitations at the project level regarding initial determination of acceptable versus unacceptable risk at an MRS. Without this initial assessment of risk supported by the conceptual site model (CSM), it is difficult to establish RAOs for a MRS. A summary of these tools and how they were assessed in support of the approach described in this paper is provided at Attachment 1.

4 Assessing Risk at Munitions Response Sites

The following section is intended to assist project teams to initially define and defend determinations of acceptable versus unacceptable risk at munitions response sites. Section 5 builds on this logic to identify acceptable site scenarios as RAOs that will achieve one of the acceptable end states.

4.1 *Defining Risk after MRS Characterization*

Characterization is critical to define the presence of MEC hazards and exposure pathways to receptors that are used to create the baseline risk determination.[3] At the completion of successful characterization, the project team must be able to determine whether the conditions at the site are "acceptable" or "unacceptable," such that only unacceptable risks require remedial action. *For determination of an unacceptable risk and to develop the RAO, the likely presence of MEC with a reasonably anticipated current or future exposure scenario must be clearly supported by MRS specific information.*

B

Presence of Site Munitions with a Specific Explosive Nature and
Site Specific Receptor and Exposure Pathway →
Determination of Risk

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[3] See Attachment 4.

The general expression for risk, shown in block B, is derived from items a and b in block A, and is directly related to the CSM[4] resulting from characterization. The determination of an explosive risk must include a) likely presence of *specific munitions* having an explosive nature at the MRS; it cannot be solely dependent on historical suspicion or general observance of uncharacterized munitions debris (MD). The known explosive component characteristics of the specific munitions present are a critical consideration in assessing and defining the sensitivity and severity of site risks.[5] Additionally, the determination of unacceptable risk in block B must also be supported by accessibility, specifically b) site-specific current or reasonably anticipated future land use scenarios, defining receptors and a pathway that would result in a likelihood of exposure.

C	"Unacceptable Explosive Risk" is determined if the CSM indicates presence of munitions having a specific explosive nature, as well as the accessibility supported by the specific land use, such that the likelihood of encounter, sensitivity of the munitions items, and severity of a potential incident are collectively unacceptable.

Multiple lines of evidence are required to define the presence and nature of specific munitions, receptors and pathways that will support a qualitative risk assessment and development of the RAO. As these data typically rely heavily on observation, geophysical data, and qualified experts to determine likely presence and nature of explosive munitions, additional lines of evidence that need to be considered whenever available are historical records identifying type of ordnance used and operational context (nature of operations, when, where, how much, etc.). Additionally, details such as the horizontal and vertical spatial distribution information resulting from characterization, as well as topography and terrain, vegetation, and geology are the types of information collectively used to support a determination of the potential of an explosive risk based on current and future land use.

In section 4.3, information from the CSM is used to assess the accessibility, severity and sensitivity of the site scenario. The section provides decision logic that supports a determination of whether there is an ***unacceptable explosive risk***.[6]

4.2 MRSs with Undefined Risk

Similar to response for chemical contamination, a remedial action that results in "zero risk" remaining on the site is ***not*** possible or required. A Feasibility Study (FS) is only conducted to

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[4] See Engineer Manual 200-1-12 for CSM development. Additional assistance with development of the CSM (lateral and vertical) is available through the EM CX.

[5] For HTRW, without definition of the specific chemical, concentration, toxicity, and an assessment of exposure, it is impossible to define (even relatively) the severity of risk or to assess an appropriate response. Similarly in MMRP, without defining the specific munition, the scale to the explosive nature of specific munitions, and assessment of site specific exposure pathways, it is impossible to assess and define risk at a MRS (See footnote 12).

[6] This is consistent with HTRW response process, conducting the risk assessment subsequent to defining hazards resulting from RI site characterization. It is also consistent with the Department of the Army Pamphlet 385-30, Safety: Risk Management, such that the CSM conditions define the presence of a hazard.

address an unacceptable risk. It is critical to note that a RAO cannot be developed for an unknown or unlikely risk.

- If there is an "unknown" risk, then characterization is not complete.
- If there is a determination that a site risk is so small (often seen in reports described as "unlikely" or "negligible") that response would result in a residual risk equal to the initial risk, then there is no further reduction possible such that a more acceptable level of protectiveness can be defined.[3]

Therefore, it is not appropriate to conduct a FS, nor can a remedial action be conducted to reduce an "unknown," "negligible," or "unlikely" risk.

D A remediation goal cannot be defined for an unknown or unlikely risk.

4.3 Approach to Assessing Acceptable versus Unacceptable Risk at MRSs

For each MRS, the project team is encouraged to develop data and structure for differentiating an acceptable versus unacceptable risk. By defining unacceptable versus acceptable using site specific characteristics of severity, accessibility, and sensitivity, a project team can more effectively communicate the risks and associated requirements for remedial action, develop a RAO, and facilitate the achievement of response complete (RC) for the Site.

A simple approach for this logic is to employ matrices using site-specific CSM data to relate accessibility, munitions sensitivity, and severity of an explosive event if it were to occur, to determine baseline risks.[7] The purpose of each matrix is introduced here, and then presented in detail in section 4.4 to support unacceptable risk determinations for a site.

- ***Matrix 1,** the Likelihood of Encounter*, relates the site characterization data for amount of MEC potentially present to site use, including *accessibility*, in order to determine the likelihood of encountering MEC at a specific site.
- ***Matrix 2,** the Severity of an Incident*, assesses the likelihood of encounter from Matrix 1 as related to the *severity* of an unintentional detonation.
- ***Matrix 3,** the Likelihood of Detonation,* relates *sensitivity* of the MEC items to the likelihood for energy to be imparted on an item during an encounter by specific land users.
- ***Matrix 4*** combines the results of the above categories to differentiate *Acceptable and Unacceptable Site Conditions.* A site which results in an unacceptable initial condition will

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[7] Accessibility, Sensitivity and Severity are the same factors used in the MEC HA. This methodology requires that data elements for these hazard components result from the site specific characterization data. It is anticipated that individual site circumstances will require different levels of the severity, accessibility, or sensitivity determinations. Decision logic used to select particular levels in the matrices must be justified and well-supported by facts presented in the CSM.

proceed to the next phase of the CERCLA response process. This matrix identifies acceptable conditions, which become possible remedial action goals that are ultimately achievable (via remedial response actions) for all portions of the MRS. Section 5 discusses these acceptable conditions as RAOs.

4.4 The Risk Matrices

4.4.1 *Matrix 1.* In Matrix 1, below, the "Likelihood of Encounter" is dependent on two factors, the amount of MEC items known or suspected to exist, and access conditions (e.g., accessibility and frequency of use). Either or both of these factors can be modified as a result of the selected remedial action to reduce or eliminate the likelihood of encounter.

"Amount of MEC" is determined using site specific characterization data or anticipated or completed results of a remedial action.[8] Although the scale emphasizes the results of distribution, the selection may also include consideration of available historical information, such as development history.[9] "Access Conditions" are selected based on considerations of the access and frequency of use for the MRS.

The selection considers "Accessibility" as similarly defined by the MEC Hazard Assessment (MEC HA); but also considers other relevant conditions, such as topography, terrain, specific land use, and specific potential receptors via defined pathways to establish access conditions as a frequency of use.[10] As such, site specific circumstances may result in different access conditions, which should be supported and documented by the CSM.

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[8] The "Amount of MEC" selection in Matrix 1 differs from the MEC HA's input factor for "Amount of MEC" which is based solely on the MRS "type" historically identified. Instead, the "Amount of MEC" in Matrix 1 is initially dependent on the results of characterization data regarding MEC and MD distribution. The Matrix is then used to assess anticipated or completed results of a remedial action (physical removal of MEC) to a "reduced" amount.

[9] For example, historical information indicating an area has been extensively developed and used for years with no MEC encounters, in many cases, will be evidence to support a low determination for "Amount of MEC" in the table, and therefore support a lower "Likelihood of Encounter."

[10] A site may be accessible but may have relatively low frequency of use due to the difficult terrain, which results in lower possible contact hours or "access" for the MRS. This scale of "access conditions" may include several factors, including number of visitors or receptor hours per year, nearby population, or residential versus industrial use. Each of these factors may have different justifications depending on the facts at the site. The concept of calculation of "receptor hours per year" is provided in the MEC HA document.

Matrix 1. Likelihood of Encounter

Likelihood of Encounter, Matrix 1: ***Amount of MEC vs. Access Conditions***		**Access Conditions (frequency of use)[10]**			
		Regular (e.g., daily use, open access)	**Often** (e.g., less regular or periodic use, some access)	**Intermittent** (e.g., some irregular use, or access limited)	**Rare** (e.g., very limited use, access prevented)
Amount of MEC[8,9]	• MEC is visible on the surface and detected in the subsurface.	**Frequent**	**Frequent**	**Likely**	**Occasional**
	• The area is identified as a Concentrated Munitions Use Area (CMUA) where MEC is known or suspected (e.g., MD indicative of MEC is identified) to be present in surface and subsurface.	**Frequent**	**Likely**	**Occasional**	**Seldom**
	• MEC presence based on physical evidence (e.g., MD indicative of MEC), although the area is not a CMUA, or • The MEC concentration is below a project-specific threshold to support this selection (e.g., less than 1.0/acre at 95% confidence).	**Likely**	**Occasional**	**Seldom**	**Unlikely**
	• MEC presence is based on isolated historical discoveries (e.g., EOD report) prior to investigation, or • A DERP response action has been conducted to physically remove MEC and known or suspected hazard remains to support this selection, (e.g., surface removal where subsurface not addressed) or • The MEC concentration is below a project-specific threshold to support this selection (e.g., less than 0.5/acre at 95% confidence).	**Occasional**	**Seldom**	**Unlikely**	**Unlikely**
	• MEC presence is suspected based on historical evidence of munitions use only, or • A DERP response action has been conducted to physically remove surface and subsurface MEC (evidence that some residual hazard remains to support this selection), or • The MEC concentration is below a project-specific threshold to support this selection (e.g., less than 0.25/acre at 95% confidence).	**Seldom**	**Seldom**	**Unlikely**	**Unlikely**
	• Investigation of the MRS did not identify evidence of MEC presence, or • A DERP response action has been conducted that will achieve UU/UE.	**Unlikely**	**Unlikely**	**Unlikely**	**Unlikely**

Matrix 2. Severity of Incident

Severity of Explosive Incident, Matrix 2: Severity vs. Likelihood of Encounter		**Likelihood of Encounter**[11]				
		Frequent: Regular, or inevitable occurrences	**Likely:** Several or numerous occurrences	**Occasional:** Sporadic or intermittent occurrences	**Seldom:** Infrequent, rare occurrences	**Unlikely:** Not probable
Severity Associated with Specific Munitions items[12]	**Catastrophic/Critical:** May result in 1 or more deaths, permanent total or partial disability, or hospitalization	A	A	B	B	D
	Modest: May result in 1 (or more) injury resulting in emergency medical treatment, without hospitalization	B	B	B	C	D
	Minor: May result in 1 or more injuries requiring first aid or medical treatment	B	C	C	C	D
	Improbable: No injury is anticipated	D	D	D	D	D

"A" indicates conditions most likely to result in determination of an unacceptable risk.
"D" indicates conditions most likely to result in determination of an acceptable risk.

4.4.2 *Matrix 2.* Matrix 2, "The Severity of Incident," relates "Likelihood of Encounter" from Matrix 1 to the severity of an unintentional detonation. Unlike the two factors affecting the likelihood of encounter in Matrix 1, the "Severity" factor in Matrix 2 is a static characteristic of each of the munitions known or suspected to exist at the property. This is consistent with the MEC HA application for munitions identified for the property. Therefore, in order to improve the Category in Matrix 2, either the items are physically treated and/or removed (reducing the amount of MEC), land use or conditions are altered, or both of these factors are improved in Matrix 1.[11]

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[11] Note that with data collected from physical remediation, it is possible to support an unlikely determination for Matrix 1 and 2, (Attachment 3).

[12] This paper recognizes there is currently no scale for ranking the explosive nature of munitions, and it therefore requires coordination with qualified UXO professionals, per TP-18 requirements (reference 15), on the project team. Initiatives are underway to evaluate these considerations of scale. There must be a defined munitions item having an explosive nature and a defined exposure scenario. Additionally, the degrees of hazards differentiate between intact UXO and munitions components such as rocket motors, fuzes, discarded military munitions (DMM), and explosive soils. Decision logic to support the selection on this scale must be supported by the CSM, and documented in the project reports. Additional research in this subject area in the future may allow for additional refinement within these categories so site specific conditions will be the primary factor for project team determination once MEC types on site have been determined.

Matrix 3. Likelihood of Detonation

Likelihood of Detonation, Matrix 3: Munitions Sensitivity vs. Likelihood of Energy to be Imparted		**Likelihood to Impart Energy on an Item**[14]		
		High e.g., areas planned for development, or seasonally tilled	***Modest*** e.g., undeveloped, wildlife refuge, parks	***Inconsequential*** e.g., not anticipated, prevented, mitigated
Sensitivity:[13] **Susceptibility to Detonation**	***High*** (e.g., classified as sensitive)	1	1	3
	Moderate (e.g., high explosive (HE) or pyrotechnics)	1	2	3
	Low (e.g., propellant or bulk secondary explosives)	1	3	3
	Not Sensitive	2	3	3

4.4.3 *Matrix 3.* Matrix 3, "The Likelihood of Detonation," relates the sensitivity of site specific munitions items to the likelihood for energy to be imparted on an item, such that the interaction results in detonation (incident). MEC sensitivity and the likelihood for energy imparted during an encounter are both specific to the site CSM. The "sensitivity" of a munitions item is alone a static component, inherent to the known or suspected munitions present at the site. The selection for sensitivity is similar to the sensitivity scale in Table 1 of the Military Munitions Response Site Prioritization Protocol (MRSPP).[13] The "Likelihood to Impart Energy" is selected from the known activities at the site that may cause an interaction that results in energy being imparted on a munitions item by human activity.[14] The "Likelihood to Impart Energy" can be affected by behavioral modifications or by altering land use, specifically to prevent accessibility or particular activities to reduce the likelihood or ability of imparting energy on a munitions item.

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[13] The Sensitivity categories are scaled highest to lowest, similar to the MRSPP Table 1: Munitions Type Data Elements Table. While the scale of sensitivity in Matrix 3 is similar to MRSPP Table 1, the matrix must have the flexibility to consider the inclusion of unlisted or undefined items, such as fuzes having small amounts of primary charge and not attached to a booster charge, which may be less sensitive than fuzes with large amounts of primary charge or any fuze connected to a booster charge. Therefore, the PDT should build from this baseline structure in Matrix 3 to include additional considerations, and provide justification for the sensitivity selection for the specific item. Selections must be supported by identifying the specific munitions on the MRS (listed with correct nomenclature).

[14] The likelihood to impart energy on an item can be high for farmed land that is regularly tilled, or areas where development is planned. Moderate areas may include parks or areas where digging is manual or limited. Areas that are Inconsequential will include areas where digging is not anticipated, or otherwise mitigated to prevent imparting energy on an item. The project team will consider land use, specifically types and amount of energy imparted at the site that will result in an interaction with a munitions item. The project team will document the justification for selection on the scale.

Matrix 4: Acceptable and Unacceptable Site Conditions

Acceptable and Unacceptable Site Conditions		**Result From Matrix 2**			
		A	B	C	D
Result from Matrix 3	1	Unacceptable	Unacceptable	Unacceptable	Acceptable
	2	Unacceptable	Unacceptable	Acceptable	Acceptable
	3	Unacceptable	Acceptable	Acceptable	Acceptable

Note: Multiple conditions may exist within an MRS, such that unique baselines risks can be established for the multiple explosive hazards that are present within the same property. Acceptable conditions indicate input factors are collectively determined to support a negligible risk. Project teams shall consider the nature of the specific item within the MRS and the probability to encounter in order to support the selection on the scale.

4.4.4 *Matrix 4.* Matrix 4 represents the overall risk for the site, and differentiates "acceptable" from "unacceptable" conditions. This is determined based on the likelihood of an encounter (Matrix 1), with consideration given to the severity of the incident (Matrix 2), combined with the likelihood of an interaction that results in detonation (Matrix 3). For example: The result of A-3 in Matrix 4 indicates "unacceptable" as depicted above. The overall risk for the selection is driven by the "frequent" or "likely" encounter (Matrix 1) with a potentially catastrophic munitions item (Matrix 2), even though the likelihood of a detonation (Matrix 3) is low (3) based on sensitivity and likelihood to impart energy on the item.

At the end of characterization, the result of Matrix 4 is used to differentiate unacceptable from acceptable conditions. Where an unacceptable scenario is identified, this matrix is then used during the feasibility study to identify acceptable conditions that are ultimately achievable via remedial response actions for all portions of the MRS. Finally, the matrices are used in a post remedy data assessment to evaluate the achievement of risk reduction for a given remedy (Attachment 3).

4.5 Addressing Multiple Risk Scenarios

The risk management matrices will be applied to all portions of an MRS. Multiple conditions may exist within an MRS, such that unique baseline risks can be established for the multiple explosive hazard scenarios that are present within the same MRS. If separate remedial actions for different locations of an MRS are anticipated, the matrices may be applied separately to support the risk management decisions in each location. Multiple entries (or multiple matrices) should be used when:

1) accessibility or land use conditions vary across the MRS (e.g. industrial vs. camping or hiking vs. residential),

2) when munitions types and and/or MEC characteristics vary within an MRS, and /or

3) when the distribution of MEC differs across the MRS (e.g., target center, identified as a concentrated munitions use area (CMUA) vs. buffer or safety zones, identified as non-concentrated munitions use areas (NCMUAs)).

Therefore, multiple RAOs may be required where multiple site conditions exist. These multiple conditions may be illustrated in a tabular form. An example of multiple risk scenarios is provided in Attachment 2.

5 Defining the RAO

A RAO must establish the acceptable condition(s) for the MRS which no longer poses an unacceptable risk.[15] Project teams must carefully consider available data and logic to support assessment of any remedial action against the RAO, such that remedial actions can be developed to feasibly take a site which currently poses an unacceptable risk to one which no longer poses an unacceptable risk.

5.1 *Planning Risk Reduction to the RAO*

After an unacceptable risk has been defined for an MRS, teams can identify conditions that are acceptable in Matrix 4 as RAOs, where remedial actions can be identified that will result in reduction of an unacceptable risk to one of these acceptable conditions.

Once Matrix 4 establishes the unacceptable baseline risk condition, the RAO can then be developed to achieve one of the acceptable conditions of Matrix 4. ***The Remedial Action Objective(s)*** can be written *"to reduce the unacceptable risk due to presence of [name specific munitions of explosive nature or components using appropriate nomenclature] within [specified horizontal MRS boundary] to a depth of [defined depth related to current and future land use, or depth of MEC determined during characterization if less than land use] below surface to address likelihood of exposure to [receptors] via [pathway] such that an acceptable condition (as defined by Matrix 4) is achieved."*

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"The **Remedial Action Objective(s)** can be written *"to reduce the unacceptable risk due to presence of [name specific munitions of explosive nature or components using appropriate nomenclature] within [specified horizontal MRS boundary] to a depth of [defined depth related to current and future land use, or depth of MEC determined during characterization if less than land use] below surface to address likelihood of exposure to [receptors] via [pathway] such that an acceptable condition of negligible risk (as defined by Matrix 4) is achieved."*

Multiple RAOs may be required where multiple site conditions exist, for example, for different MEC characteristics or components within an MRS, for different land uses within the MRS, and/or for areas having different distribution characteristics, (e.g. target area and buffer area).

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[15] For many traditional chemical analyte targets, there is either an established acceptable level on which the RAOs are based, or where there are no levels, there are standard processes used to establish project acceptable limits. For explosive hazard, however, there is no promulgated standard, nor are there standard processes to establish acceptable limits. This paper provides general guidelines as a process for defining an acceptable state for a MRS.

These multiple conditions may be illustrated in a tabular form. An example is provided in Attachment 2.

5.2 *Achieving the RAO*

The RAO is met by changing the unacceptable baseline risk conditions to one of the possible acceptable conditions in Matrix 4. This is achieved by moving to the right within Matrix 2, Matrix 3, or both.

- ***Moving to the right in Matrix 2.*** Risk is reduced by establishing remedial alternatives that reduce the "Likelihood of Encounter" which results in moving to the right on Matrix 2. This is accomplished either by reducing the amount of MEC, altering the frequency of access, or both in Matrix 1.

- ***Moving to the right in Matrix 3.*** Risk is reduced by establishing remedial alternatives to address likelihood of energy imparted to a munitions item as a result of specific activities at the MRS, which will result in moving to the right on Matrix 3. This can be accomplished by implementation of land use controls.

For example, if an MRS baseline is unacceptable, resulting from a "B" category of Matrix 2 and a "2" category from Matrix 3, the remedial alternatives can be established to reduce "B" in Matrix 2 to a "C" or "D", reduce "2" in Matrix 3 to a "3", or affect both matrices to reach any of the "Acceptable" risk levels.

Where multiple site conditions are present on a MRS, e.g., multiple accessibility parameters based on differing land use, or when locations of multiple explosive types and sensitivities can be differentiated from one another, different hazard matrices for these areas may be required. An example presenting multiple acceptable conditions where differing site scenarios are present is included at Attachment 3.

6 **Exit Strategy Using Post Remediation Data Assessments**

6.1 *Defining an Acceptable End State for a MRS*

The achievement of one of the "Acceptable" scenarios in Matrix 4 can result in one of the following "end states" to support a Response Complete (RC) determination, as illustrated in Attachment 3 (Figure A3-1):

a. Acceptable, where UU/UE is supported[16], or

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[16] DODM 4715.20, Enclosure 3, 4.b.(5)(b)1. The assessment of remedial alternatives to meet the remediation goal must include an action to remediate the site to a condition that provides for a UU/UE alternative, and an alternative that achieves protectiveness with LUCs. Upon achievement of the RAO, information should be developed which supports achievement of the acceptable hazard level and an assessment of a UU/UE determination. Project teams must keep in mind that after any site remedy is complete, if the contamination left behind does not allow for UU/UE, 5- year reviews will be required.

b. Acceptable without LUCs, where UU/UE is not supported[17], or

c. Acceptable with LUCs, where UU/UE is not supported.

6.2 Supporting the Acceptable End State Using Post Remedy Data Assessment

Where a physical removal is a component of the selected alternative, the data collected during the physical removal supplements the CSM such that one of the three exit conditions for RC above can be confidently supported. The project team is encouraged to develop "if-then" statements within the proposed plan and decision document that provide the decision logic for these conditions.

Data assessment at the completion of any physical remediation can be used to support the achievement of the RAO, to support the RC determination, and to provide additional confidence in decisions at the site. This includes determination of whether additional actions, such as LUCs, are necessary. It separately includes the determination of whether UU/UE is supported. Teams must plan for data acquisition during the response action to support this decision logic. An example of a post remedy data assessment is included at Attachment 3.

7 Summary and Considerations of Exit Strategy at MRSs

This paper provides decision logic to define and defend decisions on acceptable versus unacceptable conditions at an MRS such that remedial action objectives can be established. These RAOs must be established so the remedial action will mitigate an unacceptable risk to an acceptable one. Furthermore, a RAO cannot be established to reduce an unknown or unlikely risk.

The following recommendations are made to differentiate acceptable and unacceptable risk conditions for each site based on magnitude of evidence collected through site characterization and/or during collection of data during implementation of physical response actions to support achievement of an acceptable end state, shown in Figure A3-1.

1) The project team is encouraged to utilize the matrices presented in this paper as a site-specific risk assessment structure to differentiate acceptable and unacceptable conditions at an MRS.

    a. The likelihood of encounter must account for the characterized distribution, and specific land use scenario. Together, these data reflect the likelihood of encounter, shown in Matrix 1. The matrix may be used pre and post remedy to assess changes to the likelihood of encounter.

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[17] LUCs are additional components of a remedy that further reduce risk where the RAO is not achieved by physical remedy alone. Although UU/UE is not supported, this does not specifically necessitate LUCs. It does, however, necessitate 5-year reviews. Pre-existing site conditions may impose restrictions that are not part of the remedy and will be considered in making the remedial decision, but a site might not achieve UU/UE after RC.

  b. Through the assessment of Severity and Sensitivity Matrices 2 and 3, acceptable conditions may be differentiated from unacceptable ones, thereby supporting the development of a site specific RAO.

2) At completion of characterization (or post remedy) where likelihood of exposure is not reasonably anticipated and has been described, based on combined magnitude of evidence, as "negligible" or "unlikely," then an acceptable condition already exists for which no additional remedial response is required.

3) Project teams performing physical response actions to reduce risk levels, must plan to acquire data needed to describe the residual risk post response to evaluate achievement of the RAO. These data are used to determine if an additional remedial action (such as implementation of LUCs or additional treatment or removal) is necessary to achieve the RAO.

4) Furthermore, data acquired during a remedial action in which a physical removal is conducted may be of quality to support a UU/UE determination, if data gathering is planned and the necessary data is acquired during implementation of the remedy. Project teams are encouraged to include "if-then" statements when assessing remedial alternatives that consider potentially different results of remedial data as applicable to the determination of UU/UE.

5) Where multiple site scenarios are present on a site, (for example, multiple accessibility parameters based on differing land use, or when locations of multiple explosive types and sensitivities can be differentiated from one another), different hazard matrices for these areas may be required.

8 References

1) National Oil and Hazardous Substances Pollution Contingency Plan, (NCP). 40 CFR Part 300, Sections 1-7 and 400-525 March, 1990.

2) DoD Ammunition and Explosives Safety Standards: Criteria for Unexploded Ordnance, Munitions Response, Waste Military Munitions, and Material Potentially Presenting an Explosive Hazard (Department of Defense MANUAL NUMBER 6055.09-M, Volume 7, February 29, 2008. Administratively Reissued August 4, 2010).

3) Defense Environmental Response Program (DERP), Department of Defense Instruction Number 4715.07

4) USEPA, 1988. Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, Interim Final. EPA/540/G-89/004. OSWER Directive 9355.3-01. October.

5) Technical Guidance for Military Munitions Response Actions, Environmental and Munitions Center of Expertise Interim Guidance Document (IGD) 14-01, 20 December 2013. EM 200-1-15.

6) ESTCP studies. https://www.serdp-estcp.org/Featured-Initiatives/Munitions-Response-Initiatives/Classification-Applied-to-Munitions-Response

7) USEPA, 2001. Comprehensive Five Year Review Guidance, EPA-540-R-01-007, OSWER Number 9355.7-03B-P, June.

8) USEPA, 2007. Interim guidance for Munitions of Explosive Concern Hazard Assessment (MEC HA).

9) Office of the Secretary of Defense (OSD) Munitions Response Site Prioritization Protocol (MRSPP) Primer, 32 CFR Part 179, April 2007.

10) Office of the Secretary of Defense (OSD). DoD Evaluation of MEC HA. November 2014.

11) USACE Munitions Safety, Engineer Manual (EM) 385-1-97. Chapter III Probability Assessments

12) Department of the Army, Safety: Risk Management, DA PAM 385-30, 2 December 2014.

13) USACE Engineer Manual (EM) 200-1-12.

14) USACE Memorandum dated January 2007, RE: UFP QAPP Implementation

15) DDESB Technical Paper 18: Minimum qualification standards for personnel who support MEC related activities, 16 July 2015.

Attachment 1: Current Tools for Assessment of Hazard

A1.1 Consideration of the MEC Hazard Assessment (MEC HA)

The MEC HA is intended to provide a qualitative assessment of alternatives given a baseline MRS condition. The output for the MEC HA (baseline and alternatives) is hazard levels 1 through 4, with 1 having the highest hazard, and 4 being the lowest. Each remedial alternative receives a reduced score relative to the baseline score. The score is calculated by additive characteristics of the CSM, specifically the "accessibility" to the explosive items at the MRS, "sensitivity" of the items to function, and the "severity" of an incident, should it occur.

In consideration of MEC HA tool, the "munitions classification", "type", and "energetic material" components of the score are, understandably, static characteristics. These components (accounting for ~32% of the baseline) are never reduced, no matter what remedy is selected. However, because the MEC HA score is an additive calculation, where these factors are not changed, the score cannot efficiently account for a reduced "probability of encounter", which should be a multiplicative determination founded on the "amount of MEC" and "accessibility" conditions.

Other limitations identified by the DoD memorandum, dated November 2014, are related to the rigid selection factors of the tool which do not lend flexibility for the multitude of scenarios of site specific CSMs in the MMRP. For instance, the "Amount of MEC" selection for the MEC HA tool relies on the area category, similar to the type of range that is known or suspected, rather than the period and frequency of use, or actual anomaly distribution resulting from characterization.[18] Understanding or estimating the "Amount of MEC" should be more representative of the findings of the CSM and have direct relation to the calculation of the likelihood of encounter. By selecting a "type" of use as currently provided in the MEC HA tool, the resulting score is in no way reflective of the actual distribution data resulting from the completed characterization, and therefore cannot adequately represent differences between a highly used target areas of several years versus sites with limited use having very little findings to support presence as a result of characterization.

Based on the multiple findings of the DoD (reference 10 in Section 8 above), the probability of encounter cannot be appropriately represented by the current MEC HA tool. In this way, there are limitations to the qualitative value presented by the MEC HA score, and thus is not helpful in establishing the acceptable level of risk or in communicating a likelihood of encounter with a munitions item. It is therefore not an appropriate tool to help a project team in differentiating acceptable from unacceptable risk, or in developing a RAO. A project team is left to make these

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[18] Note the use of "anomaly" here is a general representation of information resulting from characterization. The "hazard" is the result of the explosive nature of specific munitions that may remain partially or fully intact, not the clutter or debris that may be included in this anomaly distribution. The potential for some of those anomalies to present an explosive concern for specific site receptors is the basis of the unacceptable risk determination. It is those specific items presenting an explosive concern that are the "targets of interest" at the MRS, and for which the RAO is focused to reduce risk by implementing a remedial action.

assumptions and considerations outside of the tool in order to support development of a site specific RAO.

Therefore, while utilizing MEC HA to assess different remedial alternatives could be useful for sites where an unacceptable risk is clearly evident, it is not recommended for use to establish an acceptable site scenario or to define an acceptable amount of reduction for an MRS.

A1.2 Consideration of the Munitions Response Site Prioritization Protocol (MRSPP)

The Munitions Response Site Prioritization Protocol (MRSPP) is specifically used as a funding prioritization, not a hazard or risk assessment. However, data acquired during the project life cycle is used to develop sensitivity, accessibility and severity components of the MRSPP score. Therefore, it may be useful to look at the structure of MRSPP when identifying the MRS hazards, specifically the structured scale for the munitions explosive nature, Tables 1-3 of the MRSPP. The information in the MRSPP tables may be pertinent, and should ultimately be comparable to the methods established in this paper, such that the accessibility, sensitivity, and severity components are reflected similarly. Although the MRSPP is completed annually for each MRS, or as new information is available, it is important to recognize that once a remedial process has been completed, the MRSPP score becomes "no longer required" indicating funding is no longer planned. As a result, the MRSPP is not used to determine the reduction of risk once a remedy has been implemented.

A1.3 MEC Probability Assessment

The Engineer Manual (EM) 385-1-97, Safety and Health Requirements Manual, provides planning requirements for military construction projects having a current scale of "no," "low," and "moderate to high" probability determinations of an explosive hazard defined in a Probability Assessment. Though most of EM 385-1-97 does not apply to FUDS, this Probability Assessment is instructive as to how other programs assess explosives safety. Both "low" and "moderate to high" determinations require planning for MEC construction support (MEC standby or onsite support, respectively) on military installation construction projects.

Prior to Errata sheet No 1, dated 12 April 13 for this EM, "negligible probability" was included as the lowest probability, rather than the current word "no". In consideration of defining a similar scale for an MRS, rather than a construction site, though, the change in this terminology is significant. The word "no" constitutes a zero probability, which ***cannot*** be supported by any characterization effort; however the term "negligible" can be supported, with a specified degree of confidence. Conceptually, by this scale historically in EM 385-1-97, either "no" or "negligible" would support an "acceptable" condition, as no construction support would be required for sites where "negligible" (now "no") probability of encounter is determined.

Further, there is ambiguity in the relative definition of "low" probability, and there is no definition to the former term "negligible". While these general terms can provide a qualitative scale to establish the baseline probability of a hazard that may be found at a site, based on historic use and observation, there is no established logic in these terms that supports the determination of acceptable versus unacceptable risk at a site for purposes of CERCLA response.

In considering these terms for MMRP, this team recommends the term "negligible" probability because it can be defined using this RAO methodology such that an acceptable risk for an MRS can be established. In the absence of generally accepted definitions for acceptable risk levels for munitions response sites, project teams are currently encouraged to define "negligible" or "low" as acceptable risk levels, depending on specific physical and land use conditions at a MRS. This paper provides a framework of logic to support these determinations of probability, or "likelihood of encounter", relative to acceptability.

A1.4 Army Risk Management

Department of Army Pamphlet for Risk Management (DA Pam 385-30) is used to identify mission-related hazards and conduct a risk assessment for these conditions. It is generally tailored for active military missions. It does not clearly relate to environmental hazards related to MMRP; however, it focuses generally on probability and severity as key input factors for the evaluation of risk. This paper establishes a parallel to this Army process of Risk Management, using more appropriate matrix categories and factors pertinent to MMRP, to include specific site conditions and munitions sensitivities, while incorporating appropriate elements of the MEC HA, MRSPP, and the Probability Assessment. The strength in the Army risk assessment approach is that it is intended to address potentially acute hazard scenarios by assessing real site conditions to establish risk.

Attachment 2. Example RAO Acceptable Conditions

The table below gives examples of unacceptable baseline conditions and resultant acceptable conditions the remedial alternatives can seek to achieve.

MRS Scenario	Horizontal Boundary	Receptors	Pathways	Required remedial response depth[19]	UXO and DMM	Baseline Risk Condition (from Matrix 4)	Acceptable Condition(s) (from Matrix 4)	Baseline Acceptable or Unacceptable? U→FS required A→no action
Target Area	Trails plus 15m buffer that are within Target Area	Recreational users	Interaction during hiking, camping, hunting	0.5 meter	M7 155mm intact UXO	A-1	D-1 or D-3	U
				0.5 meter	M7 155mm low-order UXO	B-2	C-2, D-2, C-3 or D-3	U
				0.2 meter	M48 Fuze	B-2	C-2, D-2, C-3, D-3	U
	All other portions of Target Area	Recreational users	Interaction during hiking, camping, hunting	0.5 meter	M7 155mm intact UXO	B-1	D-1 or D-3	U
				0.5 meter	M7 155mm low-order UXO	B-2	C-2, D-2, C-3, or D-3	U
				0.2 meter	M48 Fuze	C-2	C-2, D-2, C-3, or D-3	A
Buffer Zone	Remaining Buffer Zone Area	Recreational users	Interaction during hiking, camping, hunting	0.5 meter	M7 155mm intact UXO	B-1	D-1 or D-3	U
				0.5 meter	M7 155mm low-order UXO	B-2	C-2, C-3, D-2 or D-3	U
				0.2 meter	M48 Fuze	C-2	C-2, C-3, D-2 or D-3	A

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[19] Characterization must provide data to suggest a horizontal as well as depth distribution of the TOI (with indication of confidence). The response depth is built from that distribution, with relative consideration of land use and instrument detection capabilities. See Attachment 3 to illustrate the significance of this data and how the post removal assessment is used to determine need for additional response (LUCs) or whether UU/UE can be supported.

Attachment 3: Example Post Remedy Data Assessment

This attachment illustrates the decision logic that may be performed post-remedy, using data collected during the remedial action to support the decision. Decision logic for this type of assessment is provided in the decision tree at Figure A3-1. The example is based on the tabulated RAO for acceptable conditions, which was developed using the matrices presented in this document:

EXAMPLE: Acceptable Conditions that Achieve the RAO

MRS Scenario	Horizontal Boundary	Receptors	Pathways	Required remedial response depth	UXO and DMM	Baseline Risk Condition	Acceptable Condition(s)= RAOs
Target Area	MRS01 boundary	Recreational users	Interaction during hiking, camping, hunting	0. 65 meter	81mm Mortar	A-1	B-3, D-1 D-2, or D-3
				0.3 meter	37mm projectile	A-1	B-3, D-1 D-2, or D-3

37mm and 81mm mortars are the targets of interest (TOI) based on historic use and confirmed presence of explosives use during characterization. Assumptions resulting from characterization are that:

- *37mm exist from the surface to 30cm*
- *81mm exist from the surface to 65cm*
- *These items are easy to detect and classify in any orientation within those depth intervals.*
- *Items can be detected and recovered at deeper depths when a signal-to-noise ratio is predicted for a given depth and orientation that is equal or greater than the project-specific detection threshold required to detect a horizontal 37mm at 30cm or a horizontal 81mm at 65cm.*

Details of the remedial action will be specified and executed in accordance with the site specific Uniform Federal Policy for Quality Assurance Project Plan (UFP QAPP).[20] *Once the remedial action is complete, post remedy data is used at the Post Remedy Decision Points, indicated at Figure A3-1.*

In this example, data were collected during remedy implementation to support post remedy evaluation of the residual risk, confirm the CSM and achievement of the RAO, to determine

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[20] The Office of the Under Secretary of Defense Memorandum of April 11, 2006, first recommended use of UFP QAPP for DoD. USACE echoed recommendation in Memo dated January 2007. UFP QAPP, has since been implemented into the EM 200-1-15, 30 October 2015. *The DoD Environment, Safety, and Occupational Health Network and Information Exchange* provides the UFP QAPP worksheets at: http://www.denix.osd.mil/edqw/Documents.cfm

whether UU/UE can be supported, and/or to determine whether additional response, such as LUCs, may be required. If the RAO is satisfied, then RC is achieved.

POST-REMEDY DECISION POINTS: Confidence in the CSM and achievement of the RAO is supported when:

- All quality control criteria as specified in the site specific UFP QAPP for the remedial action are met,
- The CSM resulting from the characterization is still true, to include:
    - Identities of the items recovered were anticipated as a result of the characterization CSM.
    - The vertical distribution resulting from characterization reflects the actual vertical distribution of UXO recovered during the remedial response; and
    - All areas within the MRS Scenario (lateral and vertical boundary specifications of the RAO) have been searched for TOI.
        - Partial search (e.g., due to areas of difficult terrain, lack of ROE or other access issues) may result in considerations for additional response at the MRS (such as LUCs), or delineation of the unsearched area for further response while the searched area remedy is considered complete.

<u>Post Remedy Decision Point 1</u>: The Remedial Action work plan (UFP QAPP) defines the data quality objectives (to support achievement of the RAO). The Post Remedy Decision Point 1 assesses whether the conditions of response action met the requirements of the RAO as planned.

NO: For Remedial Responses that do not meet the criteria as specified in the remedial action UFP QAPP, there is reason to suspect the RAO has not been met. The project team must determine whether the deficiencies impact the achievement of the RAO, whether for the whole MRS Scenario, partial MRS Scenario, or if achievement of the RAO can still be supported. Justification for the decision must be provided. For instance, difficult terrain encountered during remedy prevented search of 100% of the MRS. MEC was encountered throughout the remedy of the areas immediately surrounding and within difficult terrain areas of the MRS. The PDT must determine if the reduction of the amount of MEC, with consideration of the confidence in the data can support achievement the RAO. A selection of "No" in the decision tree indicates the physical remedy did not achieve the RAO, where the likelihood of encounter, severity and sensitivity is still unacceptable, and therefore further remedial action is required. (See Post Remedy Decision Point 2b below.)

YES: For physical responses that meet the RAO, additional remedial actions (e.g., LUCs) will not be required to support an acceptable end state. In Figure A3-2, the data supports that the remedial response above the detection depth of the instrument and within the boundaries for the MRS was successful to meet the RAO. All assumptions and quality control data were met, supporting high confidence in remedy implementation. After the remedy is implemented at 100% of the MRS Scenario, the amount of MEC is confidently reduced to support selection of "unlikely" in Matrix 1, resulting in a D determination in Matrix 2. The reduction of items within the depth interval for current and reasonably anticipated future land users also supports selection of "Inconsequential" in Matrix 3.

For MRS scenarios where the physical response achieves the RAO, the project team must then assess whether UU/UE can be supported. Examples at Figures A3-2 and A3-3 are used to illustrate this subsequent post remedy data assessment for UU/UE considerations. (See ***Post Remedy Decision Point 2a*** below.)

<u>Post Remedy Decision Point 2a</u>: If the result of Decision Point 1 is "YES", the team must consider the achievement of UU/UE. Figures A3-2 and A3-3 are used as an example to illustrate how a post remedy data assessment can be used to support the consideration of UU/UE.

- *<u>Outcome A: UU/UE Supported.</u>* In further evaluation of the data, a significant gap exists below the lowest item found during implementation of the physical response and the known detection depth of the instruments used. The gap provides confidence that residual MEC at the MRS is "unlikely" to be present. In this case, a UU/UE determination is supported by the post remedy data assessment.

  Additional considerations: Another consideration for UU/UE is the limits of physical remedy imposed by site-specific limitations, such as bedrock. Removal to shallow bedrock over 100 % of the MRS Scenario, with appropriate quality data in the UFP QAPP may also be used to support a UU/UE determination.

- *<u>Outcome B: UU/UE Not Supported.</u>* In this example, two TOI were found near or just below the detection depth of the instrument, categorized as "catastrophic" in the severity Matrix 2. Both were identified as an explosive hazard. Based on the distribution of TOI in the subsurface, primarily in the 0-20 cm interval, the single detection of the 37mm at 30 cm, and the single detection of the 81mm at 70 cm are atypical of the remaining data set. However, because the items detected were "live", there is less confidence that residual presence of MEC below the RAO boundaries is "unlikely." If UU/UE is not supported, Five-Year Reviews will be required to assess long term protectiveness of the remedy to ensure the remedy remains protective.

  Consider, though, if the items at these depths were identified as inert fragments, the determination of UU/ UE may further be supported, as the dataset may suggest that MEC was limited to within 20cm of the surface.

<u>Post Remedy Decision Point 2b</u>: When the result of Decision Point 1 is "NO", the Decision Tree provides consideration of the existing data to re-assess the MRS Scenario and determine whether further remedial actions (e.g., LUCs) may be implemented to further support an Acceptable end state, according to Matrix 4.

- *Outcome C: UU/UE Not Supported.* If LUCs can be implemented to support achievement of the RAO, Outcome C is achieved, and response is complete.[21] Five Year Reviews will be required to assess long term protectiveness; however, if inclusion of LUCs does not support an acceptable end state, the project team must consider additional response actions, and return to the Remedial process.

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[21] Consideration of LUCs at this decision point should be included as a discussion in the Feasibility Study, and Proposed Plan/Decision Document. Consideration of LUCs as part of a remedial alternative may occur if the physical remedy alone is not anticipated to achieve the RAO, and these measures will further reduce Matrix 4 to an acceptable end state. Alternatively, (post physical remedy) there may be cases where the physical remedy alone is anticipated to achieve the RAO, and if after the physical remedy is complete this is not the case, a decision document amendment or an explanation of significant differences (ESD) may be required to include LUCs or include additional remedial measures. The DERP Manual requires consideration of a remedial alternative that includes LUCs. The implementation of a LUC is (or may be part of) a remedial action, so a determination that LUCs are necessary after completion of a remedy that does not include LUCs should be infrequent.

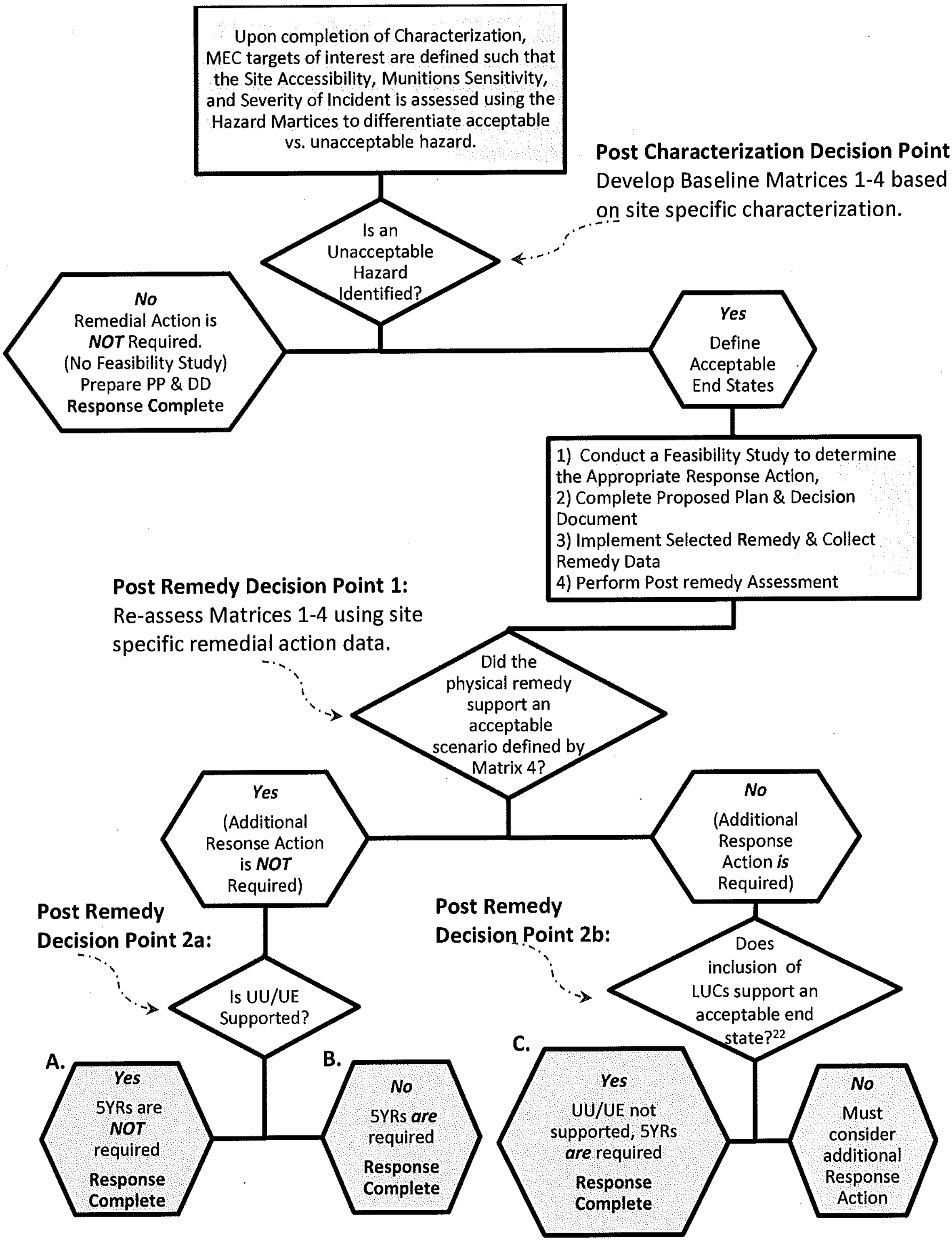

Figure A3-1. Decision Logic for post-Remedial Action data assessment, where a physical remedy is conducted. End States A, B, or C are the potential outcomes of a remedial action. Figures A3-2 and A3-3 illustrate additional consideration of UU/UE for outcome of A vs. B, where the RAO is achieved.

As illustrated below, achievement of the RAO when physical remediation is conducted should be assessed post remedy in order to determine whether the RAO is met or if additional response is required to meet the RAO. Furthermore, if the RAO is met, then assessment of UU/UE is evaluated separately from the remedial process, also conducted post remedy. If UU/UE cannot be supported by the data, Five-Year Reviews will be required.

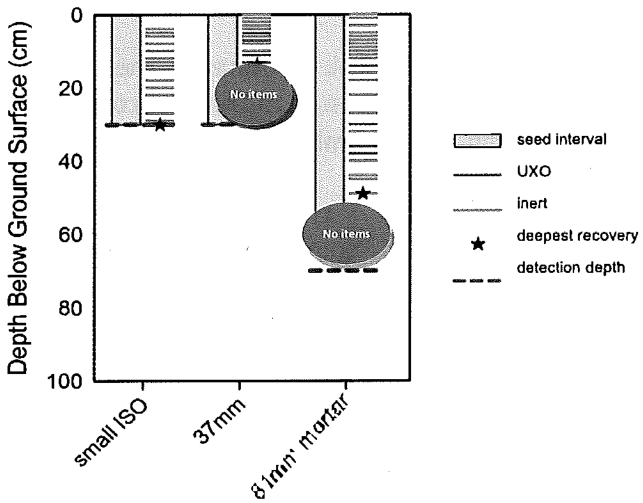

Figure A3-2. Example Outcome A. After a physical response action for 100% of the MRS, the data assessment shows that all targets of interest (TOI) were recovered from the MRS and all were well within the detection capabilities of the instrument such that there is high confidence that any potential residual presence of UXO is negligible. The end state for the MRS from Matrix 4 is 3-D. This is defined by the "Unlikely" resulting from Matrix 1, and "Inconsequential" rating in Matrix 3. There are no detections below 50 cm down to the instrument detection depth of 65 cm for the 81mm, nor below 15 cm down to the instrument detection depth of 30 cm for the 37mm. This "buffer" in the detection data versus instrument capability provides confidence that UU/UE can be reasonably supported for the MRS.

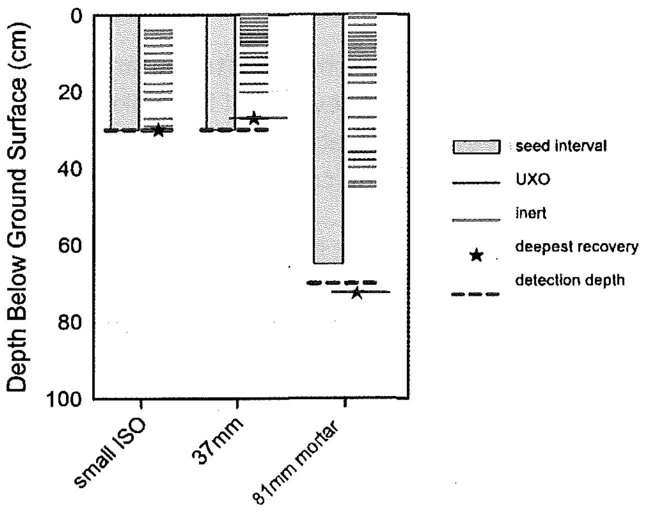

Figure A3-3. Example Outcome B. After a physical response action for 100% of the MRS, the data assessment shows that all detectable targets of interest were recovered from the MRS, but few TOI were recovered near the limits of the detection capabilities of the instrument. Like Outcome A, the supported end state within the recovery area for the MRS, Matrix 4, is 3-D. In this case, there is lower confidence in accepting the residual presence of TOI below detection depth for the MRS. UU/UE may not be supported if there is some evidence of residual hazard remaining on the MRS with some likelihood of exposure. If UU/UE is not supported, Five-Year Reviews will be required.

Attachment 4: Glossary- (Hazard versus Risk)

Definitions of Terms Found in DA Pam 385-30:[22]

Hazard. Hazard is a condition with the potential to cause injury, illness, or death of personnel; damage to or loss of equipment or property; or mission degradation. Therefore, a hazard can have several possible negative outcomes or losses (for example, injury, death, damage, mission failure, mission degradation, increased resource(s) expenditures, and adverse public relations).

Risk. Risk is determined after hazards are identified and analyzed. Risk is defined as the probability and severity of loss linked to hazards. It is simply the measure of the expected loss from a given hazard or group of hazards, usually estimated as the combination of the likelihood (probability) and consequences (severity) of the loss.

Residual risk. The risk associated with a hazard that remains after implementing all planned countermeasures or controls to eliminate, reduce, or control the impact of the hazard. The residual risk may be equal to the initial risk, especially when the initial risk is so low that the hazard does not warrant expenditure of funds to mitigate.

Probability. An approximation of the likelihood of a hazard scenario or mishap occurring. Probability is assessed as frequent, likely, occasional, seldom, or unlikely.

Severity. An approximation of the amount of potential harm, damage, or injury associated with a given mishap.

Additional definitions added to this study for purposes of munitions risk management:

Sensitivity. An approximation of the likelihood that a human receptor will be able to interact with a MEC item such that it will detonate.

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[22] The DA Pam 385-30 definition for "hazard" includes some aspects, such as "damage, mission failure, mission degradation," etc., that have no specific application for the MMRP conducted under CERCLA. As such, the definitions were used as a benchmark for this study, and are included here only as a guide to users in making risk management evaluations to recognize the presence of MEC as the "hazard", but to separate the term from the determination of "risk" as the *probability* of an incident and severity of loss due to a hazard and conditions around it. It is not intended to expand CERCLA response authority past death or injury. Additionally, these definitions recognize cases where some "residual hazard" may be determined to be acceptable, as discussed in section 4.2.

Attachment 5: Acronyms

AR	Army Regulation
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMUA	Concentrated Munitions Use Area
DA Pam	Department of the Army Pamphlet
DD	Decision Document
DMM	Discarded Military Munitions
DODI	Department of Defense Instruction
EM	Engineer Manual
FS	Feasibility Study
HE	High Explosive
HTRW	Hazardous Toxic and Radioactive Wastes
LUCs	Land Use Controls
MD	Munitions Debris
MEC	Munitions and Explosives of Concern
MEC HA	MEC Hazard Assessment
MMRP	Military Munitions Response Program
MRS	Munitions Response Sites
MRSPP	Munitions Response Site Prioritization Protocol
NCMUA	Non Concentrated Munitions Use Area
PA	Preliminary Assessment
PDT	Project Delivery Team
PP	Proposed Plan
RAO	Remedial Action Objective
RC	Response Complete
RCRA	Resource Conservation and Recovery Act
RI	Remedial Investigation
RIP	Response in Place
SI	Site Inspection
TOI	Targets of Interest
UFP QAPP	Uniform Federal Policy for Quality Assurance Project Plans
USACE	U.S. Army Corps of Engineers
UU/UE	Unlimited Use, Unrestricted Exposure
UXO	Unexploded Ordnance

NEW RISK MANAGEMENT METHODOLOGY FEEDBACK FORM

Decision Logic to Assess Risks Associated with Explosive Hazards, and to Develop Remedial Action Objectives (RAOs) for Munitions Response Sites

FUDS Property/Project Number:
Property Name:
Project Name:
MRSPP Overall Score:

1. List historically known or suspected munitions and specify what evidence of MEC was found during characterization. (If multiple munitions exist, and or different areas are identified, these areas may be presented separately):

Amount of MEC Justification: ____
____

Sensitivity Justification: ____
____

Severity Justification: ____
____

2. Specify Land Use and Site Receptors. (If multiple Land Use/Receptors exist as different areas, these areas may be identified separately):

Access Condition Justification: ____
____

Likelihood to Impart Energy Justification: ____________________________________
____

3. For each area having separate conditions above, indicate the Risk Management Results for the following:

Matrix 1:	Frequent	Likely	Occasional	Seldom	Unlikely
Matrix 2:	A	B	C	D	
Matrix 3:	1	2	3		
Matrix 4:	(result of combining Matrices 2 and 3 above, e.g., A-2, B-1, etc.)				
Risk Determination:		Acceptable		Unacceptable	

4. Other Comments, (Please identify limitations or suggestions, if any.):

____
____

5. Compare of use of RAO methodology to MEC HA, if applied:

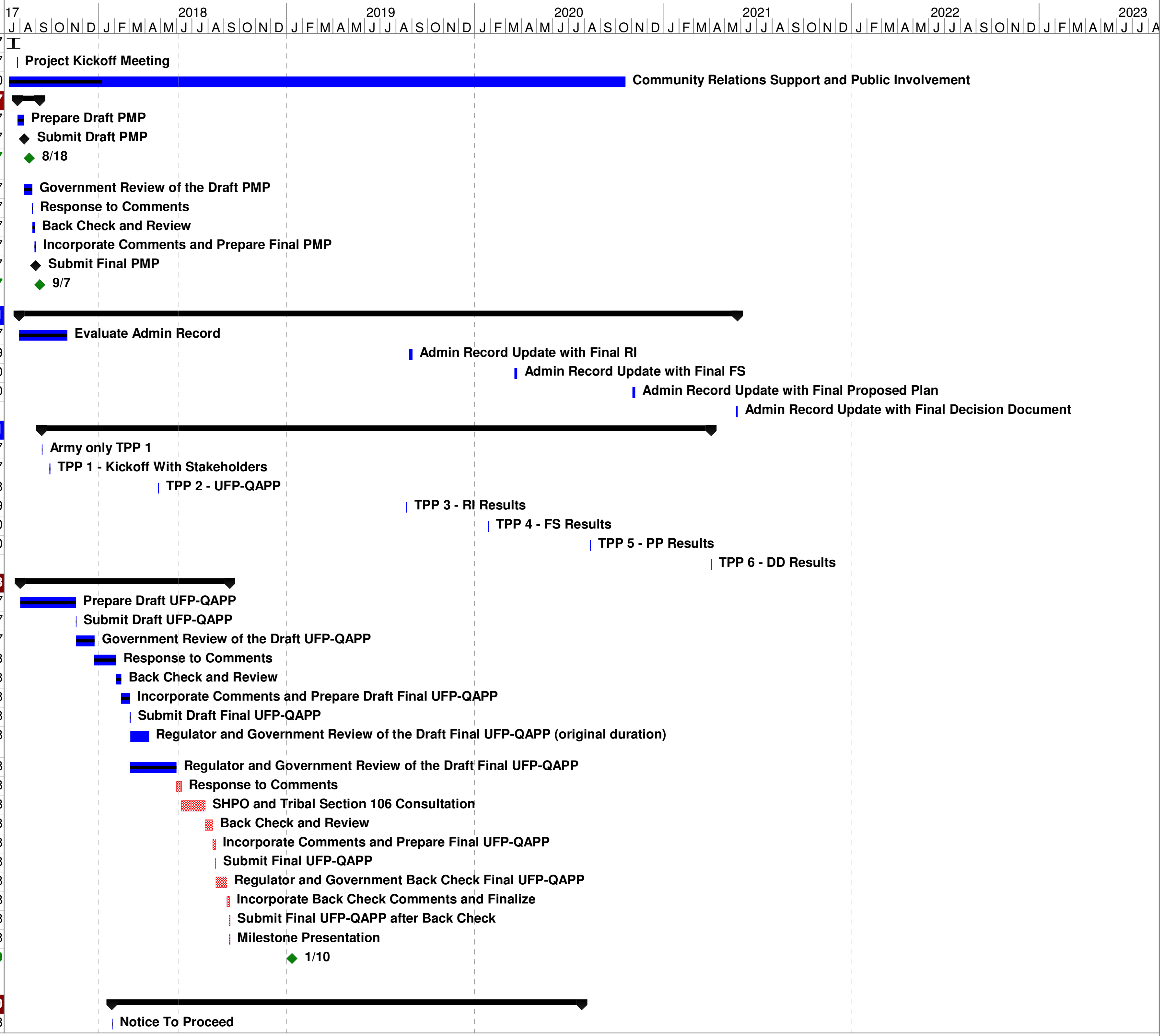
____
____

Enclosure 2

APPENDIX F
PROJECT SCHEDULE

U.S. Army Garrison West Point, New York Military Munitions Response Program - Water Ranges - Remedial Investigation / Feasibility Study Through Decision Document

ID	CLIN	Activity ID Suffix	Task Name	Calendar Days Duration	Start	Finish
1			**Contract Award**	1 day	7/19/17	7/19/17
2			Project Kickoff Meeting	1 day	7/26/17	7/26/17
3			Community Relations Support and Public Involvement	1183 days	7/10/17	10/18/20
4	**0001**		**Project Management Plan**	**43 days**	**7/27/17**	**9/7/17**
5			Prepare Draft PMP	12 days	7/27/17	8/7/17
6		PM	Submit Draft PMP	1 day	8/8/17	8/8/17
7			**Milestone Performance Objective - Draft PMP 30 days from Award**	**0 days**	**8/18/17**	**8/18/17**
8		QA	Government Review of the Draft PMP	15 days	8/9/17	8/23/17
9			Response to Comments	1 day	8/24/17	8/24/17
10			Back Check and Review	4 days	8/25/17	8/28/17
11			Incorporate Comments and Prepare Final PMP	2 days	8/29/17	8/30/17
12		PM	Submit Final PMP	0 days	8/30/17	8/30/17
13			**Milestone Performance Objective - Final PMP 15 days of Receipt of COR Comments on Draft**	**0 days**	**9/7/17**	**9/7/17**
14			**Administrative Record & Project Repository**	**1381 days**	**7/30/17**	**5/24/21**
15			Evaluate Admin Record	93 days	7/30/17	10/30/17
16			Admin Record Update with Final RI	5 days	8/27/19	8/31/19
17			Admin Record Update with Final FS	5 days	3/18/20	3/22/20
18			Admin Record Update with Final Proposed Plan	5 days	11/2/20	11/6/20
19			Admin Record Update with Final Decision Document	3 days	5/22/21	5/24/21
20			**Technical Project Planning**	**1286 days**	**9/12/17**	**4/3/21**
21			Army only TPP 1	1 day	9/12/17	9/12/17
22			TPP 1 - Kickoff With Stakeholders	1 day	9/27/17	9/27/17
23			TPP 2 - UFP-QAPP	1 day	4/26/18	4/26/18
24			TPP 3 - RI Results	1 day	8/21/19	8/21/19
25			TPP 4 - FS Results	1 day	1/27/20	1/27/20
26			TPP 5 - PP Results	1 day	8/12/20	8/12/20
27			TPP 6 - DD Results	1 day	4/3/21	4/3/21
28	**0002**		**UFP-QAPP**	**399 days**	**8/1/17**	**9/11/18**
29			Prepare Draft UFP-QAPP	108 days	8/1/17	11/16/17
30			Submit Draft UFP-QAPP	1 day	11/17/17	11/17/17
31		QA	Government Review of the Draft UFP-QAPP	35 days	11/18/17	12/22/17
32			Response to Comments	37 days	12/23/17	2/2/18
33			Back Check and Review	10 days	2/3/18	2/12/18
34			Incorporate Comments and Prepare Draft Final UFP-QAPP	17 days	2/13/18	3/1/18
35		PM	Submit Draft Final UFP-QAPP	1 day	3/2/18	3/2/18
36			Regulator and Government Review of the Draft Final UFP-QAPP (original duration)	35 days	3/3/18	4/6/18
37		QA	Regulator and Government Review of the Draft Final UFP-QAPP	88 days	3/3/18	5/30/18
38			Response to Comments	10 days	5/31/18	6/9/18
39			SHPO and Tribal Section 106 Consultation	45 days	6/10/18	7/25/18
40			Back Check and Review	15 days	7/26/18	8/9/18
41			Incorporate Comments and Prepare Final UFP-QAPP	5 days	8/10/18	8/14/18
42			Submit Final UFP-QAPP	1 day	8/15/18	8/15/18
43		QA	Regulator and Government Back Check Final UFP-QAPP	20 days	8/16/18	9/5/18
44			Incorporate Back Check Comments and Finalize	5 days	9/6/18	9/10/18
45		PM	Submit Final UFP-QAPP after Back Check	1 day	9/11/18	9/11/18
46			Milestone Presentation	1 day	9/11/18	9/11/18
47			**Milestone Performance Objective - Approved Uniform Federal Policy - Quality Assurance Project Plan (UFP-QAPP) within 18 months of award of NTP.**	**0 days**	**1/10/19**	**1/10/19**
48	**'0003**		**OPTION: Remedial Investigation/Feasibility Study**	**904 days**	**1/26/18**	**7/26/20**
49			Notice To Proceed	1 day	1/26/18	1/26/18



Task ▬ Milestone ◆ Summary ▬ Critical Path ▨ Performance Milestone ◆

Note: Duration is based on Calendar days.

U.S. Army Garrison West Point, New York Military Munitions Response Program - Water Ranges - Remedial Investigation / Feasibility Study Through Decision Document

ID	CLIN	Activity ID Suffix	Task Name	Calendar Days Duration	Start	Finish
50	'0003AA		**RI/FS Siege Battery - TD River (WSTPT-016-R-01)**	**631 days**	**6/18/18**	**3/17/20**
51			**RI - Field Work**	**192 days**	**6/18/18**	**1/2/19**
52			Mobilization for Survey and DGM	1 day	6/18/18	6/18/18
53			Setup Facilities/Survey Control	1 day	6/19/18	6/19/18
54			IVS Survey and Memo	2 days	6/24/18	6/25/18
55			Pre DGM Sea Floor Mapping	4 days	6/20/18	6/23/18
56			DGM Transect Surveys	10 days	6/26/18	7/6/18
57			Demobilization	1 day	7/7/18	7/7/18
58		QA	Data Analysis/Government Review of Data	30 days	7/8/18	8/6/18
59			Government Approval of Data	1 day	8/7/18	8/7/18
60			Remobilization for Anomaly Investigation and MC Sampling	2 days	9/11/18	9/12/18
61			Reacquisition Dive Work	16 days	9/13/18	9/28/18
62			MC Sampling	16 days	9/13/18	9/28/18
63			Demobilization	1 day	9/29/18	9/29/18
64			Lab Analysis	30 days	9/29/18	10/28/18
65			Data Validation	30 days	10/29/18	11/29/18
66		QA	Data Analysis/Government Review of Data	30 days	11/30/18	12/31/18
67		PM	Government Approval of Analytical Results	1 day	1/2/19	1/2/19
68			**RI - Report**	**236 days**	**1/2/19**	**8/26/19**
69			Prepare Draft RI Report	60 days	1/2/19	3/3/19
70			Submit Draft RI Report	1 day	3/4/19	3/4/19
71		QA	Government Review of the Draft RI Report	30 days	3/5/19	4/3/19
72			Response to Comments	7 days	4/4/19	4/10/19
73			Back Check and Review	10 days	4/11/19	4/20/19
74			Incorporate Comments and Prepare Draft Final RI Report	5 days	4/21/19	4/25/19
75		PM	Submit Draft Final RI Report	1 day	4/26/19	4/26/19
76		QA	Regulator and Government Review of the Draft Final RI Report	45 days	4/27/19	6/10/19
77			Response to Comments	5 days	6/11/19	6/15/19
78			Back Check and Review	15 days	6/16/19	6/30/19
79			Incorporate Comments and Prepare Final RI Report	5 days	7/1/19	7/5/19
80			Submit Final RI Report	1 day	7/6/19	7/6/19
81		QA	Regulator and Government Back Check Final RI Report	45 days	7/7/19	8/20/19
82			Incorporate Back Check Comments and Finalize	5 days	8/21/19	8/25/19
83		PM	Submit Final RI Report after Back Check	1 day	8/26/19	8/26/19
84			Milestone Presentation	1 day	8/26/19	8/26/19
85			**Feasibility Study Report**	**204 days**	**8/27/19**	**3/17/20**
86			Prepare Draft FS Report	30 days	8/27/19	9/25/19
87			Submit Draft FS Report	1 day	9/26/19	9/26/19
88		QA	Government Review of the Draft FS Report	30 days	9/27/19	10/26/19
89			Response to Comments	5 days	10/27/19	10/31/19
90			Back Check and Review	10 days	11/1/19	11/10/19
91			Incorporate Comments and Prepare Draft Final FS Report	5 days	11/11/19	11/15/19
92		PM	Submit Draft Final FS Report	1 day	11/16/19	11/16/19
93		QA	Regulator and Government Review of the Draft Final FS Report	45 days	11/17/19	12/31/19
94			Response to Comments	5 days	1/1/20	1/5/20
95			Back Check and Review	15 days	1/6/20	1/20/20
96			Incorporate Comments and Prepare Final FS Report	5 days	1/21/20	1/25/20
97			Submit Final FS Report	1 day	1/26/20	1/26/20
98		QA	Regulator and Government Back Check Final FS Report	45 days	1/27/20	3/11/20
99			Incorporate Back Check Comments and Finalize	5 days	3/12/20	3/16/20
100		PM	Submit Final FS Report after Back Check	1 day	3/17/20	3/17/20
101			Milestone Presentation	1 day	3/17/20	3/17/20

Task ▬ Milestone ◆ Summary ▬ Critical Path ▨ Performance Milestone ◆

Note: Duration is based on Calendar days.

U.S. Army Garrison West Point, New York Military Munitions Response Program - Water Ranges - Remedial Investigation / Feasibility Study Through Decision Document

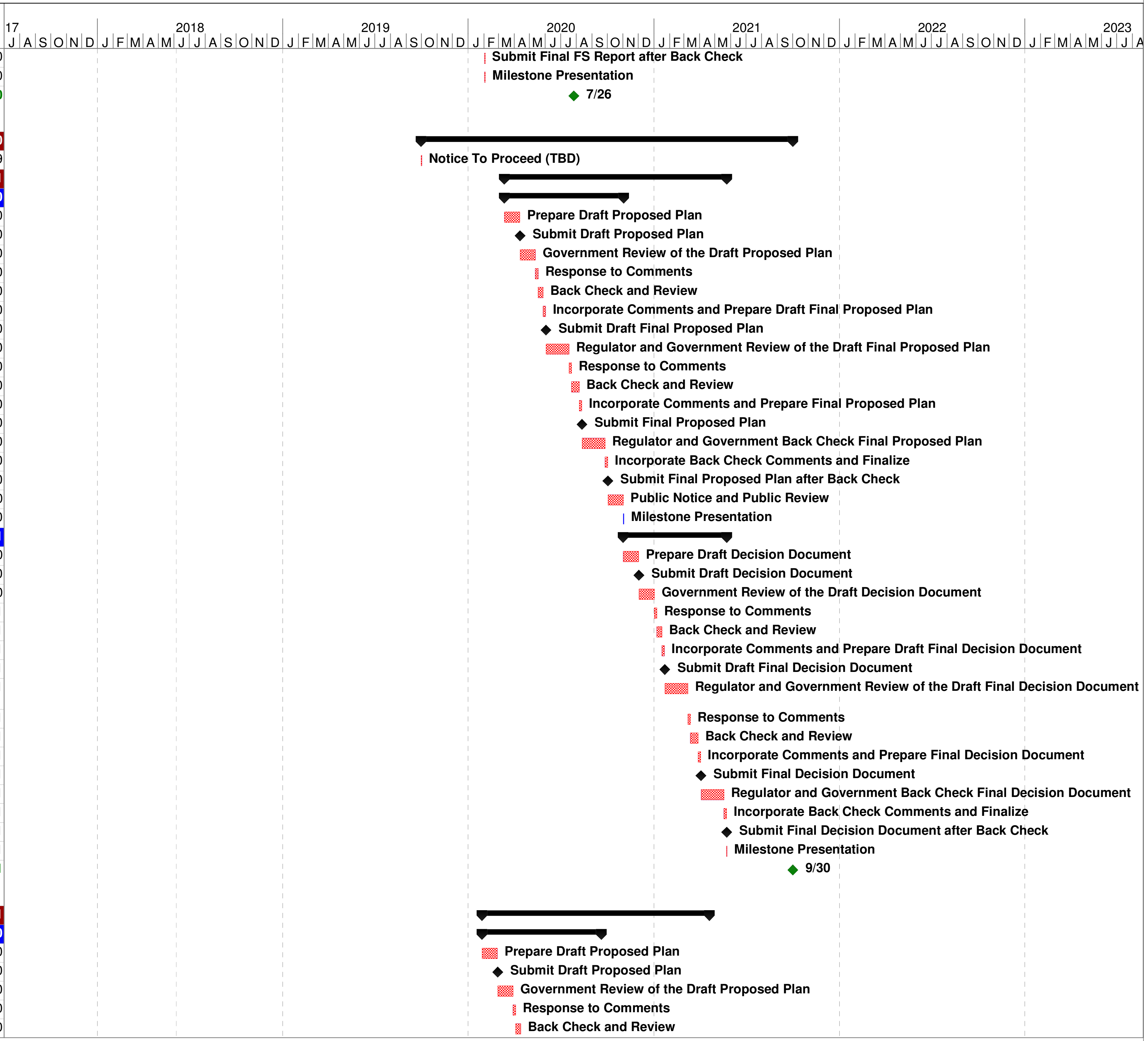
ID	CLIN	Activity ID Suffix	Task Name	Calendar Days Duration	Start	Finish
102			**Milestone Performance Objective - Achieve Remedial Investigation/Feasibility Study (RI/FS) within 30 months of award of option.**	**0 days**	**7/26/20**	**7/26/20**
103	**'0003.2**		**RI/FS Battery Knox - TD River (WSTPT-004-R-01)**	**587 days**	**6/18/18**	**2/2/20**
104			**RI - Field Work**	**148 days**	**6/18/18**	**11/14/18**
105			Mobilization for Survey and DGM	1 day	6/18/18	6/18/18
106			Setup Facilities/Survey Control	2 days	6/19/18	6/20/18
107			IVS Survey and Memo	2 days	6/21/18	6/22/18
108			Pre DGM Seafloor Mapping	2 days	6/23/18	6/24/18
109			DGM Transect Surveys	2 days	6/25/18	6/26/18
110			Demobilization	1 day	7/7/18	7/7/18
111		QA	Data Analysis/Government Review of Data	30 days	7/8/18	8/6/18
112			Government Approval of Data	1 day	8/7/18	8/7/18
113			Remobilization for Anomaly Investigation and MC Sampling	2 days	8/10/18	8/11/18
114			Reacquisition Dive Work	3 days	8/12/18	8/14/18
115			MC Sampling	3 days	8/12/18	8/14/18
116			Demobilization	1 day	9/29/18	9/29/18
117			Lab Analysis	30 days	8/15/18	9/14/18
118			Data Validation	30 days	9/15/18	10/14/18
119		QA	Data Analysis/Government Review of Data	30 days	10/15/18	11/13/18
120		PM	Government Approval of Analytical Results	1 day	11/14/18	11/14/18
121			**RI - Report**	**236 days**	**11/14/18**	**7/13/19**
122			Prepare Draft RI Report	60 days	11/14/18	1/18/19
123			Submit Draft RI Report	1 day	1/19/19	1/19/19
124		QA	Government Review of the Draft RI Report	30 days	1/20/19	2/18/19
125			Response to Comments	7 days	2/19/19	2/25/19
126			Back Check and Review	10 days	2/26/19	3/7/19
127			Incorporate Comments and Prepare Draft Final RI Report	5 days	3/8/19	3/12/19
128		PM	Submit Draft Final RI Report	1 day	3/13/19	3/13/19
129		QA	Regulator and Government Review of the Draft Final RI Report	45 days	3/14/19	4/27/19
130			Response to Comments	5 days	4/28/19	5/2/19
131			Back Check and Review	15 days	5/3/19	5/17/19
132			Incorporate Comments and Prepare Final RI Report	5 days	5/18/19	5/22/19
133			Submit Final RI Report	1 day	5/23/19	5/23/19
134		QA	Regulator and Government Back Check Final RI Report	45 days	5/24/19	7/7/19
135			Incorporate Back Check Comments and Finalize	5 days	7/8/19	7/12/19
136		PM	Submit Final RI Report after Back Check	1 day	7/13/19	7/13/19
137			Milestone Presentation	1 day	7/13/19	7/13/19
138			**Feasibility Study Report**	**204 days**	**7/14/19**	**2/2/20**
139			Prepare Draft FS Report	30 days	7/14/19	8/12/19
140			Submit Draft FS Report	1 day	8/13/19	8/13/19
141		QA	Government Review of the Draft FS Report	30 days	8/14/19	9/12/19
142			Response to Comments	5 days	9/13/19	9/17/19
143			Back Check and Review	10 days	9/18/19	9/27/19
144			Incorporate Comments and Prepare Draft Final FS Report	5 days	9/28/19	10/2/19
145		PM	Submit Draft Final FS Report	1 day	10/3/19	10/3/19
146		QA	Regulator and Government Review of the Draft Final FS Report	45 days	10/4/19	11/17/19
147			Response to Comments	5 days	11/18/19	11/22/19
148			Back Check and Review	15 days	11/23/19	12/7/19
149			Incorporate Comments and Prepare Final FS Report	5 days	12/8/19	12/12/19
150			Submit Final FS Report	1 day	12/13/19	12/13/19
151		QA	Regulator and Government Back Check Final FS Report	45 days	12/14/19	1/27/20
152			Incorporate Back Check Comments and Finalize	5 days	1/28/20	2/1/20

Task	▬	Milestone	◆	Summary	▬	Critical Path	▨	Performance Milestone ◆

Note: Duration is based on Calendar days.

U.S. Army Garrison West Point, New York Military Munitions Response Program - Water Ranges - Remedial Investigation / Feasibility Study Through Decision Document

ID	CLIN	Activity ID Suffix	Task Name	Calendar Days Duration	Start	Finish
153		PM	Submit Final FS Report after Back Check	1 day	2/2/20	2/2/20
154			Milestone Presentation	1 day	2/2/20	2/2/20
155			Milestone Performance Objective - Achieve Remedial Investigation/Feasibility Study (RI/FS) within 30 months of award of option.	0 days	7/26/20	7/26/20
156	'0004		**OPTION: Proposed Plan/Decision Document**	**728 days**	**12/3/18**	**12/3/20**
157			Notice To Proceed (TBD)	1 day	9/30/19	9/30/19
158	'0004AA		**PP/DD Siege Battery-TD River (WSTPT-016-R-01)**	**438 days**	**3/12/20**	**5/23/21**
159			**Proposed Plan**	**235 days**	**3/12/20**	**11/1/20**
160			Prepare Draft Proposed Plan	30 days	3/12/20	4/10/20
161			Submit Draft Proposed Plan	1 day	4/11/20	4/11/20
162		QA	Government Review of the Draft Proposed Plan	30 days	4/12/20	5/11/20
163			Response to Comments	5 days	5/12/20	5/16/20
164			Back Check and Review	10 days	5/17/20	5/26/20
165			Incorporate Comments and Prepare Draft Final Proposed Plan	5 days	5/27/20	5/31/20
166		PM	Submit Draft Final Proposed Plan	1 day	6/1/20	6/1/20
167		QA	Regulator and Government Review of the Draft Final Proposed Plan	45 days	6/2/20	7/16/20
168			Response to Comments	5 days	7/17/20	7/21/20
169			Back Check and Review	15 days	7/22/20	8/5/20
170			Incorporate Comments and Prepare Final Proposed Plan	5 days	8/6/20	8/10/20
171			Submit Final Proposed Plan	1 day	8/11/20	8/11/20
172		QA	Regulator and Government Back Check Final Proposed Plan	45 days	8/12/20	9/25/20
173			Incorporate Back Check Comments and Finalize	5 days	9/26/20	9/30/20
174		PM	Submit Final Proposed Plan after Back Check	1 day	10/1/20	10/1/20
175			Public Notice and Public Review	30 days	10/2/20	10/31/20
176			Milestone Presentation	1 day	11/1/20	11/1/20
177			**Decision Document**	**204 days**	**11/1/20**	**5/23/21**
178			Prepare Draft Decision Document	30 days	11/1/20	11/30/20
179			Submit Draft Decision Document	1 day	12/1/20	12/1/20
180		QA	Government Review of the Draft Decision Document	30 days	12/2/20	12/31/20
181			Response to Comments	5 days	1/1/21	1/5/21
182			Back Check and Review	10 days	1/6/21	1/15/21
183			Incorporate Comments and Prepare Draft Final Decision Document	5 days	1/16/21	1/20/21
184		PM	Submit Draft Final Decision Document	1 day	1/21/21	1/21/21
185		QA	Regulator and Government Review of the Draft Final Decision Document	45 days	1/22/21	3/7/21
186			Response to Comments	5 days	3/8/21	3/12/21
187			Back Check and Review	15 days	3/13/21	3/27/21
188			Incorporate Comments and Prepare Final Decision Document	5 days	3/28/21	4/1/21
189			Submit Final Decision Document	1 day	4/2/21	4/2/21
190		QA	Regulator and Government Back Check Final Decision Document	45 days	4/3/21	5/17/21
191			Incorporate Back Check Comments and Finalize	5 days	5/18/21	5/22/21
192		PM	Submit Final Decision Document after Back Check	1 day	5/23/21	5/23/21
193			Milestone Presentation	1 day	5/23/21	5/23/21
194			Milestone Performance Objective - Achieve Proposed (PP)/Decision Document (DD) within 24 months of award of option.	0 days	9/30/21	9/30/21
195	'0004AB		**PP/DD Battery Knox-TD River (WSTPT-004-R-01)**	**448 days**	**1/28/20**	**4/19/21**
196			**Proposed Plan**	**235 days**	**1/28/20**	**9/18/20**
197			Prepare Draft Proposed Plan	30 days	1/28/20	2/26/20
198			Submit Draft Proposed Plan	1 day	2/27/20	2/27/20
199		QA	Government Review of the Draft Proposed Plan	30 days	2/28/20	3/28/20
200			Response to Comments	5 days	3/29/20	4/2/20
201			Back Check and Review	10 days	4/3/20	4/12/20

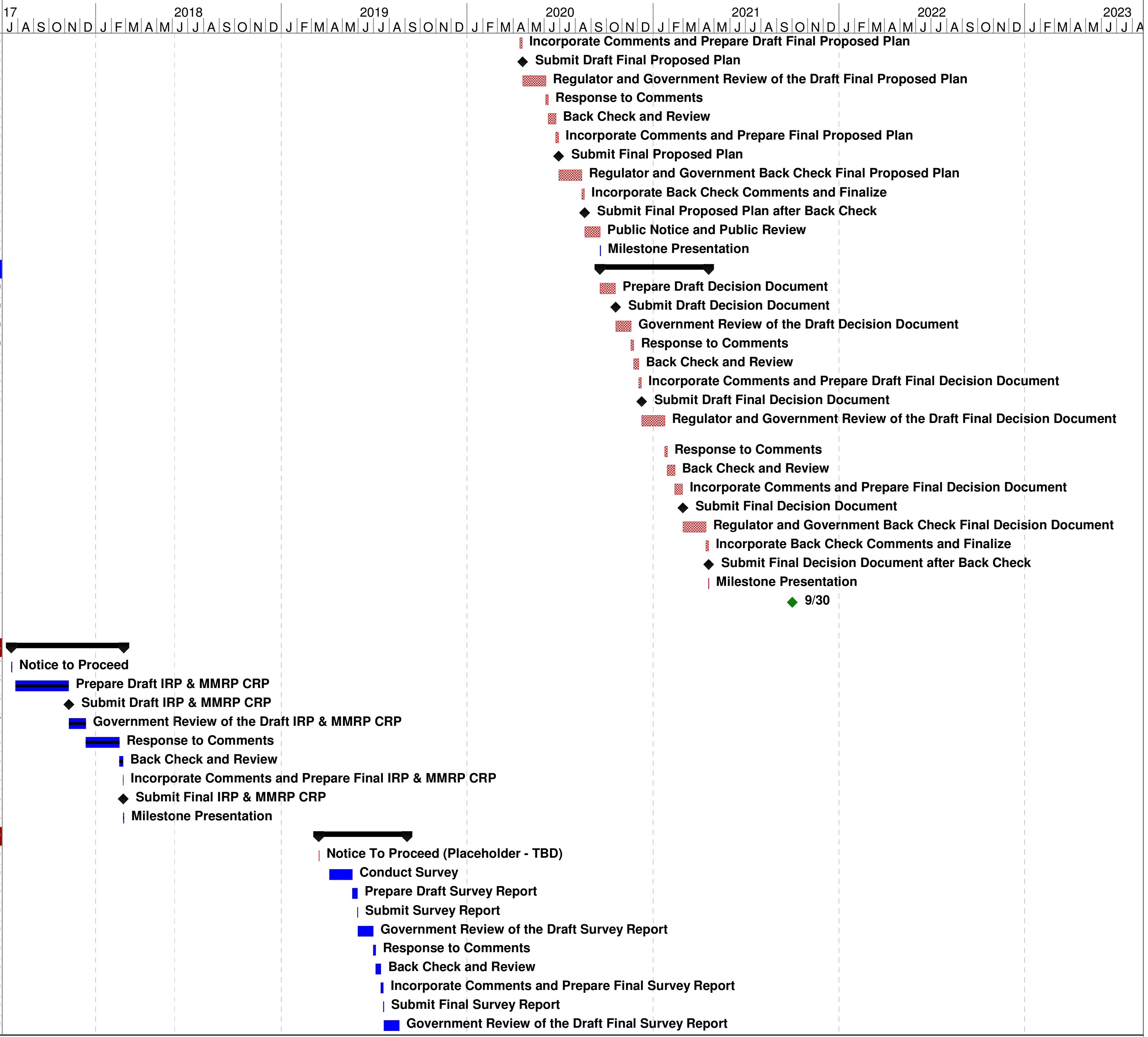


Task ▬ Milestone ◆ Summary ▬ Critical Path ▨ Performance Milestone ◆

Note: Duration is based on Calendar days.

U.S. Army Garrison West Point, New York Military Munitions Response Program - Water Ranges - Remedial Investigation / Feasibility Study Through Decision Document

ID	CLIN	Activity ID Suffix	Task Name	Calendar Days Duration	Start	Finish
202			Incorporate Comments and Prepare Draft Final Proposed Plan	5 days	4/13/20	4/17/20
203		PM	Submit Draft Final Proposed Plan	1 day	4/18/20	4/18/20
204		QA	Regulator and Government Review of the Draft Final Proposed Plan	45 days	4/19/20	6/2/20
205			Response to Comments	5 days	6/3/20	6/7/20
206			Back Check and Review	15 days	6/8/20	6/22/20
207			Incorporate Comments and Prepare Final Proposed Plan	5 days	6/23/20	6/27/20
208			Submit Final Proposed Plan	1 day	6/28/20	6/28/20
209		QA	Regulator and Government Back Check Final Proposed Plan	45 days	6/29/20	8/12/20
210			Incorporate Back Check Comments and Finalize	5 days	8/13/20	8/17/20
211		PM	Submit Final Proposed Plan after Back Check	1 day	8/18/20	8/18/20
212			Public Notice and Public Review	30 days	8/19/20	9/17/20
213			Milestone Presentation	1 day	9/18/20	9/18/20
214			**Decision Document**	**214 days**	**9/18/20**	**4/19/21**
215			Prepare Draft Decision Document	30 days	9/18/20	10/17/20
216			Submit Draft Decision Document	1 day	10/18/20	10/18/20
217		QA	Government Review of the Draft Decision Document	30 days	10/19/20	11/17/20
218			Response to Comments	5 days	11/18/20	11/22/20
219			Back Check and Review	10 days	11/23/20	12/2/20
220			Incorporate Comments and Prepare Draft Final Decision Document	5 days	12/3/20	12/7/20
221		PM	Submit Draft Final Decision Document	1 day	12/8/20	12/8/20
222		QA	Regulator and Government Review of the Draft Final Decision Document	45 days	12/9/20	1/22/21
223			Response to Comments	5 days	1/23/21	1/27/21
224			Back Check and Review	15 days	1/28/21	2/11/21
225			Incorporate Comments and Prepare Final Decision Document	15 days	2/12/21	2/26/21
226			Submit Final Decision Document	1 day	2/27/21	2/27/21
227		QA	Regulator and Government Back Check Final Decision Document	45 days	2/28/21	4/13/21
228			Incorporate Back Check Comments and Finalize	5 days	4/14/21	4/18/21
229		PM	Submit Final Decision Document after Back Check	1 day	4/19/21	4/19/21
230			Milestone Presentation	1 day	4/19/21	4/19/21
231			**Milestone Performance Objective - Achieve Proposed (PP)/Decision Document (DD) within 24 months of award of option.**	**0 days**	**9/30/21**	**9/30/21**
232	'0005		**IRP & MMRP Community Relations Plan**	**216 days**	**7/19/17**	**2/24/18**
233			Notice to Proceed	1 day	7/19/17	7/19/17
234			Prepare Draft IRP & MMRP CRP	104 days	7/27/17	11/7/17
235			Submit Draft IRP & MMRP CRP	1 day	11/8/17	11/8/17
236		QA	Government Review of the Draft IRP & MMRP CRP	33 days	11/9/17	12/11/17
237			Response to Comments	64 days	12/12/17	2/15/18
238			Back Check and Review	7 days	2/16/18	2/22/18
239			Incorporate Comments and Prepare Final IRP & MMRP CRP	1 day	2/23/18	2/23/18
240		PM	Submit Final IRP & MMRP CRP	0 days	2/23/18	2/23/18
241			Milestone Presentation	1 day	2/24/18	2/24/18
242	'0006		**OPTION: DERP RAB Public Interest Survey (Survey 1)**	**174 days**	**3/15/19**	**9/4/19**
243			Notice To Proceed (Placeholder - TBD)	1 day	3/15/19	3/15/19
244			Conduct Survey	45 days	4/5/19	5/19/19
245			Prepare Draft Survey Report	10 days	5/20/19	5/29/19
246			Submit Survey Report	1 day	5/30/19	5/30/19
247		QA	Government Review of the Draft Survey Report	30 days	5/31/19	6/29/19
248			Response to Comments	5 days	6/30/19	7/4/19
249			Back Check and Review	10 days	7/5/19	7/14/19
250			Incorporate Comments and Prepare Final Survey Report	5 days	7/15/19	7/19/19
251		PM	Submit Final Survey Report	1 day	7/20/19	7/20/19
252		QA	Government Review of the Draft Final Survey Report	30 days	7/21/19	8/19/19

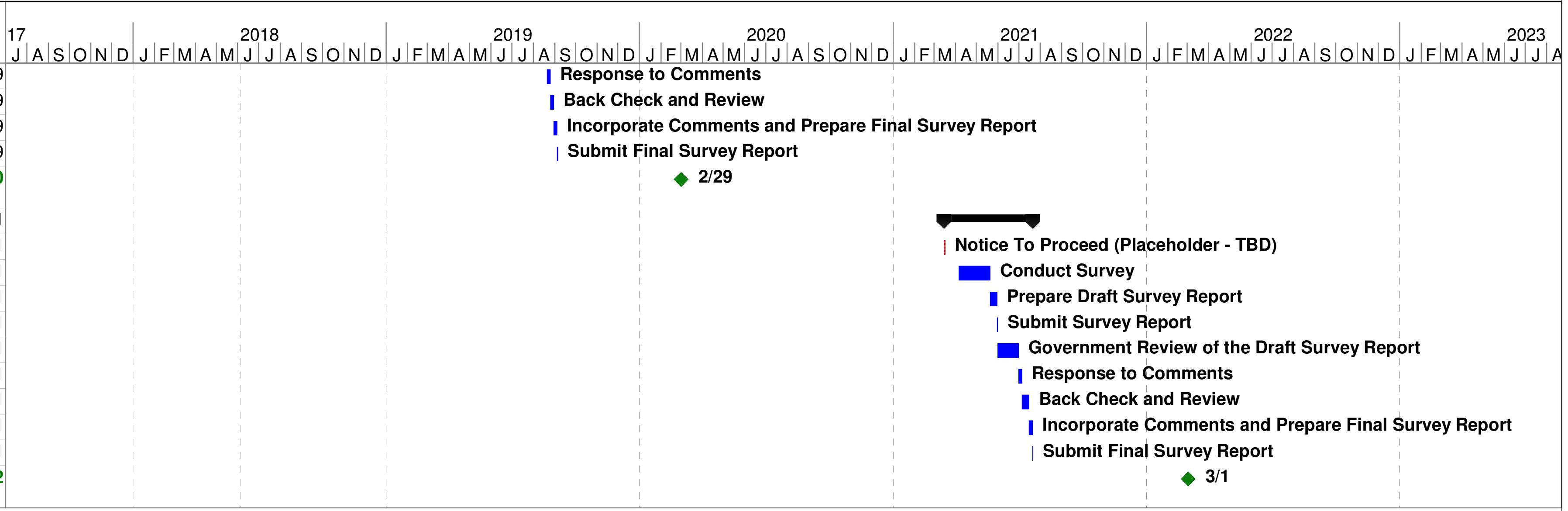


Task ▬ Milestone ◆ Summary ▬ Critical Path ▨ Performance Milestone ◆

Note: Duration is based on Calendar days.

U.S. Army Garrison West Point, New York Military Munitions Response Program - Water Ranges - Remedial Investigation / Feasibility Study Through Decision Document

ID	CLIN	Activity ID Suffix	Task Name	Calendar Days Duration	Start	Finish
253			Response to Comments	5 days	8/20/19	8/24/19
254			Back Check and Review	5 days	8/25/19	8/29/19
255			Incorporate Comments and Prepare Final Survey Report	5 days	8/30/19	9/3/19
256		PM	Submit Final Survey Report	1 day	9/4/19	9/4/19
257			**Milestone Performance Objective - Approval of DERP RAB Public Interest Survey Report within 12 months of award of option.**	**0 days**	**2/29/20**	**2/29/20**
258	**'0007**		**OPTION: DERP RAB Public Interest Survey (Survey 2)**	**128 days**	**3/15/21**	**7/20/21**
259			Notice To Proceed (Placeholder - TBD)	1 day	3/15/21	3/15/21
260			Conduct Survey	45 days	4/5/21	5/19/21
261			Prepare Draft Survey Report	10 days	5/20/21	5/29/21
262			Submit Survey Report	1 day	5/30/21	5/30/21
263		QA	Government Review of the Draft Survey Report	30 days	5/31/21	6/29/21
264			Response to Comments	5 days	6/30/21	7/4/21
265			Back Check and Review	10 days	7/5/21	7/14/21
266			Incorporate Comments and Prepare Final Survey Report	5 days	7/15/21	7/19/21
267		PM	Submit Final Survey Report	1 day	7/20/21	7/20/21
268			**Milestone Performance Objective - Approval of DERP RAB Public Interest Survey Report within 12 months of award of option.**	**0 days**	**3/1/22**	**3/1/22**



Task ▬ Milestone ◆ Summary ▬ Critical Path ▨ Performance Milestone ◆

Note: Duration is based on Calendar days.

APPENDIX G
EXPLOSIVES SITE PLAN

ESP WEST POINT WATER RANGES FINAL JULY 2017

EXPLOSIVES SITE PLAN (ESP)
REMEDIAL INVESTIGATION

West Point Water ranges

Siege Battery-TD River (WSTPT-016-R-01)
Battery Knox-TD River (WSTPT-04-R-01)

West Point Military Academy

West Point, NY

July 2017

PREPARED
BY
EMDC BALTIMORE DISTRICT, USACE

TABLE OF CONTENTS

1. **Site:**

   a. Name: West Point Military Academy
   b. State**:** New York

2. **Anticipated Dates**:

   a. Start: September 2017

3. **Purpose:**

A Remedial Investigation is required for this location based on the historic ordnance activities and the Site Investigation (SI) findings in order to further characterize the former Siege Battery-TD River (WSTPT-016-R-01) and Battery Knox-TD River (WSTPT-04-R-01).

4. **Site Background and Current Conditions:**

Siege Battery and Battery Knox are former ranges that fired across or into the Hudson River. Comprised of approximately 1163 acres located along the Hudson River. The Historical Records Review (HRR) developed for these MRS's indicate dates of operation were from the mid 1800's thru the early 1900's.

4.1 Siege Battery-TD

Siege Battery was in operation from 1845 – 1906. The site encompasses 1,088 acres on the Hudson River. Siege Battery was located on the West side of the Hudson River and fired to the northwest with Parrott Rifles and Rodman guns.

4.2 Battery Knox-TD

Battery Knox was in operation from 1836 – 1918. The site encompasses 75 acres on the Hudson River. Battery Knox was located on the west bank of the Hudson River and fired to the southeast across the river with Parrott Rifles and Rodman guns.

5. **Executing Agencies:**

   a. West Point Military Academy
   b. US Army Corps of Engineers Baltimore District (CENAB)

6. **Scope of Investigative Action:**

An underwater remedial investigation (RI) is required to investigate the nature and extent of MEC in the areas of the Hudson River affected by the historical firing fans from Siege Battery and Battery Knox.

Table 6-1

MRS	INVESTIGATION TYPE	TOTAL ACREAGE
Siege Battery TD	RI	1088 Acres
Battery Knox TD	RI	75 Acres

7. Safety Criteria:

a. The MGFD for the Munitions Response Sites (MRS) is identified in Table 7-1. If munitions of explosive concern (MEC) with a greater fragmentation distance are encountered during the course of this investigation, the Minimum Separation Distances (MSD) will be adjusted in accordance with DDESB Technical Paper 16 and the Fragmentation Data Review Forms. The work will continue with an ESP amendment submitted and the quantity distance (QD) arcs will be adjusted accordingly.

b. See Appendix B for Fragmentation Data Review Forms.

c. See Table 7-1 for Minimum Separation Distances.

d. Any occupied buildings or public roadways or waterways within the MSD areas will be evacuated and/or roadways/waterways blocked to prevent non-essential personnel from entering during the conduct of MEC operations. In the event that roadways/waterways cannot be blocked, guards will be posted and work halted if non-essential personnel enter the MSD. MEC operations will not resume until non-essential personnel have exited the MSD.

e. The Army will establish underwater QD criteria.

f. Only one team will be working in the MRS during field investigations. UXO and Dive teams will be fully qualified in accordance DDESB TP 18 qualification criteria.

Table 7-1 Minimum Separation Distance

Project Site **MRS**	**Munitions with the Greatest Fragmentation Distance (MGFD)**	**MSD (ft)**			
		Unintentional Detonations		**Intentional Detonations**	
		Hazard Frag Distance (HFD)	Team Separation Distance (K40**)**	Without Engineering Controls (MFD)	Using Engineering Controls
Siege Battery	15 Inch Cannon ball Shell	270	N/A[1]	3591	200[2]
Battery Knox	10 Inch Cannon ball Shell	237	N/A[1]	3060	200[2]

Notes:

1- Only one team will be working in the MRS during field investigations.

2- Buried Explosion Module with water calculations will be used to reduce fragmentation hazard down to 0 ft. but a 200 ft. MSD will be used for safety purposes.

8. Methods of Disposal:

a. The contractor will not maintain any explosives on site. Explosives will be delivered to the project location on an "as needed" basis and will be guarded by the contractor until use.

The Senior UXO Supervisor (SUXOS) and UXO Safety Officer (UXOSO) are authorized to approve the movement of "acceptable to move" items within the boundary of the MRS found for the purpose of activity efficiency and protection of personnel, property, and/or critical assets.

b. All recovered MEC and material presenting an explosive hazard (MPPEH) identified as material documented as an explosive hazard (MEDH) will be destroyed on the same day found. In the event this cannot occur due to weather or delay in explosive delivery, items will be guarded until disposal.

c. The MSD for intentional detonation when conducting disposal operation is identified in Table 7-1.

d. MPPEH procedures will be IAW DoDI 4140.62, and EM 385-1-97. ALL Material Potentially Presenting an Explosive Hazard (MPPEH) will be assessed and its explosives safety status determined and documented prior to transfer within DoD or release from DoD control. Prior to release to the public, MPPEH will be documented by authorized and technically qualified personnel as Material Documented as Safe (MDAS) after 100% inspection and an independent 100% re-inspection to determine that it is safe from an explosives safety perspective.

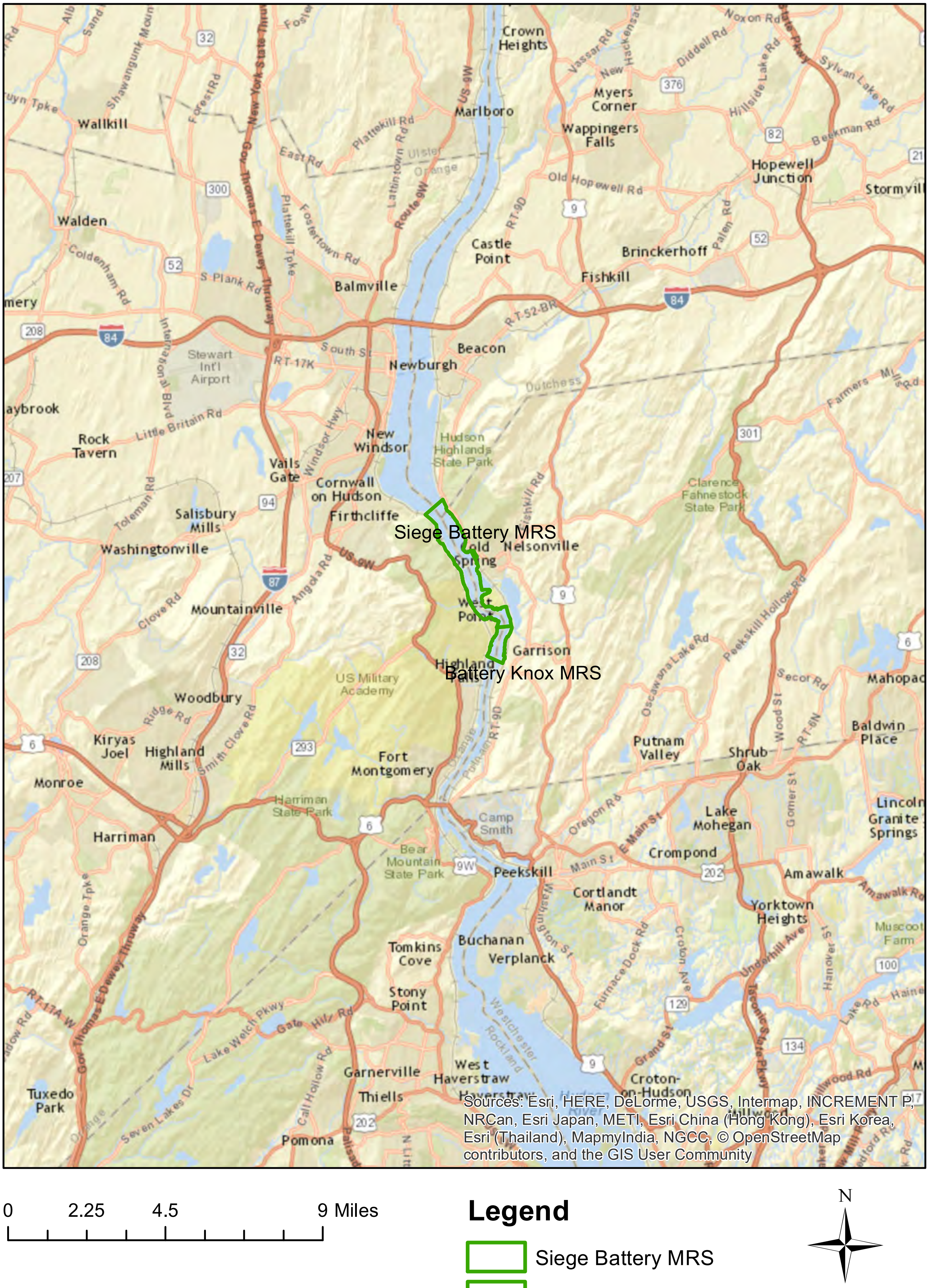
e. Collection Points are those areas used to temporarily accumulate MEC determined "acceptable to move" by the SUXOS and UXOSO personnel pending destruction at the end of the day. The maximum net explosive weight (NEW) at a collection point will be limited such that the K40 overpressure distance for the total NEW does not exceed the HFD for the area.

f. Engineering Controls (EC): These MRS's are water range MRS's and an approved engineering control is water tamping. Tamping may be used in accordance with DDESB TP 16 and the latest version of the Buried Explosion Module (BEM) as issued by DDESB. These documents will be available on site for mitigation methods used.

Appendix A

Figures

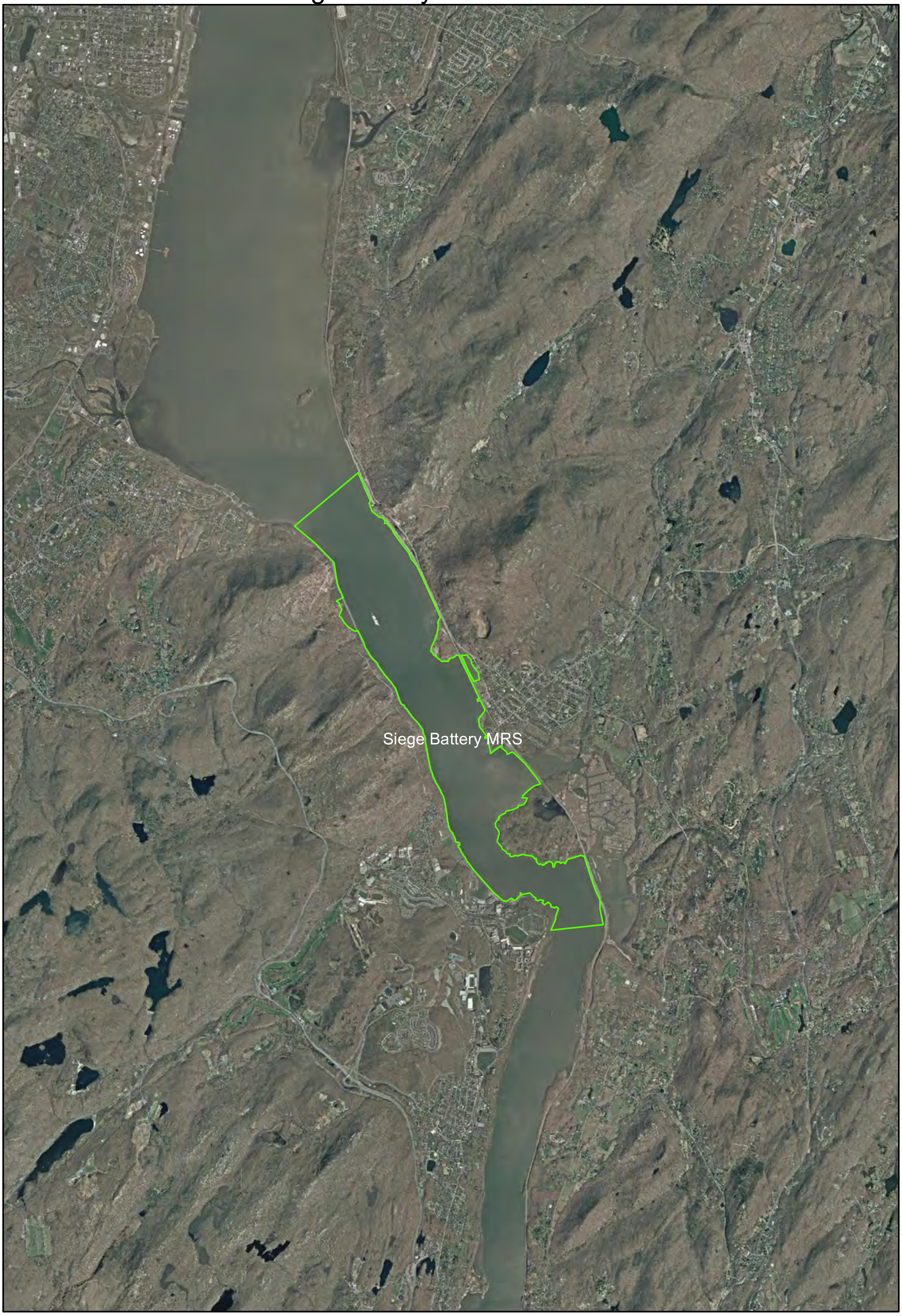
Regional Map

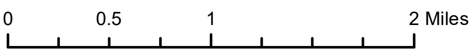


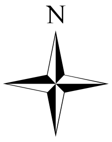
Sources: Esri, HERE, DeLorme, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), MapmyIndia, NGCC, © OpenStreetMap contributors, and the GIS User Community

Fig 1

Siege Battery MRS MAP







Coordinate System: NAD 1983 UTM Zone 18N
Projection: Transverse Mercator
Datum: North American 1983
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -75.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

1:60,000

Date: 2/15/2017

Legend

🟩 Siege Battery MRS

Fig 2

Battery Knox MRS Map

Coordinate System: NAD 1983 UTM Zone 18N
Projection: Transverse Mercator
Datum: North American 1983
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -75.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

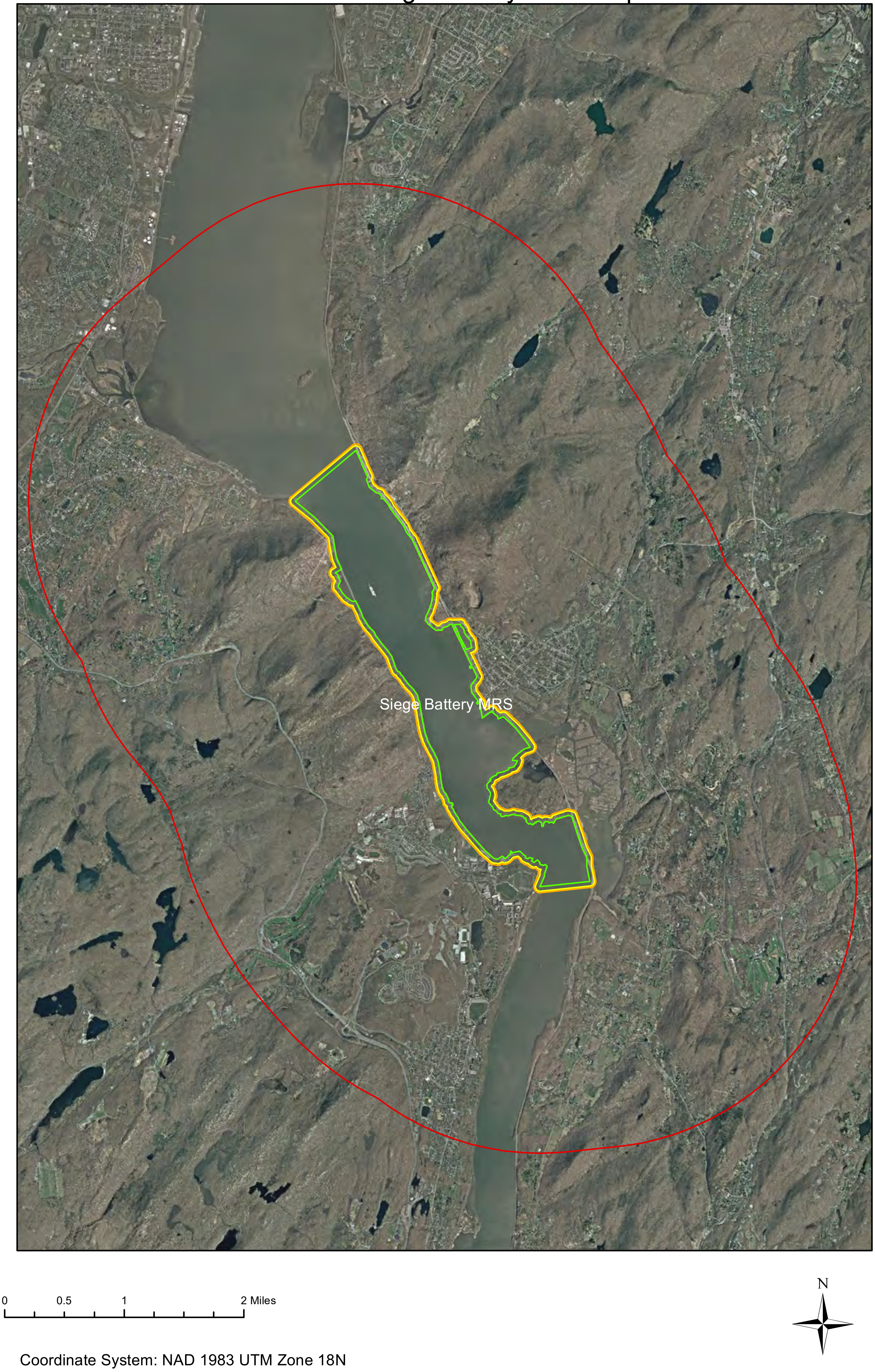
1:18,000
Date: 2/15/2017

Legend

🟩 Battery Knox Boundary

Fig 3

Exclusion Area Siege Battery MRS Map



Coordinate System: NAD 1983 UTM Zone 18N
Projection: Transverse Mercator
Datum: North American 1983
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -75.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

1:60,000

Date: 2/15/2017

Legend

- Siege_Battery_BEM_200_ft
- Siege_Battery_HFD_270_ft
- Siege_Battery_MFD_3591_ft
- Siege Battery MRS

Fig 4

Exclusion Area Battery Knox MRS Map

Coordinate System: NAD 1983 UTM Zone 18N
Projection: Transverse Mercator
Datum: North American 1983
False Easting: 500,000.0000
False Northing: 0.0000
Central Meridian: -75.0000
Scale Factor: 0.9996
Latitude Of Origin: 0.0000
Units: Meter

1:18,000
Date: 2/15/2017

Legend

- 🟧 Battery_Knox_BEM_200_ft
- 🟨 Battery_Knox_HFD_237_ft
- 🟥 Battery_Knox_MFD_3060_ft
- 🟩 Battery Knox Boundary

Fig 5

Appendix B

Fragmentation Data Review Forms

Fragmentation Data Review Form

Database Revision Date 3/7/2016

Category:	Black Powder Rounds
Munition:	10 in Cannonball Shell
Case Material:	Cast Iron, Grey, CL35
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Civil War Era
Munition Case Classification:	Extremely Heavy Case

DODIC:	
Date Record Created:	11/2/2009
Record Created By:	SDH
Last Date Record Updated:	4/15/2013
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Black Powder
Explosive Weight (lb):	4
Diameter (in):	9.8500
Cylindrical Case Weight (lb):	93.88430
Maximum Fragment Weight (Intentional) (lb):	3.5556
Design Fragment Weight (95%) (Unintentional) (lb):	0.8186
Critical Fragment Velocity (fps):	1659

Sandbag and Water Mitigation Options

TNT Equivalent (Impulse):	0.43
TNT Equivalent Weight - Impulse (lbs):	1.720
Kinetic Energy 10^6 (lb-ft²/s²):	4.8957

Single Sandbag Mitigation

Required Wall & Roof Thickness (in)	36
Expected Max. Throw Distance (ft):	220
Minimum Separation Distance (ft):	220

Double Sandbag Mitigation

Required Wall & Roof Thickness (in)	Not Permitted
Expected Max. Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Water Mitigation

Minimum Separation Distance (ft):	275
Water Containment System:	1100 gal tank

Note: Use Sandbag and Water Mitigation in accordance with all applicable documents and guidance. If a donor charge larger than 32 grams is utilized, the above mitigation options are no longer applicable. Subject matter experts may be contacted to develop site specific mitigation options.

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	237
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	3060
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2087

Overpressure Distances

TNT Equivalent (Pressure):	0.43
TNT Equivalent Weight - Pressure (lbs):	1.720
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	22
Public Traffic Route Distance (2.3 psi); K24 Distance:	29
Inhabited Building Distance (1.2 psi), K40 Distance:	48
Intentional MSD (0.0655 psi), K328 Distance:	393

Note: Per V5.E3.2.2.1 of DoD 6055.09-M the minimum sited K328 distance may be no smaller than 200 ft.

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	12.80	7.40
Mild Steel:	2.21	1.23
Hard Steel:	1.81	1.01
Aluminum:	4.07	2.36
LEXAN:	11.35	7.93
Plexi-glass:	9.75	6.06
Bullet Resist Glass:	9.20	5.43

Item Notes

The TNT equivalency for black powder rounds has been updated from 0.4 to 0.43 to agree with Rev 4 of TP 16. This has resulted in minor changes in values.

Distribution authorized to the Department of Defense and U.S. DoD contractors only for Administrative-Operational Use (17 October 2002). Other requests shall be referred to the Chairman, Department of Defense Explosives Safety Board, Room 856C, Hoffman Building I, 2461 Eisenhower Avenue, Alexandria, VA 22331-0600.

Fragmentation Data Review Form

Database Revision Date 3/7/2016

Category:	Black Powder Rounds
Munition:	15 in Cannonball Shell
Case Material:	Cast Iron, Grey, CL35
Fragmentation Method:	Naturally Fragmenting
Secondary Database Category:	Civil War Era
Munition Case Classification:	Extremely Heavy Case

DODIC:	
Date Record Created:	9/1/2011
Record Created By:	SDH
Last Date Record Updated:	4/15/2013
Individual Last Updated Record:	SDH
Date Record Retired:	

Munition Information and Fragmentation Characteristics

Explosive Type:	Black Powder
Explosive Weight (lb):	13
Diameter (in):	14.8300
Cylindrical Case Weight (lb):	329.93280
Maximum Fragment Weight (Intentional) (lb):	10.8878
Design Fragment Weight (95%) (Unintentional) (lb):	2.3526
Critical Fragment Velocity (fps):	1133

Sandbag and Water Mitigation Options

TNT Equivalent (Impulse):	0.43
TNT Equivalent Weight - Impulse (lbs):	5.590
Kinetic Energy 10^6 (lb-ft²/s²):	6.9983

Single Sandbag Mitigation

Required Wall & Roof Thickness (in)	Not Permitted
Expected Max. Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Double Sandbag Mitigation

Required Wall & Roof Thickness (in)	Not Permitted
Expected Max. Throw Distance (ft):	Not Permitted
Minimum Separation Distance (ft):	Not Permitted

Water Mitigation

Minimum Separation Distance (ft):	Not Permitted
Water Containment System:	Not Permitted

Note: Use Sandbag and Water Mitigation in accordance with all applicable documents and guidance. If a donor charge larger than 32 grams is utilized, the above mitigation options are no longer applicable. Subject matter experts may be contacted to develop site specific mitigation options.

Theoretical Calculated Fragment Distances

HFD [Hazardous Fragment Distance: distance to no more than 1 hazardous fragment per 600 square feet] (ft):	270
MFD-H [Maximum Fragment Distance, Horizontal] (ft):	3591
MFD-V [Maximum Fragment Distance, Vertical] (ft):	2350

Overpressure Distances

TNT Equivalent (Pressure):	0.43
TNT Equivalent Weight - Pressure (lbs):	5.590
Unbarricaded Intraline Distance (3.5 psi), K18 Distance:	32
Public Traffic Route Distance (2.3 psi); K24 Distance:	43
Inhabited Building Distance (1.2 psi), K40 Distance:	71
Intentional MSD (0.0655 psi), K328 Distance:	582

Note: Per V5.E3.2.2.1 of DoD 6055.09-M the minimum sited K328 distance may be no smaller than 200 ft.

Minimum Thickness to Prevent Perforation

	Intentional	Unintentional
4000 psi Concrete (Prevent Spall):	15.98	9.14
Mild Steel:	2.26	1.23
Hard Steel:	1.85	1.01
Aluminum:	4.06	2.29
LEXAN:	12.09	8.32
Plexi-glass:	10.63	6.47
Bullet Resist Glass:	10.31	5.94

Item Notes

The TNT equivalency for black powder rounds has been updated from 0.4 to 0.43 to agree with Rev 4 of TP 16. This has resulted in minor changes in values.

Distribution authorized to the Department of Defense and U.S. DoD contractors only for Administrative-Operational Use (17 October 2002). Other requests shall be referred to the Chairman, Department of Defense Explosives Safety Board, Room 856C, Hoffman Building I, 2461 Eisenhower Avenue, Alexandria, VA 22331-0600.

ESP WEST POINT WATER RANGES INSTALLATION MEMO

DEPARTMENT OF THE ARMY
U.S. ARMY INSTALLATION MANAGEMENT COMMAND
HEADQUARTERS, UNITED STATES ARMY GARRISON WEST POINT
681 HARDEE PLACE
WEST POINT, NEW YORK 10996

REPLY TO
ATTENTION OF:

IMML-ZA 12 April 2017

MEMORANDUM FOR THE Commander, U.S. Army Corps of Engineers, Environmental and Munitions Center of Expertise (USACE CX-MM), PO Box 2600, Huntsville AL, 35809

SUBJECT: Explosives Site Plan (ESP), Military Munitions Response Program (MMRP) Remedial Investigation (RI), West Point Water Ranges.

1. Reference: DOD 6055.09-M, Ammunition and Explosives Safety Standards, dated February 2008, Administratively Reissued 4 August 2010.

2. The U.S. Army Garrison West Point (USAG WP) approves this ESP.

3. The Installation Master Planner has reviewed and concurs with this ESP.

4. Request USACE submit this document through the review and approval chain to final approval by DDESB.

5. POC for the Command is Jeff Sanborn, USAG WP, ATTN: IMML-PWE, 667A Ruger Rd, West Point, New York 10996-1592, (845) 938-5041, or DSN 688-5041.

ANDREW S. HANSON
COL, SF
Commanding

DDESB APPROVAL WEST POINT RI WATER RANGES ESP

DEPARTMENT OF DEFENSE EXPLOSIVES SAFETY BOARD
4800 MARK CENTER DRIVE, SUITE 16E12
ALEXANDRIA VIRGINIA, 22350

DDESB-PE

OCT 19 2017

MEMORANDUM FOR DIRECTOR, U.S. ARMY DEFENSE AMMUNITION CENTER
ATTENTION: ATCL-AC

SUBJECT: DDESB Approval of Explosives Site Plan, Remedial Investigation of West Point Water Ranges, West Point Military Academy, West Point, NY [USATCES MEC File Number 4589]

References: (a) DAC ATCL-AC Memorandum of 25 July 2017, Subject: Request DDESB Approval of Explosives Site Plan (ESP), Military Munitions Response Program (MMRP) Remedial Investigation (RI), West Point Water Ranges, West Point, NY, July 2017 [MEC File Number 4589]

(b) Email from Mr. Chad Williams (USATCES) to Ms. Kristene Bigej (DDESB) dated 4 October 2017, Subject: FW: West Point Water Ranges (Siege Battery and Battery Know) Explosive site plan

(c) DoD 6055.09-M, DoD Ammunition and Explosives Safety Standards, date varies by volume

(d) DDESB Technical Paper 15 (TP-15), Revision 3, "Approved Protective Construction" May 2010

(e) DA PAM 385-64, 24 May 2011/RAR 10 October 2013

The Department of Defense Explosives Safety Board (DDESB) Staff has reviewed the subject explosives site plan (ESP) forwarded by reference (a), as modified by reference (b), against the requirements of reference (c). Based on the information provided, approval is granted for removal and destruction of material potentially presenting an explosive hazard (MPPEH) and munitions and explosives of concern (MEC) at West Point Military Academy, West Point, NY. This approval is based on the following:

a. The efforts addressed in this ESP involve underwater unintentional detonation operations and intentional detonations supporting munitions response actions within Munitions Response Site (MRS) Siege Battery and MRS Battery Knox.

b. The DDESB acknowledges that reference (c) currently does not provide criteria to establish the minimum separation distance (MSD) for personnel in/under the water from intrusive (i.e., unintentional and intentional detonation) explosive operations conducted underwater. Consequently, the DDESB is unable to approve intrusive underwater explosive operations. The Army, per reference (a), has established criteria addressing intrusive underwater explosive operations within MRS Siege Battery and MRS Battery Knox and accepts the risks associated with those operations in accordance with Army policy.

c. The results of this ESP will be used to prepare an explosives safety submission per reference (c).

d. Only one team is planned to be working within the MRS during field investigations.

e. The munition with the greatest fragmentation distance (MGFD) for the MRS Siege Battery is the 15-inch Cannonball Shell; the minimum separation distance (MSD) for teams for terrestrial manual unintentional detonation operations is 71 feet (ft) based on K40; the MSD for nonessential personnel from manual unintentional detonation operations is 270 ft based on the hazardous fragment distance (HFD) of the MGFD; and the MSD for all personnel from intentional detonations is 3,591 ft based on the maximum fragment distance (MFD) of the MGFD.

f. The MGFD for the MRS Battery Knox is the 10-inch Cannonball Shell; the MSD for teams for terrestrial manual unintentional detonation operations is 48 ft based on K40 of the MGFD; the MSD for nonessential personnel from manual unintentional detonation operations is 237 ft based on the HFD of the MGFD; and the MSD for all personnel from intentional detonations is 3,060 ft based on the MFD of the MGFD.

g. Collection points are authorized provided the Army ensures usage of reference (d), paragraph C6.2.7.5.

h. The use of water tamping is authorized as an engineering control for intentional detonations involving the MEC identified in reference (a) provided the Army ensures usage per reference (d), paragraph C6.2.7.5.

i. Demolition materials, per reference (a), will be delivered as needed. Handling of commercial explosives must comply with reference (e).

j. Prior to initiation and through completion of on-site explosives operations, all nonessential personnel will be evacuated and prevented from entering any area/facility encumbered by the MSD required for the operation being conducted, or explosives operations will be suspended if nonessential personnel enter the MSD.

k. MPPEH will be inspected and classified as material documented as safe prior to release to the public.

If changes occur during or after completion of this effort that could increase explosive hazards to site workers or the public due to the presence of military munitions at the site, an amendment to this ESP must be submitted to DDESB for review and approval.

The point of contact for this action is Ms. Kristene Bigej, (571) 372-6705, DSN 372-6705, E-mail address: kristene.a.bigej.civ@mail.mil.

THIERRY L. CHIAPELLO
Executive Director

ARMY AND DDESB APPROVAL ESP WEST POINT WATER RANGES
U.S. MILITARY ACADEMY, WEST POINT, NY, JULY 2017

DEPARTMENT OF THE ARMY
US ARMY DEFENSE AMMUNITION CENTER
1 C TREE ROAD
MCALESTER OK 74501-9053

ATCL-ACE 25 October 2017

MEMORANDUM FOR Military Munitions Center of Expertise, (CEHNC-EMM/Mr. Zange/Mr. Barker), P.O. Box 1600, Huntsville, AL 35807-4301

SUBJECT: Army and DDESB Final Approval of Explosives Site Plan (ESP), Remedial Investigation, West Point Water Ranges, West Point Military Academy, West Point, NY, July 2017 [MEC File Number 4589].

1. References:

a. Memorandum, DDESB-PE, dated: 19 October 2017. Subject: DDESB Approval of Explosives Site Plan, Remedial Investigation of West Point Water Ranges, West Point Military Academy, West Point, NY [USATCES MEC File Number 4589] (ENCL).

b. DoD 6055.09-M, Ammunition and Explosives Safety Standards, date varies by Volume, Administratively Reissued 4 August 2010.

c. Department of the Army Pamphlet 385-64, Ammunition and Explosives Safety Standards, 10 October 2013, Rapid Action Revision.

d. Memorandum, SAIE-ESOH, Dated 16 September, 2013, Subject: Munitions Response Actions - Minimum Separation Distance (Relative to Impulse Water Pressure) from Underwater Detonations (ENCL).

2. The ESP, has been reviewed in accordance with Reference 1.b. and 1.c. This memorandum with enclosed reference 1.a, provides U.S. Army and Department of Defense Explosives Safety Board (DDESB) final approval.

3. Any change that modifies the approved ESP or increases risk or hazard will require additional approval. All conditions stipulated in this memorandum and reference 1.a must be adhered to for this approval to be valid. This approval and the approved ESP will be made part of the administrative record for the site.

4. The Army criteria for the minimum separation distance (MSD) for personnel in/under the water from intrusive (i.e., unintentional and intentional detonation) explosive operations conducted underwater found in reference 1.d will be used.

5. The POC is Mr. Chad Williams, ATCL-ACE, (918) 420-8044, (DSN 956), email chad.t.williams7.civ@mail.mil, Alternate POC Dr. Jim L. Langley, (918) 420-8767, (DSN 956), email jimmy.l.langley.civ@mail.mil.

Encl

CARL A. THOMAS
Director, U.S. Army
Technical Center for Explosives Safety

CF:
Office of the Director of Army Safety, (DACS-SF/Mr. Patton), 2530 Crystal Drive, 3rd Floor, Suite 3058, Arlington, VA 22202

WEST POINT CONCURRENCE OF ESP

DEPARTMENT OF THE ARMY
HUNTSVILLE CENTER, CORPS OF ENGINEERS
P.O. BOX 1600
HUNTSVILLE, ALABAMA 35807-4301

REPLY TO
ATTENTION OF
CEHNC-EMM

20 Jul 2017

MEMORANDUM FOR US Army Technical Center for Explosives Safety, Explosives Safety Knowledge, OE and Chemical Division, (JMAC-ESM/Mr. Jimmy Langley), Building 35, 1C Tree Road, McAlester, OK 74501-9053

SUBJECT: Explosives Site Plan (ESP), Crows Nest Impact and Training Area (WSTP-023-R-01), United States Military Academy, West Point, NY, March 2015.

1. References:

a. ER 385-1-95, Safety and Health Concerns for Munitions and Explosives of Concern (MEC) Projects, March 2007.

b. DOD 6055.09-M, Ammunition and Explosives Safety Standards, February 2008.

c. Memorandum, COL Landy D. Dunham, Subject: Explosives Site Plan (ESP), Military Munitions Response Program (MMRP) Remedial Investigation (RI), Crows Nest Impact and Training Area (WSTP-023-R-01).

2. This ESP is submitted for review and approval at the request of the installation per reference 1c. They have requested the US Army Corps of Engineers (USACE) submit this up through the review and approval chain on their behalf.

3. This ESP has been reviewed for technical adequacy and to insure compliance with USACE, Department of the Army and Department of Defense requirements. USACE participation is approved.

4. If you have any questions, please contact Mr. Walt Zange at (256) 895-1586 or Mr. Jeff Barker at (256) 895-1513.

Encl

SANDRA M. ZEBROWSKI, P.E.
Director, Environmental and
Munitions Center of Expertise

CF: (w/o encl) electronically
USACE, (CENAB-EN-HI /Mr. Paul Greene)

APPENDIX H
EXPLOSIVES MANAGEMENT PLAN

EXPLOSIVES MANAGEMENT PLAN

MILITARY MUNITIONS RESPONSE PROGRAM
MUNITIONS RESPONSE SERVICES
U.S. ARMY GARRISON WEST POINT
WATER MUNITIONS RESPONSE SITES
WEST POINT, NEW YORK

Contract No.: W912DR-15-D-0022
Delivery Order No.: W912DR17F0131

Prepared For:

U.S. ARMY CORPS OF ENGINEERS
BALTIMORE DISTRICT
10 South Howard Street
Baltimore, MD 21203

and

U.S. ARMY GARRISON WEST POINT
667A Ruger Road
West Point, NY 10996-1952

Prepared By:

WESTON SOLUTIONS, INC.
1400 Weston Way
West Chester, PA 19380

June 2017

Work Order No. 03886.552.131

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LIST OF TABLES

LIST OF ATTACHMENTS

Attachment 1	Licenses and Permits
Attachment 2	Detonation Call Tree

LIST OF ACRONYMS

ATF	Bureau of Alcohol, Tobacco, Firearms, and Explosives
CFR	Code of Federal Regulations
CSM	Conceptual Site Model
DA PAM	Department of the Army Pamphlet
DoD	Department of Defense
DOT	Department of Transportation
EM	Engineering Manual
EMP	Explosive Management Plan
ESP	Explosives Site Plan
FAR	Federal Acquisition Regulation
IME	Institute of Makers of Explosives
MEC	Munitions and Explosives of Concern
MPPEH	Munitions Potentially Presenting an Explosive Hazard
MRS	Munitions Response Site
N/A	Not Applicable
N.E.W.	Net Explosive Weight
NY	New York
OESS	Ordnance and Explosive Safety Specialist
PM	Project Manager
RI	Remedial Investigation
SOP	Standard Operating Procedure
SUXOS	Senior Unexploded Ordnance Supervisor
TD	Transferred
USACE	United States Army Corps of Engineers
UXO	Unexploded Ordnance
UXOQCS	UXO Quality Control Specialist
UXOSO	UXO Safety Officer
WESTON®	Weston Solutions, Inc.

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EXPLOSIVES MANAGEMENT PLAN

MILITARY MUNITIONS RESPONSE PROGRAM
MUNITIONS RESPONSE SERVICES
U.S. ARMY GARRISON WEST POINT
WATER MUNITIONS RESPONSE SITES
WEST POINT, NEW YORK

Contract No.: W912DR-15-D-0022
Delivery Order No.: W912DR17F0131

Signature Page

By their specific signature, the undersigned certify that this Explosives Management Plan (EMP) is approved for use during field activities in support of the U.S. Army Garrison West Point Water Munitions Response Sites (MRSs) Remedial Investigation (RI).

Plan Prepared by:

11/14/2017

Ryan Steigerwalt,
WESTON Senior Project Geophysicist
267-258-2672

Date

Plan Reviewed by:

Brian R Grassmyer

11/14/2017

Brian Grassmyer
WESTON Senior Unexploded Ordnance Supervisor (SUXOS)
610-701-3082

Date

Plan Approved by:

11/14/2017

John Gerhard
WESTON Project Manager
610-701-3793

Date

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1.0 INTRODUCTION

The Explosives Management Plan (EMP) outlines the procedures to be used by the unexploded ordnance (UXO) personnel to acquire, receive, store, transport, issue, and report the loss of explosives utilized during the Remedial Investigation (RI) at the U.S. Army Garrison West Point Water Munitions Response Site (MRS), located in West Point, New York (NY). The Water MRSs are the Siege Battery – Transferred (TD) River (WSTPT-016-R-01) and the Battery Knox – TD River (WSTPT-04-R-01). Two areas (Area A and Area B) outside the MRS boundaries, but assumed to have a conceptual site model (CSM) similar to the Siege Battery – TD River MRS, have also been incorporated into the RI. All personnel involved with explosives will comply with all Federal, State, and local laws as required.

This EMP has also been prepared in accordance with the following: Engineering Manual (EM)-200-1-15; Federal Acquisition Regulation (FAR) 45.5; Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF) Publication 5400.7; Department of the Army Pamphlet (DA PAM) 385-64; Department of Transportation (DOT) regulations; and New York laws and regulations.

1.1 EXPLOSIVES MANAGEMENT

Demolition operations, if required, will take place at the end of each workday. If demolition cannot be accomplished within the workday due to inclement weather or other conditions (e.g., mobilization delay of licensed blaster), material potentially presenting an explosive hazard (MPPEH) may be stored overnight under constant surveillance. The Unexploded Ordnance Safety Officer (UXOSO) is responsible for determining that minimum safe conditions to conduct demolitions operations are met.

1.2 LICENSES AND PERMITS

Weston Solutions, Inc. (WESTON®) has a Type 33-User of High Explosives License (permit No. 8-PA-029-33-7H-02509) from the United States Department of Justice, ATF, Federal Explosives Licensing Center to purchase and use explosives (expires 1 August 2020). Accountability for and use of the explosives will remain with WESTON unless custody is transferred to the Government or other agency with a current ATF explosive license. A copy of the permit provided in Attachment 1 (Licenses and Permits), will be maintained on-site and will be made available to any local, state, or federal authority as needed. A local New York State Purchase, Own, Possess & Transport Explosives license will be required for any detonations during field activities. A licensed commercial explosives vendor will be contracted to provide explosives and explosive-related services as needed to complete the RI.

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2.0 ACQUISITION

2.1 SOURCE

In the event demolition of recovered MPPEH/munitions and explosives of concern (MEC) is necessary, the Senior Unexploded Ordnance Supervisor (SUXOS) or UXOSO will notify the licensed commercial explosives vendor for the delivery of required demolition material on an as-needed basis. Before the demolition materials are ordered, the Purchase/Receipt Authorization List will be completed and forwarded to the explosives distributor with a copy of the WESTON ATF license. Primary responsibility for and accountability of the explosives will remain with the vendor until custody is transferred to WESTON for use in the field. The SUXOS and/or UXOSO will be authorized to request explosives from the vendor and will record usage data for demolition material and the quantities of UXO destroyed.

2.2 DESCRIPTION AND ESTIMATION OF QUANTITY

Explosive demolition material will not be stored at the U.S. Army Garrison West Point Water MRSs at any time. The material will be delivered as needed in the quantities requested by the SUXOS or UXOSO for the destruction of specific items. Any demolition material remaining after the demolition shot will be transported back to the explosives distributor’s magazine by the vendor who delivered the demolition material.

2.3 LIST OF PROPOSED DEMOLITION MATERIALS

Table 1 lists the types of demolition materials that may be used during the project. Demolition materials may change based on the type of UXO encountered during field activities that requires disposal.

Table 1 Demolition Explosives

Description	DoD Hazard Class/Division	Quantity (As Needed)	Net Explosive Weight (N.E.W.)
Detonator Assemblies-NONEL (Shock Tube)	1.4B	30 ft	Not Applicable (N/A)
Detonating Cord (80 grain per foot)	1.4D	60 ft max per shot	0.675
Shape Charges, 19.5 gram	1.4S	1 piece per shot	0.0425

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3.0 INITIAL RECEIPT

Original explosives receipt records will be maintained by the vendor for archive in accordance with ATF regulations and requirements. Copies of records will be maintained on-site by the SUXOS and will be available for inspection by authorized agencies. The SUXOS will provide the explosives vendor with the names of individuals authorized to request explosives (Authorization List). Upon initial receipt of a shipment of explosives, each container of material will be inspected and inventoried by two WESTON personnel. The contents of the shipment will be verified based on the quantity and type of material ordered, as indicated on the invoice, shipping documents, or bills of lading.

Explosives will be ordered for same day delivery. Explosives that are delivered to the U.S. Army Garrison West Point Investigation Area will be placed in a Day Box mounted in the bed of a truck and will be used the same day. The following procedures will be adhered to upon initial receipt of explosive materials:

- Upon arrival at the U.S. Army Garrison West Point Investigation Area, the SUXOS will escort the vendor to the demolition area;
- Prior to accepting custody for the explosives, the SUXOS or a designee from the Purchase/Receipt Authorization List will compare the explosives delivery record to the actual quantity delivered;
- Once the quantities have been confirmed, the explosives delivery record will be signed and the explosives will be transferred to and stored in the Day Box; and
- If it is determined that there is a discrepancy between the quantity delivered and the quantity shipped, the following will occur:
    - The UXOSO/UXO Quality Control Specialist (UXOQCS) will be notified;
    - The shipment will not be accepted; and
    - The shipper will be contacted immediately to resolve the discrepancy.

Regardless of the outcome of the initial inventory, one copy of the bill of lading and the shipping documents will be attached to a copy of the purchase order request and the purchase order. One copy of each of these documents will be kept on file at the WESTON office.

3.1 RECEIPT PROCEDURE

The original receipt documents and an inventory will be maintained on-site by the SUXOS. Upon receipt of the explosive materials shipment, copies of the supplier’s Bill of Lading documentation will be sent to the WESTON office within 3 working days. At the completion of the project, the original documents will be sent to the WESTON office, where they will be maintained for a period of 5 years. Copies of the documentation will be in the final report.

The SUXOS or UXO Technician III team leader performing demolition will sign and date the Ammunition Consumption Report certifying that the explosives were received and used for their intended purpose. Once Energy Enterprises has delivered the demolition material and the

WESTON Demolition Team has assembled the demolition charge(s), the UXOSO will strictly control access to all demolition areas and explosives. Qualified UXO Technicians will place the charge and detonate the shot. Energy Enterprises will return any unused demolition material to its storage facilities. All receipts, issues, turn-ins, and inventories of explosives will be properly documented and verified, through physical count, by the SUXOS and quality control checked by the UXOQCS.

3.2 RECONCILING DISCREPANCIES

The SUXOS and/or UXOQCS will conduct a 100 percent inventory of the incoming explosives. The quantities annotated on the receipt documentation should match the quantities reflected in the inventory. If these quantities do not match, the SUXOS will contact the originator of the receipt documentation. WESTON personnel will only sign for the actual quantity of material received, as reflected by the inventory. Receipt documentation will be changed to reflect the proper quantities. Actual quantities will be properly annotated on the shipping documentation prior to WESTON accepting delivery. These procedures will be conducted for each receipt of explosives materials.

If a discrepancy exists and cannot be resolved within 24 hours, WESTON will notify the local law enforcement agency, ATF, and the United States Army Corps of Engineers (USACE) Project Manager (PM) and the USACE Ordnance and Explosives Safety Specialist (OESS).

4.0 EXPLOSIVES STORAGE MAGAZINE

Procedures for the storage of explosive demolition material are not applicable because demolition material will not be stored on the U.S. Military Academy West Point at any time. Explosives that were requested for use, but were not expended, will be transported back to the explosives vendor's magazine.

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5.0 EXPLOSIVES ISSUE AND INVENTORY

Prior to accepting any explosives, the procedures outlined above in the initial receipt procedures will be accomplished. The SUXOS is authorized to purchase, receive, access, issue, transport, and use explosives for this project. Any other project personnel who will have access, issue, transport, and use authority for explosives on this project will complete an Employee Possessor Form, ATF E-Form 5400.28, to be submitted to ATF. A copy will be maintained in the explosives management records.

Upon completion of each demolition operation, an ammunition (donor explosives) consumption report will be completed. Upon expenditure of all donor explosives, the authorized person will certify in writing the expenditure of all donor explosives in inventory.

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6.0 TRANSPORTATION

Transportation of demolition materials will comply with all federal, state, and local regulations. The transportation of explosives to locations requiring demolition operations will be conducted by the explosives vendor. If the location is remote and explosives transport is necessary, all vehicles transporting explosives will be properly inspected, equipped, and placarded prior to the loading of explosives onto the vehicle, and a DoD Form (DD Form) 626 “Motor Vehicle Inspection” will be completed. Demolition materials will be transferred from the vendor to on-site personnel at a safe location.

6.1 ON-SITE TRANSPORTATION

WESTON team members will transport the explosives to the shot location following standard operating procedures (SOP) and the approved Explosives Site Plan (ESP). Explosive vehicles will comply with the provisions of 49 Code of Federal Regulations (CFR) 177.835(e) and (f). The SUXOS will ensure that the following general safety precautions are observed during transport operations:

- Explosives will not be transported in the passenger compartment of a vehicle;
- Explosive laden vehicles will not be left unattended;
- No person is permitted to ride on or in the cargo compartment;
- Smoking in and around vehicles transporting explosives is prohibited; and
- Refueling of vehicles will be accomplished without the explosive cargo.

6.2 VEHICLE SAFETY REQUIREMENTS

Transportation of MPPEH/MEC and explosives will comply with all federal, state, and local regulations. Prior to movement, the driver will visually inspect the explosive-laden vehicle to ensure the load is properly secured and acceptable to move. The cargo will be checked to ensure containers are loaded, blocked, braced, tied down, or otherwise secured to the vehicle body to prevent movement. If using a vehicle with an open body, a closed container to contain the explosives will be secured to the bed of the vehicle. For transportation of MPPEH/MEC and explosives on-site, the transporter will comply with the following:

- The load will be well braced and, except when in closed vehicles or in an appropriate shipping container, or loading/unloading, will be covered with a fire-resistant tarpaulin.
- Vehicles transporting explosives or MPPEH/MEC will be inspected daily using DD Form 626, Motor Vehicle Inspection, and will be properly placarded;
- The vehicle engine will not be running when explosives are being loaded/unloaded. The vehicle will be attended while loaded with explosives or detonators;
- Beds of vehicles will have either a wooden bed liner, dunnage, or sand bags to protect the explosives from contact with the metal bed and fittings;

- Vehicles transporting explosives will have a first aid kit, one 20-BC-rated fire extinguisher (at a minimum), and communications capability;
- Vehicles used to transport explosives will have substantially constructed bodies with no sparking metal exposed in the cargo space and will be equipped with suitable sides and tail gates;
- During transportation, explosives will not be piled higher than the sides or end of the truck bed;
- Vehicles containing explosives or detonators will display the proper warning signs, will be maintained in good condition, and will be operated at a safe speed, in accordance with all safe operating practices;
- Other materials or supplies will not be placed on or in the cargo space of a vehicle containing explosives, detonating cord, or detonators, with the exception of safety fuze and properly secured non-sparking equipment to be used only for handling explosives, detonating cord, or detonators;
- Explosives or detonators will be transported promptly without delays in transit;
- Explosives or detonators will be transported at times and over routes that expose a minimum number of persons. Only the necessary attendants will ride on or in vehicles containing explosives or detonators;
- When vehicles containing explosives or detonators are parked, the brakes will be set, the vehicle will be choked, and the motor will be shut off;
- After the vehicle has been secured and prior to any explosives being removed from the containers, the Institute of Makers of Explosives (IME) Specification 22 cap-box and the containers containing the explosives will be removed from the bed of the truck and placed on the ground;
- Maps indicating the route to be traveled will be in the vehicle;
- Compatibility requirements will be observed;
- Only UXO Technicians II and above may transport explosive materials;
- Operators transporting explosives will have a valid driver’s license;
- Drivers will comply with posted speed limits, but will not exceed a safe and reasonable speed for conditions. Vehicles transporting explosives off-road will not exceed 25 miles per hour; and
- Personnel will not ride in the cargo compartment with explosives or MPPEH/MEC.

6.3 DOCUMENTATION

When explosives are being transported, completed copies of the documents described below will be in the vehicle:

- <u>Instructions for Motor Vehicle Owners-Emergency Response Information Form</u>: The form will be used to enter only the items that are being transported.

- Explosives Purchase/Receipt/Transport Authorization List: The list will be completed to ensure that the pertinent data for the personnel transporting explosives are on the form. As with the other required forms, this form will be part of the transport paperwork. Only the route shown will be used unless there is an emergency or the route is blocked.
- Motor Vehicle Inspection Checklist: The checklist will be completed before explosives are placed in the vehicle and will accompany the shipment.
- ATF Permit/License: A copy of the current WESTON ATF license will be maintained on-site at all times in the project document file.

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7.0 INVENTORY

Inventory procedures for explosive demolition material are not applicable because demolition material will not be stored at the U.S. Army Garrison West Point Water MRSs at any time. The end user of explosives will certify on the Ammunition Consumption Report that the explosives were used for their intended purpose. Upon receipt, the type, quantity, and lot number of each explosive item will be checked against the manifest. The original receipt documents will be reconciled by the UXOQCS and maintained on file by the WESTON Site Manager.

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8.0 INSPECTION OF MAGAZINES

Procedures for the inspection of storage magazines are not applicable because demolition material will not be stored at the U.S. Army Garrison West Point Water MRSs at any time.

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9.0 LOSS, THEFT, OR UNAUTHORIZED USE OF EXPLOSIVES/MEC

Lost or theft of explosives will be reported as stated in 27 CFR, Commerce in Explosives. If it is confirmed that recovered ordnance or demolition materials/explosives are missing, the SUXOS will contact the USACE PM and the USACE OESS immediately by telephone, and in writing within 24 hours. WESTON also will notify ATF within 24 hours of discovery, and complete ATF Form 5400.5, “Report of Theft or Loss –Explosive Materials,” and mail to the nearest ATF office with a copy forwarded to the WESTON PM and the USACE PM. The following persons will be notified immediately upon discovery of theft or loss of explosive materials:

- The ATF at 1-800-461-8841 (0800-1700, M-F) or 1-800-800-3855 (weekends, nights, holidays);
- Local law enforcement via 911 (from local landline);
- The USACE PM, Ms. Kim Gross at 410-962-3457;
- The USACE OESS, Mr. Paul Greene at 410-962-6741
- WESTON SUXOS, Mr. Brian Grassmyer at 757-650-3607;
- WESTON UXOSO/UXOQCS, Mr. Bruce Carnal at 502-664-7926; and
- WESTON PM, Mr. John Gerhard at 610-701-3793.

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10.0 EXPLOSIVES NOT EXPENDED

Explosives that were requested for use, but were not expended, will be transported back to the explosive vendor’s magazine by the vendor. Return of the unused explosives to the distributor will be recorded on the Ammunition Consumption Report. The original receipt document will be adjusted to reflect the returned material and will be signed by the individual returning the explosives and a second authorized WESTON UXO Technician.

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11.0 DISPOSITION OF REMAINING EXPLOSIVES

All explosive materials purchased and used will be accounted for as required by the ATF. All unused explosives will be returned to the vendor.

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12.0 ECONOMIC ANALYSIS FOR DIFFERENT ALTERNATIVES

The West Point Water MRSs RI project is a performance-based, firm-fixed price contract; therefore, this section is not applicable.

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13.0 REFERENCES

Bureau of Alcohol, Tobacco, Firearms and Explosives (ATF), 2012. ATF Publication 5400.7: Federal Explosives Law and Regulations.

Department of Defense (DoD), 2012. Manual 6055.09-M, DoD Ammunition and Explosives Safety Standard. Issued 29 February 2008. Administratively Reissued 4 August 2010. Incorporating Change 1, 12 March 2012.

United States Army Corps of Engineers (USACE), 2013. Engineer Manual (EM) 385-1-97: Explosives Safety and Health Requirements Manual. 12 April.

USACE, 2015. EM 200-1-15: Technical Guidance for Military Munitions Response Actions. 30 October. Accessed on 7/27/17. http://www.publications.usace.army.mil/Portals/76/Publications/EngineerManuals/EM_200-1-15.pdf

USACE, 2017. Remedial Investigation West Point Water Ranges: Siege Battery-TD River (WSTPT-016-R-01), Battery Knox-TD River (WSTPT-04-R0-1). West Point Military Academy, West Point, NY. July 2017.

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ATTACHMENTS

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ATTACHMENT 1

LICENSES AND PERMITS

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U.S. Department of Justice
Bureau of Alcohol, Tobacco, Firearms and Explosives

Federal Explosives License/Permit
(18 U.S.C. Chapter 40)

[redacted]

In accordance with the provisions of Title XI, Organized Crime Control Act of 1970, and the regulations issued thereunder (27 CFR Part 555), you may engage in the activity specified in this license or permit within the limitations of Chapter 40, Title 18, United States Code and the regulations issued thereunder, until the expiration date shown. **THIS LICENSE IS NOT TRANSFERABLE UNDER 27 CFR 555.53.** See "WARNINGS" and "NOTICES" on reverse.

Direct ATF Correspondence To	ATF - Chief, FELC 244 Needy Road Martinsburg, WV 25405-9431	License/Permit Number	**8-PA-029-33-0H-02509**
Chief, Federal Explosives Licensing Center (FELC) Christopher R. Reeves		Expiration Date	**August 1, 2020**

Name
WESTON SOLUTIONS INC

Premises Address (Changes? Notify the FELC at least 10 days before the move.)
1400 WESTON WAY
WEST CHESTER, PA 19380-

Type of License or Permit
33-USER OF EXPLOSIVES

Purchasing Certification Statement

The licensee or permittee named above shall use a copy of this license or permit to assist a transferor of explosives to verify the identity and the licensed status of the licensee or permittee as provided by 27 CFR Part 555. The signature on each copy must be an original signature. A faxed, scanned or e-mailed copy of the license or permit with a signature intended to be an original signature is acceptable. The signature must be that of the Federal Explosives Licensee (FEL) or a responsible person of the FEL. I certify that this is a true copy of a license or permit issued to the licensee or permittee named above to engage in the business or operations specified above under "Type of License or Permit."

Mailing Address (Changes? Notify the FELC of any changes.)
WESTON SOLUTIONS INC
1400 WESTON WAY
WEST CHESTER, PA 19380-

	Vice President
Licensee/Permittee Responsible Person Signature	Position/Title
Gregory S. Daloisio	8/24/17
Printed Name	Date

Previous Edition is Obsolete WESTON SOLUTIONS INC:1400 WESTON WAY:19380:8-PA-029-33-0H-02509:August 1, 2020:33-USER OF EXPLOSIVES

ATF Form 5400.14/5400.15 Part I
Revised October 2011

Federal Explosives License (FEL) Customer Service Information

Federal Explosives Licensing Center (FELC)
244 Needy Road
Martinsburg, WV 25405-9431

Toll-free Telephone Number: (877) 283-3352
Fax Number: (304) 616-4401
E-mail: FELC@atf.gov

ATF Homepage: www.atf.gov

Change of Address *(27 CFR 555.54(a)(1))*. Licensees or permittees may during the term of their current license or permit remove their business or operations to a new location at which they intend regularly to carry on such business or operations. The licensee or permittee is required to give notification of the new location of the business or operations not less than 10 days prior to such removal with the Chief, Federal Explosives Licensing Center. The license or permit will be valid for the remainder of the term of the original license or permit. **(The Chief, FELC, shall, if the licensee or permittee is not qualified, refer the request for amended license or permit to the Director of Industry Operations for denial in accordance with § 555.54.)**

Right of Succession *(27 CFR 555.59)*. (a) Certain persons other than the licensee or permittee may secure the right to carry on the same explosive materials business or operations at the same address shown on, and for the remainder of the term of, a current license or permit. Such persons are: (1) The surviving spouse or child, or executor, administrator, or other legal representative of a deceased licensee or permittee; and (2) A receiver or trustee in bankruptcy, or an assignee for benefit of creditors. (b) In order to secure the right provided by this section, the person or persons continuing the business or operations shall furnish the license or permit for for that business or operations for endorsement of such succession to the Chief, FELC, within 30 days from the date on which the successor begins to carry on the business or operations.

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Federal Explosives License/Permit (FEL) Information Card

License/Permit Name: **WESTON SOLUTIONS INC**

Business Name:

License/Permit Number: **8-PA-029-33-0H-02509**

License/Permit Type: **33-USER OF EXPLOSIVES**

Expiration: **August 1, 2020**

Please Note: Not Valid for the Sale or Other Disposition of Explosives.

WARNINGS

1. As provided in Title XI of the Organized Crime Control Act of 1970 (U.S.C. § 842(i)), it is unlawful for any person who (1) is under indictment for, or has been convicted in any court of, a crime punishable by imprisonment for a term exceeding 1 year, (2) is a fugitive from justice, (3) is an unlawful user of, or addicted to any controlled substance *(as defined in section 102 of the Controlled Substances Act (21 U.S.C. 802))*, (4) has been adjudicated as a mental defective or has been committed to a mental institution, to ship, transport, or receive any explosive materials in interstate or foreign commerce, (5) is an alien, other than an alien who is lawfully admitted for permanent residence *(as that term is defined in section 101(a)(20) of the Immigration and Naturalization Act)*, or meets any other exception under section 842(i)(5), (6) has been discharged from the armed forces under dishonorable conditions, or (7) having been a citizen of the United States, has renounced the citizenship of that person.
2. **Federal Regulation 27 CFR 555.53 - Licensees and permits issued under this part are not transferable to another person. In the event of the lease, sale, or other transfer of the business or operations covered by the license or permit, the successor must obtain the license or permit required by this part before commencing business or operations.**
3. **Alteration or Changes to the License or Permit. Alterations or changes in the original license or permit or in duplications thereof violates 18 U.S.C. 1001, an offense punishable by imprisonment for not more than 5 years and/or a fine of not more than $250,000.**

NOTICES

1. Any change in trade name or control of this business or operations MUST be reported within 30 days of the change to the Chief, Federal Explosives Licensing Center (FELC), 244 Needy Road, Martinsburg, WV 25405-9431. (27 CFR 555.56-555.57). A licensee or permittee who reports a Change of Control must, upon expiration of the license or permit, file an ATF Form 5400.13/5400.16.
2. Under § 555.46, Renewal of License/Permit, if a licensee or permittee intends to continue the business or operations described on a license or permit issued under this part during any portion of the ensuing year, the licensee or permittee shall, unless otherwise notified in writing by the Chief, FELC, execute and file with ATF prior to the expiration of the license or permit an application for a license or permit renewal, ATF Form 5400.14/5400.15 Part III, in accordance with the instructions on the form, and the required fee. In the event the licensee or permittee does not timely file an ATF Form 5400.14/5400.15 Part III, the licensee or permittee must file an ATF Form 5400.13/5400.16 as required by § 555.45, and obtain the required license or permit before continuing business or operations. A renewal application will automatically be mailed by ATF to the "mailing address" on the license or permit approximately 60 days prior to the expiration date of the license or permit. <u>If the application is not received 30 days prior to the expiration date, the licensee or permittee should contact the FELC.</u>
   Note: The user-limited permits are not renewable.
3. This license or permit is conditional upon compliance by you with the Clean Water Act (33 U.S.C. § 1341(a)).
4. THIS LICENSE OR PERMIT MUST BE POSTED AND KEPT AVAILABLE FOR INSPECTION (27 CFR 555.101).

ATF Form 5400.14/5400.15 Part I
Revised October 2011

Federal Explosives License (FEL) Customer Service Information

(Continued from front)

Discontinuance of Business *(27 CFR 555.61)(27 CFR 555.128)*. Where an explosives materials business or operations is succeeded by a new licensee or permittee, the records prescribed by this subpart shall appropriately reflect such facts and shall be delivered to the successor, or may be, within 30 days following business discontinuance, delivered to the ATF Out-of-Business Records Center, 244 Needy Road, Martinsburg, WV 25405, or to any ATF office in the division in which the business was located. Where discontinuance of the business is absolute, the records shall be delivered within 30 days following the business discontinuance to the ATF Out-of-Business Records Center, 244 Needy Road, Martinsburg, WV 25405, or to any ATF office in the division in which the business was located.

Explosive materials must be stored in conformance with requirements set forth in 27 CFR, Part 55. It is unlawful for any person to store any explosive materials in a manner not in conformity with these regulations.

TO REPORT LOST OR STOLEN EXPLOSIVES, YOU MUST IMMEDIATELY NOTIFY ATF:
CALL TOLL FREE - (888) ATF-BOMB

✂ **Cut Here**

Federal Explosives Licensing Center (FELC) 244 Needy Road Martinsburg, WV 25405-9431	Toll-free number: (877) 283-3352 Fax number: (304) 616-4401 E-mail: FELC@atf.gov

ATF Hotline Numbers

Arson Hotline: 1-888-ATF-FIRE (1-888-283-3473)
Bomb Hotline: 1-888-ATF-BOMB (1-888-283-2662)
Report Illegal Firearms Activity: 1-800-ATF-GUNS (1-800-283-4867)
Firearms Theft Hotline: 1-888-930-9275
Report Stolen, Hijacked or Seized Cigarettes: 1-800-659-6242
Other Criminal Activity: 1-888-ATF-TIPS (1-888-283-8477)

ATTACHMENT 2

DETONATION CALL TREE

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Medical Emergency Call Tree

as of 11 May 2018

Call Order	Contact Name	Contact Information
While enroute to boat dock, a person on the boat will make calls in the following order:		
1	Western Shore – West Point Emergency Services Eastern Shore – 911	Military Police: (845) 938-3333 Cold Spring: 911
After emergency is under control WESTON SSHO, Bob Wagner (non-intrusive work) or SUXOS, Brian Grassmyer, or designee will make calls in the following order:		
1	Gretchen Tabano WESTON Project Manager	(443) 299-6863 (work) (443) 255-6961 (cell) gretchen.tabano@westonsolutions.com
2	Jeff Sanborn West Point Environmental Engineer	(845) 938-5041 (work) (518) 963-4106 (cell) (845) 534-9080 (home) (518) 963-4106 (home 2) Jeff.Sanborn@usma.edu
3	Kim Gross USACE Project Manager	(410) 962-3457 Kimberly.U.Gross@usace.army.mil

Detonation Notification Call Tree (Land Detonations)

Call Order	Contact Name	Contact Information
SUXOS, Brian Grassmyer, or designee will make calls in the following order:		
1	Paul Greene USACE Environmental and Explosive Safety Chief	See Contact information above
2	Gretchen Tabano WESTON Project Manager	See Contact information above
If reached, WESTON PM, Gretchen Tabano, will send out an email notification to each individual below and follow up w/phone call; however, if the WESTON PM is not reached, SUXOS, Brian Grassmyer, or designee will continue to make calls in the following order:		
3	Jeff Sanborn West Point Environmental Engineer	See Contact information above
4	Kim Gross USACE Project Manager USACE	See Contact information above
5	David Crosby NYSDEC	(518) 402-9662 David.crosby@dec.ny.gov
6	Local Law Enforcement: Western Shore – West Point Emergency Services Eastern Shore – Cold Spring Police Department	Military Police: (845) 938-3333 Cold Spring: (845) 265-9551
7	USMA Constitution Island Caretaker	Roddy McCloud: (732) 600-4274
8	Warner House Renovation Project USACE NY PM	Jillian Martin: (917) 790-8122 jillian.m.martin@usace.army.mil
9	Mike Anderson West Point Harbormaster	(845) 939-3011 Michael.anderson@usma.edu
10	West Point Safety	Keith Katz: (845) 938-6729
11	Garrison Public Affairs Office	Cory Angell: (845) 938-8520 Cory.Angell@usma.edu
12	USMA Public Affairs Office	Jim Fox: (845) 938-8365 Jim.fox@usma.edu
Once detonation is complete, the WESTON PM, Gretchen Tabano, or the SUXOS, Brian Grassmyer or designee, if the WESTON PM if unavailable, will send an “all clear” email notification. Persons with no email listed will be contacted via phone.		

BIP Notification Call Tree (Prior to Performing)

Call Order	Contact Name	Contact Information
SUXOS, Brian Grassmyer, or designee will make calls in the following order:		
1	Paul Greene USACE Environmental and Explosive Safety Chief	See Contact information above
2	Gretchen Tabano WESTON Project Manager	See Contact information above
If reached, WESTON PM, Gretchen Tabano, will send out an email notification to each individual below and follow up w/phone call; however, if the WESTON PM is not reached, SUXOS, Brian Grassmyer, or designee will continue to make calls in the following order:		
1	Jeff Sanborn West Point Environmental Engineer	See Contact information above
2	Kim Gross USACE Project Manager	See Contact information above
3	David Crosby NYSDEC	(518) 402-9662 David.crosby@dec.ny.gov

BIP Notification Call Tree (if BIP Approved by NYSDEC)

Call Order	Contact Name	Contact Information
SUXOS, Brian Grassmyer, or designee will call:		
1	Gretchen Tabano WESTON Project Manager	See Contact information above
If reached, WESTON PM, Gretchen Tabano, will send out an email notification to each individual below and follow up w/phone call; however, if the WESTON PM is not reached, SUXOS, Brian Grassmyer, or designee will continue to make calls in the following order:		
1	Paul Greene USACE Environmental and Explosive Safety Chief	See Contact information above
2	Jeff Sanborn West Point Environmental Engineer	See Contact information above
3	Kim Gross USACE Project Manager	See Contact information above
4	U.S. Coast Guard Sector New York (Staten Island, NY)	(718) 354-4037 (primary) (718) 354-4353 (emergency)
5	David Crosby NYSDEC	(518) 402-9662 David.crosby@dec.ny.gov
6	Local Law Enforcement: Western Shore – West Point Emergency Services Eastern Shore – Cold Spring Police Department	Military Police: (845) 938-3333 Cold Spring: (845) 265-9551
7	West Point Cultural Resources	Pat Raley: (530) 520-9764 Patrick.Raley@usma.edu Alternate: Paul Hudson: (845) 938-5853 Paul.Hudson@usma.edu
8	West Point Harbormaster	Mike Anderson: (845) 939-3011 Michael.anderson@usma.edu
9	West Point Safety	Keith Katz: (845) 938-6729
10	Garrison Public Affairs Office	See Contact information above
11	USMA Public Affairs Office	See Contact information above
Once detonation is complete, the WESTON PM, Gretchen Tabano, or the SUXOS, Brian Grassmyer or designee, if the WESTON PM if unavailable, will send an “all clear” email notification. Persons with no email listed will be contacted via phone.		

APPENDIX I
ANALYTICAL SOPs

CA-402-10	Determination of Nitroaromatics and Nitramines by HPLC Method 8330
CA-548	Preparation of Aqueous and Solid Samples for Explosive Analysis by Method 8330
CA-551-01	Grain Size Analysis
CA-605-07	Acid Digestion of Solid Samples by USEPA METHOD 3050 for Metals Analysis by ICP-AES, ICP-MS
CA-608-18	Trace Metals Analysis by ICP-AES Using USEPA Method 6010
CA-611-11	Digestion and Analysis of Solid Samples for Mercury by USEPA Method 7471
CA-709-11	pH Concentration Measurements in Soil Matrices – SW 846 Method 9045
CA-738-03	Determination of Acid Volatile Sulfide and Simultaneously Extractable Metals in Sediments
CA-741-06	Determination of Total Organic Carbon in Solids Using the EPA Region II Lloyd Kahn Method
	DoD ELAP Scope of Accreditation for Katahdin Analytical Services, LLC.
SD-902-12	Sample Receipt and Internal Control
SD-903-06	Sample Disposal

CA-402-10
DETERMINATION OF NITROAROMATICS AND NITRAMINES BY HPLC
METHOD 8330

UNCONTROLLED DOCUMENT

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

SOP Number: CA-402
Revision History
Cover Page
Page 1

TITLE: DETERMINATION OF NITROAROMATICS AND NITRAMINES BY HPLC METHOD 8330

Prepared By: Paul Raiti Date: 5/97

Approved By:

Department Manager: Date: 6-21-06

Operations Manager: Deborah J. Nadeau Date: 6.21.06

QA Officer: Leslie Dimond Date: 6-21-06

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
02	Updated Sect. 4→10, Tables 1→3, Figures 1 & 2 to reflect current practices. Added Waste management to Sect. 1.4. Changed LIMS to KIMS. Removed Turbochrom and added Target definitions. Updated PQL's	LAD	04/06	04/06
03	Major rewrite to include new instrumentation new extraction procedures, method modifications, new low level method and new example pages.	LAD	07/08	07/08
04	Major rewrite to include new injection loop, SPE cartridge extraction, sample dilution procedures, instrument conditions and DoD QSM version 4.1 compliance. Updated figs 1, 2, 5 & 6.	LAD	08/09	08/09
05	Removed acetic acid solution and prep. Added references. Added non-conformance report. Added Table for DoDQSM QC criteria.	LAD	09/10	09/10
06	Removed Extraction procedure. Section 5 - Intermediate and calibration standards are good for 6 months. Added MDL, LOD and LOQ information.	LAD	01/12	01/12

TITLE: **DETERMINATION OF NITROAROMATICS, NITRAMINES, AND NITRATE ESTERS BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC) METHOD 8330**

Revision History (cont.):

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
07	Sect. 1 & 10 – Added and/or updated methods references. Sect. 5 – Added calibration standard additional preparation instructions. Sect. 7 – Added RT clarification, added peak coelution information. Table 1 – Clarified LCS recovery criteria.	LAD	12/13	12/13
08	minor edits ~~clary~~ LAD 081515 clarifying reporting through Lims and M.Blk. acceptance criteria. Added DODQSM 5.0 QC criteria (Table 3) updated Fig. 1 & 2. KAS INC → KAS throughout	LAD	08/15	08/15
09	Sect. 5- Added Standards to title. Sect. 8- Added DODQSM 5.0 information. Added Addendum 1- Nitroguanidine analysis	LAD	03/16	03/16
10	Sect. 7- Added % Error Calculation. Sect. 9- Added LLOQ reference.	LAD	03/17	03/17

TITLE: **DETERMINATION OF NITROAROMATICS, NITRAMINES, AND NITRATE ESTERS BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC) METHOD 8330**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ____ of document **SOP CA-402-10**, titled **DETERMINATION OF NITROAROMATICS, NITRAMINES, AND NITRATE ESTERS BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC) METHOD 8330B, MOD.**

Recipient: ____ Date:____________________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ____ of document **SOP CA-402-10**, titled **DETERMINATION OF NITROAROMATICS, NITRAMINES, AND NITRATE ESTERS BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC) METHOD 8330B, MOD.**

Recipient: ____ Date:____________________

TITLE: **DETERMINATION OF NITROAROMATICS, NITRAMINES, AND NITRATE ESTERS BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY (HPLC) METHOD 8330**

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedures used by Katahdin Analytical Services technical personnel for the extraction and analysis of waters and soil for explosive residues using high performance liquid chromatography (HPLC) in accordance with EPA Method 8330B, 8330B mod. (extraction only modifications) and 8330A mod. (modified for dual wavelength detection only). The following compounds may be determined by this method:

COMPOUND	ABBREVIATION	CAS No.
Octahydro-1,3,5,7,-tetranitro-1,3,5,7-tetrazocine	HMX	2691-41-0
Hexahydro-1,3,5-trinitro-1,3,5- triazine	RDX	121-82-4
1,3,5-Trinitrobenzene	1,3,5-TNB	99-35-4
1,3-Dinitrobenzene	1,3-DNB	99-65-0
Methyl-2,4,6-trinitrophenylnitramine	Tetryl	479-45-8
Nitrobenzene	NB	98-95-3
2,4,6-Trinitrotoluene	2,4,6-TNT	118-96-7
4-Amino-2,6-dinitrotoluene	4-Am-DNT	1946-51-0
2-Amino-4,6-dinitrotoluene	2-Am-DNT	355-72-78-2
2,6-Dinitrotoluene	2,6-DNT	606-20-2
2,4-Dinitrotoluene	2,4-DNT	121-14-2
2-Nitrotoluene	2-NT	88-72-2
3-Nitrotoluene	3-NT	99-08-1
4-Nitrotoluene	4-NT	99-99-0
Nitroglycerin	NG	55-63-0
Pentaerythritol	PETN	78-11-5
3,5-Dinitroaniline	3,5-DNA	618-87-1
Ethylene Glycol Dinitrate	EGDN	628-96-6

The laboratory PQLs (reporting limit) for each compound in reagent water and solid matrix are listed in Table 4. The sensitivity of this method is dependent upon the level of interference rather than instrumental limitations. The reporting limits listed in Table 4 for the liquid chromatographic approach represent sensitivities that can be achieved in the absence of interferences. When interferences are present, the sensitivity will be decreased.

1.1 Definitions

ANALYTICAL BATCH: 20 or fewer samples which are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods.

METHOD BLANK (laboratory reagent blank): An artificial sample designed to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus. For aqueous samples, analyte-free water (e.g., deionized water or equivalent) is used as a blank matrix; for soil/sediment samples, muffled sand is used for the blank matrix. The blank prepared and analyzed exactly like a sample.

CALIBRATION CURVE (STANDARD CURVE): A sequence of standards at varying analyte concentrations used to generate a curve which plots concentration of known analyte standard versus the instrument response to the analyte.

INDEPENDENT CHECK STANDARD: A standard obtained from a source (vendor or lot) which is different from that used to prepare the calibration curve standards. Results are used to verify the accuracy of a known concentration of analyte versus the standard curve.

CALIBRATION VERIFICATION CHECK (CV): Verification of the ratio of instrument response to analyte amount, a calibration check is done by analyzing for analyte standards in an appropriate solvent.

CALIBRATION STANDARD (WORKING STANDARD): A solution prepared from the stock standard solution that is used to calibrate the instrument response with respect to analyte concentration.

LABORATORY CONTROL SAMPLE (LCS): A blank that has been spiked with the analyte(s) from an independent source or stock standard solution and is analyzed exactly like a sample. Its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements. The matrix used should be phase matched with the samples and well characterized.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD): Duplicate samples that are spiked with known concentrations of analytes. The samples are the analyzed as routine samples. The results are used to evaluate matrix effects and the precision and accuracy of the method using actual samples.

STOCK STANDARD SOLUTION: A concentrated solution containing the analyte(s) of interest at certified known concentration(s). These solutions are often certified by the vendor. Stock standard solutions are used to prepare calibration standards.

SURROGATES: Organic compounds which are similar to analytes of interest in chemical composition, extraction and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, samples and spiked samples prior to analysis. Percent recoveries are calculated for each surrogate.

KATAHDIN INFORMATION MANAGEMENT SYSTEM (KIMS) : A complete multi-user system with the capabilities of integrating laboratory instrumentation, generating laboratory worksheets, providing complete Lab Order status and generating reports. KIMS utilizes these features through a database.

TARGET: A software system that combines full processing, reporting and comprehensive review capabilities, regardless of chromatographic vendor and data type.

TARGET DB: An oracle database used to store and organize all Target data files.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of explosives by HPLC Method 8330B. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in analysis of explosives by HPLC Method 8330B to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to indicate periodic review of the associated logbooks.

1.3 Health & Safety

ALL OF THE COMPOUNDS LISTED IN SECTION 1.0 OF THIS SOP ARE EITHER USED IN THE MANUFACTURE OF EXPLOSIVES OR ARE THE DEGRADATION PRODUCTS OF COMPOUNDS USED FOR THAT PURPOSE. WHEN MAKING STOCK SOLUTIONS FOR CALIBRATION, ESPECIALLY IF YOU ARE USING NEAT MATERIALS, TREAT EACH COMPOUND AS IF IT WERE EXTREMELY EXPLOSIVE.

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs (material safety data sheets) for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical safety procedures and the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Hazardous Waste Management Plan and Safety Manual and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

All standards and samples must be classified as flammable waste and disposed of accordingly.

2.0 SUMMARY OF METHOD

This SOP describes high performance liquid chromatographic (HPLC) conditions for the detection of part per billion (ppb) levels of certain explosive compounds. Prior to use of this method, appropriate sample extraction techniques must be used. An aqueous or soil sample is extracted by either the SPE method or the mechanical shaker method for soils. A 200 uL aliquot is of the extract is then injected into an HPLC, and compounds are detected by an ultraviolet (UV) detector at either 254nm or 210nm.

3.0 INTERFERENCES

3.1 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines, resulting in mis-integration or mis-interpretation of the chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by the analysis and evaluation of method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be required.

3.2 The chromatographic conditions described allow for a unique resolution of the specific explosive compounds covered by this method. Other explosive compounds, in addition to matrix artifacts, may interfere.

3.3 Tetryl decomposes rapidly in methanol/water solutions, as well as with heat. All aqueous samples expected to contain tetryl should be diluted with acetonitrile prior to filtration and acidified to pH <3 with aqueous sodium bisulfate. All samples expected to contain tetryl should not be exposed to temperatures above room temperature.

4.0 APPARATUS AND MATERIALS

4.1 HPLC system:

4.1.1 Agilent Hewlett Packard 1100 series HPLC system, including a multiwavelength UV detector for dual wavelength analysis.

4.1.2 Chemstation software for LC Rev A.10.02 [1757].

4.2 Primary column: Dionex Acclaim Explosives E1 reversed phase HPLC column, 4.6mm X 25 cm, 5um, order #064305; and associated pre-column or eqivalent.

4.3 Confirmation column: Dionex Acclaim Explosives E2 reverse phase HPLC column, 4.6mm X 25 cm, 5um, order # 064309, and associated pre-column. Or an equivalent.

4.4 2.0 mL auto-sampler vials with Teflon septa

5.0 REAGENTS AND STANDARDS

All reagent and solvent lots must be checked for possible contamination. Refer to the current version of Katahdin SOP CA-105, Reagent and Solvent Handling, for further details. All reagents and solvents must be free (<PQL) of any target compounds.

5.1 Laboratory Reagent Grade water: Defined as water in which an interferant is not observed at the method detection limit of the compounds of interest.

5.2 Acetonitrile, HPLC grade, J.T. Baker order # 9017-03 or equivalent.

5.3 Methanol, HPLC grade, Fisher order # A452-4 or equivalent.

5.4 Stock Standard Solution (for calibration standards): Accustandard Method 8330, order # M-8330R or equivalent, at 1.0 mg/mL in MeOH:AcCN (1:1).

5.5 Stock Standard Solution (for Independent Source and Laboratory Control Spike): Ultra Scientific Combined Stock Solution - Full Explosive Mix - order # NAIM-833E or equivalent, at 1.0 mg/mL in acetonitrile.

5.6 Stock Standard Solution (for calibration standards): nitroglycerin, Accustandard, order number M-8330-ADD-1 or equivalent, 100 mg/L in ethanol.

5.7 Stock Standard Solution (for independent source and laboratory control spike): Nitroglycerin, #31498 Restek, or equivalent, 1000µg/mL in Methanol.

5.8 Stock Standard Solution: Pentaerythritol tetranitrate (PETN), Accustandard #M8330-ADD-2-10x, or equivalent, 1000 mg/L.

5.9 Stock Standard Solution: Pentaerythritol tetranitrate (PETN), (for independent source and laboratory control spike): Restek order #31600, at 1000 mg/L or equivalent.

5.10 Stock Standard Solution: 3,5-Dintroaniline, #M8330-ADD-4 Accustandard, or equivalent.

5.11 Stock Standard Solution: 3,5-Dinitroaniline, (for independent source and laboratory control spike) Restek order #31661 at 1000 mg/L, or equivalent.

5.12 Stock Standard Solution: ethylene glycol dinitrate (EGDN), Accustandard order #M-8330-ADD-5 at 100 mg/L, or equivalent.

5.13 Stock Standard Solution (for independent source and laboratory control spike): EGDN, Restek order #31601 at 1000 mg/L.

5.14 Surrogate 1,2-Dinitirobenzene, Accustandard order # M-8330-SS equivalent, at 1.0 mg/mL in MeOH.

NOTE: Stock standard solutions must be replaced after 1 year or sooner if comparison with check standards indicates a problem.

5.15 Intermediate standard solutions: Prepare the 8330 explosive standard, nitroglycerine, PETN, EGDN, and 3,5-dinitroaniline at 100mg/L and the surrogate, 1,2-Dinitrobenzene, separately at 10µg/mL in methanol or acetonitrile. Prepare the independent source at 100µg/mL in methanol or acetonitrile.

5.15.1 Larger volumes can be used at the convenience of the analyst. Commercially prepared stock standards can be used at any concentration if they are certified by the manufacturer or by an independent source.

5.15.2 Transfer the stock standard solutions into Teflon-sealed screw-cap bottles. Store at 4 °C and protect from light. Stock and intermediate standards should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.

5.15.3 Intermediate standard solutions should be refrigerated upon preparation, and may be used for 6 months.

5.16 Calibration standards: Calibration standards, at a minimum six concentration levels, should be prepared through dilution of the intermediate stock standards with acetonitrile. One of the concentration levels should be at a concentration near, but above, the method detection limit. The remaining concentration levels should correspond to the expected range of concentrations found in real samples or should define the working range of the HPLC. The final volume of each calibration standard is 10 ml. To this, 20 ml of DI water is added. This provides the same acetonitrile to DI water ratio as the sample extracts (5ml acetonitrile plus 10 mL DI water).

Calibration standards are refrigerated and stored in the dark. They expire 6 months from date opened.

5.17 Surrogate standards: The analyst should monitor the performance of the extraction and analytical system, and the effectiveness of the method in dealing with each sample matrix by spiking each sample, standard, and reagent water blank with a surrogate (e.g., 1,2-Dinitrobenzene or other explosive compounds not expected to be present in the sample) recommended to encompass the range of the temperature program used in this method. Deuterated analogs of analytes should not be used as surrogates for HPLC analysis due to coelution problems.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Water samples are collected in 1 L amber glass bottles and stored until time of extraction. Water samples must be extracted within 7 days of collection and analyzed within 40 days after extraction. Soil and sediment samples are collected in 4 oz. soil jars and stored at < 6 °C. Soil and sediment samples must be extracted within 14 days of collection and analyzed within 40 days after extraction Extracts must be stored in the dark at < 6 °C until time of analysis.

7.0 PROCEDURES

7.1 Chromatographic Conditions:

7.1.1 Primary Conditions:

Primary Column: See section 4.2.

For HPLC conditions refer to Figure 3.

7.1.2 Confirmation Column:

Confirmation column: See section 4.3.

For HPLC conditions refer to Figure 4.

TURNING ON THE INSTRUMENT

7.2 Make sure the solvent containers are filled with the proper solvent.

7.2.1 Turn on the instrument at the computer by pressing the on button in the middle of the screen.

7.2.2 Load the correct instrument method, see section 7.6, by going file and load method at the top of the screen. Then select the method you want to use.

7.2.3 Allow instrument to equilibrate for at least a half an hour. It is ready when the baselines that appear on the front of the screens are stable and not drifting.

7.2.4 Instrument is now ready to load and analyze samples.

7.3 Calibration

7.3.1 The HPLC system is calibrated using the external standard calibration procedure. One seven-point calibration curve is prepared.

7.3.2 Each calibration standard is injected using the technique that is used to introduce the actual samples into the HPLC. The Target system will calculate the peak height or area for each compound. A calibration curve can be prepared in Target using the peak height versus the concentration of the standard. A linear calibration applying a first order polynomial equation is used to prepare the curve. In order to be used for quantitative purposes, the correlation coefficient must be greater than or equal to 0.990. The linear equation is:

$$y = mx + b$$

where: y = Instrument response
m = Slope of the line
x = Concentration of the calibration standard
b = The Y intercept

7.3.3 One curve is calibrated for explosive analysis including all the analytes and the surrogate using the primary column. One curve is also calibrated for the second column confirmation.

7.3.4 Acceptance criteria independent of calibration model

Either of the two procedures described below may be used to determine calibration function acceptability for linear and non-linear curves. Both %

Error and Relative Standard Error (RSE) evaluate the difference between the measured and the true amounts or concentrations used to create the model.

Calculation of the % Error

$$\% \, Error = \frac{xi - x'i}{xi} \, x \, 100$$

where:

x'i = Measured amount of analyte at calibration level i, in mass or concentration units
xi= True amount of analyte at calibration level i, in mass or concentration units.
Percent error between the calculated and expected amounts of an analyte should be ≤ 30% for all standards. For some data uses, ≤50% may be acceptable for the lowest calibration point.

Calculation of Relative Standard Error (RSE - expressed as %)

$$\text{RSE}{=}100 \text{ X } \sqrt{\sum_{i=1}^{n} \left| \frac{(x'i - xi)^2}{xi} \right|} / (\text{n-p})$$

where:

xi= True amount of analyte in calibration level i, in mass or concentration units
x ɨ= Measured amount of analyte in calibration level i, in mass or concentration units
p= Number of terms in the fitting equation
(average = 1, linear = 2, quadratic = 3, cubic = 4)
n= Number of calibration points.

The RSE acceptance limit criterion for the calibration model is the same as the RSD limit for CF or RF in the determinative method. If the RSD limit is not defined in the determinative method, the limit should be set at ≤20% for good performing compounds and ≤30% for poor performing compounds.

7.3.5 An independent standard (ICV) must be analyzed after the initial calibration. The percent difference for each analyte must be ≤20% of the initial calibration curve.

7.3.6 The working calibration curve must be verified daily or after every 10 field samples by injecting the mid-point calibration standard. If the response for any analyte varies from the expected response by more than ± 20%, a new calibration curve must be prepared for that analyte.

7.4 Retention time windows

7.4.5 Three injections of all single component standard mixtures are made throughout the course of a 72-hour period.

7.4.6 The standard deviation of the three retention times is calculated for each single component standard.

7.4.7 Plus or minus three times the standard deviation of the retention times for each standard is used to define the retention time window; however, the experience of the analyst should weight heavily in the interpretation of chromatograms.

7.4.8 Retention time windows are calculated for each standard on each HPLC column and whenever a new HPLC column is installed. The data is kept on file in the laboratory.

7.4.9 If the calculated retention time window results in a value of 0.05 minutes or less, the laboratory will apply nominal windows of ± 0.05. This is done in order to avoid any false negative hits because of the window being too narrow. By utilizing these windows, a false positive hit may be initially indicated, but an experienced analyst could determine a false positive from scrutinizing the chromatograms.

7.5 HPLC Analysis

7.5.5 Write the sequence in the explosives run log; follow page format and proper sample coding.

7.5.6 Refilter any cloudy samples through 0.45um filters into the 2 mL sample vials.

7.5.7 Samples are analyzed in a set referred to as an analysis sequence. The sequence begins with instrument calibration as listed in section 7.12 followed by sample extracts interspersed with mid-concentration calibration standards. Before any samples are analyzed the instrument must be calibrated by analyzing seven calibration curve or a mid-concentration standard (continuing calibration standard or CV).

7.5.8 If a CV is run, the calculated concentration must not exceed a difference of ± 20% of the expected value. Each sample analysis must be bracketed with an acceptable initial calibration or opening continuing calibration standard and a closing continuing calibration standard. The calibration standard must also be injected at intervals of not less than once every ten field samples and at the end of the analysis sequence. If the CCV fails, the instrument is checked for any obvious problems and maintenance is performed as necessary. Another CCV is analyzed or the instrument is recalibrated and then samples are injected. All samples that were injected after the standard exceeding the criterion must be reinjected to avoid errors in quantitation, if the initial analysis indicated the presence of the specific target analyte that exceeded the criterion.

7.5.9 All positive measurements observed on the E1 column must be confirmed by injection onto the E2 column.

7.5.10 The center of the retention time window for each analyte and surrogate is established by using the absolute retention time for each analyte and surrogate from the daily opening calibration verification or initial calibration.

7.5.11 An analyte is tentatively identified when a peak from a sample falls within the daily retention time window.

7.5.12 If the response for an analyte exceeds the calibration range of the system, the sample must be diluted with a 30% acetonitrile/water mixture and reanalyzed.

7.5.13 When a HPLC system is determined to be out of control because either a CV cannot pass or the calibration does not meet the correlation coefficient criteria, instrument maintenance is likely necessary. Routine instrument maintenance may involve changing the pre-column, replacing pump seals, or replacing the column. This information is recorded in the instrument run log (Figure 1). When an instrument requires more extensive maintenance, for example, replacing a detector or instrument part, this information is noted in the instrument maintenance logbook.

7.6 Calculations

7.6.5 The concentration of an analyte is calculated by using the calibrated curve that is prepared in Target. When an analyte is identified, Target displays a concentration when the file is processed through the appropriate calibrated method.

7.6.6 The concentrations from the reports are then incorporated with the extraction data to arrive at a final concentration.

Water concentration (ug/L) = (C) (Vt)/(Vo) * 1000
Soil/Sediment concentration (mg/kg) = (C) (Vt)/(Ws) (D) * 1000

where: C = amount calculated by Target in µg/mL
Vt = Volume of total extract including any instrument dilutions (L)
Vo = Volume of sample extracted (L)
Ws = Weight of sample extracted (Kg)
D = Decimal total solids

7.7 Data Review

7.7.5 Initial Data Review

The initial data review is accomplished by the analyst who ran the samples. This review is of sufficient quality and detail to provide a list of samples that need to be reanalyzed or diluted and reanalyzed. The initial data review is performed on the detailed quantitation reports of the analyzed samples. This data review examines criteria that directly impact whether or not the sample needs to be reanalyzed and/or extracted. These criteria include:

- QC criteria for method blank, LCS, MS/MSD, and calibration – refer to section 8.0.
- Surrogate recovery
- Chromatography: cleanups, manual integration.
- Target compound detection: quantitation, confirmation, false positives.

The requirement of the Organics laboratory is that this initial data review be completed no later than the end of the next workday. After the analyst has completed his or her initial data review, the information is then ready to be processed for reporting. Refer to section 7.10.

7.7.6 Surrogate recovery

All recoveries must meet the most recently established laboratory acceptance limits, which are listed on the Laboratory Surrogate Acceptance Limit sheet.

The sample is evaluated for recoveries of the surrogate. The sample chromatogram is reviewed for any interferences before determining whether to accept a sample based on the surrogate recoveries. If the surrogate recovery is affected by matrix interference, the sample result may be accepted with narration. If the recovery for the surrogate is not acceptable because the recovery is high and the sample does not contain any analytes above the PQL, the data is narrated. If the recovery for the surrogate is low and there is no apparent matrix effect, the sample is reextracted.

For method blanks, if the recovery of the surrogate is high, the blank does not contain any target analytes above the PQL, the sample results are less than the PQL, and the recovery of the surrogate in the sample(s) are acceptable, the data is narrated. If the recoveries in the blank are low and it does not contain any target analytes above the PQL, and the recoveries in the samples are acceptable but the sample contains one or more target analytes above the PQL, the sample may be reextracted.

For laboratory control samples (LCS), if the only discrepancy in the extraction batch is with the LCS, and the analyte spike recoveries are acceptable, the data is narrated. If the recovery of the surrogate and the analyte spikes are low, the samples may need to be reextracted.

7.7.7 Chromatography

The chromatography should be examined for the presence of any non-target peaks, which can be used as an indication of whether or not matrix interference might be influencing surrogate recoveries. If the chromatogram indicates interferences, then a cleanup may be needed.

Manual integrations are to be performed when chromatographic conditions preclude the computer algorithm from correctly integrating the peak of concern. In no instance shall a manual integration be performed solely to bring a peak within criteria. For specific procedures on how to manually integrate, refer to Katahdin SOP QA-812, Manual Integration, current revision.

Each peak of concern is examined by the primary analyst to ensure that the peak was integrated properly by the computer algorithm. Should a manual integration be necessary (for instance, due to a split peak, peak tailing, or incomplete resolution of isomeric pairs), an “m” qualifier will automatically be printed on the quantitation report summary.

In cases where 2 peaks coelute and there is no clear distinction between peaks, instrument maintenance must be done in order to regain peak resolution. If this is not possible, the client must be notified.

7.7.8 Target Compound Detection

The chromatogram from the primary column is evaluated. If a target analyte is detected in a sample, the sample is reanalyzed on a secondary column to confirm. If a target analyte is present on both columns, the concentration is within the calibration range and the quantitation from both chromatograms agrees within ±40%, the analyte is considered to be present in the sample. The concentration from the primary column is reported

7.8 Reporting

7.8.5 After the chromatograms have been reviewed and any target analytes have been quantitated using Target, the necessary files are brought into KIMs. Depending on the QC level requested by the client, a Report of Analysis (ROA) and additional reports, such as LCS forms and chronology forms, are generated. The package is assembled to include the necessary forms and raw data. The data package is reviewed by the primary analyst and then forwarded to the secondary reviewer. The secondary reviewer validates the data and checks the package for any errors. When completed, the package is sent to the department manager for final review. A completed review checklist (Figure 2) is provided with each package. The final data package from the Organics department is then processed by the Data Management department.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 1 and to details in this section for a summary of QC requirements, acceptance criteria, and corrective actions. These criteria are intended to be guidelines for analysts. The criterion does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in this section or in Table 1, all associated samples must be evaluated against all of the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in this section and in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations, client and project specific Data Quality Objectives and on review of chromatograms. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases “qualified” data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

8.1 Spike concentrations: The LCS and the MS/MSD are spiked with the full list of analytes. The spike concentrations are:

MATRIX	Compound	SPIKE AMT.	SPIKE CONC.	FINAL CONC.
Water	8330 explosive standard + 3,5-Dinitroaniline	0.025 mL	100 ug/mL	5 ug/L
Water	NG, PETN, EGDN	0.010 mL	1000 ug/mL	20 ug/L
Soil	All	0.1 mL	100 ug/mL	1000ug/kg

The surrogate spike (1,2-dinitrobenzene) concentrations are:

MATRIX	SPIKE AMT.	SPIKE CONC.	FINAL CONC.
Water	0.50 mL	10 ug/mL	10 ug/L
Soil	0.5 mL	10 ug/mL	500 ug/kg

8.2 LCS and MS/MSD acceptance criteria and Corrective Action: All QC samples are calculated for percent recovery of the spiked analyte(s). The recoveries are compared to the statistically derived acceptance limits or nominal limits. If samples need to be compliant with DOD QSM, version 4.2 or 5.0, we must use the acceptance limits that are found in table G-13 of QSM 4.2, or Tables 34 – 37 of QSM 5.0. These limits are used for LCSs and MS/MSDs for both soil and water matrices.

When analyzing samples compliant with DoD QSM Versions 4.2 & 5.0, solid matrix LCS's may utilize a solid reference material which is taken through the same sieving, grinding and subsampling procedures as the samples.

If any spike compound in the laboratory control sample falls outside of the established recovery acceptance limit window, the QC sample is considered to be out of control and any sample that is associated should be reextracted. However, if the recovery is high and the associated samples do not contain the specific compound(s), the data can possibly be accepted with narration.

If a spike compound is outside of the acceptance limits in the matrix spike sample but is acceptable in the LCS, the data is considered acceptable. The cause of the failure is possibly attributable to matrix interference. However, if the compound fails in both the LCS and the MS/MSD, the result for that analyte is suspect and may not be reported for regulatory compliance purposes.

The nominal limits 30-150 may be used if there are not been enough data points to calculate statistically derived limits as with 3,5-dinitroaniline & EDGN. Statistically derived limits will be established when sufficient data points are available. Refer to Katahdin SOP QA-808, "Generation and Implementation of Statistical QC Limits and/or Control Charts," current revision.

8.3 Surrogate recoveries are calculated on all samples, blanks and spikes. The recoveries are compared to laboratory established acceptance limits. If samples need to be compliant with DOD QSM, version 5.0, we must use the acceptance limits that are found in Tables 34 – 37.

When a sample has a surrogate that falls outside of the laboratory established acceptance limit window, the problem should be investigated. If the recovery looks like it is affected by the sample matrix, the sample may be reinjected to confirm matrix interference. When a sample has no detectable surrogate recovery, the sample should be reextracted.

8.4 When analyzing samples compliant with DoD QSM Version 4.2 and 5.0, one sample per batch must be subsampled in triplicate. The sample chosen must not be any type of blank sample and ideally should one with the highest suspected concentration of explosives. The RSD for the results above the PQL must not exceed 20%.

9.0 METHOD PERFORMANCE

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

The Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD’s must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Quantitation (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ’s must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the anaysis is not included in the DoD Scope of Accreditation. This may also be refered to the LLOQ verification.

MDLs are filed with the Organic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revision of Method 8330B for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA SW846, 3rd Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB and IV, February 2007, Method 8330A

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA SW846, 3rd Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB, and IV, February 2007, validated method, Method 8330B.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA SW846, 3rd Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB and IV, February 2007, Method 8000B.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.2, 10/25/2010.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.0, March, 2013

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-803, Laboratory QA: Self Inspection System, current revision.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision.

Waters Solid Phase Extraction Technology for the Analysis of Explosives, Section 5.; “Determination of Low-Level Explosive Residue in Water by HPLC: Solid-Phase Extraction vs. Salting - Out Solvent Extraction”, Michael G. Winslow; Bradley A. Weichert; and Robert D. Baker. Proceedings of the EPA 7th Annual Waste and Quality Assurance Symposium, Washington, D.C. 1991.

LIST OF TABLES AND FIGURES

TABLE 1

QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Method blank	One per prep batch of twenty or fewer samples	No analyte detected > ½ the PQL	(1) Investigate source of contamination (2) Evaluate the samples and associated QC: ie. the blank results are above the PQL, report sample results which are <PQL or > 10X the blank concentration. Otherwise, reprep a blank and the remaining samples.
LCS	One per prep batch of twenty or fewer samples	Statistically derived limits for all analytes except 3,5-dinitroaniline & EDGN. These use the nomial limits of 30-150 (70-130 for South Carolina)	(1) Evaluate the samples and associated QC: i.e. If an MS/MSD was performed and acceptable, narrate. If the surrogate recoveries in the LCS are low but are acceptable in the blank and samples, narrate. If the LCS recovery is high but the sample results are < PQL, narrate. Otherwise, reprep a blank and the remaining samples.
CCV (CV)	One after every 10 samples: midpoint of initial calibration	20% D	(1) Evaluate the samples: If the %D > +20% and sample results are < PQL, narrate. If %D > ± 20% only on one channel, narrate. If %D > ± 20% and is likely a result of matrix interference, narrate. Otherwise, reanalyze all samples back to last acceptable CV.
Matrix Spike\ Matrix Spike Duplicate	One for every set of 20 samples	Statistically derived limits 20% RSD	(1) Evaluate the samples and associated QC: ie. If the LCS results are acceptable, narrate. (2) If both the LCS and MS/MSD are unacceptable, reprep the samples and QC.
7 pt calibration of Explosive Mix	Initial cal prior to sample analysis. The lowest concentration must be at or below the PQL. Once curve is generated, the lowest calibration standard must be re-analyzed.	7 pt calibration - correlation coefficient ≥ 0.990. The signal to noise ratio at the PQL must be at least 5:1.	(1) Repeat Initial calibration .
Independent Calibration Verification	Once, immediately following calibration	20%D	Problem must be corrected. No sample analysis until calibration has been verified.
Second Column Confirmation	All positive hits must be verified	± 40% D	"J" Flag if > 40%; "Q" flag if not confirmed and narrate.
Demonstration of analyst proficiency; accuracy and precision	Once per analyst initially and annually thereafter	Must pass all applicable QC for method	Repeat analysis until able to perform passing QC; document successful performance in personal training file
MDL and-or LOD/LOQ verification study	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		

TABLE 2

DOD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria (see Section C.1.f).	Flagging criteria are not appropriate.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification	(Refer to current revision of SOP QA-806)				
LOQ establishment and verification	(Refer to current revision of SOP QA-806)				
Soil drying procedure	Soil samples requiring drying sieving, grinding and subsampling will be subcontracted for these procedures.				
Soil sieving procedure	See above				
Soil grinding procedure	See above				
Soil grinding blank	See above				
Soil subsampling process	See above				
Soil sample triplicate	See above				
Aqueous sample preparation	Each sample.	Solid phase extraction (SPE) using resin-based solid phase disks or cartridges is required. The salting-out procedure is not permitted.	NA.	Flagging criteria are not appropriate.	
Initial calibration (ICAL)	Minimum of 5 calibration standards with the lowest standard concentration at or below the RL. Once calibration curve or line is generated, the lowest calibration standard must be re-analyzed.	The apparent signal-to-noise ratio at the RL must be at least 5:1. If linear regression is used, r ≥ 0.995. If using Internal Standardization, RSD ≤ 15%.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	No samples can be run without a valid ICAL.

TABLE 2

DOD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Second source calibration verification (ICV)	Immediately following ICAL.	All analyte(s) and surrogates within ± 20% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.
Continuing calibration verification (CCV)	Prior to sample analysis, after every 10 field samples, and at the end of the analysis sequence.	All target analytes and surrogates within ± 20% of the expected value from the ICAL.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Method blank	One per preparatory batch.	No analytes detected > ½ RL and greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results.	Correct problem, then see criteria in Box D-1. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
LCS containing all analytes to be reported	One per preparatory batch.	A solid reference material containing all reported analytes must be prepared (e.g., ground and subsampled) and analyzed in exactly the same manner as a field sample. In-house laboratory control limits for the LCS must demonstrate the laboratory's ability to meet the project's MQOs.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available Refer to Table G-1 for number of marginal exceedences allowed. Contact Client if samples cannot be reprepped within hold time.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch per matrix (see Box D-7).	For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken. Percent recovery must meet LCS limits.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.

TABLE 2

DOD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix	For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken. Percent recovery must meet LCS limits and relative percent difference (RPD) < 20%.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Confirmation analysis	When target analytes are detected on the primary column using the UV Detector (HPLC) at concentrations exceeding the Limit of Detection (LOD).	Calibration and QC criteria are the same as for initial or primary column analysis. Results between primary and second column RPD ≤ 40%.	Report from both columns.	If there is a > 40% RPD between the two column results, data must be J-flagged accordingly.	Confirmation analysis is not needed if LC/MS or LC/MS/MS was used for the primary analysis. Secondary column – Must be capable of resolving (separating) all of the analytes of interest and must have a different retention time order relative to the primary column. Any HPLC column used for confirmation analysis must be able to resolve and quantify all project analytes. Detection by HPLC UV, LC/MS or LC/MS/MS. Calibration and calibration verification acceptance criteria is the same as for the primary analysis.
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

TABLE 3

DOD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Soil drying procedure	Each sample, LCS, and Method Blank.	Laboratory must have a procedure to determine when the sample is dry to constant weight. Record date, time, and ambient temperature on a daily basis while drying samples.	NA.	Flagging is not appropriate.	Commercial PT samples must reflect the grinding, extraction, and analysis steps as a minimum.
Soil sieving procedure	Each sample, LCS, and Method Blank.	Weigh entire sample. Sieve entire sample with a 10 mesh sieve. Breakup pieces of soil (especially clay) with gloved hands. Do not intentionally include vegetation in the portion of the sample that passes through the sieve unless this is a project specific requirement. Collect and weigh any portion unable to pass through the sieve.	NA.	Flagging is not appropriate.	
Soil grinding procedure	Initial demonstration.	The laboratory must initially demonstrate that the grinding procedure is capable of reducing the particle size to < 75 µm by passing representative portions of ground sample through a 200 mesh sieve (ASTM E11).	NA.	Flagging is not appropriate.	
Soil grinding blank	Prior to grinding samples; after every 10 samples; and at the end of the batch.	A grinding blank using clean solid matrix (such as Ottawa sand) must be prepared (e.g., ground and subsampled) and analyzed in the same manner as a field sample. No reported analytes must be detected > 1/2 LOQ.	Blank results must be reported and the affected samples must be flagged accordingly if blank criteria are not met.	If any individual grinding blank is found to exceed the acceptance criteria, apply B-flag to the samples following that blank.	Grinding blanks may be composited for analysis. At least one grinding blank per batch must be
Soil subsampling process	Each sample, duplicate, LCS, and Method Blank.	Entire ground sample is mixed, spread out on a large flat surface (e.g., baking tray), and 30 or more randomly located increments are removed from the entire depth to sum a ~10 g subsample.	NA.	Flagging is not appropriate.	

TABLE 3

DOD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Soil sample triplicate	At the subsampling step, one sample per batch. Cannot be performed on any sample identified as a blank (e.g., trip blank, field blank, method blank).	Three 10 g subsamples are taken from a sample expected to contain the highest levels of explosives within the quantitation range of the method. The RSD for results above the LOD must not exceed 20%.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	If reported per the client, apply J-flag if acceptance criteria are not met and explain in the case narrative.	
Aqueous sample preparation	Each sample and associated batch QC samples.	Solid phase extraction (SPE) using resin-based solid phase disks or cartridges is required.	NA.	Flagging is not appropriate.	The salting-out procedure is not permitted.
Initial Calibration (ICAL) for all analytes (including surrogates)	At instrument set-up and after ICV or CCV failure, prior to sample analysis.	ICAL must meet one of the three options below: Option 1: RSD for each analyte = 15%; Option 2: linear least squares regression for each analyte: r2 = 0.99; Option 3: non-linear least squares regression (quadratic) for each (quadratic) for each analyte: r2 ≥ 0.99.	Correct problem then repeat ICAL.	Flagging is not appropriate.	Minimum 5 levels for linear and 6 levels for quadratic. No samples shall be analyzed until ICAL has passed.
Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analyte(s) and surrogates within ± 20% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.
Continuing Calibration Verification (CCV)	Before sample analysis, after every 10 field samples, and at the end of the analysis sequence.	All reported analytes and surrogates within ± 20% of true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

TABLE 3

DOD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Method Blank (MB)	One per preparatory batch.	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Laboratory Control Sample (LCS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	A solid reference material containing all reported analytes must be prepared (e.g., ground and subsampled) and analyzed in exactly the same manner as a field sample. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike (MS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken. If MS results are outside the limits, the data shall be evaluated to determine the source(s) of difference, i.e., matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. MSD or MD: RPD = 20% (between MS and MSD or sample and MD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken. The data shall be evaluated to determine the source of difference.

TABLE 3

DOD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Surrogate Spike	All field and QC samples.	QC acceptance criteria specified by the project, if available; otherwise use QSM Appendix C limits or in-house LCS limits if analyte(s) are not listed.	Correct problem, then reprep and reanalyze all failed samples for all surrogates in the associated preparatory batch, if sufficient sample material is available. If obvious chromatographic interference with surrogate is present, reanalysis may not be nece	Apply Q-flag to all associated analytes if acceptance criteria are not met and explain in the case narrative.	Alternative surrogates are recommended when there is obvious chromatographic interference.
Confirmation of positive results (second column)	All positive results must be confirmed.	Calibration and QC criteria are the same as for initial or primary column analysis. Results between primary and secondary column RPD = 40%.	Report from both columns	Apply J-flag if RPD > 40%. Discuss in the case narrative.	Use of a UV detector with a UV diode array detector or vice versa is not considered a valid confirmation technique. Confirmation analysis is not needed if LC/MS or LC/MS/MS was used for the primary analysis. Secondary column – Must be capable of resolving (separating) all of the analytes of interest and must have a different retention time order relative to the primary column. Use project specific reporting requirements if available; otherwise, report from the primary column.

TABLE 4

SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-402-09	Method 8330B/8000
Apparatus/ Materials	None	
Reagents	None	
Sample preservation/ handling	None	
Procedures	See SOP Section 10.0 referenced method 3, section 7.2.2: "Low Level Aqueous Sample Preparation" See SOP Section 7.6.5 : If calculated retention time window results in a value of 0.05 minutes or less, nominal limits will be applied. See SOP Section 7.7.3 : Absolute retention time windows are established daily for each analyte using the mid-point of the window of that day if after analyzing the mid-point it is determined that one or more of the analytes fall outside of the previously established retention time window.	See SW 846 Method 8330; Section 7.1.1.1. See SW 846 Method 8000; Section 7.5: Plus or minus three times the standard deviation of the retention times for each standard will be used to determine the retention time window. See SW 846 Method; Section 7.6.9 : Establish daily retention time windows for each analyte.
QC - Continuing Calibration		
QC - LCS	None	
QC - Accuracy/Precision	None	
QC - MDL	PQL – Practical Quantitation Level – three to ten times the MDL.	EQL – Estimated Quantitation Level – five to ten times the MDL

TABLE 5

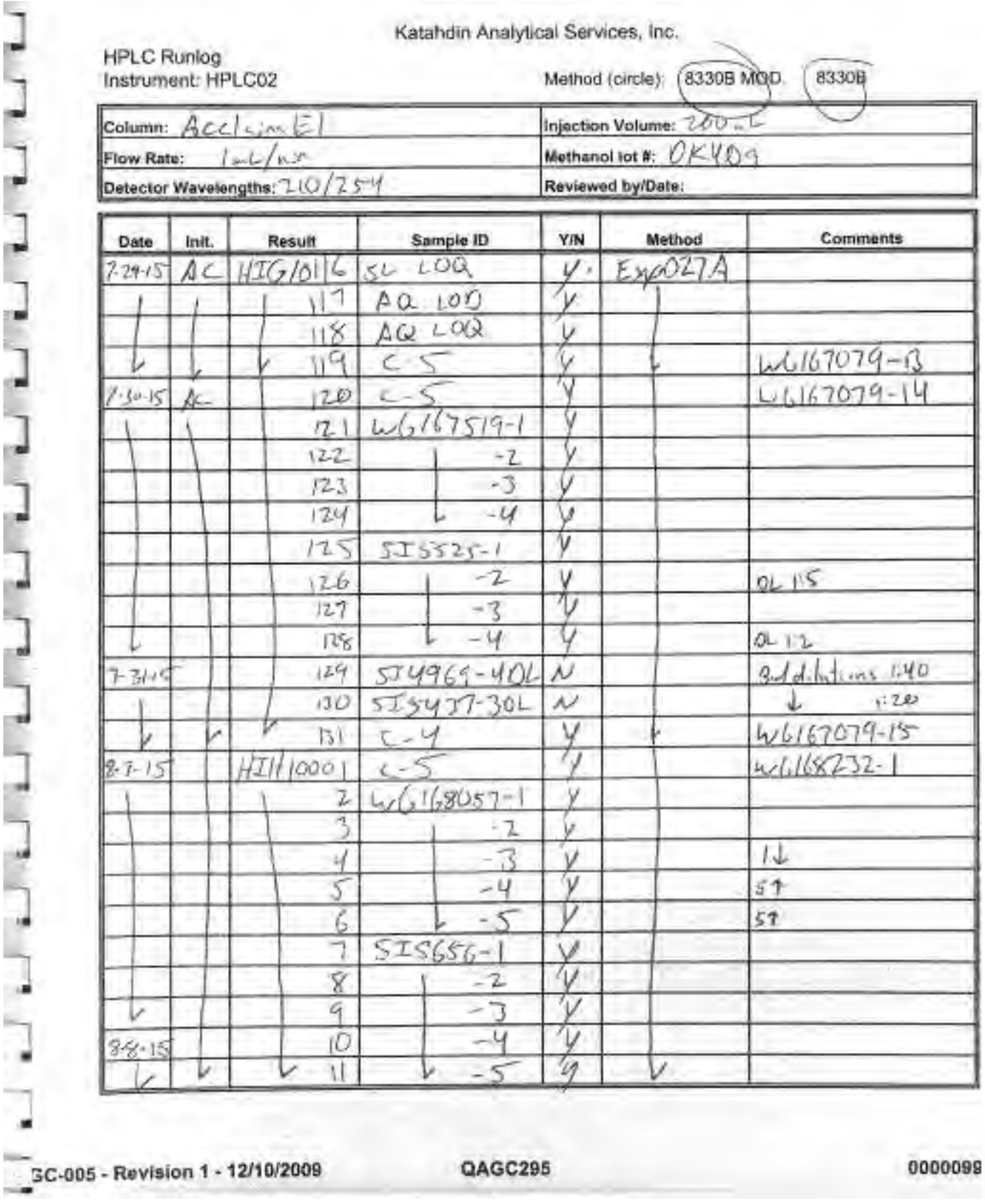
KATAHDIN REPORTING LIMITS FOR EXPLOSIVES BY METHOD 8330B mod

Katahdin Reporting Limits for Explosives

COMPOUND	WATERS (µg/L)	Soil (ug/kg)
HMX	0.25	100
RDX	0.25	100
1,3,5-TNB	0.25	100
1,3-DNB	0.25	100
Tetryl	0.25	100
NB	0.25	100
2,4,6-TNT	0.25	100
4-Am-DNT	0.25	100
2-Am-DNT	0.25	100
2,6-DNT	0.25	100
2,4-DNT	0.25	100
2-NT	0.25	100
3-NT	0.25	100
4-NT	0.25	100
3,5-dinitroaniline	0.25	100
NG	4.0	800
EGDN	4.0	800
PETN	4.0	800

FIGURE 1

EXPLOSIVES RUNLOG PAGE



Katahdin Analytical Services, Inc.

HPLC Runlog
Instrument: HPLC02

Method (circle): [✓ 8330B MOD] [✓ 8330B]

Column: Acclaim E1	**Injection Volume:** 200 uL
Flow Rate: 1mL/min	**Methanol lot #:** 0K409
Detector Wavelengths: 210/254	**Reviewed by/Date:**

Date	Init.	Result	Sample ID	Y/N	Method	Comments
7-29-15	AC	HIG10116	SL LOQ	Y.	Exp027A	
		117	AQ LOD	Y		
		118	AQ LOQ	Y		
		119	C-5	Y		WG167079-13
7-30-15	AC	120	C-5	Y		WG167079-14
		121	WG167519-1	Y		
		122	-2	Y		
		123	-3	Y		
		124	-4	Y		
		125	SI5525-1	Y		
		126	-2	Y		DL 1:5
		127	-3	Y		
		128	-4	Y		DL 1:2
7-31-15		129	SJ4969-4DL	N		3rd dilutions 1:40
		130	SI5437-3DL	N		↓ 1:20
		131	C-4	Y		WG167079-15
8-7-15		HI11 10001	C-5	Y		WG168232-1
		2	WG168057-1	Y		
		3	-2	Y		
		4	-3	Y		1↓
		5	-4	Y		5↑
		6	-5	Y		5↑
		7	SI5656-1	Y		
		8	-2	Y		
		9	-3	Y		
8-8-15		10	-4	Y		
		11	-5	Y		

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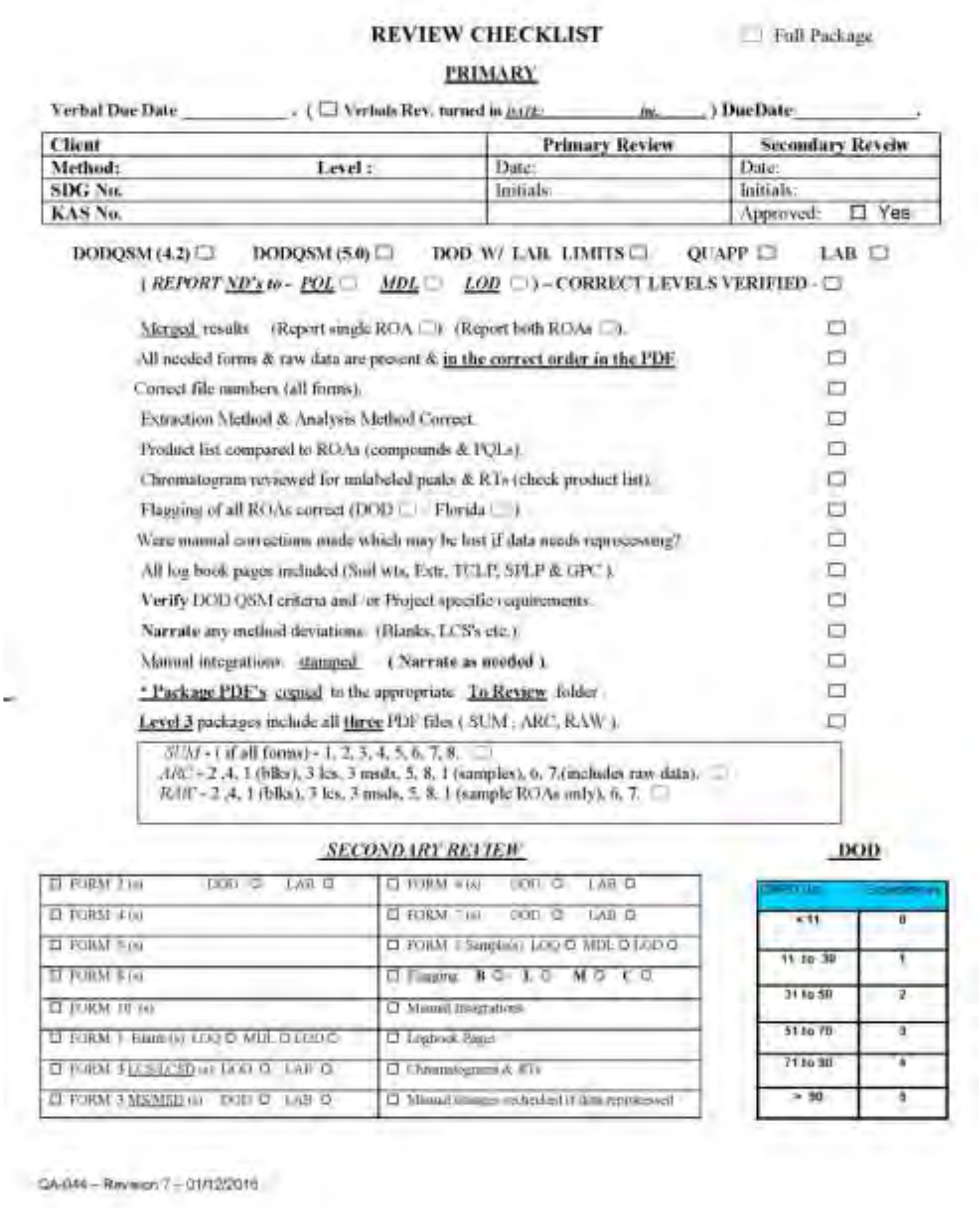
FIGURE 2

DATA REVIEW CHECKLIST



REVIEW CHECKLIST

☐ Full Package

PRIMARY

Verbal Due Date ____________ . (☐ **Verbals Rev. turned in** *date* ____________ *in.* _____) **DueDate** ______________ .

Client	**Primary Review**	**Secondary Reveiw**
Method: **Level :**	Date:	Date:
SDG No.	Initials:	Initials:
KAS No.		Approved: ☐ Yes

DODQSM (4.2) ☐ **DODQSM (5.0)** ☐ **DOD W/ LAB LIMITS** ☐ **QUAPP** ☐ **LAB** ☐

(***REPORT ND's to -* *POL*** ☐ ***MDL*** ☐ ***LOD*** ☐ **) – CORRECT LEVELS VERIFIED -** ☐

- Merged results (Report single ROA ☐) (Report both ROAs ☐). ☐
- All needed forms & raw data are present & **in the correct order in the PDF** ☐
- Correct file numbers (all forms). ☐
- Extraction Method & Analysis Method Correct. ☐
- Product list compared to ROAs (compounds & PQLs). ☐
- Chromatogram reviewed for unlabeled peaks & RTs (check product list). ☐
- Flagging of all ROAs correct (DOD ☐ / Florida ☐) ☐
- Were manual corrections made which may be lost if data needs reprocessing? ☐
- All log book pages included (Soil wts, Extr, TCLP, SPLP & GPC). ☐
- **Verify** DOD QSM criteria and /or Project specific requirements. ☐
- **Narrate** any method deviations. (Blanks, LCS's etc.) ☐
- Manual integrations stamped **(Narrate as needed).** ☐
- *** Package PDF's** copied to the appropriate **To Review** folder. ☐
- **Level 3** packages include all **three** PDF files (SUM ; ARC, RAW). ☐

SUM - (if all forms) - 1, 2, 3, 4, 5, 6, 7, 8. ☐
ARC - 2 ,4, 1 (blks), 3 lcs, 3 msds, 5, 8, 1 (samples), 6, 7.(includes raw data). ☐
RAW - 2 ,4, 1 (blks), 3 lcs, 3 msds, 5, 8, 1 (sample ROAs only), 6, 7. ☐

SECONDARY REVIEW

☐ FORM 2 (s) DOD ○ LAB ○	☐ FORM 6 (s) DOD ○ LAB ○
☐ FORM 4 (s)	☐ FORM 7 (s) DOD ○ LAB ○
☐ FORM 5 (s)	☐ FORM 1 Sample(s) LOQ ○ MDL ○ LOD ○
☐ FORM 8 (s)	☐ Flagging B ○ J ○ M ○ C ○
☐ FORM 10 (s)	☐ Manual Integrations
☐ FORM 1 Blank (s) LOQ ○ MDL ○ LOD ○	☐ Logbook Pages
☐ FORM 3 LCS/LCSD (s) DOD ○ LAB ○	☐ Chromatograms & RTs
☐ FORM 3 MS/MSD (s) DOD ○ LAB ○	☐ Manual [illegible] rechecked if data reprocessed

DOD

[illegible]	[illegible]
< 11	0
11 to 30	1
31 to 50	2
51 to 70	3
71 to 90	4
> 90	5

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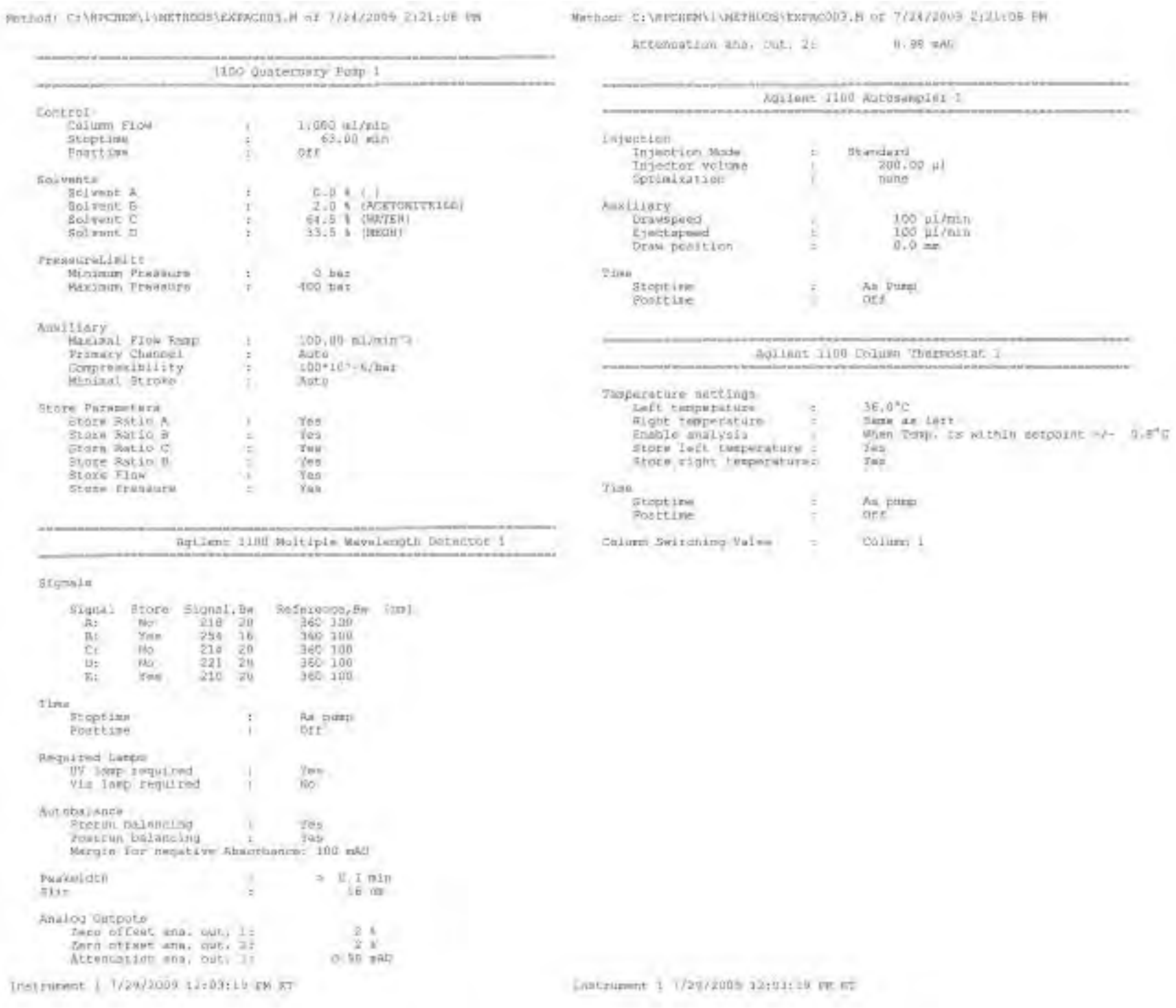
FIGURE 3

PRIMARY METHOD AND COLUMN INSTRUMENT CONDITIONS



```
Method: C:\HPCHEM\1\METHODS\EXPAC003.M of 7/24/2009 2:21:08 PM

    ==================================================================
                          1100 Quaternary Pump 1
    ==================================================================

    Control
        Column Flow              :      1.000 ml/min
        Stoptime                 :        63.00 min
        Posttime                 :      Off

    Solvents
        Solvent A                :        0.0 % ( )
        Solvent B                :        2.0 % (ACETONITRILE)
        Solvent C                :       64.5 % (WATER)
        Solvent D                :       33.5 % (MEOH)

    PressureLimits
        Minimum Pressure         :        0 bar
        Maximum Pressure         :      400 bar


    Auxiliary
        Maximal Flow Ramp        :      100.00 ml/min^2
        Primary Channel          :      Auto
        Compressibility          :      100*10^-6/bar
        Minimal Stroke           :      Auto

    Store Parameters
        Store Ratio A            :      Yes
        Store Ratio B            :      Yes
        Store Ratio C            :      Yes
        Store Ratio D            :      Yes
        Store Flow               :      Yes
        Store Pressure           :      Yes


    ==================================================================
                  Agilent 1100 Multiple Wavelength Detector 1
    ==================================================================

    Signals

        Signal  Store  Signal,Bw   Reference,Bw  [nm]
          A:     No      218  20      360 100
          B:     Yes     254  16      360 100
          C:     No      214  20      360 100
          D:     No      221  20      360 100
          E:     Yes     210  20      360 100

    Time
        Stoptime                 :      As pump
        Posttime                 :      Off

    Required Lamps
        UV lamp required         :      Yes
        Vis lamp required        :      No

    Autobalance
        Prerun balancing         :      Yes
        Postrun balancing        :      Yes
        Margin for negative Absorbance: 100 mAU

    Peakwidth                    :          > 0.1 min
    Slit                         :             16 nm

    Analog Outputs
        Zero offset ana. out. 1:               2 %
        Zero offset ana. out. 2:               2 %
        Attenuation ana. out. 1:            0.98 mAU

Instrument 1 7/29/2009 12:03:19 PM ET
```

```
Method: C:\HPCHEM\1\METHODS\EXPAC003.M of 7/24/2009 2:21:08 PM

        Attenuation ana. out. 2:            0.98 mAU


    ==================================================================
                        Agilent 1100 Autosampler 1
    ==================================================================

    Injection
        Injection Mode           :    Standard
        Injector volume          :        200.00 µl
        Optimization             :        none

    Auxiliary
        Drawspeed                :           100 µl/min
        Ejectspeed               :           100 µl/min
        Draw position            :           0.0 mm

    Time
        Stoptime                 :      As Pump
        Posttime                 :      Off


    ==================================================================
                     Agilent 1100 Column Thermostat 1
    ==================================================================

    Temperature settings
        Left temperature         :      36.0°C
        Right temperature        :      Same as left
        Enable analysis          :      When Temp. is within setpoint +/-  0.8°C
        Store left temperature   :      Yes
        Store right temperature  :      Yes

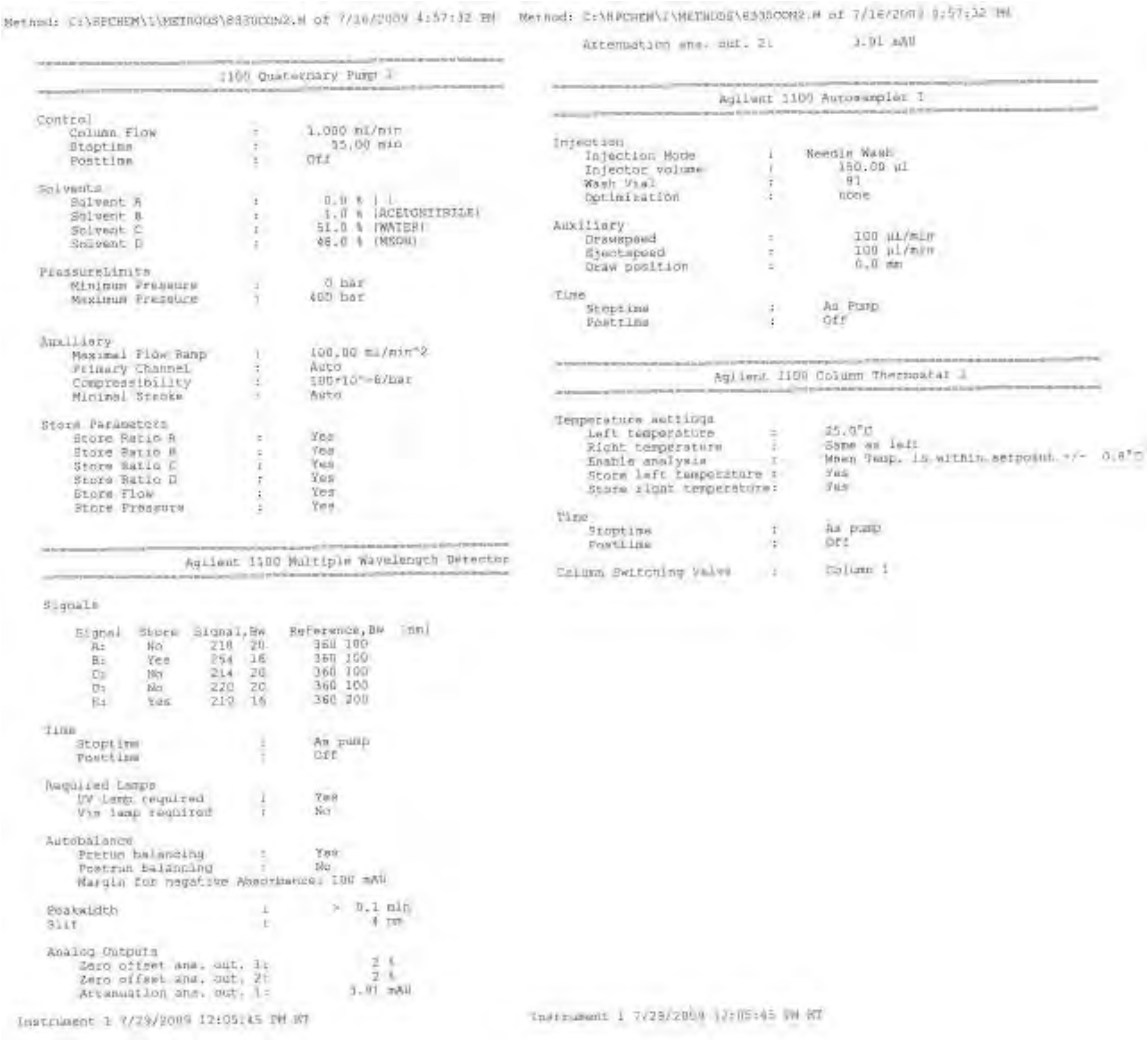
    Time
        Stoptime                 :      As pump
        Posttime                 :      Off

    Column Switching Valve       :      Column 1

Instrument 1 7/29/2009 12:03:19 PM ET
```

FIGURE 4

CONFIRMATION COLUMN INSTRUMENT CONDITIONS



```
Method: C:\HPCHEM\1\METHODS\8330CON2.M of 7/16/2009 4:57:32 PM

           ============================================================
                            1100 Quaternary Pump 1
           ============================================================

Control
    Column Flow              :      1.000 ml/min
    Stoptime                 :         55.00 min
    Posttime                 :      Off

Solvents
    Solvent A                :        0.0 % ( )
    Solvent B                :        1.0 % (ACETONITRILE)
    Solvent C                :       51.0 % (WATER)
    Solvent D                :       48.0 % (MEOH)

PressureLimits
    Minimum Pressure         :         0 bar
    Maximum Pressure         :       400 bar

Auxiliary
    Maximal Flow Ramp        :      100.00 ml/min^2
    Primary Channel          :      Auto
    Compressibility          :      100*10^-6/bar
    Minimal Stroke           :      Auto

Store Parameters
    Store Ratio A            :      Yes
    Store Ratio B            :      Yes
    Store Ratio C            :      Yes
    Store Ratio D            :      Yes
    Store Flow               :      Yes
    Store Pressure           :      Yes

           ============================================================
                      Agilent 1100 Multiple Wavelength Detector
           ============================================================

Signals

    Signal  Store  Signal,Bw   Reference,Bw  [nm]
      A:     No     210  20      360 100
      B:     Yes    254  16      360 100
      C:     No     214  20      360 100
      D:     No     220  20      360 100
      E:     Yes    210  16      360 100

Time
    Stoptime                 :      As pump
    Posttime                 :      Off

Required Lamps
    UV lamp required         :      Yes
    Vis lamp required        :      No

Autobalance
    Prerun balancing         :      Yes
    Postrun balancing        :      No
    Margin for negative Absorbance: 100 mAU

Peakwidth                    :         > 0.1 min
Slit                         :             4 nm

Analog Outputs
    Zero offset ana. out. 1:              2 %
    Zero offset ana. out. 2:              2 %
    Attenuation ana. out. 1:          1.91 mAU

Instrument 1 7/29/2009 12:05:45 PM RT
```

```
Method: C:\HPCHEM\1\METHODS\8330CON2.M of 7/16/2009 4:57:32 PM

    Attenuation ana. out. 2:           1.91 mAU

           ============================================================
                           Agilent 1100 Autosampler 1
           ============================================================

Injection
    Injection Mode           :    Needle Wash
    Injector volume          :        150.00 µl
    Wash Vial                :         91
    Optimization             :        none

Auxiliary
    Drawspeed                :          100 µl/min
    Ejectspeed               :          100 µl/min
    Draw position            :          0.0 mm

Time
    Stoptime                 :      As Pump
    Posttime                 :      Off

           ============================================================
                         Agilent 1100 Column Thermostat 1
           ============================================================

Temperature settings
    Left temperature         :      25.0°C
    Right temperature        :      Same as left
    Enable analysis          :      When Temp. is within setpoint +/-  0.8°C
    Store left temperature   :      Yes
    Store right temperature  :      Yes

Time
    Stoptime                 :      As pump
    Posttime                 :      Off

Column Switching Valve       :      Column 1

Instrument 1 7/29/2009 12:05:45 PM RT
```

APPENDENDUM 1

NITROGUANIDINE ANALYSIS

The following are differences from the standard 8330A and B analysis:

5.0 REAGENTS AND STANDARDS

5.1 Stock Standard Solution (for calibration standards): Accustandard Nitroguaridine, order # M-8330-ADD-6 or equivalent, at 1.0 mg/mL in Methanol.

5.15 Stock Standard Solution (for Independent Source and Laboratory Control Spike): Restek - Nitroguanidine - order # 31602 or equivalent, at 1.0 mg/mL in methanol.

7.0 PROCEDURES

HPLC Operating Conditions – The HPLC operating conditions for Nitroguanidine analysis are the same as the Nitroaromatics, Nitramines, and Nitrate Esters (Figure 3) with the following exceptions:

Stoptime	14 min.
Solvent B	Acetonitrile - 33.3%
Solvent C	Water - 66.4%
Solvent D	MeOH - 0
Injector volume	50 uL
Left Temperature	34 ºC
Slit	4

TABLE 5

KATAHDIN REPORTING LIMITS FOR EXPLOSIVES BY METHOD 8330B mod

COMPOUND	WATERS (µg/L)	Soil (ug/kg)
Nitroguanidine	0.25	100

CA-548
PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330

KATAHDIN ANALYTICAL SERVICES,
STANDARD OPERATING PROCEDURE

SOP Number: CA-548
Revision History
Cover Page
Page 1

TITLE: **PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330**

Prepared By: Date: 2-8-12

Approved By:

Department Manager: Date: 2-8-12

Operations Manager: Deborah J. Nadeau Date: 2.8.12

QA Officer: Leslie Dimond Date: 020812

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Significant changes to include drying sieving + grinding using a puck mill in accordance with DoD QSM & method 8330B (unmodified).	DN	12.6.13	12.6.13
02	LAD 081915 Sect. 5 - Add full 8330~~B~~B Soil standard. Sect. 7 - soil extraction edited for clarity. Table 2 - clarified modification. Changed KAS INC to KAS throughout	LAD	08/15	08/15
03	Added Nitroguanidine to Compound List.	LAD	03/16	03/16
04	Sect. 1 - Added additional safety advisories. Sect. 4 & 7 - Changed cartridges to Resprep SPE cartridges. Sect 7 - Added rinsing cartridge w/ 5ml D.I. Sect. 8 - Added MS/D information, added contingency plan information	LAD	10/17	10/17

TITLE: **PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy _____ of document **SOP CA-548-04**, titled **PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330.**

Recipient: ______________________________ Date: ______________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy _____ of document **SOP CA-548-04**, titled **PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330.**

Recipient: ______________________________ Date: ______________

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedures used by Katahdin Analytical Services technical personnel for the extraction of waters and soil for explosive residues using solid phase extraction in accordance with EPA Method 3535 and 8330 current revisions. The following compounds may be determined by this method:

COMPOUND	ABBREVIATION	CAS No.
Octahydro-1,3,5,7,-tetranitro-1,3,5,7-tetrazocine	HMX	2691-41-0
Hexahydro-1,3,5-trinitro-1,3,5- triazine	RDX	121-82-4
1,3,5-Trinitrobenzene	1,3,5-TNB	99-35-4
1,3-Dinitrobenzene	1,3-DNB	99-65-0
Methyl-2,4,6-trinitrophenylnitramine	Tetryl	479-45-8
Nitrobenzene	NB	98-95-3
2,4,6-Trinitrotoluene	2,4,6-TNT	118-96-7
4-Amino-2,6-dinitrotoluene	4-Am-DNT	1946-51-0
2-Amino-4,6-dinitrotoluene	2-Am-DNT	355-72-78-2
2,6-Dinitrotoluene	2,6-DNT	606-20-2
2,4-Dinitrotoluene	2,4-DNT	121-14-2
2-Nitrotoluene	2-NT	88-72-2
3-Nitrotoluene	3-NT	99-08-1
4-Nitrotoluene	4-NT	99-99-0
Nitroglycerin	NG	55-63-0
Pentaerythritol	PETN	78-11-5
3,5-Dinitroaniline	3,5-DNA	618-87-1
Ethylene Glycol Dinitrate	EGDN	628-96-6
Nitroguanidine	NGD	556-88-7

1.1 Definitions

ANALYTICAL BATCH: 20 or fewer samples which are analyzed together with the same method sequence and the same lots of reagents and with the manipulations common to each sample within the same time period or in continuous sequential time periods.

METHOD BLANK (laboratory reagent blank): An artificial sample designed to determine if method analytes or other interferences are present in the laboratory environment, the reagents, or the apparatus. For aqueous samples, analyte-free water (e.g., deionized water or equivalent) is used as a blank matrix; for soil/sediment samples, muffled sand is used for the blank matrix. The blank prepared and analyzed exactly like a sample.

LABORATORY CONTROL SAMPLE (LCS): A blank that has been spiked with the analyte(s) from an independent source or stock standard solution and is analyzed exactly like a sample. Its purpose is to determine whether the methodology is in control, and whether the laboratory is capable of making accurate and precise measurements. The matrix used should be phase matched with the samples and well characterized.

MATRIX SPIKE/MATRIX SPIKE DUPLICATE (MS/MSD): Duplicate samples that are spiked with known concentrations of analytes. The samples are the analyzed as routine samples. The results are used to evaluate matrix effects and the precision and accuracy of the method using actual samples.

SURROGATES: Organic compounds which are similar to analytes of interest in chemical composition, extraction and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, samples and spiked samples prior to analysis. Percent recoveries are calculated for each surrogate.

KATAHDIN INFORMATION MANAGEMENT SYSTEM (KIMS) : A complete multi-user system with the capabilities of integrating laboratory instrumentation, generating laboratory worksheets, providing complete Lab Order status and generating reports. KIMS utilizes these features through a database.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the extraction of explosives by solid phase extraction Method 3535. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in extraction of explosives by solid phase extraction Method 3535 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to indicate periodic review of the associated logbooks.

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials, and appropriate segregation of hazardous wastes. Everyone involved with the procedure must be familiar with the material safety data sheets for all the materials used in this procedure. Each qualified analyst or technician must be familiar with Katahdin Analytical safety procedures.

1.3 Health & Safety

ALL OF THE COMPOUNDS LISTED IN SECTION 1.0 OF THIS SOP ARE EITHER USED IN THE MANUFACTURE OF EXPLOSIVES OR ARE THE DEGRADATION PRODUCTS OF COMPOUNDS USED FOR THAT PURPOSE. WHEN MAKING STOCK SOLUTIONS FOR CALIBRATION, ESPECIALLY IF YOU ARE USING NEAT MATERIALS, TREAT EACH COMPOUND AS IF IT WERE EXTREMELY EXPLOSIVE.

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs (material safety data sheets) for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical safety procedures and the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

Standard precautionary measures used for handling other organic compounds should be sufficient for the safe handling of the analytes targeted by this method. Extra caution should be taken if handling the analytical standard neat material for the explosives themselves and in rare cases where soil or waste samples are highly contaminated with the explosives. Heed the warning for drying the neat materials at ambient temperatures.

Soil samples containing as much as 2% of 2,4,6-TNT have been safely ground. Samples containing higher concentrations should not be ground in a mortar and pestle or a mechanical grinder. Visual observation of a soil sample is important when the sample is taken from a site expected to contain explosives. Lumps of material that have a chemical appearance should be suspect and not ground. Chunks of TNT-based explosives that have been exposed to light are generally reddish-brown to orange in color.

The explosives laboratory relies on the project manger to gather as much information as possible concerning the expected concentration of explosives in the samples.

1.4 Pollution Prevention/Waste Disposal

Wastes generated during the preparation of samples must be disposed of in accordance with the procedures described in the current revision of the Katahdin Analytical Environmental Health and Safety Manual and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

All standards and samples must be classified as flammable waste and disposed of accordingly.

2.0 SUMMARY OF METHOD

This SOP describes sample preparation and extraction techniques that must be used. Aqueous samples are extracted by solid phase extraction Method 3535. Solid samples are extracted using the mechanical shaker method.

3.0 INTERFERENCES

3.1 Solvents, reagents, glassware, and other sample processing hardware may yield discrete artifacts and/or elevated baselines, resulting in mis-integration or mis-interpretation of the chromatograms. All of these materials must be demonstrated to be free from interferences, under the conditions of the analysis, by the analysis and evaluation of method blanks. Specific selection of reagents and purification of solvents by distillation in all-glass systems may be required.

3.2 The chromatographic conditions described allow for a unique resolution of the specific explosive compounds covered by this method. Other explosive compounds, in addition to matrix artifacts, may interfere.

3.3 Tetryl decomposes rapidly in methanol/water solutions, as well as with heat. All aqueous samples expected to contain tetryl should be diluted with acetonitrile prior to filtration and acidified to pH <3 with aqueous sodium bisulfate. All samples expected to contain tetryl should not be exposed to temperatures above room temperature.

4.0 APPARATUS AND MATERIALS

4.1 Mechanical shaker table for soil extractions.

4.2 Disposable 0.45 um Teflon-filters

4.3 Sieves - #10 mesh (2 mm) and #200 mesh (75 um) – 8” diameter with covers and collection trays.

4.4 Mortar and pestle or Dish & Puck Mill equipped with 800 cc dish set (grinding bowl, disc & lid)

4.5 Graduated cylinders - 500, 25, and 10 mLs.

4.6 Balance - ± 0.1 g for weighing large weights up to 10 kg

4.7 Balance - ± 0.01 g for weighing small weights

4.8 Aluminum drying trays with drying rack

4.9 Heavy duty aluminum foil

4.10 Stainless steel scoopulas

4.11 Dust mask

4.12 Vortex Mixer

4.13 8, 12, 16 and 40 mL amber glass vial and cap

4.14 Disposable pipettes.

4.15 Resprep SPE cartridges

4.16 Vacuum manifold, 24 position or equivalent

4.17 Vacuum Pump

4.18 Sep-Pak Vac Adapter

4.19 60 mL Sep-Pak Reservoir

4.20 Tubing, Tefzel, 1/8-inch O.D. X 0.040-inch I.D.

4.21 4 L glass vacuum trap

4.22 500 mL Teflon or glass bottles

4.23 12 mL centrifuge tubes

5.0 REAGENTS AND STANDARDS

All reagent and solvent lots must be checked for possible contamination. Refer to the current version of Katahdin SOP CA-105, Reagent and Solvent Handling, for further details. The extraction staff is responsible for submitting samples to the GC or GC/MS sections for appropriate analysis. All information concerning preparation of the reagent/solvent lot sample will be recorded in the Organic Extractions Log - Explosives (Figures 1 and 2). All reagents and solvents must be free (<PQL) of any target compounds.

5.1 Laboratory Reagent Grade water: Defined as water in which an interferant is not observed at the method detection limit of the compounds of interest.

5.2 Acetonitrile, HPLC grade, J.T. Baker order # 9017-03 or equivalent.

5.3 Methanol, HPLC grade, Fisher order # A452-4 or equivalent.

5.4 Organic-free sand, purified by baking at 400 °C. Method blanks serve as checks on the baked sand.

5.5 Stock Standard Solution (for Independent Source and Laboratory Control Spike): Ultra Scientific Combined Stock Solution - Full Explosive Mix - order # NAIM-833E or equivalent, at 1.0 mg/mL in acetonitrile.

5.6 Stock Standard Solution: 8330B Explosives 17 Compound list (for full 8330B SL prep) Restek order #33204 at 1000ug/ml

5.7 Stock Standard Solution (for independent source and laboratory control spike): Nitroglycerin, #31498 Restek, or equivalent 1000µg/mL in Methanol.

5.8 Stock Standard Solution: Pentaerythritol tetranitrate (PETN), (for independent source and laboratory control spike): Restek order #31600, at 1000 mg/L or equivalent.

5.9 Stock Standard Solution: 3,5-Dinitroaniline, (for independent source and laboratory control spike) Restek order #31661 at 1000 mg/L, or equivalent.

5.10 Stock Standard Solution (for independent source and laboratory control spike): EGDN, Restek order #31601 at 1000 mg/L.

5.11 Stock Standard Solution (for independent source and laboratory control spike): Nitroguanidine, Restek order #31602 at 1000 mg/L.

5.12 Surrogate 1,2-Dinitirobenzene, Accustandard order # M-8330-SS equivalent, at 1.0 mg/mL in MeOH.

NOTE: Stock standard solutions must be replaced after 1 year or sooner if comparison with check standards indicates a problem.

5.13 Intermediate standard solutions: Prepare the 8330 explosive standard, nitroglycerine, PETN, EGDN, 3,5-dinitroaniline and Nitroguanidine at 100mg/L and the surrogate, 1,2-Dinitrobenzene, separately at 10µg/mL in methanol or acetonitrile. Prepare the independent source at 100µg/mL in methanol or acetonitrile.

5.13.1 Larger volumes can be used at the convenience of the analyst. Commercially prepared stock standards can be used at any concentration if they are certified by the manufacturer or by an independent source.

5.13.2 Transfer the stock standard solutions into Teflon-sealed screw-cap bottles. Store at 4 °C and protect from light. Stock and intermediate standards should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.

5.13.3 Intermediate standard solutions should be refrigerated upon preparation, and may be used for 6 months.

5.14 Surrogate standards: The analyst should monitor the performance of the extraction and analytical system, and the effectiveness of the method in dealing with each sample matrix by spiking each sample, standard, and reagent water blank with a surrogate (e.g., 1,2-Dinitrobenzene or other explosive compounds not expected to be present in the sample) recommended to encompass the range of the temperature program used in this method. Deuterated analogs of analytes should not be used as surrogates for HPLC analysis due to coelution problems.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Water samples are collected in 1 L amber glass bottles and stored until time of extraction. Water samples must be extracted within 7 days of collection and analyzed within 40 days after extraction. Soil and sediment samples are collected in 4 oz. soil jars and stored at < 6 °C. Soil and sediment samples must be extracted within 14 days of collection and analyzed within 40 days after extraction. Extracts must be stored in the dark at < 6 °C until time of analysis.

For samples that are collected using the multi-incremental sampling procedure described in the appendix of method 8330B, at least 1 Kg of sample should be collected and stored at < 6 °C.

Once samples have been dried, they can be held in the dark at room temperature (22 ±4 °C) or colder prior to extraction.

7.0 PROCEDURES

7.1 The internal chain-of-custody must be signed when removing and replacing samples in storage locations. The sample preparation/extraction log must be filled out with the necessary information as extraction of each sample is completed.

7.2 The following information must be recorded in the extraction logbooks (Figures 3 & 4).

- Extraction method
- Surrogate and spike IDs
- Lot numbers of all solvents, acids and bases, sodium sulfate, filter paper
- Sample pH (if applicable)
- Extraction date
- Extraction analyst
- Sample ID or QC sample ID
- Initial and final volumes or weight
- The procedure used for subsampling and initial weight
- Surrogate and spike amounts
- Any sample cleanup preformed
- Final extract tray location
- Any comments regarding the sample extraction (ie. emulsion)
- Prep batch start time and end time
- Lot numbers of the vials the concentrated extracts are stored in.

7.3 Sample Preparation

Aqueous samples - Aqueous Solid-phase extraction method

7.3.1 Conditioning the cartridge:

7.3.1.1 Insert a Sep-Pak adapter into each Resprep SPE cartridge and connect to the manifold

7.3.1.2 Connect Sep-Pak reservoir to the adapter and fill with 15 mL of acetonitrile. Pulse the pump that is already connected to the manifold via a vacuum trap, to start the flow, let the acetonitrile drip through under gravity.

7.3.1.3 Add 30 mL of DI water just before the reservoir runs dry.

7.3.1.4 Turn on the pump and adjust the flow rate with the stopcock valves to draw the water through the cartridges at a rate of no more than 10 mL/min. Close valves when done. Dispose of the aqueous acetonitrile in the manifold.

NOTE: Once the cartridge has been conditioned do not expose it to air until the entire sample has been loaded. If the cartridge does run dry the conditioning procedure must be repeated.

7.3.2 Loading the Sample

7.3.2.1 Add 500 mL of sample to a 500 mL volumetric flask. Add 0.5 mL of 10 mg/L surrogate solution.

7.3.2.2 A method blank and a laboratory control sample (LCS) and/or laboratory control sample duplicate (LCSD) must be prepared for each daily extraction batch of twenty samples or fewer (if a work order consists of more than twenty samples, a new batch must be started on a separate page with its own method blank and LCS). To prepare the method blank and LCS/LCSD, add 500 mL reagent water to a 500 mL volumetric flask. Add 25 uL of the 8330 mix and if needed 3,5-dinitroaniline, 100ug/mL each to the LCS/LCSD. Add 100uL of nitroglycerin, EGDN and PETN, to the same LCS/LCSD sample. This blank, LCS and LCSD are carried through the entire extraction and analytical procedure.

7.3.2.3 If the batch requires an MS/MSD, transfer two 500 mL portions of the sample selected/designated for MS/MSD to two 500 mL volumetric flasks for preparation of a matrix spike/matrix spike duplicate and spike as in 7.3.6. An MS/MSD is required if requested by the client or per 20 samples or every 14days, whichever occurs first. If extra MS/MSD aliquots of sample are unavailable a laboratory control sample duplicate (LCSD) may be substituted. The MS/MSD is carried through the entire extraction procedure.

7.3.2.4 Put the Tefzel tubing into the aqueous sample and/or QC and connect the other end to the Resprep SPE cartridge using the Sep-Pak adapter. You may need tape down the tubing to the Teflon sample container to make sure the tube stays on the bottom.

7.3.2.5 Turn on the vacuum and adjust the flow rate to no more than 10 mL/min. Empty the vacuum trap as needed.

NOTE: Make sure the bed does not run dry during loading.

7.3.2.6 After the entire sample has been loaded, apply full vacuum for two minutes to remove any residual water. Turn off the vacuum and open the bleed valve.

7.3.3 Eluting the Sample

7.3.3.1 Remove the adapters from the cartridges.

7.3.3.2 Place clean collection vessels, 12 mL centrifuge tubes (labeled), into the manifold. Place the collection vessel under the needle that contains the Resprep SPE cartridge.

7.3.3.3 Using a 10mL graduated cylinder, add 5 mL of acetonitrile into the cartridge. Pulse the pump to start the flow, then let the acetonitrile drip through under gravity.

7.3.3.4 When it stops dripping turn on the vacuum for 1 to 2 minutes to draw the remaining acetonitrile through the cartridge.

7.3.3.5 After 1 to 2 minutes, shut off the vacuum and add 5 mL of reagent water to the cartridge. Allow the reagent water to pass through the cartridge under gravity flow, if practical, or apply a vacuum to complete the process. Shut off the flow once the water has been drawn through the cartridge

7.3.3.6 Open the manifold and remove the labeled tubes.

7.3.3.7 Transfer sample extracts to 16 ml vials.

7.3.3.8 Dilute the 5 mL of extract with 5 mL of DI water for a final concentration of 33.3% acetonitrile/66.6% water. Cap and mix thoroughly. The sample is now ready for HPLC analysis.

Soil and Sediment Samples

7.3.4 Preparation – Drying & Grinding – record dates, times, ambient temperature and weights during entire drying process.

If Method 8330A (modified) or 8330B (modified) is requested:

7.3.4.1 If the client does not request drying and grinding, move on to section 7.3.5.

7.3.4.2 Spread an aliquot (at least 100 gms, if available) of the soil onto a sheet pan lined with heavy duty aluminum foil and dry in air at room temperature or colder to a constant weight (last two successive dry weights within 5% RPD). Trays should be placed in rack for drying. Be careful not to expose the samples to direct sunlight. Record all weights, to 2 decimal places, in the Sample Drying Logbook, Figure 1.

7.3.4.3 Place the sample into an acetonitrile rinsed mortar, grind with a pestle. Remove any large pieces such as rocks or sticks that will not pass through a 10-mesh sieve. Sample must pass through a 10-mesh sieve. Record in Sieving & Grinding Logbook, Figure 2.

7.3.5 QC & Spiking

7.3.5.1 For all samples (8330A mod., 8330B mod. and 8330B), a method blank, LCS and MS/MSD (if required) must be prepared with each daily extraction batch of twenty samples or fewer (if a work order consists of more than twenty samples, a new batch must be started on a separate page with its own method blank and LCS).

7.3.5.2 Weigh 10 g of baked sand for each the LCS and the blank in a 40 ml vial. Record the exact weight, to two decimal places in the Soil Extraction Logbook (Figure 3).

7.3.5.3 For each sample and MS/MSD, stir ground or unground sample with a stainless steel scooplua and obtain approximately 10 gram aliquot in a 40 ml vial. Record the exact weight to two decimal places, without removing any additional amount in the Soil Extraction Logbook (Figure 3).

7.3.5.4 Add 0.5ml of surrogate solution at 10 ug/mL to the blank, LCS, MS/MSD and samples. Add 100 uL of the 14 components and 100 uL of nitroglycerin, PETN, and EGDN each at 100 ug/mL to the LCS and MS/MSD. Continue to 7.3.5.11

If Method 8330B is requested:

7.3.5.5 Spread the <u>entire</u> aliquot of soil onto a sheet pan lined with heavy duty aluminum foil and dry in air at room temperature or colder to a constant weight (last two successive dry weights within 3% RPD). Trays should be placed in rack for drying. Be careful not to expose the samples to direct sunlight. Record all weights in the Sample Drying Logbook, Figure 1.

Note: Hydric soils and sediments with high moisture content may take several days to dry to constant weight. This may increase the potential for analyte degradation and may affect extraction efficiency. If samples take several days to dry, this statement should be added to the case narrative.

7.3.5.6 Sample grinding:

- Remove the oversize fraction by passing it through a 10-mesh (2 mm) sieve. Be sure to break up caked up soil with a gloved hand.

- Weigh both fractions – oversize and <2mm. Record all weights in the Sieving & Grinding Logbook, Figure 2.

- Pulverize the entire < 2 mm fraction in a ring puck mill or equivalent mechanical grinder. In a ring puck mill samples containing crystalline energetic residues (i.e., TNT, RDX, HMX and their breakdown products) can be adequately pulverized in 90 sec. In this same device sample containing polymeric residues (i.e. propellants and rocket fuel) can be adequately pulverized by 5 separate 60 second grinding cycles. If the sample was ground in more than one portion (grinding bowls have a limited capacity) following this step the entire sample should be combined and thoroughly mixed.

  Note: A 2-minute or longer cool down period is recommended between grindings to prevent the loss of more volatile energetic compounds.

- Thoroughly clean grinding equipment between samples.

- For each sample ground, grind approximately 200 gms of baked sand afterwards. Unless otherwise directed by the client each sample must have its own grinding blank. Per direction from the client, these grinding blanks may be treated as individual samples or composited into one grinding blank.

The grinding blanks ensure that cross-contamination is not occurring.

- Record all grinding information in the Sieving & Grinding Logbook, Figure 2.

7.3.6 Subsampling

7.3.6.1 To obtain a subsample, the entire sample must be mixed with a stainless steel scoopula and spread out on a clean surface (aluminum tray lined with foil) so that it is only 1 or 2 cm thick - preferably in a fume hood designed to prevent the spread of dust and possible inhalation or residue losses. Using the scoopula, obtain at least 30 different increments, i.e., portions (~0.3 g) from randomly chosen locations throughout the entire sample profile for a total of ~10 g. Record the final weight to two decimal place in the Soil Extraction Logbook (Figure 3).

7.3.7 QC AND SPIKING

7.3.7.1 Before any samples are ground, grind 200g in the ring and puck grinder to be used as the method blank. Using the subsampling procedure described in section 7.3.5.2, remove 10 gms for the LCS and record the weight.

7.3.7.2 Add 200 uL of the 17 components at 1000 ug/mL (stock) to 200 gms of baked sand. Let this dry at room temperature. Grind all 200 gms in the ring and puck grinder. Using the subsampling procedure described in section 7.3.5.2, remove 10 gms for the LCS and record the weight.

7.3.7.3 Subsample 30 aliquots of about 0.3 gms each for a total of approximately 10 gms from each ground sample and each grinding blank as described in section 7.3.5.2. Record all weights.

7.3.7.4 Note: If the individual grinding blanks are to be composited and analyzed as one sample per client request, the 200 gram aliquots shall mixed together in a large stainless steel bowl. The mixture should be spread on an aluminum tray lined with foil and then subsampled as described in section 7.3.5.2.

7.3.7.5 For one client sample (not a blank) – perform this subsampling procedure in triplicate (i.e. three 10 gm aliquots) and treat as three separate samples. Record all weights.

7.3.7.6 Add 0.5ml of surrogate solution at 10 ug/mL to the blank, LCS, MS/MSD and samples. Add 100 uL of the 14 components and 100 uL of nitroglycerin, PETN, 3,5-DNA, and EGDN each at 100 ug/mL to separate 10 gm aliquots of a subsampled sample for the MS/MSD.

For methods 8330A mod., 8330B mod., and 8330B:

7.3.7.7 Store all unused ground aliquots in clean labeled soil jars or zip-lock bags at 4°C in the dark.

7.3.7.8 Add 20 mL of acetonitrile to all sample and QC vials, cap and vortex swirl or shake by hand for one minute. Insert each vial into a cardboard box and place on a mechanical shaker for 18 hours.

7.3.7.9 After shaking, allow each sample to settle for at least 30 minutes. Remove 6.0 mL of supernatant, and filter through a 0.45µm Teflon filter into a conical test tube and record volume. Discard the first mL.

7.3.7.10 Dilute the 5 mL of filtered extract with 10 mL of DI water for a final concentration of 33.3% acetonitrile/66.6% water. Shake and retain in a 16 ml Teflon-capped vial for HPLC analysis.

Note: Calibration standards will be prepared in the same manner. Refer to SOP CA-402, current revision.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Each extractions analyst must demonstrate proficiency in performing the extractions that prepare samples for analysis. Demonstration consists of preparation (extraction), by the analyst, of at least four aliquots which are then analyzed according to the analytical method in question. These QC samples must meet all quality control acceptance limits. Demonstration must be documented by use of a form which summarizes the results of the analysis of these aliquots, calculated percent recoveries, and standard deviation. Demonstration of proficiency must be done one time per analyst initially and then annually thereafter. Refer to SOPs QA-805 and QA-807, current revision.

If, upon analysis of the extracted samples, it is discovered that quality control acceptance criteria have not been met, all associated samples must be evaluated against all of the QC. In some cases data may be reported, perhaps with narration, while in other cases, other corrective action may be taken. The corrective actions may include re-extraction of the samples associated with the quality control sample that did not meet acceptance criteria, or may include making new reagents and standards if the standardization is suspect. These decisions are based on holding time considerations, client and project specific Data Quality Objectives and on review of chromatograms. The supervisor, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

8.1 A method blank must be extracted for each and every item listed below:

- Each sample matrix (soil, water)
- Each day of extraction (24 hours midnight - midnight)
- Each extraction method or level
- Every 20 samples extracted in a 24-hour period

8.2 A laboratory control sample (LCS) is required for each and every item listed below:

- Each sample matrix
- Each extraction method or level
- Every extraction batch of twenty or fewer samples

8.3 A matrix spike (MS), and matrix spike duplicate (MSD) should be prepared every 20 samples.

Sample specific matrix spikes and matrix spike duplicates are extracted per client request or per project requirements. When the client does not specify sample QC, the extractions lab will choose one (per 20) samples for quality control to extract and analyze.

Due to limited sample volume, it is not always possible to prepare a MS/MSD set.

8.4 Additionally, for method 8330B:

- Each sample must have a grinding blank.

8.5 Contingency for handling out-of-control or unacceptable data – Contact Department Manager, Project Manager or Quality Assurance Officer to determine the contingency plan for out-of-control or unacceptable data. A Non-conformance Report or Corrective Action Report may need to be initiated.

Refer to the current revision of the applicable Katahdin SOP for analysis of Explosives for quality control acceptance criteria.

9.0 METHOD PERFORMANCE

Refer to the applicable analytical SOP.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846, Third Edition, Final Updates I (1993), II (1995), IIA (1994), IIB (1995), III (1997), IIIA (1999), IIIB (2005), IV (2008), and V (2015), Method 8330B.

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846, Third Edition, Final Updates I (1993), II (1995), IIA (1994), IIB (1995), III (1997), IIIA (1999), IIIB (2005), IV (2008), and V (2015), Method 3535A.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.1, January, 2017.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.0, March, 2013.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Waters Solid Phase Extraction Technology for the Analysis of Explosives, Section 5.; “Determination of Low-Level Explosive Residue in Water by HPLC: Solid-Phase Extraction vs. Salting - Out Solvent Extraction”, Michael G. Winslow; Bradley A. Weichert; and Robert D. Baker. Proceedings of the EPA 7th Annual Waste and Quality Assurance Symposium, Washington, D.C. 1991.

TITLE: **PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330**

LIST OF TABLES AND FIGURES

TABLE 1

SUMMARY OF METHOD MODIFICATIONS – 8330A

Topic	**Katahdin SOP CA-548-04**	**Method 3535A/8330A**
Apparatus/Materials	None	
Reagents	None	
Sample preservation/ handling	None	
Procedures	Dry an aliquot of sample and take a 10 g subsample by weighing 10 gms. Add 10 mL of water to sample extracts and to calibration standards for a final concentration of 33.3% acetonitrile/66.6% water.	Dry an aliquot of sample and take a 2 g subsample by weighing 2 gms. Add 5 mL of calcium chloride to sample extracts and calibration standards.
QC - Spikes	MS/MSD are spiked with PETN, 3,5-DNA, NG and EGDN. For stock and intermediate standards, 2,4-DNT and 2,6-DNT are contained within the same commercially available standard mix as they are completely resolvable on the analytical column.	Compounds not included in 8330A. For stock and intermediate standards, 2,4-DNT and 2,6-DNT are contained in separate commercially available standard mixes as they are not resolvable on the analytical column.
QC - LCS	LCS is spiked with PETN, 3,5-DNA, NG and EGDN.	Compounds not included in 8330A.

TABLE 2

SUMMARY OF METHOD MODIFICATIONS – 8330B

Topic	**Katahdin SOP CA-548-04**	**Method 3535A/8330B**
Apparatus/Materials	None	
Reagents	None	
Sample preservation/ handling	None	
Procedures	If using 8330B modified- Dry an aliquot of sample and take a 10 g subsample by weighing 10 gms. Add 10 mL of water to sample extracts and calibration standards for a final concentration of 33.3% acetonitrile/66.6% water.	Dry the entire aliquot of sample and take a 10 g subsample by weighing 30 separate random 0.3 g aliquots. Sample extracts and calibration standards are not diluted with water.
QC - Spikes		
QC - LCS		

TABLE 3

DoD QSM QC REQUIREMENTS / METHOD 8330B

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Method blank	One per prep batch of twenty or fewer samples	No analyte detected > ½ the PQL	(1) Investigate source of contamination (2) Evaluate the samples and associated QC: ie. the blank results are above the PQL, report sample results which are <PQL or > 10X the blank concentration. Otherwise, reprep a blank and the remaining samples.
Soil grinding blank	Between each sample.	Ground and subsampled in the same manner as samples between each sample. May be analyzed individually or as a composite depending on instruction from the client. No analyte detected > ½ the PQL	(1) If the composite grinding blank exceeds the criteria, apply a B flag to all samples associated with the composite blank. (2) If any individual grinding blank exceeds the acceptance criteria, apply a B flag to the sample following that blank.
LCS	One per prep batch of twenty or fewer samples – ground and subsampled in the same manner as samples.	DoD QSM limits unless otherwise instructed by the client. In-house laboratory control limits for the LCS must demonstrate the laboratory's ability to meet the project's MQOs.	Refer to Table G-1 of the DoD QSM for number of marginal exceedences allowed. If criteria not met - correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available Contact Client if samples cannot be reprepped within hold time. Apply an L flag (equivalent to Q) if reanalysis cannot occur.
Matrix Spike\ Matrix Spike Duplicate	One for every set of 20 samples	For matrix evaluation only, therefore is taken post grinding from same ground sample as parent subsample is taken. Percent recovery must meet LCS limits.	Examine the project-specific DQOs. Contact the client as to additional measures to be taken. For the specific analyte(s) in the parent sample, apply M-flag if acceptance criteria are not met. (equivalent to J flag).
Soil Sample Triplicate	One per sample batch – performed at subsampling step. Cannot beperformed on a blank.	20% RSD for results above the LOQ.	Corrective action must be taken if this criterion is not met (e.g., the grinding process should be investigated to ensure that the samples are being reduced to a sufficiently small particle size).
Soil grinding procedure	Initially	Must initially demonstrate that the grinding procedure is capable of reducing the particle size to <75 um by passing representative portions of ground sample through a 200 mesh sieve.	
Demonstration of analyst proficiency; accuracy and precision	Once per analyst initially and annually thereafter	Must pass all applicable QC for method	Repeat analysis until able to perform passing QC; document successful performance in personal training file

TABLE 4

QC REQUIREMENTS – Methods 8330A (modified) & 8330B (modified)

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Method blank	One per prep batch of twenty or fewer samples	No analyte detected > the PQL	(1) Investigate source of contamination (2) Evaluate the samples and associated QC: ie. the blank results are above the PQL, report sample results which are <PQL or > 10X the blank concentration. Otherwise, reprep a blank and the remaining samples.
LCS	One per prep batch of twenty or fewer samples	Nominal limits until statistically derived limits are developed.	(1) Evaluate the samples and associated QC: i.e. If an MS/MSD was performed and acceptable, narrate. If an LCS/LCSD was performed and only one of the set was unacceptable, narrate. If the surrogate recoveries in the LCS are also low but are acceptable in the blank and samples, narrate. If the LCS recovery is high but the sample results are < PQL, narrate. Otherwise, reprep a blank and the remaining samples.
Matrix Spike\ Matrix Spike Duplicate	One for every set of 20 samples	Statistically derived limits 20% RSD	(1) Evaluate the samples and associated QC: ie. If the LCS results are acceptable, narrate. (2) If both the LCS and MS/MSD are unacceptable, reprep the samples and QC.
Demonstration of analyst proficiency; accuracy and precision	Once per analyst initially and annually thereafter	Must pass all applicable QC for method	Repeat analysis until able to perform passing QC; document successful performance in personal training file

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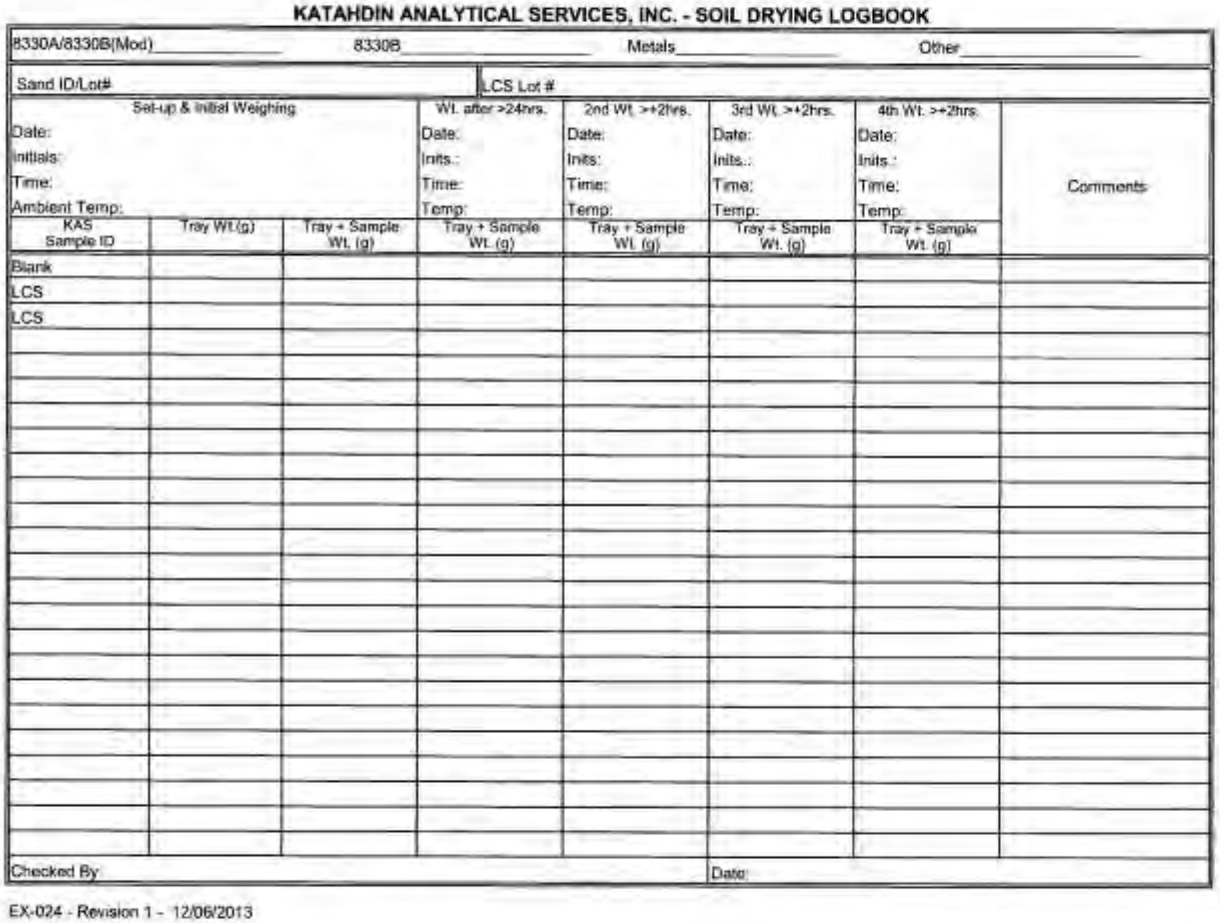
TITLE: **PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330**

FIGURE 1

EXAMPLE OF SAMPLE DRYING LOGBOOK PAGE



KATAHDIN ANALYTICAL SERVICES, INC. - SOIL DRYING LOGBOOK

8330A/8330B(Mod)__________ 8330B______________ Metals____________ Other______________

Sand ID/Lot#
LCS Lot #

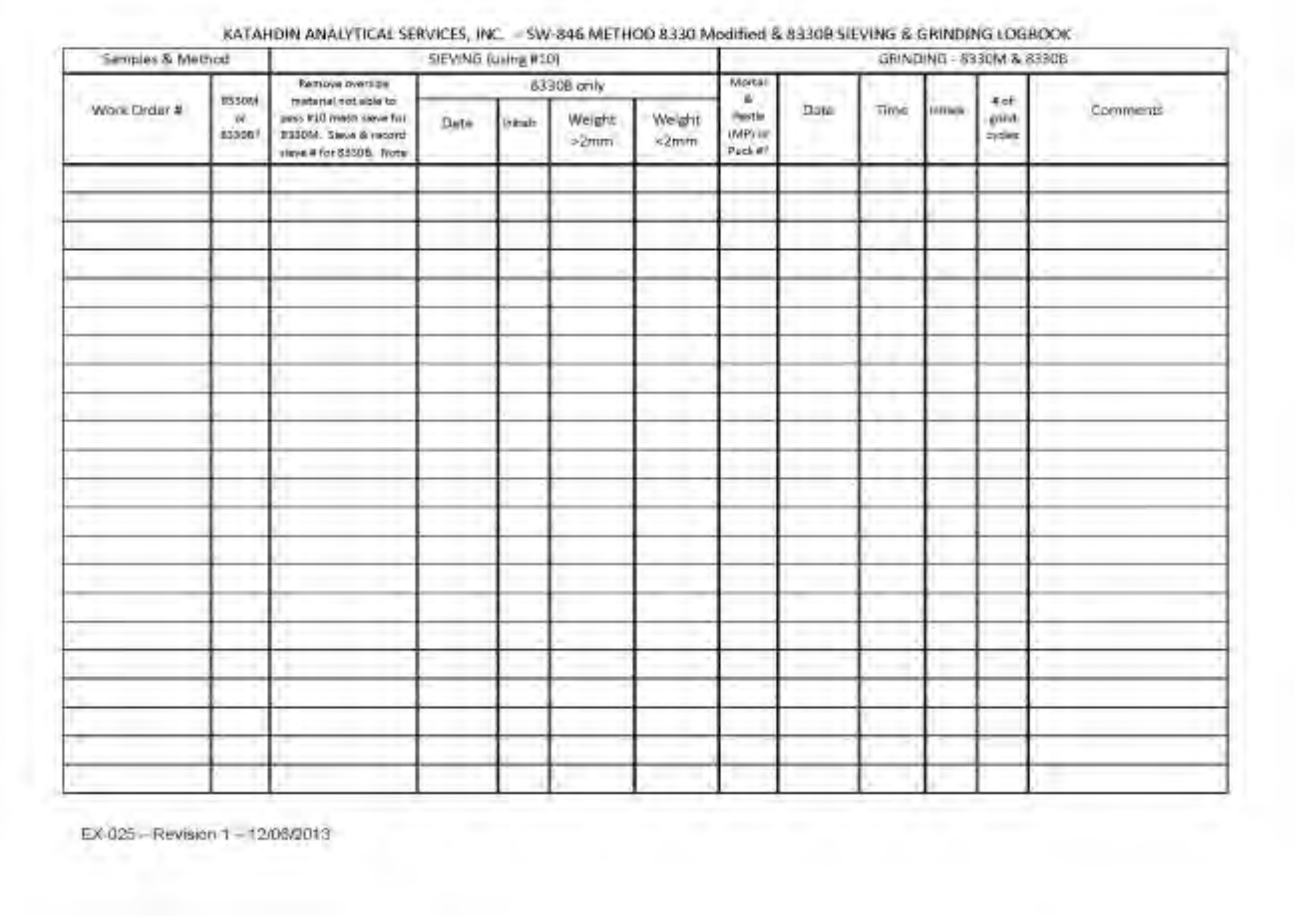
Set-up & Initial Weighing Date: Initials: Time: Ambient Temp:			Wt. after >24hrs. Date: Inits.: Time: Temp:	2nd Wt. >+2hrs. Date: Inits: Time: Temp:	3rd Wt. >+2hrs. Date: Inits.: Time: Temp:	4th Wt. >+2hrs. Date: Inits.: Time: Temp:	Comments
KAS Sample ID	Tray Wt.(g)	Tray + Sample Wt. (g)	Tray + Sample Wt. (g)	Tray + Sample Wt. (g)	Tray + Sample Wt. (g)	Tray + Sample Wt. (g)	
Blank							
LCS							
LCS							
Checked By					Date:		

EX-024 - Revision 1 - 12/06/2013

TITLE: **PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330**

FIGURE 2

EXAMPLE OF SIEVING & GRINDING LOGBOOK PAGE



KATAHDIN ANALYTICAL SERVICES, INC. – SW-846 METHOD 8330 Modified & 8330B SIEVING & GRINDING LOGBOOK

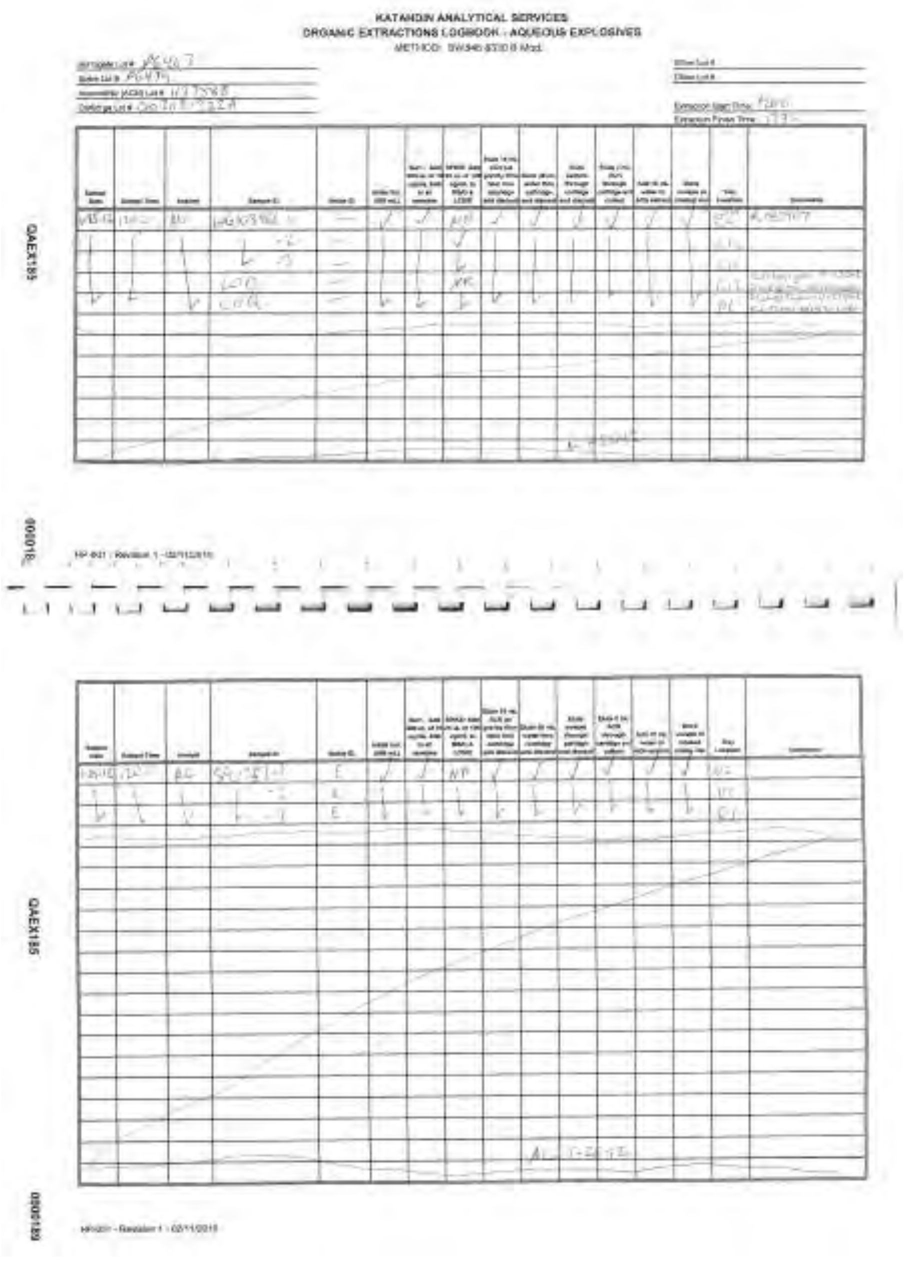
Samples & Method		SIEVING (using #10)					GRINDING - 8330M & 8330B					
Work Order #	8330M or 8330B?	Remove oversize material not able to pass #10 mesh sieve for 8330M. Sieve & record sieve # for 8330B. Note	8330B only				Mortar & Pestle (MP) or Puck #?	Date	Time	Initials	# of grind cycles	Comments
			Date	Initials	Weight >2mm	Weight <2mm						

EX-025 – Revision 1 – 12/06/2013

TITLE: **PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330**

FIGURE 3

EXAMPLE OF AQUEOUS EXTRACTIONS LOGBOOK PAGE

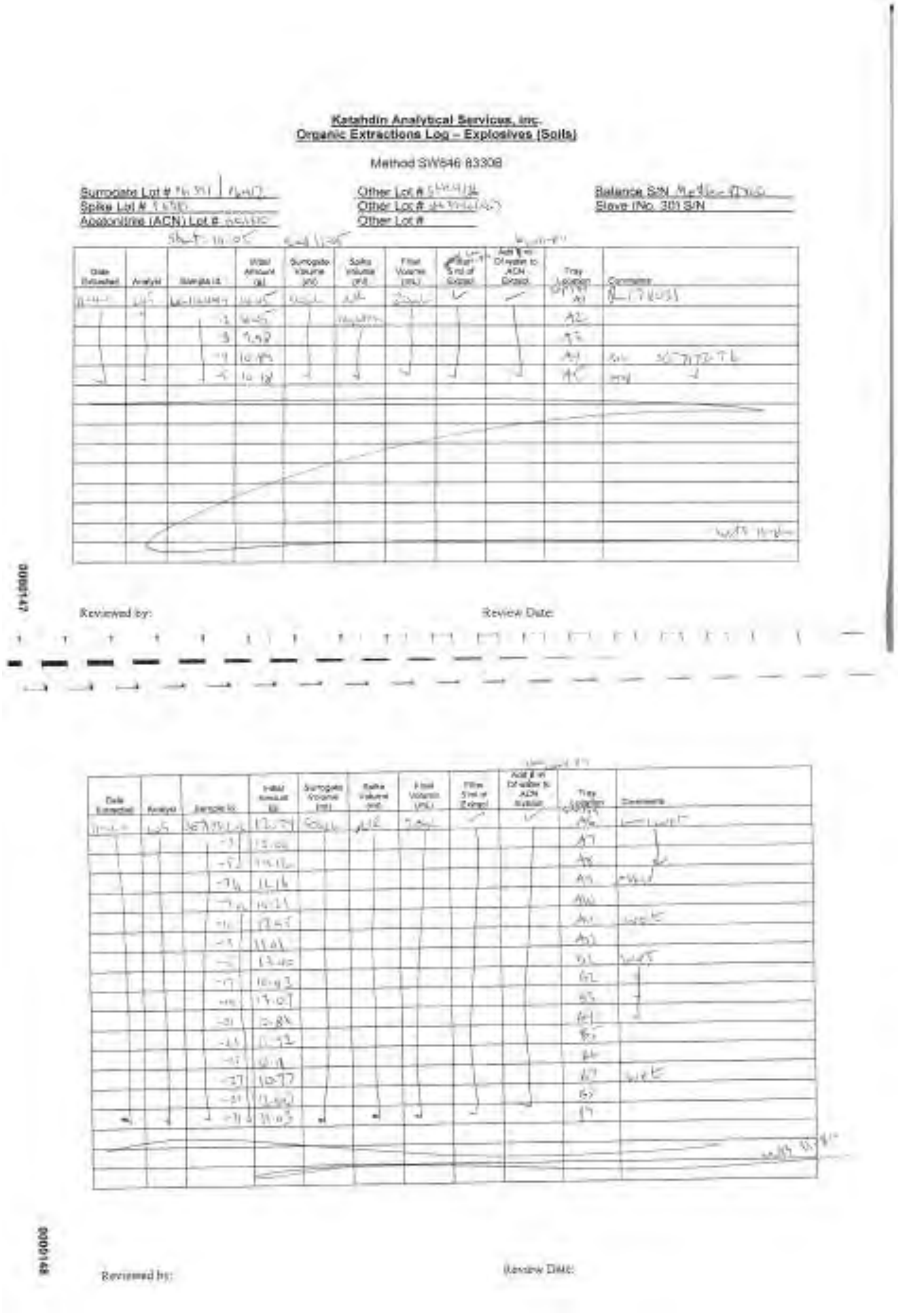


KATAHDIN ANALYTICAL SERVICES
ORGANIC EXTRACTIONS LOGBOOK - AQUEOUS EXPLOSIVES
METHOD: SW846 8330 B Mod.

TITLE: **PREPARATION OF AQUEOUS AND SOLID SAMPLES FOR EXPLOSIVE ANALYSIS BY METHOD 8330**

FIGURE 4

EXAMPLE OF SOIL EXTRACTIONS LOGBOOK PAGE



Katahdin Analytical Services, Inc.
Organic Extractions Log – Explosives (Soils)

Method SW846 8330B

Surrogate Lot #
Spike Lot #
Acetonitrile (ACN) Lot #
Other Lot #
Other Lot #
Other Lot #
Balance S/N
Sieve (No. 30) S/N

Date Extracted	Analyst	Sample ID	Initial Amount (g)	Surrogate Volume (mL)	Spike Volume (mL)	Final Volume (mL)	Filter 5 mL of Extract	Add 5 mL Of water to ACN Extract	Tray Location	Comments

0000147

Reviewed by:
Review Date:

Date Extracted	Analyst	Sample ID	Initial Amount (g)	Surrogate Volume (mL)	Spike Volume (mL)	Final Volume (mL)	Filter 5 mL of Extract	Add 5 mL Of water to ACN Extract	Tray Location	Comments

0000148

Reviewed by:
Review Date:

CA-551-01
GRAIN SIZE ANALYSIS

TITLE: GRAIN SIZE ANALYSIS

Prepared By: Date: 10-1-15

Approved By:

Department Manager: Date: 10-1-15

Operations Manager: Deborah J. Nadeau Date: 10.1.15

QA Officer: Leslie Dimond Date: 10.01.15

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Updated title of sections 1.4 + 5.0. Updated method references for NELAC + DoD Added information about hydrometer readings for sandy samples.	LAD	09/17	09/17

TITLE: **Grain Size Analysis**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-551-01,** titled **GRAIN SIZE ANALYSIS.**

Recipient: ____ Date: ____________________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-551-01,** titled **GRAIN SIZE ANALYSIS.**

Recipient: ____ Date: ____________________

1.0 SCOPE AND APPLICATION

This SOP details the procedure used by Katahdin Analytical Services technical personnel for particle size analysis in soils. This method is applicable to ASTM D422.

1.1 Definitions

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in Grain Size Analysis. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in Grain Size Analysis to read and understand this SOP, adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, that their work is properly documented and to indicate periodic review of the associated logbooks

1.3 Safety

1.3.1 Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs (material safety data sheets) for all the materials used in this procedure.

1.3.2 Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Management Program for further details on pollution prevention techniques.

Wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Hazardous Waste Plan and Safety Manual and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

2.0 SUMMARY OF METHOD

Depending on total solids of a sample, a certain amount is soaked in a dispersing agent overnight. The sample is than split into two portions, the material retained on the #10 sieve and the material passing the #10 sieve. The material retained on the #10 sieve is dried overnight to a constant weight. The sample is than passed through a large size sieve stack. Material passing the #10 sieve may be subjected to hydrometer analysis. After wet washing the sample on a #200 sieve the sample retained is dried overnight, than passed through a small size sieve stack. The material retained on each sieve, large and small sieves, are measured and recorded. All measurements, large and small sieves and hydrometer readings are used to determine the particle size distribution of the sample.

3.0 INTERFERENCES

Not Applicable

4.0 APPARATUS AND MATERIAL

4.1 Sieves ASTM E-11 Specifications, Brand Advantech, of the following size(s):

4.1.1 3.0” (75.00 mm)

4.1.2 2.0” (50.00 mm)

4.1.3 1.5” (37.50 mm)

- 4.1.4 1.0” (25.00 mm)
- 4.1.5 3/4" (19.00 mm)
- 4.1.6 3/8” (9.50 mm)
- 4.1.7 # 4 (4.75 mm)
- 4.1.8 #10 (2.00 mm)
- 4.1.9 #20 (850.0 um)
- 4.1.10 #40 (425 um)
- 4.1.11 #60 (250.0 um)
- 4.1.12 #80 (180 um)
- 4.1.13 #100 (150.0 um)
- 4.1.14 #200 (75.0 um)

4.2 Sedimentation Classico Cylinder(s) 1000 mL

4.3 Hydrometer: ASTM 151H Humboldt H-4242

4.4 Drying Oven with temperature range of 60-110°C

4.5 Stainless Steel Spatulas & Spoons

4.6 Metal & Bristle Brushes

4.7 Ro-Tap Sieve Shaker- Gilson Company

4.8 Timers- capable of counting up to 24hours

4.9 Balance, capable of weight measurement to 0.01 g

4.10 Mechanical Stirring Device and Dispersion Cup- Hamiliton Beach Humboldt

4.11 Thermometer: Accurate to 0.5°C

4.12 Mortar and Rubber Tipped Pestle

4.13 Glass beakers- 1000ml and 500ml

5.0 REAGENTS AND STANDARDS

5.1 Laboratory Grade Reagent Water

5.2 Sodium Hexametaphosphate:

5.3 **Sodium Hexametaphosphate Solution**: Add 120 g of sodium hexametaphosphate and 2940 g of reagent water to a 1-gallon plastic jug with cover. Mix the solution until it is homogeneous. Assign an expiration date of 30 days from the date made unless the parent reagent expires sooner in which case use the earliest expiration date. Store the prepared solution at ambient temperature.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Sediment/soil samples must be collected in a soil jar and must be maintained at 4°C (±2°C).

Store all extracts at 4°C (±2°C) in the dark in labeled Teflon-sealed containers. See SOP SD-902, "Sample Receipt and Internal Control," current revision, for storage areas and temperature maintenance procedures.

7.0 PROCEDURES

7.1 The following information must be recorded in the Grainsize logbook (all that are applicable).

- Start/End Date and Time
- Date/Time placement of samples in and out of oven
- Hydrometer(s) Serial Number
- Hydromter(s) Calibration Date
- Balance ID(s)
- Reagant ID
- Cylinder ID
- Initial and final volumes or weights
- Any comments regarding the sample extraction

Samples need to be “swiped” out when removing and “swiped” in when replacing samples in storage locations to maintain the internal chain of custody. Refer to Katahdin SOP, Sample Receipt and Internal Control, current revision, for the proper procedure for removal and return samples.

Fill out the sample preparation/extraction log with the necessary information before starting the extraction.

7.2 Equipment Calibration

Calibrate the balances being used each day prior to use. Record in the logbook designated for this purpose.

Calibrate the hydrometers every five years

7.3 Total Solids Determination

Refer to SOP CA-717 "Total Solids/Total Volatile Solids Determination In Solid Matrices"

7.4 Sample Preparation

7.4.1 From the calculated percent total solids and the sample characterisitics for each sample the amount needed for the analysis can be determined using Table 1.

7.4.2 After determining the amount of sample to be used, place a 1000ml glass beaker on the balance and tare the balance. Mix the sample thoroughly with the stainless steel spatula. If the sample container is full to the extent that stirring the sample is impractical, try to remove the "best representative" aliquot from the jar based on color, particle size, moisture, etc. Discard any foreign objects such as sticks, leaves, and rocks.

7.4.3 Add 125ml sodium hexametaphosphate solution to each beaker containing sample. Stir and mix thoroughly, soak sample in solution for at least 16 hours.

7.4.4 Refer to Katahdin SOP CA-108, current revision, "Basic Laboratory Technique" for more information on subsampling.

7.5 Sample Partition

After sample and solution has soaked for a minimum of 16 hours, the sample slurry is rinsed into a dispersion cup using DI water. Fill the dispersion cup ½ full with DI water and place the cup on the blender to mix for one minute.

7.5.1 If the sample appears to have large gravel, sand, or organic material that does not appear to be amendable for using the blender notify the PM and proceed to the next step without blending.

7.5.2 After the sample slurry has been blended, pour sample through a #10 sieve with pan attached, so sample smaller than a #10 sieve is collected in pan. Transfer contents in pan to a 1000ml graduated cylinder and continue to rinse the dispersion cup through the #10 sieve until transfer is complete. After all sample in the pan is rinsed into the cylinder bring the volume of the cylinder to 1000ml using DI water. Cover the cylinder with a rubber stopper and equilibrate the sample to ambient temperature for the hydrometer analysis.

7.5.3 Weigh and label a medium aluminum pan, than transfer the contents of the material retained on the # 10 sieve to the pan. Place the aluminum pan in a drying oven set at 110 ± 5° C and dry the sample material for at least 16 hours or until constant weight set aside for sieve analysis.

7.6 Hydrometer

Prepare a hydrometer blank by adding 125ml sodium hexametaphosphate and bring to 1000 mL with DI water in a 1000 mL graduated cylinder. Be sure to take readings with a hydrometer and a thermometer while taking readings on actual hydrometer samples. This will provide us with the temperature and solution correction factors later in the procedure. Also prepare a hydrometer rinse bath, used to rinse the hydrometer between uses.

7.6.1 To shake the cylinder, rotate the flask up and down for one minute approximating at least 60 turns. One turn down and one turn up equals two turns.

7.6.2 To take a hydrometer reading, gently insert the hydrometer into the graduated cylinder and wait approximately 20 seconds. Read the hydrometer from the top of the meniscus to the nearest 0.0005. Enter the reading on the logbook. After each reading, clean the hydrometer by twisting and dropping the hydrometer into the hydrometer rinse bath.

7.6.3 Insert a temperature probe into the cylinder to the same depth used for the hydrometer reading. Read the temperature to the nearest 0.5°C and enter the temperature measurement on the logbook. Rinse the temperature probe in the hydrometer rinse bath.

7.6.4 Repeat the above process taking hydrometer readings every 2, 5, 15, 30, 60, 240 and 1440 minutes, proceed to small sieve analysis.

With samples that are mostly sand, the hydrometer reading can drop below the reading of the blank. When this occurs, we will apply the lowest hydrometer reading to the blank reading. We will include this in the technical narrative. The logic behind this issue is due to the high amount of sand, resulting in more density. As a result, less DI water is added when transferring the sample/hexametaphosphate solution to the 1000 mL cylinders. Since the blank has a higher DI water/hexametaphosphate ratio, it increases the reading.

7.7 Sieve Analysis

Look at the sample material in the aluminum pan and record a description of the non-soil material (such as- sticks, grass, wood, plastic), hardness of material and shape of material in the logbook.

Hardness qualifiers include hard, soft or brittle.
Shape qualifiers include well rounded, rounded, subrounded, subangular, and angular.

Large Sieves

7.7.1 Weigh the 3/4”, 3/8”, #4 and #10 sieves and enter the weight measurements in the logbook as the tare weight.

7.7.2 Stack the sieves then transfer the sample material from the aluminum dish to the sieve stack. If the sample material is less than 30 g, manually shake the sieve stack for 2 minutes. If the sample material is greater than 30 g, place the sieve stack into the Ro-tap machine and shake the sieve stack for 10 minutes. Weigh each sieve and record these measurements in the logbook.

Small Sieves

Completely transfer the sample from the graduated cylinder to a #200 wet wash sieve. Make sure all of the sample has been transferred to the #200 wet wash sieve by rinsing the graduated cylinder several time with DI water. Using DI water, wash the sample through the #200 sieve until the water runs clear then transfer the material retained on the sieve into a 500 mL glass beaker labeled with the sample’s LAB ID.

7.8.1 Place the beaker in the drying oven and dry at a temperature of 110ºC for at least 16 hours. After 16 hours, remove the beaker from the oven and allow it to cool.

7.8.2 Gently mix the dried contents of the beaker with a rubber-tipped pestle to break any soil aggregates that may have formed during the drying stage.

7.8.3 Tare the balance and weigh the sieve stack sized between #20 and #200 and record the tare weights.

7.8.4 Transfer the sample to the sieve stack and ensure complete transfer. Use hair or wire brushes to clean the beaker. Place the sieve stack on the RoTap machine and shake for ten minutes. Weigh each sieve and record these measurements in the logbook.

7.9 Calculations

7.9.1 Sample Used (SU): total dry sample

SU =Total Sample Weight ((100-%Moisture)/100)*

HMCF = Hygroscopic moisture correction factor (we assume 1)

7.9.2 Sieve Analysis (Percent Finer = PF)

<u>Large Sieves:</u>

3 inch: PF = 100-100 (Sieve and Sample (3 inch) - Sieve (3 inch))/SU*

2 inch: PF = PF (3 inch) - 100(Sieve and Sample (2 inch) - Sieve (2 inch))/SU and so on through the #10 Sieve.*

<u>Small Sieves:</u>

#20: PF = PF(#10) - 100(mass passing #10/sample mass (Hyd))*(sieve and sample (#20) - sieve(#20))/sample used*

#40: PF = PF (#20) - 100(mass passing #10/sample mass (Hyd))*(sieve and sample (#40) - sieve (#40))/sample used and so on up through #10 sieve.*

7.9.3 Hydrometer Analysis

<u>Particle size, Micron</u>

1000*sqrt [930*viscosity/980*(SG-1))*(effective depth/time)]

Effective Depth, cm = 16.29-264.5*(actual Hydrometer reading - 1)
Time, minutes = Time of hydrometer reading from beginning of edimentation
Sqrt - square root
SG - Specific Gravity of soil (assuming a default SG)
Viscosity - is the resistance of a liquid to flow

Percent Finer (PF):

PF = Constant*(actual hydrometer reading - hydrometer correction factor - 1)

Constant = (100,000/W)*SG/(SG-1)
W = (Total sample used *sample used for hydrometer analysis*HMCF)/Amount of total sample passing #10 sieve
Hydrometer Correction = slope*sample temperature + Intercept
Slope = ((low temp. reading -1)-(high temp. reading -1)/(low temp. - high temp.))
Intercept = (low temp. reading -1) - (low temp. * slope)

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Not Applicable

9.0 METHOD PERFORMANCE

Not Applicable

10.0 APPLICABLE DOCUMENTS/REFERENCES

ASTM Standard D 422-63 (Re-approved 2007) “Standard Test Method for Particle-Size Analysis of Soils”, ASTM International, West Conshohocken, PA 2003, DOI: 10.1520/C0033-03, www.astm.org

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP SOP CA-717 “Total Solids/Total Volatile Solids Determination
In Solid Matrices”, current revision.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

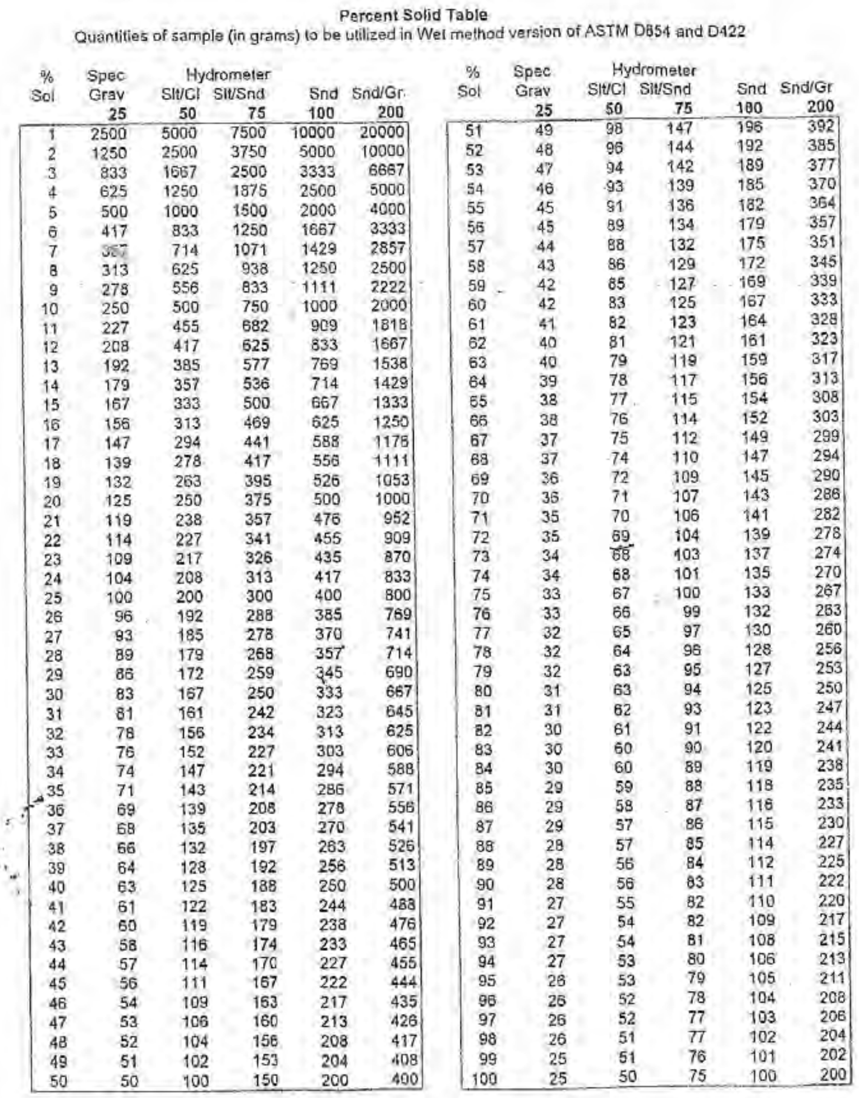
Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 5.1, January 2017.

LIST OF TABLES AND FIGURES

TITLE: **Grain Size Analysis**

TABLE 1

PERCENT SOLIDS TABLE FOR WEIGHT DETERMINATION



Percent Solid Table

Quantities of sample (in grams) to be utilized in Wet method version of ASTM D854 and D422

%	Spec	Hydrometer			
Sol	Grav	Slt/Cl	Slt/Snd	Snd	Snd/Gr
	25	50	75	100	200
1	2500	5000	7500	10000	20000
2	1250	2500	3750	5000	10000
3	833	1667	2500	3333	6667
4	625	1250	1875	2500	5000
5	500	1000	1500	2000	4000
6	417	833	1250	1667	3333
7	357	714	1071	1429	2857
8	313	625	938	1250	2500
9	278	556	833	1111	2222
10	250	500	750	1000	2000
11	227	455	682	909	1818
12	208	417	625	833	1667
13	192	385	577	769	1538
14	179	357	536	714	1429
15	167	333	500	667	1333
16	156	313	469	625	1250
17	147	294	441	588	1176
18	139	278	417	556	1111
19	132	263	395	526	1053
20	125	250	375	500	1000
21	119	238	357	476	952
22	114	227	341	455	909
23	109	217	326	435	870
24	104	208	313	417	833
25	100	200	300	400	800
26	96	192	288	385	769
27	93	185	278	370	741
28	89	179	268	357	714
29	86	172	259	345	690
30	83	167	250	333	667
31	81	161	242	323	645
32	78	156	234	313	625
33	76	152	227	303	606
34	74	147	221	294	588
35	71	143	214	286	571
36	69	139	208	278	556
37	68	135	203	270	541
38	66	132	197	263	526
39	64	128	192	256	513
40	63	125	188	250	500
41	61	122	183	244	488
42	60	119	179	238	476
43	58	116	174	233	465
44	57	114	170	227	455
45	56	111	167	222	444
46	54	109	163	217	435
47	53	106	160	213	426
48	52	104	156	208	417
49	51	102	153	204	408
50	50	100	150	200	400
51	49	98	147	196	392
52	48	96	144	192	385
53	47	94	142	189	377
54	46	93	139	185	370
55	45	91	136	182	364
56	45	89	134	179	357
57	44	88	132	175	351
58	43	86	129	172	345
59	42	85	127	169	339
60	42	83	125	167	333
61	41	82	123	164	328
62	40	81	121	161	323
63	40	79	119	159	317
64	39	78	117	156	313
65	38	77	115	154	308
66	38	76	114	152	303
67	37	75	112	149	299
68	37	74	110	147	294
69	36	72	109	145	290
70	36	71	107	143	286
71	35	70	106	141	282
72	35	69	104	139	278
73	34	68	103	137	274
74	34	68	101	135	270
75	33	67	100	133	267
76	33	66	99	132	263
77	32	65	97	130	260
78	32	64	96	128	256
79	32	63	95	127	253
80	31	63	94	125	250
81	31	62	93	123	247
82	30	61	91	122	244
83	30	60	90	120	241
84	30	60	89	119	238
85	29	59	88	118	235
86	29	58	87	116	233
87	29	57	86	115	230
88	28	57	85	114	227
89	28	56	84	112	225
90	28	56	83	111	222
91	27	55	82	110	220
92	27	54	82	109	217
93	27	54	81	108	215
94	27	53	80	106	213
95	26	53	79	105	211
96	26	52	78	104	208
97	26	52	77	103	206
98	26	51	77	102	204
99	25	51	76	101	202
100	25	50	75	100	200

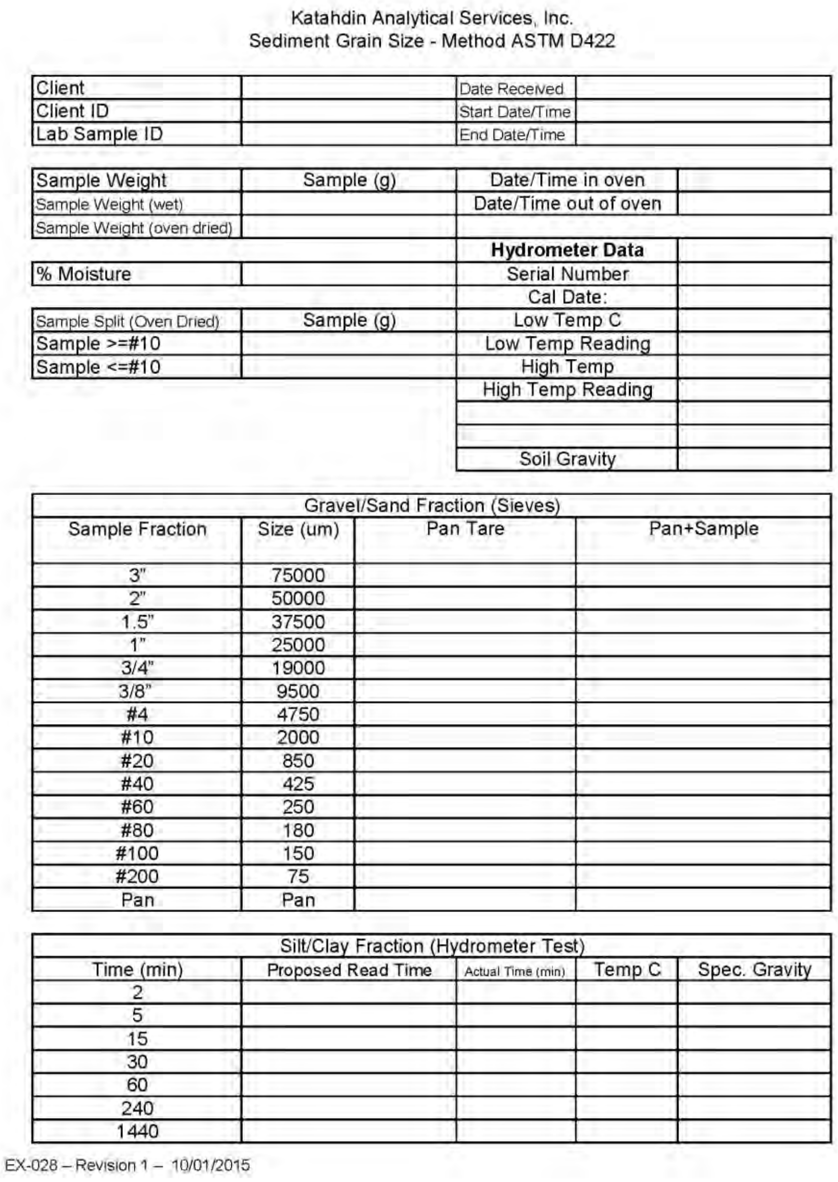
TABLE 2

SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-551-01	METHOD ASTM D 422-63
Procedures		
Apparatus/Materials		
Reagents		
Sample Preservation and handling		
QC – Accuracy/ Precision		

FIGURE 1

EXAMPLE OF LOGBOOK PAGE



Katahdin Analytical Services, Inc.
Sediment Grain Size - Method ASTM D422

Client		Date Received	
Client ID		Start Date/Time	
Lab Sample ID		End Date/Time	

Sample Weight	Sample (g)	Date/Time in oven	
Sample Weight (wet)		Date/Time out of oven	
Sample Weight (oven dried)			
		Hydrometer Data	
% Moisture		Serial Number	
		Cal Date:	
Sample Split (Oven Dried)	Sample (g)	Low Temp C	
Sample >=#10		Low Temp Reading	
Sample <=#10		High Temp	
		High Temp Reading	
		Soil Gravity	

Gravel/Sand Fraction (Sieves)			
Sample Fraction	Size (um)	Pan Tare	Pan+Sample
3"	75000		
2"	50000		
1.5"	37500		
1"	25000		
3/4"	19000		
3/8"	9500		
#4	4750		
#10	2000		
#20	850		
#40	425		
#60	250		
#80	180		
#100	150		
#200	75		
Pan	Pan		

Silt/Clay Fraction (Hydrometer Test)				
Time (min)	Proposed Read Time	Actual Time (min)	Temp C	Spec. Gravity
2				
5				
15				
30				
60				
240				
1440				

EX-028 – Revision 1 – 10/01/2015

CA-605-07

ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

Prepared By: George Brewer Date: 3/98

Approved By:

Group Supervisor: George Brewer Date: 01/24/01

Operations Manager: C. Burton Date: 1/24/01

QA Officer: Deborah J. Nadeau Date: 1.24.01

General Manager: Date: 1/25/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01 3050B	Format changes, added pollution prevention, added MSD, added spiking instruction tables	DN	1.24.01	1/24/01
02 3050B	Removed all references/procedures devoted to GFAA. Added use of digestates for ICP-MS analysis. Revised standard solution names + concs. in Tables 3+ 4 to reflect current practice.	DN	8.29.02	8.29.02
03 3050B	New Title to include ILMOS.3. Use of digestion block and polyethylene digestion tubes added to sections 4.0, 7.0 and Table 1. PBS changed from 1.0g water to 1.0g boiling chips. H_2O_2 addition from 3.0mL then 7.0mLs to 3.0mL, 2.0mL then 7.0mL. Figures and Tables updated to reflect current practices.	LAD	03/08	03/08
04	Updated Tables 3 and 4 with current Spike concentrations and volumes added. Updated logbook page. Added CA-108 reference for Subsampling Information.	LAD	08/09	08/09
05	Updated Tables 3 and 4 to reflect current spiking procedures.	LAD	09/10	09/10

TITLE: **ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS**

Revision History (cont.):

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Sect. 7 – Added wording concerning subsampling. Table 3 and 4 – Corrected standard concentrations. Attachment A - Modifications For 8330B Preparation & Digestion. Changed KAS INC. to KAS throughout	UAD	08/15	08/15
07	Update Figure 2. Change title of section 5.0. Update method references for NELAC + DoD. Minor changes to Table 1 + section 8.2.	UAD	09/17	09/17

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-605-07**, titled **ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS.**

Recipient: ______________________________ Date: ______________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-605-07**, titled **ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS.**

Recipient: ______________________________ Date: ______________

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the Katahdin Analytical Services procedure utilized to dissolve solid matrices and solubilize metals from solid samples prior to analysis for metals by ICP-AES and ICP-MS. This SOP applies to samples prepared by EPA Method 3050, with method modifications as summarized in Table 2.

This procedure applies to all solid sample (e.g. sediments, sludges, soils, and ashes) preparations for ICP-AES and ICP-MS analyses. This method is not a total digestion technique for most samples. It is a very strong acid digestion that will dissolve almost all elements that could become “environmentally available”. By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

1.1 Definitions

ICP-AES – Inductively Coupled Plasma Atomic Emission Spectroscopy.

ICP-MS – Inductively Coupled Plasma Mass Spectrometry.

LCSO – Laboratory Control Sample for Solids – An aqueous standard that had been brought through the sample preparation process.

LCSS – Laboratory Control Sample for Solids – A solid reference material that has been brought through the sample preparation process.

Matrix Spike – An aliquot of a sample to which a known amount of analyte has been added before digestion.

PBS – Preparation Blank for Solids – An aliquot of reagent water that has been brought through the sample preparation process.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the acid digestion of solid samples by USEPA Method 3050 for metals analysis. Each analyst must demonstrate the ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Training”.

It is the responsibility of all Katahdin technical personnel involved in the acid digestion of solid samples by USEPA Method 3050 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the procedure or irregularities with the samples should also be recorded in the lab notebook and reported to the responsible Department Manager or designated qualified data reviewer.

It is the responsibility of the Department Manager to ensure that technical personnel perform acid digestions in accordance with this SOP and to confirm that their work is properly documented through periodic review of the associated logbooks.

1.3 Safety

The acids used in this procedure are highly corrosive and reactive, and spiking standards contain toxic metals. The toxicity and reactivity of client samples are usually unknown, so samples should always be assumed to present a contact hazard. To reduce or eliminate exposure to potentially harmful chemicals, lab coats, gloves, and safety glasses or goggles must be worn whenever handling samples or reagents. Additional safety apparel, including face shields, aprons, dust masks, and shoe protectors, is available in the Metals prep lab and should be worn whenever circumstances warrant.

Acids should be added to samples slowly and carefully, while watching for reactions. This should be done under a hood, in case harmful fumes are evolved.

Hood sashes should be lowered as far as possible whenever beakers are being heated on a hot plate. Use caution when handling hot beakers.

Each qualified analyst or technician must be familiar with Katahdin Analytical Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from the Environmental Health and Safety Officer, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Excess spiking solutions must be emptied into the corrosive waste carboy located in the Metals prep lab for subsequent appropriate disposal in accordance with the Katahdin Hazardous Waste Management Plan and Safety Manual.

Sample digestates should be stored for a minimum of 60 days after digestion to allow for analysis, and reanalysis if necessary. Digestates older than 60 days may be emptied into the corrosive waste carboy in the Metals prep lab for subsequent appropriate disposal in accordance with the Katahdin Hazardous Waste Management Plan and Safety Manual.

2.0 SUMMARY OF METHOD

A representative 1 to 2 g (wet weight) sample is digested with repeated additions of nitric acid and hydrogen peroxide. Hydrochloric acid is added to the initial digestate and the sample is refluxed. The digestate is then filtered and diluted to a final volume of 100 mL.

3.0 INTERFERENCES

Interferences are discussed in the applicable analytical SOPs.

4.0 APPARATUS AND MATERIALS

4.1 Digestion vessels. If digestion is performed using a hot plate, the appropriate digestion vessels are 100 mL pre-cleaned Griffin beakers (cleaned according to the current revision of SOP CA-100, "Labware Cleaning" and CA-602, “Glassware Preparation and Sample Preservation for Trace Element Analyses”). If digestion is performed using a block digester, the appropriate digestion vessels are new 70 mL disposable graduated polyethylene digestion tubes with attached snap lids.

4.2 Ribbed watch glasses. If digestion is performed using a hot plate, 75 mm diameter glass watch glasses (pre-cleaned as above) are used. If digestion is performed using a block digester, 40 mm diameter disposable polyethylene watch glasses are used.

4.3 Adjustable volume automatic pipets covering the range from 10 uL to 1000 uL and disposable pipet tips; calibrated Finn pipets or Eppendorf pipets are acceptable.

4.4 Disposable graduated polystyrene specimen containers with pouring lips, 200 mL capacity.

4.5 Hot plate or block digester, griddle, or other heating source - adjustable and capable of maintaining a temperature of 95^{o}C ± 5^{o}C. Heating sources must be numbered for easy identification.

4.6 Device for measuring hot plate temperature, consisting of a flask or digestion vessel in which the bulb of a thermometer is immersed in sand or water. The temperature of each hot plate used is measured and recorded each day. The hot plate identification number and the measured temperature are recorded on the sample preparation logbook sheet.

4.7 Plastic funnels, pre-cleaned as in Section 4.1.

4.8 Filter funnel holders, capable of suspending plastic funnels above disposable specimen containers.

4.9 Polyethylene wash bottles for dispensing reagent water and 5% HNO_3.

4.10 Filter paper, Whatman No. 41 or equivalent. Filters are acid-washed immediately prior to use as follows. Place a pre-cleaned funnel in the funnel holder and put a disposable plastic specimen container under the funnel to collect the rinsates. Place a folded filter in the funnel and rinse three times with approximate 10 mL volumes of 5% HNO_3, making sure the entire surface of the filter is wetted each time and allowing each rinse to drain completely before continuing. Then rinse three times with approximate 25 mL volumes of reagent water, again allowing each rinse to drain completely. Discard the rinsates into the appropriate waste container. The acid-washed filter is now ready for use.

4.11 Polyethylene sample containers with screw caps or graduated polyethylene sample containers with attached snap lids, 125 mL capacity.

4.12 Repipetters (adjustable repeating pipetters with reservoirs) for dispensing concentrated nitric acid, 1:1 HNO_3, and concentrated HCl.

4.13 Analytical balance capable of reading to 0.01 gram.

4.14 Spatulas, scoops, or spoons; plastic or stainless steel, rinsed with 5% HNO_3 and reagent water. Disposable tongue depressors may be used and do not requrire to be rinsed.

5.0 REAGENTS AND STANDARDS

5.1 Concentrated nitric acid, HNO_3 – trace metals grade.

5.2 Concentrated hydrochloric acid, HCl – trace metals grade.

5.3 Reagent water - water that meets the performance specifications of ASTM Type II water (ASTM D1193).

5.4 Nitric acid, 1:1. Add a volume of concentrated HNO_3 to an equivalent volume of reagent water and swirl gently to mix.

5.5 Nitric acid, 5% v/v. Add 25 mL concentrated HNO_3 to 475 mL reagent water in a 500 mL wash bottle. Cap, point the dispensing tip into a sink, and shake gently to mix.

5.6 30% hydrogen peroxide (H_2O_2) - spectrometric grade.

5.7 Multielement spiking solutions (see Table 3 for a list of required spiking solutions).

5.8 Solid reference material – a soil containing all the elements of interest, with empirically established method-specific recoveries and acceptance limits for all analytes. Solid reference materials are purchased with documentation of analysis provided by the vendor. See Figure 4 for an example certificate of analysis for a solid reference material.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Samples should be collected in clean plastic or glass containers. Samples must be refrigerated ($4^{o}C \pm 2^{o}C$) upon receipt by the laboratory. The holding time for solid samples is 6 months from the date of sample collection.

7.0 PROCEDURE

The procedure described below is condensed for quick reference in Table 3.

SAMPLE PREPARATION

7.1 Prior to performing the digestion, make a list of the samples that are to be digested. Enter digestion information (Katahdin Sample Numbers, QC Batch ID, preparation date, analyst initials, etc.) into the ACCESS computer spreadsheet. Print out a copy of the spreadsheet (see Figure 2 for an example). Hand label the digestate vessels

7.2 If using glass beakers as the digestion vessels, submerge previously cleaned beakers and watch glasses three times into a 10% nitric acid bath, then rinse three times with reagent water. The polyethylene digestion tubes used in conjunction with the block digeter do not require acid rinsing or precleaning. Label the digestion vessels with sample numbers.

7.3 Weigh 1 to 2 g of well-mixed sample into a properly cleaned, labeled, and tared Griffin beaker or polyethylene digestion tube. Avoid rocks, roots, leaves and other organic or inorganic foreign material. Record (hand write) the weight of each sample on the printout of the digestion spreadsheet.

Refer to Katahdin Analytical Services SOP CA-108, current revision "Basic Laboratory Technique" for more information on subsampling.

7.4 Weigh an appropriate amount of solid reference material to a clean, labeled, and tared Griffin beaker or polyethylene digestion tube to serve as a laboratory control sample.

7.5 Add spike solutions to matrix spike samples (refer to Tables 3 and 4 for spiking instructions).

7.6 Using repipetters, add 10 mL of 1:1 HNO_3, mix the slurry. Cover with a ribbed watch glass and place on heat source. Gently heat the sample to $95^{o}C \pm 5\ ^{o}C$ and reflux for 10 to 15 minutes without boiling. Remove the digestion vessel from the heat source and cool the sample.

7.7 Add 5 mL of concentrated HNO_3 to the sample, replace the watch glass, and reflux for 30 minutes. If brown fumes are generated, indicating oxidation of the sample by HNO_3, repeat this step (addition of 5 mL of concentrated HNO_3) until no brown fumes are given off by the sample, indicating complete reaction by HNO_3.

7.8 Continue heating the sample at $95^{o}C \pm 5^{o}C$ without boiling until the digestate has evaporated to approximately 5 to 10 mL or until two hours have elapsed, whichever occurs first. Do not allow the sample to go to dryness. Remove the digestion vessel from the heat source and cool the sample.

7.9 Add 2 mL of reagent water and 2 mL of 30% H_2O_2 to the sample, replace the watch glass, and heat gently on the heat source to start the peroxide reaction. Continue heating until effervescence subsides.

7.10 Add an additional 2 mL of 30% H_2O_2 to the sample, replace the watch glass, and heat gently on the heat source to start the peroxide reaction. Continue heating until effervescence subsides.

7.11 Add an additional 6 mL of 30% H_2O_2 in 1-mL aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged.

7.12 Continue heating the sample at $95^{o}C \pm 5^{o}C$ without boiling until the digestate has evaporated to approximately 5 to 10 mL or until two hours have elapsed, whichever occurs first. Do not allow the sample to go to dryness. Remove the sample from the heat source and cool.

7.13 Add 10 mL of concentrated HCl to the digest from 7.12, replace the watch glass, and reflux at $95^{o}C \pm 5^{o}C$ for 15 minutes. Remove the sample from the heat source and cool.

7.14 Use a pre-cleaned funnel and acid-rinsed filter paper to filter the digestate into a clean graduated polystyrene specimen container or graduated polyethylene sample container with attached snap lid. Using a wash bottle, rinse the digestion vessel with reagent water and add the rinsates to the filter apparatus. After all of the liquid in the filter has drained into the specimen container, thoroughly rinse the filter three times with small (5-10 mL) volumes of reagent water, allowing the liquid to drain completely after each rinse. Using the graduations on the specimen container or snap-lid container, dilute to 100 mL with reagent water. If a specimen container has been used, transfer the contents to the corresponding labeled polyethylene sample bottle, cap the bottle, and discard the empty specimen container. If a snap-lid container has been used, close and secure the snap-lid. Shake the container gently to mix. The digestate is now ready for ICP-AES or ICP-MS analysis.

7.15 Review the ACCESS computer spreadsheet for accuracy. If any information is incorrect, make the necessary changes to the computer spreadsheet and print out a corrected copy. Do not discard the original copy of the spreadsheet. Record (hand write) reagent lot numbers, spiking information, and heat source temperature in the appropriate spaces on the spreadsheet. Record any method deviations, irregularities with the samples, or other pertinent observations at the bottom of the page, and sign and date the spreadsheet. Bind all copies of the spreadsheet in the sample preparation log. An example sample preparation logbook page (ACCESS spreadsheet) is included as Figure 2.

7.15 Reopen the electronic ACCESS spreadsheet for the digestion and transcribe the sample weights from the handwritten, bound copy into the electronic copy. The information in this electronic spreadsheet will later be imported into the ACCESS metals database and used to calculate sample concentrations on a weight basis.

7.16 Place each batch of digestates in a box labeled with the QC Batch ID, and put the box of digestates in the metals digestates storage area.

CALCULATIONS

7.17 Analytical results for solid samples are reported on a dry weight basis. Total solids are determined by the Wet Chemistry Group, and are recorded in spreadsheets that are electronically imported into the Access metals database. Final dry weight concentrations are calculated by the Access database as follows:

$$\text{Concentration (mg/kg dry weight)} = (C \times V) / (W \times S)$$

where: C = Measured concentration (mg/L)
V = Digestate final volume (L)
W = Sample wet weight (kg)
S = % Solids/100

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

USEPA Method 3050 requires the laboratory to perform specific quality control checks to assess laboratory performance and data quality. Minimum frequencies, acceptance criteria, and corrective actions for these control checks are tabulated in Table 1 and are described below. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations and client and project specific Data Quality Objectives. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases “qualified” data with narration may be advisable after consultation with the client.

8.1 At least one preparation blank for soils (PBS) is processed concurrently with each digestion batch of 20 or fewer samples, and is used to assess contamination resulting from the digestion procedure. The PBS consists of a 1.0 g of boiling stones that is digested using the same reagents as those used to digest associated samples. Refer to the appropriate analytical SOP for PBS acceptance criteria and corrective actions.

8.2 Prepare an appropriate number of laboratory control samples (LCSO for aqueous LCS or LCSS for solid LCS reference material) by weighing appropriate masses of solid reference material or by spiking the LCSO as described in Table 3. The analyte concentrations of the LCSS will depend on the solid reference material used, and the mass of each aliquot. Refer to Figure 3 for an example certificate of analysis for a solid reference material.

8.3 Matrix spike samples are processed along with each digestion batch at a minimum frequency of one per digestion batch. A matrix spike sample consists of an aliquot of a sample that is fortified with known amounts of all analytes of interest prior to digestion. Matrix spike recoveries are used to assess the biasing effects of sample matrix on digestion and analysis performance. Directions for spiking matrix spike samples are contained in Figure 2. Refer to the appropriate analytical SOP for matrix spike recovery acceptance criteria and corrective actions.

8.4 Matrix spiked duplicate samples are processed concurrently with each digestion batch at a minimum frequency of one per digestion batch. Matrix spiked duplicate samples are used to assess the precision of the digestion and analysis methods. Refer to the appropriate analytical SOP for matrix spike duplicate precision acceptance criteria and corrective actions.

NOTE: Clients may choose specific samples for matrix spike and duplicate analysis; otherwise, the choice is left to the person performing the digestion.

8.5 The quality control measures and frequencies described above are minimum requirements. Individual clients and analytical programs may impose additional QC requirements.

9.0 METHOD PERFORMANCE

Refer to the applicable instrumental analysis SOP for method performance information.

10.0 APPLICABLE DOCUMENTS/REFERENCES

"Test Methods for the Evaluation of Solid Waste," United States Environmental Protection Agency, SW-846, Third Edition, Final Update III, 12/96, Method 3050B.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 5.1, January 2017.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

LIST OF TABLES AND FIGURES

TABLE 1

QC REQUIREMENTS – METHOD 3050

Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
3050	Preparation Blank for Solids (PBS)	One per prep batch of 20 or fewer samples.	Refer to analytical method.	Refer to analytical method.
	Laboratory Control Sample for Aqueous or Solids (LCSO or LCSS)	One each per prep batch of 20 or fewer samples, if specified by project or client	Refer to analytical method.	Refer to analytical method.
	Matrix Spike Sample	One per prep batch.	Refer to analytical method.	Refer to analytical method.
	Matrix Spike Duplicate Sample	One per prep batch.	Refer to analytical method.	Refer to analytical method.
	Demonstration of analyst proficiency	One-time demonstration by each analyst performing the method.	Must pass all applicable QC for method.	Repeat analysis until able to perform passing QC; document successful performance in personal training file.

TABLE 2

SUMMARY OF METHOD MODIFICATIONS – METHOD 3050

Topic	Katahdin SOP CA-605-07	Method 3050, current revision
Apparatus /Materials	1) Digestion performed in 100 mL Griffin beaker or 70 mL polyethylene tube. 2) Graduated disposable plastic cup or 120 mL polyethylene tube used to bring digestate to final volume.	1) Digestion performed in 250 mL Griffin beaker. 2) Volumetric flask used to bring digestate to final volume.
Procedure	1) Digestate volume reduced to 5 to 10 mL prior to filtering. 2) After filtration, the filters are rinsed three times with reagent water. 3) 30% H_2O_2 is added in two 2 mL aliquots and then six 1 mL aliquots.	1) Digestate volume reduced to 5 mL prior to filtering. 2) After filtration, the filters are rinsed twice with reagent water. 3) 30% H_2O_2 is added in one 3 mL aliquot and then seven 1 mL aliquots.

TABLE 3

PREPARATION OF MATRIX SPIKES AND SPIKING SOLUTIONS FOR DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
Matrix Spike for ICP-AES	CLPP-SPK-1	Inorganic Ventures(IV)	0.10
	CLPP-SPK-INT1	Lab Prepared (see below)	1.00
	CLPP-SPK-INT2	Lab Prepared (see below)	1.00

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
CLPP-SPK-INT1	1000 mg/L As,Pb,Sb,Se,Tl	High Purity Standards	1.0 each
	1000 mg/L Cd	High Purity Standards	2.5
	10000 mg/L K	High Purity Standards	10.0
	10000 mg/L Na	High Purity Standards	7.5
	10000 mg/L Mg	High Purity Standards	5.0
	10000 mg/L Ca	High Purity Standards	2.5
CLPP-SPK-INT2	1000 mg/L Mo	IV or High Purity Standards	1.0
	1000 mg/L B,Li,Sn,Sr,Ti	IV or High Purity Standards	5.0 each
	10000 mg/L Si	High Purity Standards	1.0
	10000 mg/L U	High Purity Standards	1.0
	10000 mg/L W	High Purity Standards	1.0

TABLE 4

ELEMENT CONCENTRATIONS IN ICP-AES MATRIX SPIKES AND THEIR COMPONENT SPIKING SOLUTIONS FOR DIGESTION OF SOLID SAMPLES BY METHOD 3050

	CONCENTRATION IN SOLUTION, mg/L			
Element	**Matrix Spike**	**CLPP-SPK-1**	**CLPP-SPK-INT1**	**CLPP-SPK-INT2**
Aluminum	2.000	2000		
Antimony	0.100		10	
Arsenic	0.100		10	
Barium	2.000	2000		
Beryllium	0.050	50		
Boron	0.500			50
Cadmium	0.250		25	
Calcium	2.500		250	
Chromium	0.200	200		
Cobalt	0.500	500		
Copper	0.250	250		
Iron	1.000	1000		
Lead	0.100		10	
Lithium	0.500			50
Magnesium	5.000		500	
Manganese	0.500	500		
Molybdenum	0.300			10
Nickel	0.500	500		
Potassium	10.000		1000	
Selenium	0.100		10	
Silicon	5.000			100
Silver	0.050	50		
Sodium	7.500		750	
Strontium	0.500			50
Thallium	0.100		10	
Tin	0.500			50
Titanium	0.500			50
Tungsten	0.100			10
Uranium	0.100			10
Vanadium	0.500	500		
Zinc	0.500	500		

FIGURE 1

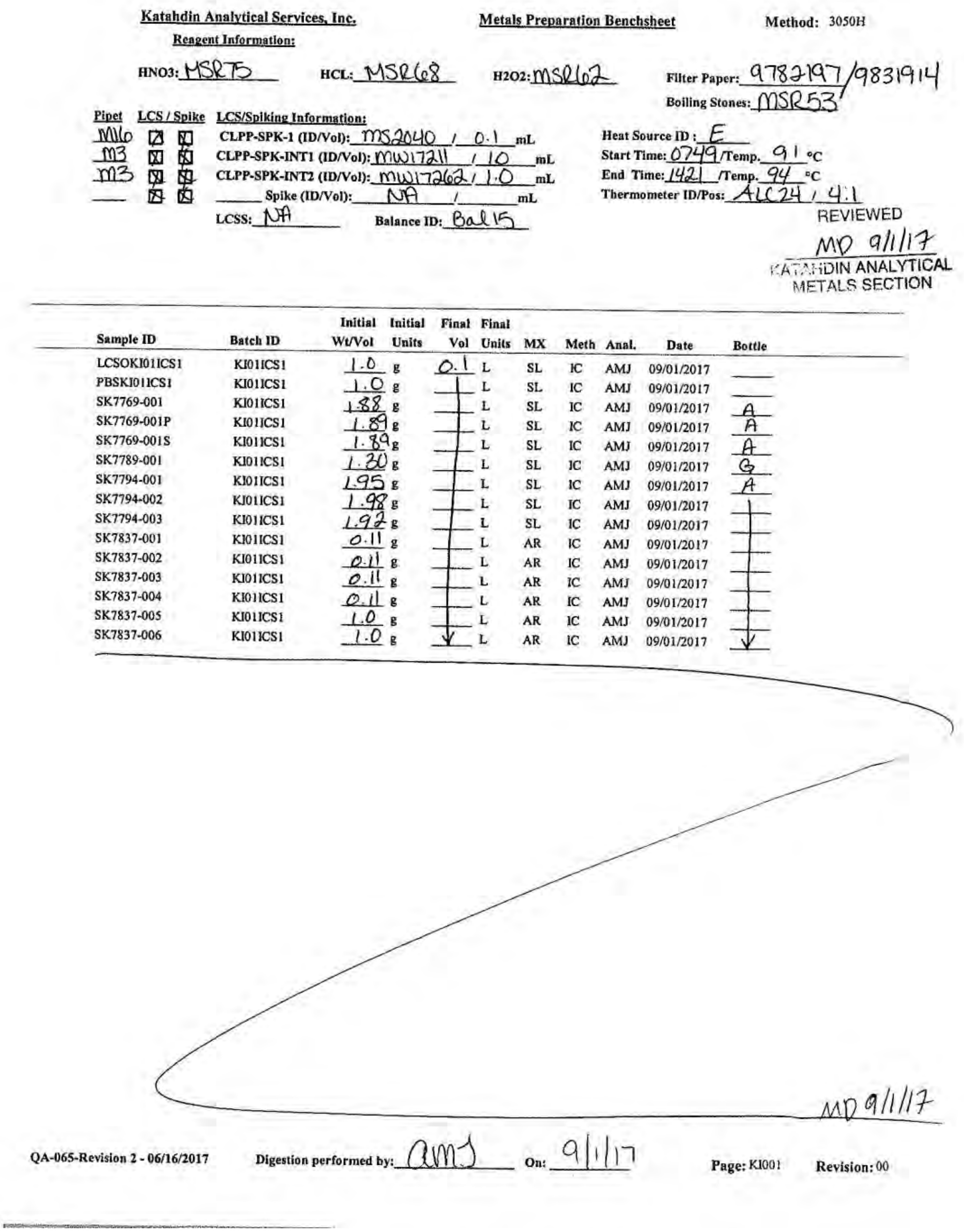
PROCEDURE CONDENSATION – METHOD 3050

1. Prepare and print out ACCESS spreadsheet.
2. If performing digestion on a hot plate, rinse 250 mL Griffin beakers and ribbed watch glasses 3 times in acid bath. Then rinse beakers and watch glasses 3 times with laboratory reagent grade water. If performing digestion with block digester, polyethylene digestion tubes do not require precleaning.
3. Label digestion vessels (beakers or polyethylene sample tubes) with sample numbers.
4. Weigh 1 to 2 g of well-mixed sample into tared digestion vessels. Record sample weights.
5. Add spike solutions to matrix spike samples.
6. Add 10 mL 1:1 HNO_3 to samples and cover with watch glasses.
7. Reflux for 10 to 15 minutes at $95^{o} \pm 5^{o}$ C. without boiling. Cool samples.
8. Add 5 mL conc. HNO_3, cover beakers, and reflux for 30 minutes.
9. Repeat Step 8 as necessary until digestion is complete.
10. Reduce sample volumes to 5 to 10 mL or heat for 2 hours, whichever occurs first.
11. Cool sample and add 2 mL reagent water and 2 mL 30% H_2O_2. Heat gently until effervescence subsides.
12. Cool sample and add 2 mL 30% H_2O_2. Heat gently until effervescence subsides.
13. Cool samples and add 6 mL of 30% H_2O_2 in 1 mL aliquots. Heat gently until effervescence subsides.
14. Reduce sample volumes to 5 to 10 mL or heat for 2 hours, whichever occurs first.
15. Add 10 mL conc. HCl and reflux for 10 to 15 minutes at $95^{o} \pm 5^{o}$ C.
16. Cool sample and filter into graduated specimen container. Bring to volume with reagent water and transfer to labeled polyethylene bottle.
17. Enter sample weights into ACCESS spreadsheet.

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

FIGURE 2

EXAMPLE PAGE FROM METALS SAMPLE PREPARATION LOGBOOK



Katahdin Analytical Services, Inc. **Metals Preparation Benchsheet** **Method:** 3050H

Reagent Information:

HNO3: MSR75 HCL: MSR68 H2O2: MSR62 Filter Paper: 9782197/9831914
Boiling Stones: MSR53

Pipet	LCS	Spike	LCS/Spiking Information:
M16	☒	☒	CLPP-SPK-1 (ID/Vol): MS2040 / 0.1 mL
M3	☒	☒	CLPP-SPK-INT1 (ID/Vol): MW17211 / 10 mL
M3	☒	☒	CLPP-SPK-INT2 (ID/Vol): MW17262 / 1.0 mL
	☒	☒	Spike (ID/Vol): NA / mL

LCSS: NA Balance ID: Bal15

Heat Source ID: E
Start Time: 0749 /Temp. 91 °C
End Time: 1421 /Temp. 94 °C
Thermometer ID/Pos: ALC24 / 4:1

REVIEWED
MD 9/1/17
KATAHDIN ANALYTICAL
METALS SECTION

Sample ID	Batch ID	Initial Wt/Vol	Initial Units	Final Vol	Final Units	MX	Meth	Anal.	Date	Bottle
LCSOKI01ICS1	KI01ICS1	1.0	g	0.1	L	SL	IC	AMJ	09/01/2017	
PBSKI01ICS1	KI01ICS1	1.0	g		L	SL	IC	AMJ	09/01/2017	
SK7769-001	KI01ICS1	1.88	g		L	SL	IC	AMJ	09/01/2017	A
SK7769-001P	KI01ICS1	1.89	g		L	SL	IC	AMJ	09/01/2017	A
SK7769-001S	KI01ICS1	1.89	g		L	SL	IC	AMJ	09/01/2017	A
SK7789-001	KI01ICS1	1.30	g		L	SL	IC	AMJ	09/01/2017	G
SK7794-001	KI01ICS1	1.95	g		L	SL	IC	AMJ	09/01/2017	A
SK7794-002	KI01ICS1	1.98	g		L	SL	IC	AMJ	09/01/2017	
SK7794-003	KI01ICS1	1.92	g		L	SL	IC	AMJ	09/01/2017	
SK7837-001	KI01ICS1	0.11	g		L	AR	IC	AMJ	09/01/2017	
SK7837-002	KI01ICS1	0.11	g		L	AR	IC	AMJ	09/01/2017	
SK7837-003	KI01ICS1	0.11	g		L	AR	IC	AMJ	09/01/2017	
SK7837-004	KI01ICS1	0.11	g		L	AR	IC	AMJ	09/01/2017	
SK7837-005	KI01ICS1	1.0	g		L	AR	IC	AMJ	09/01/2017	
SK7837-006	KI01ICS1	1.0	g		L	AR	IC	AMJ	09/01/2017	

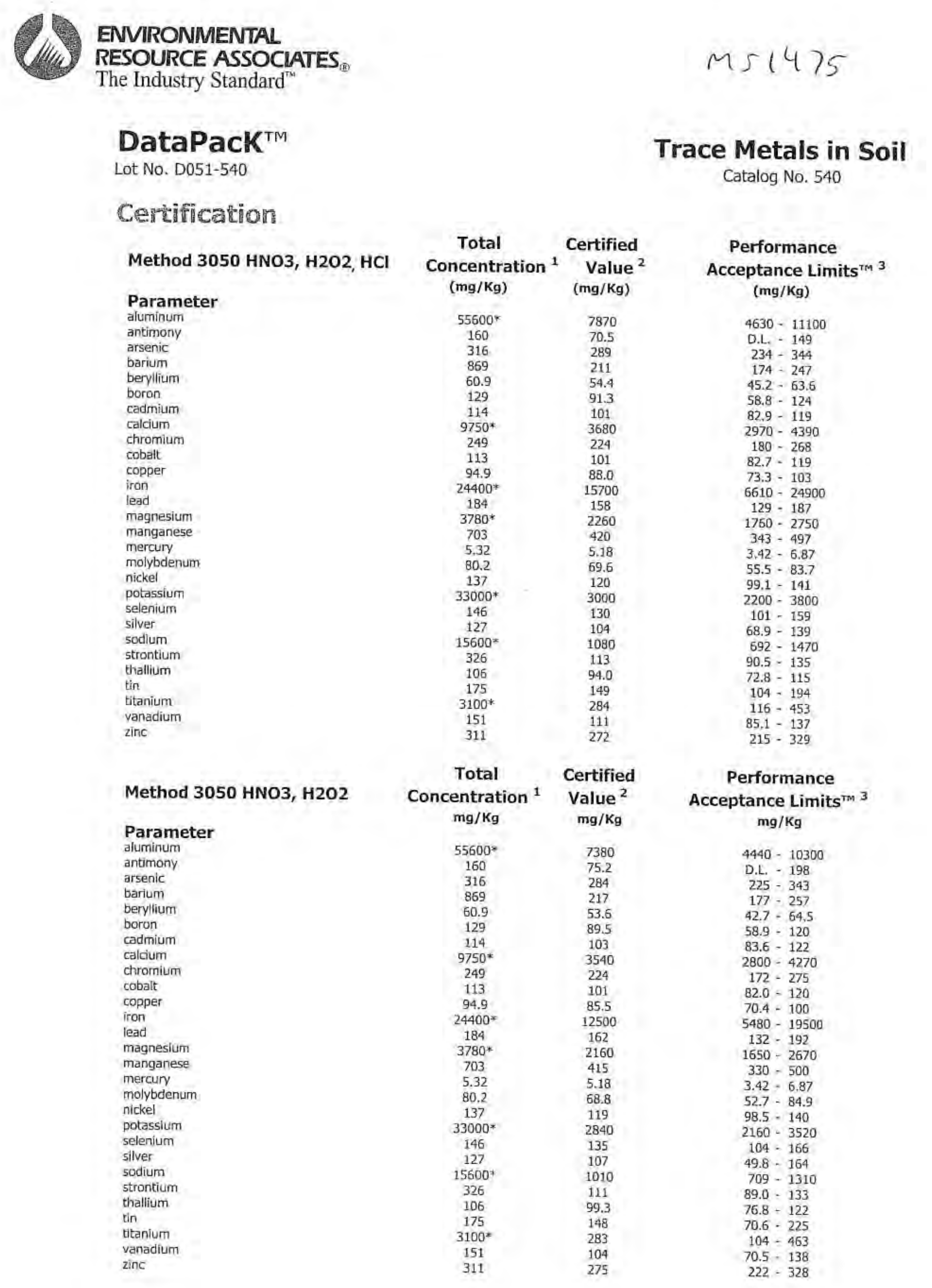
MD 9/1/17

QA-065-Revision 2 - 06/16/2017 Digestion performed by: AMJ On: 9/1/17 Page: KI001 Revision: 00

TITLE: ACID DIGESTION OF SOLID SAMPLES BY USEPA METHOD 3050 FOR METALS ANALYSIS BY ICP-AES, ICP-MS

FIGURE 3

EXAMPLE CERTIFICATE OF ANALYSIS FOR SOLID REFERENCE MATERIAL



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Trace Metals in Soil

Catalog No. 540

Certification

Method 3050 HNO_3, H_2O_2, HCl

Parameter	Total Concentration [1] (mg/Kg)	Certified Value [2] (mg/Kg)	Performance Acceptance Limits™ [3] (mg/Kg)
aluminum	55600*	7870	4630 - 11100
antimony	160	70.5	D.L. - 149
arsenic	316	289	234 - 344
barium	869	211	174 - 247
beryllium	60.9	54.4	45.2 - 63.6
boron	129	91.3	58.8 - 124
cadmium	114	101	82.9 - 119
calcium	9750*	3680	2970 - 4390
chromium	249	224	180 - 268
cobalt	113	101	82.7 - 119
copper	94.9	88.0	73.3 - 103
iron	24400*	15700	6610 - 24900
lead	184	158	129 - 187
magnesium	3780*	2260	1760 - 2750
manganese	703	420	343 - 497
mercury	5.32	5.18	3.42 - 6.87
molybdenum	80.2	69.6	55.5 - 83.7
nickel	137	120	99.1 - 141
potassium	33000*	3000	2200 - 3800
selenium	146	130	101 - 159
silver	127	104	68.9 - 139
sodium	15600*	1080	692 - 1470
strontium	326	113	90.5 - 135
thallium	106	94.0	72.8 - 115
tin	175	149	104 - 194
titanium	3100*	284	116 - 453
vanadium	151	111	85.1 - 137
zinc	311	272	215 - 329

Method 3050 HNO_3, H_2O_2

Parameter	Total Concentration [1] mg/Kg	Certified Value [2] mg/Kg	Performance Acceptance Limits™ [3] mg/Kg
aluminum	55600*	7380	4440 - 10300
antimony	160	75.2	D.L. - 198
arsenic	316	284	225 - 343
barium	869	217	177 - 257
beryllium	60.9	53.6	42.7 - 64.5
boron	129	89.5	58.9 - 120
cadmium	114	103	83.6 - 122
calcium	9750*	3540	2800 - 4270
chromium	249	224	172 - 275
cobalt	113	101	82.0 - 120
copper	94.9	85.5	70.4 - 100
iron	24400*	12500	5480 - 19500
lead	184	162	132 - 192
magnesium	3780*	2160	1650 - 2670
manganese	703	415	330 - 500
mercury	5.32	5.18	3.42 - 6.87
molybdenum	80.2	68.8	52.7 - 84.9
nickel	137	119	98.5 - 140
potassium	33000*	2840	2160 - 3520
selenium	146	135	104 - 166
silver	127	107	49.8 - 164
sodium	15600*	1010	709 - 1310
strontium	326	111	89.0 - 133
thallium	106	99.3	76.8 - 122
tin	175	148	70.6 - 225
titanium	3100*	283	104 - 463
vanadium	151	104	70.5 - 138
zinc	311	275	222 - 328

ATTACHMENT 1

MODIFICATIONS FOR 8330B PREPARATION & DIGESTION

4.0 APPARATUS AND MATERIALS – additional materials

4.1 Sieves - #10 mesh (2 mm) – 8” diameter with covers and collection trays.

4.2 Aluminum drying trays with drying rack

4.3 Heavy duty aluminum foil

4.4 Stainless steel scoopulas

4.5 Dust mask

7.0 PROCEDURES – additional procedures

Prior to the digestion of samples (section 7.1 in SOP):

Spread the entire aliquot of soil onto a drying tray lined with heavy duty aluminum foil and dry in air at room temperature or colder to a constant weight (last two successive dry weights within 3% RPD). Trays should be placed in rack for drying. Record all weights in the Sample Drying Logbook.

Note: Hydric soils and sediments with high moisture content may take several days to dry to constant weight.

Remove the oversize fraction by passing it through a 10-mesh (2 mm) sieve. Be sure to break up caked up soil with a gloved hand. Weigh both fractions – oversize and <2mm. Record all weights in the Sieving & Grinding Logbook.

To obtain a subsample, the entire sample must be mixed with a stainless steel scoopula and spread out on a clean surface (aluminum tray lined with foil) so that it is only 1 or 2 cm thick - preferably in a fume hood designed to prevent the spread of dust and possible inhalation or residue losses. Using the scoopula, obtain at least 30 different increments, i.e., portions (~0.3 g) from randomly chosen locations throughout the entire sample profile for a total of ~10 g. Mix this subsample one more time with the scapula and then obtain an aliquot for metals digestion (beginning with section 7.3).

CA-608-18
TRACE METALS ANALYSIS BY ICP-AES
USING USEPA METHOD 6010

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

Prepared By: George Brewer Date: 7/98

Approved By:

Group Supervisor: George Brewer Date: 01/23/01

Operations Manager: Jol C. Burton Date: 1/23/01

QA Officer: Deborah J. Nadeau Date: 1·23·01

General Manager: Date: 1/25/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01 6010B	Format changes added pollution prevention, expanded procedure and QC sections. Added tables.	DN	1·23·01	1/23/01
02 6010B	Calibration begins with analysis of S0 (cal. blank) followed by S1 (Mixed Cal. Std.) Changes to Section 7.5 and Table 8 to reflect this. Made changes to element concs. in Tables 3, 4, 5, 6 to reflect current practices	DN	10·21·02	10·21·02
03 6010B	Added MN-IEC to standards run. Changed frequency of LRS. Changed concentration of HNO_3 in calibration blank. CRI changed from three separate solutions to one. Changed CRI vendor.	MRC	04.15.04	04.15.04
04	updated ICV, CCV, ICB, PQL Chk std. PBW, PBS, MS & MSD acceptance criteria updated Table 1	LAD	05/06	05/06
05	Updated Tables 3, 4, 5, 6 and 7 with current standard concentrations and prep. Updated Table 1 with current practices including NAVY audit findings. Updated Sections 2, 7.2, 7.6 and Table 1 with new ICP information. Updated Table 8 with current sequence requirements.	LAD	07/07	07/07

TITLE: TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Added hardness definition and calculation (APP. 1)	LAD	09/07	09/07
07	Updated Summary to reflect new ICP functions. Removed ICP set-up updated tables to reflect changes in Standard Concentrations and preparation	LAD	11/08	11/08
08	Updates to Sections 8 and 10, Tables 1 and 2 to reflect changes from 6010B to 6010C. Added LLQC information and criteria to Sect. 8 and Table 1. Added criteria to analyze PQL standard at the beginning and END of each run.	LAD	02/09	02/09
09	Updated Sections 8, 9, 10 and Table 1 for compliance with DoD QSM version 4.1.	LAD	08/09	08/09
10	Added Table 2 - DoD QSM Ver. 4.1 QC Requirements. Minor correction to Table 1.	LAD	04/10	04/10
11	Added yttrium criteria to section 7 and Table 1.	LAD	06/10	06/10
12	Revised Tables 4 → 8 with the following information: -Add palladium and gold; removed tungsten and uranium; removed stock standard ~~QCP-CICV~~ LAD 092211 2007ICS-1; changed stock standard QCP-CICV-3 to CL-CAL-3. Added references to section 10.	LAD	09/11	09/11
13	The changes above had not been finalized in SOP-12. Sect. 9 - Added MDL, LOD and LOQ information. Added Attachment 2 - Analysis of Palladium by SW846 6010	LAD	04/12	04/12

TITLE: TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010

Revision History (cont.):

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
14	Sect. 9 & Table 1 - Fixed typos.	LAD	05/13	05/13
15	Sect. 10- Updated references. Added Table 3 - DoDQSM 5.0 QC Requirements - Renumbered rest of Tables. Updated Tables (6→8). Changed KAS INC to KAS LLC.	LAD	12/14	12/14
16	Sect. 5 & 7 - Corrected Table references. Tables 5, 6, 7 & 8 - Updated Standard, Concentrations & sources. Changed KAS LLC to KAS	LAD	05/16	05/16
17	Sect. 1 and 6 - Added Tissue matrix	LAD	07/16	07/16
18	Sect. 8.1 - Changed reagent spiked water to calibration blank solution. Sect. 10 - update method references.	LAD	09/17	09/17

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-608-18**, titled **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010.**

Recipient: ____ Date: ____________________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-608-18**, titled **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010.**

Recipient: ____ Date: ____________________

1.0 SCOPE AND APPLICATION

Inductively coupled plasma atomic-emission spectroscopy (ICP-AES) determines trace elements, including metals, in solution. The purpose of this SOP is to describe the procedures used by Katahdin Analytical Services, LLC personnel to analyze aqueous and solid samples for trace metals by USEPA Method 6010 (Test Methods for Evaluating Solid Waste, Physical/ Chemical Methods, USEPA SW846).

Sample types that may be analyzed using these methods include drinking waters, ground waters, aqueous samples, TCLP, SPLP and EP Toxicity extracts, industrial and organic wastes, soils, sludges, sediments, biological tissue and other solid wastes. The following elements may be analyzed under this SOP: Al, Sb, As, Ba, Be, B, Cd, Ca, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Se, Si, Ag, Na, Sn, Sr, Tl, Ti, V, and Zn.

All samples, except filtered ground water samples, analyzed under USEPA Method 6010 require digestion prior to analysis. USEPA Methods 3005, 3010, and 3050 describe appropriate digestion procedures for samples to be analyzed by ICP-AES under EPA Method 6010. Refer to current revisions of Katahdin SOPs CA-604 and CA-605, current revisions, for sample digestion procedures.

1.1 Definitions

Analytical Spike - An aliquot of a sample to which a known amount of analyte has been added before analysis and after digestion, if digestion is required.

CCB - Continuing Calibration Blank - An analyte-free solution consisting of acidified reagent water used to verify calibration accuracy periodically during analysis.

CCV - Continuing Calibration Verification - A midrange standard used to verify calibration accuracy periodically during analysis.

CRI - Contract Required detection limit sample for ICP - A low concentration standard used to verify calibration accuracy near the low end of the calibration range.

Duplicate - A second aliquot of a sample that is prepared and analyzed in the same way as the original sample in order to determine the precision of the method.

ICB - Initial Calibration Blank - An analyte-free solution consisting of acidified reagent water used to verify calibration accuracy.

ICP-AES - Inductively Coupled Plasma Atomic Emission Spectroscopy.

ICS - Interference Check Sample - Two standards (ICSA and ICSAB) used to verify the effectiveness of interelement correction and background correction. Solution

ICSA contains only interferents (Al, Ca, Fe, and Mg) at high concentrations (200 to 500 mg/L); solution ICSAB contains interferents at the same concentrations as well as analytes at low (20 mg/L or less) concentrations.

ICV - Initial Calibration Verification - A standard made from a source independent from the calibration standards and with analyte concentrations different from those in the CCV; used to verify the accuracy of the instrument calibration.

IDL - Instrument Detection Limit - The lowest concentration of an analyte that can be determined with 99% confidence.

LOD – Limit of Detection – An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix-specific and is used for DoD QSM acceptance criteria.

LOQ – Limit of Quantitation.- The minimum concentration of a target analyte that produces a quantitative result within specified limits of precision and bias.

LCS - Laboratory Control Sample - A standard or solid reference material that has been brought through the sample preparation process.

LRS - Linear Range Standard - A high-concentration standard used to determine the upper reporting limit of the ICP calibration.

PB - Preparation Blank - Reagent water that has been brought through the sample preparation process.

PQL - Practical Quantitation Limit - The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the IDL.

Matrix Spike - An aliquot of a sample to which a known amount of analyte has been added before digestion.

Serial Dilution - The dilution of a sample by a factor of five. When corrected by the dilution factor, the measured analyte concentrations of the diluted sample should agree with those of the original undiluted sample within specified limits. Serial dilution may reflect the influence of interferents.

Hardness – The sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in mg/L.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of, analysts experienced in ICP analysis by EPA Method 6010. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in ICP analysis by Method 6010 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

Samples, sample digestates, standards, and other reagents used in ICP analysis may contain high concentrations of acids and toxic metals. Safety glasses should be worn when changing or adjusting argon tanks.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Wastes from ICP analysis should be disposed of in a manner appropriate to the hazards they present. Wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Analytical Environmental Health and Safety Manual I and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

2.0 SUMMARY OF METHOD

This method describes multielemental determinations by ICP-AES using simultaneous optical systems and radial and axial viewing of the plasma. The basis of the method is the measurement of atomic emission from sample atoms entrained in an argon plasma by optical spectroscopy. Samples are nebulized and the aerosol that is produced is transported to the plasma torch where thermal excitation of entrained atoms and ions occurs. Characteristic atomic-line and ionic-line emission spectra are produced by a radio-frequency inductively coupled plasma (ICP). The spectra are dispersed by a grating and the intensities of the emitted lines are monitored by a solid state charge injection device (CID) camera system. Photocurrents from the CID camera system are measured by a computer system. Element concentrations of unknown samples are quantitated by comparison of sample emission intensities to emission intensities of standards of known concentration. A background correction technique is used to compensate for variable background contribution to the determination of trace elements. Background is measured adjacent to the analyte lines on samples during analysis. The position selected for the background intensity measurement, on either or both sides of the analytical line, has been determined by the complexity of the spectrum adjacent to the analytical line. The position used must be relatively free of spectral interference and must reflect the same change in background intensity as occurs at the analyte wavelength. Physical interferences are corrected through the use of an internal standard (yttrium) that is automatically added to all samples and standards prior to nebulization. The possibility of additional interferences (noted in section 3) must be recognized and appropriate corrections applied.

3.0 INTERFERENCES

Several types of interference effects may contribute to inaccuracies in the determination of trace elements. They can be summarized as spectral interferences, physical interferences, and chemical interferences.

Spectral interferences can be categorized as 1) overlap of a spectral line from another element; 2) unresolved overlap of molecular band spectra; 3) background contribution from continuous or recombination phenomena; and 4) background from stray light from the line emission of high concentration elements. The first of these effects is compensated by utilizing the computer correction of raw data, requiring the monitoring and measurement of the interfering element (interelement correction). The second effect is controlled by choosing analytical wavelengths that are free from overlapping molecular emission spectra. The third and fourth effects are usually compensated by a background correction adjacent to the analyte line. Uncorrected spectral interferences may be detected through examination of serial dilution and matrix spike data.

Physical interferences are generally considered to be effects associated with sample nebulization and transport processes. Such properties as changes in viscosity and surface tension can cause significant inaccuracies, especially in samples that may contain high dissolved solids and/or acid concentrations. Matrix matching of standards and samples and the use of a peristaltic pump may lessen these interferences. If these types of interferences are operative, they must be reduced by dilution of the sample and/or utilization of standard addition techniques. Another problem that can occur from high dissolved solids is salt buildup at the tip of the nebulizer. This affects aerosol flow rate causing instrumental drift. Regular cleaning of nebulizer tips and dilution of samples with high dissolved solids contents are used to control this problem. Physical interferences are also corrected by this laboratory through the use of an internal standard. Uncorrected physical interferences may be detected through examination of serial dilution and matrix spike data. Instrument drift caused by the salting up of nebulizer tips may also be detected by looking for oriented drift in calibration verification standards analyzed regularly throughout the run.

Chemical interferences are characterized by molecular compound formation, ionization effects, and solute vaporization effects. Normally these effects are not pronounced with the ICP technique; however, if observed they can be minimized by careful selection of operating conditions (i.e., incident power, observation position, etc.), by matrix matching, and by standard addition procedures. These types of interferences can be highly dependent on matrix type and the specific analyte element. Uncorrected chemical interferences may be detected through examination of serial dilution data.

4.0 APPARATUS AND MATERIALS

4.1 Computer-controlled inductively-coupled plasma atomic emission spectrometer (plasma viewed radially or axially) equipped for internal standardization, and capable of performing automatic background correction and interelement correction. For more information refer to the current revision of Katahdin SOP CA-632, “Operation and Maintenance of the Thermo ICAP 6500 ICP Spectrophotometer”.

4.2 Computer-controlled autosampler.

4.3 Argon gas supply – high purity.

4.4 Volumetric glassware of suitable precision and accuracy.

4.5 Automatic pipets of suitable precision and accuracy. Calibrated Eppendorf Reference pipets and Finn digital pipets are appropriate.

Refer to the appropriate instrument-specific SOP for additional required equipment.

5.0 REAGENTS AND STANDARDS

5.1 Hydrochloric acid, concentrated (HCl) – spectroscopic grade.

5.2 Nitric acid, concentrated (HNO_3) – spectroscopic grade.

5.3 Reagent water, trace metals free.

5.4 Calibration blank – reagent water containing HCl (5% v/v) and HNO_3 (5% v/v). Calibration blank solution is prepared in large volumes (up to 20 liters) and stored in a carboy. Calibration blank solution is used in establishing the analytical curve, and in all initial and continuing calibration blank determinations. This solution is also used to flush the system between standards and samples. Intermediate and working standards are prepared by diluting stock standards and intermediate standards with calibration blank solution so that all standards and blanks are acid matrix-matched to sample digestates.

5.5 Single element and multielement stock standard solutions – purchased standards prepared from high purity salts or metals, and supplied by the vendors with certificates of purity and analysis. Refer to Tables 5 and 6 for a listing of stock standards required, and to Table 9 for element concentrations in stock standards.

5.6 Intermediate standard solutions – laboratory-prepared multielement standards that are used in the subsequent preparation of working standards. Refer to Table 6 for a listing of intermediate standards required and for preparation instructions. Refer to Table 8 for element concentrations in intermediate standards.

5.7 Working standard solutions – laboratory-prepared multielement standards that are used to calibrate the instrument and to perform all necessary QC checks. Refer to Table 5 for a listing of working standards and for preparation instructions. Refer to Table 7 for element concentrations in working standards.

5.8 5 mg/L yttrium internal standard solution – add 0.5 mL 10000 mg/L yttrium stock standard to a 1000 mL volumetric flask half filled with calibration blank solution. Bring to volume with calibration blank solution.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Samples to be analyzed for trace metals by ICP should be collected and preserved as described in the following table.

Matrix	Container[1]	Volume / Weight	Preservation / Treatment	Holding Time
Aqueous (total)	P, G	250 mL	HNO_3 to pH < 2	6 months
Aqueous (dissolved)	P, G	250 mL	Filter, HNO_3 to pH < 2	6 months
Solid	P, G	10 g	Cool, 4°C	6 months
Tissue	P, G	25 g	Cool, 4°C	6 months

[1] P = polyethylene or, G = glass

7.0 PROCEDURES

7.1 Begin by following the startup and calibration instructions provided in the current revision of Katahdin SOP CA-632, “Operation and Maintenance of the Thermo ICAP 6500 ICP Spectrophotometer”

7.2 Analysis must proceed in the sequence described in Table 10 to ensure that all necessary quality control samples are analyzed at the appropriate frequencies. A minimum of two replicate integrations is required for all standards and samples. Analysis always begins with the analysis of a calibration blank solution (S0) followed by analysis of a multi-element calibration standard (S1 in Table 5) to calibrate the instrument. The system is flushed with calibration blank for two minutes between each sample and standard, and each sample and standard is aspirated for one minute prior to the beginning of emission measurements.

7.3 Analysis continues with analysis of the initial calibration verification standard (ICV) and the initial calibration blank (ICB) to verify the accuracy of the calibration. Refer to Section 8 and Tables 1 through 3 for additional information.

7.4 A continuing calibration verification standard (CCV) and a continuing calibration blank (CCB) must be analyzed at the beginning of the run, after every ten samples, and at the end of the run to verify the continued accuracy of the calibration. Refer to Section 8 and Tables 1 through 3 for additional information.

7.5 Interference check standard solutions (ICSA and ICSAB) must be analyzed at the beginning, end, and at periodic intervals (4-6 hours, 30-40 analytical samples) throughout the sample run to verify the accuracy of the IEC factors. Refer to Section 8 and Tables 1 through 3 for additional information.

7.6 A practical quantitation limit standard (PQL) must be analyzed at the beginning of each run to determine the accuracy of the calibration at the reporting limit. Refer to Section 8 and Tables 1 through 3 for additional information.

7.7 All sample analytical results for a particular element that are bracketed (preceded or followed) by failing results in a QC sample (ICV, ICB, CCV, CCB, ICSA, or ICSAB) for that element must not be reported. The sample must be reanalyzed for the element in question.

7.8 All samples that exceed the linear dynamic range must be diluted and reanalyzed. This includes samples with interfering elements that exceed the calibration ranges, because accurate quantitation of interfering elements is necessary for reliable interelement correction. For example, if a sample has been submitted to the laboratory for lead analysis, and the measured aluminum concentration of that sample exceeds the calibration range for aluminum, it must be diluted sufficiently to bring aluminum within the linear dynamic range and the lead result must be reported from that dilution analysis.

7.9 If dilutions of digested samples are performed, the measured element concentrations must be multiplied by the dilution factor prior to reporting. This is accomplished automatically by entering the dilution factor in the autosampler table prior to initiation of analysis.

7.10 All analyses are performed using yttrium as an internal standard to compensate for enhancement or depression of the analytical signal due to matrix effects. Yttrium solution is pumped at a constant rate through one channel of the peristaltic pump. Samples and standards are pumped through a second channel of the pump. The tubing carrying the internal standard is connected to the tubing carrying samples and standards downstream from the pump, and mixing of the two streams is accomplished in a mixing coil downstream from the connection, prior to nebulization. For each sample or standard, the computer that controls the spectrometer divides the detected emission signal for each element by the detected yttrium emission signal prior to quantitation, thus normalizing all emission signals to that of yttrium. The yttrium recovery must be within ± 20% of the counts of the initial calibration blank. If the recovery is outside of this, the sample must be diluted and reanalyzed.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

USEPA Method 6010 requires the laboratory to perform specific quality control checks to assess laboratory performance and data quality. Minimum frequencies, acceptance criteria, and corrective actions for these control checks are tabulated in Table 1 and are described below. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations and client and project specific Data Quality Objectives. The supervisor, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed. Tables 2 and 3 list the QC Check, minimum frequencies, acceptance criteria, corrective actions, flagging criteria and additional comments for work analyzed in accordance with DoD QSM versions 4.2 and 5.0.

INITIAL DEMONSTRATION OF PERFORMANCE

8.1 Instrument detection limits (IDL) are determined quarterly for each analyte analyzed on each instrument. This determination requires seven replicate analyses of calibration blank solution, performed on three non-consecutive days. The standard deviation of the 21 analyses is multiplied by three to obtain the IDL. For more information on performing IDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.2 Method detection limits (MDL) are determined annually for each analyte analyzed on each instrument. This determination requires at least seven replicate digestions and analyses of reagent water spiked at 3-5 times the anticipated MDL for each analyte. MDLs differ from IDLs in that the seven replicates are digested prior to analysis, and they may be analyzed on a single day. The standard deviation of the 7 (or more) replicate analyses is multiplied by the Student's t-value to obtain the MDL. For more information on performing MDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.3 Limits of Detection (LOD) are used when evaluating data using DoD QSM. The LOD is established by spiking a quality system matrix at 2-3 times the detection limit for a single analyte standard and 1-4 times the detection limit for a multi-analyte standard. The LOD must be verified quarterly. For more information on performing LOD determinations, refer to the current revision of Katahdin SOP QA-806.

8.4 Limits of Quantitation (LOQ) are used when evaluating data using DoD QSM. The LOQ must be above the LOD.

8.5 A Lower Limit of Quantitation Check (LLQC) sample must be prepared and analyzed annually or on an as-needed basis to confirm the laboratory's Practical Quantitation Limits (PQLs). The LLQC sample is equivalent to the PQL standard (Section 8.10) but is carried through the entire sample preparation and analysis process. Element recoveries for the LLQC sample must fall within 70% to 130% of the expected concentrations to confirm the previously established PQLs.

8.6 The upper limit of the linear dynamic range (LDR) must be established for each wavelength utilized. It must be determined from a linear calibration prepared in the normal manner using the established analytical operating procedure for the instrument. The LDR should be determined by analyzing succeedingly higher standard concentrations of the analyte until the observed analyte concentration differs by no more than 10% from the stated concentration of the standard. Determined LDRs must be documented and kept on file. The LDR which may be used for the analyses of samples should be judged by the analyst from the resulting data. Determined sample analyte concentrations that are greater than the determined upper LDR limit must be diluted and reanalyzed. The LDRs should be verified **every six months** or whenever, in the judgment of the analyst, a change in analytical performance caused by either a change in instrument hardware or operating conditions would dictate they be redetermined.

8.7 The alkali and alkaline earth metals may have non-linear response curves due to ionization and self-absorption effects. These curves may be used for quantitation of samples if the effective range is checked and if the second order curve fit has a correlation coefficient of 0.998 or better. Third order fits are not acceptable. Non-linear response curves must be revalidated and recalculated every six months.

ANALYTICAL RUN QC SAMPLES

8.8 An Initial Calibration Verification (ICV) solution is analyzed after the initial calibration to check calibration accuracy. The ICV solution is prepared by combining compatible elements from a standard source different than that of the calibration standard and at concentrations within the linear working range of the instrument. The results of the ICV must fall within 90% to 110% of the expected values. If the ICV fails, result for the failing elements may not be reported from the run unless the ICV recovery is greater than 110% and the sample result is less than the PQL.

No results may be accepted for failing elements if DoD QSM acceptance criteria are being used.

8.9 Continuing Calibration Verification (CCV) solutions are analyzed after the initial calibration, after every ten samples, and at the end of the analytical run. The CCV solution is prepared using the same standards used for calibration at concentrations near the mid-point of the calibration curve. Results of the CCVs must fall within 90% to 110% of the expected values. If a CCV fails, results for the failing elements may not be reported from the run unless the CCV recovery is greater than 110% and the sample result is less than the PQL (less than reporting limit for DoD QSM). Also, for failing elements, all samples analyzed after the last passing CCV must be reanalyzed.

8.10 Calibration blank solution is analyzed after each ICV and CCV. A calibration blank that is analyzed after the ICV is called an Initial Calibration Blank (ICB). A calibration blank that is analyzed after a CCV is called a Continuing Calibration Blank (CCB). The absolute values of results of ICBs and CCBs must be less than the Practical Quantitation Level (PQL) for each element. If an ICB or a CCB fails, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICB or CCB has been analyzed, with the following exception. If the result for a CCB or ICB is greater than the PQL, sample results that are less than the PQL or greater than or equal to ten times the measured CCB concentration may be reported. Also, for failing elements, all samples analyzed after the last passing CCB must be reanalyzed, with the exception noted above.

If DoD QSM acceptance criteria are being used, the absolute values of results of ICBs and CCBs must be less than the Limit of Detection (LOD). If an ICB or a CCB fails, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICB or CCB has been analyzed.

8.11 Interference check solutions ICSA and ICSAB (refer to Section 1.1) are analyzed at the beginning of each run to verify interelement correction factors and background correction. ICSA contains interferent elements (Al, Ca, Fe, and Mg) only, at concentrations of 200 mg/L to 500 mg/L. Results for interfering elements in the ICSA must fall within 80% to 120% of the expected values. Results for unspiked elements in ICSA must fall within ± PQL if the PQL is greater than 0.01 mg/L, within ± 2xPQL if the PQL is less than or equal to 0.01 mg/L. If DoD QSM acceptance criteria are being used, the absolute value of unspiked elements must be less than the LOD. ICSAB contains interferent elements at concentrations of 200 mg/L to 500 mg/L, and analytes at concentrations of 20 mg/L or less. Results for all elements (interferents and analytes) in ICSAB must fall within 80% to 120% of the expected values. If the ICSA or ICSAB fails, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICSA or ICSAB has been analyzed.

8.12 A Practical Quantitation Limit (PQL) Check Standard or low level continuing calibration verification (LLCCV) is analyzed at the beginning (after the ICV and ICB samples) and at the end of each run. Element concentrations in this solution are at the laboratories practical quantitation limit. Element recoveries for the PQL check Standard must fall between 70-130% of the expected values. If the PQL Check Standard fails, the results for the failing elements may not be reported from the run, unless the PQL Check Standard recovery is greater than 130% and the samples results are less than the PQL.

If DoD QSM acceptance criteria are being used, recoveries must fall between 80-120%. If the PQL Check Standard fails, the results for the failing elements may not be reported from the run.

PREPARATION BATCH QC SAMPLES

8.13 Each digestion batch of twenty or fewer samples will contain a preparation blank and a laboratory control sample. Each batch will also contain one or more of the following QC samples: laboratory control sample duplicate, sample duplicate, matrix spike sample or matrix spike sample duplicate.

8.14 A preparation blank (PBW or PBS), consisting of reagent water carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. The results of preparation blanks must be less than the Practical Quantitation Level (PQL) for each element. For DoD QSM acceptance criteria the results must be less than ½ the PQL except for common contaminants which must be less than the PQL. If a preparation blank fails, results for the failing elements may not be reported from the digestion batch, and all associated samples must be redigested, with the following exception. If the result for a preparation blank is greater than the PQL (greater than ½ PQL for DoD), associated sample results that are less than the PQL (less than ½ PQL for DoD) or greater than or equal to ten times the measured preparation blank concentration may be reported.

8.15 A laboratory control sample (LCS), consisting of spiked reagent water or a solid reference material carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. Results for laboratory control samples must fall within 80% to 120% of the expected value, unless vendor-supplied limits (for solid reference materials) or laboratory-generated statistical limits are available. If a laboratory control sample fails, results for the failing elements may not be reported from the digestion batch, and all associated samples must be redigested with the following exception. If the LCS fails high, sample results less than the PQL may be reported.

If DoD QSM 4.2 acceptance criteria are being used, recovery for solid matrix samples must fall between 80% to 120% except for Ag, which must fall between 75% and 120%. If DoD QSM 5.0 acceptance criteria are being used, recovery for water and solid matrix samples must fall between the limits stated in Tables 3 & 4 of the QSM. Results may not be reported without a valid LCS and will be qualified and explained if reanalysis cannot be performed.

SAMPLE MATRIX QC SAMPLES

8.16 Matrix spiked duplicate samples are prepared at a minimum frequency of one per digestion batch. The recovery for each element in a spiked sample or spiked duplicate sample must fall within 75% to 125% of the actual value if the result for the unspiked sample is less than four times the amount of spike added. If one or both spike recoveries fail, the associated sample result must be flagged on the report of analysis. If DoD QSM acceptance criteria are being used, recoveries must be the same as stated for laboratory control samples.

The relative percent difference between sample duplicate, matrix spiked duplicate or LCS duplicate, is calculated as follows:

$$\text{RPD (\%)} = \frac{|D_1 - D_2|}{(|D_1 + D_2|)/2} \text{ x } 100$$

where: D_1 = sample result
D_2= duplicate sample result

A control limit of 20% RPD is applied to duplicate analysis if the original sample result is greater than 50X the IDL. If the matrix spike duplicate analysis fails, the associated sample result must be flagged on the report of analysis.

8.15 A serial dilution is analyzed to check for chemical or physical interferences. If the analyte concentration of a sample is sufficiently high (minimally, 50 x IDL or 50 x LOQ if using DoD QSM acceptance criteria), the measured concentration of a serial dilution (1:5 dilution) of the sample should agree within 90% to 110% of the original determination. The percent difference between the original sample and the serial dilution should be calculated as follows:

$$\text{Difference (\%)} = \frac{|L-S|}{S} * 100\%$$

where: L = Serial dilution result (corrected for dilution)
S = Original sample result

If the serial dilution analysis fails, a matrix interference should be suspected. The associated sample result should be flagged on the report of analysis or the sample should be reanalyzed at dilution to eliminate the interference.

For DoD QSM samples a Post-digestion Spike (PDS) addition must be performed if the serial dilution is not within acceptance criteria.

8.16 Post-digestion Spike (PDS) additions must be performed for DoD QSM samples if the serial dilution is not within acceptance criteria or if the analyte concentrations in all samples are less than 50x the LOD. The spike addition should produce a concentration that is between 10 and 100x the LOQ. The recovery of the PDS must be within 75-125%. If the PDS fails, all samples must be run by method of standard additions or appropriately flagged.

9.0 METHOD PERFORMANCE

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD's must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Quantitation (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ's must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.

MDLs are filed with the Inorganic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revision of Method 6010 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, EPA publication SW-846, Third Edition, Final Updates I (1993), II (1995), IIA (1994), IIB (1995), III (1997), IIIA (1999), IIIB (2005), IV (2008), and V (2015), Method 6010C.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 5.1, January 2017.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-806, Method Detection Limit and Instrument Detection Limit Studies, current revision.

List of Tables & Figures

TABLE 1

QC REQUIREMENTS

Method	QC Sample	Minimum Frequency	Acceptance Criteria	Corrective Action
USEPA 6010	Initial Calibration, minimum 1 point plus a calibration blank.	Daily prior to sample analysis.	Correlation coefficient ® ≥ 0.998	Recalibrate
	Initial Calibration Verification (ICV), prepared from a second source.	Before beginning a sample run.	Recovery within ± 10% of true value.	1) Do not use results for failing elements unless the ICV > 110% and the sample < the PQL. 2) Investigate and correct 3) DoD: No samples may be run until calibration is verified
	Initial Calibration Blank (ICB)	Immediately after the ICV.	Absolute value of ICB < PQL.	1) Do not use results if ≥ PQL and 10x< CCB level. 2) Investigate and correct problem.
	Continuing Calibration Verification (CCV)	At beginning of run, after every 10 samples, and at end of run.	Recovery within ± 10% of true value.	1) Do not use results for failing elements unless the CCV > 110% and the sample < the PQL. 2) Investigate and correct problem.
	Continuing Calibration Blank (CCB)	After every 10 samples and at end of the run.	Absolute value of CCB < PQL.	1) Do not use results if ≥ PQL and < 10x CCB level. 2) Investigate and correct problem.
	Practical Quantitation Level Check Standard (PQL) (LLCCV)	At beginning and end of run.	Recovery within ± 30% of true value.	1) Do not use results for failing elements unless the LLCCV > 110% and the sample < the PQL. 2) Investigate and correct problem.
	Interference Check Solution A (ICSA)	At beginning and end of run.	For Al, Ca, Fe, and Mg, recovery within ± 20% of true value. For analytes not spiked, ± PQL, or, if PQL ≤ 0.01 mg/L, ± 2x PQL.	1) Do not use results for failing elements. 2) Investigate and correct problem.
	Interference Check Solution AB (ICSAB)	At beginning and end of run.	Recovery of each analyte within ± 20% of true value.	1) Do not use results for failing elements. 2) Investigate and correct problem.
	Preparation Blank (PBW/PBS)	One per digestion batch of 20 or fewer samples.	Less than PQL.	1) Investigate source of contamination. 2) Redigest and reanalyze all associated samples if sample concentration ≥ PQL and <10x the blank concentration.
	Laboratory Control Sample (LCSW/LCSS)	One per digestion batch of 20 or fewer samples.	Recovery within ± 20% of true value, unless vendor-supplied or statistical limits have been established.	1) Investigate source of problem. 2) Redigest and reanalyze all associated samples. 3) DoD: Flag specific analytes if samples cannot be reanalyzed.
	Matrix Spike Sample (S)	One per digestion batch of 20 or fewer samples.	Recovery ± 25% of true value, if sample < 4x spike added.	1) Flag results.
	Matrix Spike Duplicate Sample (P) or sample duplicate	One per digestion batch of 20 or fewer samples.	Recovery ± 25% of true value, if sample < 4x spike added. RPD ≤20% for duplicate spikes and sample duplicates.	1) Flag results.

TABLE 1

QC REQUIREMENTS

Method	QC Sample	Minimum Frequency	Acceptance Criteria	Corrective Action
USEPA 6010 (cont.)	Serial Dilution (L)	One per digestion batch.	If original sample result is at least 50x IDL, 5-fold dilution must agree within ± 10% of the original result. Flag result or dilute and reanalyzed sample to eliminate interference	Perform post digestion spike addition (PDS)
	Post-Digestion Spike Sample (A)	When dilution test fails or analyte concentration in all samples <50x LOD	Recovery within ± 25%.	Run associated samples by method of standard addition or flag results.
	Internal Standard	Every sample	± 20% (compared to the initial calibration blank)	Dilute sample and reanalyze.
	Instrument Detection Limit (IDL) Study	Quarterly.	IDL < MDL PQL > 2-3 * the IDL	1) Repeat IDL study. 2) Raise PQL.
	Method Detection Limit (MDL) Study	Refer to KAS SOP QA-806, “Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications”, current revision.		
	Lower Limit of Quantitation Check (LLQC) Sample	Digest and analyze annually or as needed to confirm PQLs	70% - 130% of true value	Re-evaluate PQLs
	Linear Range Study	Every six months	Run succeedingly higher stds until recovery not within ± 10%. Use highest passing concentration as upper limit of linear range.	Only accept data to highest passing concentration until next linear range study.
	Limit of Detection (LOD) Determination	Quarterly	LOD = 1-4X MDL	Repeat LOD Determination
	Limit of Quantification (LOQ) Determination	Quarterly	LOQ > LOD	

TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Demonstrate acceptable analytical capability	Prior to using any test method and at any time there is a significant change in instrument type, personnel, test method, or sample matrix.	QC acceptance criteria published by DoD, if available; otherwise, method-specified criteria.	Recalculate results; locate and fix problem, then rerun demonstration for those analytes that did not meet criteria.	NA.	This is a demonstration of analytical ability to generate acceptable precision and bias per the procedure in Appendix C. No analysis shall be allowed by analyst until successful demonstration of capability is complete.
LOD determination and verification	Refer to current revision of SOP QA-806				
LOQ establishment and verification	Refer to current revision of SOP QA-806				
Instrument detection limit (IDL) study (ICP only)	At initial set-up and after significant change in instrument type, personnel, test method, or sample matrix.	IDLs shall be ≤ LOD.	NA.	NA.	Samples may not be analyzed without a valid IDL.
Linear dynamic range or high-level check standard (ICP only)	Every 6 months.	Within ± 10% of true value.	NA.	NA.	
Initial calibration (ICAL) for all analytes ICP: minimum one high standard and a calibration blank	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r ≥ 0.995.	Correct problem, then repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until ICAL has passed.
Second source calibration verification (ICV)	Once after each ICAL, prior to beginning a sample run.	Value of second source for all analyte(s) within ± 10% of true value.	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Flagging criteria are not appropriate.	Problem must be corrected. No samples may be run until calibration has been verified.

TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Continuing calibration verification (CCV)	ICP: within ± 10% of true value; GFAA: within ± 20% of true value; CVAA: within ± 20% of true value.	Correct problem, rerun calibration verification. If that fails, then repeat ICAL. Reanalyze all samples since the last successful calibration verification.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	After every 10 field samples and at the end of the analysis sequence.	Problem must be corrected. Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-level calibration check standard	Daily, after one-point ICAL.	Within ± 20% of true value.	Correct problem, then reanalyze.	Flagging criteria are not appropriate.	No samples may be analyzed without a valid low-level calibration check standard. Low-level calibration check standard should be less than or equal to the reporting limit.
Method blank	One per preparatory batch.	No analytes detected > ½ RL (> RL for common lab contaminants) and > 1/10 the amount measured in any sample or 1/10 the regulatory limit (whichever is greater). Blank result must not otherwise affect sample results. For negative blanks, absolute value < LOD.	Correct the problem. Report sample results that are <LOD or >10x the blank concentration. Reprepare and reanalyze the method blank and all associated samples with results > LOD and < 10x the contaminated blank result.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Calibration blank	Before beginning a sample run, after every 10 samples, and at end of the analysis sequence.	No analytes detected > LOD. For negative blanks, absolute value < LOD.	Correct problem. Re-prep and reanalyze calibration blank. All samples following the last acceptable calibration blank must be reanalyzed.	Apply B-flag to all results for specific analyte(s) in all samples associated with the blank.	
Interference check solutions (ICS)	At the beginning of an analytical run.	ICS-A: Absolute value of concentration for all non-spiked analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the ICS.	

TABLE 2

DoD QSM 4.2 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
LCS containing all analytes to be reported	One per preparatory batch.	Water and Soil: Recovery must be within + 20% of the true value	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Problem must be corrected. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix spike (MS)	One per preparatory batch per matrix	For matrix evaluation, recovery must be within +/- 20% of the true value.	Examine the project-specific DQOs. If the matrix spike falls outside of DoD criteria, additional quality control tests are required to evaluate matrix effects.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	For matrix evaluation only. If MS results are outside the LCS limits, the data shall be evaluated to determine the source of difference and to determine if there is a matrix effect or analytical error.
Matrix spike duplicate (MSD) or sample duplicate	One per preparatory batch per matrix.	MSD: For matrix evaluation, recovery must be within +/- 20% of the true value. MSD or sample duplicate: RPD ≤ 20% (between MS and MSD or sample and sample duplicate).	Examine the project-specific DQOs. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	The data shall be evaluated to determine the source of difference.
Dilution test	One per preparatory batch.	If sample concentrations > 50 x LOQ, then the five-fold dilution must agree within ± 10% of the original measurement.	Perform post-digestion spike (PDS) addition.	Flagging criteria are not appropriate.	Only applicable for samples with concentrations > 50 x LOQ.
Post-digestion spike (PDS) addition	When dilution test fails or analyte concentration in all samples < 50 x LOD.	Recovery within 75-125%.	Run all associated samples in the preparatory batch by method of standard additions (MSA) or see flagging criteria.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met.	Spike addition should produce a concentration of 10 – 100 x LOQ.
Method of standard additions (MSA)	When matrix interference is confirmed.	NA.	NA.	NA.	Document use of MSA in the case narrative.
Results reported between DL and LOQ	NA.	NA.	NA.	Apply J-flag to all results between DL and LOQ.	

TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Linear Dynamic Range (LDR) or high-level check standard	At initial set up and checked every 6 months with a high standard at the upper limit of the range.	Within ± 10% of true value.	Dilute samples within the calibration range, or re-establish/ verify the LDR.	Flagging is not appropriate.	Data cannot be reported above the high calibration range without an established/passing high-level check standard.
Initial Calibration (ICAL) for all analytes	Daily ICAL prior to sample analysis.	If more than one calibration standard is used, r2 = 0.99.	Correct problem, then repeat ICAL.	Flagging is not appropriate.	Minimum one high standard and a calibration blank. No samples shall be analyzed until ICAL has passed.
Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of true value.	Correct problem. Rerun ICV. If that fails, repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.
Continuing Calibration Verification (CCV)	After every 10 field samples, and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable calibration verification.	Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Low-level Calibration Check Standard (Low-level ICV)	Daily.	All reported analytes within ± 20% of true value.	Correct problem and repeat ICAL.	Flagging is not appropriate.	No samples shall be analyzed without a valid low-level calibration check standard (LLICV). Low-level calibration check standard should be less than or equal to the LOQ.
Method Blank (MB)	One per preparatory batch.	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze method blank and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reanalyzed.

TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Initial and Continuing Calibration Blank (ICB/CCB)	Before beginning a sample run, after every 10 field samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed.	Flagging is not appropriate.	Results may not be reported without a valid calibration blank. For CCB, failures due to carryover may not require an ICAL.
Interference Check Solutions (ICS) (also called Spectral Interference Checks)	After ICAL and prior to sample analysis.	ICS-A: Absolute value of concentration for all non-spiked project analytes < LOD (unless they are a verified trace impurity from one of the spiked analytes); ICS-AB: Within ± 20% of true value.	Terminate analysis; locate and correct problem; reanalyze ICS, reanalyze all samples.	If corrective action fails, apply Q-flag to all results for specific analyte(s) in all samples associated with the failed ICS.	All analytes must be within the LDR. ICS-AB is not needed if instrument can read negative responses.
Laboratory Control Sample (LCS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for failed analytes, if sufficient sample material is available.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to specific analyte(s) in all samples in the associated preparatory batch.	Must contain all reported analytes. Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Matrix Spike(MS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	If MS results are outside the limits, the data shall be evaluated to the source(s) of difference, i.e., matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. MSD or MD: RPD of all analytes = 20% (between MS and MSD or sample and MD)	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J- flag if acceptance criteria are not met and explain in the case narrative.	The data shall be evaluated to determine the source of difference.

TABLE 3

DoD QSM 5.0 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
Dilution Test	One per preparatory batch if MS or MSD fails	Five-fold dilution must agree within ± 10% of the original measurement.	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J- flag if acceptance criteria are not met and explain in the case narrative.	Only applicable for samples with concentrations > 50 x LOQ (prior to dilution). Use along with MS/MSD and PDS data to confirm matrix effects.
Post-Digestion Spike (PDS) Addition (ICP only)	Perform if MS/MSD fails. One per preparatory batch (using the same sample as used for the MS/MSD if possible)	Recovery within 80-120%	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Criteria applies for samples with concentrations <50 X LOQ prior to dilution.
Method of Standard Additions (MSA)	When dilution test or post digestion spike fails and if required by project.	NA	NA	NA	Document use of MSA in the case narrative.

TABLE 4

SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-608-17	Method 6010, current revision
Apparatus/Materials		
Reagents		
Sample preservation/ handling		
Procedures		
QC - Spikes		
QC - LCS		
QC - Accuracy/Precision		
QC - MDL		
QC - Calibration Blanks	Acceptance criteria employed for 6010: ± PQL	Acceptance criteria stated in 6010: less than 10% of PQL

TABLE 5

PREPARATION OF CALIBRATION AND QUALITY CONTROL STANDARDS

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
Calibration Standard (STD1 or S1)	ICP- intermediate Standard	Lab Prepared (see Table 6)	10.0
	QCS 26	High Purity Standards	1.0
Initial Calibration Verification (ICV)	Calibration Standard 3	Claritas PPT	0.96
	1000 mg/L Si	Inorganic Ventures	0.98
	1000 mg/L Al	High Purity Standards	0.96
	IV-28	Inorganic Ventures	0.4
	1000 mg/L Sn, Au	Inorganic Ventures	0.04
Interference Check Sample A (ICSA)	CLPP-ICS-A	Inorganic Ventures	10.0
Interference Check Sample AB (ICSAB)	CLPP-ICS-A	Inorganic Ventures	10.0
	CLPP-ICS-B4	Inorganic Ventures	1.0
	ICSAB-INT	Lab Prepared (see Table 6)	5.0
Continuing Calibration Verification (CCV)	ICP intermediate standard	Lab Prepared (see Table 6)	5.0
	QCS 26	High Purity Standards	0.5
Practical Quantitation Limit Sample (PQL)	PQL-INT	Lab Prepared (see Table 6)	1.0

TITLE: **TRACE METALS ANALYSIS BY ICP-AES USING USEPA METHOD 6010**

TABLE 6

PREPARATION OF INTERMEDIATE STANDARDS

Sample or Solution Name	Component Solution Name	Source of Component	Amount of Component Added per 100 mL Final Volume (mL)
PQL-INT	1000 mg/L Li, Sn, Au	High Purity Standards or Inorganic Ventures	1.0 each
	10000 mg/L K, Na	High Purity Standards or Inorganic Ventures	1.0 each
	1000 mg/l B	High Purity Standards	0.50
	1000 mg/l Zn	High Purity Standards	0.20
	1000 mg/L Cu	High Purity Standards	0.25
	10000 mg/L Si	High Purity Standards	0.20
	1000 mg/L Ti, Tl	High Purity Standards	0.15 each
	1000 mg/L Se, Mo, Co, Ni, Ag, Sr, V, Cr	High Purity Standards	0.1 each
	10000 mg/L Al	High Purity Standards	0.3
	1000 mg/L As,Sb	High Purity Standards	0.08 each
	1000 mg/L Ba, Be, Cd, Mn, Pb	High Purity Standards	0.05 each
	10000 mg/L Fe, Ca, Mg	High Purity Standards	0.1 each
ICSAB-INT	10000 mg/L K,Na	High Purity Standards or Inorganic Ventures	4.0 each
	10000 mg/L B, Li, Mo,Sr,Sn,Ti, Au	High Purity Standards	1.0 each
	10000 mg/L Si	High Purity Standards	0.40
ICP-INT STD (Intermediate)	10000 mg/L Si	High Purity Standards	2.5
	10000 mg/L Ca, Mg, Fe, Al, Na	High Purity Standards	2.4
	10000 mg/L K	High Purity Standards	1.5
	1000 mg/L Au, Li, Sn. Sr	High Purity Standards	1.0

TABLE 7

ELEMENT CONCENTRATIONS IN WORKING STANDARDS

	CONCENTRATION IN SOLUTION, mg/L								
Element	**STD1**	**ICV**	**PQL**	**ICSA**	**ICSAB**	**CCV**	**AL_IEC**	**FE_IEC**	**MN_IEC**
Aluminum	25	10	0.3	500	500	12.5	500		
Antimony	1	0.4	0.008		0.6	0.5			
Arsenic	1	0.4	0.008		0.1	0.5			
Barium	1	0.4	0.005		0.5	0.5			
Beryllium	1	0.4	0.005		0.5	0.5			
Boron	1	0.4	0.05		0.5	0.5			
Cadmium	1	0.4	0.005		1.0	0.5			
Calcium	25	10	0.10	500	500	12.5			
Chromium	1	0.4	0.01		0.5	0.5			
Cobalt	1	0.4	0.01		0.5	0.5			
Copper	1	0.4	0.025		0.5	0.5			
Iron	25	10	0.1	200	200	12.5		200	
Lead	1	0.4	0.005		0.05	0.5			
Lithium	1	0.4	0.1		0.5	0.5			
Magnesium	25	10	0.10	500	500	12.5			
Manganese	1	0.4	0.005		0.5	0.5			10
Molybdenum	1	0.4	0.01		0.5	0.5			
Nickel	1	0.4	0.01		0.5	0.5			
Potassium	25	13.6	1		20	12.5			
Selenium	1	0.4	0.01		0.05	0.5			
Silicon	1	0.4	0.2		2	0.5			
Silver	1	0.4	0.01		0.2	0.5			
Sodium	25	10	1		20	12.5			
Strontium	1	0.4	0.01		0.5	0.5			
Thallium	1	0.4	0.015		0.1	0.5			
Tin	1	0.4	0.1		0.5	0.5			
Titanium	1	0.4	0.015		0.5	0.5			
Vanadium	1	0.4	0.01		0.5	0.5			
Zinc	1	0.4	0.02		1.0	0.5			
Gold	1	.04	0.1		0.5	0.5			

TABLE 8

ELEMENT CONCENTRATIONS IN INTERMEDIATE STANDARDS

Element	**CONCENTRATION IN SOLUTION, mg/L**		
	ICP Intermed STD	**PQL- INT**	**ICSAB- INT**
Aluminum	240	30	
Antimony		0.8	
Arsenic		0.8	
Barium		0.5	
Beryllium		0.5	
Boron		5	10
Cadmium		0.5	
Calcium	240	10	
Chromium		1.0	
Cobalt		1.0	
Copper		2.5	
Iron	240	10	
Lead		0.5	
Lithium	10	10	10
Magnesium	240	10	
Manganese		0.5	
Molybdenum		1.0	10
Nickel		1.0	
Potassium	150	100	400
Selenium		1.0	
Silicon	250	20	40
Silver		1.0	
Sodium	240	100	400
Strontium	10	1.0	10
Thallium		1.5	
Tin	10	10	10
Titanium		1.5	10
Vanadium		1.0	
Zinc		2.0	
Gold	10	10	10

TABLE 9

ELEMENT CONCENTRATIONS IN STOCK STANDARDS

	CONCENTRATION IN SOLUTION, mg/L				
Element	**IV-28**	**QCS-26**	**CLPP-ICS-A**	**CLPP-ICS-B4**	**CL-CAL-3**
Aluminum	100	100	5000		
Antimony	100	100		60	
Arsenic	100	100		10	
Barium	100	100		50	
Beryllium	100	100		50	
Boron	100	100			
Cadmium	100	100		100	
Calcium	100	100	5000		1000
Chromium	100	100		50	
Cobalt	100	100		50	
Copper	100	100		50	
Iron	100	100	2000		1000
Lead	100	100		5	
Lithium	100				
Magnesium	100	100	5000		1000
Manganese	100	100		50	
Molybdenum	100	100			
Nickel	100	100		100	
Potassium	1000	1000			1000
Selenium	100	100		5	
Silicon	50	50			
Silver	100	100		20	
Sodium	100	100			1000
Strontium	100				
Thallium	100	100		10	
Tin					
Titanium	100	100			
Vanadium	100	100		50	
Zinc	100	100		100	

TABLE 10

REQUIRED ANALYTICAL SEQUENCE

Sequence Number	Standard/Sample	Purpose
1	Blank (Calibration Blank)	Initial calibration
2	S1 (Calibration Standard)	Initial calibration
3	ICV (Initial Calibration Verification)	Check calibration accuracy
4	ICB (Initial Calibration Blank)	Check calibration accuracy
5	PQL (Practical Quantitation Level Sample)	Check calibration accuracy near PQL, repeat before final CCV, CCB
6	ICSA (Interference Check Solution A)	Verify accuracy of IEC factors, repeat before final CCV, CCB
7	ICSAB (Interference Check Solution AB)	Verify accuracy of IEC factors, repeat before final CCV, CCB
8	CCV (Continuing Calibration Verification)	Check calibration stability
9	CCB (Continuing Calibration Blank)	Check calibration stability
10-19	Analyze up to 10 samples	
20	CCV (Continuing Calibration Verification)	Check calibration stability
25	CCB (Continuing Calibration Blank)	Check calibration stability
…	Continue analyzing sequences of up to 10 samples, followed by a CCV and a CCB	

ATTACHMENT 1

HARDNESS BY CALCULATION

As referenced in “Standard Methods for the Examination if Water and Wastewater,” Methods 2340 A & B, Hardness Introduction and Hardness by Calculation, American Public Health Association, 18th Edition, Revised 1992, total hardness is the sum of the calcium and magnesium concentrations, both expressed as calcium carbonate, in milligrams per liter.

Once the calcium and magnesium concentrations have been determined by EPA methods 6010, 6020, 200.7 or 200.8, the total hardness of an aqueous sample may be calculated as follows:

$$\text{Total Hardness, mg equivalent } CaCO_3/L = 2.497\ (\text{Ca, mg/L}) + 4.118\ (\text{Mg, mg/L})$$

The calcium hardness of an aqueous sample may also be calculated as follows:

$$\text{Calcium Hardness, mg equivalent } CaCO_3/L = 2.497\ (\text{Ca, mg/L})$$

ATTACHMENT 2

ANALYSIS OF PALLADIUM BY SW846 6010

Palladium may be analyzed by EPA Method SW846 6010C following the method outlined in this SOP. However, due to significant spectral interferences caused by addition of palladium to the calibration and check standards used in this method, palladium is added to aliquots of the regular standards as needed for analysis. Two stock standards (1000 mg/L) are currently kept for palladium analysis. One is purchased from High Purity Standards and is used for calibration, PQL, ICSAB, and CCV. The other is purchased from Inorganic Ventures and is used as the independent check standard (ICV). Analysts should add palladium stock to the regular standards according to the table below:

Name of Working Standard	Volume of Standard Aliquot (mL)	Volume of Palladium Stock Added (mL)	Concentration of Palladium (mg/L)	Source of Palladium Stock
Calibration Std.	50	0.05	1.0	High Purity
ICV	50	0.02	0.4	Inorganic Ventures
PQL	50	0.005	0.1	High Purity
ICSAB	50	0.025	0.5	High Purity
CCV	50	0.025	0.5	High Purity

Prior to starting the run, a palladium-only standard should be analyzed along with the iron and aluminum standards to evaluate interelement correction factors as outlined in Katahdin SOP CA-632, Section 7.1.

CA-611-11
DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

TITLE: **DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471**

Prepared By: George Brewer Date: 12/97

Approved By:

Group Supervisor: George Brewer Date: 01/29/01

Operations Manager: John C Burton Date: 1/29/01

QA Officer: Deborah J. Nadeau Date: 1.29.01

General Manager: Date: 1/29/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
02 7471A	Format changes, added pollution prevention, other minor changes to sections 7, 8 and QA Table.	DN	1.29.01	1/29/01
03 7471A	Changed Leeman PS200 Automated Mercury Analyzer to Cetac M6100 Mercury analyzer. Revised Sect. 10 to show correct reference material. Removed fig. 2 Revised sect. 4.8, 5.7 and 8.9 to reflect current practises. minor changes throughout	LAD	021605	021605
04 7471A	Sect. 5.9 and 5.10 - changed preparation of intermediate mercury standards from daily to monthly. Sect. 7.8 - removed calibration blanks (LCB/CCB). They are prepared in sect. 7.6. Added weighing of boiling chips for the prep blanks. Sect. 8.3 - Removed intermediate standards	LAD	03/08	03/08
05	Revised Sections 8 and 10, and Tables 1 and 2 to update compliance from method 7471A to method 7471B.	LAD	02/09	02/09
06	Added LOD definition. Updated sections 8, 9, 10 and Table 1 for DoD QSM version 4.1 compliance.	DN	08/09	08/09

TITLE: **DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471**

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
07	Added Table 2 with DoD QSM Version 4.1 QC Requirements	LAD	04/10	04/10
08	Sect. 4.6 - Changed thermometer type. Added LCSO - A LCS prepped using aqueous mercury LCS spike. Updated type of marker used to label digestion bottles. Updated corrective action for failing PQL standard.	LAD	12/10	12/10
09	Sect. 7 - Changed calibration digestion from digestion of all points to digestion of high point and dilution of rest. Changed prep from 3 ~ 0.2g aliquots to 1 ~ 0.6g aliquot. Added additional prep info. Added Serial dilution and PDS to sect. 8, Added MDL, LOD, LOQ info. to Sect. 9. Updated and added references to Sect. 10.	LAD	04/12	04/12
10	Sect. 7 - Corrected Calibration preparation, changed digestion temperature to 95 +/- 3°C. Sect. 10 - Added and updated references. Added Table 3 - DoD QSM 5.0 QC Requirements	LAD	06/14	06/14
11	Sect. 4 - Added snap-top containers and digestion tubes. Sect 5 - Updated Aqua Regia prep. Sect. 7 - Added heat block and digestion tube instructions, minor edits. Removed Table 2, updated fig. 1, added fig. 4 Changed ~~KASNCO~~ KASINC to KAS throughout. LAD 102517	LAD	10/17	10/17

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document SOP CA-611-11, Titled Digestion and Analysis of Solid Samples for Mercury by USEPA Method 7471.

Recipient: ____Date:____________________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document SOP CA-611-11, Titled Digestion and Analysis of Solid Samples for Mercury by USEPA Method 7471.

.

Recipient: ____Date:____________________

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedure used by Katahdin Analytical Services personnel for the digestion and analysis solid samples for mercury using cold vapor atomic absorption spectrophotometry.

This method is applicable to the determination of mercury in soils, sediments, bottom deposits, sludges and tissue under USEPA Method 7471 (Test Method for Evaluating Solid Wastes, USEPA SW 846, Third Edition).

1.1 Definitions

ICB - Initial Calibration Blank - An analyte-free solution consisting of acidified laboratory reagent grade water used to verify calibration accuracy.

CCB - Continuing Calibration Blank - An analyte-free solution consisting of acidified laboratory reagent grade water used to verify calibration accuracy periodically during analysis.

ICV - Initial Calibration Verification - A standard made from a source independent from the calibration standards and with analyte concentrations different from those in the CCV; used to verify the accuracy of the instrument calibration.

CCV - Continuing Calibration Verification - A midrange standard used to verify calibration accuracy periodically during analysis.

LCS - Laboratory Control Sample - A standard or solid reference material that has been brought through the sample preparation process. LCSS utilizes the standard reference material. LCSO is spiked with aqueous mercury LCS spike.

PB - Preparation Blank - Laboratory reagent grade water that has been brought through the sample preparation process.

Matrix Spike - An aliquot of a sample to which a known amount of analyte has been added before digestion.

Duplicate - A second aliquot of a sample that is prepared and analyzed in the same way as the original sample in order to determine the precision of the method.

SERIAL DILUTION - The dilution of a sample by a factor of five. When corrected by the dilution factor, the measured analyte concentrations of the diluted sample should agree with those of the original undiluted sample within specified limits. Serial dilution may reflect the influence of interferents.

IDL - Instrument Detection Limit - The lowest concentration of an analyte that can be determined with 95% confidence by the instrument.

MDL - Method Detection Limit - The minimum concentration of an analyte that can be identified, measured, and reported with 99% confidence that the analyte concentration is greater than zero.

LOD – Limit of Detection – An estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix-specific and is used for DoD QSM acceptance criteria.

PQL - Practical Quantitation Limit - The lowest concentration of an analyte that is routinely reported by the laboratory; nominally three to five times the IDL.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of mercury by USEPA Method 7471. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in analysis of mercury by USEPA Method 7471 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to ensure that members of their group follow this SOP, to ensure that their work is properly documented, and to initiate periodic review of the associated logbooks.

1.3 Safety

Many of the samples and reagents used in cold vapor atomic absorption are toxic or corrosive. Gloves, safety glasses, lab coats, and other protective clothing should be worn whenever these materials are handled. Because of the toxic nature of mercury vapor, care must be taken to avoid its inhalation. The instrument exhaust fan must be in operation whenever the mercury analyzer is in use (the fan should never be shut off).

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Plan for further details on pollution prevention techniques.

Samples, sample digestates, standards, and other reagents used in cold vapor atomic absorption may contain high concentrations of acids, mercury, and other toxic metals. They should be disposed of in a manner appropriate to the types of hazards they present. All digested mercury samples and standards and excess reagents and standards should be disposed of in the satellite waste container for corrosive wastes (labeled “Waste Stream A”) that is located in the Metals Prep lab. Further information regarding waste classification and disposal may be obtained by consulting the laboratory's Katahdin Analytical Environmental Health and Safety Manual and the Department Manager.

2.0 SUMMARY OF METHOD

The cold vapor atomic absorption technique is based on the absorption of radiation at 253.7 nm by mercury vapor. It relies on the volatility of elemental mercury at room temperature. During preparation, organic mercurials are oxidized and elemental mercury is ionized to Hg^{3+}. During instrumental analysis, mercuric ions are reduced to elemental mercury by the addition of stannous chloride. Elemental mercury is then aerated from solution and passes through a cell positioned in the path of a mercury spectrophotometer, where absorbance (peak height) is measured as a function of mercury concentration and recorded by the associated computer. The mercury vapor is then swept out of the instrument into an exhaust hood, where it is evacuated from the laboratory.

3.0 INTERFERENCES

In addition to inorganic forms of mercury, organic mercurials may be present in environmental samples. These organo-mercury compounds will not respond to the cold vapor atomic absorption technique unless they are first broken down and converted to mercuric ions. The presence of undigested organo-mercurials in samples will result in a low bias for analytical results. Certain volatile organic materials will also non-specifically absorb radiation at the 253.7 nm analytical wavelength. The presence of such compounds may result in a high bias for analytical results. For these reasons, complete digestion using potassium permanganate is required for all environmental samples. Complete digestion is indicated by the persistence of the purple permanganate color (indicating the presence of excess permanganate) following digestion.

Samples that are high in chlorides may require additional permanganate to maintain a persistent purple color following digestion. During the oxidation step, chlorides are converted to free chlorine, which will absorb radiation at the 253.7 nm analytical wavelength. Any free chlorine thus generated will be present in the headspace of the digestion vessel following digestion. Because samples are poured into autosampler tubes prior to analysis by the mercury analyzer, any free chlorine present in the headspace of the digestion vessels is not sampled by the instrument and the analysis is free of chlorine interference.

4.0 APPARATUS AND MATERIALS

4.1 250 mL Pyrex media bottles with plastic screw caps or digestion tubes, for use as digestion vessels.

4.2 Heat source capable of maintaining a constant temperature of 95°C.

4.3 Analytical balance capable of weighing to 0.01 g.

4.4 Adjustable volume automatic pipettes - 2 to 20 uL, 10 to 100 uL, 100 to 1000 uL. Calibrated Eppendorf Reference pipets and Finn digital pipets are appropriate.

4.5 Repipetters (adjustable repeating pipetters with reservoirs) for dispensing concentrated nitric acid, concentrated sulfuric acid, and other reagents.

4.6 Thermometer, NIST-traceable, covering the range from -10° to 110° C, for monitoring the temperature of the water bath. Mercury-filled thermometers are not acceptable for use in the metals laboratory, due to the possibility of breakage and consequent contamination.

4.7 Disposable graduated polystyrene sample cups, 200 mL capacity.

4.8 CETAC M6100 Mercury Analyzer and associated peripherals and parts.

4.9 4oz graduated snap-cap container, 120 mL capacity.

Refer to Katahdin SOP CA-629, current revision, “Operation and Maintenance of the CETAC M6100 Mercury Analyzer” for additional required materials.

5.0 REAGENTS AND STANDARDS

5.1 Laboratory reagent grade water – mercury-free water.

5.2 Concentrated nitric acid (HNO_3), trace metal grade

5.3 Concentrated hydrochloric acid (HCl), trace metal grade

5.4 1:1 Aqua regia: Prepare an appropriate amount immediately before use. Start with 4 parts laboratory reagent grade water, carefully add one part of concentrated HNO3 and then three parts of concentrated HCl in a heat-proof beaker or flask. Preparation of aqua regia must be performed in a fume hood. Record preparation in “Metals Preparation Laboratory - Reagent Preparation Logbook”. Refer to Figure 4 for a cop of a page from this logbook

5.5 Potassium permanganate solution, 5% w/v: Dissolve 50 g of potassium permanganate in 1 L laboratory reagent grade water. The source reagent should be labeled as suitable for use in mercury determination.

5.6 Sodium chloride – hydroxylamine hydrochloride solution: Dissolve 120 g sodium chloride and 120 g hydroxylamine hydrochloride in laboratory reagent grade water and dilute to a final volume of 1 L.

5.7 Stannous chloride solution: Add 70 mL concentrated hydrochloric acid to 500 mL of laboratory reagent grade water. Add 100 g stannous chloride and bring to a final volume of 1 L. Mix to dissolve. Reagent should be labeled as suitable for use in mercury determination.

5.8 Mercury Stock Standards: Two 10.0 mg/L mercury stock standards, obtained from separate sources, are required. The mercury concentrations of these standards must be certified by the manufacturers as traceable to NIST reference standards.

5.9 Intermediate Mercury Standard A: Appropriately dilute a mercury stock standard to obtain a solution containing 1000 ug of mercury per liter in 2% nitric acid. This intermediate standard is used to prepare calibration standards, matrix spikes, CCVs, and laboratory control samples (refer to Section 8). The identity of the stock standard currently used to prepare this intermediate standard and instructions for its dilution may be obtained by consulting the Standards Preparation Logbook maintained in the Section. Intermediate Mercury Standard A must be prepared monthly, and disposed of appropriately after use. (Note: the concentrations of all stock standards must be certified by the vendors as traceable to NIST reference materials).

5.10 Intermediate Mercury Standard B: Appropriately dilute a mercury stock standard to obtain a solution containing 1000 ug of mercury per liter in 2% nitric acid. The source of the stock standard used to prepare Intermediate Mercury Standard B must be distinct from that used to prepare Intermediate Mercury Standard A (i.e. obtained from a separate vendor). Intermediate Mercury Standard B is used to prepare the ICV (refer to Section 8.0). The identity of the stock standard currently used to prepare this intermediate standard and instructions for its dilution may be obtained by consulting the Standards Preparation Logbook maintained in the Section. Intermediate Mercury Standard B must be prepared monthly, and disposed of appropriately after use.

5.11 Solid Reference Material: A soil with a known or empirically-established mercury concentration for use in preparing the laboratory control sample for soils. Solid reference materials should be purchased with certificates listing reference values and quality control acceptance limits. See Figure 3 for an example certificate of analysis for a solid reference material.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Soil samples to be analyzed for mercury should be collected and preserved as described in the following table.

Matrix	Container[1]	Collection Volume/ Weight	Preservation/ Treatment	Holding Time
Solid	P, G	40 g	Cool to $4^{o}C \pm 2^{o}$	28 days

[1] P = polyethylene, G = glass

7.0 PROCEDURES

BOTTLE PREPARATION

7.1 Glass mercury digestion bottles are reused, and must be cleaned between uses. After the previous contents of the bottles have been discarded, bottles are segregated according to whether the measured mercury concentrations of the previous contents were above the PQL (contaminated bottles) or below the PQL (uncontaminated bottles). Labels are removed from the bottles by wiping with a paper towel saturated with toluene. Both contaminated and uncontaminated bottles are then cleaned with Liquinox and water, if necessary, to remove visible grime, and rinsed thoroughly with tap water.

7.2 Uncontaminated bottles are then triple-rinsed with laboratory reagent grade water, and are ready for reuse.

7.3 Contaminated bottles are placed in a bath containing 10% HCl for at least 12 hours. After acid-leaching, these bottles are triple rinsed with laboratory reagent grade water, and are then ready for reuse.

PREPARATION OF STANDARDS, QC SAMPLES, AND BLANKS

7.4 Prior to performing the digestion, make a list of the samples that are to be digested. Enter digestion information (Katahdin Sample Numbers, Bottle IDs, QC Batch ID, preparation date, analyst initials, etc.) into the ACCESS computer database and print out a copy of the benchsheet. All necessary details of sample preparation (standards preparation information, digestion times, digestion temps, initial weights and final volumes, pertinent observations, etc.) must be recorded on this benchsheet, which will be bound in the Mercury Preparation Logbook. Refer to Figure 1 for an example page from the Mercury Preparation Logbook.

7.5 Using an industrial marker with super permanent ink, label clean digestion bottles with the appropriate sample numbers and standard identifications for each sample, preparation blank, laboratory control sample and matrix spike sample to be digested.

7.6 Calibration Preparation - Use a bottle-top dispenser to add 100 mL of laboratory grade reagent water to a standard digestion bottle (250 mL media bottles). Using a calibrated adjustable pipette, prepare the high calibration standard by adding 1000 uL of Intermediate Mercury Standard A to an appropriately labeled media bottle containing 100 mL of laboratory grade reagent water. The mercury concentration of this calibration standard is 10.0 ug/L. Calibration levels 0.2 ug/L, 0.5 ug/L, 1.0 ug/L, 5.0 ug/L are made by diluting the 10.0 ug/L standard into calibration blank solution. See below for amounts. The 0.2 ug/L and 5.0 ug/L standards are analyzed after calibration as the PQL standard and the CCV (refer to Section 8.0), respectively, as well as being used in the creation of the calibration curve.

Calibration Level	Amount added	Amount Calibration Blank Solution
0.2 ug/L	0.3 mL	14.7 mL
0.5 ug/L	0.5 mL	9.5 mL
1.0 ug/L	1 mL	9 mL
5.0 ug/L	5 mL	5 mL

7.7 Using a calibrated adjustable pipette, prepare the initial calibration verification (ICV) standard (refer to Section 8) by adding 600 uL of Intermediate Mercury Standard B to an appropriately labeled digestion bottle. The mercury concentration of the ICV will be 6.0 ug/L.

7.8 Prepare an appropriate number of preparation blanks (PBS) by adding 1.0 g of Teflon boiling chips to labeled digestion bottles.

7.9 Prepare an appropriate number of laboratory control samples (LCSS or LCSO) by weighing appropriate masses of solid reference material or by adding 500 uL of Intermediate Mercury Standard A respectively into labeled digestion bottles. The mercury concentration of the LCSS will depend on the solid reference material used, and the mass of each aliquot. Refer to Figure 3 for an example certificate of analysis for a solid reference material. The mercury concentration of the LCSO will be 5.0 ug/L.

7.10 Matrix spikes are prepared by adding 100 uL of Intermediate Mercury Std A to each matrix spike sample. The amount of mercury added to each matrix spike increases the final digestate concentration by 1.0 ug/L.

7.11 Preparation blanks, laboratory control spike and matrix spikes are digested in the same manner as client samples. Refer to Sample Preparation and Digestion, Steps 7.12 through 7.16 of this SOP. Calibration standards are not digested.

SAMPLE PREPARATION AND DIGESTION

7.12 Do not decant any water on the sediment sample. **Note:** Some workorders may have to decant samples in the work notes. This is **always** done during login and **never** at the time of extraction. Samples decanted during login will be marked accordingly.

Mix sample with a wooden spatula to ensure homogeneity of the sample. Please refer to the current revision of Katahdin Analytical Services SOP CA-108, "Basic Laboratory Technique", for more detailed guidance on sub-sampling to ensure reproducibility.

Weigh an approximate 0.6 g portion of untreated, homogenized sample from the sample container and place in the bottom of a labeled digestion bottle.

7.13 Add 10 Ml of 1:1 Aqua Regia to each sample, standard, and QC sample. Place bottles in a heat source located in a fume hood and heat for 2 minutes at 95 ±3°C. Remove the bottles from the water bath and allow them to cool in a fume hood.

7.14 For glass mercury bottle preparation, add 50 Ml of laboratory reagent grade water and 15 Ml of potassium permanganate solution to each digestion bottle, swirl to mix, and allow to stand for at least 15 minutes. For mercury digestion tube preparation, add 20 Ml of laboratory reagent grade water and 15 Ml of potassium permanganate solution to each digestion bottle, swirl to mix, and allow to stand for at least 15 minutes. For Samples that contain large amounts of oxidizable organic matter may require additional 15 Ml aliquots of potassium permanganate solution. This is indicated by the failure of the purple permanganate color to persist for the entire 15 minute waiting period. Add additional 15 Ml aliquots to samples as necessary until the purple color persists for 15 minutes. If any of the samples requires these additional aliquots of permanganate, note that fact on the mercury preparation benchsheet and accordingly adjust the final volumes recorded on the benchsheet for those samples.

When a persistent purple color has been obtained for all samples, place the digestion bottles in the water bath and heat for 30 minutes at 95°C. Record initial and final time and temperatures on the mercury preparation benchsheet.

7.15 Remove the bottles from water bath and allow them to cool in a fume hood. If any of the samples have become colorless during heating, add additional 15 Ml aliquots of potassium permanganate solution as necessary to obtain a persistent purple color and heat for an additional 30 minutes at 95 ±3 ^{O}c. Record any information regarding additional permanganate aliquots on the mercury preparation benchsheet and accordingly adjust the final volumes recorded on the benchsheet for the samples affected.

7.16 For glass mercury bottle preparation, add 6 Ml of sodium chloride – hydroxylamine hydrochloride solution to each digestion bottle and swirl to mix. Perform this addition in a fume hood, as chlorine gas may be evolved. This will reduce the excess permanganate, and the sample will change from purple to colorless. Add 50 Ml of laboratory reagent grade water to each bottle. Wait at least 30 seconds before proceeding with analysis.

For mercury digestion tube preparation, quantitatively transfer sample to 4oz snap cap and then add 6 Ml of sodium chloride – hydroxylamine hydrochloride solution to each digestion bottle and swirl to mix. Perform this addition in a fume hood, as chlorine gas may be evolved. This will reduce the excess permanganate, and the sample will change from purple to colorless. Bring sample to 100 Ml final volume with reagent grade water. Wait at least 30 seconds before proceeding with analysis.

INSTRUMENTAL ANALYSIS

7.17 Digested mercury samples are analyzed using the CETAC M6100 Mercury Analyzer. Analysis is automated and is controlled by the QuickTrace software running on a dedicated PC. Detailed instructions for setting up the instrument and running samples are given Katahdin SOP CA-629, “Operation and Maintenance of the CETAC M6100 Mercury Analyzer”. The following information specifically pertains to analysis of digested samples in accordance with USEPA Method 7471, and should be used in conjunction with the instructions given in Katahdin SOP CA-629.

7.18 Instrument operating conditions and quality control acceptance limits are specified in the instrument software in “templates”. The template that is used to analyze digested samples in accordance with USEPA Method 7471 is named “SW846-7470-7471”.

7.19 Prior to analysis, digested samples, standards, and QC samples are decanted into autosampler tubes which are placed in racks on the instrument’s autosampler. The “standards” autosampler rack has 10 positions for 25 x 100 mm autosampler tubes (50 Ml capacity). Tubes containing the calibration standards, the ICV, the CCV, the ICB/CCB, and the PQL standard are placed in the appropriately labeled positions in this autosampler rack.

7.20 Client samples, batch QC samples (preparation blanks and laboratory control samples), and matrix QC samples (duplicates and matrix spikes) are decanted into 17 x 100 mm autosampler tubes (15 Ml capacity), which are placed in the one of the “samples” autosampler racks. The “samples” autosampler racks have 60 positions for 17 x 100 mm autosampler tubes. Instructions for filling the “samples” autosampler racks, including recording the rack position of each sample, are contained in Katahdin SOP CA-629, “Operation and Maintenance of the CETAC M6100 Mercury Analyzer”.

METHOD OF STANDARD ADDITIONS

7.21 The standard addition technique involves adding known amounts of standard to one or more aliquots of the processed sample solution. This technique compensates for a sample constituent that enhances or depresses the analyte signal, thus producing a different slope from that of the calibration standards. It will not correct for additive interferences that cause a baseline shift. The method of standard additions shall be used for analysis of all EP extracts, on all analyses submitted as part of a delisting petition, and whenever a new sample matrix is being analyzed.

7.21.1 The simplest version of this technique is the single-addition method, in which two identical aliquots of the sample solution, each of volume V_x, are taken. To the first (labeled A) is added a known volume V_S of a standard analyte solution of concentration C_S. To the second aliquot (labeled B) is added the same volume V_S of the solvent. The analytical signals of A and B are measured and corrected for non-analyte signals. The unknown sample concentration C_x is calculated:

$$C_X = \frac{S_B V_S C_S}{(S_A - S_B) V_X}$$

where S_A and S_B are the analytical signals (corrected for the blank) of solutions A and B, respectively. V_s and C_s should be chosen so that S_A is roughly twice S_B on the average, avoiding excess dilution of the sample. If a separation or concentration step is used, the additions are best made first and carried through the entire procedure.

7.21.2 Improved results can be obtained by employing a series of standard additions. To equal volumes of the sample are added a series of standard solutions containing different known quantities of the analyte, and all solutions are diluted to the same final volume. For example, addition 1 should be prepared so that the resulting concentration is approximately 50 percent of the expected absorbance from the endogenous analyte in the sample. Additions 2 and 3 should be prepared so that the concentrations are approximately 100 and 150 percent of the expected endogenous sample absorbance. The absorbance of each solution is determined and then plotted on the vertical axis of a graph, with the concentrations of the known standards plotted on the horizontal axis. When the resulting line is extrapolated to zero absorbance, the point of interception of the abscissa is the endogenous concentration of the analyte in the sample. The abscissa on the left of the ordinate is scaled the same as on the right side, but in the opposite direction from the ordinate. An example of a plot so obtained is shown in Figure 2. A linear regression program may be used to obtain the intercept concentration.

7.22 For the results of this MSA technique to be valid, the following limitations must be taken into consideration:

- The apparent concentrations from the calibration curve must be linear over the concentration range of concern. For the best results, the slope of the MSA plot should be nearly the same as the slope of the standard curve. If the slope is significantly different (greater than 20%), caution should be exercised.

- The effect of the interference should not vary as the ratio of analyte concentration to sample matrix changes, and the standard addition should respond in a similar manner as the analyte.

- The determination must be free of spectral interference and corrected for nonspecific background interference.

DATA REDUCTION AND REPORTING

7.23 Results are obtained in units of ug/L in the digestate. Results that exceed the calibration range of the instrument may not be reported – the sample must be appropriately diluted and reanalyzed. Results for diluted samples must be multiplied by the dilution factor prior to reporting. If additional aliquots of potassium permanganate were added during digestion, the change in digestate final volume must be taken into account in calculating the final result. Mercury results for solid samples are reported in units of ug/g, calculated on a dry weight basis. Calculation of mercury results for solid samples is performed automatically by the Metals reporting database, as follows:

$$\text{Mercury Concentration in Solid (mg/kg dry wt.)} = \frac{I \times (DF) \times (FV) \times 100}{(W) \times (TS)}$$

where C = Measured digestate concentration (ug/L)
DF = Instrument dilution factor
FV = Digestate final volume (L)
W = Digested wet sample weight (g)
TS = Total Solids (%)

7.24 Results are reported down to the laboratory's practical quantitation level (PQL), unless otherwise requested. Results below the PQL should be reported as "<PQL".

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

USEPA Method 7471 requires the laboratory to perform specific quality control checks to assess laboratory performance and data quality. Minimum frequencies, acceptance criteria, and corrective actions for these control checks are tabulated in Table 1 and are described below. Preparation instructions and the resulting mercury concentrations for calibration standards, QC standards, and matrix spikes are detailed in Sections 7.6 through 7.10 of this SOP. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations and client and project specific Data Quality Objectives. The supervisor, Operations Manager, General Manager and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

INITIAL DEMONSTRATION OF PERFORMANCE

8.1 Instrument detection limits (IDL) are determined quarterly for each analyte analyzed on each instrument by each method. This determination requires seven replicate analyses of laboratory reagent grade water spiked, performed on three non-consecutive days. The standard deviation of the 21 analyses is multiplied by three to obtain the IDL. For more information on performing IDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.2 Method detection limits (MDL) are determined annually for each analyte analyzed on each instrument. This determination requires at least seven replicate digestions and analyses of laboratory reagent grade water spiked at 3-5 times the anticipated MDL for each analyte. MDLs differ from IDLs in that the replicates are digested prior to analysis, and they may be analyzed on a single day. The standard deviation of the 7 (or more) replicate analyses is multiplied by the Student's t-value to obtain the MDL. For more information on performing MDL determinations, refer to the current revision of Katahdin SOP QA-806.

8.3 Limits of Detection (LOD) are used when evaluating data using DoD QSM. The LOD is established by spiking a quality system matrix at 2-3 times the detection limit for a single analyte standard and 1-4 times the detection limit for a multi-analyte standard. The LOD must be verified quarterly. For more information on performing LOD determinations, refer to the current revision of Katahdin SOP QA-806.

ANALYTICAL RUN QC

8.4 Instrument calibration – The instrument must be calibrated each time it is set up, and calibration standards must be digested each day that samples are digested. Calibration includes analysis of a calibration blank and five calibration standards with graduated concentrations in the appropriate range. The concentration of one of the calibration standards must be at the Practical Quantitation Level (PQL). The correlation coefficient for the calibration curve must be at least 0.995. If the calibration curve does not pass this test, analysis must be halted, the problem corrected, and the instrument recalibrated.

8.5 An Initial Calibration Verification (ICV) solution is analyzed after the initial calibration to check calibration accuracy. The ICV solution is prepared from a standard source different than that of the calibration standard and at a concentration within the working range of the instrument. The result of the ICV must fall within 90% to 110% of the expected value. If the ICV fails, results may not be reported from the run until the problem is corrected and a passing ICV has been analyzed.

8.6 The Continuing Calibration Verification (CCV) solution is analyzed after the initial calibration, after every ten samples, and at the end of the analytical run. The CCV solution is prepared using the same standard used for calibration at a concentration near the mid-point of the calibration curve. Results of the CCVs must fall within 90% to 110% of the expected value. If a CCV fails, associated sample results may not be reported from the run until the problem is corrected and a passing CCV has been analyzed. Also, all samples analyzed after the last passing CCV must be reanalyzed. For DoD QSM acceptance criteria, samples that are below the reporting limit may be reported if the CCV reads greater than 120%.

8.7 A calibration blank is analyzed after each ICV and CCV. A calibration blank that is analyzed after the ICV is called an Initial Calibration Blank (ICB). A calibration blank that is analyzed after a CCV is called a Continuing Calibration Blank (CCB). The absolute values of results of ICBs and CCBs must be less than the Practical Quantitation Level (PQL) for each element. If samples are being run using DoD QSM criteria, the absolute values of ICBs and CCBs must be less than the Limit of Detection (LOD). If an ICB or a CCB fails, results for the failing elements may not be reported from the run until the problem is corrected and a passing ICB or CCB has been analyzed. Also, all samples analyzed after the last passing CCB must be reanalyzed.

8.8 A standard with a mercury concentration that is at the Practical Quantitation Limit (PQL) is analyzed at the beginning of the run to determine calibration accuracy at the reporting limit. Result of the PQL standard should fall within 70% to 130% of the expected values. If the PQL fails, results may not be reported from the run until the problem is corrected and a passing PQL has been analyzed.

PREPARATION BATCH QC SAMPLES

8.9 Preparation blank (PBW or PBS), consisting of reagent water carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. The results of preparation blanks must be less than the Practical Quantitation Level (PQL) for each element. For DoD QSM acceptance criteria the results must be less than ½ the PQL except for common contaminants which must be less than the PQL. If a preparation blank fails, results for the failing elements may not be reported from the digestion batch, and all associated samples must be redigested, with the following exception. If the result for a preparation blank is greater than the PQL (greater than ½ PQL for DoD), associated sample results that are less than the PQL (less than ½ PQL for DoD) or greater than or equal to ten times the measured preparation blank concentration may be reported.

8.10 A laboratory control sample (LCSS or LCSO), consisting of solid reference material or 500 Ul of Intermediate Standard A carried through the same process as associated samples, is prepared with each digestion batch of twenty or fewer samples. If a laboratory control sample fails, results may not be reported from the digestion batch, and all associated samples must be redigested. The laboratory uses a reference value and statistical acceptance limits for laboratory control samples that are supplied by the vendor of the solid reference material. The results of the LCSO must fall with in 80% - 120% of its true value which is 5.0 ug/L. If samples are being prepared using DoD QSM acceptance criteria, the results of the LCSS or LCSO must be within 80% - 120%.

SAMPLE MATRIX QC SAMPLES

8.11 Matrix spiked duplicate samples are prepared at a minimum frequency of one per digestion batch. Matrix spike recoveries for these samples are calculated as follows:

$$\text{Recovery (\%)} = \frac{(P - S)}{A} \times 100\%$$

where: P = Spiked sample value
S = Original sample value
A = Spike amount

The recovery for each element in a spiked sample or spiked duplicate sample must fall within 75% to 125% of the actual value if the result for the unspiked sample is less than four times the amount of spike added. If one or both spike recoveries fail, a matrix interference should be suspected and the associated sample result should be flagged on the report of analysis. If DoD QSM acceptance criteria are being used, recoveries must be the same as stated for laboratory control samples.

The relative percent difference between matrix spiked duplicate sample results is calculated as follows:

$$\text{RPD (\%)} = \frac{|D_1 - D_2|}{(|D_1 + D_2|)/2} \times 100$$

where: D_1 = Spike sample result
D_2= Spike duplicate sample result

A control limit of 20% RPD is applied to matrix spike duplicate analysis. If the matrix spike duplicate analysis fails, the associated sample result should be flagged on the report of analysis.

8.12 Serial Dilution – A serial dilution is analyzed to check for chemical or physical interferences. If the analyte concentration of a sample is sufficiently high (minimally, 50 x IDL or 50 x LOQ if using DoD QSM acceptance criteria), the measured concentration of a serial dilution (1:5 dilution) of the sample should agree within 90% to 110% of the original determination. The percent difference between the original sample and the serial dilution should be calculated as follows:

$$\text{Difference (\%)} = \frac{|L\text{-}S|}{S} * 100\%$$

where: L = Serial dilution result (corrected for dilution)
S = Original sample result

If the serial dilution analysis fails, a matrix interference should be suspected. The associated sample result should be flagged on the report of analysis or the sample should be reanalyzed at dilution to eliminate the interference.

8.13 Post-digestion Spike (PDS) additions must be performed for DoD QSM samples if the serial dilution is not within acceptance criteria or if the analyte concentrations in all samples are less than 50x the LOD. The spike addition should produce a concentration that is between 10 and 100x the LOQ. The recovery of the PDS must be within 75-125%. If the PDS fails, all samples must be run by method of standard additions or appropriately flagged.

9.0 METHOD PERFORMANCE

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD’s must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Quantiaion (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ’s must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.

MDLs are filed with the Organic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revision of Method 7471 for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, USEPA SW846, 3rd Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB and IV, February 2007, Method 7471B.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.0, March, 2013

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.1, January, 2017

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision.

QuickTrace M6100 Mercury Analyzer Operator Manual Version 1.0.1, CETAC Technologies

QuickTrace Mercury Analyzer Software Manual, CETAC Technologies.

List of Tables and Figures

TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Mercury/ USEPA Method 7471B	Initial Calibration, 5 points plus a calibration blank.	Daily prior to sample analysis.	Correlation coefficient ≥ 0.995.	Correct problem and repeat calibration.
	Initial Calibration Verification (ICV), prepared from a second source.	Before beginning a sample run.	Recovery within ± 10% of true value.	Correct problem and repeat calibration.
	Initial Calibration Blank (ICB)	Before beginning a sample run.	Less than PQL.	Correct problem and repeat calibration.
	Practical Quantitation Level Standard (PQL)	Before beginning a sample run.	Recovery within ± 30% of true value.	Correct problem and repeat calibration.
	Continuing Calibration Verification (CCV)	At beginning or run, after every 10 samples, and at end of the run	Recovery within ± 10% of true value	Repeat calibration and reanalyze all samples analyzed since the last successful CCV.
	Continuing Calibration Blank (CCB)	At beginning or run, after every 10 samples, and at end of the run	Less than PQL.	Repeat calibration and reanalyze all samples analyzed since the last successful CCB.
	Preparation Blank (PBS)	One per digestion batch of 20 or fewer samples.	Less than PQL.	1) Investigate source of contamination. 2) Redigest and reanalyze all associated samples if sample concentration □ PQL and < 10x the blank concentration.
	Laboratory Control Sample (LCSS or LCSO)	One per digestion batch of 20 or fewer samples.	LCSS: Recovery within vendor-supplied acceptance limits. LCSO: Recovery within ± 20% of true value.	Redigest all affected samples.
	Matrix Spike Sample (S)	One per digestion batch of 20 or fewer samples.	Recovery ±25% of true value, if sample > 4x spike value.	Flag results.
	Matrix Spike Duplicate Sample (P) or sample duplicate (D)	One per digestion batch of 20 or fewer samples.	1)Recovery ± 25% of true value, if sample < 4x spike added. 2) RPD ≤20% for duplicate spikes or duplicate samples.	Flag results
	Post-Digestion Matrix Spike Sample (PDS)	When matrix spike or MSD fail	Recovery ±20% of true value	Analyze serial dilution of sample
	Serial Dilution Test (L)	One per digestion batch or when PDS fails	1:5 dilution of sample must agree within 10% with undiluted result	If MS, MSD, PDS, and serial dilution fail, quantitate sample by method of standard additions
	Instrument Detection Limit (IDL) Study	Quarterly.	IDL < PQL	1)Repeat IDL study. 2)Raise PQL.
	Method Detection Limit (MDL) Study	Refer to KAS SOP QA-806, "Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications", current revision.		
	Limit of Detection (LOD) determination	Quarterly.	LOD = 2-3X MDL	Repeat LOD Determination.

TABLE 2

DoD QSM 5.0/5.1 QC REQUIREMENTS

QC Check	**Minimum Frequency**	**Acceptance Criteria**	**Corrective Action**	**Flagging Criteria**	**Comments**
Initial Calibration (ICAL) for all analytes	Daily ICAL prior to sample analysis.	r2 = 0.99.	Correct problem, then repeat ICAL.	Flagging is not appropriate.	FLAA and GFAA: minimum three standards and a calibration blank. CVAA/Mercury: minimum 5 standards and a calibration blank. No samples shall be analyzed until ICAL has passed.
Initial Calibration Verification (ICV)	Once after each ICAL, analysis of a second source standard prior to sample analysis.	All reported analytes within ± 10% of the true value.	Correct problem. Rerun ICV. If that fails, Rerun ICAL.	Flagging is not appropriate.	No samples shall be analyzed until calibration has been verified with a second source.
Continuing Calibration Verification (CCV)	After every 10 field samples and at the end of the analysis sequence.	All reported analytes within ± 10% of the true value.	Recalibrate, and reanalyze all affected samples since the last acceptable CCV; or Immediately analyze two additional consecutive CCVs. If both pass, samples may be reported without reanalysis. If either fails, take corrective action(s) and re-calibrate; then reanalyze all affected samples since the last acceptable CCV.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to all results for the specific analyte(s) in all samples since the last acceptable CCV.	Results may not be reported without a valid CCV. Flagging is only appropriate in cases where the samples cannot be reanalyzed.
Method Blank (MB)	One per preparatory batch.	No analytes detected > 1/2 LOQ or > 1/10 the amount measured in any sample or 1/10 the regulatory limit, whichever is greater.	Correct problem. If required, reprep and reanalyze MB and all samples processed with the contaminated blank.	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply B-flag to all results for the specific analyte(s) in all samples in the associated preparatory batch.	Results may not be reported without a valid method blank. Flagging is only appropriate in cases where the samples cannot be reprepped or reanalyzed.
Initial and Continuing Calibration Blank (ICB/CCB)	Before beginning a sample run, after every 10 field samples, and at end of the analysis sequence.	No analytes detected > LOD.	Correct problem and repeat ICAL. All samples following the last acceptable calibration blank must be reanalyzed.	Flagging is not appropriate.	Results may not be reported without a valid calibration blank. For CCB, failures due to carryover may not require an ICAL.
Laboratory Control Sample (LCS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are	Correct problem, then reprep and reanalyze the LCS and all samples in the associated preparatory batch for	If reanalysis cannot be performed, data must be qualified and explained in the case narrative. Apply Q-flag to	Results may not be reported without a valid LCS. Flagging is only appropriate in cases where the samples cannot be

TABLE 2

DoD QSM 5.0/5.1 QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action	Flagging Criteria	Comments
		not listed, use in-house LCS limits if project limits are not specified.	failed analytes, if sufficient sample material is available.	specific analyte(s) in all samples in the associated preparatory batch.	reanalyzed.
Matrix Spike (MS)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed use in-house LCS limits if project limits are not specified.	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	If MS results are outside the limits, the data shall be evaluated to the source of difference, i.e., matrix effect or analytical error.
Matrix Spike Duplicate (MSD) or Matrix Duplicate (MD)	One per preparatory batch.	A laboratory must use the QSM Appendix C Limits for batch control if project limits are not specified. If the analyte(s) are not listed, use in-house LCS limits if project limits are not specified. MSD or MD: RPD of all analytes = 20% (between MS and MSD or sample and MD).	Examine the project-specific requirements. Contact the client as to additional measures to be taken.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	The data shall be evaluated to determine the source of difference.
Dilution Test (Flame AA and GFAA only)	One per preparatory batch if MS or MSD fails.	Five-fold dilution must agree within ± 10% of the original measurement.	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Only applicable for samples with concentrations > 50 X LOQ (prior to dilution). Use along with MS/MSD or PDS data to confirm matrix effects.
Post-Digestion Spike (PDS) Addition (Flame AA and GFAA only)	One per preparatory batch if MS or MSD fails.	Recovery within 80-120%	No specific CA, unless required by the project.	For the specific analyte(s) in the parent sample, apply J-flag if acceptance criteria are not met and explain in the case narrative.	Criteria apply for samples with concentrations < 50 X LOQ prior to dilution.
Method of Standard Additions (MSA)	When dilution or post digestion spike fails and if the required by project.	NA.	NA.	NA.	Document use of MSA in the case narrative.

TABLE 3

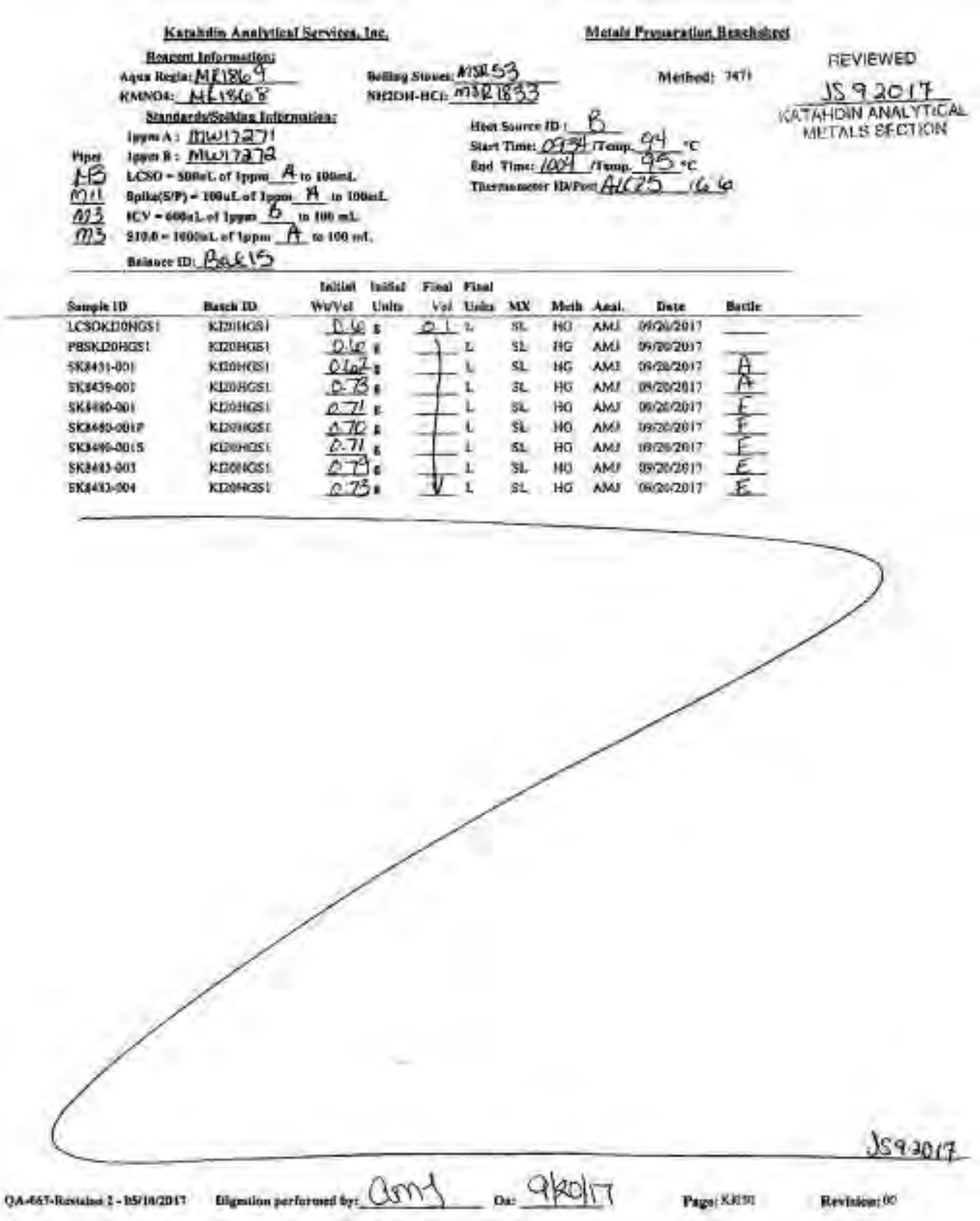
SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-611-11	USEPA Method 7471, current revision
Reagents	Stannous chloride dissolved in hydrochloric acid to prevent clogging of mercury analyzer, per instrument manufacturer's recommendation.	Stannous chloride dissolved/suspended in sulfuric acid.
Procedures	Sampling and gas stream switching performed automatically by mercury analyzer.	Sampling and gas stream switching performed manually by analyst.
Qc _ Calibration	Calibration standards are not digested.	Sect. 7.3- Requires Calibration standards are digested
QC – Calibration Verification	1)Known reference sample (ICV) analyzed daily. 2)Calibration verified after every 10 samples with CCV.	1)Known reference sample analyzed quarterly. 2)Calibration verified after every 20 samples.
QC - Calibration Blanks and Method Blanks	Acceptance Criterion: < PQL	Acceptance criteria: Low enough not to interfere with data quality objectives, or <10% of PQL, or <10% of regulatory limit, or <10% of lowest associated sample

TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

FIGURE 1

EXAMPLE PAGE FROM MERCURY PREPARATION LOGBOOK



Katahdin Analytical Services, Inc.

Metals Preparation Benchsheet

REVIEWED
JS 9 2017
KATAHDIN ANALYTICAL
METALS SECTION

Reagent Information:
Aqua Regia: MR1869
KMNO4: MR1868
Boiling Stones: MSR53
NH2OH-HCl: MSR1833
Method: 7471

Standards/Spiking Information:
1ppm A: MW17271
1ppm B: MW17272

Pipet	
MB	LCSO = 500uL of 1ppm A to 100mL
M11	Spike(S/P) = 100uL of 1ppm A to 100mL
M3	ICV = 600uL of 1ppm B to 100 mL
M3	S10.0 = 1000uL of 1ppm A to 100 mL

Balance ID: BAL15

Heat Source ID: B
Start Time: 0934 /Temp. 94 °C
End Time: 1004 /Temp. 95 °C
Thermometer ID/Post: AlC25 (6.6)

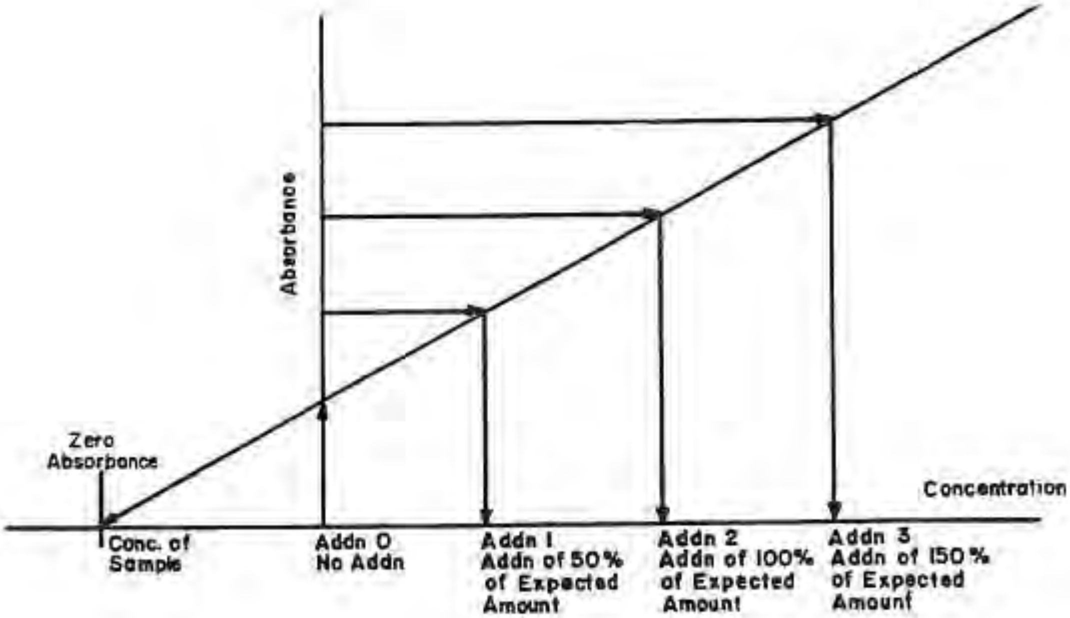
Sample ID	Batch ID	Initial Wt/Vol	Initial Units	Final Vol	Final Units	MX	Meth	Anal.	Date	Bottle
LCSOKI20HGS1	KI20HGS1	0.60	g	0.1	L	SL	HG	AMJ	09/20/2017	
PBSKI20HGS1	KI20HGS1	0.60	g		L	SL	HG	AMJ	09/20/2017	
SK8431-001	KI20HGS1	0.62	g		L	SL	HG	AMJ	09/20/2017	A
SK8439-001	KI20HGS1	0.73	g		L	SL	HG	AMJ	09/20/2017	A
SK8480-001	KI20HGS1	0.71	g		L	SL	HG	AMJ	09/20/2017	F
SK8480-001P	KI20HGS1	0.70	g		L	SL	HG	AMJ	09/20/2017	F
SK8480-001S	KI20HGS1	0.71	g		L	SL	HG	AMJ	09/20/2017	F
SK8483-003	KI20HGS1	0.79	g		L	SL	HG	AMJ	09/20/2017	E
SK8483-004	KI20HGS1	0.73	g		L	SL	HG	AMJ	09/20/2017	E

JS 9 20 17

QA-057-Revision 2 - 05/10/2017 Digestion performed by: amj On: 9/20/17 Page: KI191 Revision: 00

FIGURE 2

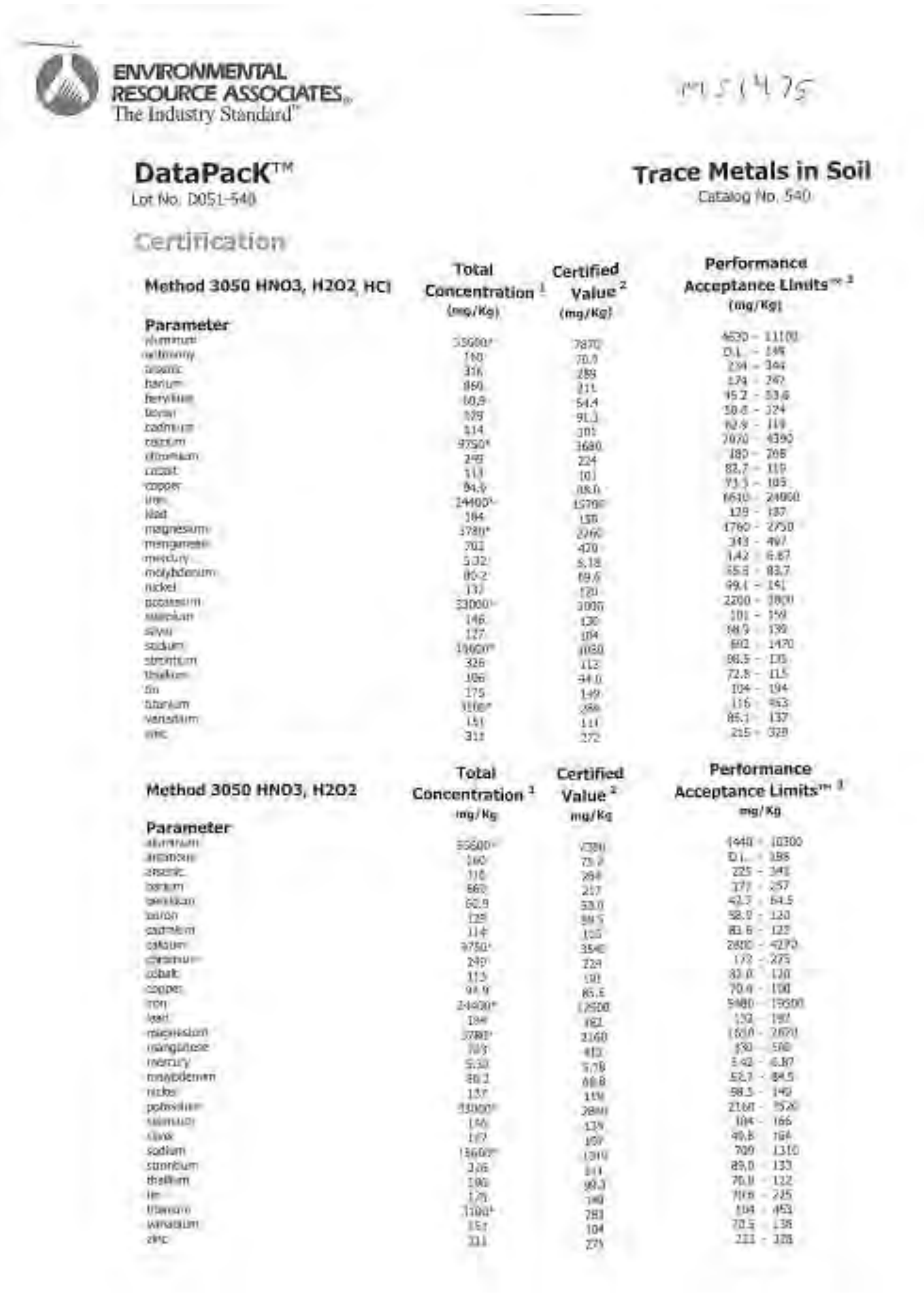
STANDARD ADDITIONS PLOT



TITLE: DIGESTION AND ANALYSIS OF SOLID SAMPLES FOR MERCURY BY USEPA METHOD 7471

FIGURE 3

EXAMPLE CERTIFICATE OF ANALYSIS FOR A SOLID REFERENCE MATERIAL



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Catalog No. 540

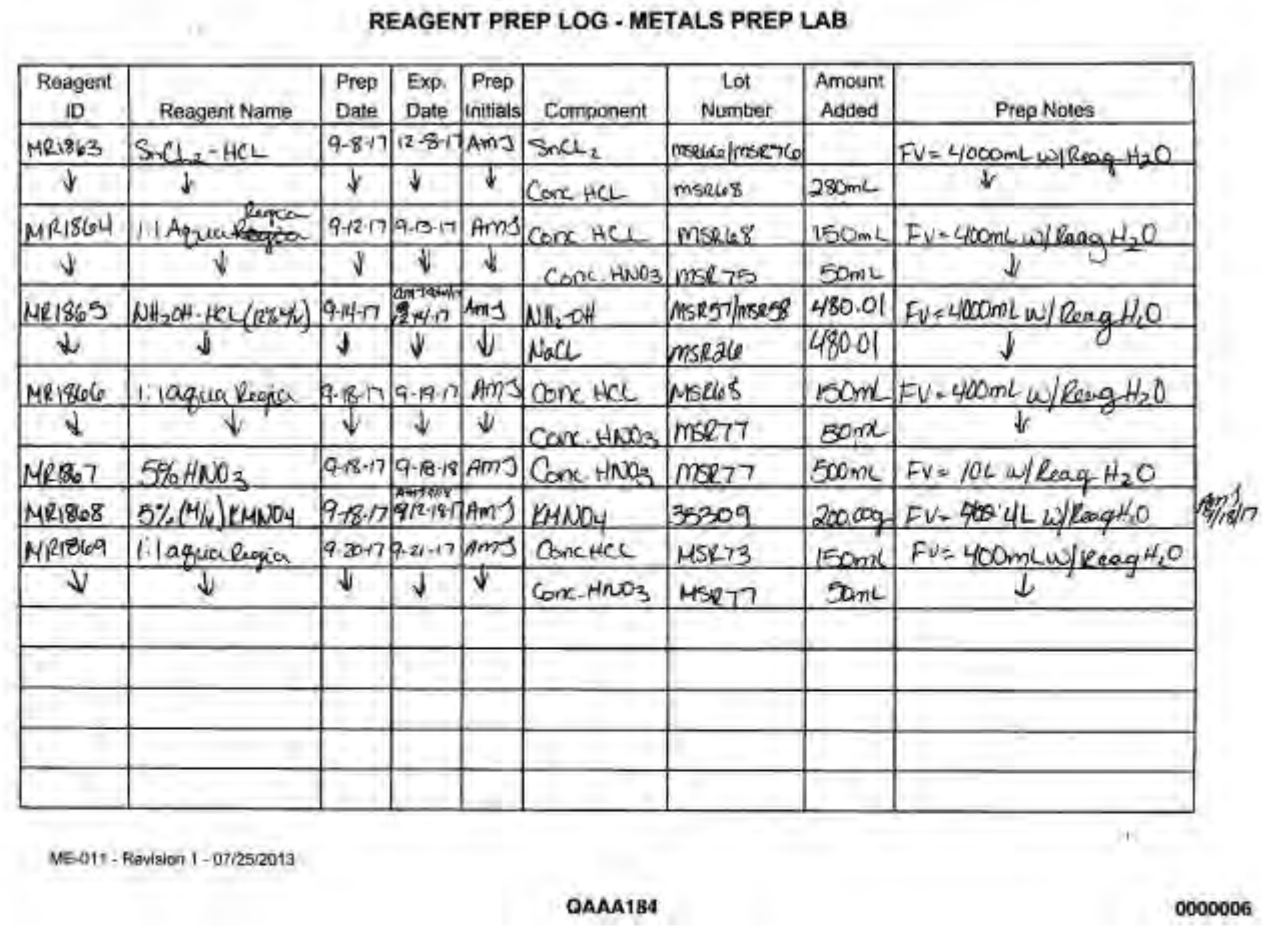
Certification

Method 3050 HNO3, H2O2, HCl Parameter	Total Concentration[1] (mg/Kg)	Certified Value[2] (mg/Kg)	Performance Acceptance Limits™[3] (mg/Kg)
aluminum	55600*	7870	4630 – 11100
antimony	160	70.9	D.L. – 149
arsenic	316	289	234 – 344
barium	860	211	174 – 247
beryllium	60.9	54.4	45.2 – 63.6
boron	129	91.3	50.6 – 124
cadmium	114	101	82.9 – 119
calcium	9750*	3680	2970 – 4390
chromium	249	224	180 – 268
cobalt	113	101	82.7 – 119
copper	94.9	88.6	71.5 – 105
iron	24400*	15700	6610 – 24900
lead	184	158	129 – 187
magnesium	3780*	2260	1760 – 2750
manganese	702	420	343 – 497
mercury	5.32	5.18	3.42 – 6.87
molybdenum	86.2	69.6	55.5 – 83.7
nickel	137	120	99.1 – 141
potassium	33000*	3000	2200 – 3800
selenium	146	130	101 – 159
silver	127	104	88.9 – 139
sodium	13600*	1030	602 – 1470
strontium	326	112	88.5 – 135
thallium	106	94.0	72.8 – 115
tin	175	149	104 – 194
titanium	3100*	288	116 – 463
vanadium	151	111	85.1 – 137
zinc	311	272	215 – 329

Method 3050 HNO3, H2O2 Parameter	Total Concentration[1] mg/Kg	Certified Value[2] mg/Kg	Performance Acceptance Limits™[3] mg/Kg
aluminum	55600*	7380	4440 – 10300
antimony	160	73.7	D.L. – 188
arsenic	316	284	225 – 341
barium	860	217	177 – 257
beryllium	60.9	53.0	42.7 – 64.5
boron	129	89.5	58.9 – 120
cadmium	114	105	83.6 – 122
calcium	9750*	3540	2800 – 4270
chromium	249	224	172 – 275
cobalt	113	101	82.0 – 120
copper	94.9	85.6	70.4 – 100
iron	24400*	12500	5480 – 19500
lead	184	162	132 – 192
magnesium	3780*	2160	1650 – 2670
manganese	703	415	330 – 500
mercury	5.32	5.78	3.42 – 6.87
molybdenum	86.2	68.8	52.7 – 84.5
nickel	137	119	98.5 – 140
potassium	33000*	2880	2160 – 3520
selenium	146	135	104 – 166
silver	127	107	49.6 – 164
sodium	13600*	1010	709 – 1310
strontium	326	111	89.0 – 133
thallium	106	99.3	76.8 – 122
tin	175	149	70.8 – 225
titanium	3100*	283	104 – 453
vanadium	151	104	70.5 – 138
zinc	311	275	221 – 328

FIGURE 4

EXAMPLE REAGENT PREP LOGBOOK PAGE



REAGENT PREP LOG - METALS PREP LAB

Reagent ID	Reagent Name	Prep Date	Exp. Date	Prep Initials	Component	Lot Number	Amount Added	Prep Notes
MR1863	$SnCl_2$-HCL	9-8-17	12-8-17	AMJ	$SnCl_2$	MSR66/MSR76		FV = 4000mL w/Reag H_2O
↓	↓	↓	↓	↓	Conc HCL	MSR68	280mL	↓
MR1864	1:1 Aqua ~~Regia~~ Regia	9-12-17	9-13-17	AMJ	Conc HCL	MSR68	150mL	FV = 400mL w/Reag H_2O
↓	↓	↓	↓	↓	Conc. HNO_3	MSR75	50mL	↓
MR1865	NH_2OH-HCL (12%%)	9-14-17	AMJ 9/14/17 12-14-17	AMJ	NH_2OH	MSR57/MSR58	480.01	FV = 4000mL w/Reag H_2O
↓	↓	↓	↓	↓	NaCL	MSR26	480.01	↓
MR1866	1:1 aqua Regia	9-18-17	9-19-17	AMJ	Conc HCL	MSR68	150mL	FV = 400mL w/Reag H_2O
↓	↓	↓	↓	↓	Conc. HNO_3	MSR77	50mL	↓
MR1867	5% HNO_3	9-18-17	9-18-18	AMJ	Conc. HNO_3	MSR77	500mL	FV = 10L w/Reag H_2O
MR1868	5% (W/V) $KMNO_4$	9-18-17	AMJ 9/18/17 12-18-17	AMJ	$KMNO_4$	35309	200.00g	FV = ~~400~~ 4L w/Reag H_2O AMJ 9/18/17
MR1869	1:1 aqua Regia	9-20-17	9-21-17	AMJ	Conc HCL	MSR73	150mL	FV = 400mL w/Reag H_2O
↓	↓	↓	↓	↓	Conc. HNO_3	MSR77	50mL	↓

ME-011 - Revision 1 - 07/25/2013

QAAA184

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CA-709-11
pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045

UNCONTROLLED DOCUMENT

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

SOP Number: CA-709
Revision History
Cover Page
Page 1

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045.**

Prepared By: Wet Chemistry Date: 8/96

Approved By:

Group Supervisor: Keith Tanguay Date: 021301

Operations Manager: John C. Burton Date: 2/13/01

QA Officer: Deborah J. Nadeau Date: 2·13·01

General Manager: Date: 2/12/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
03 9045C	Format changes, added pollution prevention, database and operation of Accumet pH meter and calibration.	DN	2·13·01	2·13·01
04 9045C	Addition to Scope and Application to include reference for 9040B use when aqueous phase is >20%	DN	8·27·02	8·27·02
05 9045C	added KIMS Minor changes throughout added wording to sect. 6 New fig. 1 and 2	LAD	120104	120104
06 9045C	Added SW-846 reference. Minor formatting changes throughout.	LAD	03/07	03/07
07 9045D	Section 7.18 - Renamed "Equipment Maintenance" and revised for current practices. Add Wet Chem. Data Entry SOP reference. Updated references in Section 10. Updated log book example.	LAD	08/09	08/09

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
08 9045D	Added references to sections 7 and 10.	LAD	06/10	06/10
09 9045D	Sect. 7.- Updated calibration procedure. Changed buffer pH probe stored in. Updated archival of reports. Added and edited references. Updated Figures 1&2 added 3. Changed H.T. from ASAP to 28 days.	LAD	05/12	05/12
10 9045D	Sect. 6 - updated holding time criteria. Sect. 7 - Updated calibration procedure to reflect current practice. Sect. 10 - Updated and added references. Updated Fig. 1→3	LAD	07/14	07/14
11 9045D	Sect. 7. Added requirement to reprep the sample if no standing water is present.	LAD	08/16	08/16

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **CA-709-11**, titled **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**.

Recipient: ____Date:____________________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **CA-709-11**, titled **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**.

Recipient: ____Date:____________________

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedures and techniques followed by Katahdin Analytical Services personnel to determine the pH of soils and waste samples in accordance with EPA method 9045 (current promulgated revision). Method 9045 is an electrometric procedure for measuring pH in soils and waste samples. Wastes may be solids, sludges, or non-aqueous liquids. If water is present, it must constitute less than 20% of the total volume of the sample. If the aqueous phase is greater than 20%, pH determination should be performed in accordance with EPA method 9040 (current promulgated revision). Refer to the current revision of Katahdin SOP CA-708, pH Concentration Measurements in Aqueous Samples.

The procedures in this SOP are applicable to all non-CLP pH measurements performed for all soil matrices analyzed in the laboratory.

1.1 Definitions

pH - A measure of the acidity or alkalinity of a solution, defined as -log [H^+].

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of pH in solids by EPA Method 9045. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in the determination of pH concentration measurements in solid matrices to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for pH data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to indicate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention and Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Analytical Environmental Health and Safety Manual and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

2.0 SUMMARY OF METHOD

A representative aliquot of sample, measured in grams, is mixed with an equivalent volume of laboratory reagent grade water, measured in mL. The solution is allowed to settle, and the pH of the standing water (decanted) is determined electrometrically.

3.0 INTERFERENCES

3.1 Samples with very low or very high pH may give incorrect readings on the meter. For samples with a true pH of >10, the measured pH may be incorrectly low. This error can be minimized by using a low-sodium-error electrode. Strong acid solutions, with a true pH of <1, may give incorrectly high pH measurements.

3.2 Temperature fluctuations will cause measurement errors.

3.3 Errors will occur when the electrodes become coated with an oily material. See section 7.18 for special cleaning instructions.

4.0 APPARATUS AND MATERIALS

4.1 pH meter, Accumet Model 20 or equivalent with Automatic Temperature Compensation (ATC)

4.2 Glass beakers, 25 mL and 400 mL

4.3 25 mL dose cups

4.4 Teflon coated stir-bars

4.5 Stir-bar retriever

4.6 Magnetic stirplate

4.7 Shaker, 12 place

4.8 Analytical balance, capable of weighing to 0.1 g

5.0 REAGENTS AND STANDARDS

5.1 Buffer solutions (pH 4.0, 6.0, 7.0, 8.0, 10.0, 12.0)

5.2 Laboratory reagent grade water (Lab Water)

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Samples are collected in soil jars and stored at 4°C until analysis. Samples are collected in plastic or glass jars and stored at 4°C until analysis.

pH samples require immediate analysis upon receipt by the laboratory.

SW846 Chapter 3 states the holding time for pH is “immediate”.

Katahdin project managers will remind clients that in order to meet the regulatory requirements for holding times, a field pH is required. If requested to perform a laboratory pH, the analysis must be performed as soon as possible and the data must be notated as being performed out of hold time.

7.0 PROCEDURES

SAMPLE PREPARATION

7.1 Please refer to Katahdin Analytical Services SOP CA-108, “Basic Laboratory Technique”, current revision, for more information on subsampling. Mix samples thoroughly. Discard any foreign objects such as sticks, leaves and rocks. Decant any standing liquid. Using the balance, weigh out 20.0 g of sample into a 400 mL glass beaker. Record weight in pH logbook (Figure 1).

7.2 Add 20 mL of laboratory reagent grade water to the sample. Cover the top of the beaker with parafilm.

7.3 Place the sample on the shaker and allow it to shake, at medium speed, for five minutes. (CLP methods require the sample to shake for one hour.)

7.4 After five minutes (or one hour), remove the sample from the shaker and allow it to settle for one hour.

7.5 After one hour, decant the standing liquid into a 25 mL beaker. If no standing liquid is present, reprep the sample using 20g of sample and 40 mL of laboratory reagent grade water, cover with parafilm, and repeat steps 7.3 and 7.4.

7.6 Record total volume of laboratory reagent grade water added to sample in pH logbook. If volume of laboratory reagent grade water (in mL) added to sample exceeds the initial gram weight of the sample, flag sample data in pH logbook and record the reason for addition of excess laboratory reagent grade water (eg. minimum volume of water required in order to cover pH probe).

NORMAL RANGE CALIBRATION (pH range 3.5 – 10.5)

7.7 Meter should be calibrated daily. As described in the following steps, conduct a three-point calibration with pH buffers 4, 7 and 10. Perform a calibration check using pH 7 buffer. The source/lot number of each solution at the time of analysis must be recorded in the logbook (Figure 1).

7.8 Rinse pH electrode and temperature probe with laboratory reagent grade water. Gently blot dry with kimwipe.

7.9 Place pH 4 buffer on stir plate. Turn stir plate on so that the stir bar spins without creating a vortex, place pH electrode and temperature probe into buffer. Push **Standardize** key. Then push *2,* to clear previous calibration. Push **Standardize** key, then push 1, to update. Enter value of pH buffer, once stabilized record the value in the pH calibration logbook (Figure 3).

7.10 Remove pH 4 buffer. Rinse pH electrode and temperature probe. Blot dry.

7.11 Repeat step 7.1.3 with the pH 7 buffer. Record the value in the pH calibration logbook (figure 3). Remove pH 7 buffer. Rinse and dry pH electrode and temperature probe.

7.12 Repeat step 7.1.3 with the pH 10 buffer. Record the value in the pH calibration logbook (figure 3). Remove pH 10 buffer. Rinse and dry pH electrode and temperature probe.

NOTE: If any buffer readings are not within 0.05 pH units of expected values prior to calibration, the electrode may need cleaning. Note any maintenance performed and rerun the calibration.

LOW RANGE CALIBRATION

7.13 For samples with a pH less than 3.5, the meter must also be calibrated with pH buffer 2.

7.14 Rinse pH electrode and temperature probe with laboratory reagent grade water. Gently blot dry with kimwipe.

7.15 Place pH 2 buffer on stir plate. Turn stir plate on so that the stir bar spins without creating a vortex, place pH electrode and temperature probe into buffer. Push **Standardize** key. Push **Standardize** key, then push 1, to update. Enter value of pH buffer, once stabilized record the value in the pH calibration logbook (Figure 3).

7.16 The source/lot number and temperature of each solution at the time of analysis must be recorded in the logbook (Figure 1).

HIGH RANGE CALIBRATION

7.17 For samples with a pH greater than 10.5, the instrument must also be calibrated using a ph buffer 12.

7.18 Rinse pH electrode and temperature probe with laboratory reagent grade water. Gently blot dry with kimwipe.

7.19 Place pH 12 buffer on stir plate. Turn stir plate on so that the stir bar spins without creating a vortex, place pH electrode and temperature probe into buffer. Push **Standardize** key. Push **Standardize** key, then push 1, to update. Enter value of pH buffer, once stabilized record the value in the pH calibration logbook (Figure 3).

7.20 The source/lot number and temperature of each solution at the time of analysis must be recorded in the logbook (Figure 1).

CALIBRATION CHECK / LABORATORY CONTROL SPIKE (LCS)

7.21 Place pH 7 buffer on stir plate. Turn stir plate on so that the stir bar spins without creating a vortex, place pH electrode and temperature probe into buffer., but DO NOT press any keys as this reading is a calibration check. Record the reading in pH logbook as the LCS. Results must be within 0.05 pH units of the true value for analysis to proceed.

ANALYSIS OF SAMPLES

7.22 Sample analysis may proceed once the meter has been calibrated for the day with three buffers that bracket the expected pH of the sample.

7.23 Run the pH 7 buffer as the LCS for the analytical batch (Section 7.21). An LCS is required at the beginning of every batch of twenty or fewer samples.

7.24 Record date, time and initials for this analytical session.

7.25 The decanted samples should be equilibrated to room temperature prior to analysis (i.e., at the same temperature as the calibration buffers, □2 □C). A more accurate pH reading will be achieved when the buffers and the samples are at the same temperature. However, the Accumet□ pH meter is equipped with automatic temperature compensation (ATC) for when samples and buffers are not at the same temperature. Refer to the Accumet□ Model 20 pH/Conductivity Meter operating Instructions, #300143.3 (Revision C) for information on the ATC probe.

7.26 Pour about 25 ml of the supernatant into a clean dose cup. Place a tiny stir bar in cup. Place on stir plate, turn on stir plate and immerse probes.

7.27 When meter locks, record value displayed.

7.28 Rinse pH electrode and temperature probe. Blot dry

7.29 Place probe in pH 7 buffer solution to store until next analysis.

EQUIPMENT MAINTENANCE

7.30 If an electrode becomes coated with an oily material that will not rinse free, the electrode can either (refer to instrument manual):

- be cleaned with an ultrasonic bath, or

- be washed with detergent, rinsed several times with laboratory reagent grade water, placed in 1:10 HCl so that the lower third of the electrode is submerged, and then thoroughly rinsed with laboratory reagent grade water.

An electrode that will not calibrate properly must be replaced.

REPORTING OF RESULTS

7.31 All pH measurements less than 10.0 are to be reported using two significant figures.

Examples:
2.46 = 2.5
6.32 = 6.3
9.94 = 9.9

7.32 All pH measurements which are at or greater than or round up to 10.0 are to be reported to three significant figures.

Examples:
9.95 = 10.0
12.25 = 12.3
13.76 = 13.8
11.95 = 12.0

7.33 When a sample duplicate is analyzed, both the original result and duplicate result are recorded in the pH logbook; however, the original sample result is to be reported to the client.

7.34 After completion of each test, the logbook must be signed and dated by the person performing the test. All unused lines are to be “z-ed” out and initialed and dated.

7.35 The sample data results, with any appropriate notations, are entered into KIMS by the analyst. Refer to the current revision of SOP CA-762 for instructions on data entry. A batch sheet is generated (Figure 2). Raw data and batch sheets are reviewed for completeness and accuracy by the Inorganic Department Manager or other qualified designee.

7.36 All batch sheets, raw data, and supporting documents are scanned after final review and the resulting image files are saved on a Katahdin server for use in data package assembly. Image files of raw data are periodically archived by the laboratory’s MIS department.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 1 for a summary of QC requirements, acceptance criteria, and corrective actions. Table 1 criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgements. These decisions are based on holding time considerations, remaining sample volume and client and project specific Data Quality Objectives. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases “qualified” data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

8.1 One sample duplicate is to be analyzed per batch or every 10 sample analyses.

8.1.1 Acceptance criteria for duplicates is a difference of less than or equal to 20% relative percent difference between sample and duplicate results.

8.1.2. If criterion is not met, check calibration and reanalyze sample in duplicate.

8.2 One Laboratory Control Sample (LCS) is to be analyzed per batch or every 20 samples.

9.0 METHOD PERFORMANCE

Refer to method 9045.

10.0 APPLICABLE DOCUMENTS/REFERENCES

“Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods”, SW-846, third Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB, and IV, February 2007, Method 9045D.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP CA-762, Wet Chemistry Data Entry and Review Using Katahdin Information Management System (KIMS), current revision.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.2, 10/25/2010.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.0, March, 2013

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

LIST OF TABLES AND FIGURES

TABLE 1

QC REQUIREMENTS

Analytical Method	Applicable Parameter	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
SW9045	PH (soil)	3-5 point calibration with pH buffers with a midrange cal. check	Once per day, prior to use	± 0.05 pH units for each buffer	If calibration is not achieved, check meter, buffer solutions, and probe; replace if necessary; repeat calibration
		LCS	One per batch of twenty or fewer samples	90-110% recovery	Correct problem, recalibrate
		Sample duplicate	One sample duplicate per every ten field samples	RPD ≤20%	(1) Investigate problem and reanalyze sample in duplicate (2) If RPD is still unacceptable, report original result with notation or narration.

TABLE 2

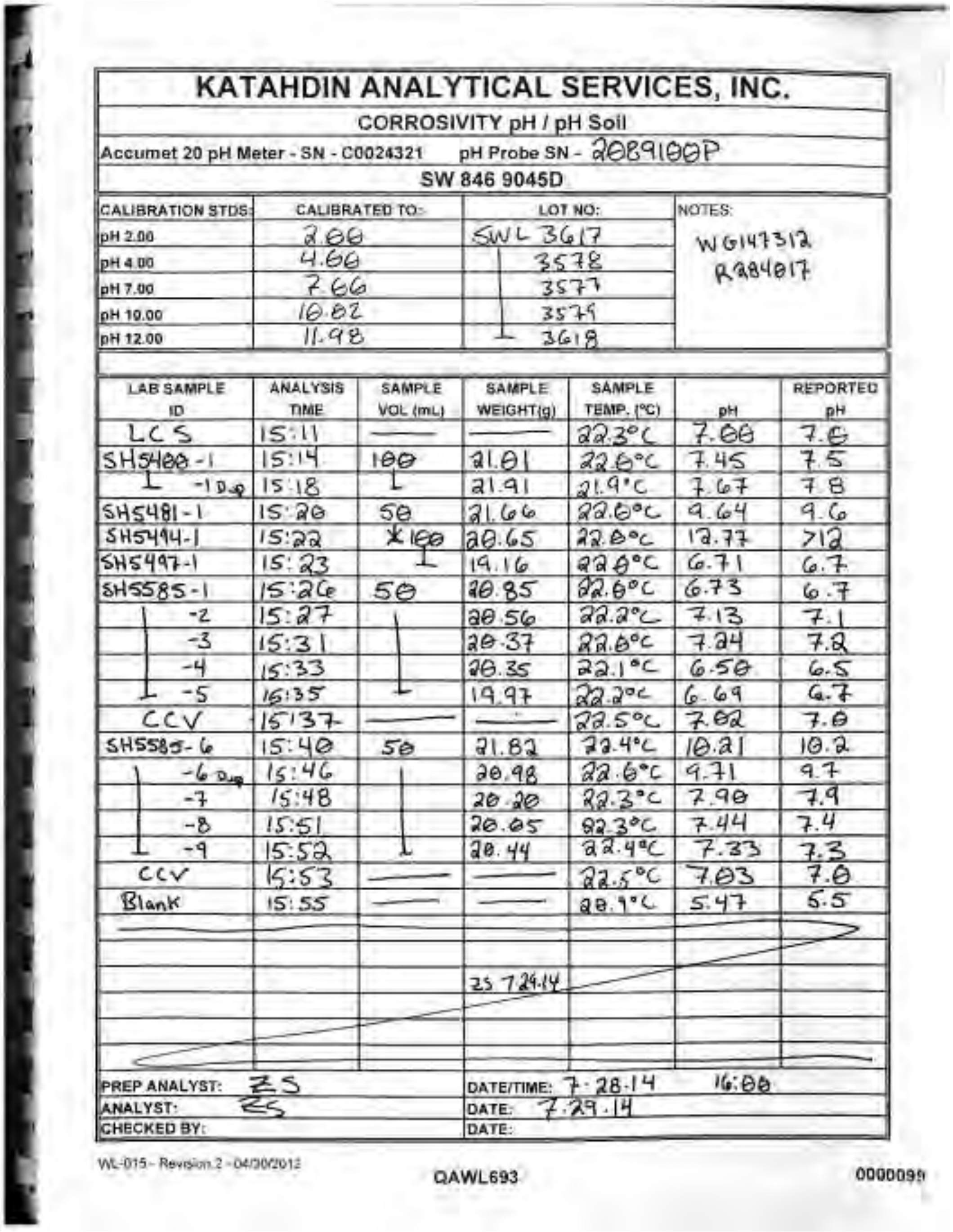
SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-709-11	METHOD SW846 9045, current revision
Apparatus/Materials		
Reagents		
Sample preservation/ handling		
Procedures	1) Shake, at medium speed, for one hour. 2) Add more liquid after shaking and settling if there is no standing liquid left. 3) All buffers and samples are analyzed at room temperature. pH meter is equipped with automatic temperature compensation.	1) Continuously stir the suspension for five minutes. 2) No guidance for samples with no standing liquid left. 3) Report both pH and temperature at the time of analysis.
QC – Spikes		
QC – LCS		
QC - Accuracy/Precision		

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

FIGURE 1

EXAMPLE OF pH LOGBOOK PAGE



KATAHDIN ANALYTICAL SERVICES, INC.

CORROSIVITY pH / pH Soil

Accumet 20 pH Meter - SN - C0024321 pH Probe SN - 2089100P

SW 846 9045D

CALIBRATION STDS:	CALIBRATED TO:	LOT NO:
pH 2.00	2.00	SWL 3617
pH 4.00	4.00	3578
pH 7.00	7.06	3577
pH 10.00	10.02	3579
pH 12.00	11.98	3618

NOTES:
WG147312
R284017

LAB SAMPLE ID	ANALYSIS TIME	SAMPLE VOL (mL)	SAMPLE WEIGHT(g)	SAMPLE TEMP. (°C)	pH	REPORTED pH
LCS	15:11	—	—	22.3°C	7.00	7.0
SH5400-1	15:14	100	21.01	22.0°C	7.45	7.5
-1 Dup	15:18		21.91	21.9°C	7.67	7.8
SH5481-1	15:20	50	21.66	22.0°C	9.64	9.6
SH5494-1	15:22	*100	20.65	22.0°C	12.77	>12
SH5497-1	15:23		19.16	22.0°C	6.71	6.7
SH5585-1	15:26	50	20.85	22.0°C	6.73	6.7
-2	15:27		20.56	22.2°C	7.13	7.1
-3	15:31		20.37	22.0°C	7.24	7.2
-4	15:33		20.35	22.1°C	6.50	6.5
-5	16:35		19.97	22.2°C	6.69	6.7
CCV	15'37	—	—	22.5°C	7.02	7.0
SH5585-6	15:40	50	21.82	22.4°C	10.21	10.2
-6 Dup	15:46		20.98	22.6°C	9.71	9.7
-7	15:48		20.20	22.3°C	7.90	7.9
-8	15:51		20.05	22.3°C	7.44	7.4
-9	15:52		20.44	22.4°C	7.33	7.3
CCV	15:53	—	—	22.5°C	7.03	7.0
Blank	15:55	—	—	20.9°C	5.47	5.5
			ZS 7.29.14			

PREP ANALYST: ZS DATE/TIME: 7.28.14 16:00
ANALYST: ZS DATE: 7.29.14
CHECKED BY: DATE:

WL-015 - Revision 2 - 04/30/2012 QAWL693 0000099

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

FIGURE 2

EXAMPLE OF BATCH SHEET FOR pH

WET CHEMISTRY BATCH REPORT
Jul 15 2014, 01:21 pm
Batch: WG146539

Parameter: pH(Soil)
Date Analyzed: 15-JUL-14
Analyst Initials: ZS

Prep Date: 15-JUL-14
Prep Method: SW846 9045C
Prep Chemist: ZS

Sample	Samp Type	Method	Initial Amt.	Final Amt.	Rpt. DF	Result	Rpt Result	TS(%)	MDL	PQL	Adj PQL	RPD	%Rec
SH4998-1	SAMP	SW846 9045D	10.43g	50mL	1	8.4	8.4 pH	83	.1	0.10	0.10		
SH4998-2	SAMP	SW846 9045D	11.06g	50mL	1	7.58	7.6 pH	82	.1	0.10	0.10		
SH5046-1	SAMP	SW846 9045D	10.01g	50mL	1	5.3	5.3 pH	22	.1	0.10	0.10		
SH5074-3	SAMP	SW846 9045D	12.17g	50mL	1	[illegible]	[illegible] pH	83	.1	0.10	0.10		
SH5074-4	SAMP	SW846 9045D	11g	50mL	1	8.34	8.3 pH	84	.1	0.10	0.10		
SH5180-1	SAMP	SW846 9045D	23.64g	100mL	1	7.03	7.0 pH	74	.1	0.10	0.10		
WG146539-1	LCS	SW846 9045D	20g	20mL	1	7	7.0 pH	NA	.1	0.10	0.10		100
WG146539-2	DUP	SW846 9045D	10.99g	20mL	1	8.06	8.1 pH	NA	.1	0.10	0.10		
WG146539-3	MBLANK	SW846 9045D	20g	20mL	1	5.69	5.7 pH	NA	.1	0.10	0.10		

Comments:

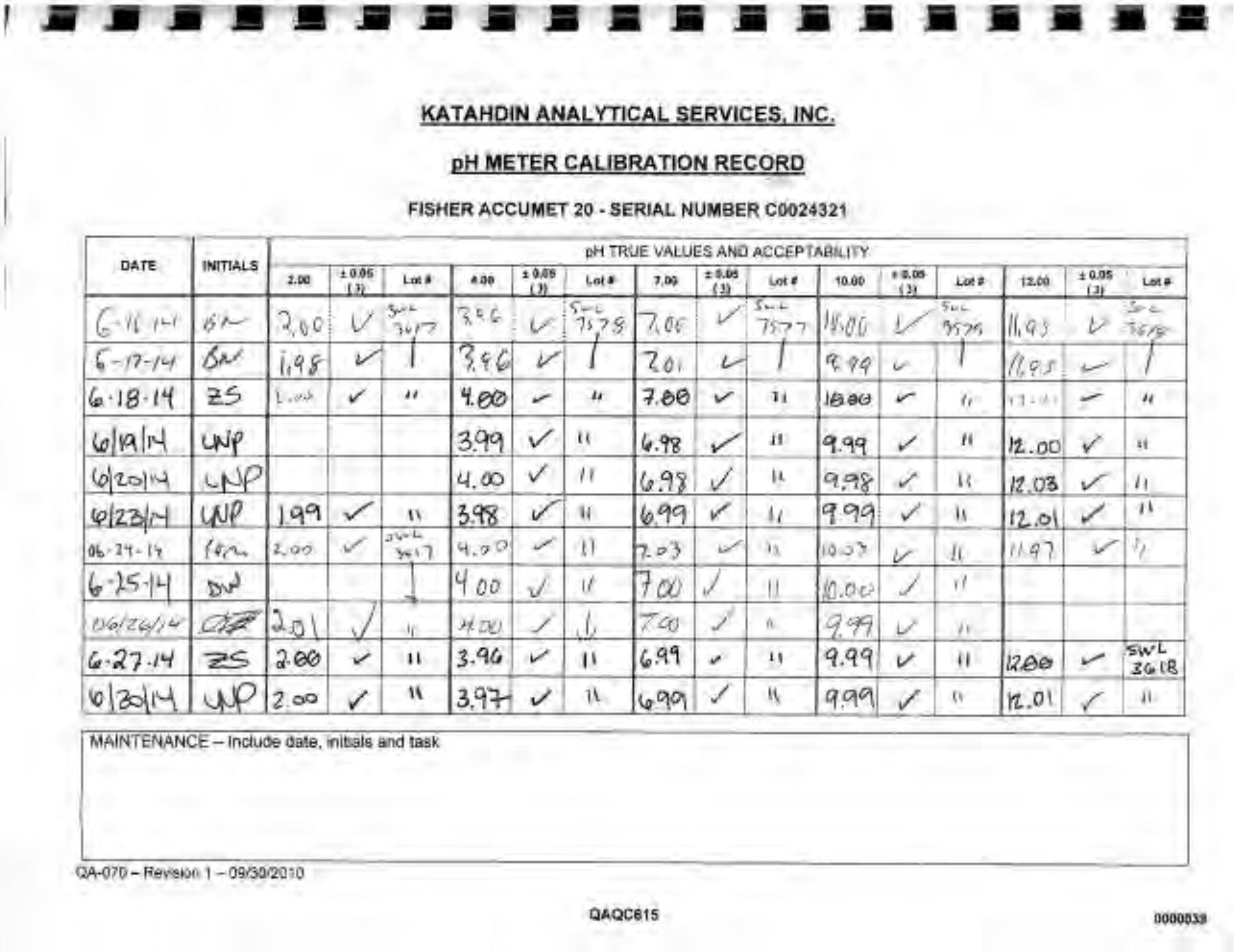
SH5074-3 MTC-NYCDEP-SED-SPLIT-21: MS/DUP on metals and cyanide. DUP on Black Carbon, TS, pH. MS/MSD on Ammonia, TKN, N+N and Total P. Can be moved to another sample if needed.
SH5074-4 MTC-NYCDEP-SED-SPLIT-22: MS/MSD on DRO and SVOC;MS/DUP on TOC. Can be moved to another sample if needed.
WG146539-1 SH5074-4
WG146539-2 SH5074-4
WG146539-3 SH5074-4

Entered by: ZS Date: 7/15/14 Accepted by: Date: 07/15/14

TITLE: **pH CONCENTRATION MEASUREMENTS IN SOIL MATRICES - SW 846 METHOD 9045**

FIGURE 3

EXAMPLE OF PH CALIBRATION LOGBOOK



KATAHDIN ANALYTICAL SERVICES, INC.

pH METER CALIBRATION RECORD

FISHER ACCUMET 20 - SERIAL NUMBER C0024321

DATE	INITIALS	pH TRUE VALUES AND ACCEPTABILITY														
		2.00	± 0.05 (3)	Lot #	4.00	± 0.05 (3)	Lot #	7.00	± 0.05 (3)	Lot #	10.00	± 0.05 (3)	Lot #	12.00	± 0.05 (3)	Lot #
6-16-14	BR	2.00	✓	SWL 3617	3.96	✓	SWL 7578	7.05	✓	SWL 7577	10.00	✓	SWL 9579	11.93	✓	SWL 3618
6-17-14	BR	1.98	✓	|	3.96	✓	|	7.01	✓	|	9.99	✓	|	11.95	✓	|
6-18-14	ZS	2.00	✓	"	4.00	✓	"	7.00	✓	"	10.00	✓	"	12.01	✓	"
6/19/14	UNP				3.99	✓	"	6.98	✓	"	9.99	✓	"	12.00	✓	"
6/20/14	UNP				4.00	✓	"	6.98	✓	"	9.98	✓	"	12.03	✓	"
6/23/14	UNP	1.99	✓	"	3.98	✓	"	6.99	✓	"	9.99	✓	"	12.01	✓	"
06-24-14	[illegible]	2.00	✓	SWL 3617	4.00	✓	"	7.03	✓	"	10.03	✓	"	11.97	✓	"
6-25-14	DW			|	4.00	✓	"	7.00	✓	"	10.00	✓	"			
06/26/14	[illegible]	2.01	✓	"	4.00	✓	|	7.00	✓	"	9.99	✓	"			
6-27-14	ZS	2.00	✓	"	3.96	✓	"	6.99	✓	"	9.99	✓	"	12.00	✓	SWL 3618
6/30/14	UNP	2.00	✓	"	3.97	✓	"	6.99	✓	"	9.99	✓	"	12.01	✓	"

MAINTENANCE – Include date, initials and task

QA-070 – Revision 1 – 09/30/2010

QAQC615

0000039

CA-738-03
DETERMINATION OF ACID VOLATILE SULFIDE AND SIMULTANEOUSLY EXTRACTABLE METALS IN SEDIMENTS

TITLE: **DETERMINATION OF ACID VOLATILE SULFIDE AND SIMULTANEOUSLY EXTRACTABLE METALS IN SEDIMENTS**

Prepared By: George Brewer Date: 05/04/07

Approved By:

Department Manager: George Brewer Date: 05/04/07

Lab Operations Mgr: Deborah J. Nadeau Date: 5.4.07

QA Officer: Leslie Dimond Date: 5-4-07

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Minor changes throughout to reflect current practices. Updated Figures 1→4. Added glassware modifications to Table 2. Corrected calculation. Added PQL of 0.1 umole/g. Added stability time criteria to Sect. 7.	LAD	05/09	05/09
02	Updated and or added references to Sect.s 1.2, 1.3, 9 and 10. Added LOQ / LOD to Table 1.	LAD	06/10	06/10
03	Sect. 5 - Added metals spiking solutions. Sect. 7 - Added instructions for spiking LCSs and MSs. Sect. 9 - Added MDL, LOD & LOQ information. Sect. 10 - Added and edited references. Updated Figures 1→3.	LAD	05/12	05/12

TITLE: DETERMINATION OF ACID VOLATILE SULFIDE AND SIMULTANEOUSLY EXTRACTABLE METALS IN SEDIMENTS

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SOP CA-738-03**, titled **Determination of Acid Volatile Sulfide and Simultaneously Extractable Metals in Sediments.**

Recipient: ____Date:____________________

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SOP CA-738-03**, titled **Determination of Acid Volatile Sulfide and Simultaneously Extractable Metals in Sediments.**

Recipient: ____Date:____________________

1.0 SCOPE AND APPLICATION

The purpose of this SOP is to describe the procedures used by Katahdin Analytical Services, Inc. technical personnel for the determination of: 1) acid volatile sulfide (AVS) and 2) the simultaneously extractable metals (SEM) that are solubilized during the acidification step. The conditions used have been reported to measure amorphous moderately crystalline monosulfides. As a precipitant of toxic heavy metals, sulfide is important in controlling the bioavailibility of metals in anoxic sediments. If the molar ratio of toxic metals measured by SEM to AVS exceeds one, the metals are potentially bioavailable. Because the relative amounts of AVS and SEM are important in the prediction of potential metal bioavailability, it is important to use the SEM procedure for sample preparation for metal analysis. This uses the same conditions for release of both sulfide and metal from the sediment and thus provides the most predictive means of assessing the amount of metal associated with sulfide.

1.1 Definitions

Method Blank - A deionized water sample that is carried through the entire analytical procedure in the same manner as a sample.

ICV - Initial Calibration Verification. One ICV per batch is prepared from a separate source from the CCV and calibration curve standards. ICV verifies the calibration curve.

LCS- Laboratory Control Standard. One LCS per batch is carried through the entire analytical procedure in the same manner as a sample. The LCS is prepared from the same source as the ICV.

CCV - Continuing Calibration Verification. The CCV is made from the same source as the calibration. One CCV is run every ten samples.

CCB - Continuing Calibration Blank. The CCB is deionized water with no reagents added. One CCB is run every ten samples.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of AVS and SEM by EPA Draft Method 821-R-91-100. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, “Personnel Training & Documentation of Capability,” current revision.

It is the responsibility of all Katahdin technical personnel involved in analysis of AVS or SEM by EPA Draft Method 821-R-91-100 to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Hydrogen sulfide is a highly poisonous, gaseous compound having a characteristic odor of rotten eggs. It is detectable in air by humans at a concentration of approximately 0.002 ppm. Handling of acid samples should be performed in a hood or in a well ventilated area.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their supervisor, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Place all analyzed samples, standards, and rinsings in a Satellite Waste “A” Acid for proper disposal in main waste area “A”. Other wastes generated during the preparation of samples must be disposed of in accordance with the Katahdin Analytical Health and Safety Manual and SOP SD-903, “Sample Disposal,” current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP.

2.0 SUMMARY OF METHOD

The method measures the concentrations of AVS and SEM liberated during the acidification of a 10 g sediment sample. Hydrochloric acid is added to the sample to liberate the volatile sufides as hydrogen sulfide (H_2S) at room temperature, and then the H_2S is purged from the sample and collected into an aqueous buffer solution. The amount of AVS that has been trapped is then measured colorimetrically, by reacting sulfide with N-N-dimethyl-p-phenylenediamine to form methylene blue. SEM are determined after filtration of the sediment-acid slurry using ICP spectrometry.

3.0 INTERFERENCES

Oxidation of sulfide in samples may result in a low bias in the results obtained for AVS and SEM. For this reason, contact of the samples with oxygen must be avoided in all stages from sampling through analysis. Collecting samples in containers with minimal headspace, minimizing contact of samples with the air during sample preparation, and using deaerated reagents during sample preparation and analysis all aid in preventing oxidation of samples.

To avoid metals contamination during the SEM digestion part of the method, all reaction vessels and scrubbers should be acid washed prior to use.

4.0 APPARATUS AND MATERIALS

4.1 Polyethylene gas-washing bottles with rubber stoppers and fritted polyethylene spargers, 250 mL capacity, for use as reaction vessels and sulfide traps.

4.2 Flexible tubing for connection from the nitrogen supply to the apparatus and from the flask to the absorber unit.

4.3 High purity nitrogen gas tank with regulator

4.4 Flow meters with needle valves

4.5 Spectrophotometer capable of measuring absorbance at 670 nm

4.6 Spectrophotometer cells, 1 cm path length

4.7 Analytical balance capable of weighing to 0.001 g

4.8 10 mL buret, calibrated in 1/10 mL increments

4.9 Calibrated adjustable pipettors, 0.1 mL, 1.0 mL, and 5.0 mL capacity

4.10 250 mL snap cap graduated containers

4.11 50 mL polyethylene graduated containers

5.0 REAGENTS

5.1 Laboratory reagent grade water, deaerated by sparging with nitrogen for one hour just prior to use. Dissolved oxygen should be close to 1 mg/L.

5.2 Sodium hydroxide (NaOH) solution, 0.5 M: Dilute 50.0 mL of 10 N NaOH solution to 1 liter with laboratory reagent grade water. This solution could also be made by dissolving 20 g of NaOH in DI water and diluting to 1 liter. This solution must be deaerated by sparging with nitrogen for one hour just prior to use.

5.3 Starch solution: Make a paste consisting of 2 g lab grade soluble starch, 0.2 g of salicylic acid in a few mL of DI water. Then bring up to volume in a 100 mL volumetric flask. Or use a purchased solution.

5.4 Standard sodium thiosulfate solution, 0.0375 N: Use a purchased primary standard sodium thiosulfate solution with its concentration certified by the vendor.

5.5 Hydrochloric acid, 6 N: In a 1 L volumetric flask, add 500 mL of concentrated HCl to approximately 400 mL of laboratory reagent grade water, slowly mix and allow to cool. Bring to a final volume of 1 L with laboratory reagent grade water. This solution should be deaerated by sparging with nitrogen for one hour prior to use.

5.6 Standard iodine solution, approximately 0.0250N: Dissolve 20 - 25 g potassium iodide in 200 mL of laboratory reagent grade water and add 3.2 g iodine. After the iodine has dissolved, dilute to 1 L with laboratory reagent grade water and standardize against 0.0375 N sodium thiosulfate using the starch solution as an indicator, as explained in Sections 7.8 – 7.11.

5.7 Saturated sodium sulfide standard solutions: Because sulfide is unstable, a standard of pre-determined concentration cannot be prepared. However, a saturated sulfide standard solution can be prepared by dissolving 20 g of sodium sulfide crystals in 10 mL of deaerated laboratory reagent grade water. The sodium sulfide crystals will not all dissolve (if at any point all the crystals in this solution dissolve add more crystals). Two saturated sodium sulfide solutions are required for the analysis – one standard (labeled “S2”) is used to prepare the calibration curve and the continuing calibration verification standard, and the other standard (labeled “S1”) is used to prepare laboratory control samples and matrix spikes. The concentrations of these saturated standards are determined titrimetrically just prior to use as described in Sections 7.12 – 7.15.

5.8 Sulfide working standard “W1”: Fill a 100 mL volumetric flask with deaerated laboratory reagent grade water to about 1 cm below the 100 mL graduation. Using a calibrated adjustable pipet, pipet 0.10 mL of saturated sodium sulfide stock standard “S1” into the flask, dispensing the standard below the surface of the water in the flask. Bring the volume in the flask to the 100 mL graduation with deaerated laboratory reagent grade water, stopper, and invert to mix. Sulfide working standard “W1” must be prepared just prior to use, and may be used to prepare an initial calibration standard for the colorimetric analysis. The sulfide concentration of this standard is 1/1000th that of saturated sodium sulfide stock standard “S1”, which is determined titrimetrically (see Sections 7.12 – 7.15).

5.9 Sulfide working standard “W2”: Fill a 100 mL volumetric flask with deaerated laboratory reagent grade water to about 1 cm below the 100 mL graduation. Using a calibrated adjustable pipet, pipet 0.10 mL of saturated sodium sulfide stock standard “S2” into the flask, dispensing the standard below the surface of the water in the flask. Bring the volume in the flask to the 100 mL graduation with deaerated laboratory reagent grade water, stopper, and invert to mix. Sulfide working standard “W2” must be prepared just prior to use, and is used to prepare the calibration standards and a continuing calibration standard for the colorimetric analysis. The sulfide concentration of this standard is 1/1000th that of saturated sodium sulfide stock standard “S2”, which is determined titrimetrically (see Sections 7.12 – 7.15).

5.10 Metals spiking standards: Four different standards, named CLPP-SPK-1, CLPP-SPK-INT1, CLPP-SPK-INT2, and Intermediate Mercury Standard A, are required. Intermediate Mercury Standard A has a mercury concentration of 1000 ug/L, and instructions for its preparation are contained in Section 5.9 of the current revision of SOP CA-615 (Digestion and Analysis of Aqueous Samples for Mercury by USEPA Method 7470). Details of the compositions and preparation of the other metals spiking standards are contained in Figures 2 and 3 of the current revision of SOP CA-405 (Acid Digestion of Aqeuous Samples for ICP and ICP-MS Analysis of Total or Dissolved Metals).

5.11 Mixed Diamine Reagent (MDR): Prepare Components A and B as follows, and then mix them together:

5.11.1 <u>Component A</u> - Add 660 mL concentrated sulfuric acid to 340 mL of laboratory reagent grade water. After the solution cools, dissolve 2.25 g N-N-dimethy-p-phenylenediamine oxalate in it.

5.11.2 <u>Component B</u> - Dissolved 5.4 g ferric chloride hexahydrate ($FeCl3{\cdot}6H2O$) in 100 mL concentrated hydrochloric acid and dilute to 200 mL with reagent water.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

6.1 Sulfide ion is unstable in the presence of oxygen. Protect sediment samples from exposure to oxygen during sample collection and storage.

6.2 Samples should be collected in wide mouth jars, and tightly capped with a minimum of air space above the sediment. The jar lids must have Teflon or polyethylene liners. Alternatively, samples may be collected in syringe samplers (syringes with the tip ends cut off) by plunging the syringe into the sediment while drawing up the plunger, and then tightly capping the open end of the syringe. The syringe sampling method effectively eliminates contact with atmospheric oxygen.

6.3 Samples should be cooled to 4^{o} C as soon as possible after collection, and stored at 4^{o} C until analysis.

6.4 Holding time for samples should not exceed 14 days.

7.0 PROCEDURES

GENERATION OF HYDROGEN SULFIDE FROM SAMPLES

7.1 Assemble the sulfide generation apparatus as shown in Figure 5. The nitrogen gas supply must be shut off. Fill each sulfide trap with 170 mL of 0.5 M NaOH solution.

7.2 Add 100 mL of deaerated laboratory reagent grade water into each reaction vessel. Weigh out approximately 10 g of sample directly into each reaction vessel, minimizing contact with the air. If the sample has been collected in a wide mouth jar, quickly open the jar, scrape away the top centimeter of sediment, scoop up an aliquot of the sample, and transfer it to the tared, water-filled reaction vessel. If the sample has been collected in a syringe sampler, quickly uncap the syringe and extrude the contents of the syringe directly into the tared, water-filled reaction vessel. Record the sediment weight. Stopper the gas reaction vessel and attach its outlet to the inlet of the sulfide trap.

7.3 Prepare a Laboratory Control Sample for Acid Volatile Sulfide (AVS) by spiking the deaerated laboratory reagent grade water in a reaction vessel with 0.10 mL of saturated sodium sulfide stock standard “S1”. Prepare AVS matrix spike samples by spiking 0.10 mL of saturated sodium sulfide stock standard “S1” into the reaction vessel containing deaerated water and a sample aliquot.

7.4 In order to prevent reactions between added AVS spiking solutions and SEM spiking solutions, Laboratory Control Samples (LCS) and matrix spikes for Simultaneously Extractable Metals (SEM) must be prepared in separate reaction vessels from the AVS Laboratory Control Sample and AVS matrix spikes. Prepare each SEM LCS and matrix spike by adding the following amounts of each spiking solution to the appropriate reaction vessels.

SEM Spiking Solution	Amount Added (mL)
CLPP-SPK-1	0.20
CLPP-SPK-INT1	2.00
CLPP-SPK-INT2	2.00
Intermediate Mercury Standard A	1.00

7.5 Unstopper the reaction vessel and quickly add 20 mL of 6.0 M HCl to the water and sediment in the vessel. Connect the inlet of the reaction vessel to the nitrogen gas supply. Make sure all tubing connections and stoppers are tight.

7.6 Turn on the main valve on the nitrogen tank and make sure the high pressure gauge reads 300 psi or more.

7.7 Use the flow meter attached to each sulfide generation apparatus to set the gas flow to approximately 40 cm^3/min. Gas will begin to bubble from the spargers in the reaction vessel and the sulfide trap. Bubbling of the gas in the reaction vessel effectively stirs the sediment / acid slurry, so no additional stirring is required.

7.8 After 60 minutes, disconnect the sulfide trap, transfer the sodium hydroxide solution from the trap into a 250 mL plastic container, and shut off the main valve on the nitrogen tank. Retain the sodium hydroxide solution for colorimetric analysis of sulfide.

7.9 Filter the solution sediment / acid slurry remaining in the reaction vessel through a membrane filter (pore size 0.45um) and save the filtrate in a 250 mL snap cap container for the SEM analysis. Bring the volume of filtrate to 200 mL in each snap cap container with deionized water, cap the vessel, and shake well to mix. The filtrate is now ready for SEM analysis.

TITRATION OF STANDARD IODINE SOLUTION

7.10 Add 15 mL of standard iodine solution and 2.0 mL of 6 N HCl to 200 mL of deaerated laboratory reagent grade water in a 250 mL Erlenmeyer flask. The solution will be an orange-yellow color.

7.11 Using the 10 mL buret, titrate this solution with 0.0375 N sodium thiosulfate standard solutions until a pale straw yellow color is obtained.

7.12 Add a few drops of starch solution to produce a deep blue color in the solution. Continue the titration with sodium thiosulfate until a colorless endpoint is reached. Record the total volume of sodium thiosulfate solution that was added to reach the endpoint.

7.13 Repeat the titration two more times, recording the volume of sodium thiosulfate required to reach the endpoint each time. Enter the appropriate volumes and normalities in the AVS Calculation Spreadsheet to calculate the normality of the standard iodine solution. The spreadsheet calculates the mean normality from the three titrations.

TITRATION OF SATURATED SODIUM SULFIDE STOCK STANDARDS

7.14 Add 200 mL of deaerated laboratory reagent grade water to a 250 mL Erlenmeyer flask. Pipet 0.10 mL of one of the saturated sodium sulfide stock standards to the water in the flask, placing the pipet tip below the surface of the water while adding the sulfide standard. Add 10.0 mL portions of standard iodine solution to the flask until a persistent orange-yellow color is obtained. Record the volume of iodine solution used, and then add 2.0 mL of 6 N hydrochloric acid to the flask.

7.15 Using the 10 mL buret, titrate this solution with 0.0375 N sodium thiosulfate standard solution until a pale straw yellow color is obtained.

7.16 Add a few drops of starch solution to produce a deep blue color in the solution. Continue the titration with sodium thiosulfate until a colorless endpoint is reached. Record the total volume of sodium thiosulfate solution that was added to reach the endpoint.

7.17 Repeat the titration two more times, recording the volume of sodium thiosulfate required to reach the endpoint each time. Enter the appropriate volumes and normalities in the AVS Calculation Spreadsheet to calculate the concentration of the saturated sodium sulfide stock standard. The spreadsheet calculates the mean sulfide concentration of the standard from the three titrations. Triplicate titrations must be performed on both of the saturated sodium sulfide stock solutions.

PREPARATION OF CALIBRATION STANDARDS AND THE CONTINUING CALIBRATION VERIFICATION STANDARD

7.18 Prepare a calibration curve as follows. Add 40 mL of 0.5 M sodium hydroxide solution into each of eight 50 mL graduated polyethylene containers. Using calibrated adjustable pipets, pipet the following volumes of Sulfide Working Standard W2 into the containers, dispensing the standard below the surface of the sodium hydroxide solution: 0.00 mL, 0.04 mL, 0.10 mL, 0.30 mL, 0.50 mL, 0.70 mL, 0.90 mL, 1.00 mL. The sulfide concentrations of the calibration standards will vary depending on the actual concentration the sulfide stock standard, as determined in Sections 7.12 – 7.15. The standard that contains 0.50 mL of Sulfide Working Standard W2 is analyzed throughout the colorimetric analysis as the Continuing Calibration Verification standard.

COLORIMETRIC ANALYSIS OF SAMPLES AND STANDARDS

7.19 Standards: Add 5.0 mL MDR to each standard, and bring the volume to the 50 mL graduation with deaerated laboratory reagent grade water. After 30 minutes, measure the absorbance of the standards at 670 nm. The absorbance of the reacted samples is stable for no more than two hours.

7.20 Samples: Transfer an appropriate volume aliquot of the scrubber solution (depending on the expected sulfide concentration) into a 50 mL graduated polyethylene container. Add sufficient 0.5M sodium hydroxide solution to bring the total volume to 40 mL. Add 5.0 mL MDR to the container and bring the solution to the 50 mL graduation with deaerated laboratory reagent grade water. After 30 minutes, measure the absorbance of the samples at 670 nm. The absorbance of the reacted samples is stable for no more than two hours.

CALCULATIONS

7.21 Calculate the concentration of the saturated sodium sulfide stock standards as follows:

$$S^{2-}\ (\text{mg/L}) = \frac{(A \times B) - (C \times D) \times 16000}{E}$$

where:
A = mL of I_2 solution
B = Normality of I_2 solution
C = mL of Thiosulfate Titrant
D = Normality of Thiosulfate Titrant
E = Volume of Sulfide Standard added to flask

7.20 Calculate the LCS and Spike level as follows:

$$\text{LCS/Spike (mg/kg)} = (F \times G) / H$$

where:
F = mL of the sulfide
G = concentration of the sulfide standard
H = weight of sample

7.21 Calculate the concentration of sulfide in samples as follows:

$$\frac{\text{umole}}{\text{g}}\ S^{2-} = \frac{\text{Final Vol x umole S-}}{\text{analysis volume}} \times \frac{1}{\text{sample wt g}} \times \frac{1}{\text{\% Solids}}$$

7.22 The above calculations can be done using a spreadsheet template (Figure 2) on which the analyst enters the sample number, date prepared, date analyzed, sample weight and final volume, volume of sample, volume of Iodine and the normality of both the iodine and thiosulfate. Manually calculated results should be reported to 2 significant figures.

7.23 All batch sheets, raw data, and supporting documents are scanned after final review and the resulting image files are saved on a Katahdin server for use in data package assembly. Image files of raw data are periodically archived by the laboratory's MIS department.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Refer to Table 1 and to details in this section for a summary of QC requirements, acceptance criteria, and corrective actions. These criteria are intended to be guidelines for analysts. The criteria does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed in this section or in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in this section and in Table 1 may rely on analyst experience to make sound scientific judgments. These decisions are based on holding time considerations, client and project specific Data Quality Objectives and on review of chromatograms. The Department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases "qualified" data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

Refer to Table 1 for summary of QC requirements.

8.1 Distill and analyze a method blank with every batch or analytical session. The concentration of the blank is expected to be less than the Practical Quantitation Limit (.1umole/g).

8.2 Analyze a Continuing Calibration Verification standard at the beginning of every analytical session, after every 10 samples, and at the end of each analytical session. The acceptance limits for the CCV are 80% - 120% recovery.

8.3 Prepare and analyze one duplicate sample in every batch of 20 or fewer samples. The results for duplicate samples must agree within 20% relative percent difference (RPD).

8.4 Prepare and analyze one matrix spike sample with every 10 client samples. The acceptance limits for matrix spike recoveries are 75% - 125% of the added analyte concentration.

9.0 METHOD PERFORMANCE

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD’s must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Detection (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ’s must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.

MDLs are filed with the Inorganic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revisions of the applicable methods for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

USEPA Draft Analytical Method for Determination of Acid Volatile Sulfide in Sediment, Allen et al, 1991, Document 821/R-91-100

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Current Version.

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision.

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision.

LIST OF TABLES AND FIGURES

TABLE 1

QC REQUIREMENTS

Parameter/ Method	QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
AVS SEM	Initial Calibration – Minimum of 5 pt. plus blank	Each day of analysis	r > 0.995	(1) Recalibrate
	Method blank	One per prep batch of 20 or fewer samples	No analyte detected >PQL	(1) Investigate source of contamination (2) Reprep and analyze method blank and all samples processed with the contaminated blank
	LCS/ICV	One of each per prep batch	80-120 %R; Statistically derived from lab data	(1) Recalibrate and reanalyze sample batch
	CCV	At beginning of run, after every 10 samples and at the end of the run. Same conc. As LCS/ICV	80-120 %R	(1) Reanalyze all samples back to last acceptable CCV recovery
	Matrix Spike	One for every set of 10 samples	75-125 %R	(1) Notate sample result in raw data with Notation I-1
	Sample Duplicate	One sample duplicate per twenty samples or per batch	RPD <20	(1) If lab QC in criteria and matrix interference suspected, flag data (2) Else, reanalyze
	Demonstration of analyst proficiency; accuracy and precision	One time demonstration by each analyst performing the method	Must pass all applicable QC for method	Repeat analysis until able to perform passing QC; document successful performance in personal training file
	MDL and-or LOD/LOQ Verification	Refer to KAS SOP QA-806, “, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision		
	CCB	At beginning of run, after every 10 samples and at the end of the run.	No analyte detected > PQL.	Reanalyze all samples after last acceptable CCB.

TABLE 2

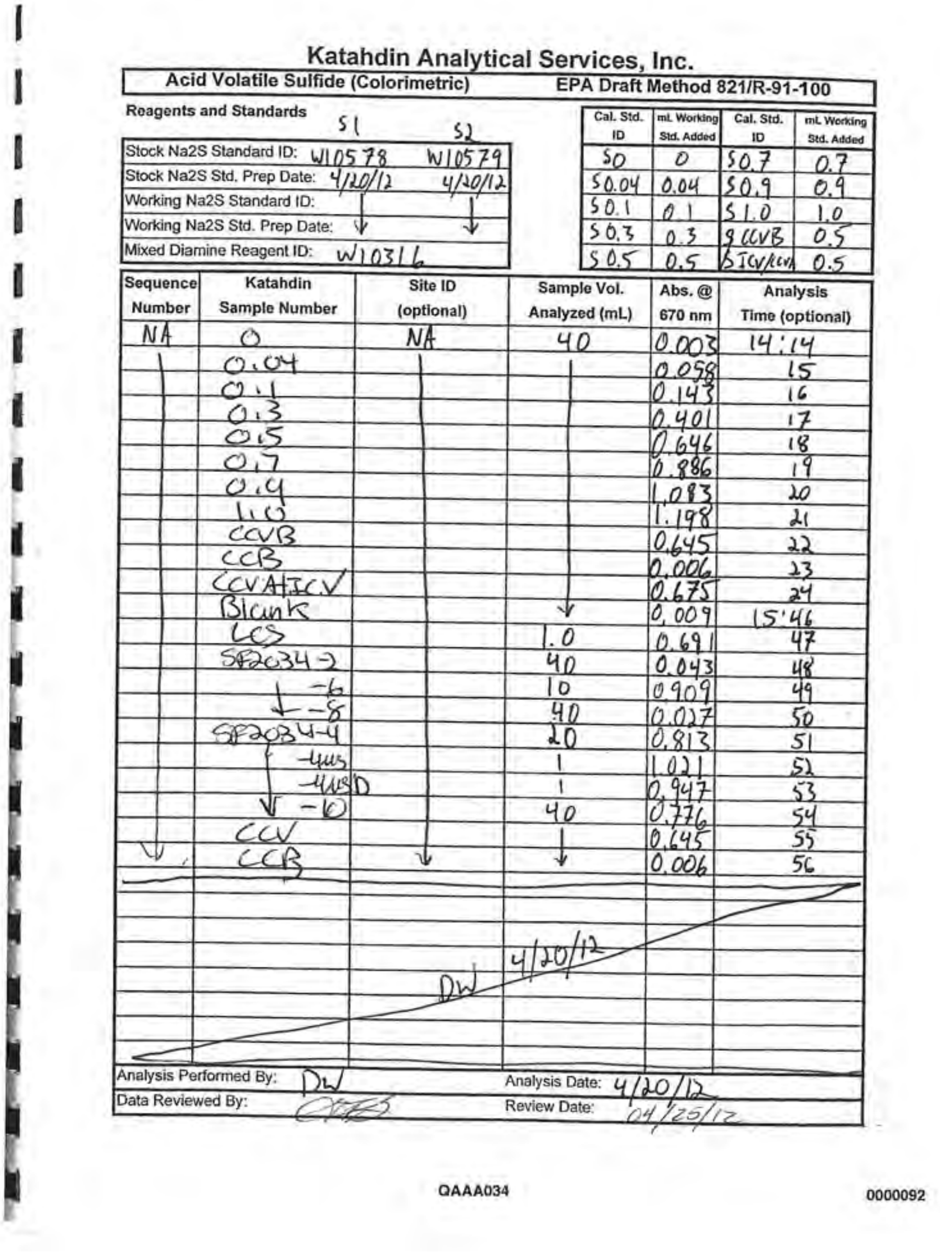
SUMMARY OF METHOD MODIFICATIONS

TOPIC	KATAHDIN SOP CA-738-03	Draft Analytical Method for Determination of Acid Volatile Sulfide in Sediment
Apparatus/ Materials	Use gas washing bottles	Use glassware with ground glass connections
Reagents		
Sample preservation/ handling		
Procedures	170 mL 0.5N NaOH used	80 mL 0.5N NaOH used
QC – Spikes	Recovery acceptance limits = 75% - 125%	Recovery acceptance limits = 85% - 105%
QC – LCS	Recovery acceptance limits = 80% - 120%	Recovery acceptance limits = 85% - 105%
QC - Accuracy/Precision		
QC – MDL		

TITLE: DETERMINATION OF ACID VOLATILE SULFIDE AND SIMULTANEOUSLY EXTRACTABLE METALS IN SEDIMENTS

FIGURE 1

EXAMPLE OF WATERS AND SOILS RUNLOG PAGE



Katahdin Analytical Services, Inc.

Acid Volatile Sulfide (Colorimetric) **EPA Draft Method 821/R-91-100**

Reagents and Standards

	S1	S2
Stock Na2S Standard ID:	W10578	W10579
Stock Na2S Std. Prep Date:	4/20/12	4/20/12
Working Na2S Standard ID:		
Working Na2S Std. Prep Date:		
Mixed Diamine Reagent ID:	W10316	

Cal. Std. ID	mL Working Std. Added	Cal. Std. ID	mL Working Std. Added
S0	0	S0.7	0.7
S0.04	0.04	S0.9	0.9
S0.1	0.1	S1.0	1.0
S0.3	0.3	S CCVB	0.5
S0.5	0.5	S ICV/CCV	0.5

Sequence Number	Katahdin Sample Number	Site ID (optional)	Sample Vol. Analyzed (mL)	Abs. @ 670 nm	Analysis Time (optional)
NA	0	NA	40	0.003	14:14
	0.04			0.058	15
	0.1			0.143	16
	0.3			0.401	17
	0.5			0.646	18
	0.7			0.886	19
	0.9			1.083	20
	1.0			1.198	21
	CCVB			0.645	22
	CCB			0.006	23
	CCV/ICV			0.675	24
	Blank			0.009	15:46
	LCS		1.0	0.691	47
	SP2034-2		40	0.043	48
	-6		10	0.909	49
	-8		40	0.027	50
	SP2034-4		20	0.813	51
	-4MS		1	1.021	52
	-4MSD		1	0.947	53
	-10		40	0.776	54
	CCV			0.645	55
	CCB			0.006	56

DW 4/20/12

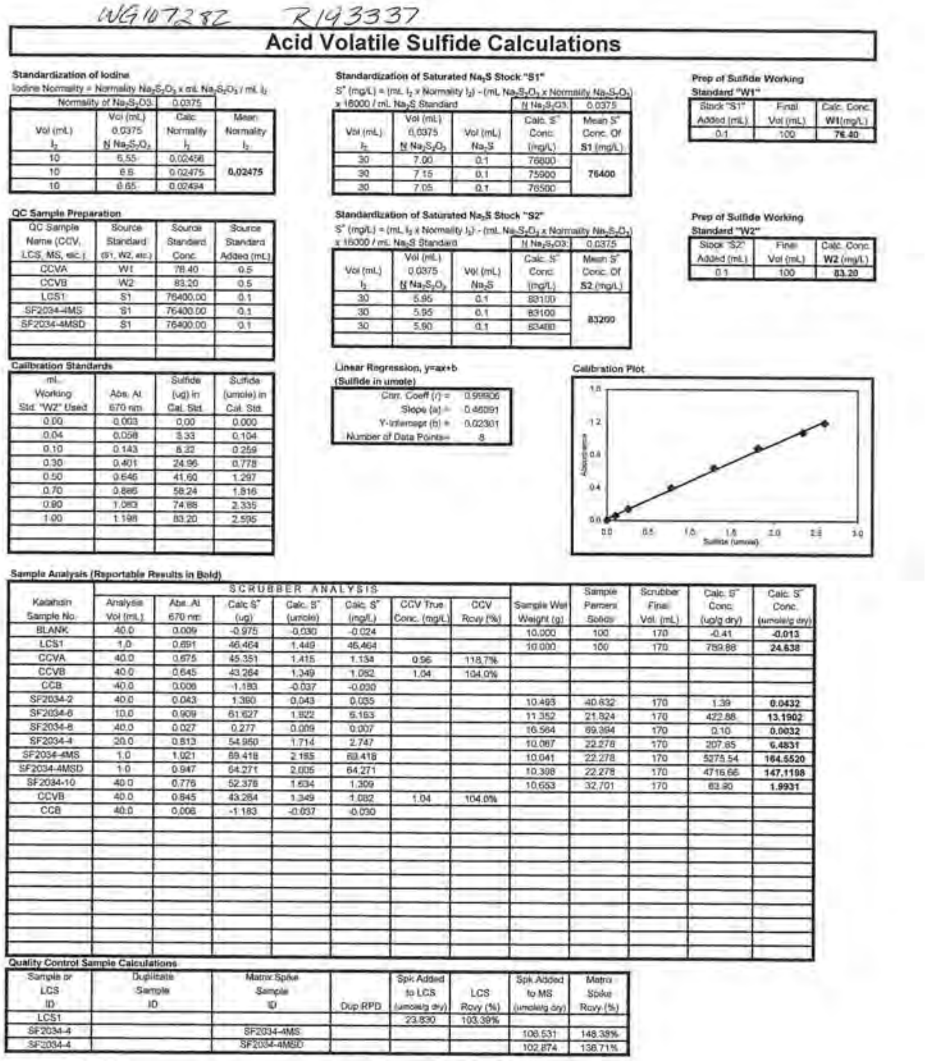
Analysis Performed By: DW
Analysis Date: 4/20/12
Data Reviewed By:
Review Date: 04/25/12

QAAA034

0000092

FIGURE 2

EXAMPLE OF AVS CALCULATION SPREADSHEET



WG107282 R193337

Acid Volatile Sulfide Calculations

Standardization of Iodine

Iodine Normality = Normality $Na_2S_2O_3$ x mL $Na_2S_2O_3$ / mL I_2

Normality of $Na_2S_2O_3$:	0.0375		
Vol (mL) I_2	Vol (mL) 0.0375 N $Na_2S_2O_3$	Calc Normality I_2	Mean Normality I_2
10	6.55	0.02456	**0.02475**
10	6.6	0.02475	
10	6.65	0.02494	

Standardization of Saturated Na_2S Stock "S1"

$S^=$ (mg/L) = (mL I_2 x Normality I_2) - (mL $Na_2S_2O_3$ x Normality $Na_2S_2O_3$) x 16000 / mL Na_2S Standard

			N $Na_2S_2O_3$:	0.0375
Vol (mL) I_2	Vol (mL) 0.0375 N $Na_2S_2O_3$	Vol (mL) Na_2S	Calc. $S^=$ Conc (mg/L)	Mean $S^=$ Conc. Of **S1** (mg/L)
30	7.00	0.1	76800	**76400**
30	7.15	0.1	75900	
30	7.05	0.1	76500	

Prep of Sulfide Working Standard "W1"

Stock "S1" Added (mL)	Final Vol (mL)	Calc. Conc **W1**(mg/L)
0.1	100	**76.40**

QC Sample Preparation

QC Sample Name (CCV, LCS, MS, etc.)	Source Standard (S1, W2, etc.)	Source Standard Conc.	Source Standard Added (mL)
CCVA	W1	78.40	0.5
CCVB	W2	83.20	0.5
LCS1	S1	76400.00	0.1
SF2034-4MS	S1	76400.00	0.1
SF2034-4MSD	S1	76400.00	0.1

Standardization of Saturated Na_2S Stock "S2"

$S^=$ (mg/L) = (mL I_2 x Normality I_2) - (mL $Na_2S_2O_3$ x Normality $Na_2S_2O_3$) x 16000 / mL Na_2S Standard

			N $Na_2S_2O_3$:	0.0375
Vol (mL) I_2	Vol (mL) 0.0375 N $Na_2S_2O_3$	Vol (mL) Na_2S	Calc. $S^=$ Conc (mg/L)	Mean $S^=$ Conc. Of **S2** (mg/L)
30	5.95	0.1	83100	83200
30	5.95	0.1	83100	
30	5.90	0.1	83400	

Prep of Sulfide Working Standard "W2"

Stock "S2" Added (mL)	Final Vol (mL)	Calc. Conc **W2** (mg/L)
0.1	100	**83.20**

Calibration Standards

mL Working Std. "W2" Used	Abs. At 670 nm	Sulfide (ug) in Cal. Std.	Sulfide (umole) in Cal. Std.
0.00	0.003	0.00	0.000
0.04	0.058	3.33	0.104
0.10	0.143	8.32	0.259
0.30	0.401	24.96	0.778
0.50	0.646	41.60	1.297
0.70	0.886	58.24	1.816
0.90	1.083	74.88	2.335
1.00	1.198	83.20	2.595

Linear Regression, y=ax+b
(Sulfide in umole)

Corr. Coeff (r) = 0.99906
Slope (a) = 0.46091
Y-Intercept (b) = 0.02301
Number of Data Points= 8

Calibration Plot

Sample Analysis (Reportable Results in Bold)

Katahdin Sample No.	SCRUBBER ANALYSIS											
	Analysis Vol (mL)	Abs. At 670 nm	Calc $S^=$ (ug)	Calc. $S^=$ (umole)	Calc. $S^=$ (mg/L)	CCV True Conc. (mg/L)	CCV Rcvy (%)	Sample Wet Weight (g)	Sample Percent Solids	Scrubber Final Vol. (mL)	Calc. $S^=$ Conc. (ug/g dry)	Calc. $S^=$ Conc. (umole/g dry)
BLANK	40.0	0.009	-0.975	-0.030	-0.024			10.000	100	170	-0.41	**-0.013**
LCS1	1.0	0.691	46.464	1.449	46.464			10.000	100	170	789.88	**24.638**
CCVA	40.0	0.675	45.351	1.415	1.134	0.96	118.7%					
CCVB	40.0	0.645	43.264	1.349	1.082	1.04	104.0%					
CCB	40.0	0.006	-1.183	-0.037	-0.030							
SF2034-2	40.0	0.043	1.380	0.043	0.035			10.493	40.632	170	1.39	**0.0432**
SF2034-6	10.0	0.909	61.627	1.922	6.163			11.352	21.824	170	422.88	**13.1902**
SF2034-8	40.0	0.027	0.277	0.009	0.007			16.564	69.394	170	0.10	**0.0032**
SF2034-4	20.0	0.813	54.950	1.714	2.747			10.067	22.278	170	207.85	**6.4831**
SF2034-4MS	1.0	1.021	69.418	2.165	69.418			10.041	22.278	170	5275.54	**164.5520**
SF2034-4MSD	1.0	0.947	64.271	2.005	64.271			10.308	22.278	170	4716.66	**147.1198**
SF2034-10	40.0	0.776	52.376	1.634	1.309			10.653	32.701	170	63.90	**1.9931**
CCVB	40.0	0.645	43.264	1.349	1.082	1.04	104.0%					
CCB	40.0	0.006	-1.183	-0.037	-0.030							

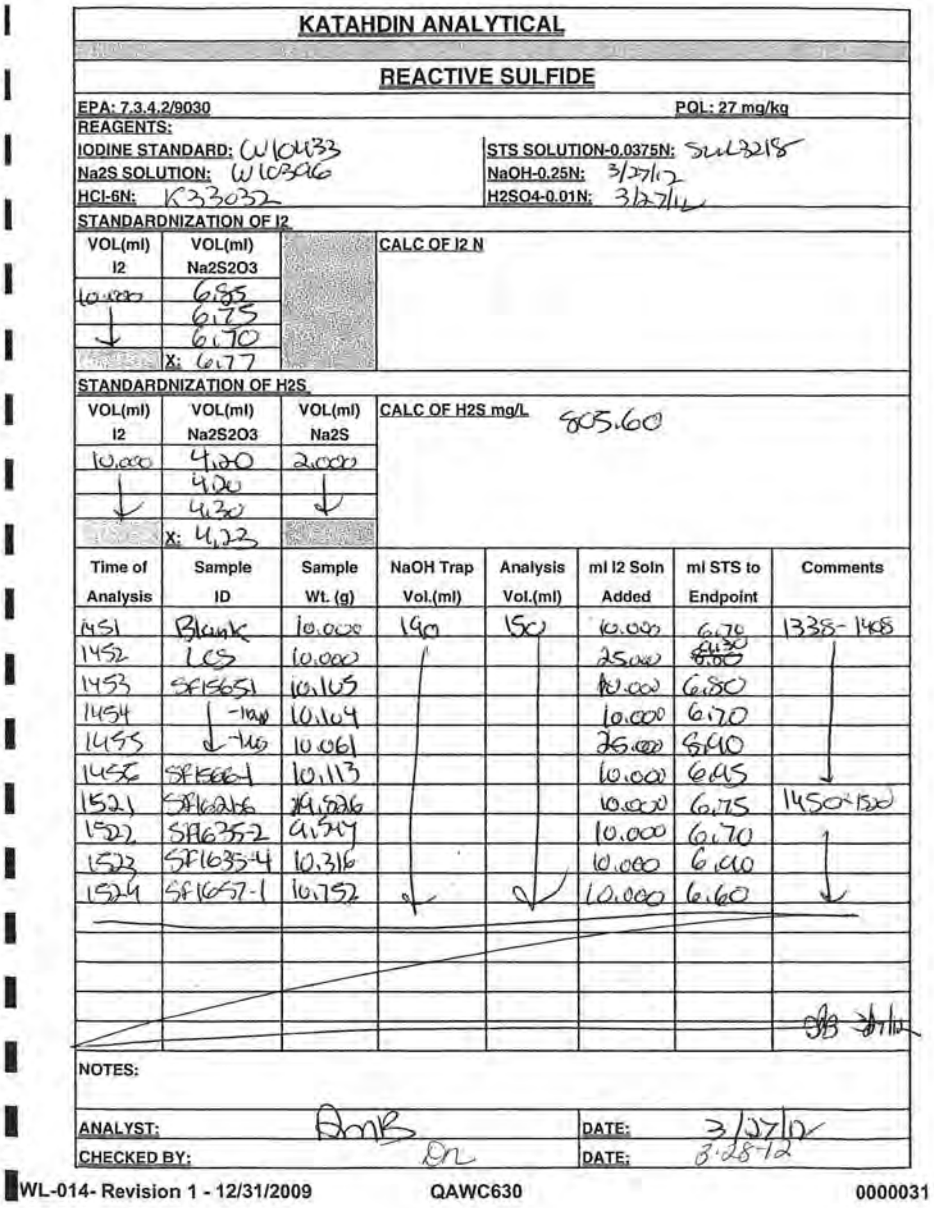
Quality Control Sample Calculations

Sample or LCS ID	Duplicate Sample ID	Matrix Spike Sample ID	Dup RPD	Spk Added to LCS (umole/g dry)	LCS Rcvy (%)	Spk Added to MS (umole/g dry)	Matrix Spike Rcvy (%)
LCS1				23.830	103.39%		
SF2034-4		SF2034-4MS				108.531	148.39%
SF2034-4		SF2034-4MSD				102.874	138.71%

TITLE: DETERMINATION OF ACID VOLATILE SULFIDE AND SIMULTANEOUSLY EXTRACTABLE METALS IN SEDIMENTS

FIGURE 3

REACTIVE SULFIDE LOGBOOK PAGE



KATAHDIN ANALYTICAL

REACTIVE SULFIDE

EPA: 7.3.4.2/9030 **PQL: 27 mg/kg**

REAGENTS:

IODINE STANDARD: W10433
Na2S SOLUTION: W10396
HCI-6N: K330322
STS SOLUTION-0.0375N: SUL3218
NaOH-0.25N: 3/27/12
H2SO4-0.01N: 3/27/12

STANDARDNIZATION OF I2

VOL(ml) I2	VOL(ml) Na2S2O3		CALC OF I2 N
10.000	6.85		
	6.75		
↓	6.70		
	X: 6.77		

STANDARDNIZATION OF H2S

VOL(ml) I2	VOL(ml) Na2S2O3	VOL(ml) Na2S	CALC OF H2S mg/L 805.60
10.000	4.20	2.000	
	4.20		
↓	4.30	↓	
	X: 4.23		

Time of Analysis	Sample ID	Sample Wt. (g)	NaOH Trap Vol.(ml)	Analysis Vol.(ml)	ml I2 Soln Added	ml STS to Endpoint	Comments
1451	Blank	10.000	140	150	10.000	6.70	1338-1408
1452	LCS	10.000			25.000	~~8.00~~ 6.30	
1453	SF15651	10.105			10.000	6.80	
1454	-Dup	10.104			10.000	6.70	
1455	-MS	10.061			25.000	8.40	
1456	SF1566-1	10.113			10.000	6.45	
1521	SF16266	9.526			10.000	6.75	1450-1500
1522	SF1635-2	9.547			10.000	6.70	
1523	SF1635-4	10.316			10.000	6.40	
1524	SF1657-1	10.752	↓	↓	10.000	6.60	↓

AB 3/27/12

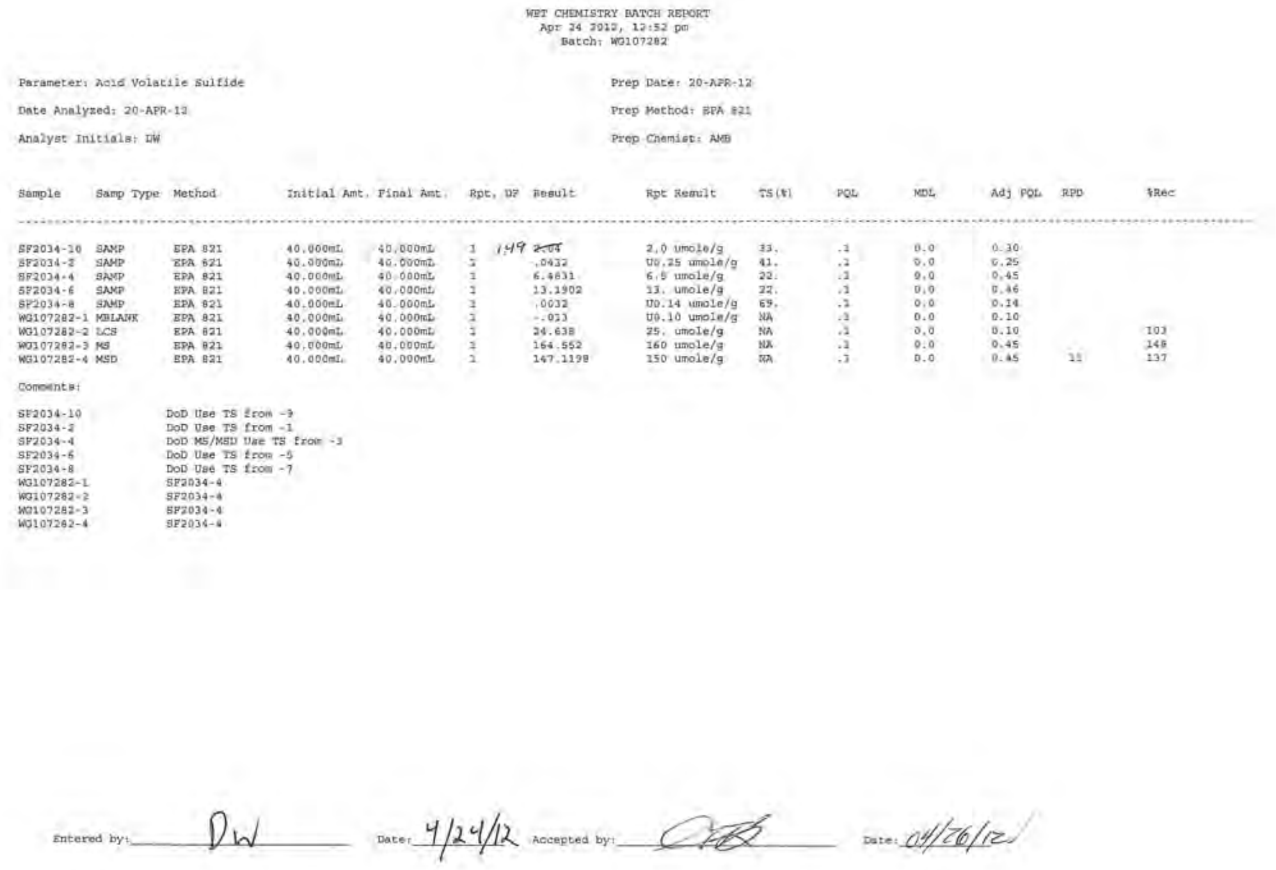
NOTES:

ANALYST: AmB **DATE:** 3/27/12
CHECKED BY: DL **DATE:** 3-28-12

WL-014- Revision 1 - 12/31/2009 QAWC630 0000031

FIGURE 4

ACID VOLATILE SULFIDE BATCH SHEET



WET CHEMISTRY BATCH REPORT
Apr 24 2012, 12:52 pm
Batch: WG107282

Parameter: Acid Volatile Sulfide
Date Analyzed: 20-APR-12
Analyst Initials: DW

Prep Date: 20-APR-12
Prep Method: EPA 821
Prep Chemist: AMB

Sample	Samp Type	Method	Initial Amt.	Final Amt.	Rpt. DF	Result	Rpt Result	TS(%)	PQL	MDL	Adj PQL	RPD	%Rec
SF2034-10	SAMP	EPA 821	40.000mL	40.000mL	1	1.49 ~~2.04~~	2.0 umole/g	33.	.1	0.0	0.30		
SF2034-2	SAMP	EPA 821	40.000mL	40.000mL	1	.0432	U0.25 umole/g	41.	.1	0.0	0.25		
SF2034-4	SAMP	EPA 821	40.000mL	40.000mL	1	6.4631	6.5 umole/g	22.	.1	0.0	0.45		
SF2034-6	SAMP	EPA 821	40.000mL	40.000mL	1	13.1902	13. umole/g	22.	.1	0.0	0.46		
SF2034-8	SAMP	EPA 821	40.000mL	40.000mL	1	.0032	U0.14 umole/g	69.	.1	0.0	0.14		
WG107282-1	MBLANK	EPA 821	40.000mL	40.000mL	1	-.013	U0.10 umole/g	NA	.1	0.0	0.10		
WG107282-2	LCS	EPA 821	40.000mL	40.000mL	1	24.638	25. umole/g	NA	.1	0.0	0.10		103
WG107282-3	MS	EPA 821	40.000mL	40.000mL	1	164.552	160 umole/g	NA	.1	0.0	0.45		148
WG107282-4	MSD	EPA 821	40.000mL	40.000mL	1	147.1198	150 umole/g	NA	.1	0.0	0.45	11	137

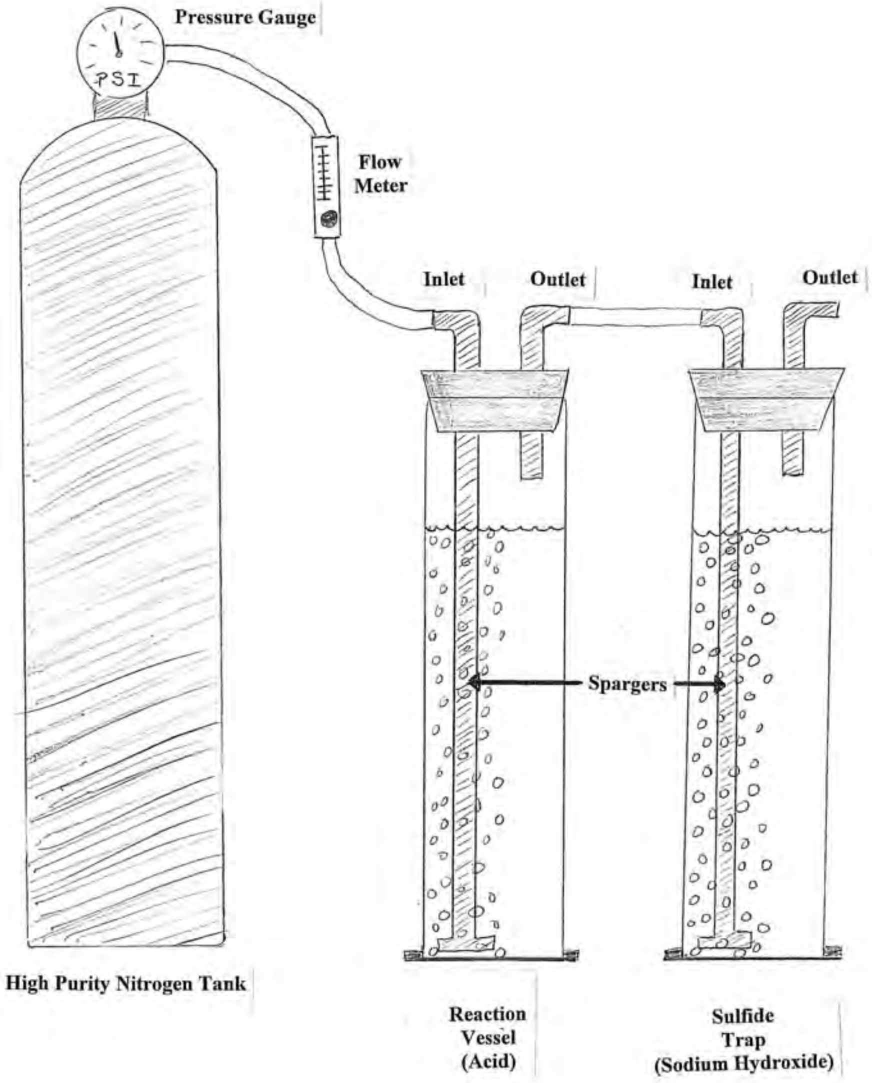
Comments:

SF2034-10	DoD Use TS from -9
SF2034-2	DoD Use TS from -1
SF2034-4	DoD MS/MSD Use TS from -3
SF2034-6	DoD Use TS from -5
SF2034-8	DoD Use TS from -7
WG107282-1	SF2034-4
WG107282-2	SF2034-4
WG107282-3	SF2034-4
WG107282-4	SF2034-4

Entered by: DW Date: 4/24/12 Accepted by: Date: 04/26/12

FIGURE 5

ACID VOLATILE SULFIDE APPARATUS



ADDENDUM

SOP NO CHANGE FORM

UNCONTROLLED DOCUMENT

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Derek Wright

Review Date: 3/3/14

SOP Number: CA-738-03

SOP Title: Determination of Acid Volatile Sulfide and Simultaneously Extractable Metals in Sediments

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: A. Brewer

Date: 03/21/14

QAO Signature: Leslie Dimond

Date: 04.15.14

UNCONTROLLED DOCUMENT

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: G. Brewer

Review Date: 06/23/16

SOP Number: CA-738

SOP Title: AVS-SEM

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature:	**Date:**
G. Brewer	06/23/16
QAO Signature:	**Date:**
Leslie Dimond	06.23.16

UNCONTROLLED DOCUMENT

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Alex Pimentel

Review Date: 1/24/17

SOP Number: CA - 738 - 03

SOP Title: Determination of Acid Volatile Sulfide & Simultaneously Extractable Metals in Sediments

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: S. Brewer

Date: 03/08/17

QAO Signature: Leslie Dimond

Date: 03.13.17

CA-741-06

DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II LLOYD KAHN METHOD

KATAHDIN ANALYTICAL SERVICES, INC.
STANDARD OPERATING PROCEDURE

SOP Number: CA-741
Revision History
Cover Page
Page 1

TITLE: DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II LLOYD KAHN METHOD

Prepared By: Greg Lull Date: 7/2002

Approved By:

Group Supervisor: Keith Tanguay Date: 091102

Lab Operations Mgr: Jol C. Burton Date: 9/11/02

QA Officer: Deborah J. Nadeau Date: 9·11·02

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Sect. 1-clarified CCB, Sect. 2-clarified phosphoric acid conc. Sect. 7- reworded software and instr. startup, added TS to calc., removed steps not currently in practise. Sect. 8 -updated LCS and CCV information. Updated Table 1	LAD	01/07	01/07
02	Added method SW846 9060 to title and Table 2. Added 9060 quadruplicate sample analysis to sect. 7 and Table 1. Removed D.I. water from MB definition, 5.3-added TIC std. info. Sect. 7.0 - rewrote for clarity on instrument and software instructions. Fixed typos- sect 2.	LAD	06/08	06/08
03	Minor changes to reflect current equipment, practices and techniques.	LAD	08/09	08/09
04	Added 9060 QC requirements to Table 1. Added method modifications to Table 2. Minor edits to Section 7 to reflect current, practice, remove redundancy and for clarification. Updated and/or added references to section 7.9 and 10.	LAD	06/10	06/10
05	Removed 1:1 phosphoric acid and added 1:1 hydrochloric acid. Added MDL, LOD and LOQ information. Updated Figures 1 → 4.	LAD	02/13	02/13

TITLE: **DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II METHOD LLOYD KAHN AND SW846 9060 MOD**

Revision History (cont.):

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Sect. 5 – Updated for current CCV and LCS source and preparation.	LAD	05/16	05/16

TITLE: DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II METHOD LLOYD KAHN AND SW846 9060 MOD.

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document SOP **CA-741-06**, titled **DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II METHOD LLOYD KAHN AND SW846 9060 MOD.**

Recipient: ____Date:____________________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document SOP **CA-741-06**, titled **DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II METHOD LLOYD KAHN AND SW846 9060 MOD.**

Recipient: ____Date:____________________

TITLE: DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II METHOD LLOYD KAHN AND SW846 9060 MOD.

1.0 SCOPE AND APPLICATION

This SOP describes the procedures used by Katahdin Analytical Services, Inc. technical personnel to determine Total Organic Carbon (TOC) in solids in accordance with EPA Region II Lloyd Kahn method.

This method is applicable to sediment, sludges, and soil samples. The detection limit for this method is 100 µg C and a method PQL of 400 ug/g.

1.1 Definitions/Acronyms

TC – Total carbon

IC – Inorganic Carbon

TOC – Total Organic Carbon

Method Blank – An empty sample boat with no reagents added that is carried through the entire analytical procedure in the same manner as a sample.

LCS/ICV - Laboratory Control Sample/ Initial Calibration Verification. One LCS/ICV per batch is prepared from a separate source from the CCV and calibration curve standards. LCS/ICV verifies the calibration curve.

CCV - Continuing Calibration Verification. The CCV is made from the same source as the calibration. One CCV is run every ten samples.

CCB - Continuing Calibration Blank. The CCB is an empty sample boat with no reagents added. One CCB is run every ten samples.

1.2 Responsibilities

This method is restricted to use by, or under the supervision of analysts experienced in the analysis of TOC in solids by the Lloyd Kahn Method. Each analyst must demonstrate and document their ability to generate acceptable results with this method. Refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”.

It is the responsibility of all Katahdin technical personnel involved in analysis of TOC in solids by the Lloyd Kahn method to read and understand this SOP, to adhere to the procedures outlined, and to properly document their data in the appropriate lab notebook. Any deviations from the test or irregularities with the samples should also be recorded in the lab notebook and reported to the Department Manager or designated qualified data reviewer responsible for this data.

It is the responsibility of the Department Manager to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method have not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical Environmental Health and Safety Manual including the Katahdin Hazardous Waste Management Plan and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their department manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Wastes generated during the preparation of samples must be disposed of in adherence with the Katahdin Analytical Environmental Health and Safety Manual and SOP SD-903, Sample Disposal, current revision. Expired standards are lab packed, placed in the Katahdin hazardous waste storage area, and disposed of in accordance with this SOP SD-903.

2.0 SUMMARY OF METHOD

Total Carbon (TC) is measured utilizing a carbonaceous analyzer with a boat sampling module and 900°C furnace attached. The resulting combustion converts carbon-to-carbon dioxide (CO_2) in the presence of oxygen. The amount of CO_2 derived from a sample is directly proportional to the concentration of carbonaceous material in the sample and is then measured by a non-dispersive infrared detector (NDIR).

TITLE: DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II METHOD LLOYD KAHN AND SW846 9060 MOD.

To determine **Total Organic Carbon** (TOC), however, carbonate and bicarbonate ions contributing to the TC result must be accounted for. This is achieved by adding 1:1 hydrochloric acid to the sample and combusting it at 103° C for 10 minutes to remove any **Inorganic Carbon** (IC) before analyzing the sample. The **Total Carbon** result then equals the **Total Organic Carbon.**

3.0 INTERFERENCES

Volatile organics in the sediment may be lost in the decarbonation step resulting in a low bias.

4.0 APPARATUS AND MATERIALS

4.1 Shimadzu model TOC-Vcph with NDIR.

4.2 SSM-5000A 900°C furnace with boat sampling module.

4.3 Mettler AE 100 balance (accurate to 0.1 mg) or equivalent.

4.4 Ceramic boats.

4.5 Drying oven capable of maintaining 103-105°C

4.6 Oxygen gas

5.0 REAGENTS AND STANDARDS

5.1 TOC Calibration / CCV Standard: D(+) Glucose Reagent ACS Anhydrous, ACROS

5.1.1 Calibration / CCV Solution – Prepare using 25.0 g and bring up to 250 mL with DI water. Stable for 3 months.

5.1.1.1 Using the table below, each calibration level is prepared by pipetting the appropriate amount of Calibration / CCV Solution into a ceramic boat filled with approximately 0.5 g of sand.

Calibration Level ug C	Weight (mg)	mL of stock
Blank	0	0
200	0.5	0.005
400	1.0	0.01
2000	5.0	0.05
4000	10	0.1
16000	40	0.4
24000	60	0.6

(Upper range limit for TOC is 24,000ugC)

5.1.1.2 The 16000 ug C level is also used as the CCV

5.2 LCS Stock Standard – Dextrose Andydrous Powder – Perpare by weighing 5.0 and bringing to 50 mL with D.I. Water. Stable for three months.

5.3 TIC Calibration / CCV Standard Sodium Carbonate, anhydrous (11.3% Carbon by weight = 113,000 ug/gC)

Calibration Standards: weigh into ceramic boat.

0.0 mg - Calibration Blank
3.5 mg - 400ugC
17.7 mg - 2000ugC
35.3 mg - 4000ugC
70.7 mg - 8000ugC
212.0 mg - 24,000ugC

(Upper range limit for TIC is 25,000 ugC)

5.4 1:1 Hydrochloric acid / DI water solution

5.5 Sodium Hydrogen Carbonate (14.28% Carbon by weight = 142,857ug/gC) used as LCS run at 4000ugC level (28 mg).

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Collect sediments in a glass jar with Teflon or aluminum foil. Cool and maintain at 4° (±2) C. Analyze within 14 days for Lloyd Kahn and 28 days for SW846 9060.

7.0 PROCEDURES

SET UP AND CALIBRATION

7.1. Turn on TOC-Vcph analyzer, SSM-5000Afurnace, and oxygen supply and connect to the TOC software program.

7.2. Start the TOC-V software program by double clicking the TOC-V icon on the desktop and selecting sample table editor. Enter user name, passwords and press **OK**. Click the “new” icon followed by “sample run”. Choose SSM-5000A from the pull down menu. This activates a sample field spreadsheet in which calibrations, controls, and samples can be inserted and run. Click the “connect” icon and choose “Settings on PC”. This will start the gas flows through both units and will activate the NDIR. Wait for the TC furnace to read 900^{o}C before beginning analysis. The gauges on the soil module for the gas lines should read 150psi and 200psi from right to left. Also place any sample boats that will be used in the furnace for several minutes to bake off any remaining residue.

7.3. To run a calibration, minimize the sample run. Click the “New” icon followed by “calibration curve”. This activates the calibration curve wizard.

7.4. Choose SSM-5000A next to system by using the pull down menu, the click **NEXT** twice. Type in the file name specifying that it is a curve in the name (i.e toccurve030510), and then click **NEXT**. Using the pull down menu select ug as the units and click **NEXT**.

7.5. A 6-point curve (for either TC or IC) must be run at least every 3 months to verify the calibration. The calibration may also be updated as necessary as demonstrated by failure of the Laboratory Control Sample (LCS) or Continuing Calibration Verification (CCV). To add the points to the curve select “(1)” then click **ADD**. In the highlighted **Conc:** box type in the concentration of the first point (24000), and then press **OK**. Click on the next point “(2)” and **ADD**. Continue with previous steps until all 6-points have been entered. Click **NEXT** twice and then **FINISH**. Now the curve needs to be run.

7.6. Maximize the sample run and highlight the first row. Select insert then calibration curve from the top menu. Select the calibration curve that was just saved and click **OK**. The calibration curve will be renamed with the date and time (i.e toccal030510, note: name must include the word curve or cal, whichever was not used in the original file name) when the start button is clicked.

7.7. Once all the boxes on the top of the sample run say “Ready”, click the start icon (traffic light) on the menu bar. Once the calibration has been started the instrument will prompt two windows.

7.8. The first will state which point will be running, verify the point and press **OK**. The second window will ask for the exact amount of dextrose that has been weighed out. Enter the amount and click OK. For the last point, the blank point, an empty sample boat is used and 500mg is used for the weight.

7.9. Once entered click **OK** and the instrument will prompt a message to move the sample boat to the measure position.

7.10. Open the TC sample port and insert the boat. Close the port tight and set timer for two (2) minutes. These two minutes ensures that the CO2 that entered the instrument has had enough time to go completely through the detector and not give any false positives. When the timer goes off slide the sample boat to the measurement position.

7.11. Once the instrument is done analyzing the sample, about 4-5 minutes, there will be a message prompt to slide the sample boat to the cooling position. After a few minutes it will then prompt again to move the sample boat back in to the port. As soon as the boat has been pulled all the way back the instrument will automatically start the process for the next point. Repeat steps 7.8 to 7.10 for the rest of the calibration.

7.12. When the entire curve is complete, print the sample report and check the curve and its linearity. The correlation coefficient must be greater than or equal to 0.995. The value of the calibration checks must fall within the control limits (80-120% recovery). If not rerun the sample up to two more times. If the calibration check is still out of the acceptable recovery range, recalibrate the instrument and repeat the procedure. If problem persists, remake the standards and repeat the procedure or perform instrument maintenance. If maintenance is required, record in TOC instrument maintenance notebook.

7.13. Once there is a valid calibration curve, the curve must be saved to the method. Click file, then open. Select method from the pull down menu and select tc method soils. Click the SSM-TC tab and change the calibration to the new one. Click OK. Samples are now ready to run. Select “new” file icon on the menu bar and, then click on sample run. Highlight the first row on the sample run. Click the insert sample icon. The parameter box opens, click the method box and select tc method soils. Click next and enter the sample name. Click next twice then finish.

7.14. Using a calibrated analytical balance weigh out 100-500 mg, wet weight, of the sample into a tarred ceramic boat. Using a disposable pipet add 1:1 hydrochloric acid to the sample until there is no more effervescing, usually 2-4 drops. If a sample concentration is greater than 24000 ug/g, a smaller sample amount must be used to achieve a concentration that is within the curve. Samples that require less than 50 mg must be analyzed in quadruplicate and the standard deviations calculated.

NOTE: Please refer to Katahdin Analytical Services SOP CA-108, "Basic Laboratory Technique", current revision, for more information on subsampling

NOTE: Samples analyzed by method SW846 9060 must be analyzed in quadruplicate.

7.15. Dry the sample in a 103° - 105° C oven for ten minutes. This process removes the inorganic carbon from the sample. For the sample blanks, LCS, and/or CCV, no 1:1 hydrochloric acid or drying is needed. For samples that require TC or Percent TC, 1:1 hydrochloric acid nor drying is needed.

7.16. To start the analysis, click the start icon. The first sample entered will bring up a file name box. Name the file by analysis and date, click OK. Then the box to enter the weight will open. Enter weight and press OK. Follow steps 7.10 and 7.11 with the exception that each sample is now entered separately throughout the batch.

7.17. Calculate the TC or IC (whichever is being preformed) concentration using the following equation:

$$\frac{\text{Abs C value (instrument reading) in ug}}{\text{Sample Weight (g)}} \times \frac{100}{\%\text{TS}} = \text{TC or IC result in ug/g C}$$

7.18. Workgroup samples and get run ID. Enter true values for the LCS and MS and save. Go back to the spreadsheet and enter "LLOYD", "Percent", or "TOC" in the comments section for the samples you wish to report. Change QC to match workgroup. Data is then exported by selecting the ASCII export option from the file menu. Select "save as" and choose parsefiles on LVSlims. Select TOC and type file name. Click save and wait for data to export, then review data in wetrev.\

7.19. A batch sheet is generated (Figure 4). Raw data, calibrations, and batch sheets are reviewed for completeness and accuracy by the Wet Chemistry supervisor or other qualified designee.

7.20. Analysts file printouts of instrument calibrations and sample data in the lab for approximately 3 months for reference. Prior calibrations are archived and all are available for retrieval.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

See below and refer to Table 1 for a summary of QC requirements, acceptance criteria, and corrective actions. These criteria are intended to be guidelines for analysts. The table does not cover all possible situations. If any of the QC requirements are outside the recovery ranges listed below and in Table 1, all associated samples must be evaluated against all the QC. In some cases data may be reported, but may be reanalyzed in other cases. Making new reagents and standards may be necessary if the standardization is suspect. The corrective actions listed in Table 1 may rely on analyst experience to make sound scientific judgements. These decisions are based on holding time considerations and client and project specific Data Quality Objectives. The department Manager, Operations Manager, and/or Quality Assurance Officer may be consulted to evaluate data. Some samples may not be able to be reanalyzed within hold time. In these cases “qualified” data with narration may be advisable after consultation with the client.

In some cases the standard QC requirements listed in this section and in Table 1 may not be sufficient to meet the Data Quality Objectives of the specific project. Much of the work performed at the lab is analyzed in accordance with specific QC requirements spelled out in a project specific Quality Assurance Project Plan (QAPP) or in a program specific Quality Systems Manual (QSM). The reporting limits, acceptance criteria and/or corrective actions may be different than those specified in this SOP. In these cases the appropriate information will be communicated to the Department Manager and/or senior chemists before initiation of the analyses so that specific product codes can be produced for the project. In addition, the work order notes for each project will describe the specific QAPP or QSM to be followed.

8.1 A Method Blank is analyzed at the beginning of the run and a CCB is analyzed every ten samples thereafter and at the end of the run. The Method Blank and CCBs are boat blanks. The boat should be analyzed empty. Results must not be greater than the reporting limit (PQL). The PQL for this test is 400mg/kg.

8.2 Analyze an LCS (40-50 mg of Dextrose = 16000-20000ugC for TC) / (28 mg Sodium Hydogen Carbonate = 4000 ug C for IC) with each batch of 20 samples. Acceptance criteria is 80-120% of expected value.

8.3 Run a CCV (40-50 mg Dextrose = 16000-20000 ug C for TC) / (35.3 mg Hydrogen Carbonate = 4000 ug C for IC) every 10 samples and at the end of each batch. Acceptance criteria is 80-120% of expected value.

8.4 Run a duplicate every 20 samples. Run a matrix spike every 10 samples by weighing out the sample and adding 10 mg of dextrose to it for the TC spike or 35.3 mg of hydrogen carbonate for the IC spike. Run a matrix spike duplicate every 10 samples for SW 9060 samples. The recovery can be determined by calculating the theoretical yield from the sample result based on the weight as compared to the native result and adding 4000 ug C that was added from the spike component. The actual yield divided by the theoretical yield will give the recovery.

9.0 METHOD PERFORMANCE

The method detection limit (MDL) is defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the value is above zero. The MDLs shall be determined and verified one time per type of instrument unless otherwise required by the method.

A Limit of Detection (LOD) is an estimate of the minimum amount of a substance that an analytical process can reliably detect. An LOD is analyte and matrix specific and may be laboratory-dependent. LODs must be determined for all parameters for which the laboratory is accredited under the DoD Environmental Laboratory Accreditation Program. LOD's must be verified for every preparation and analytical method combination and on every applicable instrument on a quarterly basis.

The Limit of Quantitation (LOQ) is the minimum levels, concentrations, or quantities of a target variable (e.g., target analyte) that can be reported with a specified degree of confidence. The LOQ shall be set at the lowest point in the calibration curve for all analyses utilizing an initial calibration. LOQ's must be verified quarterly for every preparation and analytical method combination and on every applicable instrument on a quarterly basis for all parameters included in the DoD Scope of Accreditation. The LOQ must be verified at least once annually if the analysis is not included in the DoD Scope of Accreditation.

MDLs are filed with the Organic Department Manager and then with the QAO. LOD and LOQ verifications are filed with the QAO

Refer to the current revision of Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, for procedures on determining the MDL.

Refer to the current revision of EPA SW846 9060 and the Lloyd Kahn method for other method performance parameters and requirements.

10.0 APPLICABLE DOCUMENTS/REFERENCES

Determination of Total Organic Carbon in Sediment, Lloyd Kahn, USEPA Region II, 7/88.

"Test Methods for the Evaluation of Solid Waste: Physical/Chemical Methods", SW-846, third Edition, Final Update III, December 1996, Method 9060.

TOC-V series SSM-5000A user's manual.

Installation and Operation of Shimadzu's Solid Sample Module.

Department of Defense Quality Systems Manual for Environmental Laboratories (DOD QSM), Version 4.2, 10/25/2010.

Department of Defense (DoD) and Department of Energy (DOE) Consolidated Quality Systems Manual (QSM) for Environmental Laboratories, DoD QSM Version 5.0, March, 2013

The National Environmental Laboratory Accreditation Conference (NELAC) Standards, June 2003

Katahdin SOP CA-101, Equipment Maintenance and Troubleshooting, current revision

Katahdin SOP QA-806, Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications, current revision

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LIST OF TABLES AND FIGURES

TABLE 1

QC REQUIREMENTS

QC Check	Minimum Frequency	Acceptance Criteria	Corrective Action
Method blank	One per prep batch	No analyte detected >PQL	(1) Investigate source of contamination (2) Evaluate the samples and associated QC: i.e. If the blank results are above the PQL, report sample results which are <PQL or > 10X the blank concentration. Otherwise, reprep a blank and the remaining samples.
LCS/ICV	One per prep batch of twenty samples (Lloyd Kahn); one per fifteen samples (SW 9060)	80-120% recovery	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <PQL, narrate. Otherwise, reprep a blank and the remaining samples.
CCV	CCV at the beginning of the analysis and one after every 10 samples: same conc. as LCS/ICV	80-120% recovery	(1) Investigate source of problem. (2) If the LCS recovery is high but the sample results are <PQL, narrate. Otherwise, reanalyze all samples back to last acceptable CCV recovery
Sample Quadruplicate	One every twenty samples. SW 9060 – all samples are analyzed in quadruplicate	≤ 30% RPD	(1) If lab QC in criteria and matrix interference suspected, flag data (2) Else, reanalyze
Matrix spike/Matrix spike duplicate	One MS per ten samples(MSD required every 10 samples for SW 9060)	75-125% recovery	(1) If LCS in criteria and matrix interference suspected, flag data (2) Else, reanalyze
Demonstration of analyst proficiency; accuracy and precision	One time demonstration by each analyst performing the method	Must pass all applicable QC for method	Repeat analysis until able to perform passing QC; document successful performance in personal training file
MDL and-or LOD/LOQ Verification study	Refer to KAS SOP QA-806, “Method Detection Limit, Instrument Detection Limit and Reporting Limit Studies and Verifications”, current revision.		

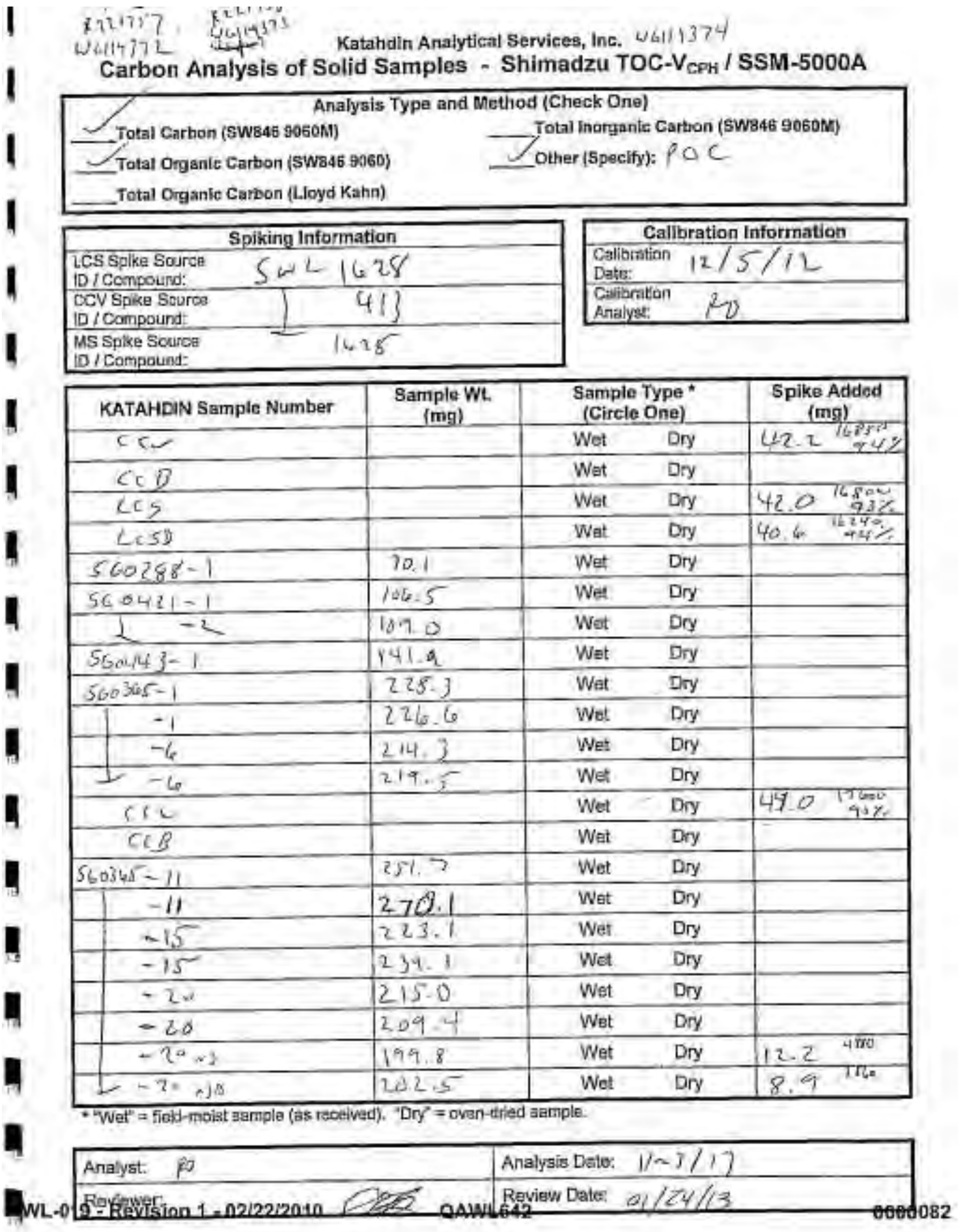
TABLE 2

SUMMARY OF METHOD MODIFICATIONS

Topic	Katahdin SOP CA-741-06	METHOD LLOYD KAHN/SW846 9060
Apparatus/Materials		
Reagents	Dextrose solid for TC calibration (Dextrose for LCS) Sodium Carbonate for IC calibration (Sodium Hydrogen Carbonate for LCS)	Potassium Hydrogen Phthalate solution used for calibration.
Sample preservation/ handling		
Procedures	Report one of the duplicate samples using an RPD of 30%.	Report average and range of quadruplicate analysis (SW 9060) Use 3 standard deviation limit (Lloyd Kahn)
QC - Spikes		
QC - LCS		
QC - Accuracy/Precision		
QC - MDL		

FIGURE 1

EXAMPLE OF TOC SOLIDS LOGBOOK PAGE



[illegible]
WG114772
WG119373
WG111374

Katahdin Analytical Services, Inc.

Carbon Analysis of Solid Samples - Shimadzu TOC-V_{CPH} / SSM-5000A

Analysis Type and Method (Check One)

✓ Total Carbon (SW846 9060M)
✓ Total Organic Carbon (SW846 9060)
___ Total Organic Carbon (Lloyd Kahn)
___ Total Inorganic Carbon (SW846 9060M)
✓ Other (Specify): POC

Spiking Information	
LCS Spike Source ID / Compound:	SWL 1628
CCV Spike Source ID / Compound:	413
MS Spike Source ID / Compound:	1628

Calibration Information	
Calibration Date:	12/5/12
Calibration Analyst:	PD

KATAHDIN Sample Number	Sample Wt. (mg)	Sample Type * (Circle One)	Spike Added (mg)
CCV		Wet Dry	42.2 16850 94%
CCB		Wet Dry	
LCS		Wet Dry	42.0 16800 93%
LCSD		Wet Dry	40.6 16240 94%
560288-1	70.1	Wet Dry	
560421-1	106.5	Wet Dry	
-2	109.0	Wet Dry	
560443-1	141.9	Wet Dry	
560365-1	228.3	Wet Dry	
-1	226.6	Wet Dry	
-6	214.3	Wet Dry	
-6	219.5	Wet Dry	
CCV		Wet Dry	49.0 17600 93%
CCB		Wet Dry	
560365-11	251.7	Wet Dry	
-11	270.1	Wet Dry	
-15	223.1	Wet Dry	
-15	234.1	Wet Dry	
-20	215.0	Wet Dry	
-20	209.4	Wet Dry	
-20 MS	199.8	Wet Dry	12.2 [illegible]
-20 MSD	202.5	Wet Dry	8.9 [illegible]

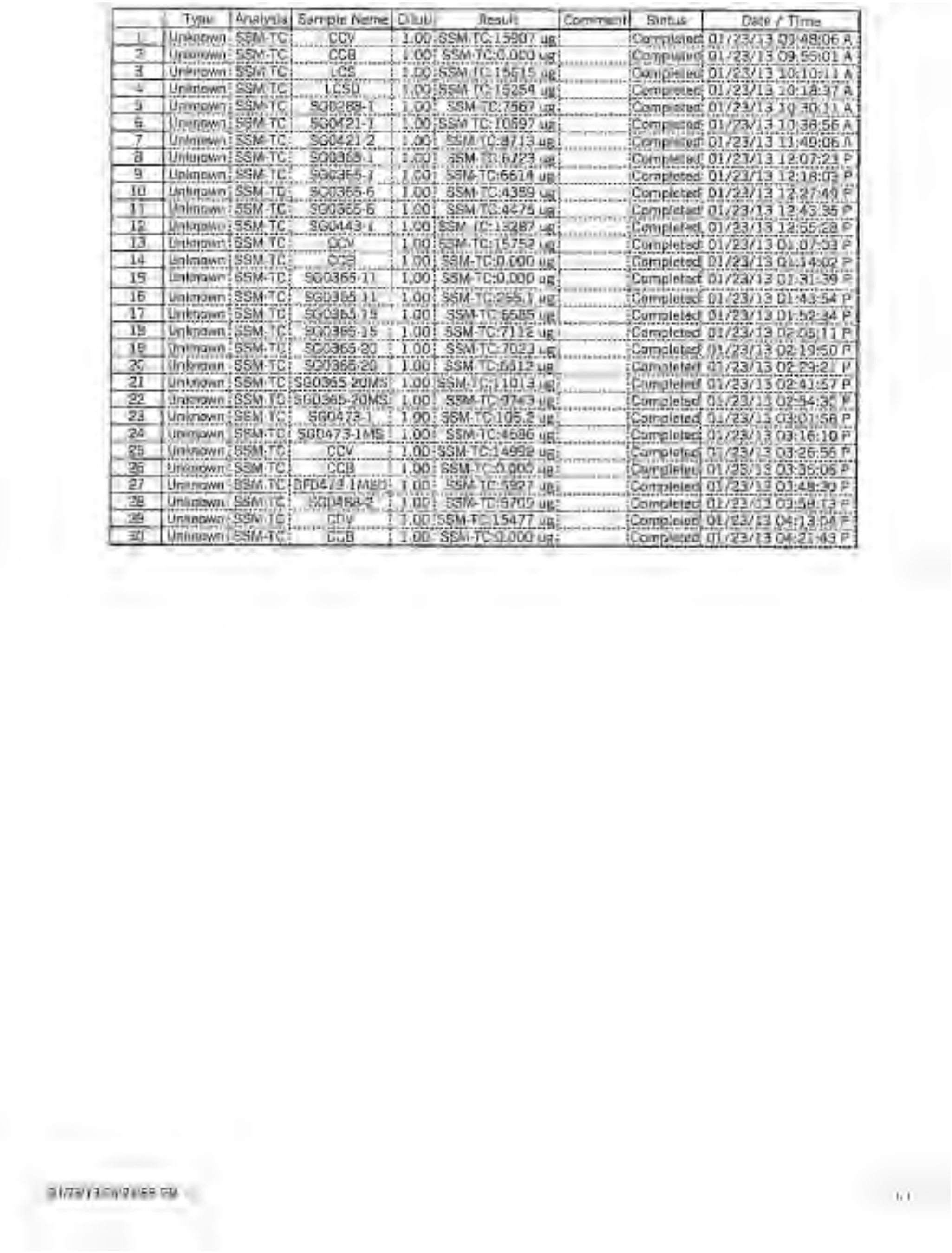
* "Wet" = field-moist sample (as received). "Dry" = oven-dried sample.

Analyst: PD	Analysis Date: 1/~3/13
Reviewer:	Review Date: 01/24/13

WL-019 - Revision 1 - 02/22/2010 QAWL642 0000082

FIGURE 2

EXAMPLE OF TOC SOLIDS INSTRUMENT PRINTOUT

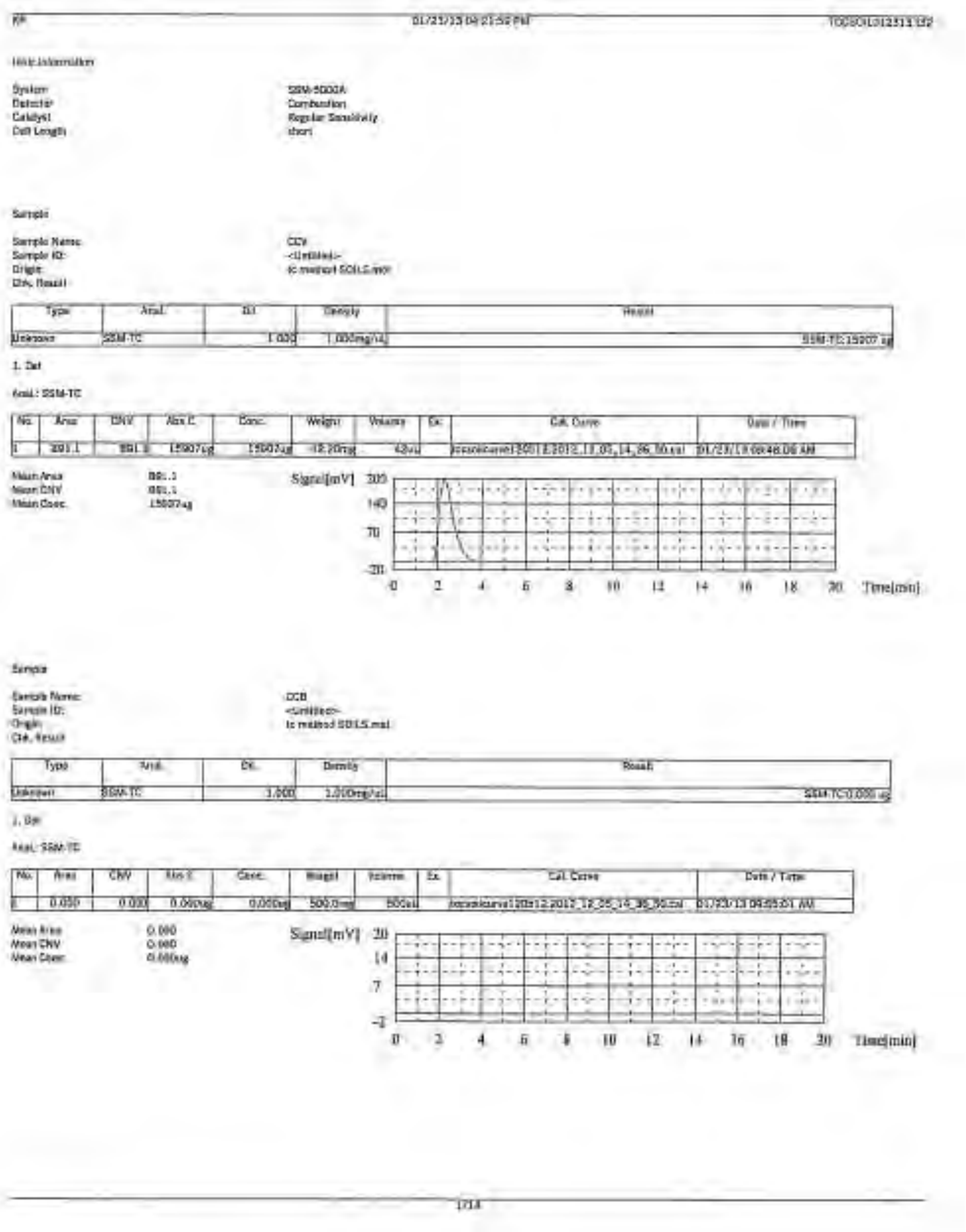


	Type	Analysis	Sample Name	Dilut	Result	Comment	Status	Date / Time
1	Unknown	SSM-TC	CCV	1.00	SSM-TC:15807 ug		Completed	01/23/13 09:48:06 A
2	Unknown	SSM-TC	CCB	1.00	SSM-TC:0.000 ug		Completed	01/23/13 09:55:01 A
3	Unknown	SSM-TC	LCS	1.00	SSM-TC:15615 ug		Completed	01/23/13 10:10:11 A
4	Unknown	SSM-TC	LCSD	1.00	SSM-TC:15254 ug		Completed	01/23/13 10:18:37 A
5	Unknown	SSM-TC	SG0288-1	1.00	SSM-TC:7567 ug		Completed	01/23/13 10:30:11 A
6	Unknown	SSM-TC	SG0421-1	1.00	SSM-TC:10697 ug		Completed	01/23/13 10:38:56 A
7	Unknown	SSM-TC	SG0421-2	1.00	SSM-TC:8713 ug		Completed	01/23/13 11:49:06 A
8	Unknown	SSM-TC	SG0365-1	1.00	SSM-TC:6723 ug		Completed	01/23/13 12:07:21 P
9	Unknown	SSM-TC	SG0365-1	1.00	SSM-TC:6614 ug		Completed	01/23/13 12:18:03 P
10	Unknown	SSM-TC	SG0365-6	1.00	SSM-TC:4359 ug		Completed	01/23/13 12:27:40 P
11	Unknown	SSM-TC	SG0365-6	1.00	SSM-TC:4475 ug		Completed	01/23/13 12:43:35 P
12	Unknown	SSM-TC	SG0443-1	1.00	SSM-TC:13287 ug		Completed	01/23/13 12:55:28 P
13	Unknown	SSM-TC	CCV	1.00	SSM-TC:15752 ug		Completed	01/23/13 01:07:53 P
14	Unknown	SSM-TC	CCB	1.00	SSM-TC:0.000 ug		Completed	01/23/13 01:14:02 P
15	Unknown	SSM-TC	SG0365-11	1.00	SSM-TC:0.000 ug		Completed	01/23/13 01:31:39 P
16	Unknown	SSM-TC	SG0365-11	1.00	SSM-TC:255.1 ug		Completed	01/23/13 01:43:54 P
17	Unknown	SSM-TC	SG0365-15	1.00	SSM-TC:6585 ug		Completed	01/23/13 01:52:34 P
18	Unknown	SSM-TC	SG0365-15	1.00	SSM-TC:7112 ug		Completed	01/23/13 02:05:11 P
19	Unknown	SSM-TC	SG0365-20	1.00	SSM-TC:7023 ug		Completed	01/23/13 02:19:50 P
20	Unknown	SSM-TC	SG0365-20	1.00	SSM-TC:6612 ug		Completed	01/23/13 02:29:21 P
21	Unknown	SSM-TC	SG0365-20MS	1.00	SSM-TC:11013 ug		Completed	01/23/13 02:41:57 P
22	Unknown	SSM-TC	SG0365-20MS	1.00	SSM-TC:9743 ug		Completed	01/23/13 02:54:35 P
23	Unknown	SSM-TC	SG0473-1	1.00	SSM-TC:105.2 ug		Completed	01/23/13 03:01:58 P
24	Unknown	SSM-TC	SG0473-1MS	1.00	SSM-TC:4686 ug		Completed	01/23/13 03:16:10 P
25	Unknown	SSM-TC	CCV	1.00	SSM-TC:14992 ug		Completed	01/23/13 03:26:56 P
26	Unknown	SSM-TC	CCB	1.00	SSM-TC:0.000 ug		Completed	01/23/13 03:35:06 P
27	Unknown	SSM-TC	SG0473-1MSD	1.00	SSM-TC:5927 ug		Completed	01/23/13 03:48:30 P
28	Unknown	SSM-TC	SG0488-2	1.00	SSM-TC:5709 ug		Completed	01/23/13 03:58:13 P
29	Unknown	SSM-TC	CCV	1.00	SSM-TC:15477 ug		Completed	01/23/13 04:13:04 P
30	Unknown	SSM-TC	CCB	1.00	SSM-TC:0.000 ug		Completed	01/23/13 04:21:43 P

TITLE: DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II METHOD LLOYD KAHN AND SW846 9060 MOD.

FIGURE 3

EXAMPLE OF TOC SOIL INSTRUMENT RESULTS PRINTOUT



KP 01/23/13 04:21:58 PM [illegible]

H/W Information

System SSM-5000A
Detector Combustion
Catalyst Regular Sensitivity
Cell Length short

Sample

Sample Name: CCV
Sample ID: <Untitled>
Origin: tc method SOILS.met
Chk. Result

Type	Anal.	Dil.	Density	Result
Unknown	SSM-TC	1.000	1.000mg/uL	SSM-TC:15907 ug

1. Det

Anal.: SSM-TC

No.	Area	CNV	Abs C.	Conc.	Weight	Volume	Ex.	Cal. Curve	Date / Time
1	881.1	881.1	15907ug	15907ug	18.20mg	42uL		[illegible]	01/23/13 08:48:06 AM

Mean Area 881.1
Mean CNV 881.1
Mean Conc. 15907ug

Sample

Sample Name: CCB
Sample ID: <Untitled>
Origin: tc method SOILS.met
Chk. Result

Type	Anal.	Dil.	Density	Result
Unknown	SSM-TC	1.000	1.000mg/uL	SSM-TC:0.000 ug

1. Det

Anal.: SSM-TC

No.	Area	CNV	Abs C.	Conc.	Weight	Volume	Ex.	Cal. Curve	Date / Time
1	0.000	0.000	0.000ug	0.000ug	500.0mg	500uL		[illegible]	01/23/13 08:55:01 AM

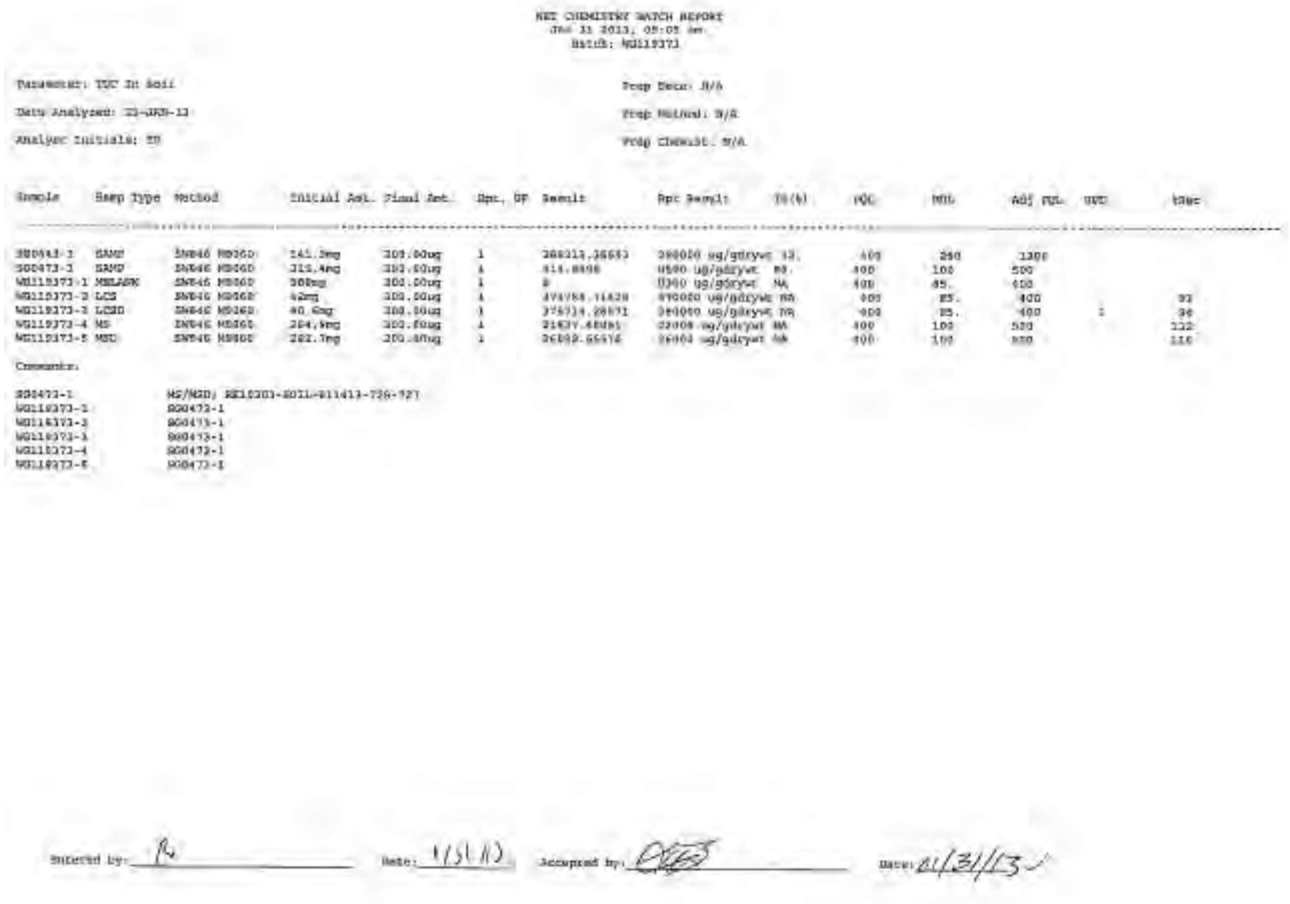
Mean Area 0.000
Mean CNV 0.000
Mean Conc. 0.000ug

1714

TITLE: DETERMINATION OF TOTAL ORGANIC CARBON IN SOLIDS USING THE EPA REGION II METHOD LLOYD KAHN AND SW846 9060 MOD.

FIGURE 4

EXAMPLE OF TOC SOLIDS BATCH SHEET



WET CHEMISTRY BATCH REPORT

Parameter: TOC In Soil

Prep Date: N/A

Prep Method: N/A

Prep Chemist: N/A

UNCONTROLLED DOCUMENT

KATAHDIN ANALYTICAL SERVICES, INC.
SOP "REVIEW WITH NO CHANGES" FORM

Name of Person Reviewing SOP: Zach Fuller

Review Date: 1/24/17

SOP Number: CA-741-06

SOP Title: L. KAHN TOC

THE ABOVE REFERENCED SOP HAS BEEN REVIEWED BY A QUALIFIED AND TRAINED ANALYST OR SUPERVISOR. NO CHANGES ARE REQUIRED TO THE SOP AT THIS TIME.

Department Supervisor Signature: A. Brewer

Date: 03/08/17

QAO Signature: Leslie Dimond

Date: 03.13.17

DOD ELAP SCOPE OF ACCREDITATION
FOR
KATAHDIN ANALYTICAL SERVICES, LLC.

LABORATORY
ACCREDITATION
BUREAU

Certificate # L2223

Scope of Accreditation
For
Katahdin Analytical Services, LLC.

600 Technology Way
Scarborough, ME 04074
Leslie Dimond
207-874-2400

In recognition of a successful assessment to ISO/IEC 17025:2005 and the requirements of the DoD Environmental Laboratory Accreditation Program (LABPR 403 DoD ELAP) as detailed in the DoD Quality Systems Manual for Environmental Laboratories (DoD QSM V5) based on the TNI Standard - Environmental Laboratory Sector, Volume 1 – Management and Technical Requirements for Laboratories Performing Environmental Analysis, Sept 2009 (EL-V1-2009); accreditation is granted to **Katahdin Analytical Services, LLC.** to perform the following tests:

Accreditation granted through: **February 1, 2019**

Testing - Environmental

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	2, 4`-DDD
GC/ECD	EPA 8081B	2, 4`-DDE
GC/ECD	EPA 8081B	2, 4`-DDT
GC/ECD	EPA 608; EPA 8081B	4, 4`-DDD
GC/ECD	EPA 608; EPA 8081B	4, 4`-DDE
GC/ECD	EPA 608; EPA 8081B	4, 4`-DDT
GC/ECD	EPA 608; EPA 8081B	Aldrin
GC/ECD	EPA 608; EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane
GC/ECD	EPA 608; EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Cis-Nonaclor
GC/ECD	EPA 608; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 608; EPA 8081B	delta-BHC
GC/ECD	EPA 608; EPA 8081B	Dieldrin
GC/ECD	EPA 608; EPA 8081B	Endosulfan I

Non-Potable Water

Technology	Method	Analyte
GC/ECD	EPA 608; EPA 8081B	Endosulfan II
GC/ECD	EPA 608; EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 608; EPA 8081B	Endrin
GC/ECD	EPA 608; EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 608; EPA 8081B	Heptachlor
GC/ECD	EPA 608; EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 608; EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	trans-Nonachlor
GC/ECD	EPA 608; EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 608; EPA 8082A	Aroclor-1260 (PCB-1260)
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,5',6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5,6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2,2',3,3',4,4',5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2,2',3,3',4,4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)

Non-Potable Water

Technology	Method	Analyte
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (BZ 48)
GC/ECD	EPA 8082A	2, 2', 4, 5’-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (BZ 157)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3, 3’, 4, 4’, 5, 5’-Heptachlorobiphenyl (BZ 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	EPA 8082A	2, 3', 4, 4',5’-Pentachlorobiphenyl (BZ 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 3, 4, 4’, 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 169)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 126)
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (BZ 77)
GC/ECD	EPA 8082A	3, 4, 4’, 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	EPA 8151A	2, 4, 5-T
GC/ECD	EPA 8151A	2, 4-D
GC/ECD	EPA 8151A	2, 4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8151A	Dichloroprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D MOD	Diesel range organics (DRO)
GC/FID	EPA 8015C/D MOD	Total Petroleum Hydrocarbon (TPH)
GC/FID	EPA 8015C/D MOD	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons
GC/FID	CT ETPH	Total Petroleum Hydrocarbons
GC/FID	TNRCC Method 1005	Total Petroleum Hydrocarbons
GC/FID	FL-PRO	Petroleum Range Organics
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromoethane (EDB)
GC/ECD	EPA 8011; EPA 504	1, 2-Dibromo-3-chloropropane
GC/FID	RSK-175	Methane Ethane Ethene
GC/MS	EPA 8260B/C; EPA 524.2	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1, 1-Trichloroethane
GC/MS	EPA 624; 8260B/C; EPA 524.2	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1, 2-Trichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1-Dichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 1-Dichloroethene
GC/MS	EPA 8260B/C; EPA 524.2	1, 1-Dichloropropene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 3-Trichloropropane
GC/MS	EPA 8260B/C	1,2,3-Trimethylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 4-Trichlorobenzene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B/C; EPA 524.2	1, 2, 4-Trimethylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C; EPA 524.2	1, 2-Dibromoethane (EDB)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichlorobenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 2-Dichloropropane
GC/MS	EPA 8260B/C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 3, 5-Trimethylbenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 3-Dichlorobenzene
GC/MS	EPA 8260B/C; EPA 524.2	1, 3-Dichloropropane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	1, 4-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 4-Dioxane
GC/MS	EPA 8260B/C	1-Chlorohexane
GC/MS	EPA 8260B/C; EPA 524.2	2, 2-Dichloropropane
GC/MS	EPA 8260B/C; EPA 524.2	2-Butanone
GC/MS	EPA 624; EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/C; EPA 524.2	2-Chlorotoluene
GC/MS	EPA 8260B/C; EPA 524.2	2-Hexanone
GC/MS	EPA 8260B/C; EPA 524.2	4-Chlorotoluene
GC/MS	EPA 8260B/C; EPA 524.2	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C; EPA 524.2	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 624; EPA 8260B/C	Acrolein
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Acrylonitrile
GC/MS	EPA 8260B/C; EPA 524.2	Allyl chloride
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Benzene
GC/MS	EPA 8260B/C	Benzyl chloride
GC/MS	EPA 8260B/C; EPA 524.2	Bromobenzene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B/C; EPA 524.2	Bromochloromethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Bromodichloromethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Bromoform
GC/MS	EPA 8260B/C; EPA 524.2	Carbon disulfide
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Carbon tetrachloride
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chlorobenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chloroethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 8260B/C; EPA 524.2	cis-1, 2-Dichloroethene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	cis-1, 3-Dichloropropene
GC/MS	EPA 8260B/C	Cis-1,4-Dichloro-2-butene
GC/MS	EPA 8260B/C	Cyclohexane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Dibromochloromethane
GC/MS	EPA 8260B/C; EPA 524.2	Dibromomethane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Dichlorodifluoromethane
GC/MS	EPA 8260B/C; EPA 524.2	Diethyl ether
GC/MS	EPA 8260B/C	Di-isopropylether
GC/MS	EPA 8260B/C; EPA 524.2	Ethyl methacrylate
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Ethylbenzene
GC/MS	EPA 8260B/C	Ethyl-t-butylether
GC/MS	EPA 8260B/C; EPA 524.2	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Iodomethane
GC/MS	EPA 8260B/C	Isobutyl alcohol
GC/MS	EPA 8260B/C	Isopropyl alcohol
GC/MS	EPA 8260B/C; EPA 524.2	Isopropyl benzene
GC/MS	EPA 8260B/C; EPA 524.2	m p-xylenes

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	Methyl acetate
GC/MS	EPA 8260B/C; EPA 524.2	Methacrylonitrile
GC/MS	EPA 624; EPA 8260B/C	Methyl bromide (Bromomethane)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Methyl chloride (Chloromethane)
GC/MS	EPA 8260B/C; EPA 524.2	Methyl methacrylate
GC/MS	EPA 8260B/C; EPA 524.2	Methyl tert-butyl ether
GC/MS	EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Methylene chloride
GC/MS	EPA 8260B/C; EPA 524.2	Naphthalene
GC/MS	EPA 8260B/C; EPA 524.2	n-Butylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	n-Propylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	o-Xylene
GC/MS	EPA 8260B/C	Pentachloroethane
GC/MS	EPA 8260B/C; EPA 524.2	p-Isopropyltoluene
GC/MS	EPA 8260B/C; EPA 524.2	Propionitrile
GC/MS	EPA 8260B/C; EPA 524.2	sec-butylbenzene
GC/MS	EPA 8260B/C; EPA 524.2	Styrene
GC/MS	EPA 8260B/C	t-Amylmethylether
GC/MS	EPA 8260B/C; EPA 524.2	tert-Butyl alcohol
GC/MS	EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Tetrachloroethene (Perchloroethylene)
GC/MS	EPA 8260B/C; EPA 524.2	Tetrahydrofuran
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Toluene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	trans-1, 2-Dichloroethylene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260B/C; EPA 524.2	trans-1, 4-Dichloro-2-butuene
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Trichloroethene (Trichloroethylene)
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Trichlorofluoromethane

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B/C	Vinyl acetate
GC/MS	EPA 624; EPA 8260B/C; EPA 524.2	Vinyl chloride
GC/MS	EPA 624; EPA 8260B/C	Xylene
GC/MS	EPA 8260B/C SIM	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B, C SIM	1,1,1-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,2,3-Trichloropropane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethene
GC/MS	EPA 8260B/C SIM	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/C SIM	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C SIM	1,2-Dibromoethane
GC/MS	EPA 8260B/C SIM	1,2-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,2-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,3-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,3-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,4-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	2-Hexanone
GC/MS	EPA 8260B/C SIM	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C SIM	Benzene
GC/MS	EPA 8260B/C SIM	Bromodichloromethane
GC/MS	EPA 8260B/C SIM	Carbon Disulfide
GC/MS	EPA 8260B/C SIM	Carbon Tetrachloride
GC/MS	EPA 8260B/C SIM	Chloroform
GC/MS	EPA 8260B/C SIM	Chloromethane
GC/MS	EPA 8260B/C SIM	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Dibromochloromethane

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8260B/C SIM	Ethylbenzene
GC/MS	EPA 8260B/C SIM	Isopropylbenzene
GC/MS	EPA 8260B/C SIM	Hexachlorobutadiene
GC/MS	EPA 8260B/C SIM	Methylcyclohexane
GC/MS	EPA 8260B/C SIM	m,p-Xylene
GC/MS	EPA 8260B/C SIM	o-Xylene
GC/MS	EPA 8260B/C SIM	Tetrachloroethene
GC/MS	EPA 8260B/C SIM	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	Trans-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Trichloroethene
GC/MS	EPA 8260B/C SIM	Trichlorofluoromethane
GC/MS	EPA 8260B/C SIM	Vinyl Chloride
GC/MS	EPA 8260B/C SIM	Xylenes (total)
GC/MS	EPA 8270C/D	1, 2, 4, 5-Tetrachlorobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 2, 4-Trichlorobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 2-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1, 3, 5-Trinitrobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 3-Dinitrobenzene
GC/MS	EPA 625; EPA 8270C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 4-Dioxane
GC/MS	EPA 8270C/D	1, 4-Naphthoquinone
GC/MS	EPA 8270C/D	1, 4-Phenylenediamine
GC/MS	EPA 8270C/D	1-Chloronaphthalene
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	1-Naphthylamine
GC/MS	EPA 8270C/D	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2, 4, 5-Trochlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4, 6-Trichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dichlorophenol

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dimethylphenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dinitrophenol
GC/MS	EPA 625; EPA 8270C/D	2, 4-Dinitrotoluene (2, 4-DNT)
GC/MS	EPA 8270C/D	2, 6-Dichlorophenol
GC/MS	EPA 625; EPA 8270C/D	2, 6-Dinitrotoluene (2, 6-DNT)
GC/MS	EPA 8270C/D	2-Acetylaminofluorene
GC/MS	EPA 625; EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 625; EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 625; EPA 8270C/D	2-Methyl-4 6-dinitrophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol
GC/MS	EPA 8270C/D	2-Naphthylamine
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 625; EPA 8270C/D	2-Nitrophenol
GC/MS	EPA 8270C/D	2-Picoline
GC/MS	EPA 8270C/D	3-Methylcholanthrene
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4-Aminobiphenyl
GC/MS	EPA 625; EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 625; EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 625; EPA 8270C/D	4-Chlorophenyl phenylether
GC/MS	EPA 8270C/D	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270C/D	3, 4-Methylphenol
GC/MS	EPA 8270C/D	4-Nitroaniline
GC/MS	EPA 625; EPA 8270C/D	4-Nitrophenol
GC/MS	EPA 8270C/D	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	5-Nitro-o-toluidine
GC/MS	EPA 8270C/D	7, 12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	a a-Dimethylphenethylamine
GC/MS	EPA 625; EPA 8270C/D	Acenaphthene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 625; EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetophenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 625; EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Aramite
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Azobenzene
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 625; EPA 8270C/D	Benzidine
GC/MS	EPA 625; EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 625; EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 625; EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 625; EPA 8270C/D	Benzo(g h i)perylene
GC/MS	EPA 625; EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	1,1-Biphenyl
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroethyl) ether
GC/MS	EPA 625; EPA 8270C/D	bis(2-Chloroisopropyl) ether (2, 2`-Oxybis(1-chloropropane)
GC/MS	EPA 625; EPA 8270C/D	bis(2-Ethylhexyl)adipate
GC/MS	EPA 625; EPA 8270C/D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 625; EPA 8270C/D	Butyl benzyl phthalate
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chlorobenzilate
GC/MS	EPA 625; EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Diallate
GC/MS	EPA 8270C/D	Dibenzo(a,j)acridine
GC/MS	EPA 625; EPA 8270C/D	Dibenz(a h)anthracene
GC/MS	EPA 8270C/D	Dibenzofuran

Non-Potable Water		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Diethyladipate
GC/MS	EPA 625; EPA 8270C/D	Diethyl phthalate
GC/MS	EPA 8270C/D	Dimethoate
GC/MS	EPA 625; EPA 8270C/D	Dimethyl phthalate
GC/MS	EPA 625; EPA 8270C/D	Di-n-butyl phthalate
GC/MS	EPA 625; EPA 8270C/D	Di-n-octyl phthalate
GC/MS	EPA 8270C/D	Dinoseb
GC/MS	EPA 8270C/D	Disulfoton
GC/MS	EPA 8270C/D	Ethyl methanesulfonate
GC/MS	EPA 8270C/D	Ethyl parathion
GC/MS	EPA 8270C/D	Ethyl methacrylate
GC/MS	EPA 8270C/D	Famfur
GC/MS	EPA 625; EPA 8270C/D	Fluoranthene
GC/MS	EPA 625; EPA 8270C/D	Fluorene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorobenzene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorobutadiene
GC/MS	EPA 625; EPA 8270C/D	Hexachlorocyclopentadiene
GC/MS	EPA 625; EPA 8270C/D	Hexachloroethane
GC/MS	EPA 8270C/D	Hexachlorophene
GC/MS	EPA 8270C/D	Hexachloropropene
GC/MS	EPA 625; EPA 8270C/D	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270C/D	Isodrin
GC/MS	EPA 625; EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Isosafrole
GC/MS	EPA 8270C/D	Kepone
GC/MS	EPA 8270C/D	Methapyriline
GC/MS	EPA 8270C/D	Methy methanesulfonate
GC/MS	EPA 8270C/D	Methyl parathion
GC/MS	EPA 625; EPA 8270C/D	Naphthalene
GC/MS	EPA 625; EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	Nitroquinoline-1-oxide

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270C/D	n-Nitrosodiethylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodimethylamine
GC/MS	EPA 8270C/D	n-Nitroso-di-n-butylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodi-n-propylamine
GC/MS	EPA 625; EPA 8270C/D	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D	n-Nitrosomethylethylamine
GC/MS	EPA 8270C/D	n-Nitrosomorpholine
GC/MS	EPA 8270C/D	n-Nitrosopiperidine
GC/MS	EPA 8270C/D	n-Nitrosopyrrolidine
GC/MS	EPA 8270C/D	O,O,O-Triethyl phosphorothioate
GC/MS	EPA 8270C/D	o,o-Diethyl o-2pyrazinyl phosphorothioate
GC/MS	EPA 8270C/D	o-Toluidine
GC/MS	EPA 8270C/D	Pentachlorobenzene
GC/MS	EPA 8270C/D	Pentachloronitrobenzene
GC/MS	EPA 625; EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenacetin
GC/MS	EPA 625; EPA 8270C/D	Phenanthrene
GC/MS	EPA 625; EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Phorate
GC/MS	EPA 8270C/D	Pronamide
GC/MS	EPA 625; EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/MS	EPA 8270C/D	Safrole
GC/MS	EPA 8270C/D	Sulfotepp
GC/MS	EPA 8270C/D	Thionazin
GC/MS	EPA 625; EPA 8270C/D	3, 3’-Dichlorobenzidine
GC/MS	EPA 8270C/D	3, 3’-Dimethylbenzidine
GC/MS	EPA 8270C/D SIM	1,1'-Biphenyl
GC/MS	EPA 8270C/D SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D SIM	1,4-Dioxane
GC/MS	EPA 8270C/D SIM	1-Methylnaphthalene

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270C/D SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270C/D SIM	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D SIM	2,4,5-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dimethylphenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrophenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2-Chloronaphthalene
GC/MS	EPA 8270C/D SIM	2-Chlorophenol
GC/MS	EPA 8270C/D SIM	2-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2-Methylphenol
GC/MS	EPA 8270C/D SIM	2-Nitroaniline
GC/MS	EPA 8270C/D SIM	2-Nitrophenol
GC/MS	EPA 8270C/D SIM	3&4-Methylphenol
GC/MS	EPA 8270C/D SIM	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/D SIM	3-Nitroaniline
GC/MS	EPA 8270C/D SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/D SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D SIM	4-Chloroaniline
GC/MS	EPA 8270C/D SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Nitroaniline
GC/MS	EPA 8270C/D SIM	4-Nitrophenol
GC/MS	EPA 8270C/D SIM	Acenaphthene
GC/MS	EPA 8270C/D SIM	Acenaphthylene
GC/MS	EPA 8270C/D SIM	Acetophenone
GC/MS	EPA 8270C/D SIM	Anthracene
GC/MS	EPA 8270C/D SIM	Atrazine
GC/MS	EPA 8270C/D SIM	Benzaldehyde

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270C/D SIM	Benzo(a)anthracene
GC/MS	EPA 8270C/D SIM	Benzo(a)pyrene
GC/MS	EPA 8270C/D SIM	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/D SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270C/D SIM	Butylbenzylphthalate
GC/MS	EPA 8270C/D SIM	Caprolactam
GC/MS	EPA 8270C/D SIM	Carbazole
GC/MS	EPA 8270C/D SIM	Chrysene
GC/MS	EPA 8270C/D SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D SIM	Dibenzofuran
GC/MS	EPA 8270C/D SIM	Diethylphthalate
GC/MS	EPA 8270C/D SIM	Dimethyl phthalate
GC/MS	EPA 8270C/D SIM	Di-n-butylphthalate
GC/MS	EPA 8270C/D SIM	Di-n-octylphthalate
GC/MS	EPA 8270C/D SIM	Fluoranthene
GC/MS	EPA 8270C/D SIM	Fluorene
GC/MS	EPA 8270C/D SIM	Hexachlorobenzene
GC/MS	EPA 8270C/D SIM	Hexachlorobutadiene
GC/MS	EPA 8270C/D SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D SIM	Hexachloroethane
GC/MS	EPA 8270C/D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D SIM	Isophorone
GC/MS	EPA 8270C/D SIM	Naphthalene
GC/MS	EPA 8270C/D SIM	Nitrobenzene
GC/MS	EPA 8270C/D SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270C/D SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D SIM	Pentachlorophenol

Non-Potable Water

Technology	Method	Analyte
GC/MS	EPA 8270C/D SIM	Phenanthrene
GC/MS	EPA 8270C/D SIM	Phenol
GC/MS	EPA 8270C/D SIM	Pyrene
HPLC/UV	EPA 8330A/B	1, 3, 5-Trinitrobenzene
HPLC/UV	EPA 8330A/B	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330A/B	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330A/B	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Amino-4, 6 -Dinitrotoluene
HPLC/UV	EPA 8330A/B	2-Nitrotoluene
HPLC/UV	EPA 8330A/B	3-Nitrotoluene
HPLC/UV	EPA 8330A/B	3,5-Dinitroaniline
HPLC/UV	EPA 8330A/B	4-Amino-2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A/B	4-Nitrotoluene
HPLC/UV	EPA 8330A/B	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330A/B	Hexahydro-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330A/B	Nitrobenzene
HPLC/UV	EPA 8330A MOD	Nitroglycerin
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330A/B	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A/B	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A/B	Tetryl
CVAA	EPA 245.1; EPA 7470A	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 200.7; EPA 6010B/C	Aluminum
ICP/AES	EPA 200.7; EPA 6010B/C	Antimony
ICP/AES	EPA 200.7; EPA 6010B/C	Arsenic
ICP/AES	EPA 200.7; EPA 6010B/C	Barium
ICP/AES	EPA 200.7; EPA 6010B/C	Beryllium
ICP/AES	EPA 200.7; EPA 6010B/C	Boron
ICP/AES	EPA 200.7; EPA 6010B/C	Cadmium

Non-Potable Water

Technology	Method	Analyte
ICP/AES	EPA 200.7; EPA 6010B/C	Calcium
ICP/AES	EPA 200.7; EPA 6010B/C	Chromium
ICP/AES	EPA 200.7; EPA 6010B/C	Cobalt
ICP/AES	EPA 200.7; EPA 6010B/C	Copper
ICP/AES	EPA 200.7; EPA 6010B/C	Iron
ICP/AES	EPA 200.7; EPA 6010B/C	Lead
ICP/AES	EPA 200.7; EPA 6010B/C	Magnesium
ICP/AES	EPA 200.7; EPA 6010B/C	Manganese
ICP/AES	EPA 200.7; EPA 6010B/C	Molybdenum
ICP/AES	EPA 200.7; EPA 6010B/C	Nickel
ICP/AES	EPA 200.7; EPA 6010B/C	Potassium
ICP/AES	EPA 200.7; EPA 6010B/C	Selenium
ICP/AES	EPA 200.7; EPA 6010B/C	Silicon
ICP/AES	EPA 200.7; EPA 6010B/C	Silver
ICP/AES	EPA 200.7; EPA 6010B/C	Sodium
ICP/AES	EPA 6010B/C	Strontium
ICP/AES	EPA 200.7; EPA 6010B/C	Thallium
ICP/AES	EPA 200.7; EPA 6010B/C	Tin
ICP/AES	EPA 200.7; EPA 6010B/C	Titanium
ICP/AES	EPA 200.7; EPA 6010B/C	Vanadium
ICP/AES	EPA 200.7; EPA 6010B/C	Zinc
ICP/MS	EPA 200.8; EPA 6020A	Aluminum
ICP/MS	EPA 200.8; EPA 6020A	Antimony
ICP/MS	EPA 200.8; EPA 6020A	Arsenic
ICP/MS	EPA 200.8; EPA 6020A	Barium
ICP/MS	EPA 200.8; EPA 6020A	Beryllium
ICP/MS	EPA 200.8; EPA 6020A	Boron
ICP/MS	EPA 200.8; EPA 6020A	Cadmium
ICP/MS	EPA 200.8; EPA 6020A	Calcium
ICP/MS	EPA 200.8; EPA 6020A	Chromium
ICP/MS	EPA 200.8; EPA 6020A	Cobalt

Non-Potable Water

Technology	Method	Analyte
ICP/MS	EPA 200.8; EPA 6020A	Copper
ICP/MS	EPA 200.8; EPA 6020A	Iron
ICP/MS	EPA 200.8; EPA 6020A	Lead
ICP/MS	EPA 200.8; EPA 6020A	Magnesium
ICP/MS	EPA 200.8; EPA 6020A	Manganese
ICP/MS	EPA 200.8; EPA 6020A	Molybdenum
ICP/MS	EPA 200.8; EPA 6020A	Nickel
ICP/MS	EPA 200.8; EPA 6020A	Potassium
ICP/MS	EPA 200.8; EPA 6020A	Selenium
ICP/MS	EPA 200.8; EPA 6020A	Silicon
ICP/MS	EPA 200.8; EPA 6020A	Silver
ICP/MS	EPA 200.8; EPA 6020A	Sodium
ICP/MS	EPA 6020A	Strontium
ICP/MS	EPA 200.8; EPA 6020A	Thallium
ICP/MS	EPA 200.8; EPA 6020A	Tin
ICP/MS	EPA 200.8; EPA 6020A	Titanium
ICP/MS	EPA 200.8; EPA 6020A	Tungsten
ICP/MS	EPA 200.8	Uranium
ICP/MS	EPA 200.8; EPA 6020A	Vanadium
ICP/MS	EPA 200.8; EPA 6020A	Zinc
IC	EPA 300.0; EPA 9056A	Chloride
IC	EPA 300.0; EPA 9056A	Fluoride
IC	EPA 300.0; EPA 9056A	Nitrate as N
IC	EPA 300.0; EPA 9056A	Nitrite as N
IC	EPA 300.0; EPA 9056A	Nitrate + Nitrite
IC	EPA 300.0; EPA 9056A	Orthophosphate as P
IC	EPA 300.0; EPA 9056A	Sulfate
IC	SOP CA-776	Lactic Acid
IC	SOP CA-776	Acetic Acid
IC	SOP CA-776	Propionic Acid
IC	SOP CA-776	Formic Acid

Non-Potable Water

Technology	Method	Analyte
IC	SOP CA-776	Butyric Acid
IC	SOP CA-776	Pyruvic Acid
IC	SOP CA-776	i-Pentanoic Acid
IC	SOP CA-776	Pentanoic Acid
IC	SOP CA-776	i-Hexanoic Acid
IC	SOP CA-776	Hexanoic Acid
Titration	EPA 310.1; SM 2320B	Alkalinity
Caculation	SM 2340B	Hardness
Gravimetric	EPA 1664A; EPA 9070A	Oil and Grease, Oil and Grease with SGT
Gravimetric	SM 2540B/C/D	Solids
ISE	EPA 120.1; SM 2510B	Conductivity
ISE	SM 2520B	Practical Salinity
ISE	SM 4500F- C	Fluoride
ISE	SM 4500H+ B	pH
ISE	SM 5210B	TBOD / CBOD
Physical	EPA 1010A	Ignitability
Physical	EPA 9040C	pH
Titration	SM 2340C	Hardness
Titration	SM 4500SO_3 B	Sulfite
Titration	EPA 9034; SM 4500S^{2-} F	Sulfide
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
IR	EPA 9060A; SM 5310B	Total organic carbon
Turbidimetric	EPA 180.1; SM 2130B	Turbidity
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 335.4; EPA 9012B; SM 4500-CN G	Amenable cyanide
UV/VIS	EPA 350.1; SM 4500NH3 H	Ammonia as N
UV/VIS	SM 3500Fe D	Ferrous Iron
UV/VIS	EPA 351.2	Kjeldahl nitrogen - total
UV/VIS	EPA 353.2; SM 4500NO3 F	Nitrate + Nitrite
UV/VIS	EPA 353.2; SM 4500NO3 F	Nitrate as N
UV/VIS	EPA 353.2; SM 4500NO3 F	Nitrite as N

Non-Potable Water

Technology	Method	Analyte
UV/VIS	EPA 365.2; SM 4500P E	Orthophosphate as P
UV/VIS	EPA 365.4	Phosphorus total
UV/VIS	EPA 821/R-91-100	AVS-SEM
UV/VIS	EPA 410.4	COD
UV/VIS	EPA 420.1; EPA 9065	Total Phenolics
UV/VIS	SM 4500Cl G	Total Residual Chlorine
UV/VIS	SM 5540C	MBAS
UV/VIS	EPA 7196A; SM 3500-Cr D	Chromium VI
UV/VIS	EPA 9012B; EPA 335.4	Total Cyanide
UV/VIS	EPA 9251; SM 4500Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide
Preparation	**Method**	**Type**
Cleanup Methods	EPA 3640A	Gel Permeation Clean-up
Cleanup Methods	EPA 3630C	Silica Gel
Cleanup Methods	EPA 3660B	Sulfur Clean-Up
Cleanup Methods	EPA 3665A	Sulfuric Acid Clean-Up
Organic Preparation	EPA 3510C	Separatory Funnel Extraction
Organic Preparation	EPA 3520C	Continuous Liquid-Liquid Extraction
Inorganic Preparation	EPA 3010A	Hotblock
Volatile Organic Preparation	EPA 5030C	Purge and Trap

Solid and Chemical Waste

Technology	Method	Analyte
GC/ECD	EPA 8081B	2,4`-DDD
GC/ECD	EPA 8081B	2,4`-DDE
GC/ECD	EPA 8081B	2,4`-DDT
GC/ECD	EPA 8081B	4, 4`-DDD
GC/ECD	EPA 8081B	4, 4`-DDE
GC/ECD	EPA 8081B	4, 4`-DDT

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8081B	Aldrin
GC/ECD	EPA 8081B	alpha-BHC (alpha-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	Alpha-Chlordane
GC/ECD	EPA 8081B	beta-BHC (beta-Hexachlorocyclohexane)
GC/ECD	EPA 608; EPA 8081B	Chlordane (tech.)
GC/ECD	EPA 8081B	Cis-Nonachlor
GC/ECD	EPA 8081B	delta-BHC
GC/ECD	EPA 8081B	Dieldrin
GC/ECD	EPA 8081B	Endosulfan I
GC/ECD	EPA 8081B	Endosulfan II
GC/ECD	EPA 8081B	Endosulfan sulfate
GC/ECD	EPA 8081B	Endrin
GC/ECD	EPA 8081B	Endrin aldehyde
GC/ECD	EPA 8081B	Endrin Ketone
GC/ECD	EPA 8081B	gamma-BHC (Lindane gamma-Hexachlorocyclohexane)
GC/ECD	EPA 8081B	gamma-Chlordane
GC/ECD	EPA 8081B	Heptachlor
GC/ECD	EPA 8081B	Heptachlor epoxide
GC/ECD	EPA 8081B	Hexachlorobenzene
GC/ECD	EPA 8081B	Methoxychlor
GC/ECD	EPA 8081B	Mirex
GC/ECD	EPA 8081B	Oxychlordane
GC/ECD	EPA 8081B	Toxaphene (Chlorinated camphene)
GC/ECD	EPA 8081B	Trans-Nonachlor
GC/ECD	EPA 8082A	Aroclor-1016 (PCB-1016)
GC/ECD	EPA 8082A	Aroclor-1221 (PCB-1221)
GC/ECD	EPA 8082A	Aroclor-1232 (PCB-1232)
GC/ECD	EPA 8082A	Aroclor-1242 (PCB-1242)
GC/ECD	EPA 8082A	Aroclor-1248 (PCB-1248)
GC/ECD	EPA 8082A	Aroclor-1254 (PCB-1254)
GC/ECD	EPA 8082A	Aroclor-1260 (PCB-1260)

Solid and Chemical Waste

Technology	Method	Analyte
GC/ECD	EPA 8082A MOD	Aroclor-1262 (PCB-1262)
GC/ECD	EPA 8082A MOD	Aroclor-1268 (PCB-1268)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 5', 6-Nonachlorobiphenyl (BZ 206)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5, 6-Octachlorobiphenyl (BZ 195)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4', 5-Heptachlorobiphenyl (BZ 170)
GC/ECD	EPA 8082A	2, 2', 3, 3', 4, 4'-Hexachlorobiphenyl (BZ 128)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5, 5'-Heptachlorobiphenyl (BZ 180)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5', 6-Heptachlorobiphenyl (BZ 183)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 5-Hexachlorobiphenyl (BZ 138)
GC/ECD	EPA 8082A	2, 2', 3, 4, 4', 6, 6'-Heptachlorobiphenyl (BZ 184)
GC/ECD	EPA 8082A	2, 2', 3, 4', 5, 5', 6-Heptachlorobiphenyl (BZ 187)
GC/ECD	EPA 8082A	2, 2', 3, 4, 5'-Pentachlorobiphenyl (BZ 87)
GC/ECD	EPA 8082A	2, 2', 3, 5'-Tetrachlorobiphenyl (BZ 44)
GC/ECD	EPA 8082A	2, 2', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 153)
GC/ECD	EPA 8082A	2, 2', 4, 5, 5'-Pentachlorobiphenyl (BZ 101)
GC/ECD	EPA 8082A	2, 2', 4, 5-Tetrachlorobiphenyl (BZ 48)
GC/ECD	EPA 8082A	2, 2', 4, 5’-Tetrachlorobiphenyl (BZ 49)
GC/ECD	EPA 8082A	2, 2', 5, 5'-Tetrachlorobiphenyl (BZ 52)
GC/ECD	EPA 8082A	2, 2', 5-Trichlorobiphenyl (BZ 18)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5-Hexachlorobiphenyl (BZ 156)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4', 5'-Hexachlorobiphenyl (BZ 157)
GC/ECD	EPA 8082A	2, 3, 3', 4, 4'-Pentachlorobiphenyl (BZ 105)
GC/ECD	EPA 8082A	2, 3, 3’, 4, 4’, 5, 5’-Heptachlorobiphenyl (BZ 189)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 167)
GC/ECD	EPA 8082A	2, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 118)
GC/ECD	EPA 8082A	2, 3', 4, 4',5’-Pentachlorobiphenyl (BZ 123)
GC/ECD	EPA 8082A	2, 3', 4, 4'-Tetrachlorobiphenyl (BZ 66)
GC/ECD	EPA 8082A	2, 3, 4, 4’, 5-Pentachlorobiphenyl (BZ 114)
GC/ECD	EPA 8082A	2, 4, 4'-Trichlorobiphenyl (BZ 28)
GC/ECD	EPA 8082A	2, 4'-Dichlorobiphenyl (BZ 8)
GC/ECD	EPA 8082A	3, 3', 4, 4', 5, 5'-Hexachlorobiphenyl (BZ 169)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/ECD	EPA 8082A	3, 3', 4, 4', 5-Pentachlorobiphenyl (BZ 126)
GC/ECD	EPA 8082A	3, 3', 4, 4'-Tetrachlorobiphenyl (BZ 77)
GC/ECD	EPA 8082A	3, 4, 4', 5-Tetrachlorobiphenyl (BZ 81)
GC/ECD	EPA 8082A	Decachlorobiphenyl (BZ 209)
GC/ECD	EPA 8151A	2, 4, 5-T
GC/ECD	EPA 8151A	2, 4-D
GC/ECD	EPA 8151A	2, 4-DB
GC/ECD	EPA 8151A	Dalapon
GC/ECD	EPA 8151A	Dicamba
GC/ECD	EPA 8151A	Dichloroprop
GC/ECD	EPA 8151A	Dinoseb
GC/ECD	EPA 8151A	MCPA
GC/ECD	EPA 8151A	MCPP
GC/ECD	EPA 8151A	Pentachlorophenol
GC/ECD	EPA 8151A	Silvex (2, 4, 5-TP)
GC/FID	EPA 8015C/D	Diesel range organics (DRO)
GC/FID	EPA 8015C/D	Total Petroleum Hydrocarbons (TPH)
GC/FID	EPA 8015C/D	Gasoline range organics (GRO)
GC/FID/PID	MA DEP VPH	Volatile Organic Hydrocarbons
GC/FID	MA DEP EPH	Extractable Petroleum Hydrocarbons
GC/FID	MA DEP EPH EPA 3546	Extractable Petroleum Hydrocarbons Microwave Extraction Preparation
GC/FID	CT-ETPH	Total Petroleum Hydrocarbons
GC/FID	TNRCC Method 1005	Total Petroleum Hydrocarbons
GC/FID	FL-PRO	Petroleum Range Organics
GC/ECD	EPA 8011	1, 2-Dibromoethane (EDB)
GC/ECD	EPA 8011	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C	1, 1, 1, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1,1,2-Trichloro-1,2,2-trifluoroethane
GC/MS	EPA 8260B/C	1, 1, 1-Trichloroethane
GC/MS	EPA 8260B/C	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA 8260B/C	1, 1, 2-Trichloroethane

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	1, 1-Dichloroethane
GC/MS	EPA 8260B/C	1, 1-Dichloroethylene
GC/MS	EPA 8260B/C	1, 1-Dichloropropene
GC/MS	EPA 8260B/C	1, 2, 3-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 2, 3-Trichloropropane
GC/MS	EPA 8260B/C	1,2,3-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 2, 4-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C	1, 2-Dibromoethane
GC/MS	EPA 8260B/C	1, 2-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 2-Dichloroethane
GC/MS	EPA 8260B/C	1, 2-Dichloropropane
GC/MS	EPA 8260B/C	1,3,5-Trichlorobenzene
GC/MS	EPA 8260B/C	1, 3, 5-Trimethylbenzene
GC/MS	EPA 8260B/C	1, 3-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 3-Dichloropropane
GC/MS	EPA 8260B/C	1, 4-Dichlorobenzene
GC/MS	EPA 8260B/C	1, 4-Dioxane
GC/MS	EPA 8260B/C	1-Chlorohexane
GC/MS	EPA 8260B/C	2, 2-Dichloropropane
GC/MS	EPA 8260B/C	2-Butanone
GC/MS	EPA 8260B/C	2-Chloroethyl vinyl ether
GC/MS	EPA 8260B/C	2-Chlorotoluene
GC/MS	EPA 8260B/C	2-Hexanone
GC/MS	EPA 8260B/C	4-Chlorotoluene
GC/MS	EPA 8260B/C	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C	Acetone
GC/MS	EPA 8260B/C	Acetonitrile
GC/MS	EPA 8260B/C	Acrolein
GC/MS	EPA 8260B/C	Acrylonitrile

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	Allyl chloride
GC/MS	EPA 8260B/C	Benzene
GC/MS	EPA 8260B/C	Benzyl chloride
GC/MS	EPA 8260B/C	Bromobenzene
GC/MS	EPA 8260B/C	Bromochloromethane
GC/MS	EPA 8260B/C	Bromodichloromethane
GC/MS	EPA 8260B/C	Bromoform
GC/MS	EPA 8260B/C	Carbon disulfide
GC/MS	EPA 8260B/C	Carbon tetrachloride
GC/MS	EPA 8260B/C	Chlorobenzene
GC/MS	EPA 8260B/C	Chloroethane
GC/MS	EPA 8260B/C	Chloroform
GC/MS	EPA 8260B/C	Chloroprene
GC/MS	EPA 8260B/C	cis-1, 2-Dichloroethene
GC/MS	EPA 8260B/C	cis-1, 3-Dichloropropene
GC/MS	EPA 8260B/C	cis-1,3-Dichloro-2-butene
GC/MS	EPA 8260B/C	Cyclohexane
GC/MS	EPA 8260B/C	Dibromochloromethane
GC/MS	EPA 8260B/C	Dibromomethane
GC/MS	EPA 8260B/C	Dichlorodifluoromethane
GC/MS	EPA 8260B/C	Diethyl ether
GC/MS	EPA 8260B/C	Di-isopropylether
GC/MS	EPA 8260B/C	1,2-Dibromoethane (EDB)
GC/MS	EPA 8260B/C	Ethyl methacrylate
GC/MS	EPA 8260B/C	Ethylbenzene
GC/MS	EPA 8260B/C	Ethyl-t-butylether
GC/MS	EPA 8260B/C	Hexachlorobutadiene
GC/MS	EPA 8260B/C	Iodomethane
GC/MS	EPA 8260B/C	Isobutyl alcohol
GC/MS	EPA 8260B/C	Isopropyl alcohol
GC/MS	EPA 8260B/C	Isopropyl benzene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	m p-xylenes
GC/MS	EPA 8260B/C	Methyl acetate
GC/MS	EPA 8260B/C	Methacrylonitrile
GC/MS	EPA 8260B/C	Methyl bromide (Bromomethane)
GC/MS	EPA 8260B/C	Methyl chloride (Chloromethane)
GC/MS	EPA 8260B/C	Methyl methacrylate
GC/MS	EPA 8260B/C	Methyl tert-butyl ether
GC/MS	EPA 8260B/C	Methylcyclohexane
GC/MS	EPA 8260B/C	Methylene chloride
GC/MS	EPA 8260B/C	Naphthalene
GC/MS	EPA 8260B/C	n-Butylbenzene
GC/MS	EPA 8260B/C	n-proplybenzene
GC/MS	EPA 8260B/C	o-Xylene
GC/MS	EPA 8260B/C	pentachloroethane
GC/MS	EPA 8260B/C	p-Isopropyltoluene
GC/MS	EPA 8260B/C	Propionitrile
GC/MS	EPA 8260B/C	sec-butylbenzene
GC/MS	EPA 8260B/C	Styrene
GC/MS	EPA 8260B/C	t-Amylmethylether
GC/MS	EPA 8260B/C	tert-Butyl alcohol
GC/MS	EPA 8260B/C	tert-Butylbenzene
GC/MS	EPA 8260B/C	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA 8260B/C	Tetrahydrofuran
GC/MS	EPA 8260B/C	Toluene
GC/MS	EPA 8260B/C	trans-1, 2-Dichloroethylene
GC/MS	EPA 8260B/C	trans-1, 3-Dichloropropylene
GC/MS	EPA 8260B/C	Trans-1, 4-Dichloro-2-butuene
GC/MS	EPA 8260B/C	Trichloroethene (Trichloroethylene)
GC/MS	EPA 8260B/C	Trichlorofluoromethane
GC/MS	EPA 8260B/C	Vinyl acetate
GC/MS	EPA 8260B/C	Vinyl chloride

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C	Xylene
GC/MS	EPA 8260B/C SIM	1,1,1,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1,1,1-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,1,2,2-Tetrachloroethane
GC/MS	EPA 8260B/C SIM	1, 1, 2-Trichloroethane
GC/MS	EPA 8260B/C SIM	1,2,3-Trichloropropane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,1-Dichloroethene
GC/MS	EPA 8260B/C SIM	1,2,4-Trichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2,4-Trimethylbenzene
GC/MS	EPA 8260B/C SIM	1,2-Dibromo-3-chloropropane
GC/MS	EPA 8260B/C SIM	1,2-Dibromoethane
GC/MS	EPA 8260B/C SIM	1,2-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,2-Dichloroethane
GC/MS	EPA 8260B/C SIM	1,2-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,3-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	1,3-Dichloropropane
GC/MS	EPA 8260B/C SIM	1,4-Dichlorobenzene
GC/MS	EPA 8260B/C SIM	2-Hexanone
GC/MS	EPA 8260B/C SIM	4-Methyl-2-pentanone
GC/MS	EPA 8260B/C SIM	Benzene
GC/MS	EPA 8260B/C SIM	Bromodichloromethane
GC/MS	EPA 8260B/C SIM	Carbon Disulfide
GC/MS	EPA 8260B/C SIM	Carbon Tetrachloride
GC/MS	EPA 8260B/C SIM	Chloroform
GC/MS	EPA 8260B/C SIM	Chloromethane
GC/MS	EPA 8260B/C SIM	cis-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	cis-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Dibromochloromethane
GC/MS	EPA 8260B/C SIM	Ethylbenzene
GC/MS	EPA 8260B/C SIM	Isopropylbenzene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8260B/C SIM	Hexachlorobutadiene
GC/MS	EPA 8260B/C SIM	Methylcyclohexane
GC/MS	EPA 8260B/C SIM	m,p-Xylene
GC/MS	EPA 8260B/C SIM	o-Xylene
GC/MS	EPA 8260B/C SIM	Tetrachloroethene
GC/MS	EPA 8260B/C SIM	trans-1,2-Dichloroethene
GC/MS	EPA 8260B/C SIM	Trans-1,3-Dichloropropene
GC/MS	EPA 8260B/C SIM	Trichloroethene
GC/MS	EPA 8260B/C SIM	Trichlorofluoromethane
GC/MS	EPA 8260B/C SIM	Vinyl Chloride
GC/MS	EPA 8260B/C SIM	Xylenes (total)
GC/MS	EPA 8270C/D	1, 2, 4, 5-Tetrachlorobenzene
GC/MS	EPA 8270C/D	1, 2, 4-Trichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 2-Diphenylhydrazine
GC/MS	EPA 8270C/D	1, 3, 5-Trinitrobenzene
GC/MS	EPA 8270C/D	1, 3-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 3-Dinitrobenzene
GC/MS	EPA 8270C/D	1, 4-Dichlorobenzene
GC/MS	EPA 8270C/D	1, 4-Dioxane
GC/MS	EPA 8270C/D	1, 4-Naphthoquinone
GC/MS	EPA 8270C/D	1, 4-Phenylenediamine
GC/MS	EPA 8270C/D	1,1-Biphenyl
GC/MS	EPA 8270C/D	1-Chloronaphthalene
GC/MS	EPA 8270C/D	1-Methylnaphthalene
GC/MS	EPA 8270C/D	1-Naphthylamine
GC/MS	EPA 8270C/D	2, 3, 4, 6-Tetrachlorophenol
GC/MS	EPA 8270C/D	2, 4, 5-Trochlorophenol
GC/MS	EPA 8270C/D	2, 4, 6-Trichlorophenol
GC/MS	EPA 8270C/D	2, 4-Dichlorophenol
GC/MS	EPA 8270C/D	2, 4-Dimethylphenol

Solid and Chemical Waste

Technology	Method	Analyte
GC/MS	EPA 8270C/D	2, 4-Dinitrophenol
GC/MS	EPA 8270C/D	2, 4-Dinitrotoluene (2 4-DNT)
GC/MS	EPA 8270C/D	2, 6-Dichlorophenol
GC/MS	EPA 8270C/D	2, 6-Dinitrotoluene (2 6-DNT)
GC/MS	EPA 8270C/D	2-Acetylaminofluorene
GC/MS	EPA 8270C/D	2-Chloronaphthalene
GC/MS	EPA 8270C/D	2-Chlorophenol
GC/MS	EPA 8270C/D	2-Methyl-4, 6-dinitrophenol
GC/MS	EPA 8270C/D	2-Methylnaphthalene
GC/MS	EPA 8270C/D	2-Methylphenol
GC/MS	EPA 8270C/D	2-Naphthylamine
GC/MS	EPA 8270C/D	2-Nitroaniline
GC/MS	EPA 8270C/D	2-Nitrophenol
GC/MS	EPA 8270C/D	2-Picoline
GC/MS	EPA 8270C/D	3, 3`-Dichlorobenzidine
GC/MS	EPA 8270C/D	3, 3’-Dimethylbenzidine
GC/MS	EPA 8270C/D	3,4-Methylphenol
GC/MS	EPA 8270C/D	3-Methylcholanthrene
GC/MS	EPA 8270C/D	3-Nitroaniline
GC/MS	EPA 8270C/D	4-Aminobiphenyl
GC/MS	EPA 8270C/D	4-Bromophenyl phenyl ether
GC/MS	EPA 8270C/D	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D	4-Chloroaniline
GC/MS	EPA 8270C/D	4-Chlorophenyl phenylether
GC/MS	EPA 8270C/D	4-Dimethyl aminoazobenzene
GC/MS	EPA 8270C/D	4-Nitroaniline
GC/MS	EPA 8270C/D	4-Nitrophenol
GC/MS	EPA 8270C/D	4-Nitroquinoline-1-oxide
GC/MS	EPA 8270C/D	5-Nitro-o-toluidine
GC/MS	EPA 8270C/D	7,12-Dimethylbenz(a)anthracene
GC/MS	EPA 8270C/D	a a-Dimethylphenethylamine

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Acenaphthene
GC/MS	EPA 8270C/D	Acenaphthylene
GC/MS	EPA 8270C/D	Acetophenone
GC/MS	EPA 8270C/D	Aniline
GC/MS	EPA 8270C/D	Anthracene
GC/MS	EPA 8270C/D	Aramite
GC/MS	EPA 8270C/D	Atrazine
GC/MS	EPA 8270C/D	Azobenzene
GC/MS	EPA 8270C/D	Benzaldehyde
GC/MS	EPA 8270C/D	Benzidine
GC/MS	EPA 8270C/D	Benzo(a)anthracene
GC/MS	EPA 8270C/D	Benzo(a)pyrene
GC/MS	EPA 8270C/D	Benzo(b)fluoranthene
GC/MS	EPA 8270C/D	Benzo(g h i)perylene
GC/MS	EPA 8270C/D	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D	Benzoic Acid
GC/MS	EPA 8270C/D	Benzyl alcohol
GC/MS	EPA 8270C/D	bis(2-Chloroethoxy)methane
GC/MS	EPA 8270C/D	bis(2-Chloroethyl) ether
GC/MS	EPA 8270C/D	bis(2-Chloroisopropyl) ether (2, 2`-Oxybis(1-chloropropane))
GC/MS	EPA 8270C/D	bis(2-Ethylhexyl) phthalate (DEHP)
GC/MS	EPA 8270C/D	Bis(2-Ethylhexyl)adipate
GC/MS	EPA 8270C/D	Butyl benzyl phthalate
GC/MS	EPA 8270C/D	Caprolactam
GC/MS	EPA 8270C/D	Carbazole
GC/MS	EPA 8270C/D	Chlorobenzilate
GC/MS	EPA 8270C/D	Chrysene
GC/MS	EPA 8270C/D	Diallate
GC/MS	EPA 8270C/D	Dibenz(a h)anthracene
GC/MS	EPA 8270C/D	Dibenzo(a,j)acridine
GC/MS	EPA 8270C/D	Dibenzofuran

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D	Diethyl phthalate
GC/MS	EPA 8270C/D	Diethyladipate
GC/MS	EPA 8270C/D	Dimethoate
GC/MS	EPA 8270C/D	Dimethyl phthalate
GC/MS	EPA 8270C/D	Di-n-butyl phthalate
GC/MS	EPA 8270C/D	Di-n-octyl phthalate
GC/MS	EPA 8270C/D	Dinoseb
GC/MS	EPA 8270C/D	Disulfoton
GC/MS	EPA 8270C/D	Ethyl methacrylate
GC/MS	EPA 8270C/D	Ethyl methanesulfonate
GC/MS	EPA 8270C/D	Ethyl parathion
GC/MS	EPA 8270C/D	Famfur
GC/MS	EPA 8270C/D	Fluoranthene
GC/MS	EPA 8270C/D	Fluorene
GC/MS	EPA 8270C/D	Hexachlorobenzene
GC/MS	EPA 8270C/D	Hexachlorobutadiene
GC/MS	EPA 8270C/D	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D	Hexachloroethane
GC/MS	EPA 8270C/D	Hexachlorophene
GC/MS	EPA 8270C/D	Hexachloropropene
GC/MS	EPA 8270C/D	Indeno(1, 2, 3-cd)pyrene
GC/MS	EPA 8270C/D	Isodrin
GC/MS	EPA 8270C/D	Isophorone
GC/MS	EPA 8270C/D	Isosafrole
GC/MS	EPA 8270C/D	Kepone
GC/MS	EPA 8270C/D	Methapyriline
GC/MS	EPA 8270C/D	Methyl methanesulfonate
GC/MS	EPA 8270C/D	Methyl parathion
GC/MS	EPA 8270C/D	Naphthalene
GC/MS	EPA 8270C/D	Nitrobenzene
GC/MS	EPA 8270C/D	n-Nitrosodiethylamine

Solid and Chemical Waste

Technology	Method	Analyte
GC/MS	EPA 8270C/D	n-Nitrosodimethylamine
GC/MS	EPA 8270C/D	n-Nitroso-di-n-butylamine
GC/MS	EPA 8270C/D	n-Nitrosodi-n-propylamine
GC/MS	EPA 8270C/D	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D	n-Nitrosomethylethylamine
GC/MS	EPA 8270C/D	n-Nitrosomorpholine
GC/MS	EPA 8270C/D	n-Nitrosopiperidine
GC/MS	EPA 8270C/D	n-Nitrosopyrrolidine
GC/MS	EPA 8270C/D	O, O, O-Triethyl phosphorothioate
GC/MS	EPA 8270C/D	o,o-Diethyl o-2-pyrazinyl phosphorothioate
GC/MS	EPA 8270C/D	o-Toluidine
GC/MS	EPA 8270C/D	Pentachlorobenzene
GC/MS	EPA 8270C/D	Pentachloronitrobenzene
GC/MS	EPA 8270C/D	Pentachlorophenol
GC/MS	EPA 8270C/D	Phenacetin
GC/MS	EPA 8270C/D	Phenanthrene
GC/MS	EPA 8270C/D	Phenol
GC/MS	EPA 8270C/D	Phorate
GC/MS	EPA 8270C/D	Pronamide
GC/MS	EPA 8270C/D	Pyrene
GC/MS	EPA 8270C/D	Pyridine
GC/MS	EPA 8270C/D	Safrole
GC/MS	EPA 8270C/D	Sulfotepp
GC/MS	EPA 8270C/D	Thionazin
GC/MS	EPA 8270C/D SIM	1,1'-Biphenyl
GC/MS	EPA 8270C/D SIM	1,2,4,5-Tetrachlorobenzene
GC/MS	EPA 8270C/D SIM	1,4-Dioxane
GC/MS	EPA 8270C/D SIM	1-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2,2'-Oxybis(1-chloropropane
GC/MS	EPA 8270C/D SIM	2,3,4,6-Tetrachlorophenol
GC/MS	EPA 8270C/D SIM	2,4,5-Trichlorophenol

Solid and Chemical Waste

Technology	Method	Analyte
GC/MS	EPA 8270C/D SIM	2,4,6-Trichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dichlorophenol
GC/MS	EPA 8270C/D SIM	2,4-Dimethylphenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrophenol
GC/MS	EPA 8270C/D SIM	2,4-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2,6-Dinitrotoluene
GC/MS	EPA 8270C/D SIM	2-Chloronaphthalene
GC/MS	EPA 8270C/D SIM	2-Chlorophenol
GC/MS	EPA 8270C/D SIM	2-Methylnaphthalene
GC/MS	EPA 8270C/D SIM	2-Methylphenol
GC/MS	EPA 8270C/D SIM	2-Nitroaniline
GC/MS	EPA 8270C/D SIM	2-Nitrophenol
GC/MS	EPA 8270C/D SIM	3&4-Methylphenol
GC/MS	EPA 8270C/D SIM	3,3'-Dichlorobenzidine
GC/MS	EPA 8270C/D SIM	3-Nitroaniline
GC/MS	EPA 8270C/D SIM	4,6-Dinitro-2-methylphenol
GC/MS	EPA 8270C/D SIM	4-Bromophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Chloro-3-methylphenol
GC/MS	EPA 8270C/D SIM	4-Chloroaniline
GC/MS	EPA 8270C/D SIM	4-Chlorophenyl-phenylether
GC/MS	EPA 8270C/D SIM	4-Nitroaniline
GC/MS	EPA 8270C/D SIM	4-Nitrophenol
GC/MS	EPA 8270C/D SIM	Acenaphthene
GC/MS	EPA 8270C/D SIM	Acenaphthylene
GC/MS	EPA 8270C/D SIM	Acetophenone
GC/MS	EPA 8270C/D SIM	Anthracene
GC/MS	EPA 8270C/D SIM	Atrazine
GC/MS	EPA 8270C/D SIM	Benzaldehyde
GC/MS	EPA 8270C/D SIM	Benzo(a)anthracene
GC/MS	EPA 8270C/D SIM	Benzo(a)pyrene
GC/MS	EPA 8270C/D SIM	Benzo(b)fluoranthene

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
GC/MS	EPA 8270C/D SIM	Benzo(g,h,i)perylene
GC/MS	EPA 8270C/D SIM	Benzo(k)fluoranthene
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethoxy)methane
GC/MS	EPA 8270C/D SIM	Bis(2-chloroethyl)ether
GC/MS	EPA 8270C/D SIM	Bis(2-ethylhexyl)phthalate
GC/MS	EPA 8270C/D SIM	Butylbenzylphthalate
GC/MS	EPA 8270C/D SIM	Caprolactam
GC/MS	EPA 8270C/D SIM	Carbazole
GC/MS	EPA 8270C/D SIM	Chrysene
GC/MS	EPA 8270C/D SIM	Dibenzo(a,h)anthracene
GC/MS	EPA 8270C/D SIM	Dibenzofuran
GC/MS	EPA 8270C/D SIM	Diethylphthalate
GC/MS	EPA 8270C/D SIM	Dimethyl phthalate
GC/MS	EPA 8270C/D SIM	Di-n-butylphthalate
GC/MS	EPA 8270C/D SIM	Di-n-octylphthalate
GC/MS	EPA 8270C/D SIM	Fluoranthene
GC/MS	EPA 8270C/D SIM	Fluorene
GC/MS	EPA 8270C/D SIM	Hexachlorobenzene
GC/MS	EPA 8270C/D SIM	Hexachlorobutadiene
GC/MS	EPA 8270C/D SIM	Hexachlorocyclopentadiene
GC/MS	EPA 8270C/D SIM	Hexachloroethane
GC/MS	EPA 8270C/D SIM	Indeno(1,2,3-cd)pyrene
GC/MS	EPA 8270C/D SIM	Isophorone
GC/MS	EPA 8270C/D SIM	Naphthalene
GC/MS	EPA 8270C/D SIM	Nitrobenzene
GC/MS	EPA 8270C/D SIM	n-Nitroso-di-n-propylamine
GC/MS	EPA 8270C/D SIM	n-Nitrosodiphenylamine
GC/MS	EPA 8270C/D SIM	Pentachlorophenol
GC/MS	EPA 8270C/D SIM	Phenanthrene
GC/MS	EPA 8270C/D SIM	Phenol
GC/MS	EPA 8270C/D SIM	Pyrene

Solid and Chemical Waste

Technology	Method	Analyte
HPLC/UV	EPA 8330A	1 ,3, 5-Trinitrobenzene
HPLC/UV	EPA 8330A	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330A	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330A	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330A	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330A	2-Amino-4, 6-dinitrotoluene
HPLC/UV	EPA 8330A	2-Nitrotoluene
HPLC/UV	EPA 8330A	3-Nitrotoluene
HPLC/UV	EPA 8330A	3,5-Dinitroaniline
HPLC/UV	EPA 8330A	4-Amino-2,6-dinitrotoluene
HPLC/UV	EPA 8330A	4-Nitrotoluene
HPLC/UV	EPA 8330A	Ethylene glycol dinitrate (EGDN)
HPLC/UV	EPA 8330A	Hexahydr-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330A	Nitrobenzene
HPLC/UV	EPA 8330A MOD	Nitroglycerin
HPLC/UV	EPA 8330A	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330A	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330A	Tetryl
HPLC/UV	EPA 8330A	Nitroguanidine
HPLC/UV	EPA 8330B	1, 3, 5-Trinitrobenzene
HPLC/UV	EPA 8330B	1, 3-Dinitrobenzene
HPLC/UV	EPA 8330B	2, 4, 6-Trinitrotoluene
HPLC/UV	EPA 8330B	2, 4-Dinitrotoluene
HPLC/UV	EPA 8330B	2, 6-Dinitrotoluene
HPLC/UV	EPA 8330B	2-Amino-4, 6 –Dinitrotoluene
HPLC/UV	EPA 8330B	2-Nitrotoluene
HPLC/UV	EPA 8330B	3-Nitrotoluene
HPLC/UV	EPA 8330B	3,5-Dinitroaniline
HPLC/UV	EPA 8330B	4-Amino-2,3-Dinitrotoluene
HPLC/UV	EPA 8330B	4-Nitrotoluene
HPLC/UV	EPA 8330B	Ethylene glycol dinitrate (EGDN)

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
HPLC/UV	EPA 8330B	Hexahydr-1, 3, 5-trinitro-1, 3, 5-triazine (RDX)
HPLC/UV	EPA 8330B	Nitrobenzene
HPLC/UV	EPA 8330B	Nitroglycerin
HPLC/UV	EPA 8330B	Octahydro-1, 3, 5, 7-tetrazocine (HMX)
HPLC/UV	EPA 8330B	Pentaerythritol Tetranitrate (PETN)
HPLC/UV	EPA 8330B	Tetryl
HPLC/UV	EPA 8330B	Nitroguanidine
CVAA	EPA 7471B	Mercury
CVAF	EPA 1631E	Low Level Mercury
ICP/AES	EPA 6010B/C	Aluminum
ICP/AES	EPA 6010B/C	Antimony
ICP/AES	EPA 6010B/C	Arsenic
ICP/AES	EPA 6010B/C	Barium
ICP/AES	EPA 6010B/C	Beryllium
ICP/AES	EPA 6010B/C	Boron
ICP/AES	EPA 6010B/C	Cadmium
ICP/AES	EPA 6010B/C	Calcium
ICP/AES	EPA 6010B/C	Chromium
ICP/AES	EPA 6010B/C	Cobalt
ICP/AES	EPA 6010B/C	Copper
ICP/AES	EPA 6010B/C	Iron
ICP/AES	EPA 6010B/C	Lead
ICP/AES	EPA 6010B/C	Magnesium
ICP/AES	EPA 6010B/C	Manganese
ICP/AES	EPA 6010B/C	Molybdenum
ICP/AES	EPA 6010B/C	Nickel
ICP/AES	EPA 6010B/C	Potassium
ICP/AES	EPA 6010B/C	Selenium
ICP/AES	EPA 6010B/C	Silicon
ICP/AES	EPA 6010B/C	Silver
ICP/AES	EPA 6010B/C	Sodium

Solid and Chemical Waste

Technology	Method	Analyte
ICP/AES	EPA 6010B/C	Strontium
ICP/AES	EPA 6010B/C	Thallium
ICP/AES	EPA 6010B/C	Tin
ICP/AES	EPA 6010B/C	Titanium
ICP/AES	EPA 6010B/C	Vanadium
ICP/AES	EPA 6010B/C	Zinc
ICP/MS	EPA 6020A	Aluminum
ICP/MS	EPA 6020A	Antimony
ICP/MS	EPA 6020A	Arsenic
ICP/MS	EPA 6020A	Barium
ICP/MS	EPA 6020A	Beryllium
ICP/MS	EPA 6020A	Boron
ICP/MS	EPA 6020A	Cadmium
ICP/MS	EPA 6020A	Calcium
ICP/MS	EPA 6020A	Chromium
ICP/MS	EPA 6020A	Cobalt
ICP/MS	EPA 6020A	Copper
ICP/MS	EPA 6020A	Iron
ICP/MS	EPA 6020A	Lead
ICP/MS	EPA 6020A	Magnesium
ICP/MS	EPA 6020A	Manganese
ICP/MS	EPA 6020A	Molybdenum
ICP/MS	EPA 6020A	Nickel
ICP/MS	EPA 6020A	Potassium
ICP/MS	EPA 6020A	Selenium
ICP/MS	EPA 6020A	Silver
ICP/MS	EPA 6020A	Sodium
ICP/MS	EPA 6020A	Strontium
ICP/MS	EPA 6020A	Thallium
ICP/MS	EPA 6020A	Tin
ICP/MS	EPA 6020A	Titanium

Solid and Chemical Waste

Technology	Method	Analyte
ICP/MS	EPA 6020A	Tungsten
ICP/MS	EPA 6020A	Vanadium
ICP/MS	EPA 6020A	Zinc
IC	EPA 9056A	Chloride
IC	EPA 9056A	Fluoride
IC	EPA 9056A	Nitrate as N
IC	EPA 9056A	Nitrite as N
IC	EPA 9056A	Orthophosphate
IC	EPA 9056A	Sulfate
Gravimetric	EPA 9071A/B	Oil and Grease, Oil and Grease with SGT
Physical	EPA 1010A	Ignitability
Physical	EPA 9045D	pH
Titration	EPA SW-846 Chapter 7.3.4	Reactive Sulfide
Titration	Walkley-Black	Total Organic Carbon
IR	Lloyd Kahn	Total organic carbon
Turbidimetric	EPA 9038; ASTM 516-02	Sulfate
UV/VIS	EPA 350.1; SM 4500NH3 H	Ammonia as N
UV/VIS	EPA 9251; SM 4500Cl E	Chloride
UV/VIS	EPA SW-846 Chapter 7.3.4	Reactive Cyanide
UV/VIS	EPA 821/R-91-100	AVS-SEM
UV/VIS	SM 3500Fe D	Ferrous Iron
Cleanup Methods	EPA 3630C	Silica Gel
UV/VIS	EPA 7196	Chromium VI
UV/VIS	EPA 7196A	Chromium VI
UV/VIS	EPA 9012B	Total cyanide
Grain Size	ASTM D422	
Preparation	**Method**	**Type**
Preparation	EPA 1311	Toxicity Characteristic Leaching Procedure
Preparation	EPA 1312	Synthetic Precipitation Leaching Procedure
Cleanup Methods	EPA 3660B	Sulfur Clean-up

Solid and Chemical Waste		
Technology	**Method**	**Analyte**
Cleanup Methods	EPA 3620C	Florsil Clean-up
Cleanup Methods	EPA 3630C	Silica Gel Clean-up
Cleanup Methods	EPA 3640A	GPC Clean-up
Organic Preparation	EPA 3540C	Soxhlet Extraction
Organic Preparation	EPA 3545A	Pressurized Fluid Extraction
Organic Preparation	EPA 3546	Microwave Extraction Preparation for EPA 8082A, 8081B and 8270C, D
Organic Preparation	EPA 3550C	Sonication
Inorganics Preparation	EPA 3050B	Hotblock
Inorganics Preparation	EPA 3060A	Alkaline Digestion
Volatile Organics Preparation	EPA 5035/5035A	Closed System Purge and Trap

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	Propene
GC/MS	EPA TO-15	1, 1, 1-Trichloroethane
GC/MS	EPA TO-15	1, 1, 2, 2-Tetrachloroethane
GC/MS	EPA TO-15	1, 1, 2-Trichloroethane
GC/MS	EPA TO-15	1, 1-Dichloroethane
GC/MS	EPA TO-15	1, 1-Dichloroethylene
GC/MS	EPA TO-15	1, 2, 4-Trichlorobenzene
GC/MS	EPA TO-15	1, 2, 4-Trimethylbenzene
GC/MS	EPA TO-15	1, 2-Dibromoethane (EDB)
GC/MS	EPA TO-15	1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)
GC/MS	EPA TO-15	1, 2-Dichlorobenzene
GC/MS	EPA TO-15	1, 2-Dichloroethane
GC/MS	EPA TO-15	1, 2-Dichloroethenes (Total)
GC/MS	EPA TO-15	1, 2-Dichloropropane
GC/MS	EPA TO-15	1, 3, 5-Trimethylbenzene
GC/MS	EPA TO-15	1, 3-Butadiene

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	1, 3-Dichlorobenzene
GC/MS	EPA TO-15	1, 4-Dichlorobenzene
GC/MS	EPA TO-15	1,4-Difluorobenzene
GC/MS	EPA TO-15	1, 4-Dioxane
GC/MS	EPA TO-15	2-Butanone
GC/MS	EPA TO-15	2-Hexanone
GC/MS	EPA TO-15	2-Propanol
GC/MS	EPA TO-15	4-Ethyltoluene
GC/MS	EPA TO-15	4-Methyl-2-pentanone
GC/MS	EPA TO-15	Acetone
GC/MS	EPA TO-15	Acrolein
GC/MS	EPA TO-15	Benzene
GC/MS	EPA TO-15	Benzyl chloride
GC/MS	EPA TO-15	Bromochloromethane
GC/MS	EPA TO-15	Bromodichloromethane
GC/MS	EPA TO-15	Bromoform
GC/MS	EPA TO-15	Carbon disulfide
GC/MS	EPA TO-15	Carbon tetrachloride
GC/MS	EPA TO-15	Chlorobenzene
GC/MS	EPA TO-15	Chloroethane
GC/MS	EPA TO-15	Chloroform
GC/MS	EPA TO-15	Cis-1, 2-Dichloroethene
GC/MS	EPA TO-15	Cis-1, 3-Dichloropropene
GC/MS	EPA TO-15	Cyclohexane
GC/MS	EPA TO-15	Dibromochloromethane
GC/MS	EPA TO-15	Dichlorodifluoromethane (Freon 12)
GC/MS	EPA TO-15	Ethanol
GC/MS	EPA TO-15	Ethyl acetate
GC/MS	EPA TO-15	Ethylbenzene
GC/MS	EPA TO-15	Hexachlorobutadiene
GC/MS	EPA TO-15	Isopropyl alcohol
GC/MS	EPA TO-15	m, p-Xylene

Air		
Technology	**Method**	**Analyte**
GC/MS	EPA TO-15	Methyl bromide (Bromomethane)
GC/MS	EPA TO-15	Methyl chloride (Chloromethane)
GC/MS	EPA TO-15	Methyl methacrylate
GC/MS	EPA TO-15	Methyl tert-butyl ether
GC/MS	EPA TO-15	Methylene chloride
GC/MS	EPA TO-15	Naphthalene
GC/MS	EPA TO-15	n-Heptane
GC/MS	EPA TO-15	n-Hexane
GC/MS	EPA TO-15	o-Xylene
GC/MS	EPA TO-15	Styrene
GC/MS	EPA TO-15	Tetrachloroethylene (Perchloroethylene)
GC/MS	EPA TO-15	Tetrahydrofuran
GC/MS	EPA TO-15	Toluene
GC/MS	EPA TO-15	trans-1, 2-Dichloroethylene
GC/MS	EPA TO-15	trans-1, 3-Dichloropropylene
GC/MS	EPA TO-15	Trichloroethene (Trichloroethylene)
GC/MS	EPA TO-15	Trichlorofluoromethane (Freon 11)
GC/MS	EPA TO-15	1,1,2-Trichloro1,2,2-trifluoroethane (Freon 113)
GC/MS	EPA TO-15	Vinyl acetate
GC/MS	EPA TO-15	Vinyl chloride
GC/MS	EPA TO-15	Xylenes (Total)
GC/MS	MA DEP APH	Aliphatic C5-C8 range
GC/MS	MA DEP APH	Aliphatic C9-C12 range
GC/MS	MA DEP APH	Aromatic C9-C10 range
GC/MS	MA DEP APH	1,3-Butadiene
GC/MS	MA DEP APH	Benzene
GC/MS	MA DEP APH	Ethylbenzene
GC/MS	MA DEP APH	m+p-Xylene
GC/MS	MA DEP APH	Methyl tert-butyl ether
GC/MS	MA DEP APH	Naphthalene
GC/MS	MA DEP APH	o-Xylene
GC/MS	MA DEP APH	Toluene

Biological Tissue		
Technology	**Method**	**Analyte**
ICP/AES	EPA 6010C	Lead

Notes:

1) This laboratory offers commercial testing service.

Approved by: ______________________
R. Douglas Leonard
Chief Technical Officer

Date: August 31, 2016

Re-issued: 1/27/16 Revised: 8/31/16

SD-902-12
SAMPLE RECEIPT AND INTERNAL CONTROL

TITLE: **SAMPLE RECEIPT AND INTERNAL CONTROL**

Prepared By: Andrea Colby Date: 6/2002

Approved By:

Group Supervisor: Date: 6/6/02

Lab Operations Mgr: C. Burton Date: 6/5/02

QA Officer: Deborah J. Nadeau Date: 6·6·02

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
04	Changed cover sheet, minor changes to sections 7.1, 7.6 7.7.4, 7.10 + 7.20. Complete rewrite of sections 7.11 + 7.12 to comply with new KIMS	DN	6·6·02	6·6·02
05	Added verbal date entry to KIMS. Added reference to immediate internal COC book. Added Department Manager reference. Added section 7.7.3. Updated new incoming	DN	05·04	05·04
06	Added procedure + logbook page for checking turbidity of drinking water samples. Changed wet chem shorts board to a book (included example page). Added custody procedures for food/micro. Added VOA soil freezer storage.	DN	01·26·04	01·26·04
07	Added instructions to create lettered labels. Changed sample locations to reflect new building. Removed Figures 8 and 10. Updated Table and figures w/ current ones. Added wording to Sect. 7.7.5 to clarify how pH measurements are taken.	LAD	02/07	02/07
08	Added summary stating sample acceptance policy. Deleted all references to radiation checks (not performed). Add IR gun usage. Reorganized section 7.0 to prioritize time sensitive tasks. Added wireless thermometer monitoring. Updated SRCR. Other minor changes.	DN	~~05/09~~ 08/09 8.4.09	~~05/09~~ 08/09

Added section concerning locking of coolers. Added more detail to 7.18 on unique container IDS. Added more detail on immediate COCs & a section on retention of samples.

TITLE: **SAMPLE RECEIPT AND INTERNAL CONTROL**

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
09	Added new login information for bottle IDs & screen attachment. Added procedures for bar code scanning for internal custody & deleted manual forms. Added new Incoming from KIMS & deleted old. Added form controlled forms to figures.	Dn	9.24.10	09/10
10	Sect.7 - Removed F9 function in printing labels, fixed how the lab ID appears on labels, and fixed how the date needs to be entered. Updated Fig.s 6 and 13.	LAD	08/13	08/13
11	Sect.7 - Updated WC shirts and rushes from log-book to Google Doc.s, updated microbiological/food login process, updated bottle labeling. Updated Table 1 and Figures 1→7 & 12. Added Figure 17 - Sample Acceptance Policy	LAD	05/16	05/16
12	Sect. 7.15.4 - Added additional fields in login Info. Updated Table 1	LAB	09/17	09/17

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SD-902-12**, titled **Sample Receipt and Internal Control**.

Recipient: ____ Date: ____________________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SD-902-12**, titled **Sample Receipt and Internal Control**.

Recipient: ____ Date: ____________________

1.0 SCOPE AND APPLICATION

Katahdin Analytical Services requires the use of specific receiving, acceptance, identification, storage, and distribution procedures for samples it accepts for analyses. These procedures assure that:

- samples are uniquely identified,
- samples are protected from loss or damage,
- essential sample characteristics are preserved,
- any alteration of samples (e.g., filtration, preservation) is documented,
- the correct samples are analyzed, and
- a record of continuous sample custody and utilization is established.

The purpose of this SOP is to describe the procedures used for the receipt and tracking of samples received by Katahdin Analytical Services (Katahdin).

1.1 Definitions

SDG: Sample Delivery Group – A group of samples to be reported as one data package.

1.2 Responsibilities

It is the responsibility of all Katahdin staff who receive samples or handle samples in the course of analysis to follow the procedures set forth in this SOP, to document their understanding of the procedures in their training files (refer to Katahdin SOP QA-805, current revision, “Personnel Training & Documentation of Capability”), and to suggest changes and revisions when appropriate. All technical staff are responsible for monitoring their immediate areas, stopping an activity when a problem is detected or suspected, initiating corrective action when needed, documenting any actions taken, and notifying the appropriate individual (e.g., President, Department Manager, QAO). The primary responsibility for implementing real-time corrective actions and maintaining an effective QA self-inspection system resides with Katahdin staff. When problems are identified, Katahdin personnel are expected to attempt to resolve situations within the scope of their technical knowledge, and to seek assistance from peers and the Department Manager as necessary.

It is the responsibility of Department Managers to oversee the adherence to Katahdin QC practices and internal documentation of laboratory activities within their area, to take corrective actions where needed and communicate problems to the QAO or President when warranted.

It is the responsibility of the Quality Assurance Officer (QAO) to oversee adherence to this SOP, to conduct periodic audits of each laboratory, to track corrective action reports, resolution, and documentation, and to communicate concerns and report findings to the President. The QA Officer shall function independently from laboratory operations and be able to evaluate data objectively and perform assessments without outside influence. The QA Officer has the authority to independently halt production operations (including data reporting) if warranted by quality problems.

1.3 Safety

Users of this procedure must be cognizant of inherent laboratory hazards, proper disposal procedures for contaminated materials and appropriate segregation of hazardous wastes. The toxicity or carcinogenicity of each reagent used in this method has not been precisely defined; however, each chemical should be treated as a potential health hazard. A reference file of material safety data sheets is available to all personnel involved in the chemical analysis. Everyone involved with the procedure must be familiar with the MSDSs for all the materials used in this procedure.

Each qualified analyst or technician must be familiar with Katahdin Analytical safety procedures and the Katahdin Environmental Health & Safety Manual and must follow appropriate procedures. These include the use of appropriate personal protective equipment (PPE) such as safety glasses, gloves and lab coats when working with chemicals or near an instrument and not taking food or drink into the laboratory. Each analyst should know the location of all safety equipment. Each analyst shall receive a safety orientation from their Department Manager, or designee, appropriate for the job functions they will perform.

1.4 Pollution Prevention/Waste Disposal

Whenever possible, laboratory personnel should use pollution prevention techniques to address their waste generation. Refer to the current revision of the Katahdin Hazardous Waste Management Program for further details on pollution prevention techniques.

Wastes generated during the receipt of samples must be disposed of in accordance with the Katahdin Environmental Health & Safety Manual and SOPs SD-903, “Sample Disposal” and CA-107, “The Management of Hazardous Waste as it Relates to the Disposal of Laboratory Process Waste, Reagents, Solvents and

Standards,” current revisions. Expired standards are placed in the Katahdin hazardous waste storage area, and disposed of in accordance with these SOPs.

2.0 SUMMARY OF METHOD

Regulatory, program, and/or method requirements dictate the specifics of sample acceptance. These requirements include, but are not limited to, temperature upon receipt, chemical preservation, container type, sample amount, holding time considerations and complete and accurate documentation of all of these conditions, as well as sample identification. Katahdin's sample acceptance policy is to note any anomalies, discrepancies or non-compliances concerning the receipt of samples. The client is always notified with these issues to direct Katahdin on how and whether to proceed with analysis. All guidance from the client is recorded in the project phone logs and/or on the Sample Receipt Condition Report, which becomes part of the final report. Conditions or analyses performed which do not meet the necessary requirements are narrated or notated as described in the individual analytical SOPs.

3.0 INTERFERENCES

Not applicable.

4.0 APPARATUS AND MATERIALS

4.1 Thermometer – Oakton® Non-Contact Infrared Thermometer, or equivalent, capable of reading 0.1°C and digital probe style capable of reading 0.1°C (used for back-up).

4.2 Capillary tubes – 75 mm Hematocrit Tubes, disposable

4.3 Wide range pH test strips, pH 0 to 14 pH, EMD ColorpHast or equivalent.

4.4 Narrow range pH test strips, pH 0 to 2.5 pH, EMD ColorpHast or equivalent.

4.5 Narrow range pH test strips, pH 11 to 13 pH, EMD ColorpHast or equivalent.

5.0 REAGENTS AND STANDARDS

Preservatives - refer to Table 1, Sampling and Preservation Requirements, for specifics.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Refer to Table 1, Sampling and Preservation Requirements, for specifics.

7.0 PROCEDURES

PROCEDURES FOR SAMPLE CUSTODIAN

The following procedures include all steps to be completed for satisfactory receipt and acceptance of samples at Katahdin. These steps do not necessarily have to be performed in the exact order as described. Sample deliveries occur constantly throughout the day, so the sample custodian must multi-task and move back and forth between different procedures to accomplish the most critical tasks of checking receipt temperatures and checking for “RUSH” or quick hold time parameters.

7.1 When samples (except for non-environmental food samples) are dropped off, by either a delivery service (i.e. FEDEX or UPS) or by the client, the Chain-of-Custody (COC) should be signed immediately. The client (who is delivering or that has shipped samples with a delivery service) shall sign (at the lab upon delivery or prior to shipment of samples) that they have relinquished custody to the laboratory. The laboratory shall sign and record the date and time that custody is accepted. (Refer to Figures 1-3 for a Katahdin standard COC, a Katahdin Homeowner COC, and a Katahdin Food/Microbiology COC).

7.2 Cut custody seals and open all coolers. Remove the packets containing the client Chains-of-Custody (COCs).

7.3 Using the COCs, enter the date and time of sample receipt and the client name into the next available work order/login number in the sample receipt logbook (Figure 5). Initial each entry (line) to maintain a record of the individual who assigned each group of samples a discreet lab work order/login number. Record the assigned work order numbers in the appropriate space on the client COCs. Complete the log-in entry date and time once samples are logged in as described below.

7.4 Inventory the COCs for any “rush turn around” samples or “short hold-time” analyses. Notify the appropriate department Managers/Supervisors of these analyses.

7.4.1 Short hold-time analyses need to be entered into the “Wet Chemistry Shorts Spreadsheet” (Figure 6) on the company Google Docs system. Be sure to list the client, number of samples and date and time of the earliest sample.

7.4.2 GC or GC/MS personnel must be informed when ENCORES are received so that they may be scheduled for extrusion.

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7.4.3 Notify all applicable personnel of samples with limited hold-time remaining or rush turn around samples. Appropriate supervisors and PMs must be emailed when a client has requested rush results. The email should include the work order number, the client, the matrix, number of samples, analysis requested and the turnaround time. Samples for microbiology lab should be brought to them immediately.

7.4.4 Parameters that we routinely analyze which have short analytical hold times are:

Coliforms	Color	pH
Nitrate/Nitrite	Dissolved Oxygen	Turbidity
Ferrous iron	Orthophosphate	Hex. Chromium
MBAS	TBOD	Free CO_2
Sulfite	ENCORE soil samples	Settleable Solids
Odor	Residual Chlorine	CBOD

7.5 Inspect the condition of custody seals, cooler, ice condition and samples received. Note any non-intact conditions on the Sample Receipt Condition Report (SRCR - Figure 7). Notify the Katahdin project manager (PM) of any discrepancies or problems with sample receipt. The PM contacts the client as necessary. If breakage of a potentially hazardous sample is discovered, close and seal the packing container with all the samples inside and move to a hood in the organic extractions area or to the smaller hood in the login area if space permits. One of the three Katahdin Emergency Response Coordinators or the Katahdin Environmental Health & Safety Manager must be notified. Disposition of the broken and other possibly contaminated samples will be determined on a case-by-case basis in accordance with the laboratory's handling procedures for hazardous waste as outlined in the Katahdin Environmental Health & Safety Manual. Generally, when a sample has broken and has mixed with any ice in the cooler, that liquid will be poured off into 2 liter plastic containers and labeled as "do not use". These containers will be disposed of as soon as the disposition of the appropriate samples has been determined through analysis.

7.6 If there is no breakage of a potentially hazardous sample:

Check cooler temperatures using the IR thermometer assigned to the sample receipt area. If a cooler temperature blank is present, aim the IR gun at the temperature blank; otherwise aim the IR gun at any sample in the cooler if no temperature blank is present. Be sure that the IR gun is within 6 inches of the bottle and not aimed at a label on the bottle. Press the trigger on the handle and be sure the red dot is visible on the bottle surface. The IR gun has been set to read in degrees celcius. If checking the temperature of a plastic bottle, set the emissivity at 0.90. If checking the temperature of a glass bottle (either amber or clear), set the emissivity at 0.85. Refer to Figure 8 for manufacturer's instructions on changing the emissivity. Record the temperature on the Sample Receipt Condition Report. Receipt temperatures should be <6 °C, without freezing. Any temperature falling outside of this range must be noted on the SRCR and reported to the appropriate Katahdin project manager.

Note: Samples received for metals analysis only do not have to meet any temperature receipt requirements.

Note: A probe type thermometer is retained as back-up in case there is a problem with the IR thermometer.

7.7 Note the condition of the ice or ice packs. If the ice has melted and the temperature is out of acceptance criteria, note this on the SRCR. For samples that are hand delivered to the laboratory immediately after collection (i.e. sample collection times are <6 hours old), the temperature blank and/or cooler temperature will most likely not meet the acceptance criteria. The samples shall be considered acceptable if there is evidence that the chilling process has begun such as arrival on ice. Note this on the SRCR. If samples (that were just collected) have not arrived on ice, note this on the SRCR, and start the cooling process as soon as possible after arrival at the laboratory.

Note: All clients must be notified when samples are received that do not meet the appropriate temperature requirements. In these cases, certain regulatory requirements may not be met and may invalidate certain data.

7.11 Notify the PM immediately if there are any discrepancies or problems with sample receipt. The PM will contact the client for information and resolution as necessary. All decisions to proceed or not to proceed with analysis associated with samples received that do not meet specified acceptance criteria (i.e. cooler temperature, preservation, container, etc.) must be fully documented on the SRCR. Although this form is included with all client reports, additional narration or flagging of data may be necessary.

7.12 Review any additional paperwork that accompanies the sample(s) submitted for analysis along with laboratory-generated information. This includes shipping forms, letters, chain-of-custody forms, sample labels, Incoming Sample Reports (generated from KIMS), quotes, memos, etc. These forms may provide details on specific client requests. The Incoming will provide information on specifics for log-in. Refer to Figure 11 for an example.

7.13 Resolve any questions or concerns raised by steps 7.1-7.14 by consulting the correspondence files or client services personnel or communicating directly with the client. Note in the notes section of the SRCR any deviations from normal sample handling or analytical procedures (e.g., client requests analysis although hold-time expired).

7.14 Samples requiring microbiological and/or food analyses are stored in the F/M laboratory walkin. For environmental tests, samples are logged in by the sample receipt department and a copy of the chain of custody is brought with the samples. For non-environmental microbiological tests, a workorder number is assigned by sample receipt but the samples are not logged in. The workorder number, the chain of custody and a copy of the chain of custody are delivered with the samples. The samples are then logged in by the F/M staff. Sample that require both environmental and non-environmental microbiological analyses are usually processed the same as non-environmental samples

7.15 The following information is documented via the Katahdin Information Management System (KIMS) and a work order/login COC report (Figure 12) is generated for the samples received:

7.15.1 Log onto KIMS by entering employee ID under “Username”, employee specific password under “Password” and KIMS under “Database”.

7.15.2 Once logged onto KIMS select “Sample Management” and then “Login”.

7.15.3 Select “New” and the next available Login ID number will automatically be entered. Select “OK” and the Sample Definition screen will open.

Note: If a Work Order number has already been opened, select “change” and type in the appropriate number to access the information.

7.15.4 In the Sample Definition Screen, enter the following information.

<u>Top Section of Screen</u>:

Client ID -	Enter client sample description.
ReceiveDate -	Enter in date that samples were received in the lab in the format Day-Month-Year (ex. August 23, 2013 is 23-AUG-13).
CollectDate -	Enter in date that samples were collected in the format Day-Month-YearTime (ex. 8:30am August 23, 2013 is 23-AUG-13).
TAT -	Enter TAT for hardcopy report.
DueDate -	Due date will automatically be calculated based on calendar days.
VerbalDate -	Manually type in verbal due date.
QuoteRef -	Enter quote number if applicable.
Project -	Enter project number if applicable.

Account -	Enter client specific account number.
Account Name -	Account name will automatically be entered.
Collected By -	Enter name/initials of sampler listed on COC. If unknown, enter “Client”.
Locator -	May be used for client ID information when requested by the project manager.
Site -	Enter project site name.
Description -	May be used for food descriptions.
Discount -	No entry-not currently used.
Priority -	No entry-not currently used.
Fact. -	No entry-not currently used.
Expected -	No entry-not currently used.
Mailed -	Data Management will enter the mailed date of the report or SDG right after the report is mailed.
Comments -	Enter MS/MSD, verbal due date and any sample irregularities if applicable. Also may be used for long client IDs when requested by the project manager.
OrderDate -	Current date is automatically entered.

Middle Section of Screen:

Highlight the first sample in the top section of the screen and then proceed with entries in the middle section of the screen.

Matrix - Enter sample matrix code where

AQ = Aqueous
SL = Solid, Soil, Sludge
FP = Free Product
WP = Wipe
NOAQ = NonAqueous
DW = Drinking Water
SLD = Food Solid
AR = Air
SWAB = Swab
SAL = Saline
TIS = Tissue

Product Code -	Enter analysis code per test requested on COC. Log-in personnel should refer to Project Incomings, quotes or past Work Orders to aid in the entry of correct product codes.
Type -	Product code type will automatically be entered where S = Stand alone P = Parent C = Children
Fact. -	No entry-default is 1.
Price -	This is left as is by sample log-in. During project management review of the work order, the prices are entered based on quotes or standard prices.
Cost -	No entry needed.
Lev -	No entry needed.
Container Type -	Container type will automatically be entered. Please change from the various choices if the automatic entry is not correct. This is especially important for volatiles in soil since there are many types of preservations.
Container Key-	Make sure “Container Type” is populated. Determine how many bottles there are for each container type. Assign bottles by entering sequential letters for each bottle. For example, sample 1 has six containers, one for metals which we’ll assign container ID, “A”, two for PCBs which we’ll assign container IDs, “B” and “C”, and three for volatiles which we’ll assign container IDs, “D”, “E”, and “F”. The letters should be typed in all in a row with no commas or spaces in between. If 26 bottles per samplenum are exceeded the next ‘key’ would be, ‘A1’, ‘B1’ etc. If no container IDs are needed (i.e. for food or field) it is okay to leave the container key field blank. After the Container Keys are entered click ‘SAVE’. This will create the containers section in the bottom section of the screen. This will also initiate the creation of container labels.

Bottom Section of Screen:

Container # -	The container ID numbers will automatically fill in for each analysis from the container key information above.
Container Type -	The container types will automatically fill in for each analysis from the container key information above.
Current Location -	The current location is automatically entered based on the analysis.
Cooler -	Currently not used.
pH -	Currently not used.
Temperature -	Currently not used.
Seal -	Currently not used.
Properly Preserved -	Currently not used.
Comments -	Comments on individual containers may be entered here, i.e. bubble in VOA vial. Comments regarding problems or breaks with internal custody scanning of bar codes are also automatically entered here.

Select Login Info tab at top of screen and proceed with entry:

Login Info - Parameter Data Screen will open. Enter following information

KAS Proj. Manager -	Initials of Katahdin person overseeing the project.

Client Project Manager – Name of client manager

Contract – Name or number of contract for the job.

Client PO# - Client purchase order.

Project - Project name.

Cooler Temperature -	Temperature blanks or cooler temps.

Delivery Services - Method of delivery to the lab.

QC Level - QC Level of report

SDG ID - Sample Delivery Group ID if applicable.

SDG Status - Begin, Continue or End.

Analysis Instructions - PM will enter special instructions regarding project.

Report Instructions - PM will enter special instructions regarding project.

Regulatory List - Not used.

EDD Format - Specific KAS EDD format.

Login Initials – Initials of person that logged the work order in.

Check – Check number when client pays at sample delivery

Select “SAVE” and then “CANCEL”.

Addresses - Select “Addresses” and the Address Links screen will open. The billing address is the default address of the account. Enter the client account code under “Project/Account” and select the report to contact under “Address Type”. Select the appropriate boxes for report, report CC and invoice CC. Select “SAVE” and then “CLOSE”.

Refer to Figure 13 for a screen snapshot of the log-in process in KIMS. Log-in personnel should also refer to the current revision of Katahdin SOP, SD-918, KIMS Work Order Approval & Dispatching, for further hints on log-in.

7.15.5 To print the login report, select “Reports”, “Login” and “Login COC”. Enter login number under “Login Number”. Select “OK”, “Run Report” and then “Print”.

7.16 To print labels, select “Reports”, “Login” and “Labels”. Enter login number under “Login/Prelogin”, select “Background (IDXL) (this is the default)”. Select “OK” and then “Print”. After labels print out select “Cancel”.

Note: As stated in “container key” above, each sample bottle is assigned a unique ID. The job is given a work order number. Each different client sample ID is given a numerical number following the work order number and each sample container with the same client ID is given a container ID using alphabetical letters. This series of work order, sample number and container ID is transcribed throughout the raw data for traceability purposes.

Example: One job containing one client sample with 3 different containers:

SC9001-1A, SC9001-1B, SC9001-1C

Example: One job containing two client samples with 2 different containers for each:

SC9002-1A, SC9002-1B, SC9002-2A, SC9002-2B

7.17 Print the Label Bottle Reference report (under reports tab) for a cross reference to use during labeling. This report will list the bottle type and products related to each Container ID.

7.18 Remove samples from cooler and place them on the counter. Organize them by site ID, in the order of the chain and then by sample analysis.

7.19 Inventory the samples against the chain of custody (COC). If the COC is incomplete, the sample custodian must inform the appropriate Katahdin project manager (PM). The PM may make changes to correct or complete the COC, but all changes must be initialed and dated. Changes must be noted on the SRCR. Any discrepancies between the samples and the COC must also be noted on the SRCR.

7.20 Using the Sampling and Preservation Requirements Table (Table 1) as a reference, check if samples are in proper containers and received correct pretreatment (e.g., filtration, preservation) for the analyses requested. For aqueous parameters requiring preservation, check pH by inserting a clean capillary tube into the sample and dabbing the tube on wide range pH paper. If the pH is not clearly either less than 2 or greater than 12, the appropriate narrow range pH paper must be used. NOTE: The pH of volatile organic (VOA) samples is checked and recorded by the analyst after completion of analysis and not by sample receipt personnel. The used capillary tube is discarded and a new capillary tube is used for each sample.

Additional preservative is added to samples if the pH is not in the range specified in the Sampling and Preservation Requirements Table. No more than 10% of the original sample volume should be added as preservative. If the client has noted that the sample reacts violently (i.e., foams and bubbles) upon preservation, add no more preservative to the sample. Some clients may wish to be contacted if their samples are found to be improperly preserved. Record all preservation discrepancies on the Sample Receipt Condition Report including the lot number of the preservative added. If additional preservative is added, a sticker with the type of preservative must be placed on the sample container.

Note: Preservatives are obtained from the larger containers in the bottle preparation area.

Note: If samples are received unpreserved for 200.7 or 200.8 analysis, the samples must be preserved to pH <2 with nitric acid. Samples must be held for 16 hours after preservation before sample preparation can begin.

7.21 For samples requiring filtration as pretreatment (i.e. for dissolved metals), the work order/login numbers are recorded in the filtration logbook (see Figure 9). The samples are filtered by the Metals Group or the Wet Chemistry Group depending on which group requires the filtered samples.

7.21.1 A 500 mL filter flask and filter funnel are acid rinsed three times in a 10% nitric acid bath, then three times with Laboratory Reagent Grade Water.

7.21.2 A vacuum pump is attached.

7.21.3 A 0.45 micron filter is rinsed three times with 5% nitric acid and three times with Laboratory Reagent Grade Water. The rinsate is discarded.

7.21.4 A sufficient sample aliquot is filtered and preserved with concentrated nitric acid to pH <2.

7.21.5 The bottles are labeled with the work order/login number and other sample information and stored at <6 ° C until the time of digestion.

7.22 Using the Sampling and Preservation Requirements Table (Table 1) as a reference, determine if sufficient volume of sample is present for analysis. Note discrepancies on the SRCR.

7.23 For drinking water samples, enter the appropriate information (work order, date, etc.) into the Measured Turbidity and Preservation of Incoming Samples Logbook. Inform the appropriate analyst of the sample. The turbidity must be measured prior to sample preparation. If the turbidity is <1 NTU, the sample does not have to be digested prior to metals analysis. If the turbidity is >1 NTU, the sample must be digested prior to metals analysis. The sample must be preserved after the turbidity measurement is taken. Record the appropriate information in the logbook (Figure 10).

7.24 Affix permanent sample number labels to sample containers, assuring that sample IDs on labels correspond to sample bottle IDs. Do not obscure client ID on the bottles.

40 mL vial, 125 ml plastic bottle and 4 oz jar labels will have to be placed vertically on the sample container instead of the standard horizontal placement. Additionally, label for 2 oz jars must be placed on the cover.

7.25 Scan the containers into the appropriate storage locations using the following steps. Note that non-environmental food samples are not scanned and are taken immediately to the food/microbiology lab for storage.

7.25.1 In KIMS, click on “containers”. This can also be done at the walk-in computer or on the “D” instrument computer in the VOA lab, depending on where you are storing samples.

7.25.2 Click on “transfer/update” then “transfer” and select. This will bring you to the screen where you scan your badge. **NOTE: make sure you keep your badge available for this**. Alternatively, at the walk-in computer, click on the check-in/check-out ICON. This will also bring you to the screen where you scan your badge.

7.25.3 Scan the barcode on your badge.

7.25.4 Pick “log-in”.

7.25.5 Pick “check-in”.

7.25.6 Select the location you are checking into, i.e. walk-in, VOA Walkin, etc.

7.25.7 The sample screen will now be open. Scan each sample, so that you hear a beep and the sample pops up on the screen. The program is set so that you can continuously scan each sample without having to click anything on the screen. The samples do not have to be scanned in numerical order.

7.25.8 Hit “done/save”.

7.25.9 Hit “close/cancel”. This will return you to the badge scanning screen.

Note: An internal custody report may currently be printed, per client request, by the MIS department.

7.26 Place samples in their designated storage locations. Storage location of the samples is determined by type of sample and/or type of analysis, as outlined below. Most samples are stored in the walk-in cooler, which is organized by test type and work order/login number.

Specific storage locations are described below.

7.26.1 Aqueous samples for wet chemistry (except hardness, see 7.19.4 below) - left aisle, both sides, as you enter walk-in cooler. TOC vials are to be stored in the trays designated for TOC samples.

7.26.2 Aqueous samples for organic extractions – right aisle, left side, as you enter walk-in cooler.

7.26.3 Non-aqueous samples (all analyses except volatile organics) - to the right and towards the back as you enter walk-in cooler. Non-aqueous samples for volatile organics are stored in “VOA Refrigerator 2” located in the Volatiles Laboratory.

7.26.4 Aqueous samples for metals and/or hardness analyses – right aisle, right side towards the front as you enter walk-in cooler.

7.26.5 Samples (aqueous and solid) for volatile organics analyses (VOA) – All aqueous and soil samples in VOA vials (except those which are preserved with D.I. water) are stored in “VOA walkin” in the Volatiles Laboratory. VOA samples known or suspected to be hazardous (such that cross-contamination of other samples might occur) are placed in a “paint can” and stored in the sample receipt walk-in.

7.26.6 Soil samples for volatile organics analyses (VOA) that are preserved with Laboratory Reagent Grade Water are stored in “VOA Freezer 1” in the volatiles laboratory.

Sample storage coolers are not locked, but internal chain-of-custody is documented through the bar code system with respect to native samples. Internal chain-of-custody for extracts and digestates is documented on hardcopy batch sheets. The laboratory maintains a secure facility with respect to unauthorized personnel, as described in the current revision of Katahdin SOP, AD-004, Laboratory Facility Security and Confidentiality. All sample storage coolers are equipped with locks if specific project or regulatory requirements deem it necessary.

7.27 Sample Receipt gives the Work order/login COC report and confirmation of the job, as logged-in, to the appropriate Katahdin project manager. All chain-of-custody and other receipt documentation must accompany the job. The project manager reviews the job for accuracy and completeness. Any unresolved issues should be resolved at this time. Any project or program specific forms should be included with the paperwork at this time. These forms may include CLP forms or state-specific forms. The project manager then dispatches the work order/login to the individual department worklists. The dispatched work order/login package is then filed in Data Management where the complete package will eventually be compiled.

7.28 The temperature of all sample storage refrigerators and freezers is recorded daily by assigned individuals. Notebooks containing a record of each refrigerator and freezer temperature history are used for this purpose and are maintained by the assigned individuals. Temperatures above or below the acceptance range are to be brought to the attention of a Department Manager, Operations Manager, or Quality Assurance Officer. Such an occurrence and the actions taken to correct it must be noted in the comments column of the temperature recording notebook next to the temperature measurement. (See Figure 14).

Additionally, temperatures of storage units are monitored continuously by wireless thermometers. A temperature is recorded electronically every 10 minutes. The QAO can generate a specified report as needed, including every reading or maximum/minimum temperatures for a given timeframe. These monitoring devices ensure continual compliance seven days per week. The data can be used to check for problems.

PROCEDURES FOR CHEMISTS

7.29 When removing or returning a sample from its storage location, it must be scanned in or out using the bar code on the container.

7.29.1 In KIMS, click on “containers”.

7.29.2 Click on “transfer/update” then “transfer” and select.

7.29.3 This will bring you to the screen where you scan your badge. Alternatively, at the walk-in computer, click on the check-in/check-out ICON. This will also bring you to the screen where you scan your badge.

7.29.4 Scan the barcode on your badge.

7.29.5 Pick the department that you are bringing samples to or from.

7.29.6 Pick “check-in” or “check-out”.

7.29.7 For check-in, select the location you are checking into.

7.29.8 The sample screen will now be open. Scan each sample, so that you hear a beep and the sample pops up on the screen.

7.29.9 Hit “done/save”.

7.29.10 Hit “close/cancel”. This will return you to the badge scanning screen.

7.30 If the samples have not been logged in yet and they need to be pulled in order to analyze short holding time parameters, the analyst taking the sample must use the designated logbook (Immediate Internal COC – Figure 15) to sign the samples out. Many circumstances lead to analysts having to pull samples before they are logged into the KIMS system. It is everyone's responsibility to ensure that all samples can be accounted for at all times. Failure to do so can create confusion and bottle necks for others trying to access the samples. Samples that are pulled before log-in must be returned to the designated bin in the sample receipt area. The Immediate Internal COC Logbook must always be consulted if there is ever a question about internal custody.

7.31 If there is an error (i.e. a sample was checked out, but not checked back, and you are trying to check it out), an error screen will pop up indicating who made the error. Take note of who made the error and click "accept bottle". This will allow you to continue, and a note will automatically be applied to the record. If you notice somebody making a lot of errors, please talk to them or let a manager know.

7.32 For samples that are consumed during analysis or preparation, i.e. extractables – either log the samples out and then rescan your badge and log them back in to "consumed" or remove the labels in the lab (when finished) and stick them to your lab coat and then return to scan them into "consumed".

7.33 If a sample is not consumed by an analysis, return the remaining sample to its assigned storage location and rescan back in using the steps in 7.23.

7.34 After the completion of all analyses, the original "left over" sample containers will remain in sample storage until their final disposal. Samples are held during this period for the purposes of retesting if required by a laboratory corrective action or by a client. Refer to the current revision of Katahdin SOP, SD-903, Sample Disposal, for details on final disposal of samples.

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

Each thermometer used to monitor sample storage or cooler temperatures must be calibrated quarterly against a NIST traceable thermometer. The QAO is responsible for ensuring that the thermometer(s) are scheduled for calibration and for maintaining the calibration records. All other procedures and documentation listed in this SOP must be followed at all times.

9.0 METHOD PERFORMANCE

Not applicable.

10.0 APPLICABLE DOCUMENTS/REFERENCES

"Handbook for Analytical Quality Control in Water and Wastewater Laboratories," U.S. EPA EMSL Office of Research and Development, March 1979.

Code of Federal Regulations 40, Parts 136 and 141.

"Test Methods for Evaluating Solid Waste: Physical/Chemical Methods," SW-846 Chapters 1 & 2, USEPA, Third Edition, including Updates I, II, IIA, and IIB, III June, 1997.

Katahdin Analytical Services, Environmental Health & Safety Manual, current revision.

Katahdin QA Manual, current revision

Department of Defense Quality Systems Manual for Environmental Laboratories (DoD QSM), Current Version.

The NELAC Institute, Laboratory Accreditation Standards, Volume 1, Management and Technical Requirements for Laboratories Performing Environmental Analysis, 10/06/2010.

LIST OF TABLES & FIGURES

TABLE 1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES - AQUEOUS					
Acidity	SM 2310B, 305.1	100 mL	P,G	1,2	14 days
Alkalinity- Titrimetric	SM2320B, 310.1	100 mL	P,G	1,2	14 days
Ammonia-Nitrogen with distill-Auto. Phenate	350.1/350.2 SM4500NH3 B&H	100 mL	P,G	1,3	28 days
Ammonia-Nitrogen-Automated Phenate	350.1, SM4500NH3 H	100 mL	P,G	1,3	28 days
Anions (F, Cl, Br, SO4, NO2, NO3)	300.0	250 mL	P, G	1	48hr/28days
Bicarbonate, Carbonate (calculation from alkalinity)	SM4500-CO2 D				
Biochemical Oxygen Demand-Carbonaceous	SM 5210B, 405.1	1 L	P,G	1	48 hours
Biochemical Oxygen Demand-Total	SM 5210B, 405.1	1 L	P,G	1	48 hours
Chemical Oxygen Demand-Manual Colorimetric	410.4	100 mL	P,G	1,3	28 days
Chloride-Automated Ferricyanide	SM4500-Cl E, 325.2	100 mL	P,G	1	28 days
Chlorine, Total Residual	SM4500-Cl G, HACH 8167	100 mL	P,G	1,9	ASAP
Chromium, Hexavalent	SM3500Cr D / SW7196	200 mL	P,G	1,9	24 hours
Color, Apparent	SM2120B, 110.2	100 mL	P,G	1,2	48 hours
Cyanide, Amenable-Spectrophotometric	SM4500CN G, 335.1	100 mL	P,G	1,5	14 days
Cyanide, Total-Spectrophotometric	SM4500CN C 335.4	100 mL	P,G	1,5	14 days
Dissolved Oxygen(Lab)-Membrane Electrode	SM4500-O G, 360.1	500 mL	G	1	ASAP
Ferrous Iron - Colorimetric	SM3500-Fe D	250mL	P	1,12	24 hrs
Fluoride with distillation, Potentiometric ISE	SM4500F B/C, 340.2	500 mL	P only	1	28 days
Fluoride, Potentiometric ISE	SM4500F C, 340.2	200 mL	P only	1	28 days
Free CO2	SM4500-CO2 C	250mL	P	1	24 hrs.
Hardness, Total-Manual Titrimetric	130.2, SM2340C	250 mL	P,G	4	6 months
MBAS, Extraction-Colorimetric	SM5540C	1 L	P,G	1	48 hours
Nitrate+Nitrite-Automated Cadmium Reduction	SM4500-NO3 F, 353.2	100 mL	P,G	1,3	28 days
Nitrate-Automated Cadmium Red./Diazotization	SM4500-NO3 F, 353.2	100 mL	P,G	1	48 hours
Nitrite-Automated Diazotization	SM4500-NO3 F, 353.2	100 mL	P,G	1	48 hours
Oil & Grease-Total Recoverable, Gravimetric N-Hexane extractable material N-Hexane extractable material w/ silica gel cleanup	1664	(2) 1 L	glass only	1, 3 OR 11	28 days
pH (Laboratory)	SM 4500H B 150.1	100 mL	P,G	1,2	24 hours
Phenolics, Total Recoverable-Manual 4AAP	420.1	1000 mL	glass only	1,3	28 days
Phosphate, Ortho- Ascorbic Acid	SM4500-P E, 365.2	100 mL	P,G	1	48 hours

TABLE 1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
Phosphate,Total	365.4	100 mL	P,G	1,3	28 days
Solids-Filterable Residue (TDS),Gravimetric180	SM 2540C, 160.1	250 mL	P,G	1	7 days
Solids-Nonfilterable Residue (TSS)	SM 2540D, 160.2	1 L	P,G	1	7 days
Solids-Settleable Solids (SS)	SM2540F, 160.5	1 L	P,G	1	48 hours
Solids-Total Solids	SM 2540B, 160.3	250 mL	P,G	1	7 days
Solids-Total Volatile (TVS)	SM 2540E, 160.4	250mL	P,G	1	7 days
Solids-Volatile Filterable Residue (VDS)	SM2540C/E, 160.1/160.4	250 mL	P,G	1	7 days
Solids-Volatile Nonfilterable Residue (VSS)	SM 2540 F	500 mL	P,G	1	7 days
Specific Conductance	SM2510B, 120.1	100 mL	P,G	1,2	28 days
Sulfate-Turbidimetric	ASTM D516-02, 375.4	100 mL	P,G	1	28 days
Sulfide-Iodometric	SM4500-S2 F, 376.1	500 mL	P,G	1,7	7 days
Sulfite-Titrimetric	SM4500-SO3 B, 377.1	500 mL	P,G	1,9	ASAP
Tannin/Lignin-Colorimetric	SM 5550 B	100 mL	P,G	1	7 days
TKN-Auto Block Digest, Spect.	351.2	100 mL	P,G	1,3	28 days
Total Inorganic Carbon	SM 5310B, 415.1	(2) 40 mL	VOA vial	1	28 days
Total Inorganic Carbon	SM 5310B, 415.1	(2) 40 mL	VOA vial	1	28 days
Total Organic Carbon	SM 5310B, 415.1	(2) 40 mL	VOA vial	1,3	28 days
Total Organic Halogen	9020	500 mL	Amber Glass	1,3	28 days
Turbidity	SM2130B, 180.1	100 mL	P,G	1	48 hours
Volatile Fatty Acids	SOP CA-776	(2) 40 mL	VOA vial	17	14 days
ELEMENTAL ANALYSES - AQUEOUS					
Chromium, Hexavalent	7196/6010	500 mL	P,G	1,9	24 hrs
ICP Elements	200.7/6010	500 mL	P,G	4	6 months
ICP MS Elements	200.8/6020	500 mL	P,G	4	6 months
Low Level Mercury	1631	500 mL	G	16	90 days
Mercury	245.1/7470	500 mL	P,G	4	28 days
GC ORGANIC ANALYSES - AQUEOUS					
EDB, DBCP & 1,2,3-TCP	8011 & 504.1	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Extractable Petroleum Hydrocarbons	MADEP EPH	(2) 1000 mL	Amber Glass	1,12	14days/40days
Formaldehyde	556	(2) 40 mL	VOA vial	1, 18	14 days(~)
Fuel Oil in Water	8015Modified	(2) 1000 mL	Amber Glass	1,8	7days/40days
Fuel Oil in Water	ME HETL 4.1.25	(2) 1000 mL	Amber Glass	1,8	7days/40days
Gasoline in Water	8015Modified	(2) 40 mL	VOA vial	1,8	14 days
Gasoline in Water	ME HETL 4.2.17	(2) 40 mL	VOA vial	1,8	14 days
Petroleum Range Organics	FL-PRO	(2) 1000 mL	Amber Glass	1,12	7days/40days

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

TABLE 1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
Total Petroleum Hydrocarbons	TX1005	(2) 40 mL	VOA vial	12	14days/14days
Extractable Total Petroleum Hydrocarbons	CT-ETPH	(2) 1000 mL	Amber Glass	1	7days/40days
Glycols	8015Modified	(2) 40 mL	VOA vial	1,8,9	14 days(~)
Herbicides	8151	(2) 1000 mL	Amber Glass	1	7days/40days
Methane, Ethane & ethene	RSK 175	(2) 40 mL	VOA vial	1,8,9	14 days(~)
PCB's	608 & 8082	(2) 1000 mL	Amber Glass	1	7days/40days
PCB Congeners	8082	(2) 1000 mL	Amber Glass	1	7days/40days
Pesticides	608 & 8081	(2) 1000 mL	Amber Glass	1	7days/40days
Pesticides and PCB's	608 & 8081/8082	(2) 1000 mL	Amber Glass	1	7days/40days
Solvents (Direct Injection)	8015M	(2) 40 mL	VOA vial	1	14 days
Volatile Petroleum Hydrocarbons	MADEP VPH	(2) 40 mL	VOA vial	1,11	14days
Chloropicrin	8011 Mod.	(2) 40 mL	VOA vial	1,8,9	14 days
HPLC ANALYSES – AQUEOUS					
HPLC-Explosives	8330A/B/ B Mod.	(2) 1000 mL	Amber Glass	1	7days/40days
GC/MS ORGANIC ANALYSES – AQUEOUS					
Acid Extractables	625	(2) 1000 mL	Amber Glass	1	7days/40days
Acid Extractables	8270	(2) 1000 mL	Amber Glass	1	7days/40days
Base Neutral Extractables	625	(2) 1000 mL	Amber Glass	1	7days/40days
Base Neutral Extractables	8270	(2) 1000 mL	Amber Glass	1	7days/40days
Drinking Water Volatiles – Low Level	524.2	(3) 40 mL	VOA vial	1,8,9,10	14 days(~)
Polyaromatic Hydrocarbons	8270/8270 SIM	(2) 1000 mL	Amber Glass	1	7days/40days
Semivolatile Extractables	625	(2) 1000 mL	Amber Glass	1	7days/40days
Semivolatile Extractables & (SIM)	8270/8270 SIM	(2) 1000 mL	Amber Glass	1	7days/40days
Volatile Organics & (limited SIM)	8260/8260 SIM	(3) 40 mL	VOA vial	1,8,9	14 days(~)
Volatile Organics	624	(3) 40 mL	VOA vial	1,8,9	14 days(~)
MICROBIOLOGICAL ANALYSES – AQUEOUS					
Coliform, Fecal (wastewater)	SM 9222D	100 mL	P,G	1,6	6 hours
Coliform, Fecal (wastewater)	Colilert-18 w/ Quantitray	100 mL	P,G	1,6	6 hours
Coliform, Total (wastewater)	SM 9222B	100 mL	P,G	1,6	6 hours
Coliform, Total (drinking water)	SM 9222B	100 mL	P,G	1,6	30 hours
Coliform and E-coli, Total (drinking water)	SM9223B, Colitag	100 mL	P,G	1,6	30 hours
E-coli (wastewater)	SM9213D	100 mL	P,G	1,6	6 hours
E-coli (wastewater)	SM9223B Colilert w/ Quantitray	100 mL	P,G	1,6	6 hours
Heterotrophic Plate Count	SM9215B, SIMPlate	100 mL	P,G	1,6	8 hours for compliance samples, 24 for non-compliance samples

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

TABLE 1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
GENERAL CHEMICAL ANALYSES – SOLID					
% Carbon	9060 mod.	4 oz	Soil Jar	1	28 days
Ammonia-Nitrogen-Automated Phenate	350.1/350.2 SM4500NH3 B&H mod.	4 oz	Soil Jar	1	28 days (^)
Anions (F, Cl, Br, NO3, NO2, SO4)	9056	4 oz	Soil Jar	1	48hrs to 28 days (^)
Cation Exchange Capacity	9081	4 oz	Soil Jar	1	14days/7days (^)
Chloride-Automated Ferricyanide	9251/9056	4 oz	Soil Jar	1	28days (^)
Cyanide, Amenable-Spectrophotometric	9012	4 oz	Soil Jar	1	14 days
Cyanide, Total-Spectrophotometric	9012	4 oz	Soil Jar	1	14 days
Fluoride, Potentiometric ISE	SM4500F B/C, 340.2 mod.	4 oz	Soil Jar	1	28 days (^)
Lime Equivalency	310.1 mod.	4 oz	Soil Jar	1	28 days (^)
Nitrate+Nitrite-Automated Cadmium Reduction	9056 mod./353.2	4 oz	Soil Jar	1	28 days (^)
Nitrate-Automated Cadmium Red./Diazotization	9056 mod./353.2	4 oz	Soil Jar	1	48 hrs (^)
Nitrite-Automated Diazotization	9056 mod./353.2	4 oz	Soil Jar	1	48 hrs (^)
Oil & Grease-Total Recoverable, Gravimetric N-Hexane extractable material N-Hexane extractable material w/ silica gel cleanup	9071	4 oz	Soil Jar	1	28 days (^)
Organic Nitrogen-Auto. Block Digest.,Spectro.	350.1/351.2 mod.	4 oz	Soil Jar	1	28 days (^)
pH (Laboratory)	9045	4 oz	Soil Jar	1	28 days (^)
Phenolics, Total Recoverable-Manual 4AAP	Mod. 9065	4 oz	Soil Jar	1	28 days (^)
Phosphate, Ortho- Ascorbic Acid	9056 mod./365.2	4 oz	Soil Jar	1	48 hrs (^)
Phosphate,Tot.-Auto Ascorbic Acid/Block Dig.	Mod. 365.4	4 oz	Soil Jar	1	28 days (^)
Solids-Ash	SM 2540 G	4 oz	Soil Jar	1	28 days (^)
Solids-Total Solids	SM2540 G, current CLP SOW	4 oz	Soil Jar	1	28 days (^)
Solids-Volatile Solids	SM 2540 G	4 oz	Soil Jar	1	28 days (^)
Sulfate-Turbidimetric	9038	4 oz	Soil Jar	1	28 days (^)
Sulfide-Iodometric	9030	4 oz	Soil Jar	1	7days (^)
TKN-Auto Block Digest,Spectro.	351.2 mod.	4 oz	Soil Jar	1	28 days (^)
Total Organic Carbon	9060	4 oz	Soil Jar	1	28 days
Total Organic Carbon	Llyod Kahn	4 oz	Soil Jar	1	14 days
Total Organic Carbon	Walkley Black	4 oz	Soil Jar	1	14 days
ELEMENTAL ANALYSES – SOLID					
ICP Elements	6010	4 oz	Soil Jar	1	6 months
ICP MS Elements	6020	4 oz	Soil Jar	1	6 months
Mercury	7471	4 oz	Soil Jar	1	28 days
Chromium, Hexavalent	3060/7196	4 oz	Soil Jar	1	30dys/24hrs
GC ORGANIC ANALYSES – SOLID					

TABLE 1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
Extractable Petroleum Hydrocarbons	MADEP EPH	4 oz	Soil Jar	1	14days/40days
Fuel Oil	ME HETL 4.1.25 & 8015 mod.	4 oz	Soil Jar	1	14days/40days
Petroleum Range Hydrocarbons	FL-PRO	4 oz	Soil Jar	1	14days/40days
Total Petroleum Hydrocarbons	TX1005	4 oz	Soil Jar	1	14days/14days
Extracted Total Petroleum Hydrocarbons	CT-ETPH	4 oz	Soil Jar	1	14days/40days
Gasoline	ME HETL 4.2.17 & 8015 mod.	(2) 40 mL	VOA Vial	1	14 days
Herbicides	8151	4 oz	Soil Jar	1	14days/40days
PCB’s	8082	4 oz	Soil Jar	1	14days/40days
PCB’s in Oil	8082	4 oz	VOA Vial	1	40 days
Pesticides	8081	4 oz	Soil Jar	1	14days/40days
Pesticides and PCB’s	8081/8082	4 oz	Soil Jar	1	14days/40days
Solvents (Direct Injection)	8015M	(2) 40 mL	VOA Vial	1	14 days
Volatile Petroleum Hydrocarbons	MADEP VPH	(2)40 mL	VOA vial	1,13	28days
HPLC ANALYSES – SOLID					
HPLC-Explosives	8330B/B Mod.	4 oz or ISM sample	Soil Jar	1	14days/40days
GC/MS ANALYSES – SOLID					
Acid Extractables	8270	4 oz	Soil Jar	1	14 days/40 days
Base Neutral Extractables	8270	4 oz	Soil Jar	1	14 days/40 days
Polyaromatic Hydrocarbons	8270/8270SIM	4 oz	Soil Jar	1	14 days/40 days
Semivolatile Extractables & (SIM)	8270/8270 SIM	4 oz	Soil Jar	1	14 days/40 days
Volatile Organics – High Soil (>200 ug/kg) (Please refer to Figure 6-2 for details on collection and preservation)	5035/8260	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2
Volatile Organics – Low Soil (<200 ug/kg) (Please refer to Figure 6-2 for details on collection and preservation)	5035/8260	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2	Please refer to Figure 6-2
Volatile Organics & (limited SIM)	8260/8260 SIM	(2) 40 mL	VOA Vial	1	14 days
Miscellaneous – SOLID					
Grain Size (sieve and hydrometer)	ASTM D422	8 oz	Soil jar or bag	1	none
RCRA – HAZARDOUS WASTE CHARACACTERIZATION					
Corrosivity-pH	9045	4 oz	Soil Jar	1	24 hours (^)
Ignitability-Flash Point (closed cup)	1010	4 oz	Soil Jar	1	14 days (^)
Reactivity-Reactive Cyanide	7.3.3.2	4 oz	Soil Jar	1	14 days
Reactivity-Reactive Sulfide	7.3.4.1	4 oz	Soil Jar	1	7 days
TCLP					
TCLP Extraction-Volatile Organics	1311/8260	100 g	Soil Jar	1	14 days/14 days

TABLE 1

SAMPLING AND PRESERVATION REQUIREMENTS

PARAMETER	METHOD	QUANTITY	CONTAINER	PRSV	HOLD TIME
TCLP Extraction-Semivolatiles	1311/8270	200 g	Soil Jar	1	14 days/7 days/40 days
TCLP Extraction-Pesticides & Herbicides	1311/8081 & 8151	400 g	Soil Jar	1	14 days/7 days/40 days
TCLP Extraction-Metals	1311/6010/6020	200 g	Soil Jar	1	28 days/180 days
TCLP Extraction-Mercury	1311/7470	200 g	Soil Jar	1	28 days/28 days
GC/MS ANALYSES – AIR					
Volatile Organics	TO-15	(1) 1.4 or 6 L	Canister	16	30 days
Volatile Organics	MA-DEP APH	(1) 1.4 or 6 L	Canister	16	30 days

METHODS OF PRESERVATION
1 = Cool at 4 Degrees Celsius
2 = Settled
3 = H2SO4 to pH<2
4 = HNO3 to pH<2
5 = NaOH to pH>12
6 = 1 mL 0.1M Na2S2O3 or 1 10 mg pellet
7 = 1 m/L 2NznAc/L & NaOH
8 = 2 drops 1:1 HCl
9 = No headspace
10 = Na2S2O3, if chlorinated
11 = HCl to pH < 2
12 = 5 mL of HCL
13 = 15 mL of methanol
14 = methanol
15 = sodium bisulfate
16 = None
17 = benzalkonium chloride
18 = 0.02g ammonium sulfate, 0.02g copper (II) sulfate pentahydrate

~ Hold time for unpreserved samples is 7 days.

^ Because there are no published holding times for Wet Chemistry soil methods, these are only recommended holding times. They are not regulatory.

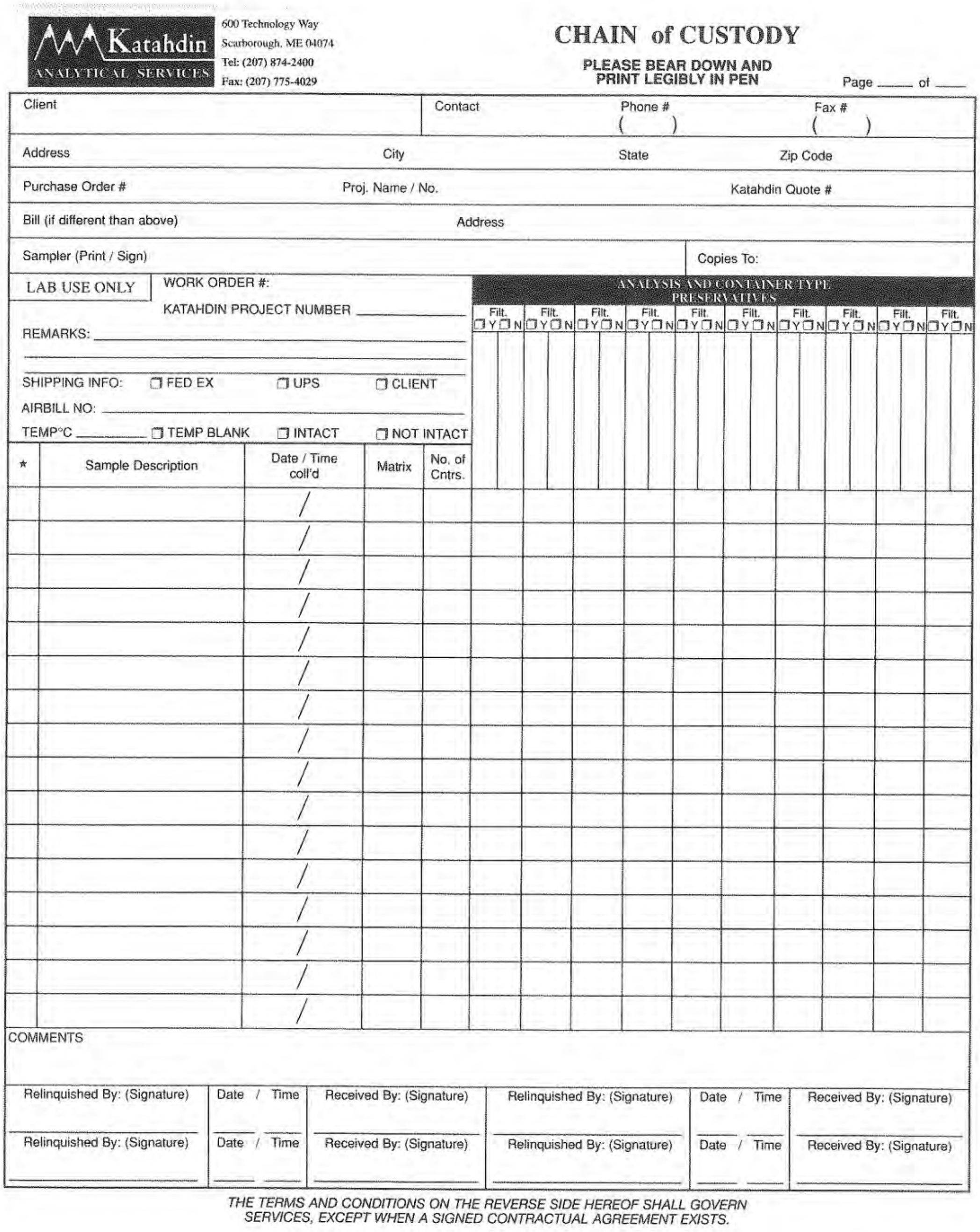
Project-specific (i.e. CLP, NYSDEC) hold times take precedence over these hold times as appropriate.

For solid samples, please place parameters of the same analytical group (ie. wet chemistry) in the same container whenever possible. In addition, organic and inorganic parameters should be placed in separate containers. Volatile organics should always be placed in organic-free jars. Several 4 oz. soil jars may be needed when numerous parameters are required.

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 1

EXAMPLE OF STANDARD KATAHDIN CHAIN-OF-CUSTODY FORM



Katahdin
ANALYTICAL SERVICES

600 Technology Way
Scarborough, ME 04074
Tel: (207) 874-2400
Fax: (207) 775-4029

CHAIN of CUSTODY

PLEASE BEAR DOWN AND PRINT LEGIBLY IN PEN

Page ____ of ____

Client

Contact

Phone # (   )

Fax # (   )

Address

City

State

Zip Code

Purchase Order #

Proj. Name / No.

Katahdin Quote #

Bill (if different than above)

Address

Sampler (Print / Sign)

Copies To:

LAB USE ONLY

WORK ORDER #:

KATAHDIN PROJECT NUMBER ________

REMARKS: ________

SHIPPING INFO: ☐ FED EX ☐ UPS ☐ CLIENT

AIRBILL NO: ________

TEMP°C ______ ☐ TEMP BLANK ☐ INTACT ☐ NOT INTACT

ANALYSIS AND CONTAINER TYPE PRESERVATIVES

*	Sample Description	Date / Time coll'd	Matrix	No. of Cntrs.	Filt. ☐Y☐N	Filt. ☐Y☐N	Filt. ☐Y☐N	Filt. ☐Y☐N	Filt. ☐Y☐N	Filt. ☐Y☐N	Filt. ☐Y☐N	Filt. ☐Y☐N	Filt. ☐Y☐N	Filt. ☐Y☐N
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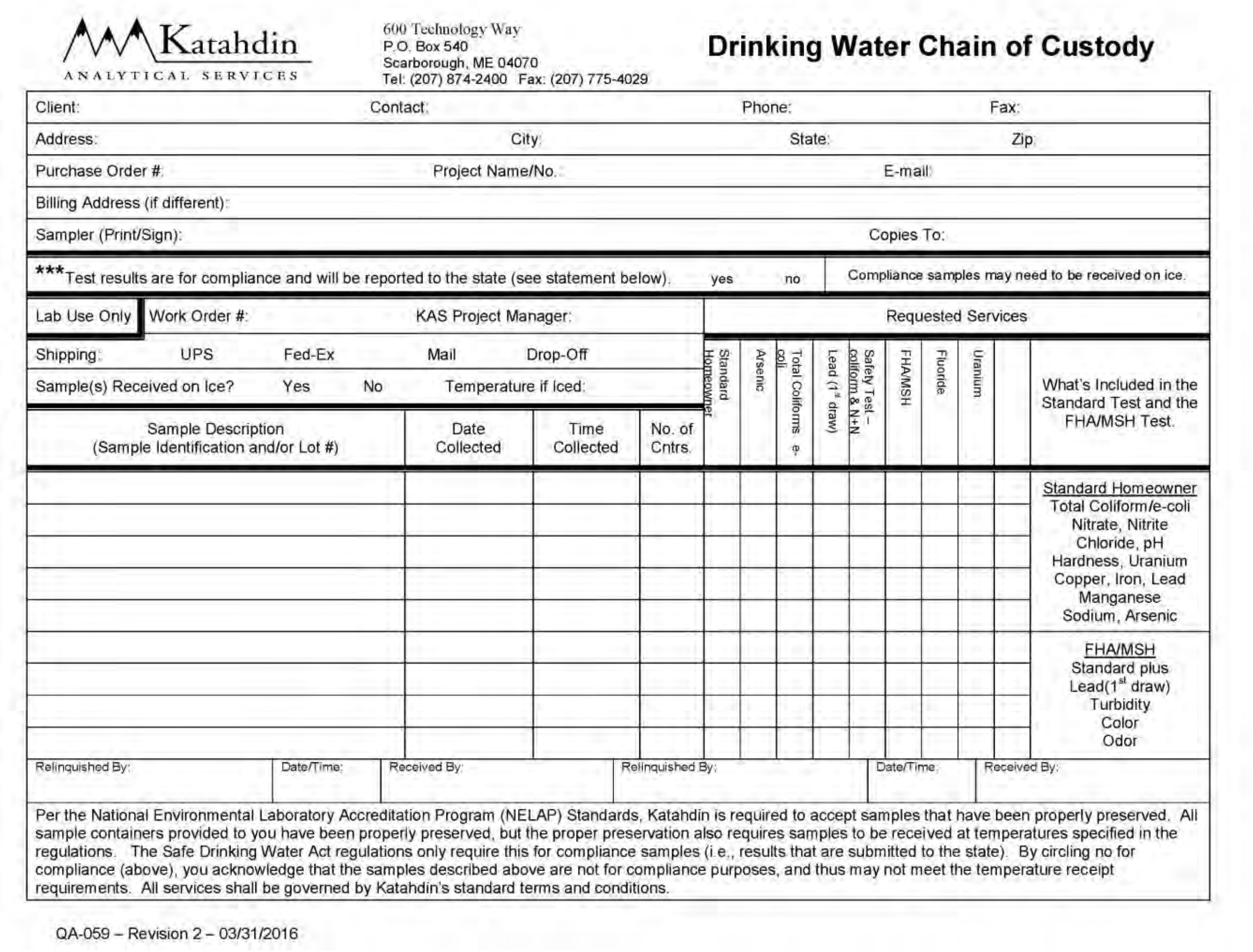
COMMENTS

Relinquished By: (Signature)	Date / Time	Received By: (Signature)	Relinquished By: (Signature)	Date / Time	Received By: (Signature)
Relinquished By: (Signature)	Date / Time	Received By: (Signature)	Relinquished By: (Signature)	Date / Time	Received By: (Signature)

THE TERMS AND CONDITIONS ON THE REVERSE SIDE HEREOF SHALL GOVERN SERVICES, EXCEPT WHEN A SIGNED CONTRACTUAL AGREEMENT EXISTS.

FIGURE 2

EXAMPLE OF KATAHDIN HOMEOWNER CHAIN-OF-CUSTODY FORM



Katahdin
ANALYTICAL SERVICES

600 Technology Way
P.O. Box 540
Scarborough, ME 04070
Tel: (207) 874-2400 Fax: (207) 775-4029

Drinking Water Chain of Custody

Client: Contact: Phone: Fax:
Address: City: State: Zip:
Purchase Order #: Project Name/No.: E-mail:
Billing Address (if different):
Sampler (Print/Sign): Copies To:

***Test results are for compliance and will be reported to the state (see statement below). yes no
Compliance samples may need to be received on ice.

Lab Use Only | Work Order #: KAS Project Manager: | Requested Services

Shipping: UPS Fed-Ex Mail Drop-Off
Sample(s) Received on Ice? Yes No Temperature if Iced:

Sample Description (Sample Identification and/or Lot #)	Date Collected	Time Collected	No. of Cntrs.	Standard Homeowner	Arsenic	Total Coliforms e-coli	Lead (1^{st} draw)	Safety Test – coliform & N+N	FHA/MSH	Fluoride	Uranium		What's Included in the Standard Test and the FHA/MSH Test.
													Standard Homeowner Total Coliform/e-coli Nitrate, Nitrite Chloride, pH Hardness, Uranium Copper, Iron, Lead Manganese Sodium, Arsenic
													FHA/MSH Standard plus Lead(1^{st} draw) Turbidity Color Odor

Relinquished By:	Date/Time:	Received By:	Relinquished By:	Date/Time:	Received By:

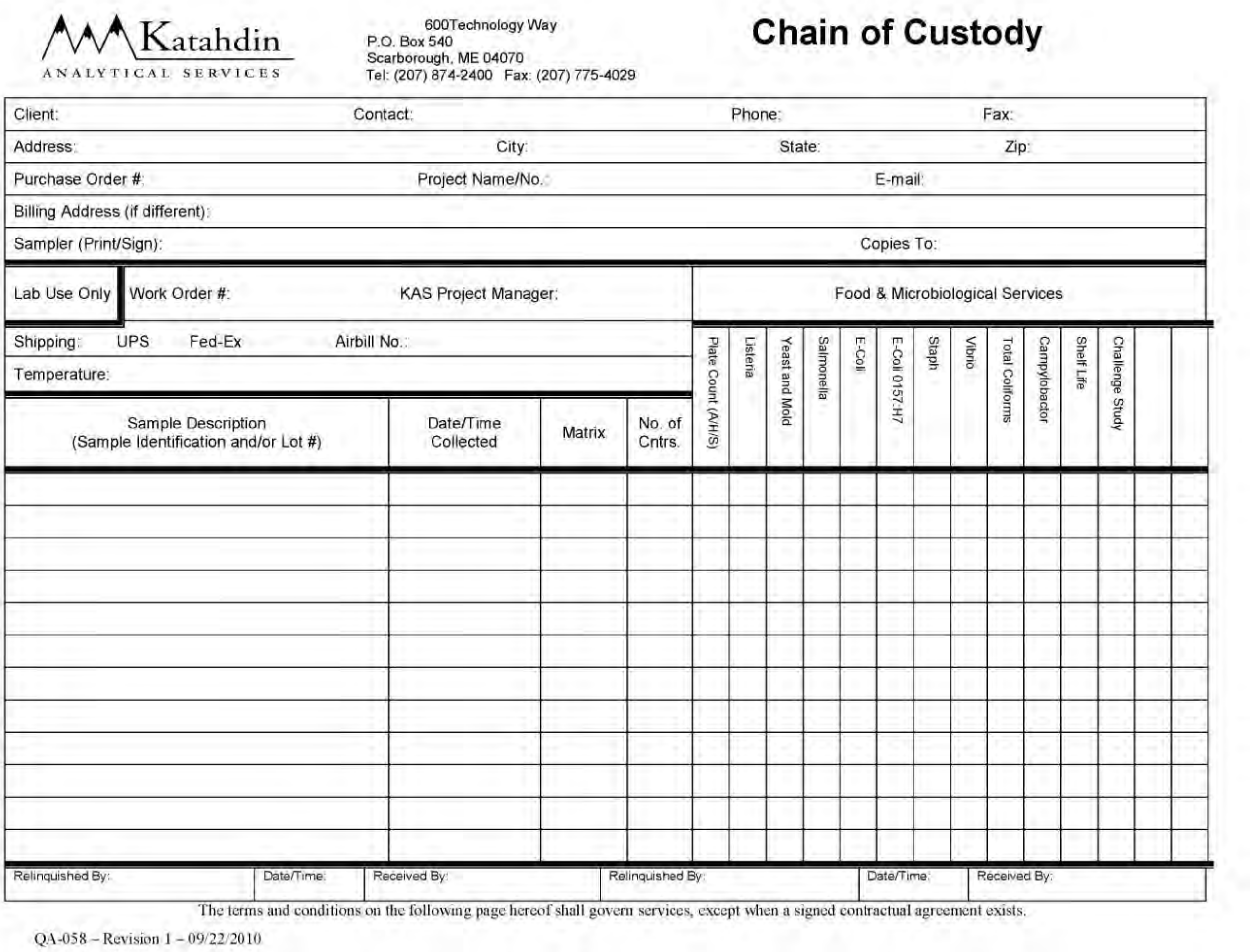
Per the National Environmental Laboratory Accreditation Program (NELAP) Standards, Katahdin is required to accept samples that have been properly preserved. All sample containers provided to you have been properly preserved, but the proper preservation also requires samples to be received at temperatures specified in the regulations. The Safe Drinking Water Act regulations only require this for compliance samples (i.e., results that are submitted to the state). By circling no for compliance (above), you acknowledge that the samples described above are not for compliance purposes, and thus may not meet the temperature receipt requirements. All services shall be governed by Katahdin's standard terms and conditions.

QA-059 – Revision 2 – 03/31/2016

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 3

EXAMPLE OF KATAHDIN FOOD/MICROBIOLOGY CHAIN-OF-CUSTODY FORM



Katahdin
ANALYTICAL SERVICES

600Technology Way
P.O. Box 540
Scarborough, ME 04070
Tel: (207) 874-2400 Fax: (207) 775-4029

Chain of Custody

Client: Contact: Phone: Fax:
Address: City: State: Zip:
Purchase Order #: Project Name/No.: E-mail:
Billing Address (if different):
Sampler (Print/Sign): Copies To:

Lab Use Only | Work Order #: KAS Project Manager: | Food & Microbiological Services

Shipping: UPS Fed-Ex Airbill No.:
Temperature:

Sample Description (Sample Identification and/or Lot #)	Date/Time Collected	Matrix	No. of Cntrs.	Plate Count (A/H/S)	Listeria	Yeast and Mold	Salmonella	E-Coli	E-Coli 0157:H7	Staph	Vibrio	Total Coliforms	Campylobactor	Shelf Life	Challenge Study		

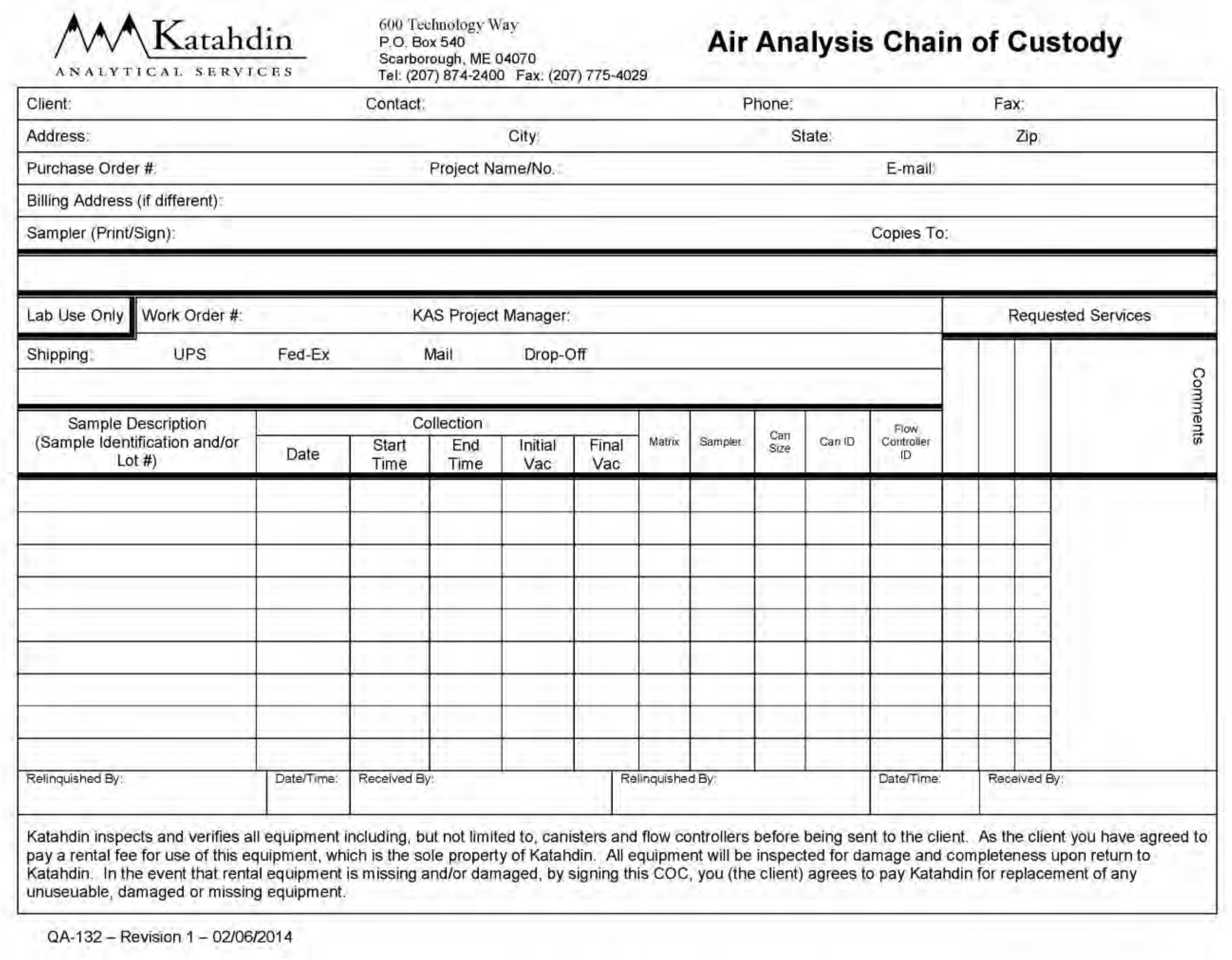
Relinquished By:	Date/Time:	Received By:	Relinquished By:	Date/Time:	Received By:

The terms and conditions on the following page hereof shall govern services, except when a signed contractual agreement exists.

QA-058 – Revision 1 – 09/22/2010

FIGURE 4

EXAMPLE OF KATAHDIN AIR CHAIN-OF-CUSTODY FORM



Katahdin
ANALYTICAL SERVICES

600 Technology Way
P.O. Box 540
Scarborough, ME 04070
Tel: (207) 874-2400 Fax: (207) 775-4029

Air Analysis Chain of Custody

Client: Contact: Phone: Fax:
Address: City: State: Zip:
Purchase Order #: Project Name/No.: E-mail:
Billing Address (if different):
Sampler (Print/Sign): Copies To:

Lab Use Only | Work Order #: KAS Project Manager:
Shipping: UPS Fed-Ex Mail Drop-Off

Sample Description (Sample Identification and/or Lot #)	Collection					Matrix	Sampler	Can Size	Can ID	Flow Controller ID	Requested Services			Comments
	Date	Start Time	End Time	Initial Vac	Final Vac									

Relinquished By:	Date/Time:	Received By:	Relinquished By:	Date/Time:	Received By:

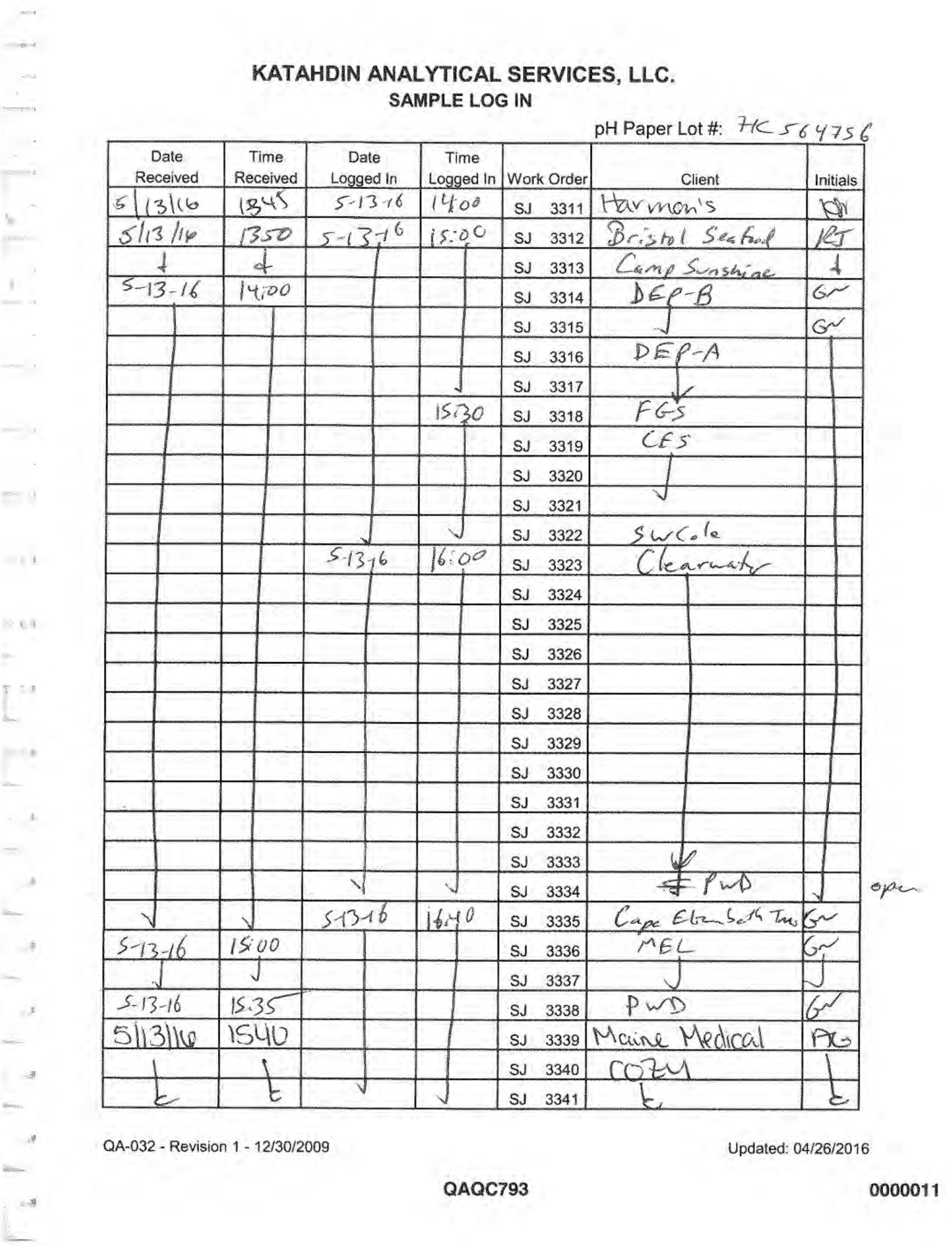
Katahdin inspects and verifies all equipment including, but not limited to, canisters and flow controllers before being sent to the client. As the client you have agreed to pay a rental fee for use of this equipment, which is the sole property of Katahdin. All equipment will be inspected for damage and completeness upon return to Katahdin. In the event that rental equipment is missing and/or damaged, by signing this COC, you (the client) agrees to pay Katahdin for replacement of any unuseuable, damaged or missing equipment.

QA-132 – Revision 1 – 02/06/2014

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 5

EXAMPLE OF KATAHDIN SAMPLE RECEIPT LOGBOOK



KATAHDIN ANALYTICAL SERVICES, LLC.
SAMPLE LOG IN

pH Paper Lot #: 7K 564756

Date Received	Time Received	Date Logged In	Time Logged In	Work Order	Client	Initials
5/13/16	1845	5-13-16	14:00	SJ 3311	Harmon's	[illegible]
5/13/16	1350	5-13-16	15:00	SJ 3312	Bristol Seafood	RT
				SJ 3313	Camp Sunshine	
5-13-16	14:00			SJ 3314	DEP-B	GN
				SJ 3315		GN
				SJ 3316	DEP-A	
				SJ 3317		
			15:30	SJ 3318	FGS	
				SJ 3319	CES	
				SJ 3320		
				SJ 3321		
				SJ 3322	SWCole	
		5-13-16	16:00	SJ 3323	Clearwater	
				SJ 3324		
				SJ 3325		
				SJ 3326		
				SJ 3327		
				SJ 3328		
				SJ 3329		
				SJ 3330		
				SJ 3331		
				SJ 3332		
				SJ 3333		
				SJ 3334	PWD	
		5-13-16	16:40	SJ 3335	Cape Elizabeth Tns	GN
5-13-16	15:00			SJ 3336	MEL	GN
				SJ 3337		
5-13-16	15:35			SJ 3338	PWD	GN
5/13/16	1540			SJ 3339	Maine Medical	PG
				SJ 3340	COZY	
				SJ 3341		

open

QA-032 - Revision 1 - 12/30/2009

Updated: 04/26/2016

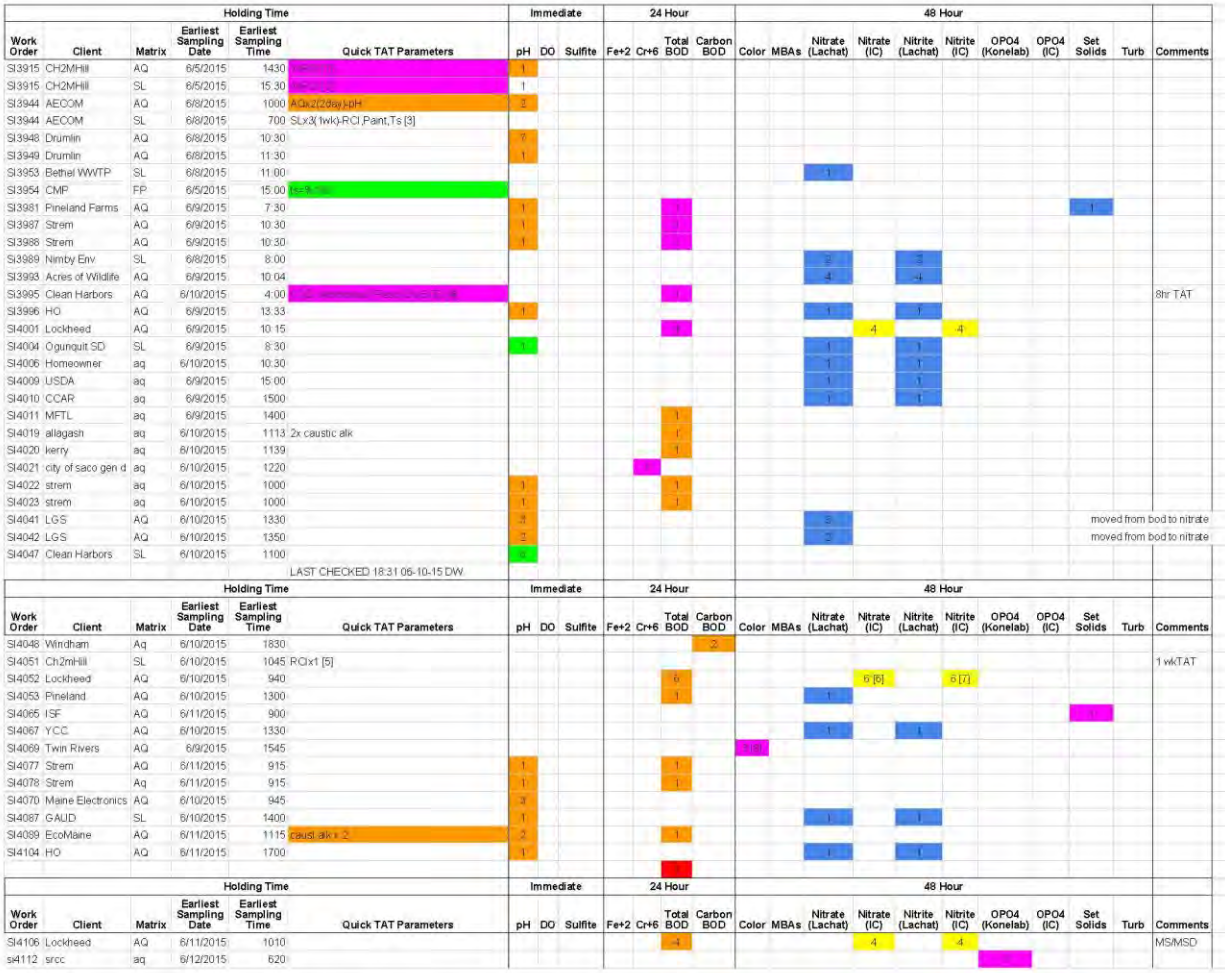
QAQC793

0000011

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 6

EXAMPLE OF WET CHEMISTRY SHORTS AND RUSHES SCREEN SHOT



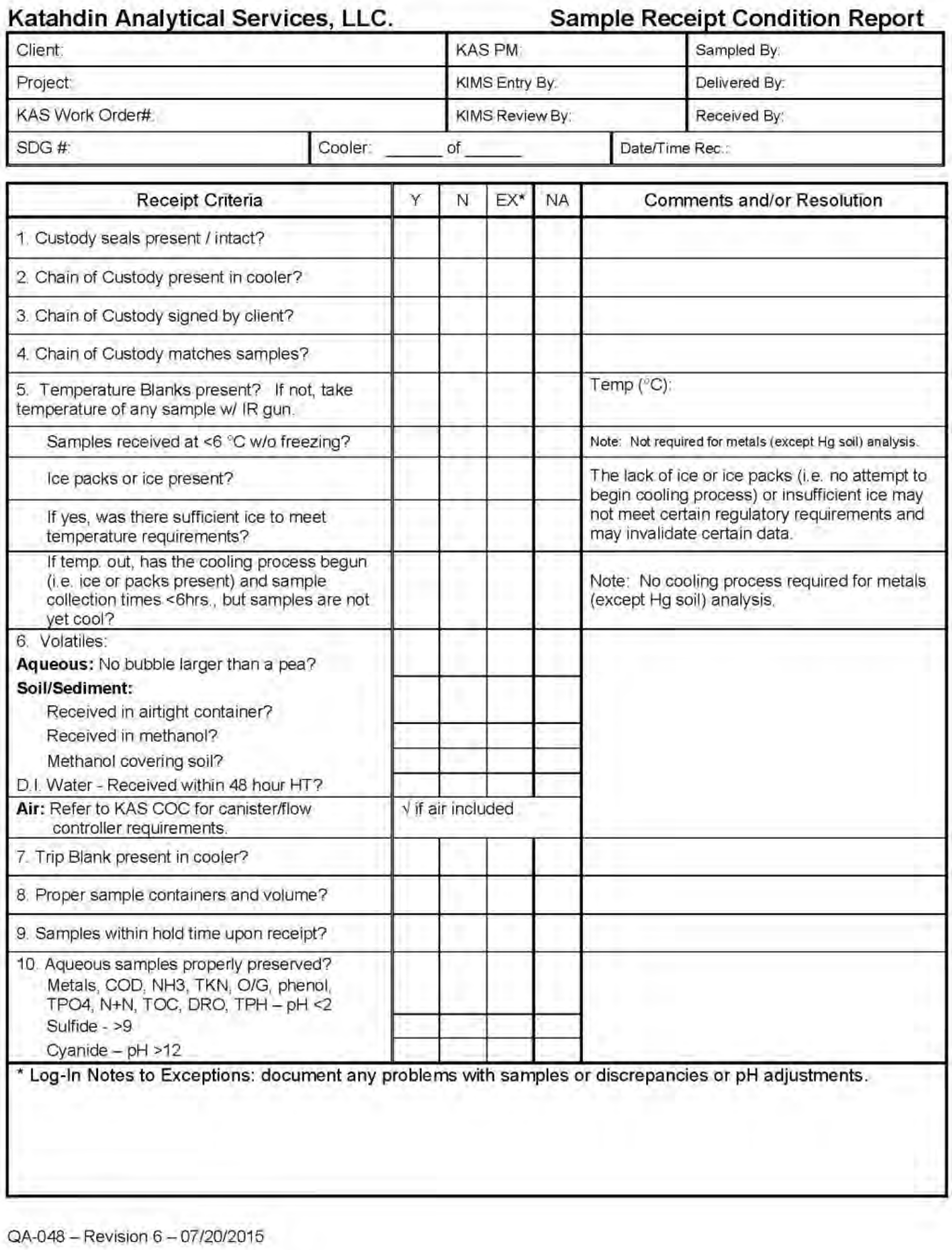
Holding Time						Immediate			24 Hour				48 Hour										
Work Order	Client	Matrix	Earliest Sampling Date	Earliest Sampling Time	Quick TAT Parameters	pH	DO	Sulfite	Fe+2	Cr+6	Total BOD	Carbon BOD	Color	MBAs	Nitrate (Lachat)	Nitrate (IC)	Nitrite (Lachat)	Nitrite (IC)	OPO4 (Konelab)	OPO4 (IC)	Set Solids	Turb	Comments
SI3915	CH2MHill	AQ	6/5/2015	1430	[illegible]	1																	
SI3915	CH2MHill	SL	6/5/2015	15:30	[illegible]	1																	
SI3944	AECOM	AQ	6/8/2015	1000	AQx2(2day)-pH	2																	
SI3944	AECOM	SL	6/8/2015	700	SLx3(1wk)-RCI,Paint,Ts [3]																		
SI3948	Drumlin	AQ	6/8/2015	10:30		7																	
SI3949	Drumlin	AQ	6/8/2015	11:30		1																	
SI3953	Bethel WWTP	SL	6/8/2015	11:00											1								
SI3954	CMP	FP	6/5/2015	15:00	[illegible]																		
SI3981	Pineland Farms	AQ	6/9/2015	7:30		1					1										1		
SI3987	Strem	AQ	6/9/2015	10:30		1					1												
SI3988	Strem	AQ	6/9/2015	10:30		1					[illegible]												
Si3989	Nimby Env	SL	6/8/2015	8:00											2		3						
SI3993	Acres of Wildlife	AQ	6/9/2015	10:04											4		4						
Si3995	Clean Harbors	AQ	6/10/2015	4:00	[illegible]						1												8hr TAT
SI3996	HO	AQ	6/9/2015	13:33		1									1		1						
SI4001	Lockheed	AQ	6/9/2015	10:15							1					4		4					
SI4004	Ogunquit SD	SL	6/9/2015	8:30		1									1		1						
SI4006	Homeowner	aq	6/10/2015	10:30											1		1						
SI4009	USDA	aq	6/9/2015	15:00											1		1						
SI4010	CCAR	aq	6/9/2015	1500											1		1						
SI4011	MFTL	aq	6/9/2015	1400							1												
SI4019	allagash	aq	6/10/2015	1113	2x caustic alk						1												
SI4020	kerry	aq	6/10/2015	1139							1												
SI4021	city of saco gen d	aq	6/10/2015	1220						[illegible]													
SI4022	strem	aq	6/10/2015	1000		1					1												
SI4023	strem	aq	6/10/2015	1000		1					1												
SI4041	LGS	AQ	6/10/2015	1330		3									3								moved from bod to nitrate
SI4042	LGS	AQ	6/10/2015	1350		2									2								moved from bod to nitrate
SI4047	Clean Harbors	SL	6/10/2015	1100		[illegible]																	
					LAST CHECKED 18:31 06-10-15 DW																		

Holding Time						Immediate			24 Hour				48 Hour										
Work Order	Client	Matrix	Earliest Sampling Date	Earliest Sampling Time	Quick TAT Parameters	pH	DO	Sulfite	Fe+2	Cr+6	Total BOD	Carbon BOD	Color	MBAs	Nitrate (Lachat)	Nitrate (IC)	Nitrite (Lachat)	Nitrite (IC)	OPO4 (Konelab)	OPO4 (IC)	Set Solids	Turb	Comments
SI4048	Windham	Aq	6/10/2015	1830								2											
SI4051	Ch2mHill	SL	6/10/2015	1045	RClx1 [5]																		1 wkTAT
SI4052	Lockheed	AQ	6/10/2015	940							6					6 [6]		6 [7]					
SI4053	Pineland	AQ	6/10/2015	1300							1				1								
SI4065	ISF	AQ	6/11/2015	900																	[illegible]		
SI4067	YCC	AQ	6/10/2015	1330											1		1						
SI4069	Twin Rivers	AQ	6/9/2015	1545									[illegible]										
SI4077	Strem	AQ	6/11/2015	915		1					1												
SI4078	Strem	Aq	6/11/2015	915		1					1												
SI4070	Maine Electronics	AQ	6/10/2015	945		3																	
SI4087	GAUD	SL	6/10/2015	1400		1									1		1						
SI4089	EcoMaine	AQ	6/11/2015	1115	caust alk x 2	2					1												
SI4104	HO	AQ	6/11/2015	1700		1									1		1						
											[illegible]												

Holding Time						Immediate			24 Hour				48 Hour										
Work Order	Client	Matrix	Earliest Sampling Date	Earliest Sampling Time	Quick TAT Parameters	pH	DO	Sulfite	Fe+2	Cr+6	Total BOD	Carbon BOD	Color	MBAs	Nitrate (Lachat)	Nitrate (IC)	Nitrite (Lachat)	Nitrite (IC)	OPO4 (Konelab)	OPO4 (IC)	Set Solids	Turb	Comments
SI4106	Lockheed	AQ	6/11/2015	1010							4					4		4					MS/MSD
si4112	srcc	aq	6/12/2015	620															[illegible]				

FIGURE 7

EXAMPLE OF SAMPLE RECEIPT CONDITION REPORT FORM



Katahdin Analytical Services, LLC. **Sample Receipt Condition Report**

Client:	KAS PM:	Sampled By:
Project:	KIMS Entry By:	Delivered By:
KAS Work Order#:	KIMS Review By:	Received By:
SDG #:	Cooler: ______ of ______	Date/Time Rec.:

Receipt Criteria	Y	N	EX*	NA	Comments and/or Resolution
1. Custody seals present / intact?					
2. Chain of Custody present in cooler?					
3. Chain of Custody signed by client?					
4. Chain of Custody matches samples?					
5. Temperature Blanks present? If not, take temperature of any sample w/ IR gun.					Temp (°C):
Samples received at <6 °C w/o freezing?					Note: Not required for metals (except Hg soil) analysis.
Ice packs or ice present?					The lack of ice or ice packs (i.e. no attempt to begin cooling process) or insufficient ice may not meet certain regulatory requirements and may invalidate certain data.
If yes, was there sufficient ice to meet temperature requirements?					
If temp. out, has the cooling process begun (i.e. ice or packs present) and sample collection times <6hrs., but samples are not yet cool?					Note: No cooling process required for metals (except Hg soil) analysis.
6. Volatiles:					
Aqueous: No bubble larger than a pea?					
Soil/Sediment:					
Received in airtight container?					
Received in methanol?					
Methanol covering soil?					
D.I. Water - Received within 48 hour HT?					
Air: Refer to KAS COC for canister/flow controller requirements.	√ if air included				
7. Trip Blank present in cooler?					
8. Proper sample containers and volume?					
9. Samples within hold time upon receipt?					
10. Aqueous samples properly preserved? Metals, COD, NH3, TKN, O/G, phenol, TPO4, N+N, TOC, DRO, TPH – pH <2					
Sulfide - >9					
Cyanide – pH >12					

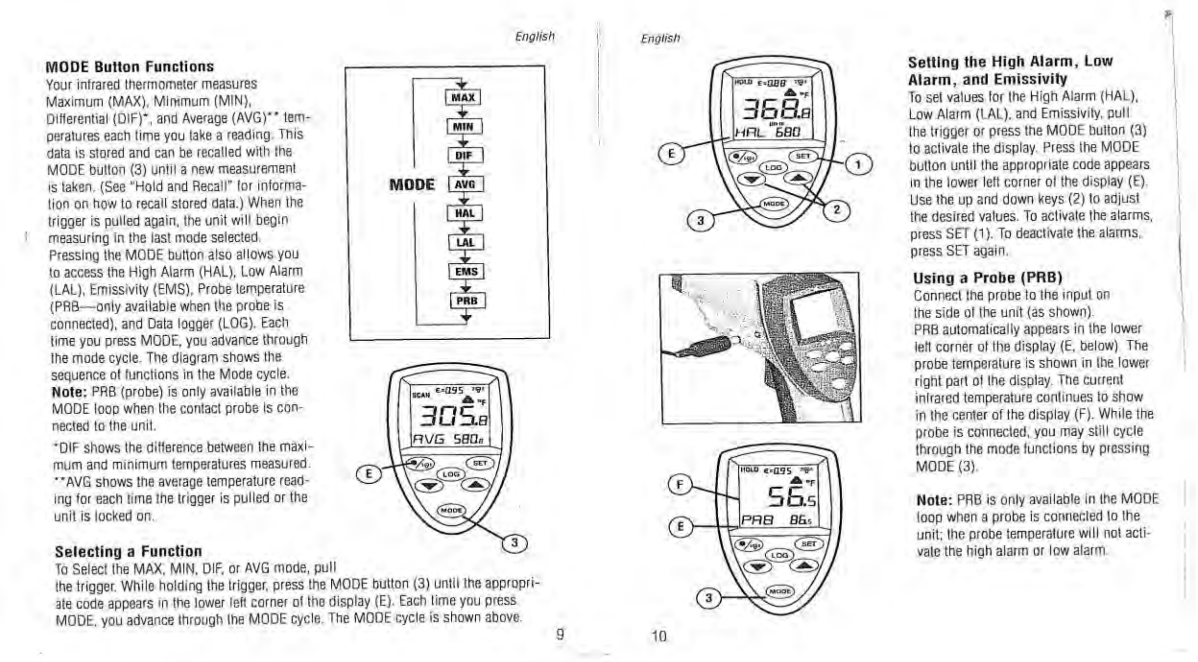
* Log-In Notes to Exceptions: document any problems with samples or discrepancies or pH adjustments.

QA-048 – Revision 6 – 07/20/2015

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 8

IR THERMOMETER MANUFACTURER'S INSTRUCTIONS FOR CHANGING EMISSIVITY



MODE Button Functions

Your infrared thermometer measures Maximum (MAX), Minimum (MIN), Differential (DIF)*, and Average (AVG)** temperatures each time you take a reading. This data is stored and can be recalled with the MODE button (3) until a new measurement is taken. (See "Hold and Recall" for information on how to recall stored data.) When the trigger is pulled again, the unit will begin measuring in the last mode selected.

Pressing the MODE button also allows you to access the High Alarm (HAL), Low Alarm (LAL), Emissivity (EMS), Probe temperature (PRB—only available when the probe is connected), and Data logger (LOG). Each time you press MODE, you advance through the mode cycle. The diagram shows the sequence of functions in the Mode cycle.

Note: PRB (probe) is only available in the MODE loop when the contact probe is connected to the unit.

*DIF shows the difference between the maximum and minimum temperatures measured.
**AVG shows the average temperature reading for each time the trigger is pulled or the unit is locked on.

Selecting a Function

To Select the MAX, MIN, DIF, or AVG mode, pull the trigger. While holding the trigger, press the MODE button (3) until the appropriate code appears in the lower left corner of the display (E). Each time you press MODE, you advance through the MODE cycle. The MODE cycle is shown above.

Setting the High Alarm, Low Alarm, and Emissivity

To set values for the High Alarm (HAL), Low Alarm (LAL), and Emissivity, pull the trigger or press the MODE button (3) to activate the display. Press the MODE button until the appropriate code appears in the lower left corner of the display (E). Use the up and down keys (2) to adjust the desired values. To activate the alarms, press SET (1). To deactivate the alarms, press SET again.

Using a Probe (PRB)

Connect the probe to the input on the side of the unit (as shown). PRB automatically appears in the lower left corner of the display (E, below). The probe temperature is shown in the lower right part of the display. The current infrared temperature continues to show in the center of the display (F). While the probe is connected, you may still cycle through the mode functions by pressing MODE (3).

Note: PRB is only available in the MODE loop when a probe is connected to the unit; the probe temperature will not activate the high alarm or low alarm.

FIGURE 9

EXAMPLE OF KATAHDIN SAMPLE FILTRATION LOGBOOK

KATAHDIN ANALYTICAL SERVICES, INC.
Sample Filtration Logbook

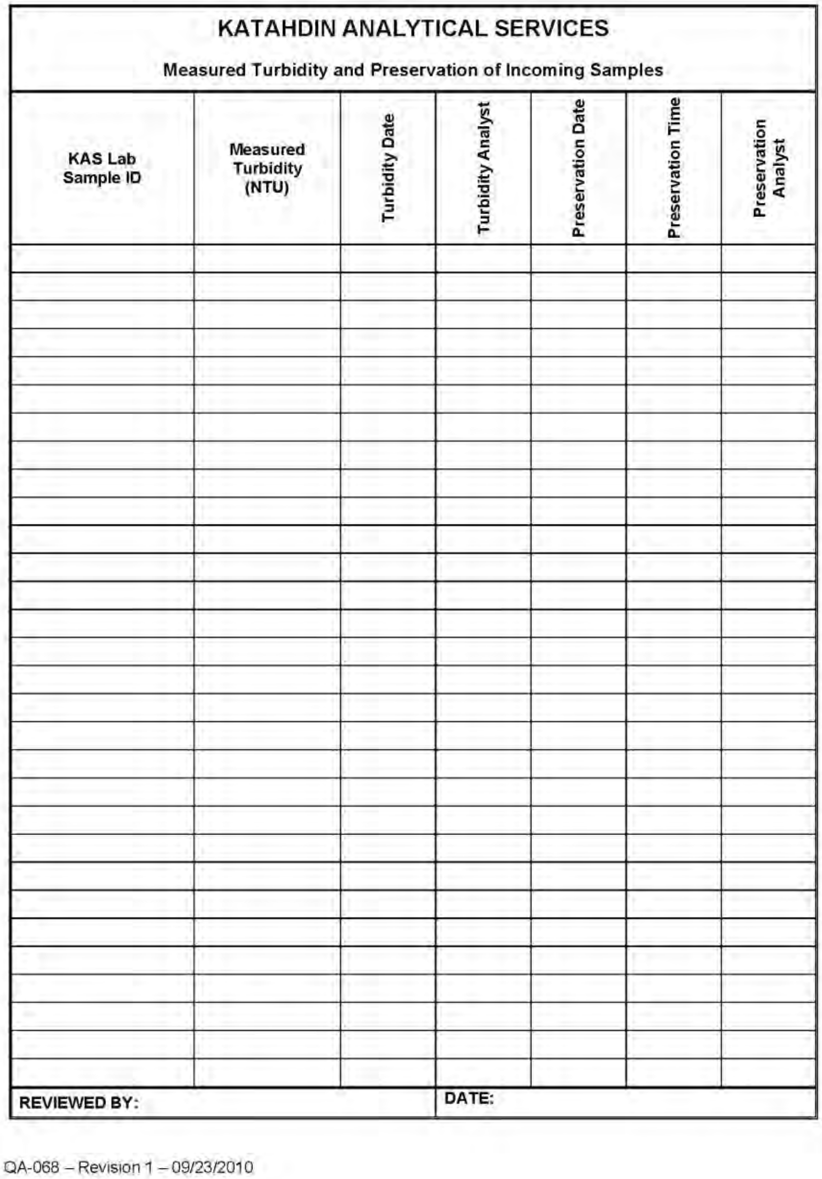
Katahdin Sample No.	Site ID	Filtration Requested By:		Filtered and Preserved By:		
List Individually	(Optional)	Initials	Date	Initials	Date	Time

Reviewed and Approved by: ____________________ **Date:** __________

ME-005 - Revision 1 - 09/23/2010

FIGURE 10

MEASURED TURBIDITY AND PRESERVATION OF INCOMING SAMPLES LOGBOOK



KATAHDIN ANALYTICAL SERVICES

Measured Turbidity and Preservation of Incoming Samples

KAS Lab Sample ID	Measured Turbidity (NTU)	Turbidity Date	Turbidity Analyst	Preservation Date	Preservation Time	Preservation Analyst

REVIEWED BY:

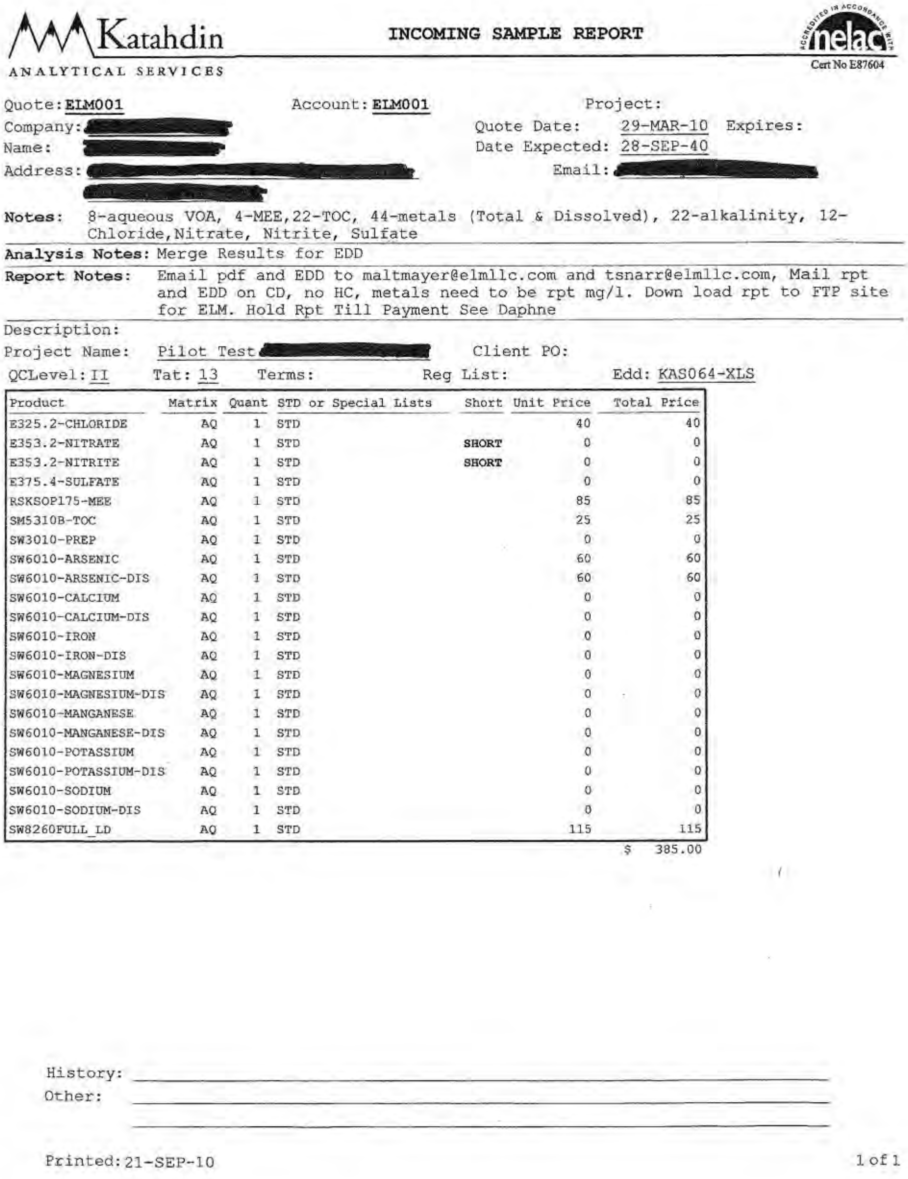
DATE:

QA-068 – Revision 1 – 09/23/2010

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 11

EXAMPLE OF KIMS LABORATORY INCOMING SAMPLE REPORT



Katahdin
ANALYTICAL SERVICES

INCOMING SAMPLE REPORT

Cert No E87604

Quote: ELM001
Account: ELM001
Project:
Company: [redacted]
Name: [redacted]
Address: [redacted]
Quote Date: 29-MAR-10 Expires:
Date Expected: 28-SEP-40
Email: [redacted]

Notes: 8-aqueous VOA, 4-MEE,22-TOC, 44-metals (Total & Dissolved), 22-alkalinity, 12-Chloride,Nitrate, Nitrite, Sulfate

Analysis Notes: Merge Results for EDD

Report Notes: Email pdf and EDD to maltmayer@elmllc.com and tsnarr@elmllc.com, Mail rpt and EDD on CD, no HC, metals need to be rpt mg/l. Down load rpt to FTP site for ELM. Hold Rpt Till Payment See Daphne

Description:
Project Name: Pilot Test [redacted]
Client PO:
QCLevel: II
Tat: 13
Terms:
Reg List:
Edd: KAS064-XLS

Product	Matrix	Quant	STD or Special Lists	Short	Unit Price	Total Price
E325.2-CHLORIDE	AQ	1	STD		40	40
E353.2-NITRATE	AQ	1	STD	**SHORT**	0	0
E353.2-NITRITE	AQ	1	STD	**SHORT**	0	0
E375.4-SULFATE	AQ	1	STD		0	0
RSKSOP175-MEE	AQ	1	STD		85	85
SM5310B-TOC	AQ	1	STD		25	25
SW3010-PREP	AQ	1	STD		0	0
SW6010-ARSENIC	AQ	1	STD		60	60
SW6010-ARSENIC-DIS	AQ	1	STD		60	60
SW6010-CALCIUM	AQ	1	STD		0	0
SW6010-CALCIUM-DIS	AQ	1	STD		0	0
SW6010-IRON	AQ	1	STD		0	0
SW6010-IRON-DIS	AQ	1	STD		0	0
SW6010-MAGNESIUM	AQ	1	STD		0	0
SW6010-MAGNESIUM-DIS	AQ	1	STD		0	0
SW6010-MANGANESE	AQ	1	STD		0	0
SW6010-MANGANESE-DIS	AQ	1	STD		0	0
SW6010-POTASSIUM	AQ	1	STD		0	0
SW6010-POTASSIUM-DIS	AQ	1	STD		0	0
SW6010-SODIUM	AQ	1	STD		0	0
SW6010-SODIUM-DIS	AQ	1	STD		0	0
SW8260FULL_LD	AQ	1	STD		115	115

$ 385.00

History:
Other:

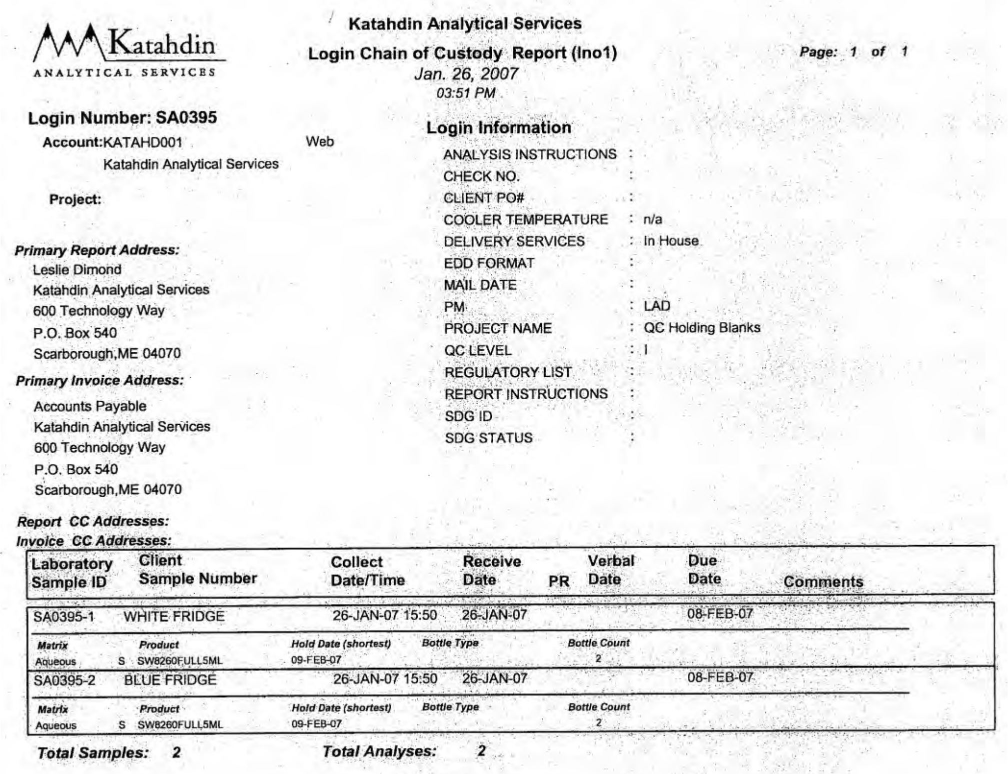
Printed: 21-SEP-10

1 of 1

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 12

EXAMPLE OF KATAHDIN WORK ORDER/LOGIN COC REPORT



Katahdin
ANALYTICAL SERVICES

Katahdin Analytical Services
Login Chain of Custody Report (lno1)
Jan. 26, 2007
03:51 PM

Page: 1 of 1

Login Number: SA0395
Account:KATAHD001 Web
Katahdin Analytical Services

Project:

Primary Report Address:
Leslie Dimond
Katahdin Analytical Services
600 Technology Way
P.O. Box 540
Scarborough,ME 04070

Primary Invoice Address:
Accounts Payable
Katahdin Analytical Services
600 Technology Way
P.O. Box 540
Scarborough,ME 04070

Report CC Addresses:
Invoice CC Addresses:

Login Information
ANALYSIS INSTRUCTIONS :
CHECK NO. :
CLIENT PO# :
COOLER TEMPERATURE : n/a
DELIVERY SERVICES : In House
EDD FORMAT :
MAIL DATE :
PM : LAD
PROJECT NAME : QC Holding Blanks
QC LEVEL : I
REGULATORY LIST :
REPORT INSTRUCTIONS :
SDG ID :
SDG STATUS :

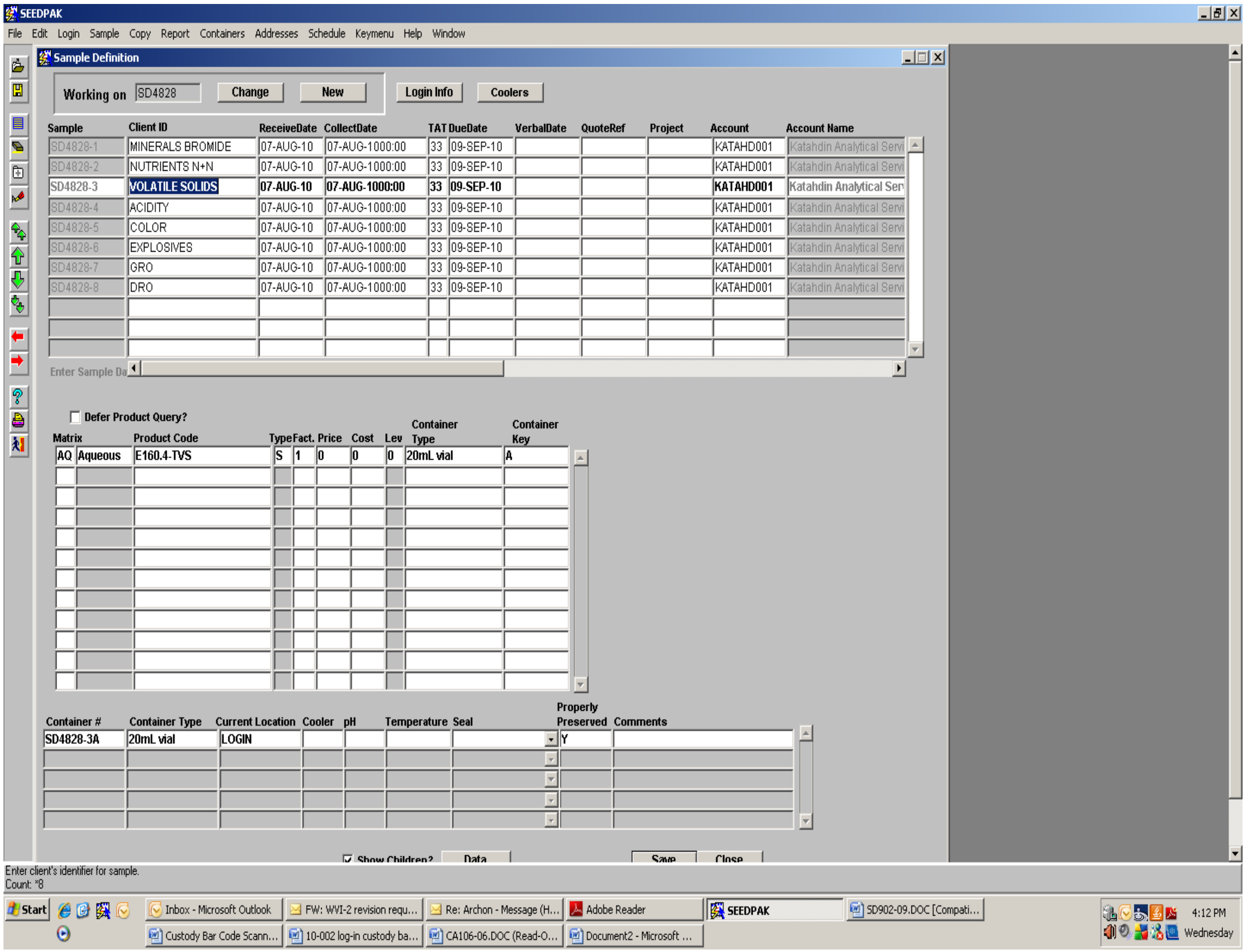
Laboratory Sample ID	Client Sample Number	Collect Date/Time	Receive Date	PR	Verbal Date	Due Date	Comments
SA0395-1	WHITE FRIDGE	26-JAN-07 15:50	26-JAN-07			08-FEB-07	
Matrix	***Product***	***Hold Date (shortest)***	***Bottle Type***		***Bottle Count***		
Aqueous	S SW8260FULL5ML	09-FEB-07			2		
SA0395-2	BLUE FRIDGE	26-JAN-07 15:50	26-JAN-07			08-FEB-07	
Matrix	***Product***	***Hold Date (shortest)***	***Bottle Type***		***Bottle Count***		
Aqueous	S SW8260FULL5ML	09-FEB-07			2		

***Total Samples:* 2** ***Total Analyses:* 2**

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 13

EXAMPLE OF LOGIN SCREEN IN KIMS



Working on SD4828

Sample	Client ID	ReceiveDate	CollectDate	TAT	DueDate	VerbalDate	QuoteRef	Project	Account	Account Name
SD4828-1	MINERALS BROMIDE	07-AUG-10	07-AUG-1000:00	33	09-SEP-10				KATAHD001	Katahdin Analytical Servi
SD4828-2	NUTRIENTS N+N	07-AUG-10	07-AUG-1000:00	33	09-SEP-10				KATAHD001	Katahdin Analytical Servi
SD4828-3	VOLATILE SOLIDS	07-AUG-10	07-AUG-1000:00	33	09-SEP-10				KATAHD001	Katahdin Analytical Ser
SD4828-4	ACIDITY	07-AUG-10	07-AUG-1000:00	33	09-SEP-10				KATAHD001	Katahdin Analytical Servi
SD4828-5	COLOR	07-AUG-10	07-AUG-1000:00	33	09-SEP-10				KATAHD001	Katahdin Analytical Servi
SD4828-6	EXPLOSIVES	07-AUG-10	07-AUG-1000:00	33	09-SEP-10				KATAHD001	Katahdin Analytical Servi
SD4828-7	GRO	07-AUG-10	07-AUG-1000:00	33	09-SEP-10				KATAHD001	Katahdin Analytical Servi
SD4828-8	DRO	07-AUG-10	07-AUG-1000:00	33	09-SEP-10				KATAHD001	Katahdin Analytical Servi

☐ Defer Product Query?

Matrix		Product Code	Type	Fact.	Price	Cost	Lev	Container Type	Container Key
AQ	Aqueous	E160.4-TVS	S	1	0	0	0	20mL vial	A

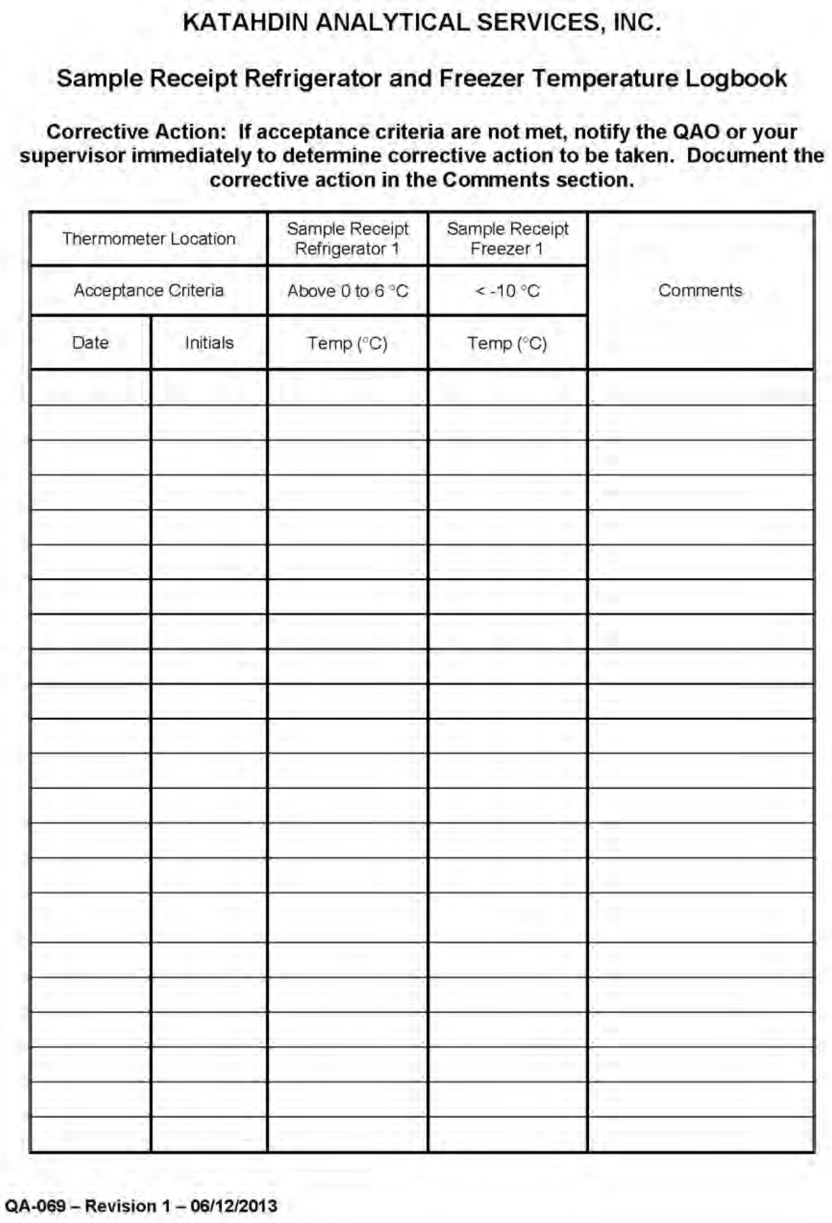
Container #	Container Type	Current Location	Cooler	pH	Temperature	Seal	Properly Preserved	Comments
SD4828-3A	20mL vial	LOGIN					Y	

☑ Show Children?

Enter client's identifier for sample.
Count: *8

FIGURE 14

EXAMPLE OF REFRIGERATOR TEMPERATURE LOGBOOK



KATAHDIN ANALYTICAL SERVICES, INC.

Sample Receipt Refrigerator and Freezer Temperature Logbook

Corrective Action: If acceptance criteria are not met, notify the QAO or your supervisor immediately to determine corrective action to be taken. Document the corrective action in the Comments section.

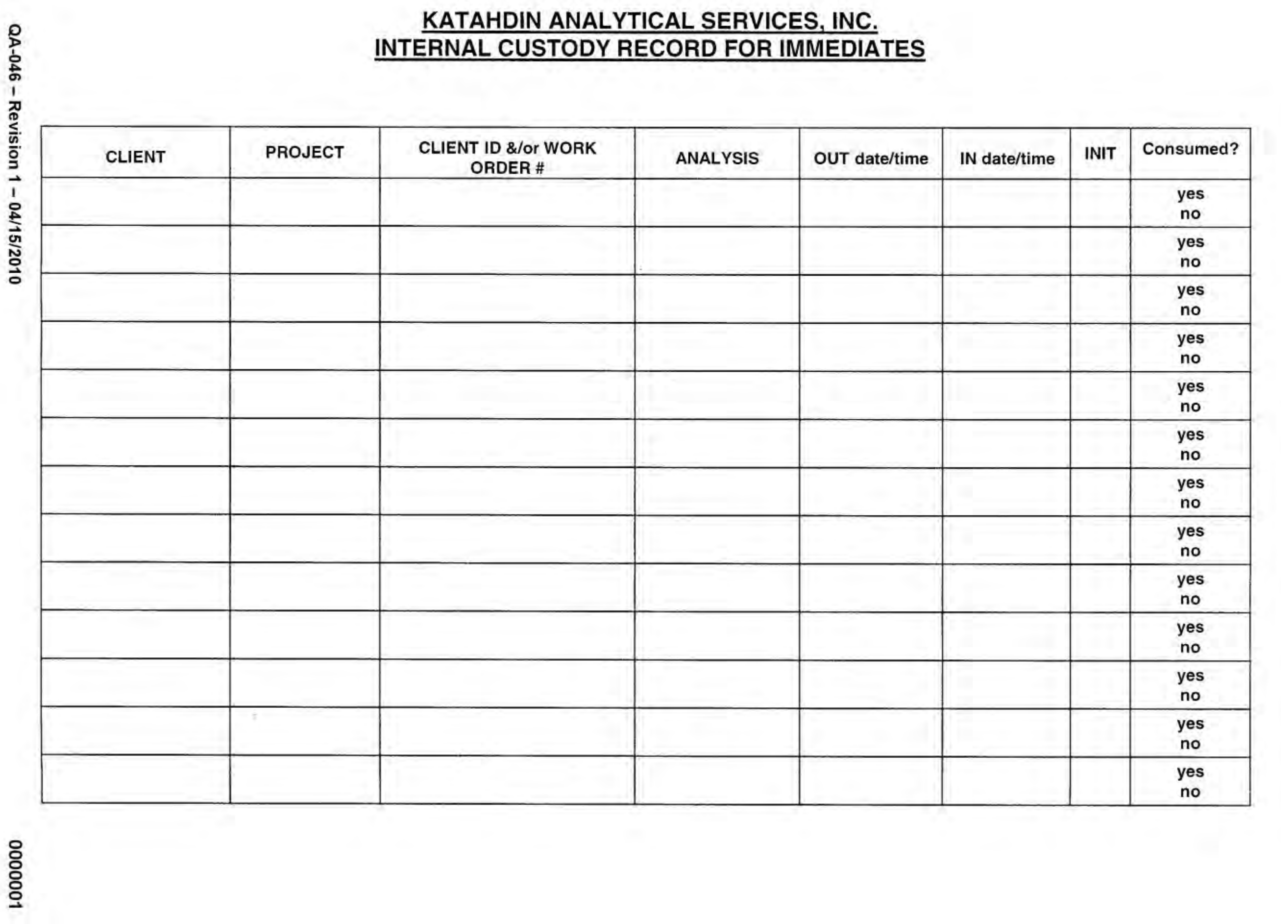
Thermometer Location		Sample Receipt Refrigerator 1	Sample Receipt Freezer 1	Comments
Acceptance Criteria		Above 0 to 6 °C	< -10 °C	
Date	Initials	Temp (°C)	Temp (°C)	

QA-069 – Revision 1 – 06/12/2013

TITLE: SAMPLE RECEIPT AND INTERNAL CONTROL

FIGURE 15

EXAMPLE OF IMMEDIATE INTERNAL COC LOGBOOK



QA-046 – Revision 1 – 04/15/2010

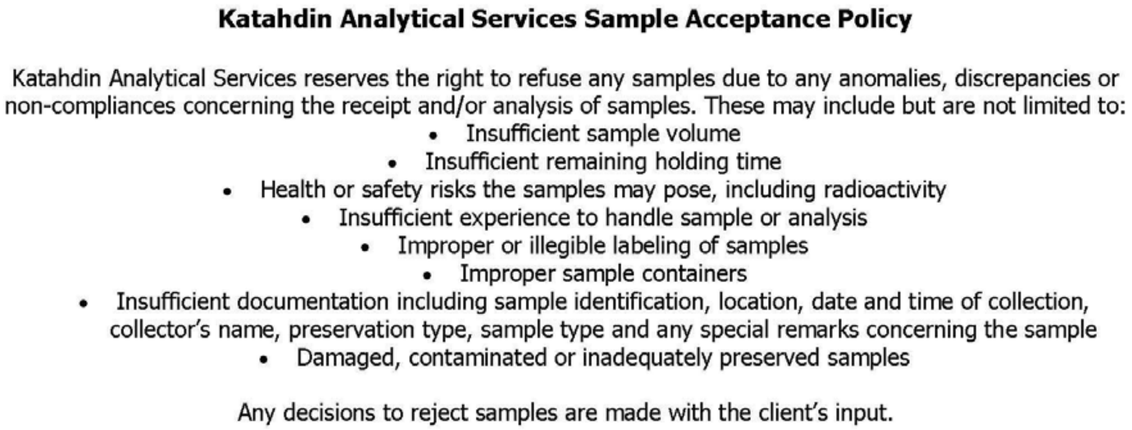
KATAHDIN ANALYTICAL SERVICES, INC.
INTERNAL CUSTODY RECORD FOR IMMEDIATES

CLIENT	PROJECT	CLIENT ID &/or WORK ORDER #	ANALYSIS	OUT date/time	IN date/time	INIT	Consumed?
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no
							yes no

0000001

FIGURE 16

SAMPLE ACCEPTANCE POLICY



Katahdin Analytical Services Sample Acceptance Policy

Katahdin Analytical Services reserves the right to refuse any samples due to any anomalies, discrepancies or non-compliances concerning the receipt and/or analysis of samples. These may include but are not limited to:

- Insufficient sample volume
- Insufficient remaining holding time
- Health or safety risks the samples may pose, including radioactivity
- Insufficient experience to handle sample or analysis
- Improper or illegible labeling of samples
- Improper sample containers
- Insufficient documentation including sample identification, location, date and time of collection, collector's name, preservation type, sample type and any special remarks concerning the sample
- Damaged, contaminated or inadequately preserved samples

Any decisions to reject samples are made with the client's input.

SD-903-06
SAMPLE DISPOSAL

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

SOP Number: SD-903
Revision History
Cover Page
Page 1

TITLE: **SAMPLE DISPOSAL**

Prepared By: ________________ Date: 2/01

Approved By:

Group Supervisor: ________________ Date: ________

Operations Manager: C. Burton Date: 2/01

QA Officer: Deborah J. Nadeau Date: 2·01

General Manager: ________________ Date: 2/01

Revision History:

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
01	Format changes, ~~added pollution prevention~~, added updated log book and greater detail on disposal.	DN	2·01	2/01
02	Major rewrite to include more detail on hazardous waste regulations + to reflect current practices.	DN	02/05	02/05
03	Rewrite of section 7 to comply with current practices in new facility. Updated Figures 1 to 3.	DN	02·08	02·08
04	Added elementary neutralization to section 7.0. Other minor edits.	DN	05·09	0509
05	Sect. 7- Added non-hazardous samples are recycled, added PCB information, changed elementary neutralization target pH to 5-~~8~~9. Added wording for clarification. Updated Figures 1, 3 and 5.	LAD	06/13	06/13

TITLE: **SAMPLE DISPOSAL**

Revision History (cont.):

SOP Revision	Changes	Approval Initials	Approval Date	Effective Date
06	Corrected typos, updated Figure 3	LAD	09/17	09/17

TITLE: SAMPLE DISPOSAL

Please acknowledge receipt of this standard operating procedure by signing and dating both of the spaces provided. Return the bottom half of this sheet to the QA Department.

I acknowledge receipt of copy ___ of document **SD-903-06**, titled **SAMPLE DISPOSAL**.

Recipient: ____ Date: ____________________

KATAHDIN ANALYTICAL SERVICES
STANDARD OPERATING PROCEDURE

I acknowledge receipt of copy ___ of document **SD-903-06**, titled **SAMPLE DISPOSAL**.

Recipient: ____ Date: ____________________

1.0 SCOPE AND APPLICATION

Katahdin Analytical Services requires strict adherence to specific procedures for the disposal of samples. The procedures are designed to categorize waste materials, provide for their safe and timely disposal and to ensure compliance with local and federal regulations pertaining to disposal of chemicals and environmental samples. Any other means of disposal not described in this SOP is prohibited without consent from the Katahdin Environmental Health & Safety Officer and/or the Katahdin Environmental Compliance Officer.

The purpose of this SOP is to describe the procedures utilized by Katahdin Analytical personnel for the disposal of samples. These procedures apply to the disposal of all samples received or processed by Katahdin. Refer to the current revision of Katahdin SOP CA-107 regarding the disposal of spent preparation and analysis reagents, standards, sample extracts, distillates, or digestates.

1.1 Definitions

Hazardous Waste – A “Solid Waste” which displays a hazardous characteristic or is specifically listed as hazardous waste.

Solid Waste – Any discarded material that is not excluded from the definition of hazardous waste.

Discarded Material – Material that is abandoned, recycled or inherently waste-like.

Waste (State of Maine) –

- Any useless, unwanted, or discarded substance or material, whether or not such substance or material has any other future use.
- Any substance or material that is spilled, leaked, pumped, poured, emptied or dumped onto the land or into the water or ambient air.
- Materials which are used in a matter constituting disposal, burned for energy recovery, reclaimed, or accumulated speculatively.

Ignitable Hazardous Waste – EPA Waste Code D001

- Liquids with a flash point less than 140°F or 60°C.
- Solids capable of spontaneous combustion under normal temperature and pressure.
- Ignitable compressed gas.
- Oxidizers.

Corrosive Hazardous Waste - Liquids with a pH less than or equal to 2.0 or greater than or equal to 12.5. EPA waste code D002.

Reactive Hazardous Waste – EPA waste code D003.

- A material that reacts violently with water.
- A material that generates toxic gases or fumes.
- Explosives.

Toxic Hazardous Waste – A material that exceeds certain concentration levels based on the toxicity characteristic leaching procedure (TCLP). See Figure 3 for the chemicals and concentration levels covered under this definition.

Listed Wastes – Lists of chemicals that are considered hazardous based on the following criteria

- Virgin chemical or unused product.
- Sole active ingredient.
- Single substance spill debris.

Listed wastes are divided into 5 subcategories

- F-wastes – Describe hazardous waste from non-specific sources usually containing halogenated and non-halogenated solvents.
- K-wastes – Describe hazardous wastes created by specific processes.
- U-wastes – Describe toxic or non-acute hazardous wastes.
- P-wastes – Describe acute hazardous wastes. (Note: Maine considers a material to be a P-listed waste if it contains 10% or more of any P-listed chemical.
- State listed wastes – Maine lists any material with a concentration of greater than 50 ppm Polychlorinated Biphenyls (PCB) as a hazardous waste.

Organics hit – A liquid sample containing greater than 1 mg/L of organic contaminants or a soil sample containing greater than 20 mg/kg of organic contaminants.

1.2 Responsibilities

Only designated analysts/technicians trained in these procedures may dispose of samples or analytical by-products. Each analyst or technician must be familiar with Katahdin Analytical safety procedures. Gloves, safety glasses, lab coats and/or other protective clothing must be worn at all times.

It is the responsibility of the designated Katahdin personnel involved in the disposal of samples to read and understand this SOP, to adhere to the procedures outlined, to properly document their activities in the appropriate lab notebook and file the necessary manifests and reports to outside agencies in the required manner. Refer to Katahdin SOP QA-805, “Personnel Training & Documentation of Capability,” current revision.

It is the responsibility of the Department Managers to oversee that members of their group follow this SOP, to ensure that their work is properly documented and to initiate periodic review of the associated logbooks.

It is the responsibility of the Katahdin Environmental Health & Safety Officer (EHSO) to manage the proper classification and disposal of samples. Katahdin is responsible for regulatory compliance of Katahdin’s waste storage areas (less than 90 day storage). The EHSO ensures compliance of the waste storage areas with applicable state and federal regulations. The EHSO is responsible for providing the appropriate training to all individuals involved in the proper classification and/or disposal of samples. The EHSO is responsible for working with the Laboratory Operations Manager/Environmental Compliance Officer to help identify problems and assure resolution, to facilitate corrective action where needed, and to communicate unresolved problems and concerns to the Laboratory President.

It is the responsibility of the Environmental Compliance Officer to oversee adherence to Katahdin sample disposal and hazardous waste practices by all laboratory groups under his/her authority, to help identify problems and assure resolution, to facilitate corrective action where needed, and to communicate problems and concerns to the EHSO and/or the Laboratory President.

It is the responsibility of the Laboratory President to provide the necessary resources to meet the regulatory requirements of proper classification and disposal of samples.

2.0 SUMMARY OF METHOD

Not applicable.

3.0 INTERFERENCES

Not applicable.

4.0 APPARATUS AND MATERIALS

Not applicable.

5.0 REAGENTS AND STANDARDS

Not applicable.

6.0 SAMPLE COLLECTION, PRESERVATION AND HANDLING

Not applicable.

7.0 PROCEDURES

7.1 Sample purging is the removal of samples from laboratory refrigerated storage. Sample storage areas where samples are removed (purged) from include wet chemistry, organic extractables, metals, volatiles, total organic carbon and soils. Wet chemistry, aqueous metals, organic extractables, total organic carbon, and soils can all be found in the walk-in refrigerator. Aqueous and soil volatiles can be found in the volatiles laboratory refrigerators/freezer.

7.2 Samples are purged from storage, after analysis and reporting, on a routine basis to make room for incoming samples. Samples are to be kept in storage for a duration of 30 days past the report mailed date. Some samples must be kept for 60 or 90 days beyond the report mailed date, depending on specific client requests and contracts.

7.3 The first step in disposing of samples is to generate a disposal list. The disposal list contains sample analysis information stored in the Katahdin Information Management System (KIMS). The analytical data for the samples is compared to the hazardous waste criteria specified in 40CFR Part 261 and to local wastewater discharge criteria. Refer to Figure 4 for 40 CFR Part 261 Characteristic Hazardous Waste Criteria. Based on this comparison, the report displays information on the classification/category for disposal of each sample. The disposal report should be reviewed against the data reports for accuracy. Refer to Figure 2 for an example of a KIMS generated disposal list. The primary disposal categories listed in the report are: non-hazardous, high organics, high metals, flashpoint, high mercury, high PCBs, and high cyanide. Katahdin has established 14 waste stream profiles with a 3rd party waste transporter/waste disposal firm for sample disposal based on these categories. As required, new or special temporary waste profiles are established based on the characteristics of samples.

7.4 Sorting through samples and preparing them for disposal is a crucial quality checkpoint. Samples put into the incorrect waste stream could not only produce adverse environmental effects, but, could also interrupt the 3rd party's waste treatment efficiency, or endanger an individual handling the waste stream. Therefore, when sorting through samples pay close attention to which waste stream each sample falls into.

7.5 Once you are ready to dispose of the samples of interest (the oldest samples that have been purged), these samples must be sorted, logged, and the classification/category (sample knowledge) information recorded.

Sample storage times (as listed in section 7.2) and space should be taken into consideration when purging samples. It is important to make room for future samples, but to make sure that samples are not purged too early. Samples should be pulled from the walk-in or the volatiles refrigerators to make room for new samples. When purging, chose a section that needs extra space the most and remove the oldest samples.

Safety glasses, nitrile gloves, lab coat, and a splash apron must be worn when handling samples during disposal

7.6 Remove the designated purge samples from the shelf one by one and line them up on the countertop in the log-in area. Generally, removing two cartloads at a time is a good amount to purge at one time. For volatile samples in 40mL vials, 5 or 6 vial trays should be purged at a time. Samples should be lined up across the counter with the earliest sample to the left and building up to the right, organizing the samples according to work order and sample number. After the samples are lined up, they should be recorded in the Sample Disposal Logbook (SDL). Refer to Figure 1 for an example SDL page. The location the samples were removed from should also be recorded. Sample storage areas are recorded with the following designations:

VOA (Aq)	Aqueous Volatiles (VOA)
VOA (SL)	Solid Volatiles (VOA)
M	Metals
EXT	Extractables (Organic)
TOC	Total Organic Carbon
WC	Wet Chemistry
S	Soils

7.7 The next step is to use the sample disposal list to determine the earliest release date of the reports and to determine each samples appropriate waste classification/characterization. As stated in section 7.3, the primary disposal categories listed in the report are: non-hazardous, high organics, high metals, flashpoint, high mercury, high PCBs, and high cyanide.

Using the information from the KIMS disposal list, record the appropriate classification for each sample in the SDL. If multiple categories are identified as being present then a single category is selected as controlling. The order of precedence is PCB's, metals and then organics. If another scenario is found, the individual should bring it to the EHSO for a determination of the acceptable waste stream designation or a determination that it should be lab packed separately.

If samples have been sorted that have not been in storage for the 30 days beyond the release date (60 or 90 for certain clients), then these samples need to be placed back in storage and it should be noted in the SDL.

7.8 As stated above, a sample may be categorized into a waste stream based upon the analytes it contains as determined by laboratory testing. In addition, many samples are also categorized as hazardous waste based upon the preservative that they contain. Since many samples contain preservatives, caution must be used when dumping samples. It is also important to ensure that the sample container is empty. This can be accomplished by holding the container upside down and shaking gently until liquid is no longer observed coming out of the container.

7.9 Once waste categories have been determined and entered into the SDL, The following waste categories are disposed of as follows:

7.9.1 Dumping non-hazardous samples (as determined by laboratory testing)

Non-hazardous liquid samples (non-preserved) are poured directly into the sink in the warehouse.

Non-hazardous solid samples and their containers are disposed of with the recycling trash, which is picked up by commercial trash collectors and ultimately turned into construction material.

7.9.2 Dumping Samples with high Organics (as determined by laboratory testing)

Aqueous samples get dumped into waste stream “K”. Containers are disposed of with general trash. Solid samples are placed into waste stream “I” with their containers. The disposal date is recorded in the SDL.

7.9.3 Dumping samples high in metals, including mercury (as determined by the by laboratory testing)

Aqueous samples get disposed of in waste stream “A”. Containers are disposed of with general trash. Solid samples are placed in waste stream “L” with their containers. The disposal date is recorded in the SDL.

7.9.4 Dumping Acidic Samples that do not contain any other hazardous waste constituents (as determined by the acidic preservative or by laboratory testing)
Refer to section 7.10 below.

7.9.5 Dumping samples with high PCBs (as determined by laboratory testing)

Aqueous samples are disposed of in waste stream “Q”. Containers are disposed of with general trash. Solid samples get disposed of in waste stream “F” with their containers. The disposal date is recorded in the SDL. Any PCB samples with PCB content 50 ppm or greater, solid or aqueous, are set aside for TCSA regulated disposal.

7.9.6 Dumping samples with low flashpoints (as determined by laboratory testing)

Aqueous samples are disposed of in waste stream “O”. Containers are disposed of with general trash. Solid samples get disposed of in waste stream “I” with their containers. The disposal date is recorded in the SDL.

7.9.7 Dumping samples with high cyanide (as determined by laboratory testing)

Aqueous samples are disposed of in waste stream “NHi”. Containers are disposed of with general trash. Solid samples should be set aside for labpack. The disposal date is recorded in the SDL.

7.9.8 Miscellaneous Disposal (as determined by the preservative)

7.9.8.1 Sodium Bisulfate: Sodium Bisulfate often comes in vials, but may also come in the 2-4oz glass jars. Dump the Sodium Bisulfate out of the container into waste stream “A”. There may be remaining soil left in the sample container. The soil’s waste stream and dump date will be dictated by the SDL. The disposal date is recorded in the SDL.

7.9.8.2 Methanol / Free Products: This often comes in vials, but may also come in the 2-4oz glass jars. Dump the methanol out of the container into the mix-flammables accumulation. When this satellite accumulation container gets full it can be dumped into the “O” waste stream. There may be remaining soil left in the sample container. The soil’s waste stream and dump date will be dictated by the SDL. Lastly, samples marked “free product” on the Katahdin sample ID label can be dumped into the mixed flammables stream. The disposal date is recorded in the SDL.

7.10 Pursuant to Maine DEP regulations, Katahdin has the necessary agreements, processes and documentation in place to neutralize samples without a license. Refer to the current revision of the Katahdin Environmental Health & Safety Manual for additional information. Generally, the following procedures are followed.

7.10.1 Samples that have been determined to be hazardous due **solely** to the corrosivity characteristic are neutralized using sodium hydroxide pellets. In the warehouse, samples are emptied into a five gallon heavy duty carboy to about 60% capacity. The carboy is kept in a secondary container. Sodium hydroxide pellets are added slowly to the carboy (about 5 grams at a time) and stirred with a long glass stirring rod. The pH is checked with pH paper.

7.10.2 This process is continued until the pH is between 5 and 9. This normally takes about 30-40 grams of sodium hydroxide pellets, but may vary depending on the buffering capacity of the individual samples.

7.10.3 The carboy is emptied into the sink in the warehouse. The tap water is run at the same time as the neutralized material is disposed of. An eyewash station and spill material is located at this sink.

7.10.4 All neutralization activities are documented, including the date and time of neutralization, the name of the person doing the neutralizing, the amount of neutralized liquid discharged, details on the inspection of the drain area and the date and nature of any significant repairs or corrective actions. This documentation is maintained by the EHSO. Refer to Figure 5 for an example logbook page of neutralization documentation.

7.11 Dumping Basic samples (as determined by the basic preservative or by laboratory testing). If the samples have been to be hazardous due solely to the corrosivity characteristic, they are included in the neutralization process above.

7.12 Every 3 to 5 weeks a pickup of hazardous waste is scheduled with the 3rd party waste transporter/waste disposal firm. An inventory is faxed to the transporter summarizing the number of drums and waste streams/profiles. As required, a “lab pack” of expired chemicals or orphan samples is organized as necessary. A designated individual, with applicable Hazardous Waste (RCRA) and Department of Transportation (DOT) training, oversees the waste pickup and signs the hazardous manifests and land ban documentation. Within 7 days a copy is forwarded to the Maine Department of Environmental Protection (MEDEP) and the environmental agency in the designation state (if required by that state). Once the report is received at the disposal facility a copy is returned to KATAHDIN and the MEDEP.

7.13 Prior to March 31 of each year, the laboratory prepares the Annual Hazardous Waste Report (i.e., MEDEP modified EPA Form 8700-13A) as required by MEDEP Hazardous Waste Management Rules. The complete report is reviewed by the Katahdin Environmental Compliance Officer and then forwarded to the following address:

Maine Department of Environmental Protection
Bureau of Remediation & Waste Management
State House Station #17
Augusta, ME. 04333
Attn: Annual Hazardous Waste Report

8.0 QUALITY CONTROL AND ACCEPTANCE CRITERIA

On a daily basis, a designated individual performs quality checks in all hazardous waste storage areas. The daily check documentation is located in login. Any discrepancy is copied to the Environmental Compliance Officer and the Katahdin President for corrective action. Refer to the current revision of Katahdin SOP CA-107, *The Management of Hazardous Waste as it Relates to the Disposal of Laboratory Process Waste, Reagents, Solvents & Standards*, for more information. Refer to Figure 3 for a copy of the daily check documentation.

9.0 METHOD PERFORMANCE

Not applicable.

10.0 APPLICABLE DOCUMENTS/REFERENCES

USEPA Code of Federal Regulations, 40 CFR Part 261.

Maine Department of Environmental Protection (ME DEP) Hazardous Waste Management Rules

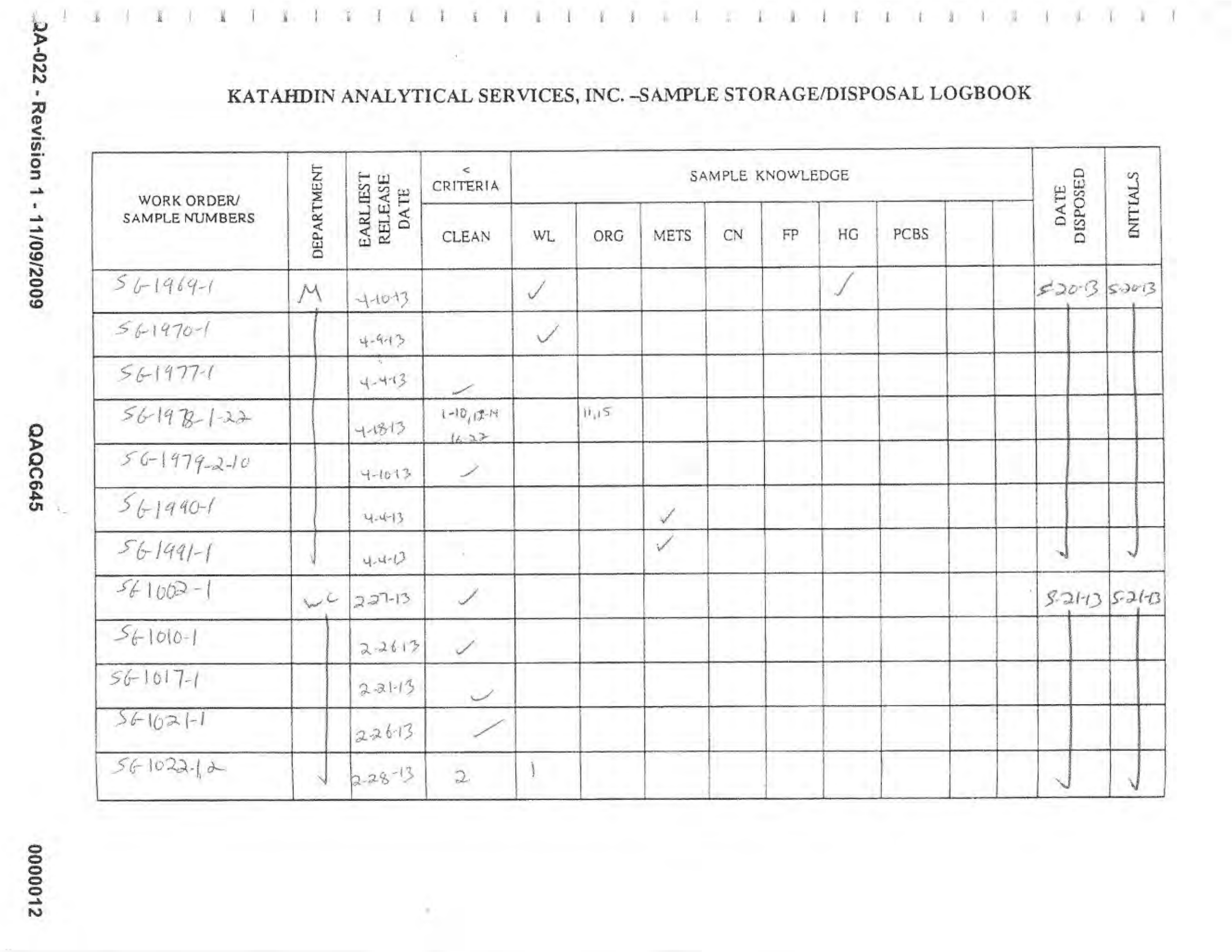
ME DEP modified EPA Form 8700-13A

LIST OF TABLES AND FIGURES

TITLE: SAMPLE DISPOSAL

FIGURE 1

EXAMPLE OF SAMPLE DISPOSAL LOGBOOK (SDL)



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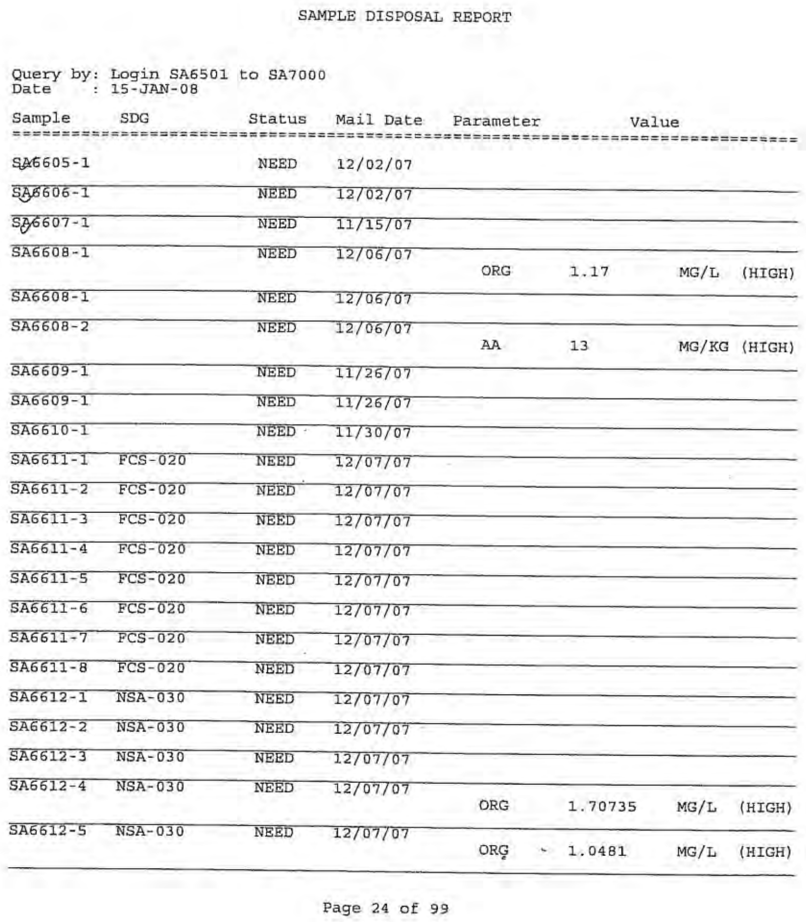
KATAHDIN ANALYTICAL SERVICES, INC. –SAMPLE STORAGE/DISPOSAL LOGBOOK

WORK ORDER/ SAMPLE NUMBERS	DEPARTMENT	EARLIEST RELEASE DATE	< CRITERIA	SAMPLE KNOWLEDGE									DATE DISPOSED	INITIALS
			CLEAN	WL	ORG	METS	CN	FP	HG	PCBS				
SG-1969-1	M	4-10-13		✓					✓				5-20-13	5-20-13
SG-1970-1		4-9-13		✓										
SG-1977-1		4-4-13	✓											
SG-1978-1-22		4-18-13	1-10, 12-14 16-22		11, 15									
SG-1979-2-10		4-10-13	✓											
SG-1990-1		4-4-13				✓								
SG-1991-1	↓	4-4-13				✓							↓	↓
SG-1002-1	WC	2-27-13	✓										5-21-13	5-21-13
SG-1010-1		2-26-13	✓											
SG-1017-1		2-21-13	✓											
SG-1021-1		2-26-13	✓											
SG-1022-1,2	↓	2-28-13	2	1									↓	↓

TITLE: SAMPLE DISPOSAL

FIGURE 2

EXAMPLE OF KIMS GENERATED WASTE DISPOSAL REPORT



```
                              SAMPLE DISPOSAL REPORT

Query by: Login SA6501 to SA7000
Date    : 15-JAN-08

Sample    SDG          Status   Mail Date   Parameter          Value
================================================================================

SA6605-1               NEED     12/02/07

SA6606-1               NEED     12/02/07

SA6607-1               NEED     11/15/07

SA6608-1               NEED     12/06/07
                                               ORG       1.17          MG/L  (HIGH)

SA6608-1               NEED     12/06/07

SA6608-2               NEED     12/06/07
                                               AA        13            MG/KG (HIGH)

SA6609-1               NEED     11/26/07

SA6609-1               NEED     11/26/07

SA6610-1               NEED     11/30/07

SA6611-1  FCS-020      NEED     12/07/07

SA6611-2  FCS-020      NEED     12/07/07

SA6611-3  FCS-020      NEED     12/07/07

SA6611-4  FCS-020      NEED     12/07/07

SA6611-5  FCS-020      NEED     12/07/07

SA6611-6  FCS-020      NEED     12/07/07

SA6611-7  FCS-020      NEED     12/07/07

SA6611-8  FCS-020      NEED     12/07/07

SA6612-1  NSA-030      NEED     12/07/07

SA6612-2  NSA-030      NEED     12/07/07

SA6612-3  NSA-030      NEED     12/07/07

SA6612-4  NSA-030      NEED     12/07/07
                                               ORG       1.70735     MG/L  (HIGH)

SA6612-5  NSA-030      NEED     12/07/07
                                               ORG       1.0481      MG/L  (HIGH)


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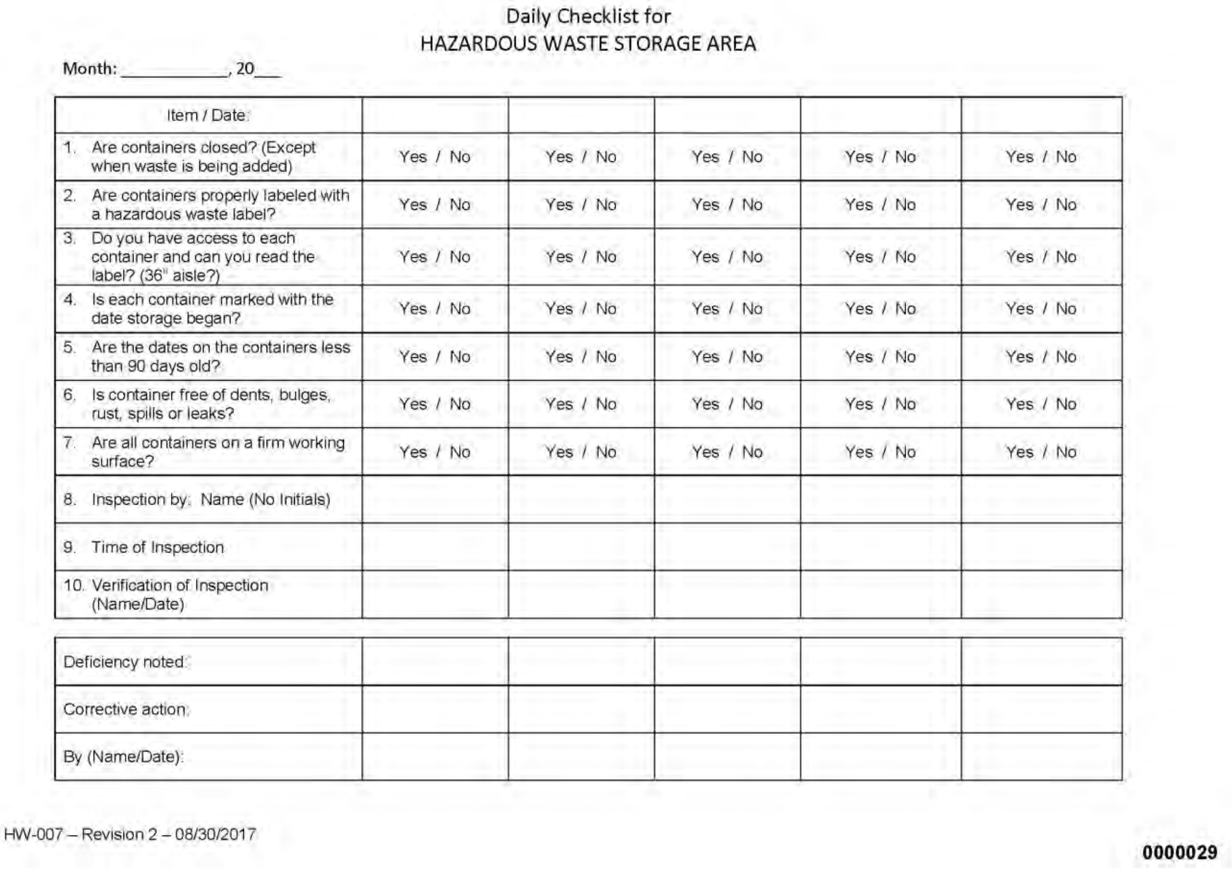
FIGURE 3

EXAMPLE OF HAZARDOUS WASTE STORAGE AREA DAILY CHECK



Daily Checklist for
HAZARDOUS WASTE STORAGE AREA

Month: ___________, 20___

Item / Date					
1. Are containers closed? (Except when waste is being added)	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
2. Are containers properly labeled with a hazardous waste label?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
3. Do you have access to each container and can you read the label? (36" aisle?)	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
4. Is each container marked with the date storage began?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
5. Are the dates on the containers less than 90 days old?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
6. Is container free of dents, bulges, rust, spills or leaks?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
7. Are all containers on a firm working surface?	Yes / No	Yes / No	Yes / No	Yes / No	Yes / No
8. Inspection by: Name (No Initials)					
9. Time of Inspection					
10. Verification of Inspection (Name/Date)					

Deficiency noted:					
Corrective action:					
By (Name/Date):					

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FIGURE 4

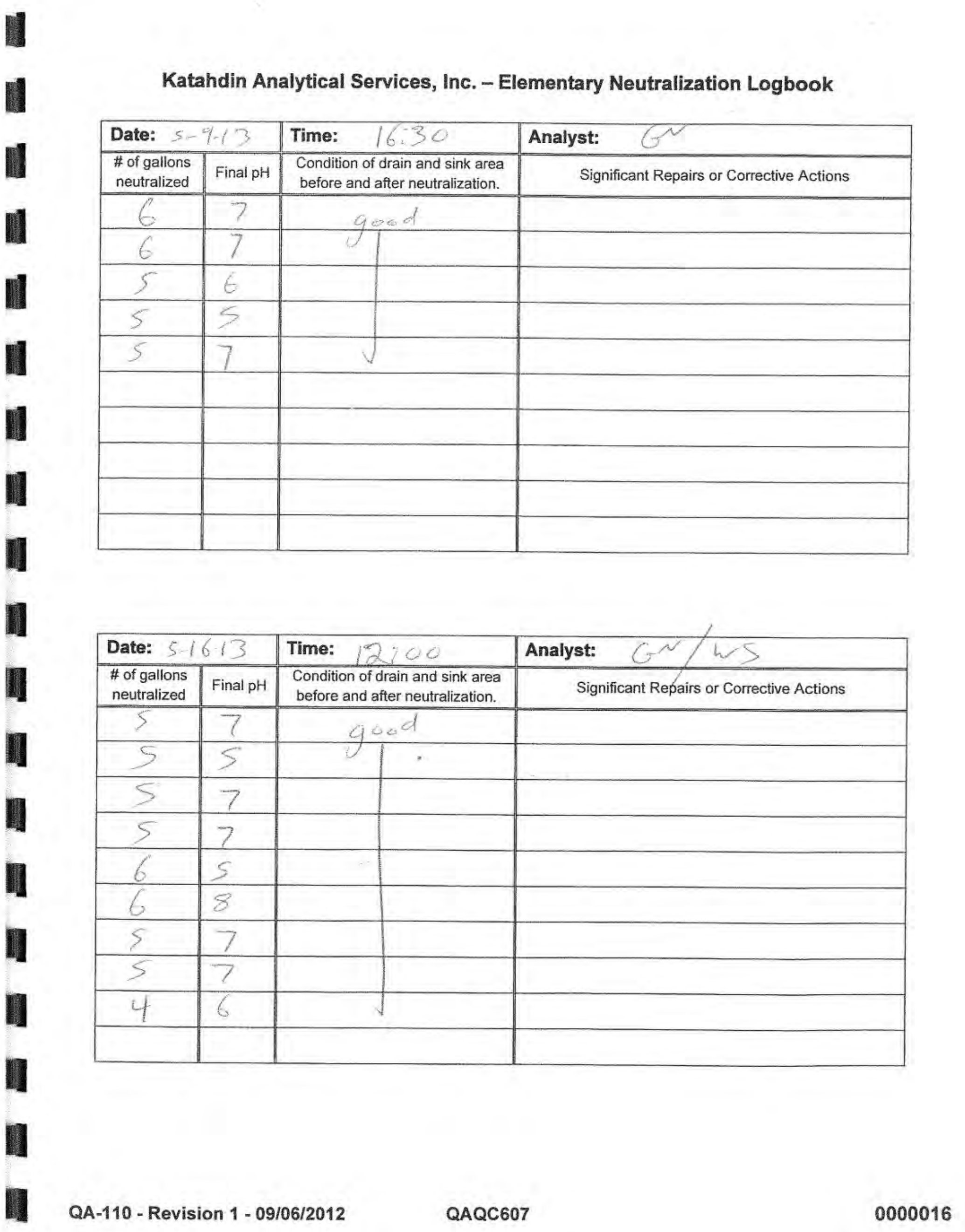
CHARACTERISTIC TOXIC HAZARDOUS WASTE AND TCLP CONCENTRATIONS

Chemical Name	CAS Number	Waste Code	TCLP conc. liquid	Equivalent conc. In Soil
Arsenic	7440-38-2	D004	5.0 mg/L	100 mg/kg
Barium	7440-39-3	D005	100 mg/L	2000 mg/kg
Cadmium	7440-43-9	D006	1.0 mg/L	20 mg/kg
Chromium	7440-47-3	D007	5.0 mg/L	100 mg/kg
Lead	7439-92-1	D008	5.0 mg/L	100 mg/kg
Mercury	7439-97-6	D009	0.2 mg/L	4 mg/kg
Selenium	7782-49-2	D010	1.0 mg/L	100 mg/kg
Silver	7440-22-4	D011	5.0 mg/L	20 mg/kg
Endrin	72-20-8	D012	0.02 mg/L	0.4 mg/kg
Lindane	58-89-9	D013	0.4 mg/L	8 mg/kg
Methoxychlor	72-43-5	D014	10 mg/L	200 mg/kg
Toxaphene	8001-35-2	D015	0.5 mg/L	10 mg/kg
2,4-D	94-75-7	D016	10 mg/L	200 mg/kg
2,4,5-TP (Silvex)	93-72-1	D017	1.0 mg/L	20 mg/kg
Benzene	71-43-2	D018	0.5 mg/L	10 mg/kg
Carbon Tetrachloride	56-23-5	D019	0.5 mg/L	10 mg/kg
Chlordane	57-74-9	D020	0.03 mg/L	0.6 mg/kg
Chlorobenzene	108-90-7	D021	100 mg/L	2000 mg/kg
Chloroform	67-66-3	D022	6.0 mg/L	120 mg/kg
o-Cresol	95-48-7	D023	200 mg/L	4000 mg/kg
m-Cresol	108-39-4	D024	200 mg/L	4000 mg/kg
p-Cresol	106-44-5	D025	200 mg/L	4000 mg/kg
Cresol	1319-77-3	D026	200 mg/L	4000 mg/kg
1,4-Dichlorobenzene	106-46-7	D027	7.5 mg/L	150 mg/kg
1,2-Dichloroethane	107-06-2	D028	0.5 mg/L	10 mg/kg
1,1-Dichloroethylene	75-35-4	D029	0.7 mg/L	14 mg/kg
2,4-Dinitrotoluene	121-14-2	D030	0.13 mg/L	2.6 mg/kg
Heptachlor	76-44-8	D031	0.008 mg/L	0.16 mg/kg
Hexachlorobenzene	118-74-1	D032	0.13 mg/L	2.6 mg/kg
Hexachlorobutadiene	87-68-3	D033	0.5 mg/L	10 mg/kg
Hexachloroethane	67-72-1	D034	3.0 mg/L	60 mg/kg
Methyl Ethyl Ketone	78-93-3	D035	200 mg/L	4000 mg/kg
Nitrobenzene	98-95-3	D036	2.0 mg/L	40 mg/kg
Pentachlorophenol	87-86-5	D037	100 mg/L	2000 mg/kg
Pyridine	110-86-1	D038	5.0 mg/L	100 mg/kg
Tetrachloroethylene	127-18-4	D039	0.7 mg/L	14 mg/kg
Trichloroethylene	79-01-6	D040	0.5 mg/L	10 mg/kg
2,4,5-Trichlorophenol	95-95-4	D041	400 mg/L	8000 mg/kg
2,4,6-Trichlorophenol	88-06-2	D042	2.0 mg/L	40 mg/kg
Vinyl Chloride	75-01-4	D043	0.2 mg/L	4.0 mg/kg

TITLE: SAMPLE DISPOSAL

FIGURE 5

EXAMPLE OF ELEMENTARY NEUTRALIZATION LOGBOOK



Katahdin Analytical Services, Inc. – Elementary Neutralization Logbook

Date: 5-9-13		**Time:** 16:30	**Analyst:** GN
# of gallons neutralized	Final pH	Condition of drain and sink area before and after neutralization.	Significant Repairs or Corrective Actions
6	7	good	
6	7		
5	6		
5	5		
5	7		

Date: 5-16-13		**Time:** 12:00	**Analyst:** GN/WS
# of gallons neutralized	Final pH	Condition of drain and sink area before and after neutralization.	Significant Repairs or Corrective Actions
5	7	good	
5	5		
5	7		
5	7		
6	5		
6	8		
5	7		
5	7		
4	6		

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