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National Fuel Gas Distribution Corporation

FINAL

Remedial Investigation Work Plan

Dunkirk Former Manufactured Gas Plant Site
(Site No. 9-07-035)
Dunkirk, New York

March 2013

New York State Department of Environmental Conservation
Division of Environmental Remediation
Remedial Bureau C, 11th Floor
625 Broadway, Albany, New York 12233-7014
Phone: (518) 402-9662 • **Fax:** (518) 402-9679
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Joe Martens
Commissioner

March 12, 2013

Tanya B. Alexander, CHMM, REM
Manager, Environmental Services
National Fuel Gas Distribution Corporation
6363 Main St
Williamsville, NY 14221-5887

Dear Ms. Alexander:

Re: Dunkirk Former Manufactured Gas Plant Site
Chautauqua County, Site ID: 907035
Draft Remedial Investigation Work Plan (ARCADIS, March 11, 2013)

The New York State Department of Environmental Conservation (Department) and the New York State Department of Health have reviewed the referenced work plan. The work plan is acceptable, can be finalized, and is hereby approved with the following modification:

- Consistent with the language of the scope of work approved by the Department on February 27, 2013, National Fuel will deliver the brief letter reports of the SVI sampling results to each property owner.

Please notify the Department at least 7 days in advance of any field activities.

Please feel free to contact me with any questions via email at wxwu@gw.dec.state.ny.us, or via phone at (518) 402-9662.

Sincerely,

William Wu

William Wu
Environmental Engineer
Remedial Bureau C
Division of Environmental Remediation

ec: G. Cross, NYSDEC
N. Freeman, NYSDOH

On behalf of National Fuel Gas Distribution Corporation (National Fuel), ARCADIS has prepared this work plan for conducting a Remedial Investigation (RI) at the Dunkirk Former Manufactured Gas Plant (MGP) Site (the “site”) in Dunkirk, New York. This RI Work Plan was prepared in response to the New York State Department of Environmental Conservation’s (NYSDEC’s) February 27, 2013 e-mail to National Fuel. The NYSDEC’s February 27th e-mail contained the following:

- An approval of the February 8, 2013 RI Scope of Work.
- A request that National Fuel submit a single bound RI Work Plan that would contain the RI scope of work and relevant appendices of the NYSDEC-approved Site Characterization (SC) Work Plan.

Following the NYSDEC’s February 27th e-mail, National Fuel submitted a draft RI Work Plan on March 11, 2013. The NYSDEC provided a conditional approval of the RI Work Plan as documented in a letter dated March 12, 2013 (inside cover). In their March 12th letter the NYSDEC requested that National Fuel submit letter reports of the Soil Vapor Intrusion (SVI) results to respective property owners, rather than the New York State Department of Health (NYSDOH) providing the submittals. This final RI Work Plan reflects the NYSDEC’s request.

This work plan contains the following documentation:

Attachment 1	**Table 1: RI Work Plan Table** — Presents the scope of the RI activities and provides a rationale for each of the activities. This is the same table that was provided in National Fuel’s February 7, 2013 RI Scope of Work letter to the NYSDEC.
	Table 2: Target Analyte List and Reporting Limits for Soil Vapor Intrusion (SVI) sampling.
	Figure 1: Onsite Investigation Locations — Shows the locations of onsite RI soil borings and monitoring wells.
	Figure 2: Offsite Investigation Locations — Shows the location of onsite and offsite RI soil borings and monitoring wells, and shows the locations of properties targeted for the SVI investigation.

Attachment 2	**Field Sampling Plan (FSP)** — Contains detailed field procedures and protocols that will be followed during the RI.
Attachment 3	**Quality Assurance/Sampling and Analysis Project Plan (QA/SAPP)** — Presents the analytical methods and procedures that will be used to analyze soil, groundwater, and vapor samples collected during the RI.
Attachment 4	**Health and Safety Plan (HASP)** — Presents the health and safety procedures, methods, and requirements that will apply to field personnel during implementation of the RI field work.
Attachment 5	**DNAPL Contingency Plan (DCP)** — Describes procedures to be followed during drilling to limit the potential for remobilizing dense non-aqueous phase liquid (DNAPL), if encountered.
Attachment 6	**Community Air Monitoring Plan (CAMP)** – Presents air monitoring activities that will be conducted to protect the public from potential vapor or dust emissions generated during subsurface soil disturbance activities.
Attachment 7	**SVI Standard Operating Procedures (SOPs)** – Presents procedures to be followed during the SVI investigations.

Attachment 1

Table 1:	RI Work Plan Table
Table 2:	Target Analyte List and Reporting Limits
Figure 1:	Onsite Investigation Locations
Figure 2:	Offsite Investigation Locations

TABLE 1
REMEDIAL INVESTIGATION WORK PLAN

NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK

Location/Activity	Action	Rationale
Soil Vapor Intrusion Evaluation (Four Properties) – First RI Activity (2013 Heating Season)		
National Fuel Service Center Building **17 Second Street** **24 Second Street** **28 Second Street**	A soil vapor intrusion (SVI) evaluation will be the first field activity conducted during the Remedial Investigation (RI). The SVI will be conducted at four properties. The first step in the SVI evaluation will be to evaluate the construction and usage of the buildings on each property. Building construction and usage will be used to determine the potential scope of the SVI evaluation for each building. Once the building assessments are completed, National Fuel will transmit an e-mail to the NYSDEC/NYSDOH to confirm the sampling approach for each building. At a minimum, National Fuel anticipates that one indoor air, one sub-slab or soil vapor, and one ambient air sample will be collected during the SVI evaluation at each building; however, the final sampling approach will be determined based on the building assessments. Each SVI evaluation will be conducted in conformance with the New York State Department of Health (NYSDOH) document entitled Guidance for Evaluating Soil Vapor Intrusion in the State of New York, Final, October 2006 (Guidance), and the attached Standard Operating Procedures (SOPs). As detailed in the attached SOPs, each soil vapor, indoor air, and ambient outdoor air sample will be collected using a 6-liter SUMMA® canister with an attached, pre-set flow regulator. The laboratory will provide batch-certified-clean canisters with and initial vacuum of approximately 29 inches of mercury (in. of Hg) for sample collection. Flow regulators will be pre-set by the laboratory to provide uniform sample collection over the desired sampling duration. Sampling durations will be as follows: • Residential properties – 24-hr sampling duration • Businesses – 8 hr sampling duration A tracer gas (helium) will be used while collecting soil vapor samples to evaluate the integrity of the seals around the soil vapor sampling apparatus. This will provide a means to evaluate whether the samples are diluted by surface air.	The purpose of the SVI evaluation is to • Determine the SVI sampling approach for each property. • Determine whether site-related volatile organic compounds (VOCs) are present in sub-slab, soil vapor, and/or indoor air. • If present in indoor air, evaluate if the VOCs are attributable to the site or other potential sources. • If present in indoor air, evaluate if the VOCs levels warrant additional investigation.

Location/Activity	Action	Rationale
	Samples will be submitted for laboratory analysis to an ELAP certified laboratory in accordance with the United States Environmental Protection Agency (USEPA) Compendium Method TO-15, titled “Determination of VOCs in Air Collected in Specially-Prepared Canisters and Analyzed by Gas Chromatography/Mass Spectrometry (GC/MS)”. Samples will be analyzed for the standard TO-15 Target Analyte List, including n-alkanes as presented in Table 1. Laboratory analysis will be performed on a standard turnaround for reporting of analytical results (i.e., three to four weeks following sample collection). Within 48 hours after receiving initial, unvalidated data from the laboratory, a preliminary analytical report and figure will be prepared and transmitted to the New York State Department of Environmental Conservation (NYSDEC) and NYSDOH. National Fuel will prepare brief letter reports of the SVI sampling results for submittal to each property owner. Draft letters will be provided to NYSDEC/NYSDOH for review prior to National Fuel’s submittal to property owners. We’ve assumed each letter will be approximately two pages in length and will attach a table of analytical results with comparison to appropriate criteria.	
Sump Sampling	If, during the building assessments, buildings are determined to have sub-grade foundations with groundwater seeping into the foundations or into sumps, a grab groundwater sample will be collected from basements for Target Compound List (TCL) VOCs analysis using USEPA Method 8260.	The analytical results of potential grab groundwater samples from basements will be evaluated to determine whether dissolved-phase benzene could be present in groundwater entering the basements.

TABLE 1
REMEDIAL INVESTIGATION WORK PLAN

NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK

Location/Activity	Action	Rationale
Source Delineation Near MW-1 (Gas Holder No. 1) – Second RI Activity (Spring 2013)		
Ground Penetrating Radar (GPR)/Electromagnetic (EM) Surveys	GPR and EM-31 will be the first field activity conducted in connection with the Source Delineation program. GPR and EM-31 will be completed in a dense grid over the location of Former Holder No. 1 and former oil tank. GPR and EM-31 surveying will also be used at each drilling location to clear utilities prior to drilling.	GPR and EM-31will be used to: • Fine tune the location of Former Holder No. 1. • Attempt to locate remnants of the former oil tank foundation. • Fine tune the locations of soil borings and monitoring wells to be installed during the RI. • Locate underground utilities at each drilling location.
Vacuum Excavator Utility Clearance and Former Foundation Confirmation	A vacuum excavator will be used to clear each soil boring and monitoring well location to approximately 5 feet below grade. The vacuum excavator will also be used to confirm the location of Former Holder No. 1 foundation and former oil tank foundation. The vacuum excavator confirmation borings will be positioned based on the results of the GPR and EM-31 geophysical survey. Vacuum excavator borings will be completed until the intact foundations are exposed. The soil borings targeted to be inside and outside of the holder ring (below) will be fine-tuned based on the results of the vacuum excavator borings.	The vacuum excavator will enable safe drilling by identifying potential utilities at each drilling location. The vacuum excavator will also allow for visual confirmation of the intact Former Holder No. 1 foundation and potentially the former oil tank foundation. Both of these structures could be a potential source of the dissolved-phase benzene observed in the MW-1 area.
Soil Borings SB-13 through SB-24	Soil borings will be continuously-sampled using hollow stem auger (HSA) and/or direct-push drilling techniques. The drilling rig chosen for the program will have both capabilities. Soil samples will be collected using 2-inch diameter by 2- or 4-feet long macro-core samplers. Soil recovered from each 2- or 4-foot interval will be visually characterized for color, texture, and moisture content. The presence of visible discoloration, NAPL, and obvious odors encountered in the soil will be noted. Each boring will be drilled to the bedrock surface, which is expected to be encountered at a depth of approximately 18 to 20 feet below grade. Drilling will not be performed through any subsurface structures (e.g., concrete or brick slabs) where significant quantities of NAPL are encountered, in an effort to limit the potential downward migration of NAPL. Drilling may continue to greater depths at such	The purpose of drilling these soil borings is to: • Collect soil samples to help define the three-dimensional distribution of benzene impacts and potential MGP-related impacts in soil in the MW-1 area. • Better define the source of elevated benzene concentrations. • Evaluate whether Former Holder No. 1 was constructed with a floor. • Assess the potential presence of MGP-related impacts within and/or beneath the floor of Former Holder No. 1 (if a floor is present).

TABLE 1
REMEDIAL INVESTIGATION WORK PLAN

NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK

Location/Activity	Action	Rationale
	locations at an alternate boring located just outside the footprint of the subsurface structure. This will be determined in the field based on field observations. Up to two soil samples will be collected from each boring and submitted to an ELAP certified laboratory for analysis of TCL VOCs, TCL SVOCs, and total cyanide using United States Environmental Protection Agency (USEPA) methods. Samples will be collected from interval(s) based on visual/olfactory observations and photoionization detector (PID) screening results. Priority will be given to intervals containing potential MGP-related impacts. Samples will also be collected from apparently "clean" intervals to provide information to define the "bottom" extent of impacted areas. If no impacts are observed in a soil boring, one soil sample will be collected near the water table and the other will be collected from the bottom of the boring (above the bedrock surface).	• Assess whether the potential source of elevated benzene detected in the MW-1 area could be outside/upgradient of Former Holder No. 1 and whether MGP-related impacts are present outside of Former Holder No. 1. • Gather data to support a potential remedial action for the MW-1/Former Holder No. 1 area.
Temporary Wells (at SB-13 through SB-24)	Temporary wells will be installed at each boring using 1-inch diameter PVC with 10-foot long screens. Temporary wells will be installed at each location by lowering the PVC well material to the bottom of the soil boring (assumed to be on the bedrock surface) prior to pulling the augers/direct-push tooling from the boring. Natural soils will be allowed to collapse around the well screen. Groundwater samples will be collected using a new, disposable polyethylene mini bailer to purging approximately one well volume prior to sampling. Groundwater samples will be submitted to an ELAP certified laboratory and analyzed for TCL VOCs using USEPA Method 8260. Borings will be abandoned after sampling by filling the temporary well with a loose grout mixture and allowing the grout to seep into the formation, then topping the temporary well will another slug of grout prior to pulling the PVC.	The overall purpose of the temporary well groundwater sampling is to collect data to help define the distribution of benzene impacts and other potential MGP-related impacts in groundwater in the Former Holder No.1/MW-1 area, and to better define the source of elevated benzene concentrations.

TABLE 1
REMEDIAL INVESTIGATION WORK PLAN

NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK

Location/Activity	Action	Rationale
Downgradient Plume Delineation (Downgradient from MW-3 and MW-7/MW-8) – Second RI Activity (Spring 2013)		
Monitoring Wells **MW-9 through MW-12 (downgradient from MW-7 and MW-8)** **MW-13 (downgradient from MW-3)**	Install and sample groundwater from four monitoring wells located downgradient from MW-7 and MW-8 and one monitoring well downgradient from MW-3. Well borings will be drilled and sampled in the same manner as the soil borings (described above). Monitoring wells will be constructed using two-inch diameter schedule 40 PVC material and 0.010-inch slotted, 10-foot long well screens. The monitoring well downgradient from MW-3 will be constructed similar to the construction of MW-3: a 10-ft screen from approximately 5 to 15 feet below grade. Monitoring wells downgradient from MW-7 and MW-8 will be installed similar to the construction of MW-7/MW-8, with the bottom of each well situated on the bedrock surface (assumed to be approximately 18 feet below grade). Monitoring wells will be developed by surging/purging the saturated portion of the screened interval. An attempt will be made to remove a minimum of 10 well volumes from each well, depending on the yielding capacity of the well. Two rounds of groundwater samples will be collected from the monitoring wells using low-flow sampling techniques and specific-capacity test data will be measured at the new monitoring wells as water is purged during sampling. Both rounds of groundwater samples will be submitted to an ELAP certified laboratory and analyzed for TCL VOCs, TCL SVOCs, and total cyanide using USEPA methods. Field parameters measured during groundwater sampling will include pH, turbidity, temperature, conductivity, dissolved oxygen, and oxidation-reduction potential (ORP).	The overall purpose of monitoring wells MW-9 through MW-13 will be to define the downgradient extent of dissolved-phase site –related impacts and better define the groundwater flow direction. The specific purpose of each well is as follows: • MW-9 through MW-12: define the extent of dissolved-phase benzene downgradient from MW-7 and MW-8. • MW-13: define the extent of dissolved-phase BTEX compounds detected in MW-3. Monitoring wells will be developed to promote the hydraulic connection between the well screen and the surrounding geologic formation and to help remove fine sediment from the borehole wall and sand pack. Specific-capacity data will be used to estimate the hydraulic conductivity of the saturated material screened by the monitoring wells.

TABLE 1
REMEDIAL INVESTIGATION WORK PLAN

NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK

Location/Activity	Action	Rationale
Survey		
Survey New Borings, Wells, and Vacuum Excavator Borings	Determine location and elevation of new wells and soil borings using a licensed land surveyor. Information measured will include the horizontal location and vertical locations of the top of the protective casing, the top of the inner casing, and the ground surface adjacent to the wells and soil borings.	Provide the information necessary to determine groundwater elevations, location/elevation of subgrade soil horizons or encountered structures. The survey of the vacuum excavator confirmation borings will be used to update the location of Former Holder No. 1 and possibly the former oil tank onto site mapping.
Field Methods and Quality Assurance for Soil and Groundwater Sampling		
The field and sampling activities will be conducted in general accordance with the appendices included in the NYSDEC-approved *Site Characterization Work Plan,* dated August 2009. The appendices include the Field Sampling Plan (FSP), Quality Assurance Sampling and Analysis Project Plan (QASAPP), Health and Safety Plan (HASP), and DNAPL Contingency Plan (DCP). Community air monitoring will also be conducted in accordance with the NYSDOH-approved Community Air Monitoring Plan (CAMP), dated March 2012. As described in the QAPP, soil and groundwater samples will be submitted for laboratory analysis using United States Environmental Protection Agency (USEPA) SW-846 Methods as referenced in the most recent edition of the NYSDEC Analytical Services Protocol (ASP), with Category B analytical laboratory reports. Soil and groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, and/or total cyanide. The soil and groundwater sample(s) (including quality assurance/quality control [QA/QC] samples) will be collected, packaged, handled, and shipped in general accordance with the QA/QC protocols and the soil and groundwater sampling protocols presented in the FSP and QASAPP. A Data Usability Summary Report (DUSR) of the laboratory data packages will be prepared and the results of the DUSR will be incorporated into data tables which will be provided in subsequent reports.		

TABLE 2
TARGET ANALYTE LIST AND REPORTING LIMITS

SVI EVALUATION
NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK

Analyte	CAS Number	Molecular Weight	Reporting Limit	
			(ppbv)	(mg/m^3)
Benzene	71-43-2	78.11	0.20	0.64
Benzyl chloride	100-44-7	140.57	0.40	2.3
Bromodichloromethane	75-27-4	163.83	0.20	1.3
Bromoform	75-25-2	252.75	0.20	2.1
Bromomethane (Methyl bromide)	74-83-9	94.95	0.20	0.78
2-Butanone (Methyl ethyl ketone)	78-93-3	72.11	1.0	2.9
Carbon Tetrachloride	56-23-5	153.84	0.20	1.3
Chlorobenzene	108-90-7	112.56	0.20	0.92
Chloroethane	75-00-3	64.52	0.20	0.53
Chloroform	67-66-3	119.39	0.20	0.98
Chloromethane (Methyl chloride)	74-87-3	50.49	0.50	1.0
Cyclohexane	110-82-7	84.16	0.50	1.7
Dibromochloromethane	124-48-1	208.29	0.20	1.7
1,2-Dibromoethane	106-93-4	187.88	0.20	1.5
1,2-Dichlorobenzene	95-50-1	147.01	0.20	1.2
1,3-Dichlorobenzene	541-73-1	147.01	0.20	1.2
1,4-Dichlorobenzene	106-46-7	147.01	0.20	1.2
Dichlorodifluoromethane (Freon 12)	75-71-8	120.92	0.20	0.99
1,1-Dichloroethane	75-34-3	98.97	0.20	0.81
1,2-Dichloroethane	107-06-2	98.96	0.20	0.81
1,1-Dichloroethene	75-35-4	96.95	0.20	0.79
1,2-Dichloroethene (cis)	156-59-2	96.95	0.20	0.79
1,2-Dichloroethene (trans)	156-60-5	96.95	0.20	0.79
1,2-Dichloropropane	78-87-5	112.99	0.20	0.92
cis-1,3-Dichloropropene	10061-01-5	110.98	0.20	0.91
trans-1,3-Dichloropropene	10061-02-6	110.98	0.20	0.91
1,2-Dichlorotetrafluoroethane (Freon 114)	76-14-2	170.93	0.20	1.4
1,4-Dioxane	123-91-1	88.11	0.50	1.8
Ethanol *	64-17-5	46.07	0.20	0.38
Ethylbenzene	100-41-4	106.16	0.20	0.87
Hexachlorobutadiene	87-68-3	260.76	1.0	10.7
n-Hexane	110-54-3	86.18	0.50	1.8
Methylene Chloride	75-09-2	84.94	0.50	1.7
4-Methyl-2-pentanone (MIBK)	108-10-1	100.16	0.50	2.0
MTBE (Methyl tert-butyl ether)	1634-04-4	88.15	1.0	3.6
Styrene	100-42-5	104.14	0.20	0.85
Tertiary Butyl Alcohol (TBA)	76-65-0	74.12	2.0	6.1
1,1,2,2-Tetrachloroethane	79-34-5	167.86	0.20	1.4
Tetrachloroethene (PCE)	127-18-4	165.85	0.20	1.4
Toluene	108-88-3	92.13	0.20	0.75
1,2,4-Trichlorobenzene	120-82-1	181.46	1.0	7.4
1,1,1-Trichloroethane	71-55-6	133.42	0.20	1.1
1,1,2-Trichloroethane	79-00-5	133.42	0.20	1.1
1,1,2-trichloro-1,2,2-trifluoroethane (Freon 113)	76-13-1	187.38	0.20	1.5
Trichloroethene (TCE)	79-01-6	131.40	0.20	1.1
Trichlorofluoromethane (Freon 11)	75-69-4	137.38	0.20	1.1
1,2,4-Trimethylbenzene	95-63-6	120.19	0.20	0.98
1,3,5-Trimethylbenzene	108-67-8	120.19	0.20	0.98
2,2,4-Trimethylpentane	540-84-1	114.23	0.50	2.3

See Notes on Page 2.

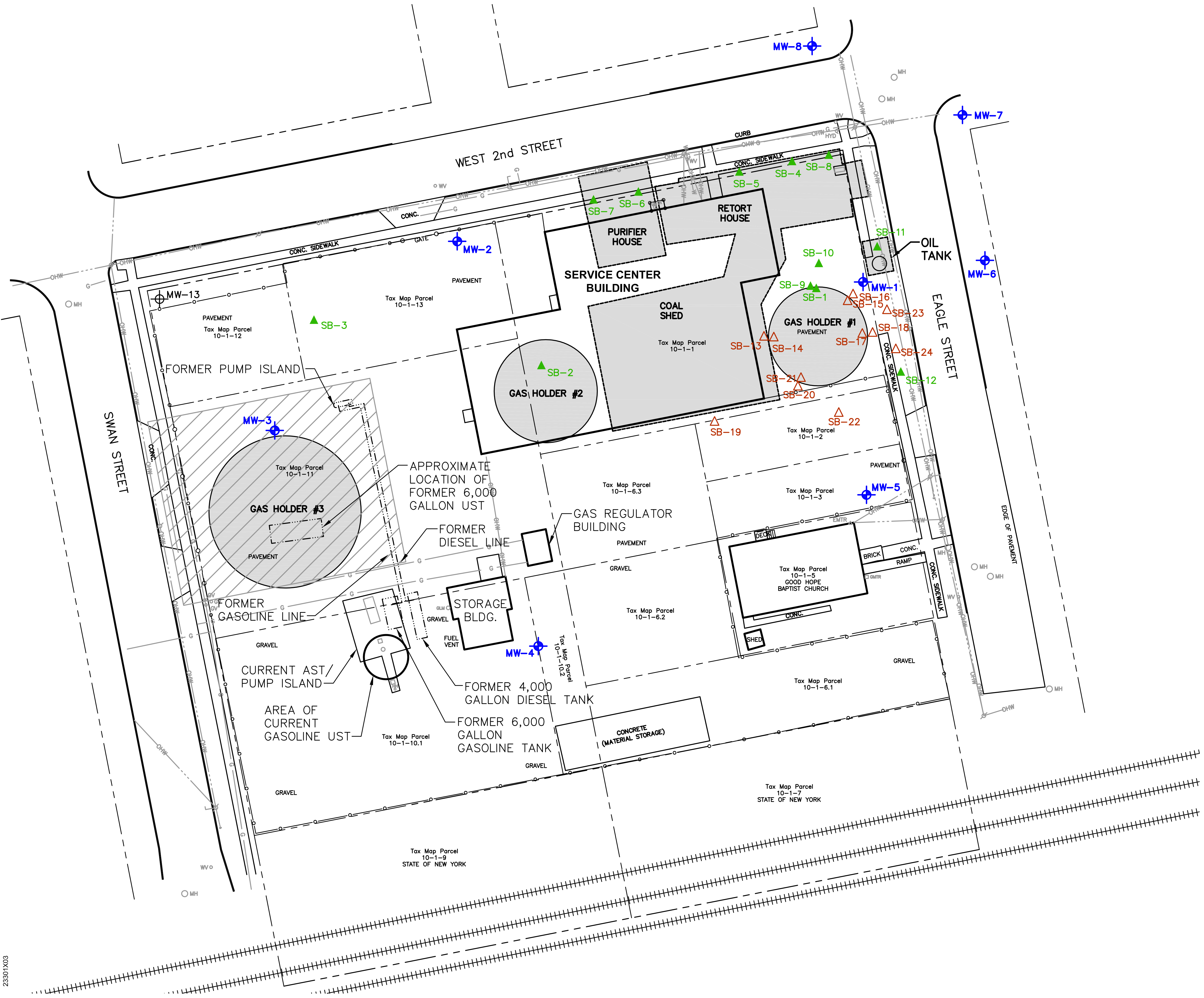
TABLE 2
TARGET ANALYTE LIST AND REPORTING LIMITS

SVI EVALUATION
NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK

Analyte	CAS Number	Molecular Weight	Reporting Limit	
			(ppbv)	(mg/m^3)
Vinyl Chloride	75-01-4	62.50	0.20	0.51
Xylenes (m&p)	1330-20-7	106.16	0.20	0.9
Xylenes (o)	95-47-6	106.16	0.20	0.87
Acetone (2-propanone)	67-64-1	58.08	5.0	12
Bromoethene	593-60-2	106.96	0.20	0.87
1,3-Butadiene	106-99-0	54.09	0.40	0.88
Carbon Disulfide	75-15-0	76.14	0.50	1.6
3-Chloropropene (allyl chloride)	107-05-1	76.53	0.20	0.63
2-Chlorotoluene	95-49-8	126.59	0.40	2.1
4-Ethyltoluene (p-ethyltoluene)	622-96-8	120.20	0.40	2.0
n-Heptane	142-82-5	101.20	0.50	2.1
Isopropyl Alcohol	67-63-0	61.09	2.0	5.0
Methyl Butyl Ketone	591-78-6	100.16	0.50	2.0
n-Butane	106-97-8	58.12	0.40	1.0
n-Decane	124-18-5	142.29	1.0	5.8
n-Dodecane	112-40-3	170.34	1.0	7.0
n-Nonane	111-84-2	128.26	0.50	2.6
n-Octane	111-65-9	114.23	0.40	1.9
n-Pentane	109-66-0	72.15	1.0	3.0
n-Undecane	1120-21-4	156.31	1.0	6.4
1,2,3-Trimethylbenzene**	80-62-6	120.19	0.20	1.0
Naphthalene	91-20-3	128.17	0.50	2.6
1-Methylnaphthalene**	90-12-0	142.20	2.50	15
2-Methylnaphthalene**	91-57-6	142.20	2.50	15
Tetramethylbenzene*	25619-60-7	134.21	TBD	TBD
Indene**	95-13-6	116.16	0.40	1.9
Indane**	496-11-7	118.18	0.20	1.0
Thiophene**	110-02-1	84.14	0.20	0.7

Notes:

1. Analyses to be performed using United States Environmental Protection Agency (USEPA) Compendium Method TO-15.
2. CAS = Chemical Abstract Services.
3. Molecular weights are presented in grams per mole.
4. ppbv = parts per billion volumetric basis.
5. mg/m^3 = micrograms per cubic meter.
6. TBD = To be determined; reporting limit not available.
7. * = Compound to be included in laboratory analysis as a tentatively identified compound (TIC).
8. ** = 1-point calibration.



LEGEND:

⌖	PROPOSED MONITORING WELL
△	PROPOSED SOIL BORING
▲	SOIL BORING
⌖	MONITORING WELL
▭	FORMER MGP STRUCTURE
—···—···—	FORMER PETROLEUM DISTRIBUTION STRUCTURES
▨	APPROXIMATE EXTENT OF PETROLEUM REMEDIATION AREA
—— – – ——	APPROXIMATE PROPERTY LINE
┼┼┼┼┼┼┼┼	RAILROAD
━━━━	EXISTING BUILDING
——o——	CHAIN LINK FENCE
—— –G– ——	GAS LINE
—— -OHW- ——	OVERHEAD WIRE
——W——	WATER LINE

NOTES:

1. ALL LOCATIONS APPROXIMATE.
2. BASEMAP FROM NYS GIS CLEARINGHOUSE WEBPAGE FOR ORTHOIMAGERY AND CT MALE SURVEY OBTAINED ON SEPTEMBER 14, 2010.
3. APPROXIMATE EXTENT OF PETROLEUM REMEDIATION AREA BASED ON A HAND SKETCH MAP PROVIDED BY NATIONAL FUEL ON JANUARY 26, 2009. DATE OF REMEDIATION NOT DEFINED ON THAT MAP.
4. LOCATIONS OF GAS HOLDERS 2 AND 3 DIGITIZED FROM A MAY 10, 1956 DRAWING PROVIDED BY NATIONAL FUEL. ALL OTHER MGP STRUCTURES DIGITIZED FROM 1893 AND 1904 SANBORN FIRE INSURANCE MAPS.
5. LOCATIONS OF FORMER USTs, PUMP ISLAND, AND ASSOCIATED DISTRIBUTION LINES FROM MESCH ENGINEERING, P.C. DRAWING ENTITLED "SITE PLAN", ORIGINAL DRAWING DATED 9/17/87.
6. MONITORING WELLS MW-5 AND MW-6, AND SOIL BORINGS SB-9 THROUGH SB-12 FROM SURVEY FILE PROVIDED BY C.T. MALE ASSOCIATES, DATED 10/7/11.

0 50' 100'

GRAPHIC SCALE

NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK
SITE CHARACTERIZATION

ONSITE INVESTIGATION LOCATIONS

ARCADIS

FIGURE
1

CITY: SYRACUSE, N.Y. DIV/GROUP: 141/ENVCAD DB: LPOSENAUER, R.ALLEN, R. BASSETT LD:(Opt) PIC:(Opt) PM: S.POWLIN TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACT\B0023301\0001\00002\DWG\RI\23301B01.dwg LAYOUT: 1 SAVED: 1/29/2013 9:48 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 1/29/2013 9:48 AM BY: BASSETT, RICHARD

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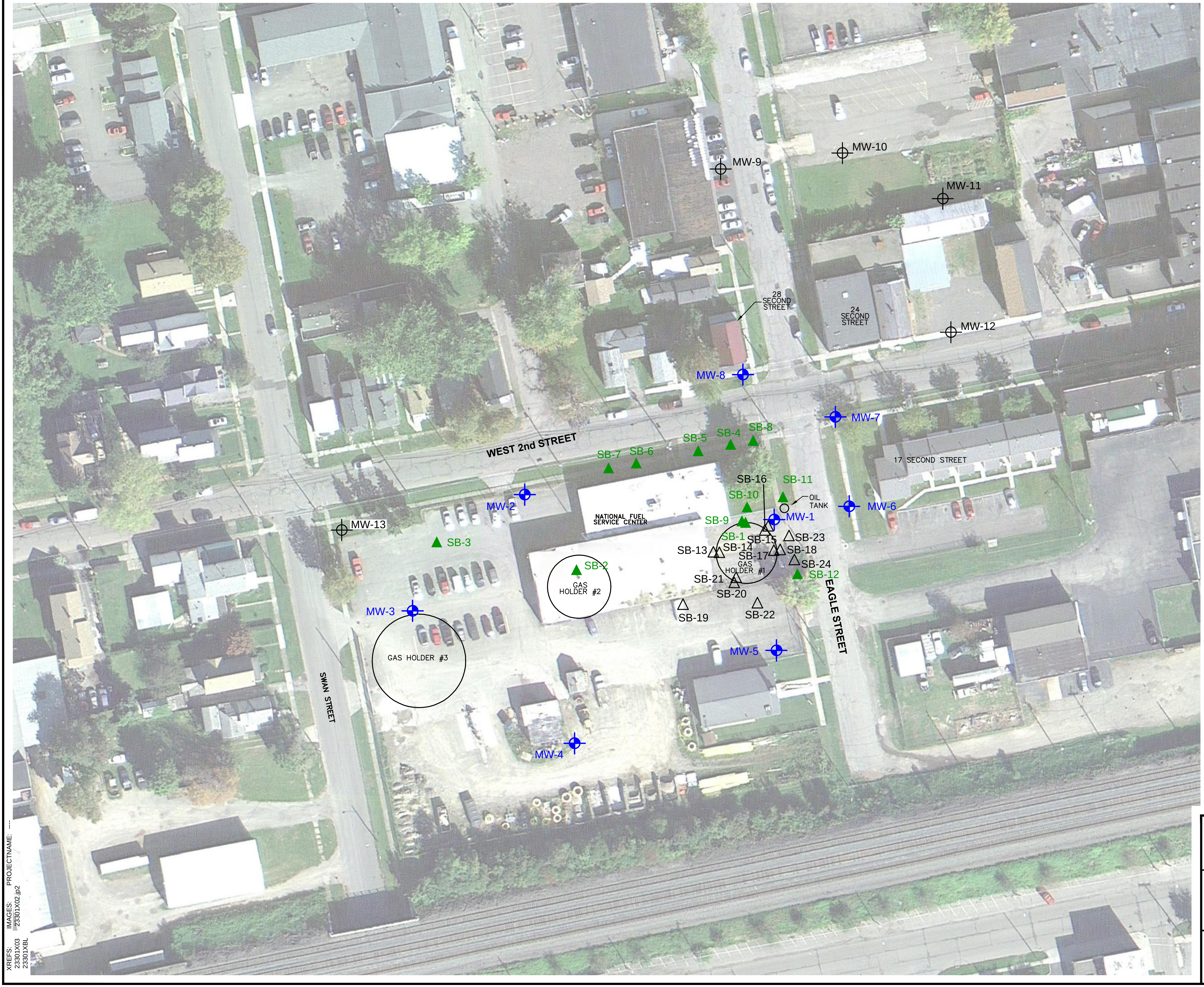

LEGEND:

⌖	PROPOSED MONITORING WELL
△	PROPOSED SOIL BORING
⌖	MONITORING WELL
▲	SOIL BORING

NOTES:

1. ALL LOCATIONS APPROXIMATE.
2. LOCATIONS OF GAS HOLDERS 2 AND 3 DIGITIZED FROM A MAY 10, 1956 DRAWING PROVIDED BY NATIONAL FUEL. ALL OTHER MGP STRUCTURES DIGITIZED FROM 1893 AND 1904 SANBORN FIRE INSURANCE MAPS.
3. MONITORING WELLS MW-5 AND MW-6, AND SOIL BORINGS SB-9 THROUGH SB-12 FROM SURVEY FILE PROVIDED BY C.T. MALE ASSOCIATES, DATED 10/7/11. MONITORING WELLS MW-7 AND MW-8 FROM SURVEY FILE PROVIDED BY C.T. MALE ASSOCIATES, DATED 10/1/12.
4. AERIAL PHOTOGRAPH FROM GOOGLE EARTH PRO OBTAINED ON JANUARY 28, 2012 DATED OCTOBER 6, 2011.

0 80' 160'
GRAPHIC SCALE

NATIONAL FUEL
DUNKIRK FORMER MGP SITE
DUNKIRK, NEW YORK
REMEDIAL INVESTIGATION

OFFSITE INVESTIGATION LOCATIONS

ARCADIS

FIGURE
2

CITY: SYRACUSE, N.Y. DIV/GROUP: ENV/IM-DV DB: LPOSENAUER, R.ALLEN, R. BASSETT LD:(Opt) PIC:(Opt) PM: S.POWLIN TM:(Opt) LYR:(Opt)ON=*;OFF=*REF*
G:\ENVCAD\SYRACUSE\ACT\B0023301\0001\00002\DWG\RI\23301P02.dwg LAYOUT: 2 SAVED: 1/29/2013 9:52 AM ACADVER: 18.1S (LMS TECH) PAGESETUP: ---- PLOTSTYLETABLE: PLTFULL.CTB PLOTTED: 1/29/2013 9:54 AM BY: BASSETT, RICHARD
XREFS: IMAGES: PROJECTNAME: ----
23301X03 23301X02.jp2
23301XBL

Attachment 2

Field Sampling Plan

ARCADIS
Infrastructure, environment, buildings

Imagine the result

National Fuel Gas Distribution Corporation

Appendix A
Field Sampling Plan

Dunkirk Former Manufactured Gas Plant Site
(Site No. 9-07-035)
Dunkirk, New York

February 2009

ARCADIS

Terry W. Young
Principal-in-Charge

Scott A. Powlin
Senior Geologist

Appendix A
Field Sampling Plan

Dunkirk Former Manufactured Gas Plant Site
Dunkirk, New York

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Our Ref.:

B0023301.0000.00001

Date:

February 2009

Figures

Attachments

1. Introduction

1.1 General

This Field Sampling Plan (FSP) supports the Site Characterization (SC) Work Plan prepared by ARCADIS for the Dunkirk former Manufactured Gas Plant (MGP) Site (the “site”) located in Dunkirk, New York. The investigation locations described in the SC Work Plan are shown on Figure 1 of the Work Plan. The SC Work Plan and this FSP were prepared on behalf of National Fuel Gas Distribution Corporation (National Fuel).

This FSP contains field procedures and sample collection methods to be used during implementation of the field activities described in the SC Work Plan. The FSP should be used in conjunction with the SC Work Plan, the Quality Assurance/Sampling and Analysis Project Plan (QA/SAPP), and the Health and Safety Plan (HASP). The SC Work Plan presents the site background and defines the field sampling program. The QA/SAPP outlines the procedures that will be used during the SC to ensure that data collected and subsequent reports are of high enough quality to meet project objectives. The HASP presents the procedures and practices to be followed during the SC field work to help ensure the safety of workers, and is designed to prevent occupational injuries and worker exposures to chemical, physical and biological hazards. The QA/SAPP and HASP are provided in Appendix B and Appendix C, respectively, of the SC Work Plan.

1.2 Project Objectives

The overall objectives of the SC are to:

- assess whether MGP-related residual materials are present at the site related to the operation of the former MGP.

- determine whether MGP-related residual materials, if present at the site, have a potential to pose a significant threat to public health or the environment.

- determine whether a Remedial Investigation (RI) of the site is appropriate.

The technical approach to address the above objectives is provided in Table 1 of the SC Work Plan.

1.3 Overview of Investigation Field Activities

To obtain information necessary to meet the investigation objective stated above, the following activities will be conducted:

- Drilling soil borings
- Installing monitoring wells
- Measuring fluid levels
- Collecting soil samples during the advancement of the monitoring wells and soil borings
- Collecting groundwater samples
- Conducting a geophysical survey
- Conducting a site survey

The sampling locations and quantities for each field sampling activity are described in detail in the SC Work Plan, and therefore, are not further described in this FSP.

1.4 Site Description and History

1.4.1 Site Description

The approximately 3 acre site is located at 31 West 2nd Street at the southeastern corner of the intersection of Swan Street and West 2nd Street in Dunkirk, Chautauqua County, New York (see Figure 1 of the SC Work Plan). The site comprises a generally rectangular piece of land that is now located in a mixed commercial and residential area. Lake Erie is located about 600 feet north of the site. The site is bordered by Swan Street to the west, West 2nd Street to the north, Eagle Street to the east, and an elevated railroad bed to the south. A Baptist Church is located near the southeastern corner of the site; however, a narrow strip of National Fuel property borders the church property to the south (see Figure 2 of the SC Work Plan).

A National Fuel Service Center building sits on the northeastern quadrant of the site. The Service Center building consists of a high-bay garage located south of the attached office area. Two other buildings are present at the property – a small metal sided storage building and a brick gas regulator building, which are both located south-south west of the Service Center building. A fuel pump island is located west of the metal sided storage building and consists of a pump island supported by an above ground storage tank (AST) containing diesel and an underground storage tank (UST) containing gasoline. The current site structures are shown on Figure 2 of the SC Work Plan.

The site is generally flat-lying and is largely paved with asphalt. A gravel-covered area used for staging gas distribution supplies is found in the southern approximately ¼ of the site. Small strips of grass areas are located in the rights-of-way along the perimeter of the site and in the northeast corner of the site. A grassy area also exists on the southern edge of the site, near the railroad.

1.4.2 Site History

The MGP operated from the late 1800s to approximately 1910. National Fuel currently owns the site (NFG, 2008). Based on a review of available Sanborn Fire Insurance Maps from 1888 to 1964, at its peak, the MGP consisted of three gas holders (which for the purpose of this Work Plan are numbered sequentially from east to west as holder 1 to holder 3), a retort house, a purifier house, a coal shed, and an oil tank. With the exception of holder 3, (the furthest to the west), the plant structures all existed in the northeast corner of the site. The current Service Center Building sits over at least a portion of holder 2, the retort house, the purifier house, and the coal shed. Figure 2 of the SC Work Plan shows the locations of the former MGP structures as they relate to present-day features. Limited information is available regarding gas production at the Dunkirk MGP; however, a review of the publication “Survey of Town Gas and By-Product Production and Locations in the U.S.” indicates that approximately 7, 23, and 26 million cubic feet of gas was produced at the MGP in 1890, 1900, and 1910 (Radian Corporation, 1985).

Coal was the primary feedstock for the manufactured gas process at the site (Radian Corporation, 1985). This method of producing gas, known as the coal carbonization method, consisted of heating bituminous coal in a sealed chamber (i.e., retorts), with destructive distillation of gas from the coal and the formation of coke. The gases were collected, cleaned (or purified), and distributed while coke was removed and sold or used. The main byproducts of the coal carbonization method were tars, oils, coke, ammoniacal liquor, ash and clinker, and residuals associated with the gas purification process (purifier wastes). The tars were generally viscous and contained higher concentrations of phenols and base nitrogen organics when compared to the tars generated from a later gas producing process known as the carbureted water-gas process. Coal carbonization also produced cyanide in the gas, which was removed during gas purification and often appears in wastes such as lime and wood chips.

2. Field Activities

2.1 General Field Guidelines

All underground utilities will be identified prior to any drilling or subsurface sampling. Public and privately owned utilities will be located by contacting Dig Safely New York such that responsible agencies can mark their underground utilities at the site. Site access agreements will be obtained prior to conducting any field work on properties not owned by National Fuel. Other potential on site hazards such as traffic, overhead power lines, and building hazards will be identified during a site reconnaissance visit.

Field log books will be maintained by the Field Manager/ Site Supervisor and other team members to provide a daily record of significant events, observations, and measurements during the field investigation.

Information pertinent to the field investigation and/or sampling activities will also be recorded in the log books. The books will be bound with consecutively numbered pages. Entries in the log book will include, at a minimum, the following information:

- Name of author, date of entry, and physical/environmental conditions during field activity
- Purpose of sampling activity
- Location of sampling activity
- Name of field crew members
- Name of any site visitors
- Sample media (soil, sediment, groundwater, etc.)
- Sample collection method
- Number and volume of sample(s) taken
- Description of sampling point(s)
- Volume of groundwater removed before sampling (where appropriate)
- Preservatives used
- Date and time of collection
- Sample identification number(s)
- Field observations
- Any field measurements made, such as pH, temperature, conductivity, water-level, etc.

All original data recorded in field log books and Chain of Custody (COC) records will be written with indelible ink. If an error is made in these documents, the individual entering the data will make all corrections simply by crossing a single line through the error and entering the correct information. The erroneous information will not be erased or made illegible. Any subsequent error discovered on an accountable document will be corrected by the person who made the entry. All subsequent corrections will be initialed and dated.

2.2 Sample Labeling, Packing, and Shipping

Each sample will be given a unique identification. With this type of identification, no two samples will have the same label.

Samples will be promptly labeled upon collection with the following information:

- Project number and site
- Unique sample identification
- Analysis required
- Date and time sampled
- Sample type (composite or grab)
- Preservative, if applicable

Clear tape will be secured over the sample label and the COC will be initiated. A sample COC form is included on Figure A-1.

If samples are to be shipped by commercial carrier (e.g., UPS), sample bottles/jars will be packed in coolers containing the following:

- One-to-two inches of vermiculite or bubble wrap on the bottom of the cooler
- Water ice packaged in re-sealable plastic bags
- Sufficient vermiculite or bubble wrap to fill in the remaining area
- The completed COC in a re-sealable plastic bag, taped in place on the inside cover of the cooler

The cooler will then be sealed with tape. If the cooler contains a drain plug, it must be sealed with duct tape. Appropriate shipping labels, such as "this-end-up" and "fragile" stickers will be affixed to the cooler. Samples will be hand delivered or delivered by an express carrier within 48 hours of sample collection. The express carrier will not be required to sign the COC form; however, the shipping receipt should be retained by the sampler, and forwarded to the project files.

2.3 Equipment Decontamination

2.3.1 Drill Rig Decontamination

A decontamination pad will be lined with plastic sheeting on a surface sloped to a sump. The sump must also be lined and of sufficient volume to contain approximately 20 gallons of decontamination water. All drilling equipment including rear-end of drilling rig, augers, bits, rods, tools, split spoon samplers, and tremie pipe will be cleaned on the decontamination pad with a high pressure hot water "steam cleaner" unit and scrubbed with a wire brush, as needed, to remove dirt, grease, and oil before beginning work in the project area. If heavy accumulations of tars or oils are present on the downhole tools, a citrus-based cleaner (e.g., Citra-Solv®) may be used to aid in equipment cleaning. Tools, drill rods, and augers will be placed on sawhorses, decontaminated pallets, or polyethylene plastic sheets following steam cleaning. Direct contact with the ground will be avoided. The back of the drill rig and augers, rods, and tools will be decontaminated between each drilling location according to the above procedures. Decontamination water will be contained in a dedicated plastic tank or 55-gallon open-top drums located on site. All open-top drums will remain closed when not in use.

Following decontamination of all heavy site equipment, the decontamination pad will be decommissioned. The decommissioning will be completed by:

- Transferring the bulk of the remaining liquids and solids into the drums, tanks, and roll-offs to be provided by National Fuel or the drilling subcontractor for these materials.

- Rolling the sheeting used in the decontamination pad onto itself to prevent discharge of the remaining materials to the ground surface. Once rolled up, the polyethylene sheeting will be placed in the roll-off or drums used for disposal of personal protective equipment (PPE) and disposable equipment.

Unless sealed in manufacturer’s packaging, polyvinyl chloride (PVC) monitoring well casing screens will be decontaminated by the above procedures before installation.

2.3.2 Sampling Equipment Decontamination

Prior to every entry into each borehole, all non dedicated bowls, spoons, hand augers, bailers, and filtering equipment will be washed with potable water and a detergent (such as Alconox). Decontamination may take place at the sampling location as long as all liquids are contained in pails, buckets, etc. The sampling equipment will then be rinsed with potable water, followed by a 10% “pesticide-grade” methanol rinse, and finally a distilled water rinse. When sampling for inorganic constituents in an aqueous phase, an additional rinse step will be added prior to the rinse with methanol. The rinse step will entail a rinse with a 10% “ultra pure-grade” nitric acid followed by a distilled water rinse. Between rinses, equipment will be placed on polyethylene sheets or aluminum foil if necessary. At no time will washed equipment be placed directly on the ground. Equipment will be either be used immediately or wrapped in plastic or aluminum foil for storage or transportation from the designated decontamination area to the sampling location.

2.4 Drilling Procedures

The drilling and geological logging methods to be used during the subsurface investigation are as follows:

- Boreholes in the overburden will be drilled using hollow stem auger or direct push techniques. If difficult drilling conditions are encountered in the subsurface soils, alternate drilling methods may be used.

- Boreholes drilled using hollow stem augers will be advanced using a drill rig equipped with 3- or 4-inch hollow stem augers. Soil samples will be collected continuously to the bottom of the borings using 2-foot-long, 2-inch diameter discrete split spoon samplers advanced 2 feet per sampling run. Sampling method ASTM D1586-84 (Standard Method for Penetration Test and Split-Barrel Sampling of Soils) will be followed, unless otherwise authorized by the Field Manager/Site Supervisor.

- Boreholes drilled using direct push techniques will be advanced using either a truck or tractor mounted push/percussion drill rig. Soil samples will be collected continuously to the bottom of the borings using 2- or 4-foot-long, 2-inch diameter Macrocore® samplers, equipped with disposable PVC liners, advanced 2 to 4 feet per sampling run.

- For samples that may be submitted for chemical analysis, split spoons will be decontaminated, as specified in Section 2.3.2, between uses. Sample descriptions, photoionization detector (PID) readings, and location will be recorded in the field book.

- Upon completion of each boring, the borehole will be sealed with a bentonite/cement grout tremied in place from the bottom of the borehole up.

- A plywood sheet or tub may be placed around the auger or casing when drilling to contain cuttings.

- Cuttings will be placed in a drum or roll off supplied by National Fuel or the drilling subcontractor. Decontamination water will be placed in drums or plastic tanks supplied by National Fuel or the drilling subcontractor. Soil cuttings and decontamination water will be picked up and containerized at the end of each work day. The roll-offs or open-top drums used to contain the solids will be covered when not in use.

Pertinent notes regarding the drilling work will be recorded in the field book.

2.5 Sample Description

Collected samples will be described by persons who have been trained in ARCADIS soil description procedures and have a degree in geology or a geology-related discipline. The procedure that will be followed for describing soils is contained in Attachment A-1.

2.6 Subsurface Soil Analytical Sampling Procedure

Subsurface soils collected from the unconsolidated fill and soils beneath the site using split spoon or Macrocore® sampling methods will be selected for laboratory analysis based on:

- their position in relation to potential source areas.
- the visual presence of source materials.
- the relative levels of volatile organics based on PID field screening measurements.
- the discretion of the field manager.

Samples selected for laboratory analysis will be placed in the appropriate containers provided by the laboratory. Sample containers for volatile organic analyses will be filled first. Next, a sufficient amount of the remaining soil will be homogenized by mixing the sample in a decontaminated stainless steel tray or bowl with a decontaminated stainless steel trowel or disposable scoop. Laboratory-supplied sample containers for other analytes will then be filled. Duplicate samples will be collected at the frequency detailed in the QA/SAPP (Appendix B) by alternately filling two sets of sample containers.

Where there is sufficient sample volume, representative portions of each soil sample will be placed in a one-pint jar or re-closable plastic bag, labeled, and stored on site. This container will be labeled with the following:

- Site
- Boring number
- Interval sampled
- Date
- Initials of sampling personnel

2.7 Monitoring Well Installation and Development

Monitoring wells will be installed to the depths and at the locations defined in the SC Work Plan. After completion of drilling and well installation, all wells will be developed to establish hydraulic connection between the well and the formation. The following procedures will be used to install, and develop monitoring wells.

2.7.1 Monitoring Well Specifications

Figure A-2 shows details of a typical monitoring well construction for shallow wells installed in unconsolidated soils that do not penetrate a presumed confining layer. The overburden monitoring wells will be installed according to the following specifications:

- PVC 2-inch diameter, threaded, flush-joint casing and 10-foot-long, 0.010-inch or 0.020-inch slot screens will be installed, depending on the grain size of the material being screened.

- A sump, 2 feet in length and grouted in place with cement, may be attached to the bottom of the screen for potential collection of dense non-aqueous phase liquids (DNAPLs), if present.

- The top of the casing will extend approximately 2 feet above ground surface given site-specific considerations; otherwise, flush-mount casings will be used.

- The annulus around the screens will be backfilled with an appropriate size of silica sand to a minimum height of 1 foot above the top of the screen, assuming there is sufficient room to install an appropriate surface seal above the sand.

- An approximately 2-foot-thick (depending on conditions) chipped bentonite seal or slurry (30 gallons water to 25 to 30 pounds bentonite, or relative proportions) will be placed above the sand pack.

- The remainder of the annular space will be filled with a cement/bentonite grout to approximately 2 feet below grade. The grout will be placed with a tremie pipe from the bottom up. The grout will consist of a cement mixture of one 94 pound bag of Portland cement, approximately 5 pounds of granular bentonite, and approximately 7 gallons of water. The grout will be allowed to set for a minimum of 24 hours before wells are developed.

- Each monitoring well will have a vented cap and be protected at the surface with a 4-inch steel casing containing a locking cap. The protective casing will extend approximately 1 to 2 feet below ground surface (bgs) and be set in concrete. In some areas, it may be necessary to provide flush-mounted surface completions.

- A concrete seal or pad, approximately 2 feet in diameter and 1.5 feet deep, will be installed.

The following characteristics of each newly installed well will be recorded in the field log book:

- Date/time of construction
- Drilling method and drilling fluid used
- Approximate well location
- Borehole diameter and well casing diameter
- Well depth
- Drilling and lithologic logs
- Casing materials
- Screen materials and design
- Casing and screen joint type
- Screen slot size/length
- Filter pack material/size
- Filter pack placement method
- Sealant materials

- Sealant placement method
- Well development procedure
- Type of protective well cap
- Detailed drawing of well (including dimensions)

2.7.2 Monitoring Well Development

A minimum of 24 hours after installation, the monitoring wells will be developed by surging/bailing, using a centrifugal pump and dedicated polyethylene tubing, or by Waterra positive displacement pumps and dedicated polyethylene tubing, or other methods at the discretion of the Field Manager/Site Supervisor. The development water will be contained in a tank on site or in drums to be provided by National Fuel or the drilling subcontractor. The wells will be developed until the water removed from the well is reasonably free of visible sediment (50 nephelometric turbidity units [NTUs]), if possible, or until the turbidity levels stabilize, assuming a minimum of 10 well volumes of water have been removed from the monitoring well during development. Following development, wells will be allowed to recover for at least one week before groundwater is purged and sampled. All monitoring well development will be overseen by a field geologist and the duration, method of development, and approximate volume of water removed will be recorded in the field book.

2.8 Fluid-level Measurements

The following procedure will be used to measure fluid-level depths at monitoring wells and surface water gauges:

- Decontaminate the water level probe or oil/water interface probe (for wells expected to contain non-aqueous phase liquids [NAPLs]).

- Measure the static fluid-level, fluid interfaces (i.e., NAPL/water interface), and sound the bottom of the well (if applicable) with reference to the surveyed elevation mark on the top of the PVC casing or surface water gauge. Record all measurements to nearest 0.01 foot and record in the field book.

The measurements will be made in as short a timeframe as practical to minimize temporal fluctuations in hydraulic conditions.

2.9 Low-Flow Groundwater Sampling Procedures for Monitoring Wells

This protocol describes the procedures to be used to collect groundwater samples. No wells will be sampled until well development has been performed. During precipitation events, groundwater sampling will be discontinued until precipitation ceases. When one round of water levels is taken to generate water-elevation data, the water levels will be taken consecutively at one time prior to sampling or other activities.

The following materials, as required, shall be available during groundwater sampling:

- Sample pump
- Sample tubing
- Power source (i.e., generator, battery)
- PID
- Appropriate health and safety equipment as specified in the HASP
- Plastic sheeting (for each sampling location)
- Dedicated or disposable bailers
- New disposable polypropylene rope
- Buckets to measure purge water
- Water-level probe
- Six-foot rule with gradation in hundredths of a foot
- Conductivity/temperature meter
- pH meter
- Turbidity meter
- Appropriate water sample containers
- Appropriate blanks (trip blank supplied by the laboratory)
- Appropriate transport containers (coolers) with ice and appropriate labeling, packing, and shipping materials
- Groundwater sampling logs
- COC forms
- Indelible ink pens
- Site map with well locations and groundwater contours maps
- Keys to wells

The following 21 steps detail the monitoring well sampling procedures:

1. Review materials checklist (Part II) to ensure that the appropriate equipment has been acquired.

2. Identify site and well sampled on sampling log sheets, along with date, arrival time, and weather conditions. Identify the personnel and equipment used and other pertinent data requested on the logs (Attachment A-2).

3. Label all sample containers using an appropriate label.

4. Use safety equipment, as required in the HASP.

5. Place plastic sheeting adjacent to the well to use as a clean work area.

6. Establish the background reading with the PID and record the reading on the field log.

7. Remove lock from the well and if rusted or broken replace with a new brass keyed-alike lock.

8. Unlock and open the well cover while standing upwind of the well. Remove well cap and place on the plastic sheeting. Insert PID probe in the breathing zone above the well casing following instructions in the HASP.

9. Set out on plastic sheeting the dedicated or disposable sampling device and meters.

10. Prior to sampling, groundwater elevations will be measured at each monitoring well and the presence of light non-aqueous phase liquid (LNAPL) or DNAPL (if any) within the well will be evaluated. Obtain a water-level depth and bottom of well depth using an electric well probe and record on the sampling log sheet. Clean the well probe after each use with a soapy (Alconox) water wash and a tap water rinse. [Note: water levels will be measured at all wells prior to initiating a sampling event].

11. After groundwater elevations are measured and NAPLs are determined not to be present, groundwater will be purged from the wells. If NAPLs are determined present, then a groundwater sample will not be collected, rather a representative NAPL sample may be collected (if required) using a peristaltic pump or other method determined by the Field Manager/Site Supervisor.

12. Pump, safety cable, electrical lines, and/or tubing (for peristaltic pumps) will be lowered slowly into the well to a depth corresponding to the center of the saturated screen section of the well.

13. Measure the water level again with the pump in the well before starting the pump. Start pumping the well at 200 to 500 milliliters per minute. Ideally, the pump rate should cause little water-level drawdown in the well (less than 0.3 feet and the water level should stabilize). The water level should be monitored every three to five minutes (or as appropriate) during pumping. Care should be taken not to cause the pump suction to be broken or entrainment of air in the sample. Record pumping rate adjustments and depths to water. Pumping rates should, if needed, be reduced to the minimum capabilities of the pump to avoid pumping the well dry and/or to ensure stabilization of indicator parameters. If the recharge rate of the well is very low, purging should be interrupted so as not to cause the drawdown within the well to advance below the pump. However, a steady flow rate should be maintained to the extent practicable. Sampling should commence as soon as the volume in the well has recovered sufficiently to permit sample collection.

14. During well purging, monitor the field indicator parameters (turbidity, temperature, specific conductance, pH, dissolved oxygen [DO], and oxidation-reduction potential [ORP]) every three to five minutes (or as appropriate). The well is considered stabilized and ready for sample collection when the indicator parameters have stabilized for three consecutive readings as follows (Puls and Barcelona, 1996):

    ±0.1 for pH

    ±3% for specific conductance (conductivity)

    ±10 mV for ORP

    ±10% for turbidity and DO

    Note that turbidity and DO usually require the longest time to achieve stabilization. As such, sampling may be allowed prior to stabilization of turbidity and/or DO if all other parameters have stabilized. The decision to sample under this scenario must be agreed to by the Project Manager.

    The pump must not be removed from the well between purging and sampling. If the parameters have stabilized, but the turbidity is not in the range of the 50 NTU goal, the pump flow rate should be decreased to no more than 100 millimeters per minute. Measurement of the indicator parameters should continue every three to five minutes. Measurements for parameters may be taken using a flow-thru cell or in a clean container such as a glass beaker. Measurements of DO should be taken from a sample collected using an in-line tee fitting installed before the tubing outlet, prior to connection to the flow-through cell (if one is being used). DO measurements should be measured using a field test kit (e.g., colorimetric).

15. Fill in the sample label and cover the label with clear packing tape to secure the label onto the container.

16. After the groundwater quality parameters have stabilized as discussed above, obtain the groundwater sample needed for analysis directly from the sampling device in the appropriate container and tightly screw on the caps. Note that groundwater samples collected for analysis of VOCs cannot be collected using a peristaltic pump. If purging the well using a peristaltic pump, collect all other types of samples (e.g., SVOCs, inorganics, etc.) prior to collecting the sample for VOC analysis. Once other samples are collected, remove the peristaltic pump tubing and collect the VOC samples using a new disposable polyethylene bailer. The bailer should be gently lowered to the approximate depth that the pump intake was set, and then retrieved.

17. Secure with packing material and store at 4 degrees Celsius on wet ice in an insulated transport container provided by the laboratory.

18. After all sampling containers have been filled, remove one additional volume of groundwater. Check the calibration of the meters and then measure and record on the field log the physical appearance, pH, temperature, turbidity, and conductivity.

19. Record the time sampling procedures were completed on the field logs.

20. Place all disposable sampling materials (plastic sheeting, disposable bailers, and health and safety equipment) in appropriately labeled containers. Go to the next well and repeat Step 1 through Step 21 until all wells are sampled.

21. Complete the procedures for packaging, shipping, and handling with associated COC forms.

2.10 Geophysical Survey

A geophysical investigation will be performed to assist in the delineation of subsurface structures (e.g., former holder structures, foundation walls, utility locations, etc.) that may be present at the site, and could influence the distribution of MGP-related material. The geophysical investigation will consist of ground penetrating radar (GPR) and electromagnetic (EM) surveys. These surveys will be performed following the general procedures provided below.

2.10.1 EM Survey

The EM survey will be conducted on a 10-foot grid across the accessible areas of the site. This survey is designed to identify anomalies that may be associated with buried former MGP structures and/or areas that have decreased or elevated ground conductivity (as compared to background values), which could represent MGP-related structures or materials.

The EM survey will be performed using a Geonics EM-31 frequency-domain conductivity meter equipped with a digital data recorder. The EM survey data will be collected using vertical dipole orientation with both quadrature (apparent conductivity) and inphase (metal sensitivity) modes. The EM-31 uses a fixed intercoil spacing of 12.1 feet to provide an exploration depth of approximately 16 feet. This exploration depth should be adequate for evaluating subsurface features of interest at the site.

The EM data will be reduced, contoured and evaluated at the site and compared with historic information to determine if any anomalies that are present are associated with past activities. Areas of decrease or elevated EM measurements will be further investigated using GPR. A contour map of the EM measurements will be generated for the geophysical letter report.

2.10.2 Ground Penetrating Radar Survey

The Ground Penetrating Radar (GPR) survey will be performed to further investigate the EM anomalies and any additional locations of interest at the site as identified from historical site information, to characterize subsurface structures. The GPR data will be used to help identify potential locations for confirmatory test pits and/or soil borings.

The GPR survey will be performed using Subsurface Interfacing Radar (SIR) System 3000, manufactured by Geophysical Survey Systems, Inc. (GSSI). The GPR system transmits high-frequency electromagnetic waves into the ground and detects the energy reflected to the surface. Energy is reflected along boundaries of subsurface interfaces that have different electrical properties. Reflections typically occur at lithologic contacts or at changes in subsurface material having high electrical contrasts, including metal objects, concrete structures, and utility pipes. These reflections are detected by an antenna and processed into an electrical signal that is used to create an image of the subsurface feature. The GPR data will be evaluated in the field to determine the location of subsurface features of interest. Subsurface features considered to be of significant interest will be located and marked in the field for potential investigation using intrusive methods (test pits and/or soil borings).

2.11 Air Monitoring

Air monitoring will be conducted in accordance with the procedures detailed in the HASP (Appendix C). Air monitoring will be conducted with a PID and dust monitor during all intrusive land activities and only a PID during sampling activities. The PID will be used to monitor organic vapors in the breathing zone and borehole, and to screen samples for analysis and the dust monitor will be used to monitor particulate concentration in the breathing zone for particulates less than 10 microns in diameter.

The PID and dust monitor readings will be recorded in the field book during trenching and drilling activities. The instruments will be calibrated at least once each day, and more frequently if needed. A detailed procedure for the PID calibration is included as Attachment A-3.

3. Field Instruments

At a minimum, all field screening equipment will be calibrated immediately prior to each day's use. Additional calibration may be required if measurements appear erroneous. The calibration procedures will conform to the manufacturer's standard instructions. Records of all instrument calibration will be maintained by the field personnel. Copies of all of the instrument manuals will be maintained on site by the field personnel.

3.1 Portable Photoionization Analyzer

The photoionization analyzer will be a Photovac MicroTip (or equivalent), equipped with a 10.6 eV lamp or 11.7 eV lamp, depending on the requirements of the HASP. The Photovac is capable of ionizing and detecting compounds with an ionization potential of less than 10.6 eV. This accounts for up to 73% of the TCL VOCs. Calibration will be performed according to the procedures outlined in Attachment A-3.

3.2 Dust Monitor

The dust monitor will be a MIE DataRAM (or equivalent) and will be calibrated at the start of each day of use. Calibration and maintenance of the dust monitor will be conducted in accordance with the manufacturer’s specifications. The calibration data will be recorded in field notebooks.

3.3 pH Meter

The pH meter will be calibrated at the start of each day of use, and after very high or low readings as required by this plan. National Institute of Standards and Technology traceable standard buffer solutions that bracket the expected pH range will be used. The standards will most likely be a pH of 7.0 and 10.0 standard units. The pH calibration and slope knobs will be used to set the meter to display the value of the standard being checked. The calibration data will be recorded in field notebooks.

3.4 Conductivity Meter

Calibration checks using the appropriate conductivity standard for the meter will be performed at the start of each day of use, and after very high or low readings, as required by this plan. Readings must be within 5% to be acceptable.

3.5 Water-Level Meter

The water-level cable will be checked once to a standard to assess if the meter has been correctly calibrated by the manufacturer or vendor. If the markers are incorrect, the meter will be sent back to the manufacturer or vendor.

3.6 Turbidity Meter

The turbidity meter will be calibrated daily prior to use. Calibration and maintenance will be conducted in accordance with the manufacturer’s specifications. Calibration and maintenance information will be recorded in the field notebook.

ARCADIS

Appendix A
Field Sampling Plan

FIGURES

Figure A-1

Sample Chain-of-Custody Form

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ID#: 11999

CHAIN OF CUSTODY & LABORATORY ANALYSIS REQUEST FORM

Page ___ of ___

Lab Work Order #

Send Results to:

Contact & Company Name:	Telephone:
Address:	Fax:
City State Zip	E-mail Address:
Project Name/Location (City, State):	Project #:
Sampler's Printed Name:	Sampler's Signature:

Preservative							
Filtered (✓)							
# of Containers							
Container Information							

PARAMETER ANALYSIS & METHOD

Keys

Preservation Key:
A. H_2SO_4
B. HCL
C. HNO_3
D. NaOH
E. None
F. Other: ______
G. Other: ______
H. Other: ______

Container Information Key:
1. 40 ml Vial
2. 1 L Amber
3. 250 ml Plastic
4. 500 ml Plastic
5. Encore
6. 2 oz. Glass
7. 4 oz. Glass
8. 8 oz. Glass
9. Other: ______
10. Other: ______

Matrix Key:

SO - Soil	SE - Sediment	NL - NAPL/Oil
W - Water	SL - Sludge	SW - Sample Wipe
T - Tissue	A - Air	Other: ______

Sample ID	Collection		Type (✓)		Matrix								REMARKS
	Date	Time	Comp	Grab									

Special Instructions/Comments:

☐ **Special QA/QC Instructions(✓):**

Laboratory Information and Receipt		Relinquished By	Received By	Relinquished By	Laboratory Received By
Lab Name:	Cooler Custody Seal (✓)	Printed Name:	Printed Name:	Printed Name:	Printed Name:
☐ Cooler packed with ice (✓)	☐ Intact ☐ Not Intact	Signature:	Signature:	Signature:	Signature:
Specify Turnaround Requirements:	Sample Receipt:	Firm:	Firm/Courier:	Firm/Courier:	Firm:
Shipping Tracking #:	Condition/Cooler Temp: ______	Date/Time:	Date/Time:	Date/Time:	Date/Time:

Distribution: WHITE – Laboratory returns with results YELLOW – Lab copy PINK – Retained by BBL

Figure A-2

Monitoring Well Construction
Diagram

Date Start/Finish:
Drilling Company:
Driller's Name:
Drilling Method:
Bit Size:
Auger Size:
Rig Type:
Sampling Method:

Northing: NA
Easting: NA
Casing Elevation: NA

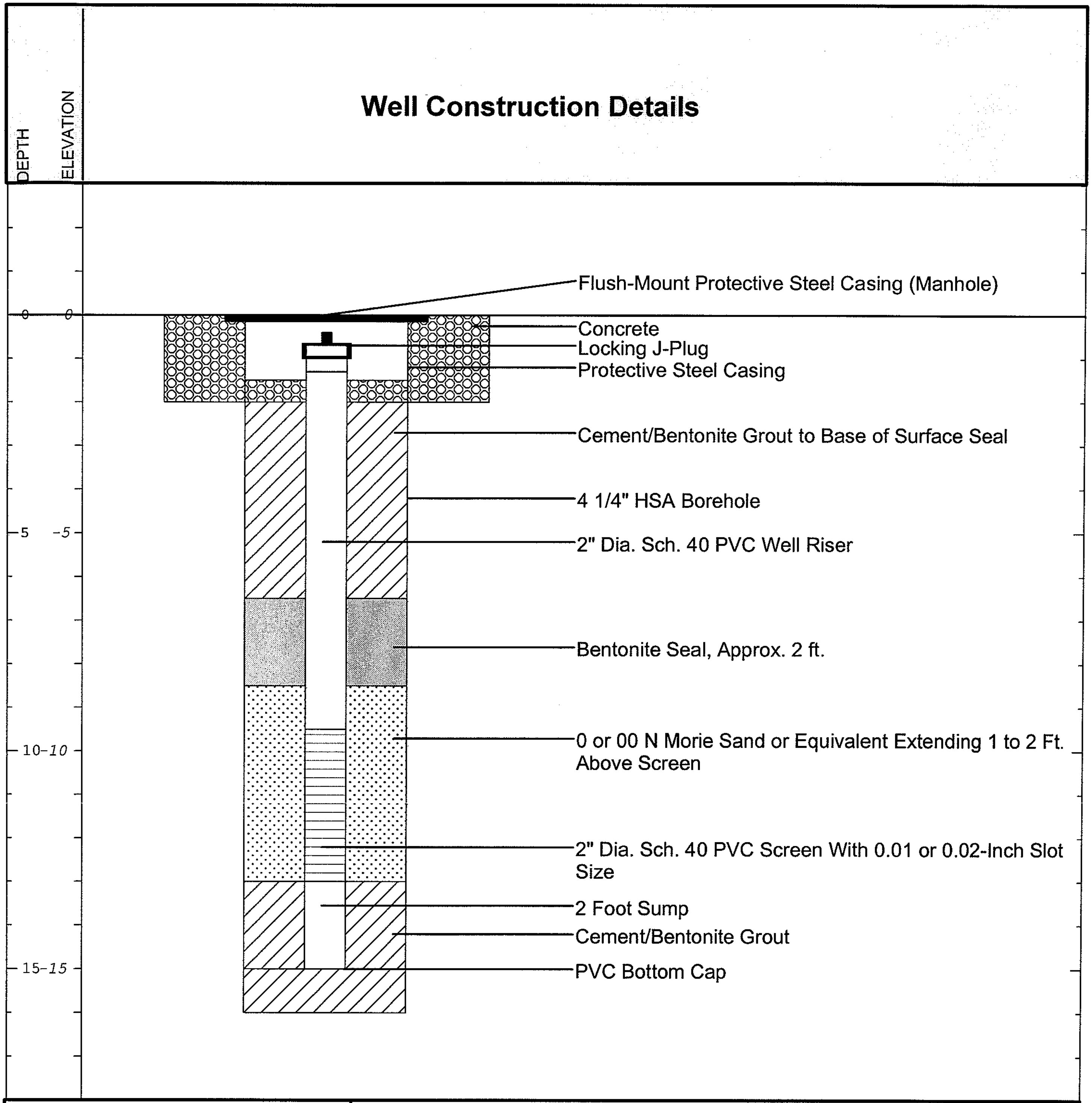
Borehole Depth:
Surface Elevation:

Descriptions By:

Well ID: **EXAMPLE WELL 1**
Client:

Location:

Well Construction Details



ARCADIS BBL
Infrastructure, environment, facilities

Remarks:

Project Number:
Data File:Wellconst2005.dat

Template:J:\Rockware\LogPlot2001\LogFiles\20530\Proposed Single-Cased MWdraft.dat
Date: 5/30/2007

Appendix A
Field Sampling Plan

ATTACHMENTS

ARCADIS

Attachment A-1

Soil Description Procedures

ARCADIS
Infrastructure, environment, facilities

Imagine the result

Soil Description

Rev. #: 0

Rev Date: May 20, 2008

Approval Signatures

Prepared by: Joel A. Hunt Date: 5/22/08

Reviewed by: Date: 5/22/08
(Technical Expert)

Reviewed by Michael J Gefell Date: 5/22/08
(Technical Expert)

I. Scope and Application

This ARCADIS standard operating procedure (SOP) describes proper soil description procedures. This SOP should be followed for all unconsolidated material unless there is an established client-required specific SOP or regulatory-required specific SOP. In cases where there is a required specific SOP, it should be followed and should be referenced and/or provided as an appendix to reports that include soil classifications and/or boring logs. When following a required non-ARCADIS SOP, additional information required by this SOP should be included in field notes with client approval.

This SOP has been developed to emphasize field observation and documentation of details required to:

- make hydrostratigraphic interpretations guided by depositional environment/geologic settings;

- provide information needed to understand the distribution of constituents of concern; properly design wells, piezometers, and/or additional field investigations; and develop appropriate remedial strategies.

This SOP incorporates elements from various standard systems such as ASTM D2488-06, Unified Soil Classification System, Burmister and Wentworth. However, none of these standard systems focus specifically on contaminant hydrogeology and remedial design. Therefore, although each of these systems contain valuable guidance and information related to correct descriptions, strict application of these systems can omit information critical to our clients and the projects that we perform.

This SOP does not address details of health and safety; drilling method selection; boring log preparation; sample collection; or laboratory analysis. Refer to other ARCADIS SOPS, the project work plans including the quality assurance project plan, sampling plan, and health and safety plan (HASP), as appropriate.

II. Personnel Qualifications

Soil descriptions will be completed only by persons who have been trained in ARCADIS soil description procedures. Field personnel will complete training on the ARCADIS soil description SOP in the office and/or in the field under the guidance of an experienced field geologist. For sites where soil descriptions have not previously been well documented, soil descriptions should be performed only by trained persons with a degree in geology or a geology-related discipline.

III. Equipment List

The following equipment should be taken to the field to facilitate soil descriptions:

- field book, field forms or PDA to record soil descriptions;
- field book for supplemental notes;
- this SOP for Soil Descriptions and any project-specific SOP (if required);
- field card showing Wentworth scale;
- Munsell® soil color chart;
- tape measure divided into tenths of a foot;
- stainless steel knife or spatula;
- hand lens;
- water squirt bottle;
- jar with lid;
- personal protective equipment (PPE), as required by the HASP; and
- digital camera.

IV. Cautions

Drilling and drilling-related hazards including subsurface utilities are discussed in other SOPs and site-specific HASPs and are not discussed herein.

Soil samples may contain hazardous substances that can result in exposure to persons describing soils. Routes for exposure may include dermal contact, inhalation and ingestion. Refer to the project specific HASP for guidance in these situations.

V. Health and Safety Considerations

Field activities associated with soil sampling and description will be performed in accordance with a site-specific HASP, a copy of which will be present on site during such activities. Know what hazardous substances may be present in the soil and understand their hazards. Always avoid the temptation to touch soils with bare hands, detect odors by placing soils close to your nose, or tasting soils.

VI. Procedure

1. Select the appropriate sampling method to obtain representative samples in accordance with the selected sub-surface exploration method, e.g. split-spoon or Shelby sample for hollow-stem drilling, Lexan or acetate sleeves for dual-tube direct push, etc.

2. Proceed with field activities in required sequence. Although completion of soil descriptions is often not the first activity after opening sampler, identification of stratigraphic changes is often necessary to select appropriate intervals for field screening and/or selection of laboratory samples.

3. Examine all of each individual soil sample (this is different than examining each sample selected for laboratory analysis), and record the following for each stratum:

- depth interval;
- principal component with descriptors, as appropriate;
- amount and identification of minor component(s) with descriptors as appropriate;
- moisture;
- consistency/density;
- color; and
- additional description or comments (recorded as notes).

The above is described more fully below.

DEPTH

To measure and record the depth below ground level (bgl) of top and bottom of each stratum, the following information should be recorded.

1. Measured depth to the top and bottom of sampled interval. Use starting depth of sample based upon measured tool length information and the length of sample interval.

2. Length of sample recovered, not including slough (material that has fallen into hole from previous interval), expressed as fraction with length of recovered sample as numerator over length of sampled interval as denominator (e.g. 14/24 for 14 inches recovered from 24-inch sampling interval that had 2 inches of slough discarded).

3. Thickness of each stratum measured sequentially from the top of recovery to the bottom of recovery.

4. Any observations of sample condition or drilling activity that would help identify whether there was loss from the top of the sampling interval, loss from the bottom of the sampling interval, or compression of the sampling interval. Examples: 14/24, gravel in nose of spoon; or 10/18 bottom 6 inches of spoon empty.

DETERMINATION OF COMPONENTS

Obtain a representative sample of soil from a single stratum. If multiple strata are present in a single sample interval, each stratum should be described separately. More specifically, if the sample is from a 2-foot long split-spoon where strata of coarse sand, fine sand and clay are present, then the resultant description should be of the three individual strata unless a combined description can clearly describe the interbedded nature of the three strata. Example: Fine Sand with interbedded lenses of Silt and Clay, ranging between 1 and 3 inches thick.

Identify principal component and express volume estimates for minor components on logs using the following standard modifiers.

Modifier	Percent of Total Sample (by volume)
and	36 - 50
some	21 - 35
little	10 - 20
trace	<10

Determination of components is based on using the Udden-Wentworth particle size classification (see below) and measurement of the average grain size diameter. Each size grade or class differs from the next larger grade or class by a constant ratio of ½. Due to visual limitations, the finer classifications of Wentworth’s scale cannot be distinguished in the field and the subgroups are not included. Visual determinations in the field should be made carefully by comparing the sample to the field gauge card that shows Udden-Wentworth scale or by measuring with a ruler. Use of field sieves s recommended to assist in estimating percentage of coarse grain sizes. Settling test or wash method (Appendix X4 of ASTM D2488) is recommended for determining presence and estimating percentage of clay and silt.

Udden-Wenworth Scale Modified ARCADIS, 2008			
Size Class	Millimeters	Inches	Standard Sieve #
Boulder	256 – 4096	10.08+	
Large cobble	128 - 256	5.04 -10.08	
Small cobble	64 - 128	2.52 – 5.04	
Very large pebble	32 – 64	0.16 - 2.52	
Large pebble	16 – 32	0.63 – 1.26	
Medium pebble	8 – 16	0.31 – 0.63	
Small pebble	4 – 8	0.16 – 0.31	No. 5 +
Granule	2 – 4	0.08 – 0.16	No.5 – No.10
Very coarse sand	1 -2	0.04 – 0.08	No.10 – No.18
Coarse sand	½ - 1	0.02 – 0.04	No.18 - No.35
Medium sand	¼ - ½	0.01 – 0.02	No.35 - No.60
Fine sand	1/8 -¼	0.005 – 0.1	No.60 - No.120
Very fine sand	1/16 – 1/8	0.002 – 0.005	No. 120 – No. 230
Silt (subgroups not included)	1/256 – 1/16	0.0002 – 0.002	Not applicable (analyze by pipette or hydrometer)
Clay (subgroups not included	1/2048 – 1/256	.00002 – 0.0002	

Identify components as follows. Remove particles greater than very large pebbles (64-mm diameter) from the soil sample. Record the volume estimate of the greater than very large pebbles. Examine the sample fraction of very large pebbles and smaller particles and estimate the volume percentage of the pebbles, granules, sand, silt and clay. Use the jar method, visual method, and/or wash method (Appendix X4 of ASTM D2488) to estimate the volume percentages of each category.

Determination of actual dry weight of each Udden-Wentworth fraction requires laboratory grain-size analysis using sieve sizes corresponding to Udden-Wentworth fractions and is highly recommended to determine grain-size distributions for each hydrostratigraphic unit.

Lab or field sieve analysis is advisable to characterize the variability and facies trends within each hydrostratigraphic unit. Field sieve-analysis can be performed on selected samples to estimate dry weight fraction of each category using ASTM D2488 Standard Practice for Classification of Soils for Engineering Purposes as guidance, but replace required sieve sizes with the following Udden-Wentworth set: U.S. Standard sieve mesh sizes 6; 12; 20; 40; 70; 140; and 270 to retain pebbles; granules; very coarse sand; coarse sand; medium sand; fine sand; and very fine sand, respectively.

PRINCIPAL COMPONENT

The principal component is the size fraction or range of size fractions containing the majority of the volume. Examples: the principal component in a sample that contained 55% pebbles would be “Pebbles”; or the principal component in a sample that was 20% fine sand, 30% medium sand and 25% coarse sand would be “Fine to coarse Sand” or for a sample that was 40% silt and 45% clay the principal component would be “Clay and Silt”.

Include appropriate descriptors with the principal component. These descriptors vary for different particle sizes as follows.

Angularity – Describe the angularity for very coarse sand and larger particles in accordance with the table below (ASTM D-2488-06). Figures showing examples of angularity are available in ASTM D-2488-06 and the ARCADIS Soil Description Field Guide.

Description	Criteria
Angular	Particles have sharp edges and relatively plane sides with unpolished surfaces.
Subangular	Particles are similar to angular description but have rounded edges.
Subrounded	Particles have nearly plane sides but have well-rounded corners and edges.
Rounded	Particles have smoothly curved sides and no edges.

Plasticity – Describe the plasticity for silt and clay based on observations made during the following test method (ASTM D-2488-06).

- As in the dilatancy test below, select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material, adding water if necessary, until it has a soft, but not sticky, consistency.

- Shape the test specimen into an elongated pat and roll by hand on a smooth surface or between the palms into a thread about 1/8 inch (3 mm) in diameter. (If the sample is too wet to roll easily, it should be spread into a thin layer and allowed to lose some water by evaporation.) Fold the sample threads and reroll repeatedly until the thread crumbles at a diameter of about 1/8 inch. The thread will crumble when the soil is near the plastic limit.

Description	Criteria
Nonplastic	A $^{1}/_{8}$ inch (3 mm) thread cannot be rolled at any water content.
Low	The thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit

Dilatancy – Describe the dilatancy for silt and silt-sand mixtures using the following field test method (ASTM D-2488-06).

- From the specimen select enough material to mold into a ball about ½ inch (12 mm) in diameter. Mold the material adding water if necessary, until it has a soft, but not sticky, consistency.

- Smooth the ball in the palm of one hand with a small spatula.

- Shake horizontally, striking the side of the hand vigorously with the other hand several times.

- Note the reaction of water appearing on the surface of the soil.

- Squeeze the sample by closing the hand or pinching the soil between the fingers, and not the reaction as none, slow, or rapid in accordance with the table below. The reaction is the speed with which water appears while shaking and disappears while squeezing.

Description	Criteria
None	No visible change in the specimen.
Slow	Water appears slowly on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing.
Rapid	Water appears quickly on the surface of the specimen during shaking and disappears quickly upon squeezing.

MINOR COMPONENT(S)

The minor component(s) are the size fraction(s) containing less than 50% volume. Example: the identified components are estimated to be 60% medium sand to granules, 25 % silt and clay; 15 % pebbles – there are two identified minor components: silt and clay; and pebbles.

Include a standard modifier to indicate percentage of minor components (see Table on Page 5) and the same descriptors that would be used for a principal component. Plasticity should be provided as a descriptor for the silt and clay. Dilatancy should be provided for silt and silt-sand mixtures. Angularity should be provided as a descriptor for pebbles and coarse sand. For the example above, the minor constituents with modifiers could be: some silt and clay, low plasticity; little medium to large pebbles, sub-round.

SORTING

Sorting is the opposite of grading, which is a commonly used term in the USCS or ASTM methods to describe the uniformity of the particle size distribution in a sample. Well-sorted samples are poorly graded and poorly sorted samples are well graded. ARCADIS prefers the use of sorting for particle size distributions and grading to describe particle size distribution trends in the vertical profile of a sample or hydrostratigraphic unit because of the relationship between sorting and the energy of the depositional process. For soils with sand-sized or larger particles, sorting should be determined as follows:

- Well sorted – the range of particle sizes is limited (e.g. the sample is comprised of predominantly one or two grain sizes)

- Poorly sorted – a wide range of particle sizes are present

You can also use sieve analysis to estimate sorting from a sedimentological perspective; sorting is the statistical equivalent of standard deviation. Smaller standard deviations correspond to higher degree of sorting (see Remediation Hydraulics, 2008).

MOISTURE

Moisture content should be described for every sample since increases or decreases in water content is critical information. Moisture should be described in accordance with the table below (percentages should not be used unless determined in the laboratory).

Description	Criteria
Dry	Absence of moisture, dry to touch, dusty.
Moist	Damp but no visible water.
Wet (Saturated)	Visible free water, soil is usually below the water table.

CONSISTENCY or DENSITY

This can be determined by standard penetration test (SPT) blow counts (ASTM D-1586) or field tests in accordance with the tables below. For SPT blow counts the N-value is used. The N-value is the blows per foot for the 6” to 18” interval. Example: for 24-inch spoon, recorded blows per 6-inch interval are: 4/6/9/22. Since the second interval is 6” to12”, the third interval is 12” to 18”, the N value is 6+9, or 15. Fifty blow counts for less than 6 inches is considered refusal.

Fine-grained soil – Consistency

Description	Criteria
Very soft	N-value < 2 or easily penetrated several inches by thumb.
Soft	N-value 2-4 or easily penetrated one inch by thumb.
Medium stiff	N-value 9-15 or indented about ¼ inch by thumb with great effort.
Very stiff	N-value 16-30 or readily indented by thumb nail.
Hard	N-value > than 30 or indented by thumbnail with difficulty

Coarse-grained soil – Density

Description	Criteria
Very loose	N-value 1- 4
Loose	N-value 5-10
Medium dense	N-value 11-30
Dense	N-value 31- 50
Very dense	N-value >50

COLOR

Color should be described using simple basic terminology and modifiers based on the Munsell system. Munsell alpha-numeric codes are required for all samples. If the sample contains layers or patches of varying colors this should be noted and all representative colors should be described. The colors should be described for moist samples. If the sample is dry it should be wetted prior to comparing the sample to the Munsell chart.

ADDITIONAL COMMENTS (NOTES)

Additional comments should be made where observed and should be presented as notes with reference to a specific depth interval(s) to which they apply. Some of the significant information that may be observed includes the following.

- **Odor -** You should not make an effort to smell samples by placing near your nose since this can result in unnecessary exposure to hazardous materials. However, odors should be noted if they are detected during the normal sampling procedures. Odors should be based upon descriptors such as those used in NIOSH “Pocket Guide to Chemical Hazards”, e.g. “pungent” or “sweet” and should not indicate specific chemicals such as “phenol-like” odor or “BTEX” odor.
- Structure
- Bedding planes (laminated, banded, geologic contacts)
- Presence of roots, root holes, organic material, man-made materials, minerals, etc.
- Mineralogy
- Cementation
- NAPL presence/characteristics, including sheen (based on client-specific guidance)
- Reaction with HCl (typically used only for special soil conditions)
- Origin, if known (capital letters: LACUSTRINE; FILL; etc.)

EXAMPLE DESCRIPTIONS

51.4 to 54.0’ Clay, some silt, medium to high plasticity; trace small to large pebbles, subround to subangular up to 2” diameter; moist; stiff; dark grayish brown (10YR 4/2) NOTE: Lacustrine; laminated 0.01 to 0.02 feet thick, laminations brownish yellow (10 YR 4/3).

32.5 to 38.0’ Sand, medium to Pebbles, coarse; sub-round to sub-angular; trace silt; poorly sorted; wet; grayish brown (10YR5/2). NOTE: sedimentary, igneous and metamorphic particles.

Unlike the first example where a density of cohesive soils could be estimated, this rotosonic sand and pebble sample was disturbed during drilling (due to vibrations in a loose Sand and Pebble matrix) so no density description could be provided. Neither sample had noticeable odor so odor comments were not included.

The standard generic description order is presented below.

- Depth

- Principal Components
    - Angularity for very coarse sand and larger particles
    - Plasticity for silt and clay
    - Dilatancy for silt and silt-sand mixtures
- Minor Components
- Sorting
- Moisture
- Consistency or Density
- Color
- Additional Comments

VII. Waste Management

Project-specific requirements should be identified and followed. The following procedures, or similar waste management procedures are generally required.

Water generated during cleaning procedures will be collected and contained onsite in appropriate containers for future analysis and appropriate disposal. PPE (such as gloves, disposable clothing, and other disposable equipment) resulting from personnel cleaning procedures and soil sampling/handling activities will be placed in plastic bags. These bags will be transferred into appropriately labeled 55-gallon drums or a covered roll-off box for appropriate disposal.

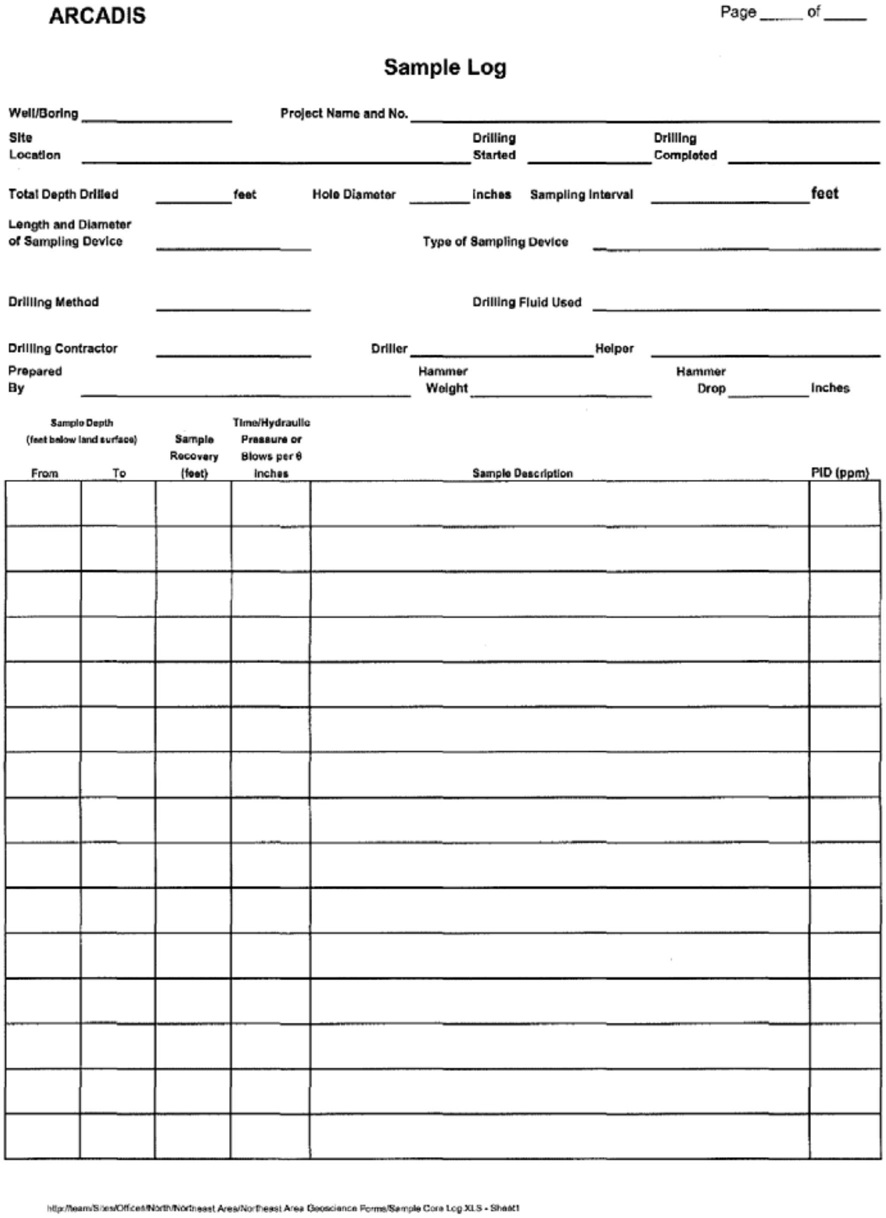
Soil materials will be placed in sealed 55-gallon steel drums or covered roll-off boxes and stored in a secured area. Once full, the material will be analyzed to determine the appropriate disposal method.

VIII. Data Recording and Management

Upon collection of soil samples, the soil sample should be logged on a standard boring log and/or in the field log book depending on Data Quality Objectives (DQOs) for the task/project. Two examples of standard boring logs are presented below.

The general scheme for soil logging entries is presented above; however, depending on task/project DQOs, specific logging entries that are not applicable to task/project goals may be omitted at the project manager's discretion. In any case, use of a consistent logging procedure is required.

Completed logs and/or logbook will be maintained in the task/project field records file. Digital photographs of typical soil types observed at the site and any unusual features should be obtained whenever possible. All photographs should include a ruler or common object for scale. Photo location, depth and orientation must be recorded in the daily log or log book and a label showing this information in the photo is useful.



ARCADIS

Page _____ of _____

Sample Log

Well/Boring ________________ Project Name and No. ________________

Site Location ________________ Drilling Started ________________ Drilling Completed ________________

Total Depth Drilled ________ feet Hole Diameter ________ inches Sampling Interval ________________ feet

Length and Diameter of Sampling Device ________________ Type of Sampling Device ________________

Drilling Method ________________ Drilling Fluid Used ________________

Drilling Contractor ________________ Driller ________________ Helper ________________

Prepared By ________________ Hammer Weight ________________ Hammer Drop ________ inches

Sample Depth (feet below land surface)		Sample Recovery (feet)	Time/Hydraulic Pressure or Blows per 6 inches	Sample Description	PID (ppm)
From	To				

http://team/Sites/Office/North/Northeast Area/Northeast Area Geoscience Forms/Sample Core Log.XLS - Sheet1

IX. Quality Assurance

Soil descriptions should be completed only by appropriately trained personnel. Descriptions should be reviewed by an experienced field geologist for content, format and consistency. Edited boring logs should be reviewed by the original author to assure that content has not changed.

X. References

ARCADIS Soil Description Field Guide, 2008 (in progress)

Munsell® Color Chart – available from Forestry Suppliers, Inc.- Item 77341 “Munsell® Color Soil Color Charts

Field Gauge Card that Shows Udden-Wentworth scale – available from Forestry Suppliers, Inc. – Item 77332 “Sand Grain Sizing Folder”

ASTM D-1586, Test Method for Penetration Test and Split-Barrel Sampling of Soils

ASTM D-2488-00, Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)

United States Bureau of Reclamation. Engineering Geology Field Manual. United States Department of Interior, Bureau of Reclamation. http://www.usbr.gov/pmts/geology/fieldmap.htm

Petrology of Sedimentary Rocks, Robert L. Folk, 1980, p. 1-48

NIOSH Pocket Guide to Chemical Hazards

Remediation Hydraulics, Fred C. Payne, Joseph A. Quinnan, and Scott T. Potter, 2008, p 59-63

ARCADIS

Attachment A-2

Field Sampling Log

Site *Event*

GROUND-WATER SAMPLING LOG

Sampling Personnel: **Well ID:**
Client / Job Number: **Date:**
Weather: **Time In:** **Time Out:**

Well Information

Depth to Water: (feet) (from MP)
Total Depth: (feet) (from MP)
Length of Water Column: (feet)
Volume of Water in Well: (gal)
Three Well Volumes: (gal)

Well Type: Flushmount Stick-Up
Well Material: Stainless Steel PVC
Well Locked: Yes No
Measuring Point Marked: Yes No
Well Diameter: 1" 2" Other:

Purging Information

Purging Method: Bailer Peristaltic Grundfos Other:
Tubing/Bailer Material: St. Steel Polyethylene Teflon Other:
Sampling Method: Bailer Peristaltic Grundfos Other:
Duration of Pumping: (min)
Average Pumping Rate: (ml/min) Water-Quality Meter Type:
Total Volume Removed: (gal) Did well go dry: Yes No

Conversion Factors

gal / ft. of water	1" ID	2" ID	4" ID	6" ID
	0.041	0.163	0.653	1.469
1 gal = 3.785 L =3875 ml = 0.1337 cubic feet				

Unit Stability

pH	DO	Cond.	ORP
± 0.1	± 10%±	3.0%	± 10 mV

Parameter:	1	2	3	4	5	6	7	8	9
Volume Purged (gal)									
Rate (mL/min)									
Depth to Water (ft.)									
pH									
Temp. (C)									
Conductivity (mS/cm)									
Dissolved Oxygen									
ORP (mV)									
Turbidity (NTU)									
Notes:									

Sampling Information

Analyses	#	Laboratory
Sample ID:		Sample Time:
MS/MSD: Yes		No
Duplicate: Yes		No
Duplicate ID		Dup. Time:
Chain of Custody Signed By:		

Problems / Observations

ARCADIS

Attachment A-3

MicroTIP Photoionization Detector Calibration, Operation, and Maintenance Procedures

Attachment A-3. Photovac MicroTIP Photoionization Detector Calibration, Operation & Maintenance Procedures

I. Introduction

The MicroTIP measures relative total concentrations of organic and inorganic vapors in the field and will be calibrated daily prior to use. The MicroTIP does not carry an Intrinsic Safety Rating and will be used in a controlled environment only. The MicroTIP will be used to screen soil samples, the head space of soil/water samples, and to monitor the breathing and work zones as specified in the Health and Safety Plan.

II. Materials

- Photovac MicroTIP (PID)
- Isobutylene calibration gas tank with pressure regulator and up to four other selected span gases
- zero span gas (clean outdoor air or zero grade gas)
- gas sampling bag with plastic tubing to connect PID probe to calibration gas
- flow regulator
- PID calibration and maintenance log

III. Calibration Procedures

1. Turn on the MicroTIP and monitor the ambient air. If there is any doubt of the air quality, then zero grade gas will be obtained.
2. Connect the regulator to the span gas cylinder. Hand-tighten the fittings.
3. Open the valve on the gas bag by turning the valve stem fully counterclockwise.
4. Attach the gas bag to the regulator. Hand-tighten the fittings.
5. Turn the regulator knob counterclockwise half a turn to start the gas flow.

6. Fill the gas bag half full and then close the regulator fully clockwise to turn off the flow of gas.

7. Fill the gas bag, and then turn the valve clockwise.

8. Press "CAL" and expose MicroTIP to zero gas. Press "ENTER", and MicroTIP sets its zero point.

9. MicroTIP then asks for the Span Gas concentration. Enter the known Span Gas concentration and then expose the MicroTIP to the Span Gas.

10. Press "ENTER" and MicroTIP sets its response factor.

11. When MicroTIP's display reverts to normal, the MicroTIP is calibrated and ready to use. Remove the Span Gas from the inlet.

12. After seven hours of use, recharge the battery pack. Record the time the battery pack was charged on the MicroTIP Calibration and Maintenance Log.

13. Record the date, time, your initials, calibration gas, and concentration on the Micro TIP Calibration and Maintenance Log.

IV. Operation Procedures

1. Use the health and safety equipment as required by the Health and Safety Plan.

2. Calibrate the instrument as described in subsection III of this Appendix.

3. Measure and record the background PID reading.

4. If the PID will be used for more than seven hours during optimal weather conditions (50º or greater), or during extreme cold or precipitation, have a fully charged battery available for use.

5. In the event of precipitation, fully cover the instrument, leaving the probe accessible for measurements.

6. Measure and record PID reading.

V. Maintenance Procedures

1. At the end of each day or when the battery is fully discharged, recharge batteries overnight.
2. Store the instrument in the protective case when not in use.
3. Keep records of operation, maintenance, calibration problems, and repairs.
4. A replacement instrument will be available on site or ready for overnight shipment, if necessary.
5. The MicroTIP will be sent back to the manufacturer for service if needed.

ARCADIS

Attachment 3

Quality Assurance/Sampling and Analysis Project Plan

National Fuel Gas Distribution Corporation

Appendix B
Quality Assurance Sampling and Analysis Project Plan

Dunkirk Former Manufactured Gas Plant Site
(Site No. 9-07-035)
Dunkirk, New York

February 2009

ARCADIS

Appendix B
Quality Assurance Sampling and Analysis Project Plan

Dunkirk Former Manufactured Gas Plant Site
Dunkirk, New York

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B0023301.0000.00001

Date:
February 2009

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Preface

This Quality Assurance Sampling and Analysis Project Plan (QASAPP) presents the sampling and analytical methods and procedures that will be used during implementation of the Site Characterization Work Plan (SC) at the Dunkirk Former Manufactured Gas Plant (MGP) Site in Dunkirk, New York. The QASAPP should be used in conjunction with the SC Work Plan, the Field Sampling Plan (FSP), and the Health and Safety Plan (HASP). The SC Work Plan presents the site background and defines the field sampling program. The FSP contains field procedures and sample collection methods to be used during implementation of the SC Work Plan. The HASP provides a mechanism for establishing safe working conditions at the site. The FSP and HASP are provided in Appendix A and Appendix C, respectively, of the SC Work Plan.

This QASAPP was prepared in a manner consistent with the following reference and guidance documents:

- United States Environmental Protection Agency's (USEPA's) "Test Methods for Evaluating Solid Waste, SW-846" (USEPA, 1996).

- The USEPA's guidance document entitled "EPA Requirements for Quality Assurance Project Plans for Environmental Operations, "EPA-QA/R-5 (USEPA, 2001), which replaces QAMS-005/80 "Interim Guidance and Specifications for Preparing Quality Assurance Project Plans" (USEPA, 1980).

- The National Enforcement Investigations Center (NEIC) Policies and Procedures Manual (USEPA, 1991).

Information contained in this QASAPP has been organized into the following sections:

Section	Content
Project Management	
1	Project Organization
2	Project Background
3	Project Description
4	Quality Objectives and Criteria for Measurement Data
5	Specialized Training Requirements/Certification
6	Documentation and Records

Section	Content
Measurement/Data Acquisition	
7	Sampling Process Design
8	Sampling Method Requirements
9	Sample Handling and Custody Requirements
10	Analytical Method Requirements
11	Quality Control Requirements
12	Instrument/Equipment Testing, Inspection, and Maintenance Requirements
13	Instrument Calibration and Frequency
14	Inspection/Acceptance Requirements for Supplies and Consumables
15	Data Acquisition Requirements for Nondirect Measurements
16	Data Management
Assessment/Oversight	
17	Assessment and Response Actions
18	Reports to Management
Data Validation and Usability	
19	Data Review, Validation, and Verification
20	Validation and Verification methods
21	Reconciliation with User Requirements

Details are provided in the subsequent sections. This document also contains pertinent information from the Work Plan related to the measurements and evaluation of the analytical data.

1. Project Organization and Responsibilities

1.1 Project Organization

The Dunkirk Former Manufactured Gas Plant (MGP) Site in Dunkirk, New York, will require integration of personnel from the organizations identified below, collectively referred to as the project team. A detailed description of the responsibilities of each member of the project team is presented in Section 2.2.

1.1.1 Overall Project Management

ARCADIS, on behalf of National Fuel Gas Distribution Corporation (National Fuel), has overall technical responsibility for the Site Characterization (SC). ARCADIS personnel will perform the tasks and subtasks presented in Section 3 and will be responsible for evaluating resultant investigation data, and preparing the SC deliverables specified in the Work Plan. Project direction and oversight will be provided by National Fuel personnel. A listing of project management personnel and their responsibilities is provided below.

Title	Company/ Organization	Name	Phone Number
Project Manager	National Fuel	Tanya B. Alexander, CHMM, REM	716.857.7410
Principal in Charge	ARCADIS	Terry W. Young	315.446.9120
Project Manager	ARCADIS	Scott A. Powlin	315.446.9120
Field Activities Task Manager	ARCADIS	TBD	NA

1.1.2 Analytical Laboratory Services and Subcontractors

Subcontractors for the analytical and drilling work have not yet been selected; however, laboratory subcontractors will be ELAP-approved, and drilling subcontractor will be licensed in New York State.

Title	Company/ Organization	Name	Phone Number
Laboratory Project Manager	TBD	NA	NA
Driller	TBD	NA	NA

1.1.3 Quality Assurance Staff

The QA aspects of the SC will be conducted by ARCADIS. The following personnel have been assigned to this project component:

Title	Company/ Organization	Name	Phone Number
Quality Assurance Manager	ARCADIS	Dennis Capria	315.446.9120
Quality Assurance Officer	TBD	NA	NA

1.2 Team Member Responsibilities

This section of the QASAPP discusses the responsibilities and duties of the project team members.

1.2.1 National Fuel

<u>Project Manager</u>

1. Overall direction of the SC

2. Review of ARCADIS work products

1.2.2 ARCADIS

<u>Principal in Charge</u>

1. Oversight of the ARCADIS SC work products

2. Provide ARCADIS approval for major project deliverables

<u>Project Manager</u>

1. Management and coordination of all aspects of the project as defined in the SC Work Plan with an emphasis on adhering to the project objectives

2. Reviews SC Report and all documents prepared by ARCADIS

3. Assures corrective actions are taken for deficiencies cited during audits of the SC activities

Field Activities Task Manager

1. Oversight of Soil Investigation
2. Oversight of Groundwater Investigation
3. Oversight of field hydrogeologic efforts
4. Oversight of field screening and collection of soil samples
5. Review of field hydrogeologic records and boring logs
6. Oversight of groundwater sampling
7. Oversight of field analysis and collection of QA samples
8. Reduction of field data calibration and maintenance
9. Review of the field instrumentation, maintenance, and calibration to maintain quality data
10. Preparation of draft reports and other key documents
11. Maintenance of field files of notebooks and logs, and calculations
12. Instruction of field staff
13. Coordination of field and laboratory schedules

Field Personnel

1. Perform field procedures associated with the tasks and subtasks presented in 1.3.1 (above)
2. Perform field analyses and collect QA samples

3. Calibrate, operate, and maintain field equipment

4. Reduce field data

5. Maintain sample custody

6. Prepare field records and logs

Quality Assurance Manager

1. Review laboratory data packages

2. Oversee and interface with the analytical laboratories

3. Coordinate field QA/QC activities with task managers, including audits of SC activities, concentrating on field analytical measurements and practices to meet DQOs

4. Review field reports

5. Review audit reports

6. Prepare QA/QC report which includes an evaluation of field and laboratory data and data validation reports

1.2.3 Laboratory Subcontractor

General responsibilities and duties include:

1. Perform sample analyses

2. Supply sample containers and shipping cartons

3. Maintain laboratory custody of samples

4. Strictly adhere to laboratory protocols

Laboratory Project Manager

1. Serve as primary communication link between ARCADIS and laboratory staff
2. Monitor workloads and ensure availability of resources
3. Oversee preparation of analytical reports
4. Supervise in-house chain-of-custody

Quality Assurance Officer

1. Supervise technical staff in QA/QC procedures
2. Conduct audits of all laboratory activities

Data Validator

1. Provide independent validation of analytical data

File Custodian

1. Responsible for maintaining project file with original and pertinent documentation

Database Administrator

1. Responsible for maintaining project database

Drilling Subcontractor

1. Performance of groundwater monitoring well installations and test borings in accordance with the SC protocols
2. Decontamination of drilling and sampling equipment

2. Project Background

The following summarizes background information for the site. Additional information can be found in the SC Work Plan.

2.1 Site Description and History

2.1.1 Site Description

The approximately 3 acre site is located at 31 West 2nd Street at the southeastern corner of the intersection of Swan Street and West 2nd Street in Dunkirk, Chautauqua County, New York (see Figure 1 of the SC Work Plan). The site comprises a generally rectangular piece of land that is now located in a mixed commercial and residential area. Lake Erie is located about 600 feet north of the site. The site is bordered by Swan Street to the west, West 2nd Street to the north, Eagle Street to the east, and an elevated railroad bed to the south. A Baptist Church is located near the southeastern corner of the site; however, a narrow strip of National Fuel property borders the church property to the south (see Figure 2 of the SC Work Plan).

A National Fuel Service Center building sits on the northeastern quadrant of the site. The Service Center building consists of a high-bay garage located south of the attached office area. Two other buildings are present at the property – a small metal sided storage building and a brick gas regulator building, which are both located south-south west of the Service Center building. A fuel pump island is located west of the metal sided storage building and consists of a pump island supported by an above ground storage tank (AST) containing diesel and an underground storage tank (UST) containing gasoline. The current site structures are shown on Figure 2 of the SC Work Plan.

The site is generally flat-lying and is largely paved with asphalt. A gravel-covered area used for staging gas distribution supplies is found in the southern approximately ¼ of the site. Small strips of grass areas are located in the rights-of-way along the perimeter of the site and in the northeast corner of the site. A grassy area also exists on the southern edge of the site, near the railroad.

2.1.2 Site History

The MGP operated from the late 1800s to approximately 1910. National Fuel currently owns the site (NFG, 2008). Based on a review of available Sanborn Fire Insurance Maps from 1888 to 1964, at its peak, the MGP consisted of three gas holders (which for the purpose of this Work Plan are numbered sequentially from east to west as holder 1 to holder 3), a retort house, a purifier house, a coal shed, and an oil tank. With the exception of holder 3, (the furthest to the west), the plant structures all existed in the northeast corner of the site. The current Service Center Building sits over at least a portion of holder 2, the retort house, the purifier house, and the coal shed. Figure 2 of the SC Work Plan shows the locations of the former MGP structures as they relate to present-day features. Limited information is available regarding gas production at the Dunkirk MGP; however, a review of the publication “Survey of Town Gas and By-Product Production and Locations in the U.S.” indicates that approximately 7, 23, and 26 million cubic feet of gas was produced at the MGP in 1890, 1900, and 1910 (Radian Corporation, 1985).

Coal was the primary feedstock for the manufactured gas process at the site (Radian Corporation, 1985). This method of producing gas, known as the coal carbonization method, consisted of heating bituminous coal in a sealed chamber (i.e., retorts), with destructive distillation of gas from the coal and the formation of coke. The gases were collected, cleaned (or purified), and distributed while coke was removed and sold or used. The main byproducts of the coal carbonization method were tars, oils, coke, ammoniacal liquor, ash and clinker, and residuals associated with the gas purification process (purifier wastes). The tars were generally viscous and contained higher concentrations of phenols and base nitrogen organics when compared to the tars generated from a later gas producing process known as the carbureted water-gas process. Coal carbonization also produced cyanide in the gas, which was removed during gas purification and often appears in wastes such as lime and wood chips.

2.2 SC Objectives

The overall objectives of the SC are to:

- assess whether MGP-related residual materials are present at the site related to the operation of the former MGP.
- determine whether MGP-related residual materials, if present at the site, have a potential to pose a significant threat to public health or the environment.
- determine whether a Remedial Investigation (RI) of the site is appropriate.

The technical approach to address the above objectives is provided in Table 1 of the SC Work Plan.

3. Project Description

This section presents a description of the investigation activities to be conducted during the SC. Sampling activities associated with the SC will be conducted under the following tasks:

- Soil Investigation
- Groundwater Investigation
- Geophysical Survey

Sampling protocols to be followed during the investigation activities are detailed in the FSP. Samples collected during the investigation will be analyzed in accordance with USEPA's SW-846, Test Methods for Evaluating Solid Waste. Table B-2 presents a list of the constituents that will be analyzed for samples collected as part of the SC. Health and Safety protocols to be followed by field personnel during completion of the investigation activities are discussed in the Health and Safety Plan (HASP).

A brief description of the objectives for each task associated with the SC is presented below. A more detailed description can be found in the associated SC Work Plan.

3.1 Soil Investigation

The objectives of the soil investigation are to:

- assess whether MGP-related residual materials are present in subsurface soil in and around former MGP structures.

- preliminarily assess the depths of holders 1 and 2 and the presence/absence of potential MGP-related residual materials within the holders.

- better characterize the nature and distribution of the upper approximately 20 feet of underlying geologic materials.

3.2 Groundwater Investigation

The objectives of the groundwater investigation are to:

- characterize the general shape of the water table, and develop a preliminary assessment of shallow groundwater flow patterns at the site.

- assess the hydraulic characteristics of the materials screened by the wells.

- determine the presence/absence of MGP-related constituents dissolved in groundwater and if present, whether they are at a concentration in excess of NYSDEC Class GA Standards.

3.3 Geophysical Survey

A geophysical survey will be performed using electromagnetic (EM-31) and Ground Penetrating Radar (GPR) surveys in accessible areas of the site and inside the high-bay garage area of the Service Center. The objectives of the geophysical survey are to:

- locate below-grade remnants of former MGP structures (particularly the former holders).

- assess the location of possible underground utilities.

- evaluate the depth to and configuration of the bedrock surface (if the bedrock surface is less than approximately 15 feet below grade).

- fine-tune the locations of soil borings and monitoring wells to be installed during the SC.

The geophysical survey will be the first field task completed during the SC.

4. Quality Objectives and Criteria for Measurement Data

The DQO process, as described in the USEPA QA/G-5 QASAPP instructions document (USEPA, 2002b), is intended to provide a “logical framework” for planning field investigations. The following section addresses, in turn, each of the seven sequential steps in the USEPA QA/G-5 QASAPP DQO process.

Data quality objectives (DQOs) are qualitative and quantitative statements that specify the quality of the data required to support decisions made during site-related activities and are based on the end uses of the data to be collected. Preliminary DQOs were identified to ensure that the data generated during field investigations will be of adequate quality and sufficient quantity to form a sound basis for decision making relative to the above objectives. Data quality objectives have been specified for each data collection activity or investigation. The DQOs presented herein address investigation efforts only and do not cover health and safety issues, which are addressed in detail in the HASP for this project.

Step 1: State the Problem

The SC will be conducted at the site to evaluate the presence and extent of MGP and/or non-MGP constituents of concern at the site. The sampling and analysis program is intended to generate data to initiate a site database that may potentially support further investigations.

Step 2: Identify the Goal of the Study

The initial use of the data is descriptive (distribution and concentration) and there is no decision point for this descriptive application. Subsequent to review of the descriptive information, an exposure evaluation will be performed based on the findings of the site investigation. The decision in this case is to determine if MGP and/or non-MGP constituents of concern are present at the site and to evaluate potential exposure pathways and concentrations if constituents are discovered.

Step 3: Identify Information Inputs

Decision inputs incorporate both concentration and distribution of constitutes of concern in site media. A fundamental basis for decision making is that a sufficient number of data points of acceptable quality are available from the investigation to support the decision. Thus, the necessary inputs for the decision are: 1) the proportion of non-rejected (usable) data points and 2) the quantity of data needed to evaluate whether there are unacceptable risks to human health and the environment at the site.

The data will be evaluated for completeness, general conformance with requirements of this QASAPP and consistency among data sets, and with historical data, as appropriate.

Step 4: Define the Boundaries of the Study

The boundaries of the study area include the site (property owned by National Fuel) which is bordered by Swan Street to the west, West 2nd Street to the north, Eagle Street to the east, and an elevated railroad to the south.

Step 5: Develop the Analytical Approach

The decision on whether data can be used in the pre-qualification and post-excavation confirmation evaluation will be based on the validation results. Following validation, the data will be flagged, as appropriate, and any use restrictions noted. The Sampling and Analysis Plan (SAP) has been devised so that the loss of any single data point will not hinder description of the distribution of constitutes of concern or the development of a risk assessment. Given this, a reasonable decision rule would be that 90 percent of the data points not be rejected and deemed unusable for exposure evaluation purposes. Applicable actions would be evaluated, if needed, based on the results of the exposure evaluation.

Step 6: Specify Performance or Acceptance Criteria

Specifications for this step call for: 1) giving forethought to corrective actions to improve data usability and 2) understanding the representative nature of the sampling design. This QASAPP has been designed to meet both specifications for this step. The sampling and analysis program has been developed based on a review of previous site data and knowledge of present site conditions. Corrective actions are described elsewhere in this QASAPP and in the appended documents. The representative nature of the sampling design has been determined by discussions among professionals familiar with the site and the appropriate government agencies.

Step 7: Develop the Plan for Obtaining Data

The overall QA objective is to develop and implement procedures for field sampling, COC, laboratory analysis, and reporting that will provide results to support the evaluation of site data consistent with National Contingency Plan requirements. Specific procedures for sampling, COC, laboratory instrument calibration, laboratory analysis, data reporting, internal QC, audits, preventive maintenance of field equipment, and corrective action are described in other sections of this QASAPP.

The SAP involves a phased approach to both sampling and analysis. This provides the opportunity to evaluate and focus each data collection step to optimize the overall data collection process.

A DQO summary for the sampling investigation efforts is presented in the subsequent section. The summary consists of stated DQOs relative to data uses, data types, data quantity, sampling and analytical methods, and data measurement performance criteria.

A DQO summary for the sampling investigation efforts is presented below. The summary consists of stated DQOs relative to data uses, data types, data quantity, sampling and analytical methods, and data measurement performance criteria.

Three data categories have been defined to address various analytical data uses and the associated QA/QC effort and methods required to achieve the desired levels of quality. These categories are:

Screening Data: Screening data affords a quick assessment of site characteristics or conditions. This objective for data quality is applicable to data collection activities that involve rapid, non-rigorous methods of analysis and quality assurance. This objective is generally applied to physical and/or chemical properties of samples, degree of contamination relative to concentration differences, and preliminary health and safety assessment.

Screening Data with Definitive Confirmation: Screening data allows rapid identification and quantitation, although the quantitation can be relatively imprecise. This objective for data quality is available for data collection activities that require qualitative and/or quantitative verification of a select portion of sample findings (10% or more). This objective can also be used to verify less rigorous laboratory-based methods.

Definitive Data: Definitive data are generated using analytical methods, such as approved USEPA reference methods. Data are analyte-specific, with confirmation of analyte identity and concentration. Methods produce raw data (e.g., chromatograms, spectra, digital values) in the form of paper printouts or computer-generated electronic files.

It is anticipated that both the screening and definitive data categories will be used during the investigation. Field parameters (i.e., turbidity, conductivity, temperature, pH, dissolved oxygen, and oxidation-reduction potential) that will be obtained during groundwater sampling for use in qualitatively interpreting other site data will be determined using screening techniques. All remaining parameters will be determined using definitive techniques.

For this project, three levels of data reporting have been defined. They are as follows:

Level 1 – Minimal Reporting: Minimal or “results only” reporting is used for analyses that, either due to their nature (i.e., field monitoring) or the intended data use (i.e., preliminary screening), do not generate or require extensive supporting documentation.

Level 2 – Modified Reporting: Modified reporting is used for analyses that are performed following standard USEPA-approved methods and QA/QC protocols and that, based on the intended data use, require some supporting documentation but not, however, full “CLP-type” reporting.

Level 3 – Full Reporting: Full “CLP-type” reporting is used for those analyses that, based on intended data use, require full documentation. This reporting level would include ASP Superfund and Category B reporting.

The analytical methods to be used during the SC will be USEPA SW-846 methods with New York State Department of Environmental Conservation (NYSDEC) Analytical Services Protocol (ASP) Revision 2005, QA/QC requirements and Category B reporting deliverables.

To obtain information necessary to meet the SC objectives stated above in Section 2.3, the following tasks and subtasks will be performed (Note: Only subtasks that require collection and analysis of environmental samples or collecting field measurements are listed below. Refer to the SC Work Plan for a description of the tasks and subtasks.):

- Task 1 – Soil Sampling
- Task 2 – Groundwater Sampling

A description of the DQOs for the SC is presented below.

4.1 DQOs for Task 1 – Soil Sampling

As described in the SC Work Plan, numerous soil borings will be drilled to investigate the MGP structures and the nature of the native and fill materials. Numerous surface and subsurface soil samples will be collected and submitted for laboratory analysis for the following:

- Method 8260 for TCL VOCs
- Method 8270 for TCL SVOCs
- Method 9010 or 9012 for cyanide

The number of soil samples that will be collected, including QA/QC samples, is summarized in Table B-1. Table B-2 presents the parameters to be analyzed under each of the methods described above with the laboratory quantitation limits.

4.2 DQOs for Task 2 – Groundwater Sampling

This task involves the installation of monitoring wells and collecting one round of groundwater samples from the monitoring wells. The resulting groundwater-quality data will be used to determine the presence and level of potentially MGP-related constituents dissolved in groundwater. The number of samples that will be collected, including QA/QC samples, is summarized in Table B-1. Table B-2 presents the parameters to be analyzed under each of the methods described above with the laboratory quantitation limits.

As described in the SC Work Plan, both hydrogeologic and water quality data are required to meet the objective of this task. Hydrogeologic data will consist of water level information and hydraulic conductivity values that will be used to calculate other hydrogeologic parameters. Groundwater quality data will consist of field parameters, including pH, turbidity, temperature, conductivity, dissolved oxygen, and oxidation-reduction potential, as well as the laboratory parameters described below. The rationale for the selection of these parameters is discussed in Table 1 of the SC Work Plan.

The groundwater and surface water level measurement procedures, the field parameter measurement procedures, and the groundwater sampling methods are provided in the FSP and SC Work Plan.

Groundwater samples will be analyzed according to the following methods:

- Method 8260 for TCL VOCs
- Method 8270 for TCL SVOCs
- Method 9010 or 9012 for cyanide

5. Special Training Requirements/Certification

Compliant with the Occupational Safety and Health Administration's (OSHA's) final rule, "Hazardous Waste Operations and Emergency Response," 29 CFR§1910.120(e), all personnel performing remedial activities at the site will have completed the requirements for OSHA 40-hour Hazardous Waste Operations and Emergency Response training. Persons in field supervisory positions will have also completed the additional OSHA 8-hour Supervisory Training.

6. Documentation and Records

6.1 General

Samples of the various media will be collected as described in the SC Work Plan. Detailed descriptions of the documentation and reporting requirements are presented below.

6.2 Field Documentation

Field personnel will provide comprehensive documentation covering all aspects of field sampling, field analysis, and sample chain-of-custody. This documentation constitutes of a record that allows reconstruction of all field events to aid in the data review and interpretation process. All documents, records, and information relating to the performance of the field work will be retained in the project file.

The various forms of documentation to be maintained throughout the action include:

- Daily Production Documentation – A field notebook consisting of a waterproof, bound notebook that will contain a record of all activities performed at the site.

- Sampling Information – Detailed notes will be made as to the exact site of sampling, physical observations, and weather conditions (as appropriate).

- Sample Chain-of-Custody – Chain-of-custody (COC) forms will provide the record of responsibility for sample collection, transport, and submittal to the laboratory. COC forms will be filled out at each sampling site, at a group of sampling sites, or at the end of each day of sampling by ARCADIS field personnel designated to be responsible for sample custody. In the event that the samples are relinquished by the designated sampling person to other sampling or field personnel, the COC form will be signed and dated by the appropriate personnel to document the sample transfer. The original COC form will accompany the samples to the laboratory, and copies will be forwarded to the project files. A sample COC form is included in Appendix A.

  Persons will have custody of samples when the samples are in their physical possession, in their view after being in their possession, or in their physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

- Field Equipment, Calibration, and Maintenance Logs – To document the calibration and maintenance of field instrumentation, calibration and maintenance logs will be maintained for each piece of field equipment that is not factory-calibrated.

6.3 Laboratory Documentation

6.3.1 Laboratory Project Files

The laboratory will establish a file for all pertinent data. The file will include all correspondence, faxed information, phone logs, and COC forms. The laboratory will retain all project files and data packages for a period of 5 years.

6.3.2 Laboratory Logbooks

Workbooks, bench sheets, instrument logbooks, and instrument printouts will be used to trace the history of samples through the analytical process and document and relate important aspects of the work, including the associated quality controls. As such, all logbooks, bench sheets, instrument logs, and instrument printouts will be part of the permanent record of the laboratory.

Each page or entry will be dated and initialed by the analyst at the time of entry. Errors in entry will be crossed out in indelible ink with a single stroke, corrected without the use of whiteout or by obliterating or writing directly over the erroneous entry, and initialed and dated by the individual making the correction. Pages of logbooks that are not used will be completed by lining out unused portions.

Information regarding the sample, analytical procedures performed, and the results of the testing will be recorded on laboratory forms or personal notebook pages by the analyst. These notes will be dated and will also identify the analyst, the instrument used, and the instrument conditions.

Laboratory notebooks will be periodically reviewed by the laboratory group leaders for accuracy, completeness, and compliance to this QASAPP. All entries and calculations will be verified by the laboratory group leader. If all entries on the pages are correct, then the laboratory group leader will initial and date the pages. Corrective action will be taken for incorrect entries before the laboratory group leader signs.

6.3.3 Computer Tape and Hard Copy Storage

All electronic files will be maintained on magnetic tape or diskette for 5 years; hard copy data packages will be maintained in files for 5 years.

6.4 Data Reporting Requirements

6.4.1 Field Data Reporting

Information collected in the field through visual observation, manual measurement, and/or field instrumentation will be recorded in field notebooks or data sheets and/or on forms. Such data will be reviewed by the appropriate Task Manager for adherence to the Work Plan and for consistency. Concerns identified as a result of this review will be discussed with the field personnel, corrected if possible, and, as necessary, incorporated into the data evaluation process.

Where appropriate, field data forms and calculations will be processed and included in appendices to a Site Action Report (when generated). The original field logs, documents, and data reductions will be kept in the project file at the ARCADIS office in Syracuse, New York.

6.4.2 Laboratory Data Reporting

The laboratory is responsible for preparing ASP Category B data packages for all VOC, SVOC, and TAL Inorganic (including cyanide and total organic carbon), reduced data packages, and case narratives for all other analyses.

All data reports for all parameters will include, at a minimum, the following items:

Narrative: Summary of activities that took place during the course of sample analysis, including the following information:

- Laboratory name and address
- Date of sample receipt
- Cross reference of laboratory identification number to contractor sample identification
- Analytical methods used
- Deviations from specified protocol
- Corrective actions taken

Included with the narrative will be any sample handling documents, including field and internal COC forms, air bills, and shipping tags.

Analytical Results: Reported according to analysis type and including the following information, as acceptable:

- Sample ID
- Laboratory ID
- Date of collection
- Date of receipt
- Date of extraction
- Date of analysis
- Detection limits

Sample results on the report forms will be collected for dilutions. Soil samples will be reported on a dry weight basis. Unless otherwise specified, results will be reported uncorrected for blank contamination.

The data for TCL VOC, TCL SVOC, and total cyanide analyses will be expanded to include all supporting documentation necessary to provide a Category B package. This additional documentation will include, but is not limited to, all raw data required to recalculate any result, including printouts, chromatograms, and quantitation reports. The report also will include: standards used in calibration and calculation of analytical results; sample extraction; digestion; and other preparation logs; standard preparation logs, instrument run logs; and moisture content calculations.

6.5 Project File

Project documentation will be placed in a single project file at the ARCADIS office in Syracuse, New York. This file will consist of the following components:

1. Agreements (file chronologically)

2. Correspondence (filed chronologically)

3. Memos (file chronologically)

4. Notes and Data (filed by topic)

Reports (including QA reports) will be filed with correspondence. Analytical laboratory documentation when received) and field data will be filed with notes and data. Filed materials may be removed and signed out by authorized personnel on a temporary basis only.

7. Sampling Process Design

Information regarding the sampling design and rationale and associated sampling locations can be found in the SC Work Plan.

8. Sampling Method Requirements

Surface and subsurface soil, groundwater, soil vapor, and sediment samples will be collected as described in the SC Work Plan and the FSP. The FSP also contains the procedures that will be followed to collect split-spoon samples; install monitoring wells; measure water levels; install soil vapor points; conduct sediment probing; perform field measurements; and handle, package, and ship collected samples.

9. Sample Handling and Custody Requirements

9.1 Sample Containers and Preservation

Appropriate sample containers, preservation methods, and laboratory holding times for the samples are shown in Table B-3.

The analytical laboratory will supply appropriate sample containers and preservatives, as necessary. The bottles will be purchased pre-cleaned to USEPA Office of Solid Waste and Emergency Response (OSWER) Directive 9240.05A requirements. The field personnel will be responsible for properly labeling containers and preserving samples (as appropriate).

9.2 Packing, Handling, and Shipping Requirements

Sample packaging and shipment procedures are designed to insure that the samples will arrive at the laboratory, with the COC, intact.

Samples will be packaged for shipment as outlined below:

- Ensure that all sample containers have the sample labels securely affixed to the container with clear packing tape.

- Check the caps on the sample containers to ensure that they are properly sealed.

- Wrap the sample container cap with clear packing tape to prevent it from becoming loose.

- Complete the COC form with the required sampling information and ensure the recorded information matches the sample labels. NOTE: If the designated sampler relinquishes the samples to other sampling or field personnel for packing or other purposes, the sampler will complete the COC prior to this transfer. The appropriate personnel will sign and date the COC form to document the sample custody transfer.

- Using duct tape, secure the outside drain plug at the bottom of the cooler.

- Wrap sample containers in bubble wrap or other cushioning material.

- Place 1 to 2 inches of cushioning material at the bottom of the cooler.

- Ice layer.
- Place the sealed sample containers into the cooler.
- Place ice in plastic bags and seal. Place loosely in the cooler.
- Fill the remaining space in the cooler with cushioning material.
- Place COC forms in a plastic bag and seal. Tape the forms to the inside of the cooler lid.
- Close the lid of the cooler, lock, and secure with duct tape.
- Wrap strapping tape around both ends of the cooler at least twice.
- Mark the cooler on the outside with the following information: shipping address, return address, "Fragile" labels, and arrows indicating "this side up." Cover the labels with clear plastic tape. Place a signed custody seal over the cooler lid.

All samples will be packaged by the field personnel and transported as low-concentration environmental samples. The samples will be hand-delivered or delivered by an express carrier within 48 hours of the time of collection. All shipments will be accompanied by the COC form identifying the contents. The original form will accompany the shipment; copies will be retained by the sampler for the sampling office records. If the samples are sent by common carrier, a bill of lading should be used. Receipts or bills of lading will be retained as part of the permanent project documentation. Commercial carriers are not required to sign off on the COC form, as long as the forms are sealed inside the sample cooler and the custody seals remain intact.

Sample custody seals and packing materials for filled sample containers will be provided by the analytical laboratory. The filled, labeled, and sealed containers will be placed in a cooler on ice and carefully packed to eliminate the possibility of container breakage. Trip blank(s) of analyte-free water will be provided by the laboratory and included in each cooler containing aqueous samples to be analyzed for VOCs.

Procedures for packing, handling, and shipping environmental samples are included in the FSP.

9.3 Field Custody Procedures

The objective of field sample custody is to assure that samples are not tampered with from the time of sample collection through the time of transport to the analytical laboratory. Persons will have “custody of samples” when the samples are in their physical possession, in their view after being in their possession, or in the physical possession and secured so they cannot be tampered with. In addition, when samples are secured in a restricted area accessible only to authorized personnel, they will be deemed to be in the custody of such authorized personnel.

Field custody documentation consists of both field logbooks and field COC forms.

9.3.1 Field Logbooks

Field logbooks will provide the means of recording data collecting activities performed. As such, entries will be described in as much detail as possible so that persons going to the site could reconstruct a particular situation without reliance on memory.

Field logbooks will be bound field survey books or notebooks. Logbooks will be assigned to field personnel, but will be stored in a secure location when not in use. Each logbook will be identified by the project-specific document number. The title page of each logbook will contain the following:

- Person to whom the logbook is assigned
- Logbook number
- Project name
- Project start date
- End date

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection being used, and the signature of the person making the entry will be entered. The names of visitors to the site, field sampling or investigation team personnel, and the purpose of their visit will also be recorded in the field logbook.

Measurements made and samples collected will be recorded. All entries will be made in ink, and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark. Whenever a sample is collected or a measurement is made, a detailed description of the location of the station shall be recorded. The number of the photographs taken of the station, if any, will also be noted. All equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in the FSP. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume, and number of containers. Sample identification numbers will be assigned prior to sample collection. Field duplicate samples, which will receive an entirely separate sample identification number, will be noted under sample description.

9.3.2 Sample Labeling

Preprinted sample labels will be affixed to sample bottles prior to delivery at the sampling site. The following information is required in each sample label.

- Project
- Date collected
- Time collected
- Location
- Sampler
- Analysis to be performed
- Preservative
- Sample number

9.3.3 Field Chain-of-Custody Forms

Completed COC forms will be required for all samples to be analyzed. COC forms will be initiated by the sampling crew in the field. The COC forms will contain the sample's unique identification number, sample date and time, sample description, sample type, preservation (if any), and analyses required. The original COC form will accompany the samples to the laboratory. Copies of the COC will be made prior to shipment (or multiple copy forms used) for field documentation. The COC forms will remain with the samples at all times. The samples and signed COC forms will remain in the possession of the sampling crew until the samples are delivered to the express carrier (e.g., Federal Express) or hand delivered to a mobile or permanent laboratory, or placed in secure storage.

Sample labels will be completed for each sample using waterproof ink, unless prohibited by weather conditions. The labels will include sample information, such as: sample number and location, type of sample, date and time of sampling, sampler's name or initials, preservation, and analyses to be performed. The completed sample labels will be affixed to each sample bottle and covered with clear tape.

Whenever samples are co-located with a source or government agency, a separate Sample Receipt will be prepared for those samples and marked to indicate with whom the samples are being co-located. The person relinquishing the samples to the facility or agency should request the representative's signature, acknowledging sample receipt. If the representative is unavailable or refuses, this is noted in the “Received By” space.

9.4 Management of Investigation-Derived Materials and Wastes

Disposable equipment, debris, and decontamination rinseate (e.g., tap and distilled water containing small amounts of solvent) will be containerized during the sampling events and labeled for appropriate disposal.

9.5 Laboratory Procedures

9.5.1 General

Upon sample receipt, laboratory personnel will be responsible for sample custody. A field chain-of-custody form will accompany all samples requiring laboratory analysis. Samples will be kept secured in the laboratory until all stages of analysis are complete. All laboratory personnel having samples in their custody will be responsible for maintaining sample integrity.

9.5.2 Sample Receipt and Storage

Upon sample receipt, the laboratory sample custodian will verify the package seal, open the package, verify the sample integrity, and compare the contents against the field chain-of-custody. If a sample container is broken, the sample is in an inappropriate container, has not been preserved by appropriate means, or if there is a discrepancy between the chain-of-custody and the sample shipment, ARCADIS will be notified. The laboratory sample custodian will then log the samples in, assign a unique laboratory identification number to each, and label the sample bottle with the laboratory identification number. The project name, field sample code, date sampled, date received, analysis required, storage location and date, and action for final disposition will be recorded in the laboratory information management system. If the sample container is broken, the sample is in an inappropriate container, or has not been preserved by appropriate means, ARCADIS will be notified.

9.5.3 Sample Chain-of-Custody and Documentation

Laboratory chain-of-custody and documentation will follow procedures consistent with Exhibit F of the NYSDEC ASP 2005.

9.5.4 Sample Analysis

Analysis of an acceptable sample will be initiated by worksheets that contain all pertinent information for analysis. The analyst will sign and date the laboratory COC form when removing the samples from storage.

Samples will be organized into sample delivery groups (SDGs) by the laboratory. An SDG may contain up to 20 field samples (field duplicates, trip blanks, and rinse blanks are considered field samples for the purposes of SDG assignment). All field samples assigned to a single SDG shall be received by the laboratory over a maximum of 7 calendar days, and must be processed through the laboratory (preparation, analysis, and reporting) as a group. Every SDG must include a minimum of one site-specific matrix/matrix spike duplicate (MS/MSD) pair, which shall be received by the laboratory at the start of the SDG assignment.

Each SDG will be self-contained for all of the required quality control samples. All parameters within an SDG will be extracted and analyzed together in the laboratory. At no time will the laboratory be allowed to run any sample (including QC samples) at an earlier or later time than the rest of the SDG. These rules for analysis will ensure that the QC samples for an SDG are applicable to the field samples of the same SDG and that the best possible comparisons can be made.

9.5.5 Sample Storage Following Analysis

The remaining samples will be maintained by the laboratory for 1 month after the final report is delivered to ARCADIS. After this period, the samples will be disposed of in accordance with applicable rules and regulations.

10. Analytical Procedures

10.1 Field Analytical Procedures

Field analytical procedures will include the measurement of dissolved oxygen, pH, turbidity, temperature, oxidation-reduction potential and conductivity, and groundwater levels. Specific field measurement protocols are provided in the FSP.

10.2 Laboratory Analytical Procedures

Laboratory analytical requirements presented in the sub-sections below include a general summary of requirements, specifics related to each sample medium to be analyzed, and details of the methods to be used for this project. SW-846 methods with NYSDEC, ASP, 2005 Revision, QA/QC and reporting deliverables requirements will be used for all analytes.

10.2.1 General

The following tables summarize general analytical requirements:

Table	Title
Table B-1	Environmental and Quality Control Sample Analyses
Table B-2	Parameters, Methods, and Quantitation Limits
Table B-3	Sample Containers, Preservation Methods, and Holding Times Requirements

10.2.2 SC Sample Matrices

10.2.2.1 Surface/Subsurface Soil and Sediments

Analyses in this category will relate to soil and sediments samples. Analyses will be performed following the methods listed in Table B-1. Results will be reported as dry weight, in units presented in Table B-2. Moisture content will be reported separately.

10.2.2.2 Groundwater

Analyses will be performed following the methods listed in Table B-1. Analytical results for all analyses will be reported in units identified in Table B-2.

10.2.2.3 Soil Vapor

Analyses will be performed following the methods listed in Table B-1. Analytical results for all analyses will be reported in units identified in Table B-2.

10.2.3 Analytical Requirements

The primary sources to describe the analytical methods to be used during the investigation are provided in USEPA SW-846 Test Methods for Evaluating Solid Waste, Third Edition and USEPA Methods for Chemical Analysis of Water and Waste with NYSDEC ASP 2005 Revision, QA/QC and reporting deliverables requirements. Detailed information regarding quality control procedures including matrix spike, matrix spike duplicates, matrix spike blanks, and surrogate recoveries is provided in NYSDEC, ASP 2005 Revision, Exhibit E.

11. Quality Control Requirements

11.1 Quality Assurance Indicators

The overall quality assurance objective for this QASAPP is to develop and implement procedures for sampling, chain-of-custody, laboratory analysis, instrument calibration, data reduction and reporting, internal quality control, audits, preventive maintenance, and corrective action such that valid data will be generated. These procedures are presented or referenced in the following sections of the QASAPP. Specific QC checks are discussed in Section 11.2.

Quality assurance indicators are generally defined in terms of five parameters:

1. Representativeness
2. Comparability
3. Completeness
4. Precision
5. Accuracy

Each parameter is defined below. Specific objectives for the site actions are set forth in other sections of this QASAPP, as referenced below.

11.1.1 Representativeness

Representativeness is the degree to which sampling data accurately and precisely represent site conditions, and is dependent on sampling and analytical variability. The SC has been designed to assess the presence of the constituents at the time of sampling. The Work Plan presents the rationale for sample quantities and location. The FSP and this QASAPP present field sampling methodologies and laboratory analytical methodologies. The use of the prescribed field and laboratory analytical methods with associated holding times and preservation requirements are intended to provide representative data.

11.1.2 Comparability

Comparability is the degree of confidence with which one data set can be compared to another. Comparability between this investigation, and to the extent possible, with existing data will be maintained through consistent sampling and analytical methodology set forth in the FSP and this QASAPP, SW-846 analytical methods with NYSDEC ASP Revision 2005 QA/QC requirements and Category B reporting deliverables, and through use of QA/QC procedures and appropriately trained personnel.

11.1.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from an event and/or investigation compared to the amount that was expected to be obtained under normal conditions. This will be determined upon assessment of the analytical results, as discussed in Section 11.6.

11.1.4 Precision

Precision is the measure of reproducibility of sample results. The goal is to maintain a level of analytical precision consistent with the project objectives. To maximize precision, sampling and analytical procedures will be followed. All work for this investigation will adhere to established protocols presented in the SC Work Plan. Checks for analytical precision will include the analysis of matrix spike duplicates, laboratory duplicates and field duplicates. Checks for field measurement precision will include obtaining duplicate field measurements. Further discussion of precision QC checks is provided in Section 11.4.

11.1.5 Accuracy

Accuracy is the deviation of a measurement from the true value of a known standard. Both field and analytical accuracy will be monitored through initial and continuing calibration of instruments. In addition, internal standards, matrix spikes, blank spikes, and surrogates (system monitoring compounds) will be used to assess the accuracy of the laboratory analytical data. Further discussion of these QC samples is provided in Section 11.4.

11.2 Field Quality Control Checks

11.2.1 Field Measurements

To verify the quality of data using field instrumentation, duplicate measurements will be obtained and reported for all field analytical measurements.

11.2.2 Sample Containers

Certified-clean sample containers in accordance with Exhibit I of the NYSDEC ASP Revision 2005 (Eagle Picher pre-cleaned containers or equivalent) will be supplied by the laboratory.

11.2.3 Field Duplicates

Field duplicates will be collected for groundwater and source materials/soil samples to check reproducibility of the sampling methods. Field duplicates will be prepared as discussed in the FSP. In general, source material/soil and groundwater sample field duplicates will be analyzed at a 5 percent frequency (every 20 samples). Table B-1 provides an estimated number of field duplicates for each applicable parameter and matrix.

11.2.4 Rinse Blanks

Rinse blanks are used to monitor the cleanliness of the sampling equipment and the effectiveness of the cleaning procedures. Rinse blanks will be prepared and submitted for analysis at a frequency of one per day (when sample equipment cleaning occurs) or once for every 20 samples collected, whichever is less. Rinse blanks will be prepared by filling sample containers with analyte-free water (supplied by the laboratory) which has been routed through a cleaned sampling device. When dedicated sampling devices are used or sample containers are used to collect the samples, rinse blanks will not be necessary. Table B-1 provides an estimated number of rinse blanks collected during the SC.

11.2.5 Trip Blanks

Trip blanks will be used to assess whether site samples have been exposed to non-site-related volatile constituents during storage and transport. Trip blanks will be analyzed at a frequency of once per day, per cooler containing groundwater samples to be analyzed for volatile organic constituents. A trip blank will consist of a container filled with analyte-free water (supplied by the laboratory) which remains unopened with field samples throughout the sampling event. Trip blanks will only be analyzed for aqueous volatile organic constituents. Table B-1 provides an estimated number of trip blanks collected for each matrix and parameter during the SC.

11.3 Analytical Laboratory Quality Control Checks

Internal quality control procedures are specified in the analytical methods. These specifications include the types of QC checks required (method blanks, reagent/preparation blanks, matrix spike and matrix spike duplicates (MS/MSD), calibration standards, internal standards, surrogate standards, the specific calibration check standards, laboratory duplicate/replicate analysis), compounds and concentrations to be used, and the QC acceptance criteria.

11.3.1 Method Blanks

Method blanks will serve as a measure of contamination attributable to a variety of sources including glassware, reagents, and instrumentation. The method blank will be initiated at the beginning of an analytical procedure and is carried through the entire process.

11.3.2 Matrix Spike/Matrix Spike Duplicates

The MS will serve as a measure of method accuracy in a given matrix. The MS and the MSD together will serve as a measure of method precision.

11.3.3 Surrogate Spikes

Surrogate spikes are organic compounds that have similar properties to those being tested. They will serve as indicators of method performance and accuracy in organic analyses.

11.3.4 Laboratory Duplicates

Laboratory duplicates will serve to the measure method precision in inorganic and supplemental analyses.

11.3.5 Calibration Standards

Calibration check standards analyzed within a particular analytical series provide insight regarding the instruments' stability. A calibration check standard will be analyzed at the beginning and end of an analytical series, or periodically throughout a series containing a large number of samples.

In general, calibration check standards will be analyzed after every 12 hours, or more frequently, as specified in the applicable analytical method. In analyses where internal standards are used, a calibration check standard will only be analyzed in the beginning of an analytical series. If results of the calibration check standard exceed specified tolerances, then all samples analyzed since the last acceptable calibration check standard will be reanalyzed.

Laboratory instrument calibration standards will be selected utilizing the guidance provided in the analytical methods, as summarized in Section 13.

11.3.6 Internal Standards

Internal standard areas and retention times will be monitored for organic analyses performed by GC/MS methods. Method-specified internal standard compounds will be spiked into all field samples, calibration standards, and QC samples after preparation and prior to analysis. If internal standard areas in one or more samples exceed the specified tolerances, then cause will be investigated, the instrument will be recalibrated if necessary, and all affected samples will be reanalyzed.

The acceptability of internal standard performance will be determined using the guidance provided within the analytical methods.

11.3.7 Reference Standards/Control Samples

Reference standards are standards of known concentration and independent in origin from the calibration standards. The intent of reference standard analysis is to provide insight into the analytical proficiency within an analytical series. This includes the preparation of calibration standards, the validity of calibration, sample preparation, instrument set-up, and the premises inherent in quantitation. Reference standards will be analyzed at the frequencies specified within the analytical methods.

11.4 Data Precision Assessment Procedures

Field precision is difficult to measure because of temporal variations in field parameters. However, precision will be controlled through the use of experienced field personnel, properly calibrated meters, and duplicate field measurements. Field duplicates will be used to assess precision for the entire measurement system including sampling, handling, shipping, storage, preparation, and analysis.

Laboratory data precision for organic analyses will be monitored through the use of MSD, laboratory duplicate, and field duplicates as identified in Table B-1.

The precision of data will be measured by calculation of the relative percent differences (RPDs) of duplicate sample sets.

The RPD can be calculated by the following equation:

$$\text{RPD} = \frac{(A-B)}{(A+B)/2} \times 100$$

Where:

A = Analytical result from one of two duplicate measurements.
B = Analytical result from the second measurement.

Precision objectives for matrix spike duplicate and laboratory duplicate analyses are identified in the NYSDEC ASP Revision 2005.

11.5 Data Accuracy Assessment Procedures

The accuracy of field measurements will be controlled by experienced field personnel, properly calibrated field meters, and adherence to established protocols. The accuracy of field meters will be assessed by review of calibration and maintenance logs.

Laboratory accuracy will be assessed via the use of matrix spikes, surrogate spikes, and internal standards. Where available and appropriate, QA performance standards will be analyzed periodically to assess laboratory accuracy. Accuracy will be calculated as a percent recovery as follows:

$$\text{Accuracy} = \frac{A-X}{B} \times 100$$

Where:

A = Value measured in spiked sample or standard.
X = Value measured in original sample.
B = True value of amount added to sample or true value of standard.

This formula is derived under the assumption of constant accuracy over the original and spiked measurements. If any accuracy calculated by this formula is outside of the acceptable levels, data will be evaluated to determine whether the deviation represents unacceptable accuracy, or variable, but acceptable accuracy. Accuracy objectives for matrix spike recoveries and surrogate recovery objectives are identified in the NYSDEC ASP, 2005 Revision.

11.6 Data Completeness Assessment Procedures

Completeness of a field or laboratory data set will be calculated by comparing the number of samples collected or analyzed to the proposed number.

$$\text{Completeness} = \frac{\text{No. Valid Samples Collected or Analyzed}}{\text{No. Proposed Samples Collected or Analyzed}} \times 100$$

As general guidelines, overall project completeness is expected to be at least 90 percent. The assessment of completeness will require professional judgment to determine data usability for intended purposes.

12. Instrument/Equipment Testing, Inspection, and Maintenance Requirements

Preventive maintenance schedules have been developed for both field and laboratory instruments. A summary of the maintenance activities to be performed is presented below.

12.1 Field Instruments and Equipment

Prior to any field sampling, each piece of field equipment will be inspected to assure it is operational. If the equipment is not operational, it must be serviced prior to use. All meters which require charging or batteries will be fully charged or have fresh batteries. If instrument servicing is required, it is the responsibility of the Field Activities Task Manager to follow the maintenance schedule and arrange for prompt service.

Field instrumentation to be used in this study includes meters to measure pH, ORP, turbidity, temperature, conductivity, and dissolved oxygen and groundwater levels. Field equipment also includes sampling devices for groundwater. A logbook will be kept for each field instrument. Each logbook contains records of operation, maintenance, calibration, and any problems and repairs. The Field Activities Task Manager will review calibration and maintenance logs.

Field equipment returned from a site will be inspected to confirm it is in working order. This inspection will be recorded in the logbook or field notebooks as appropriate. It will also be the obligation of the last user to record any equipment problems in the logbook.

Non-operational field equipment will be either repaired or replaced. Appropriate spare parts will be made available for field meters. A summary of preventive maintenance requirements for field instruments, and details regarding field equipment maintenance, operation, and calibration, are provided in the FSP.

12.2 Laboratory Instruments and Equipment

12.2.1 General

Only qualified personnel will service instruments and equipment. Repairs, adjustments, and calibrations are documented in the appropriate logbook or data sheet.

12.2.2 Instrument Maintenance

Preventive maintenance of laboratory equipment will follow the guidelines recommended by the manufacturer. A malfunctioning instrument will be repaired by in-house staff or through a service call by the manufacturer as appropriate.

The laboratory will maintain a sufficient supply of spare parts for its instruments to minimize downtime. Whenever possible, backup instrumentation will be retained.

Whenever practical, analytical equipment will be maintained under a service contract. The contract allows for preventative system maintenance and repair on an “as-needed” basis. The laboratory has sufficiently trained staff to allow for the day-to-day maintenance of equipment.

12.2.3 Equipment Monitoring

On a daily basis, the operation of balances, incubators, ovens, refrigerators, and water purification systems will be checked and documented. Any discrepancies will be immediately reported to the appropriate laboratory personnel for resolution.

13. Instrument Calibration and Frequency

13.1 Field Equipment Calibration Procedures and Frequency

Specific procedures for performing and documenting calibration and maintenance for the equipment measuring conductivity, temperature, pH, groundwater levels, and surface water levels are provided in the FSP. Calibration checks will be performed daily when measuring pH, ORP, turbidity, temperature, conductivity, and dissolved oxygen. Field equipment operation, calibration, and maintenance procedures are provided in the FSP.

13.2 Laboratory Equipment Calibration Procedures and Frequency

Instrument calibration will follow the specifications provided by the instrument manufacturer or specific analytical method used. The analytical methods for target constituents are identified separately below.

Volatile Organics, Semivolatile Organics, Cyanide (total) and Total Organic Carbon (TOC)

Equipment calibration procedures will follow guidelines presented in NYSDEC ASP 2005 Revision, Exhibit E.

Total Organic Carbon

Equipment calibration procedures will follow guidelines presented in Lloyd Kahn Method.

14. Inspection/Acceptance Requirements for Supplies and Consumables

The laboratory shall inspect/test all supplies and consumables prior to use with SC samples. Documentation shall be maintained for all associated testing and analyses.

15. Data Acquisition Requirements for Nondirect Measurements

At this point in time, historical data generated by outside parties is not anticipated to be used directly in completing the SC. However, historical data will be used as guidance in determining sampling locations for the SC.

Prior to their use, historic data sets will be reviewed according to the procedures identified in subsequent sections of this QASAPP to determine the appropriate uses of such data. The extent to which these data can be validated will be determined by the analytical level and QC data available. The evaluation of historic data for SC purposes requires the following:

- Identification of analytical levels
- Evaluation of QC data, when available
- Development of conclusions regarding the acceptability of the data for intended uses

Acceptability of historic data for intended uses will be determined by application of these procedures and professional judgment. If the historic data quality cannot be determined, its use will be limited to general trend evaluations.

16. Data Management

The purpose of the data management is to ensure that all of the necessary data are accurate and readily accessible to meet the analytical and reporting objectives of the project. The field investigations will encompass a large number of samples and a variety of sample matrices and analytes from a large geographic area. From the large amount of resulting data, the need arises for a structured, comprehensive, and efficient program for management of data.

The data management program established for the project includes field documentation and sample QA/QC procedures, methods for tracking and managing the data, and a system for filing all site-related information. More specifically, data management procedures will be employed to efficiently process the information collected such that the data are readily accessible and accurate. These procedures are described in detail in the following section.

The data management plan has five elements:

1. Sample designation system

2. Field activities

3. Sample tracking and management

4. Data management system

5. Document control and inventory

16.1 Sample Designation System

A concise and easily understandable sample designation system is an important part of the project sampling activities. It provides a unique sample number that will facilitate both sample tracking and easy re-sampling of select locations to evaluate data gaps, if necessary. The sample designation system to be employed during the sampling activities will be consistent, yet flexible enough to accommodate unforeseen sampling events or conditions. A combination of letters and numbers will be used to yield a unique sample number for each field sample collected.

16.2 Field Activities

Field activities designed to gather the information necessary to make decisions regarding the off-site areas require consistent documentation and accurate record keeping. During site activities, standardized procedures will be used for documentation of field activities, data security, and QA. These procedures are described in further detail in the following subsections.

16.2.1 Field Documentation

Complete and accurate record keeping is a critical component of the field investigation activities. When interpreting analytical results and identifying data trends, investigators realize that field notes are an important part of the review and validation process. To ensure that all aspects of the field investigation are thoroughly documented, several different information records, each with its own specific reporting requirements, will be maintained, including:

- Field logs
- Instrument calibration records
- Chain-of-custody forms

A description of each of these types of field documentation is provided below.

<u>Field Logs</u>

The personnel performing the field activities will keep field logs that detail all observations and measurements made during the SC. Data will be recorded directly into site-dedicated, bound notebooks, with each entry dated and signed. To ensure at any future date that notebook pages are not missing, each page will be sequentially numbered. Erroneous entries will be corrected by crossing out the original entry, initialing it, and then documenting the proper information. In addition, certain media sampling locations will be surveyed to accurately record their locations. The survey crew will use their own field logs and will supply the sampling location coordinates to the File Custodian.

<u>Instrument Calibration Records</u>

As part of data quality assurance procedures, field monitoring and detection equipment will be routinely calibrated. Instrument calibration ensures that equipment used is of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and desired results. Calibration procedures for the various types of field instrumentation are described in Section 13.1. In order to demonstrate that established calibration procedures have been followed, calibration records will be prepared and maintained to include, as appropriate, the following:

- Calibration date and time
- Type and identification number of equipment
- Calibration frequency and acceptable tolerances
- Identification of individual(s) performing calibration
- Reference standards used
- Calibration data
- Information on calibration success or failure

The calibration record will serve as a written account of monitoring or detection equipment QA. All erratic behavior or failures of field equipment will be subsequently recorded in the calibration log.

Chain-of-Custody Forms

COC forms are used as a means of documenting and tracking sample possession from time of collection to the time of disposal. A COC form will accompany each field sample collected, and one copy of the form will be filed in the field office. All field personnel will be briefed on the proper use of the COC procedure. A more thorough description of the COC forms is located in the FSP.

16.2.2 Data Security

Measures will be taken during the field investigation to ensure that samples and records are not lost, damaged, or altered. When not in use, all field notebooks will be stored at the field office in a locked cabinet. Access to these files will be limited to the field personnel who utilize them.

16.3 Sample Management and Tracking

A record of all field documentation, as well as analytical and QA/QC results, will be maintained to ensure the validity of data used in the site analysis. To effectively execute such documentation, carefully constructed sample tracking and data management procedures will be used throughout the sampling program.

Sample tracking will begin with the completion of COC forms, as described in Section 9.3.3. On a daily basis, the completed COC forms associated with samples collected that day will be faxed from the project office to the QAM. Copies of all completed COC forms will be maintained in the field office. On the following day, the QAM will telephone the laboratory to verify receipt of samples.

When analytical data are received from the laboratory, the QAM will review the incoming analytical data packages against the information on the COCs to confirm that the correct analyses were performed for each sample and that results for all samples submitted for analysis were received. Any discrepancies noted will be promptly followed-up by the QAM.

16.4 Data Management System

In addition to the sample tracking system, a data management system may be implemented. The central focus of the data management system will be the development of a personal computer-based project database. The project database, to be maintained by the Database Administrator, will combine pertinent geographical, field, and analytical data. Information that will be used to populate the database will be derived from three primary sources: surveying of sampling locations, field observations, and analytical results. Each of these sources is discussed in the following sections.

16.4.1 Computer Hardware

If required, the database will be constructed on Pentium®-based personal computer work stations connected through a Novell network server. The Novell network will provide access to various hardware peripherals, such as laser printers, backup storage devices, image scanners, modems, etc. Computer hardware will be upgraded to industrial and corporate standards, as necessary, in the future.

16.4.2 Computer Software

If required, the database will be written in Microsoft Access, running in a Windows operating system.

16.4.3 Surveying Information

In general, each location sampled as part of the SC will be surveyed to ensure accurate documentation of sample locations for mapping and GIS purposes (if appropriate), to facilitate the re-sampling of select sample locations during future monitoring programs, if needed, and for any potential remediation activities. The surveying activities that will occur in the field will consist of the collection of information that will be used to compute a northing and easting in state plane coordinates for each sample location and the collection of information to compute elevations relative to the National Geodetic Vertical Datum of 1988 for select sample locations, as appropriate. All field books associated with the surveying activities will be stored as a record of the project activities.

Conventional surveying techniques will be used to gather information such as the angle and distance between the sample location and the control monument, as well as point attributes. This information will be digitally stored in a data logger attached to the total station. On a weekly basis, each data logger in use will be transferred to the ARCADIS Syracuse Office, where the information will be downloaded into a personal computer for processing with surveying software. Control monuments will be established using GPS techniques. The surveying software allows the rapid computation of a location’s state plane coordinates.

Differential leveling techniques will be used to gather information to be used to compute a sample location's (or top-of-casing for groundwater monitoring wells) elevation. During the differential leveling process, which includes at least one benchmark of known elevation, detailed field notes will be kept in a field book. On a weekly basis, a copy of the relevant pages will be forwarded to Syracuse, New York, where the relevant information will be manually keyed into ARCADIS' surveying software package for further processing. The surveying software reduces the field notes and calculates a location's elevation relative to the project datum.

Following computation of a location's state plane coordinates and, at select locations, elevations, the computer information will undergo a QA/QC review by a licensed land surveyor. Following the approval of the computed information, the coordinates and elevations will be transferred to the File Custodian both in a digital and a hard copy format.

16.4.4 Analytical Results

Analytical results provided by the laboratory will generally be available in both a digital and a hard copy format. Upon receipt of each analytical package, the original COC form will be placed in the project files. The data packages will be examined to ensure that the correct analyses were performed for each sample submitted and that all of the analyses requested on the COC form were performed. If discrepancies are noted, the QAM will be notified and will promptly follow up with the laboratory to resolve any issues.

Where appropriate, the data packages will be validated in accordance with the procedures presented in Section 20. Any data that does not meet the specified standards will be flagged pending resolution of the issue. The flag will not be removed from the data until the issue associated with the sample results is resolved. Although flags may remain for certain data, the use of that data may not necessarily be restricted.

Following completion of the data validation, the digital files will be used to populate the appropriate database tables. An example of the format of electronic data deliverable (EDD) format is included in Table B-5. This format specifies one data record for each constituent for each sample analyzed. Specific fields include:

- sample identification number
- date sampled
- date analyzed
- parameter name
- analytical result
- units
- detection limit
- qualifier(s)

The individual EDDs, supplied by the laboratory in either an ASCII comma separated value (CSV) format or in a Microsoft Excel 97 worksheet, will be loaded into the appropriate database table. Any analytical data that cannot be provided by the laboratory in electronic format will be entered manually.

After entry into the database, the EDD data will be compared to the field information previously entered into the database to confirm that all requested analytical data have been received.

16.4.5 Data Analysis and Reporting

The database management system will have several functions to facilitate the review and analysis of the SC data. Data entry screens will be developed to assist in the keypunching of field observations. Routines will also be developed to permit the user to scan analytical data from a given site for a given media. Several output functions that have been developed by ARCADIS will be appropriately modified for use in the data management system.

A valuable function of the data management system will be the generation of tables of analytical results from the project databases. The capability of the data management system to directly produce tables reduces the redundant manual entry of analytical results during report preparation and precludes transcription errors that may occur otherwise. This data management system function creates a digital comma-delimited ASCII file of analytical results and qualifiers for a given media. The ASCII file is then processed through a spreadsheet, which transforms the comma-delimited file into a table of rows and columns. Tables of analytical data will be produced as part of data interpretation tasks, the reporting of data, and the generation of the SC Report.

Another function of the data management system will be to create digital files of analytical results and qualifiers suitable for transfer to mapping/presentation software. A function has been created by ARCADIS that creates a digital file consisting of sample location number, state plane coordinates, sampling date, and detected constituents and associated concentrations and analytical qualifiers. The file is then transferred to an AutoCAD work station, where another program has been developed to plot a location's analytical data in a "box" format at the sample location (represented by the state plane coordinates). This routine greatly reduces the redundant keypunching of analytical results and facilitates the efficient production of interpretative and presentation graphics.

The data management system also has the capability of producing a digital file of select parameters that exists in one or more of the databases. This type of custom function is accomplished on an interactive basis and is best used for transferring select information into a number of analysis tools, such as statistical or graphing programs.

16.5 Document Control and Inventory

ARCADIS maintains project files in its Syracuse, New York office. Each client project is assigned a file/job number. Each file is then broken down into the following subfiles:

- #1- Agreements and Contracts - all agreements and contracts involving the off-site investigations

- #2- Correspondence - all external correspondence, including reports

- #3- Memoranda - all internal and external memoranda

- #4- Notes and Data - notes and data from field, laboratory, and internal calculations

- #5- News Clippings - local newspapers, regulatory publications, and technical publications are sources of articles

Originals, when possible, are placed in the files. These are the central files and will serve as the site-specific files for the investigations.

17. Assessment and Response Actions

Performance and systems audits will be completed in the field and the laboratory during the SC as described below.

17.1 Field Audits

The following field performance and systems audits will be completed during this project.

17.1.1 Performance Audits

The Project Manager will monitor field performance. Field performance audit summaries will contain an evaluation of field measurements and field meter calibrations to verify that measurements are taken according to established protocols. The ARCADIS Quality Assurance Manager will review all field reports and communicate concerns to the ARCADIS Project Manager, as appropriate. In addition, the ARCADIS Quality Assurance Manager will review the rinse and trip blank data to identify potential deficiencies in field sampling and cleaning procedures.

17.1.2 Internal Systems Audits

A field internal systems audit is a qualitative evaluation of all components of field QA/QC. The systems audit compares scheduled QA/QC activities from this document with actual QA/QC activities completed. The Project Manager will periodically confirm that work is being performed consistent with the SC Work Plan, the FSP, and the HASP.

17.2 Laboratory Audits

The laboratory will perform internal audits consistent with NYSDEC ASP, 2005 Revision, Exhibit E.

In addition to the laboratory’s internal audits and participation in state and federal certification programs, the laboratory sections at the laboratory are audited by representatives of the regulatory agency issuing certification. Audits are usually conducted on an annual basis and focus on laboratory conformance to the specific program protocols for which the laboratory is seeking certification. The auditor reviews sample handling and tracking documentation, analytical methodologies, analytical supportive documentation, and final reports. The audit findings are formally documented and submitted to the laboratory for corrective action, if necessary.

ARCADIS reserves the right to conduct an on-site audit of the laboratory prior to the start of analyses for the project. Additional audits may be performed during the course of the project, as deemed necessary.

17.3 Corrective Action

Corrective actions are required when field or analytical data are not within the objectives specified in this QASAPP, the FSP, or the Work Plan. Corrective actions include procedures to promptly investigate, document, evaluate, and correct data collection and/or analytical procedures. Field and laboratory corrective action procedures for the SC are described below.

17.3.1 Field Procedures

When conducting the SC field work, if a condition is noted that would have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action implemented will be documented on a Corrective Action Report Form and reported to the ARCADIS Project Manager.

Examples of situations that would require corrective actions are provided below:

1. Protocols as defined by this QASAPP, the FSP, or the Work Plan have not been followed.

2. Equipment is not in proper working order or properly calibrated.

3. QC requirements have not been met.

4. Issues resulting from performance or systems audits.

Project personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities.

17.3.2 Laboratory Procedures

In the laboratory, when a condition is noted to have an adverse effect on data quality, corrective action will be taken so as not to repeat this condition. Condition identification, cause, and corrective action to be taken will be documented, and reported to the Project Manager.

Corrective action may be initiated, at a minimum, under the following conditions:

1. Specific laboratory analytical protocols have not been followed.

2. Predetermined data acceptance standards are not obtained.

3. Equipment is not in proper working order or calibrated.

4. Sample and test results are not completely traceable.

5. QC requirements have not been met.

6. Issues resulting from performance or systems audits.

Laboratory personnel will continuously monitor ongoing work performance in the normal course of daily responsibilities.

18. Reports to Management

18.1 Internal Reporting

The analytical laboratory will submit analytical reports to ARCADIS for review. If required, ARCADIS will, in turn, submit the reports to the data validator for review. Supporting data (i.e., historic data, related field or laboratory data) will also be reviewed to evaluate data quality, as appropriate. The ARCADIS Quality Assurance Manager will incorporate results of the data validation reports (if required) and assessments of data usability into a summary report (if required) that will be submitted to the ARCADIS Project Manager. If required, this report will be filed in the project file at ARCADIS' office and will include the following:

1. Assessment of data accuracy, precision, and completeness for both field and laboratory data

2. Results of the performance and systems audits

3. Significant QA/QC problems, solutions, corrections, and potential consequences

4. Analytical data validation report

18.2 SC Reporting

Upon sample transport to the laboratory, a copy of the chain-of-custody will be forwarded to National Fuel. Upon receipt of the ASP - Category B Data Package from the laboratory, the ARCADIS Quality Assurance Manager will determine if the data package has met the required data quality objectives. The analytical data package will also be incorporated into the SC Report.

19. Data Review, Validation, and Verification

After field and laboratory data are obtained, these data will be subject to:

1. Validation of the data

2. Reduction or manipulation of the data mathematically or otherwise into meaningful and useful forms

3. Organization, interpretation, and reporting of the data

19.1 Field Data Reduction, Validation, and Reporting

19.1.1 Field Data Reduction

Information that is collected in the field through visual observation, manual measurement and/or field instrumentation will be recorded in field notebooks, log sheets, and/or other appropriate forms. Such data will be reviewed by the Project Manager for adherence to the Work Plan and consistency of data. Any concerns identified as a result of this review will be discussed with the field personnel, corrected if possible, and as necessary incorporated into the data evaluation process.

19.1.1.1 Task 1 – Soil Investigation

The specific data reduction activity that will be performed during Task 1 is:

1. Mapping of areas impacted with MGP-related constituents based on findings of the soil-boring program

19.1.1.2 Task 2 – Groundwater Investigation

Reduction of the field data collected during performance of Task 3 will include:

1. Calculation of water elevations by subtracting the depth-to-water data from the surveyed elevation of the measuring point

2. Production of hydrogeologic contour maps by contouring lines of equal water elevations using known elevation points

19.1.2 Field Data Validation

Field data calculations, transfers, and interpretations will be conducted by the field personnel and reviewed for accuracy by the Project Manager and the Quality Assurance Manager. The Project Manager will recalculate at least five percent of all data reductions. Field documentation and data reduction prepared by field personnel will be reviewed by the Project Manager and Quality Assurance Manager. All logs and documents will be checked for:

1. General completeness
2. Readability
3. Usage of appropriate procedures
4. Appropriate instrument calibration and maintenance
5. Reasonableness in comparison to present and past data collected
6. Correct sample locations
7. Correct calculations and interpretations

19.1.3 Field Data Reporting

Where appropriate, field data forms and calculations will be processed and included in appendices to the SC Report. The original field logs, documents, and data reductions will be kept in the project file at the ARCADIS office in Syracuse, New York.

19.2 Laboratory Data Reduction, Review, and Reporting

19.2.1 Laboratory Data Reduction

Laboratory analytical data will be directly transferred from the instrument to the computer or the data reporting form (as applicable). Calculation of sample concentrations will be performed using the appropriate regression analysis program, response factors, and dilution factors (where applicable).

19.2.2 Laboratory Data Review

All data will be subject to multi-level review by the laboratory. The group leader will review all data reports prior to release for final data report generation, and the laboratory director will review a cross section of the final data reports. All final data reports are reviewed by the laboratory QAM prior to shipment to ARCADIS.

If discrepancies or deficiencies exist in the analytical results, then corrective action will be taken, as discussed in Section 17. Deficiencies discovered as a result of internal data review, as well as the corrective actions to be used to rectify the situation, will be documented on a Corrective Action Form. This form will be submitted to the ARCADIS Project Manager.

20. Validation and Verification Methods

Data validation entails a review of the QC data and the raw data to verify that the laboratory was operating within required limits, the analytical results are correctly transcribed from the instrument, and which, if any, environmental samples are related to any out-of-control QC samples. The objective of data validation is to identify any questionable or invalid laboratory measurements.

No validation of the analytical data collected during the SC is proposed at this time. If required, data validation will consist of data screening, checking, reviewing, editing, and interpreting to document analytical data quality and determine if the quality is sufficient to meet the DQOs. The data validation will also include a review of completeness and compliance, including the elements provided in Table B-4.

ARCADIS will validate all data generated producing a NYSDEC data usability summary report (DUSR) for each individual SDG using the most recent versions of the USEPA's Function Guidelines (USEPA, 1999; 2002) and USEPA Region II SOPs for data validation available at the time of project initiation, where appropriate. These procedures and criteria may be modified as necessary to address project-specific and method-specific criteria, control limits, and procedures. Data validation will consist of data screening, checking, reviewing, editing, and interpretation to document analytical data quality and to determine whether the quality is sufficient to meet the DQOs.

The data validator will verify that reduction of laboratory measurements and laboratory reporting of analytical parameters is in accordance with the procedures specified for each analytical method and/or as specified in this QASAPP. Any deviations from the analytical method or any special reporting requirements apart from that specified in this QASAPP will be detailed on COC forms.

Upon receipt of laboratory data, the following procedures will be executed by the data validator:

- Evaluate completeness of data package.
- Verify that field COC forms were completed and that samples were handled properly.
- Verify that holding times were met for each parameter. Holding time exceedences, should they occur, will be documented. Data for all samples exceeding holding

time requirements will be flagged as either estimated or rejected. The decision as to which qualifier is more appropriate will be made on a case-by-case basis.

- Verify that parameters were analyzed according to the methods specified.

- Review QA/QC data (i.e., make sure duplicates, blanks, and spikes were analyzed on the required number of samples, as specified in the method; verify that duplicate and MS recoveries are acceptable).

- Investigate anomalies identified during review. When anomalies are identified, they will be discussed with the Project Manager and/or Laboratory Manager, as appropriate.

- If data appears suspect, investigate the specific data of concern. Calculations will be traced back to raw data; if calculations do not agree, the cause will be determined and corrected.

Deficiencies discovered as a result of the data review, as well as the corrective actions implemented in response, will be documented and submitted in the form of a written report addressing the following topics as applicable to each method:

- Assessment of the data package
- Description of any protocol deviations
- Failures to reconcile reported and/or raw data
- Assessment of any compromised data
- Overall appraisal of the analytical data
- Table of site name, sample quantities, matrix, and fractions analyzed

It should be noted that qualified results do not necessarily invalidate data. The goal to produce the best possible data does not necessarily mean producing data without quality control qualifiers. Qualified data can provide useful information.

Resolution of any issues regarding laboratory performance or deliverables will be handled between the laboratory and the data validator. Suggestions for reanalysis may be made by the ARCADIS QAC at this point.

1. Data validation reports will be kept in the project file at the ARCADIS office in Syracuse, New York.

21. Reconciliation with User Requirements

The data results will be examined to determine the performance that was achieved for each data usability criteria. The performance will then be compared with the project objectives. Of particular note will be samples at or near action levels. All deviations from objectives will be noted. Additional action may be warranted when performance does not meet performance objectives for critical data. Action options may include any or all of the following:

- Retrieval of missing information
- Request for additional explanation or clarification
- Reanalysis of sample from extract (when appropriate)
- Recalculation or reinterpretation of results by the laboratory

These actions may improve the data quality, reduce uncertainty, and may eliminate the need to qualify or reject data.

If these actions do not improve the data quality to an acceptable level, the following actions may be taken:

- Extrapolation of missing data from existing data points
- Use of historical data
- Evaluation of the critical/non-critical nature of the sample

If the data gap cannot be resolved by these actions, an evaluation of the data bias and potential for false negatives and positives can be performed. If the resultant uncertainty level is unacceptable, then the following action must be taken:

- Additional sample collection and analysis

Acronyms

ASTM	American Society for Testing and Material
ARCADIS	ARCADIS
ASP	Analytical Services Protocol
CLP	Contract Laboratory Program
COC	Chain-of-Custody
CSV	Comma Separated Value
DUP	Duplicate
DQOs	Data Quality Objectives
EDD	Electronic Data Deliverable GC Gas Chromatography
FSP	Field Sampling Plan
GC/MS	Gas Chromatography/Mass Spectrometry
GIS	Geographic Information System
GPS	Global Positioning System
HASP	Health and Safety Plan
mg/kg	Milligram per kilogram
mg/L	Milligrams per liter
mS/cm	Millisiemens per centimeter
MS	Matrix Spike
MSD	Matrix Spike Duplicate

NEIC	National Enforcement Investigations Center
ng	Nanogram
NIST	National Institute of Science and Technology
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
PCBs	Polychlorinated Biphenyls
PID	Photoionization Detector
PNP	Paranitrophenol
PPE	Personal Protective Equipment
ppb	Parts per billion
ppm	Parts per million
QAM	Quality Assurance Manager
QASAPP	Quality Assurance Sampling and Analysis Project Plan
QA/QC	Quality Assurance/Quality Control
RCRA	Resource Conservation Recovery Act
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SC	Site Characterization
SDG	Sample Delivery Group
SOP	Standard Operating Procedures

SU	Standard Units
TOC	Total Organic Carbon
TSS	Total Suspended Solids
USCS	Unified Soil Classification System
USEPA	United States Environmental Protection Agency

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ARCADIS

Appendix B
Quality Assurance Sampling and Analysis Project Plan

TABLES

Table B-1. Environmental and Quality Control Analyses, Site Characterization, Dunkirk Former MGP Site, Dunkirk, New York

Environmental Sample Matrix/ Laboratory Parameters	Estimated Environmental Sample Quantity	Field QC Analyses							Laboratory QC Analyses[1,2]						Estimated Overall Total
		Trip Blank		Field Duplicate		Rinse Blank[3]		Est. Matrix Total	MS		MSD		Lab Duplicate		
		Freq	No.	Freq	No.	Freq	No.		Freq	No.	Freq	No.	Freq	No.	
Soils															
Volatile Organics Method 8260	10	1/day	4	1/20	1	1/20	1	16	1/20	1	1/20	1	--	--	18
Semivolatile Organics Method 8270	10	--	--	1/20	1	1/20	1	12	1/20	1	1/20	1	--	--	14
Total Cyanide Method 9012	10	--	--	1/20	1	1/20	1	12	1/20	1	--	--	1/20	1	14
Groundwater															
Volatile Organics Method 8260	4	1/day	1	1/20	1	--	--	6	1/20	1	1/20	1	--	--	8
Semivolatile Organics Method 8270	4	--	--	1/20	1	--	--	5	1/20	1	1/20	1	--	--	7
Cyanide (total) Method 9012	4	--	--	1/20	1	--	--	5	1/20	1	--	--	1/20	1	7

Notes:

[1] The number of laboratory QC analyses is based on the frequencies given for the number of environmental samples estimated, not including field QC analyses (i.e., rinse and trip blanks).

[2] Laboratory QC analyses are listed only for those parameters that must be performed on site samples. The laboratory is required to analyze QC samples for the remaining parameters at the frequency listed in the associated analytical method.

[3] Rinse blank samples will be collected only when non-dedicated sampling devices are used. Rinse blanks will be collected at a frequency of one per day of use or one per 20 samples, whichever is less.

MS = Matrix spike.
MSB = Matrix spike blank.
MSD = Matrix spike duplicate.

Table B-2. Method Reporting Limits and Action Limits, Site Characterization, Dunkirk Former MGP Site, Dunkirk, New York

	Water (ug/L)		Soil (ug/kg)		
Analyte	**Laboratory MDL**	**Laboratory RL**	**Laboratory MDL**	**Laboratory Low Level RL**	**Laboratory Medium RL**
Volatile Organic Compounds 8260 [1]					
1,1,1,2-Tetrachloroethane	0.35	1.0	0.31	5	500
1,1,1-Trichloroethane	0.26	1.0	0.36	5	500
1,1,2,2-Tetrachloroethane	0.48	1.0	0.33	5	500
1,1,2-Trichloroethane	0.42	1.0	0.25	5	500
1,1-Dichloroethane	0.27	1.0	0.58	5	500
1,1-Dichloroethene	0.29	1.0	0.61	5	500
1,2 Dichloroethane	0.46	1.0	0.25	5	500
1,2,3-Trichloropropane	0.32	1.0	0.51	5	500
1,2-Dibromo-3-chloropropane (DBCP)	0.47	1.0	0.37	5	500
1,2-Dibromoethane (EDB)	0.42	1.0	0.19	5	500
1,2-Dichlorobenzene	0.4	1.0	0.32	5	500
1,2-Dichloropropane	0.33	1.0	0.26	5	500
1,3-Dichlorobenzene	0.33	1.0	0.3	5	500
1,4-Dichlorobenzene	0.37	1.0	0.23	5	500
2-Butanone (MEK)	1.3	5.0	0.81	25	500
2-Chloroethyl vinyl ether	0.96	1.0	6.25	5	500
2-Hexanone	1.3	5.0	6.3	25	500
4-Methyl-2-pentanone (MIBK)	1.3	5.0	6.3	25	500
Acetone	1.3	5.0	1.1	5	500
Acrylonitile	1.39	5	25	200	500
Benzene	0.35	1.0	0.55	5	500
Bromochloromethane	0.4	1.0	0.36	5	500
Bromoform	0.26	1.0	0.46	5	500
Bromomethane	0.28	1.0	0.46	5	500
Carbon Disulfide	0.23	1.0	0.43	5	500
Carbon Tetrachloride	0.27	1.0	0.68	5	500
Chlorobenzene	0.32	1.0	0.51	5	500
Chloroethane	0.32	1.0	0.36	5	500
Chloroform	0.34	1.0	0.31	5	500
cis-1,2-Dichloroethene	0.22	1.0	0.25	5	500
cis-1,3-Dichloropropene	0.32	1.0	0.29	5	500
Dibromochloromethane	0.34	1.0	0.28	5	500
Dichlorobromomethane	0.39	1.0	0.26	5	500
Ethylbenzene	0.45	1.0	0.35	5	500
Iodomethane	0.27	1.0	0.61	5	500
Methyl Chloride	0.35	1.0	0.3	5	500
Methylene Chloride	0.44	1.0	2.2	5	500
Styrene	0.31	1.0	0.25	5	500
Tetrachloroethene	0.36	1.0	0.3	5	500
Toluene	0.51	1.0	0.85	5	500
Total Xylenes	0.93	1.0	2.9	15	500
trans-1,2-Dichloroethene	0.33	1.0	0.52	5	500
trans-1,3-Dichloropropene	0.37	1.0	0.64	5	500
trans-1,4-Dichloro-2-butene	2.12	5	0.36	5	500
Trichloroethene	0.32	1.0	0.35	5	500
Trichlorofluoromethane	0.15	1.0	0.55	5	500
Vinyl Acetate	1.29	5	0.36	5	500
Vinyl Chloride	0.24	1.0	0.2	10	500
Semivolatile Organic Compounds 8270 [1]					
1,2,4-Trichlorobenzene	0.11	10	4.83	330	330
1,2-Dichlorobenzene	0.14	10	3.23	330	330
1,3-Dichlorobenzene	0.14	10	3.02	330	330
1,4-Dichlorobenzene	0.16	10	2.22	330	330
2,4,5-Trichlorophenol	0.99	10	37	330	330
2,4,6 Trichlorophenol	0.99	10	11	330	330
2,4-Dichlorophenol	0.79	10	8.8	330	330
2,4-Dimethylphenol	0.96	10	46	330	330
2,4-Dinitrophenol	2.2	10	59	830	800
2,4-Dinitrotoluene	0.45	10	26	330	330
2,6 Dinitrotoluene	0.51	10	41	330	330
2-Chloronaphthalene	0.08	10	11	330	330
2-Chlorophenol	0.51	10	8.6	330	330
2-Methylnaphthalene	0.08	10	2	330	330
2-Methylphenol	0.23	10	5.1	330	330
2-Nitroaniline	0.5	10	54	830	800
2-Nitrophenol	0.6	10	7.7	330	330
3,3'-Dichlorobenzidine	0.37	10	148	330	600

See Notes on Page 2.

Table B-2. Method Reporting Limits and Action Limits, Site Characterization, Dunkirk Former MGP Site, Dunkirk, New York

Analyte	Water (ug/L) Laboratory MDL	Water (ug/L) Laboratory RL	Soil (ug/kg) Laboratory MDL	Soil (ug/kg) Laboratory Low Level RL	Soil (ug/kg) Laboratory Medium RL
Semivolatile Organic Compounds 8270 [1] (Cont'd.)					
3-Nitroaniline	1.5	10	39	830	800
4-Bromophenyl-phenylether	0.9	10	54	330	330
4-Chloro-3-Methylphenol	0.6	10	6.9	330	330
4-Chloroaniline	0.33	10	50	330	330
4-Chlorophenyl-phenylether	0.17	10	3.6	330	330
4,6-Dinitro-2-methylphenol	0.23	10	58	830	800
4-Methylphenol	0.35	10	9.4	330	330
4-Nitroaniline	0.46	10	19	830	800
4-Nitrophenol	1.5	10	41	830	800
Acenaphthene	0.11	10	2	330	330
Acenaphthylene	0.05	10	1.4	330	330
Anthracene	0.06	10	4.3	330	330
Benzo(a)anthracene	0.06	10	2.9	330	330
Benzo(b)fluoranthene	0.06	10	3.3	330	330
Benzo(k)fluoranthene	0.07	10	1.9	330	330
Benzo (g,h,i,) Perylene	0.08	10	2	330	330
Benzo(a)pyrene	0.09	10	4.1	330	330
Benzyl alcohol	0.29	10	8.06	330	330
bis(2-Chloroethoxy)methane	0.38	10	9.2	330	330
bis(2-chloroethyl)ether	0.18	10	15	330	330
bis(2-chloroisopropyl)ether	0.42	10	17.6	330	330
bis(2-Ethylhexyl) phthalate	4.8	10	54	330	330
Butyl benzyl phthalate	1.7	10	45	330	330
Chrysene	0.27	10	1.7	330	330
Di-n-butyl phthalate	0.3	10	58	330	330
Di-n-octyl phthalate	0.24	10	3.9	330	330
Dibenzo(a,h)anthracene	0.2	10	2	330	330
Dibenzofuran	0.1	10	1.8	330	330
Diethyl phthalate	0.11	10	5.1	330	330
Dimethylphthalate	0.3	10	4.4	330	330
Fluoranthene	0.1	10	2.4	330	330
Fluorene	0.07	10	2.4	330	330
Hexachlorobenzene	0.44	10	8.4	330	330
Hexachlorobutadiene	2.6	10	8.6	330	330
Hexachlorocyclopentadiene	2.5	10	51	330	330
Hexachloroethane	2.8	10	13	330	330
Indeno(1,2,3-cd)pyrene	0.15	10	4.7	330	330
Isophorone	0.32	10	8.4	330	330
N-Nitrosodimethylamine	1	10	12	330	330
N-Nitroso-di-n-propylamine	0.45	10	13	330	330
N-Nitrosodiphenylamine	0.26	10	9.2	330	330
Naphthalene	0.12	10	2.8	330	330
Nitrobenzene	0.54	10	7.5	330	330
Pentachlorophenol	5.1	10	58	830	800
Phenanthrene	0.11	10	3.5	330	330
Phenol	0.45	10	18	330	330
Pyrene	0.07	10	1.1	330	330
Inorganics - 9010B/9012A[1]					
Cyanide	5	10	870	1000	1000

Notes:

1. USEPA. Office of Solid Waste and Emergency Response. *Test Methods for Evaluating Solid Waste SW-846 3rd ed. Washington, D.C. 1996.*
2. The target reporting limits are based on wet weight. The actual reporting limits will vary based on sample weight and moisture content.
3. The reporting limits listed are the Maximum Concentration of Contaminants for the Toxicity Characteristic (Fed. Reg.).

Table B-3. Sample Containers, Preservation, and Holding Time Requirements, Site Characterization, Dunkirk Former MGP Site, Dunkirk, New York

Parameter	Container	Preservation	Maximum Holding Time from VTSR
Groundwater Samples			
Volatile Organics	(2) 40-ml Teflon-lined septa (glass)	Cool 4ºC HCl to pH <2	5 days (unpreserved) 12 days (preserved)
Semivolatile Organics	(2) 1-liter containers (glass)	Cool 4ºC	5 days extraction; 40 days analysis
Cyanide	(1) 500-ml container (plastic)	Cool 4ºC NaOH to pH >12	12 days
Soil Samples			
Volatile Organics	(1) 4-oz container (glass)	Cool 4ºC	12 days
Semivolatile Organics	(1) 4-oz container (glass)	Cool 4ºC	5 days extraction; 40 days analysis
Cyanide	(1) 4-oz container (glass)	Cool 4ºC	12 days

Notes:
VTSR = Verifiable time of sample receipt. Samples must be delivered to laboratory within 48 hours from day of collection.

Table B-4. Data Validation Checklist - Laboratory Analytical Data, Site Characterization, Dunkirk Former MGP Site, Dunkirk, New York

REVIEW FOR COMPLETENESS
1. Chain-of-custody forms included.
2. Sample preparation and analysis summary tables included.
3. QA/QC summaries of analytical data included.
4. Relevant calibration data included with analytical data.
5. Instrument and method performance data included.
6. Method detection limits documented.
7. Data report forms of examples for calculations of concentrations.
8. Raw data used in identification and quantification of the analysis required.
REVIEW OF COMPLIANCE
1. Data package completed.
2. QAPP requirements for data met.
3. QA/QC criteria met.
4. Instrument type and calibration procedures met.
5. Initial and continuing calibration met.
6. Data reporting forms completed.
7. Problems and corrective actions documented.

Table B-5. Electronic Data Deliverable (EDD) Format, Site Characterization, Dunkirk Former MGP Site, Dunkirk, New York

Field Name	Maximum Length	Data Type	Comments
FIELD SAMPLE ID	50	TEXT	From the chain of custody. Add "RE" or "DL" to differentiate reanalyses and dilutions.
SDG	50	TEXT	
LAB SAMPLE ID	50	TEXT	
MATRIX	10	TEXT	SOIL, WATER, etc.
SAMPLE TYPE	10	TEXT	FB, RB, TB, FD, FS for Field Blank, Rinse Blank, Trip Blank, Field Duplicate and Field Sample, respectively. DEFAULT TO FS
DATE COLLECTED	--	DATE/TIME	MM/DD/YY
TIME COLLECTED*	--	DATE/TIME	Military time
DEPTH START	--	NUMBER	
DEPTH END	--	NUMBER	
DEPTH UNITS	25	TEXT	FEET, INCHES, METERS, etc.
ANALYTICAL METHOD	50	TEXT	
CAS NUMBER	25	TEXT	
ANALYTE	100	TEXT	
RESULT VALUE	--	NUMBER	For non-detected results, enter Reporting Limit ("U" must be present in Lab Qualifier field).
LAB QUALIFIER	10	TEXT	"U" for non-detected, others as defined by laboratory.
REPORTING LIMIT	--	NUMBER	
RESULT UNIT	25	TEXT	
DILUTION FACTOR	--	NUMBER	
REPORTABLE RESULT	--	YES/NO	DEFAULT TO YES
FILTERED?	--	YES/NO	
DATE ANALYZED	--	DATE/TIME	MM/DD/YY
TIME ANALYZED*	--	DATE/TIME	Military time
DATE EXTRACTED*	--	DATE/TIME	MM/DD/YY
LABORATORY NAME*	50	TEXT	

Notes:

1. This definition is for an "Excel-type" spreadsheet. Fields flagged with an "*" are optional and may be left blank if not available electronically from the laboratory.
2. Depth-related fields may be left blank for samples and matrices for which they are not applicable.

Attachment 4

Health and Safety Plan

ARCADIS
Infrastructure, environment, buildings

Imagine the result

National Fuel Gas Distribution Corporation

Appendix C
Health and Safety Plan

Dunkirk Former Manufactured Gas Plant Site
(Site No. 9-07-035)
Dunkirk, New York

February 2009

ARCADIS

Appendix C
Health and Safety Plan

Dunkirk Former Manufactured Gas Plant Site
Dunkirk, New York

Terry W. Young, P.E.
Principal-In-Charge

Scott A. Powlin
Project Manager

Charles Webster
Health and Safety Manager

Prepared for:
National Fuel Gas Distribution Corporation

Prepared by:
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Our Ref.:
B0023301.0000.00001

Date:
February 2009

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Attachments

Approvals and Acknowledgments

Approvals

I have read and approved this Health and Safety Plan (HASP) with respect to project hazards, regulatory requirements, and ARCADIS procedures.

Project Name: National Fuel Gas Distribution Corporation, Dunkirk Former Manufactured Gas Plant Site – Dunkirk, New York
Project Number: B0023301.0000.00001

Project Manager/Date

Health and Safety Officer/Date

Health and Safety Supervisor/Date

Acknowledgments

The final approved version of this HASP has been provided to the Site Supervisor. I acknowledge my responsibility to provide the Site Supervisor with the equipment, materials and qualified personnel to implement fully all safety requirements in this HASP. I will formally review this plan with the Health and Safety Staff every six months until project completion.

Project Manager/Date

I acknowledge receipt of this HASP from the Project Manager, and that it is my responsibility to explain its contents to all site personnel and cause these requirements to be fully implemented. Any change in conditions, scope of work, or other change that might affect worker safety requires me to notify the Project Manager and/or the Health and Safety Officer.

Site Supervisor/Date

1. Introduction

1.1 Objective

The objective of site activities is to conduct a Site Characterization (SC) at the Dunkirk Former Manufactured Gas Plant (MGP) Site (the site), in Dunkirk, New York in accordance with the approach outlined in the SC Work Plan. Field activities are expected to include the following general tasks:

- Mobilization
- Soil boring installations
- Monitoring well installations
- Collection of soil samples during the advancement of the monitoring wells and soil borings
- Collection of groundwater samples
- Measurement of fluid levels
- Geophysical Survey
- Survey
- Decontamination
- Demobilization

The objective of this Health and Safety Plan (HASP) is to provide a mechanism for establishing safe working conditions at the site. The safety organization, procedures, and protective equipment have been established based on an analysis of potential physical, chemical, and biological hazards. Specific hazard control methodologies have been evaluated and selected to minimize the potential of injury, illness, or other hazardous incident.

The HASP should be used in conjunction with the SC Work Plan, the Field Sampling Plan (FSP), and the Quality Assurance/Sampling and Analysis Project Plan (QA/SAPP). The SC Work Plan presents the site background and defines the field sampling program. The FSP contains field procedures and sample collection methods to be used during implementation of the SC Work Plan. The QA/SAPP presents the quality assurance/quality control (QA/QC) procedures to be used during implementation of the SC Work Plan, as well as a description of the general field and laboratory procedures. The FSP and QA/SAPP are provided in Appendix A and Appendix B, respectively, of the SC Work Plan.

1.2 Site Description and History

1.2.1 Site Description

The approximately 3 acre site is located at 31 West 2nd Street at the southeastern corner of the intersection of Swan Street and West 2nd Street in Dunkirk, Chautauqua County, New York (see Figure 1 of the SC Work Plan). The site comprises a generally rectangular piece of land that is now located in a mixed commercial and residential area. Lake Erie is located about 600 feet north of the site. The site is bordered by Swan Street to the west, West 2nd Street to the north, Eagle Street to the east, and an elevated railroad bed to the south. A Baptist Church is located near the southeastern corner of the site; however, a narrow strip of National Fuel property borders the church property to the south (see Figure 2 of the SC Work Plan).

A National Fuel Service Center building sits on the northeastern quadrant of the site. The Service Center building consists of a high-bay garage located south of the attached office area. Two other buildings are present at the property – a small metal sided storage building and a brick gas regulator building, which are both located south-south west of the Service Center building. A fuel pump island is located west of the metal sided storage building and consists of a pump island supported by an above ground storage tank (AST) containing diesel and an underground storage tank (UST) containing gasoline. The current site structures are shown on Figure 2 of the SC Work Plan.

The site is generally flat-lying and is largely paved with asphalt. A gravel-covered area used for staging gas distribution supplies is found in the southern approximately ¼ of the site. Small strips of grass areas are located in the rights-of-way along the perimeter of the site and in the northeast corner of the site. A grassy area also exists on the southern edge of the site, near the railroad.

1.2.2 Site History

The MGP operated from the late 1800s to approximately 1910. National Fuel currently owns the site (NFG, 2008). Based on a review of available Sanborn Fire Insurance Maps from 1888 to 1964, at its peak, the MGP consisted of three gas holders (which for the purpose of this Work Plan are numbered sequentially from east to west as holder 1 to holder 3), a retort house, a purifier house, a coal shed, and an oil tank. With the exception of holder 3, (the furthest to the west), the plant structures all existed in the northeast corner of the site. The current Service Center Building sits over at least a portion of holder 2, the retort house, the purifier house, and the coal shed. Figure 2 of the SC Work Plan shows the locations of the former MGP structures as they relate to present-day features. Limited information is available regarding gas production at the Dunkirk MGP; however, a review of the publication “Survey of Town Gas and By-Product Production and Locations in the U.S.” indicates that approximately 7, 23, and 26 million cubic feet of gas was produced at the MGP in 1890, 1900, and 1910 (Radian Corporation, 1985).

Coal was the primary feedstock for the manufactured gas process at the site (Radian Corporation, 1985). This method of producing gas, known as the coal carbonization method, consisted of heating bituminous coal in a sealed chamber (i.e., retorts), with destructive distillation of gas from the coal and the formation of coke. The gases were collected, cleaned (or purified), and distributed while coke was removed and sold or used. The main byproducts of the coal carbonization method were tars, oils, coke, ammoniacal liquor, ash and clinker, and residuals associated with the gas purification process (purifier wastes). The tars were generally viscous and contained higher concentrations of phenols and base nitrogen organics when compared to the tars generated from a later gas producing process known as the carbureted water-gas process. Coal carbonization also produced cyanide in the gas, which was removed during gas purification and often appears in wastes such as lime and wood chips.

1.3 Policy Statement

The policy of ARCADIS is to provide a safe and healthful work environment. No aspect of operations is of greater importance than injury and illness prevention. A fundamental principle of safety management is that all injuries, illnesses, and incidents are preventable. ARCADIS will take every reasonable step to eliminate or control hazards in order to minimize the possibility of injury, illness, or incident.

This HASP prescribes the procedures that must be followed during activities at the site. Operational changes that could affect the health and safety of personnel, the community, or the environment will not be made without the prior approval of the Project Manager (PM) and the Health and Safety Officer (HSO) or his designee. This document will be reviewed periodically to ensure that it is current and technically correct. Any changes in site conditions and/or the scope of work will require a review and modification to this HASP. Such changes will be completed in the form of an addendum or a revision to the plan.

The provisions of this plan are mandatory for all ARCADIS personnel and ARCADIS subcontractors assigned to the project. Subcontractors may prepare their own site-specific HASPs that must meet the basic requirements of this HASP. All visitors to ARCADIS work areas at the site must abide by the requirements of this plan.

1.4 References

This HASP complies with applicable Occupational Safety and Health Administration (OSHA) regulations, United States Environmental Protection Agency (USEPA) regulations, and ARCADIS health and safety policies and procedures. This plan follows the guidelines established in the following:

- *Standard Operating Safety Guides*, USEPA (Publication 9285.1-03, June 1992).
- *Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities*, National Institute for Occupational Safety and Health (NIOSH), OSHA, United States Coast Guard (USCG), USEPA (86116, October 1985).
- *Title 29 of the Code of Federal Regulations* (CFR), Part 1910.
- *Title 29 of the* CFR, Part 1926.
- *Pocket Guide to Chemical Hazards*, Department of Health and Human Services (DHHS), Public Health Service (PHS), Center for Disease Control and Prevention (CDC), NIOSH (2005).
- *Threshold Limit Values*, American Conference of Governmental Industrial Hygienists (ACGIH) (2007).
- *Guide to Occupational Exposure Values*, ACGIH (2007).
- *Quick Selection Guide to Chemical Protective Clothing*, Forsberg, K. and S.Z. Mansdorf, 2nd Ed. (1993).
- *Health and Safety Manual*, ARCADIS.

1.5 Definitions

The following definitions (listed alphabetically) are applicable to this HASP:

- *Contamination Reduction Zone (CRZ)* - Area between the exclusion zone and support zone that provides a transition between contaminated and clean areas. Decontamination stations are located in this zone.

- *Exclusion Zone (EZ)* - Any portions of the site where hazardous substances are, or are reasonably suspected to be present, and pose an exposure hazard to onsite personnel.

- *Incident* - All losses, including first aid cases, injuries, illnesses, near misses, spills/leaks, equipment and property damage, motor vehicle accidents, regulatory violations, fires, and business interruptions.

- *Near Miss* - An incident in which no injury, illness, motor vehicle accident, equipment or property damage, etc., occurred, but under slightly different circumstances, could have occurred.

- *Onsite Personnel* - All ARCADIS and subcontractor personnel involved with the project.

- *Project* - All onsite work performed under the scope of work.

- *Site* - The area described in Section 1.2, Site and Facility Description, where the work is to be performed by ARCADIS personnel and subcontractors.

- *Subcontractor* - Includes contractor personnel hired by ARCADIS.

- *Support Zone (SZ)* - All areas of the site, except the EZ and CRZ; the SZ surrounds the CRZ and EZ. Support equipment and break areas are located in this zone.

- *Visitor* - All other personnel, except the onsite personnel.

- *Work Area* - The portion of the site where work activities are actively being performed. This area may change daily as work progresses and includes the SZ, CRZ, and EZ. If the work area is located in an area on the site that is not contaminated, or suspected of being contaminated, the entire work area may be a SZ.

1.6 Acronyms

The following acronyms (listed alphabetically) are applicable to this HASP:

- *ACGIH* – American Conference of Governmental Industrial Hygienists
- *ANSI* – American National Standards Institute
- *BTEX* – Benzene, Toluene, Ethylbenzene, Xylene

- *CPR* – Cardiopulmonary Resuscitation
- *COC* – Constituent(s) of Concern
- *CRZ* – Contamination Reduction Zone
- *EMS* – Emergency Management System
- *EZ* – Exclusion Zone
- *GFCI* – Ground Fault Circuit Interrupter
- *HASP* – Health and Safety Plan
- *HSM* – Health and Safety Manager
- *HSO* – Health and Safety Officer
- *HSS* – Health and Safety Supervisor
- *II* – Incident Investigation
- *JSA* – Job Safety Analysis
- *LEL* – Lower Explosive Limit
- *LPS* – Loss Prevention System
- *LPO* – Loss Prevention Observation
- *MGP* – Manufactured Gas Plant
- *MSDS* – Material Safety Data Sheet
- *NIOSH* – National Institute for Occupational Safety and Health
- *NRR* – Noise Reduction Rating
- *NYSDEC* – New York State Department of Environmental Conservation
- *NYSDOH* – New York State Department of Health
- *OSHA* – Occupational Safety and Health Administration
- *PAH* – Polycyclic Aromatic Hydrocarbons
- *PEL* – Permissible Exposure Limit
- *PFD* – Personal Floatation Device
- *PIC* – Principal in Charge
- *PID* – Photoionization Detector
- *PM* – Project Manager
- *PO* – Project Officer
- *PPE* – Personal Protective Equipment
- *SPSA* – Safe Performance Self-Assessment
- *SC* – Site Characterization
- *SS* – Site Supervisor
- *SZ* – Support Zone
- *TLV* – Threshold Limit Value
- *USCG* – United States Coast Guard
- *USEPA* – United States Environmental Protection Agency
- *VOC* – Volatile Organic Compound

2. Roles and Responsibilities

2.1 All Personnel

All ARCADIS and subcontractor personnel must adhere to the procedures outlined in this HASP during the performance of their work. Each person is responsible for completing tasks safely, and reporting any unsafe acts or conditions to their supervisor. No person may work in a manner that conflicts with these procedures. After due warnings, the PM will dismiss from the site any person or subcontractor who violates safety procedures.

All ARCADIS and subcontractor personnel will receive training in accordance with applicable regulations, and be familiar with the requirements and procedures contained in this HASP prior to initiating site activities. In addition, all personnel will attend an initial hazard briefing prior to beginning work at the site.

The roles of ARCADIS personnel and subcontractors are outlined in the following sections. Key project personnel and contacts are summarized in Table 2-1.

2.2 ARCADIS Personnel

2.2.1 Project Officer (PO)/Principal in Charge (PIC)

The PO or PIC is responsible for providing resources to assure project activities are completed in accordance with this HASP, and for meeting all regulatory and contractual requirements.

2.2.2 Health and Safety Officer

The HSO or his designee (the Health and Safety Manger (HSM)) has overall responsibility for the technical health and safety aspects of the project, including review and approval of this HASP. Inquiries regarding ARCADIS health and safety procedures, project procedures, and other technical or regulatory issues should be addressed to this individual. The HSO or his designee must approve changes or addenda to this HASP.

2.2.3 Project Manager

The PM is responsible for verifying that project activities are completed in accordance with the requirements of this HASP. The PM is responsible for confirming that the Site Supervisor (SS) has the equipment, materials, and qualified personnel to fully implement the safety requirements of this HASP, and/or that subcontractors assigned to this project meet the requirements established by ARCADIS. It is also the responsibility of the PM to:

- Consult with the HSO/ HSM on site health and safety issues.
- Verify that subcontractors meet health and safety requirements prior to commencing work.
- Review Loss Prevention Observation (LPO) forms.
- Verify that all incidents are thoroughly investigated.
- Approve, in writing, addenda or modifications of this HASP.
- Suspend work or modify work practices, as necessary, for personal safety, protection of property, and regulatory compliance.

2.2.4 Health and Safety Supervisor (HSS)

The HSS is responsible for field health and safety issues, including the execution of this HASP. Questions in the field regarding health and safety procedures, project procedures, and other technical or regulatory issues should be addressed to this individual. The HSS will advise the PM on health and safety issues, and will establish and coordinate the project air monitoring program if one is deemed necessary (see Section 6.1, Air Monitoring). The HSS is the primary site contact on health and safety matters. It is the responsibility of the HSS to:

- Provide onsite technical assistance, if necessary.
- Participate in all incident investigations (IIs) and ensure that they are reported to the HSM/HSO, PIC, National Fuel Gas Distribution Corporation (National Fuel) and PM within 24 hours.
- Coordinate site and personal air monitoring as required, including equipment maintenance and calibration.
- Conduct site safety orientation training and safety meetings.
- Verify that ARCADIS personnel and subcontractors have received the required physical examinations and medical certifications.

- Review site activities with respect to compliance with this HASP.
- Maintain required health and safety documents and records.
- Assist the SS in instructing field personnel on project hazards and protective procedures.
- Review LPO forms.

2.2.5 Site Supervisor

The SS is responsible for implementing this HASP, including communicating requirements to onsite personnel and subcontractors. The SS will be responsible for informing the PM of changes in the work plan, procedures, or site conditions so that those changes may be addressed in this HASP. Other responsibilities are to:

- Consult with the HSS on site health and safety issues.
- Conduct LPOs at the site, and complete the LPO forms.
- Stop work, as necessary, for personal safety, protection of property, and regulatory compliance.
- Obtain a site map and determine and post routes to medical facilities and emergency telephone numbers.
- Notify local public emergency representatives (as appropriate) of the nature of the site operations, and post their telephone numbers (i.e., local fire department personnel who would respond for a confined space rescue).
- Observe onsite project personnel for signs of ill health effects.
- Investigate and report any incidents to the HSS.
- Verify that all onsite personnel have had applicable training.
- Verify that onsite personnel are informed of the physical, chemical, and biological hazards associated with the site activities, and the procedures and protective equipment necessary to control the hazards.
- Issue/obtain any required work permits (hot work, confined space, etc.).

For this SC project, the HSS and SS duties may be performed by the same person for some of the work activities and tasks (e.g. soil boring and monitoring well installations where subcontractors are working onsite).

2.3 Subcontractors

Subcontractors and their personnel must understand and comply with applicable regulations and site requirements established in this HASP. Subcontractors may prepare their own site-specific HASP that must be consistent with the requirements of this HASP.

All subcontractor personnel will receive training in accordance with applicable regulations, and be familiar with the requirements and procedures contained in this HASP prior to initiating site activities. All subcontractor personnel will attend an initial hazard briefing prior to beginning work at the site. Additionally, onsite subcontractor personnel must attend and participate in the daily site safety meetings.

Subcontractors must designate individuals to function as the PM, HSO, HSS, and SS. In some firms, it is not uncommon for the duties of the HSO to be carried out by the PM. This is acceptable provided the PM has the required knowledge, training, and experience to properly address all hazards associated with the work, and to prepare, approve, and oversee the execution of the site-specific HASP. A subcontractor may designate the same person to perform the duties of both the HSS and the SS. However, depending on the level of complexity of a contractor’s scope of work, it may be infeasible for one person to perform both functions satisfactorily.

2.4 All Onsite Personnel

All onsite personnel (including subcontractors) must read and acknowledge their understanding of this HASP before commencing work, and abide by the requirements of the plan. All onsite personnel shall sign the HASP Acknowledgement Form following their review of this HASP.

All ARCADIS and subcontractor personnel will receive training in accordance with applicable regulations, and be familiar with the requirements and procedures contained in this HASP prior to initiating site activities. In addition, all onsite personnel will attend an initial hazard briefing prior to beginning work at the site and the daily safety meetings.

All onsite personnel must perform a Safe Performance Self-Assessment (SPSA) prior to beginning each work activity. The SPSA process is presented in Section 4.2.1. This process must be performed prior to beginning each activity, and must be performed after any near miss or other incident in order to determine if it is safe to proceed. Onsite personnel will immediately report the following to the SS or HSS:

- Personal injuries and illnesses no matter how minor
- Unexpected or uncontrolled release of chemical substances
- Symptoms of chemical exposure
- Unsafe or hazardous situations
- Unsafe or malfunctioning equipment
- Changes in site conditions that may affect the health and safety of project personnel
- Damage to equipment or property
- Situations or activities for which they are not properly trained
- Near misses

2.5 Visitors

All visitors to ARCADIS work areas must check in with the SS. Visitors will be cautioned to avoid skin contact with surfaces, soils, groundwater, or other materials that may impacted or be suspected to be impacted by constituents of concern (COC).

Visitors requesting to observe work at the site must don appropriate personal protective equipment (PPE) prior to entry to the work area and must have the appropriate training and medical clearances to do so. If respiratory protective devices are necessary, visitors who wish to enter the work area must have been respirator-trained and fit tested for a respirator within the past 12 months.

Table 2-1. Key Personnel

ARCADIS Personnel		
Role	**Name**	**Address/Telephone No.**
Principal in Charge	Terry W. Young	6723 Towpath Rd., P.O. Box 66 Syracuse, NY 13214-0066 315.446.9120
Project Manager	Scott A. Powlin, P.G.	6723 Towpath Rd., P.O. Box 66 Syracuse, NY 13214-0066 315.446.9120
Health and Safety Officer	Jay D. Keough, CIH	8 South River Road Cranbury, NJ 08512 609.860.0590
Health and Safety Manager	Charles Webster	6723 Towpath Rd., P.O. Box 66 Syracuse, NY 13214-0066 315.446.9120

ARCADIS Personnel		
Role	**Name**	**Address/Telephone No.**
Site Supervisor	TBD	6723 Towpath Rd., P.O. Box 66 Syracuse, NY 13214-0066 315.446.9120
Health and Safety Supervisor	TBD	6723 Towpath Rd., P.O. Box 66 Syracuse, NY 13214-0066 315.446.9120
Subcontractors		
Company/Role	**Name**	**Address/Telephone No.**
TBD - Driller	TBD	TBD
Central Hudson Gas & Electric Personnel		
Role	**Name**	**Address/Telephone No.**
National Fuel Project Manager	Tanya B. Alexander, CHMM, REM	6363 Main Street Williamsville, NY 14221 716.857-7410
Agency Personnel		
Agency/Role	**Name**	**Address/Telephone No.**
New York State Department of Environmental Conservation (NYSDEC) Project Manager	William S. Ottaway	Division of Environmental Remediation NYSDEC 625 Broadway Albany, NY 12233 (518) 402-9686

2.6 Stop Work Authority

Every ARCADIS employee and ARCADIS subcontractor has the authority and the responsibility to stop the work of another co-worker if the working conditions or behaviors are considered unsafe, and is expected to do so.

2.7 Short-Service Employee (SSE) Program

Recognizing that inexperienced employees are at a greater risk for incidents, the following guidelines are established to identify those employees and ease their transition.

- ARCADIS employees new to the industry and new to ARCADIS will be identified in the field by wearing an orange hardhat/ballcap for 6 months.

- ARCADIS employees experienced in the industry, but new to ARCADIS will wear the orange hardhat/ballcap for 3 months.

The following guidelines apply:

- A crew of two to three may have one SSE onsite.
- A crew of five may have two SSEs onsite.
- A crew of ten may have no more than four SSEs onsite.

2.8 Near-Miss Reporting Hotline

To streamline near-miss reporting, especially for employees conducting field work who do not have real-time access to the web, ARCADIS has established a toll-free Near-Miss Reporting Hotline. The hotline will be checked daily and data will be entered into the ARCADIS LPS Database, with the caller listed as the primary contact for the event. All entries will be saved as initial and can be accessed by the caller when they return to their computers. Entry into the database does not relieve the caller from the responsibility of following through with the near-miss investigation, or of notifying other employees in the office or project team of the occurrence.

THE NEAR-MISS REPORTING NUMBER IS 1-866-242-4304.

Callers will be prompted to provide the following information:

- Name and phone number
- Date of near miss
- Location
- Project number (if applicable)
- Brief description of what happened
- Name of division or office Vice President
- What you think could have happened if this situation had resulted in an injury or damage
- Any other information you think may be important

The intent of this service is to enable employees to phone in near misses immediately and have the events entered into the ARCADIS LPS Database. As we all know, the expectation is that immediately after having a near miss, an SPSA will be conducted to provide that it is safe to continue whatever the employee was doing.

Remember, reporting and acting on a near-miss today can save your fellow employees from an injury in the future. Please do your part to help us reach our goal of zero injuries at ARCADIS!

3. Project Hazards and Control Measures

3.1 Scope of Work

Field activities are expected to include the following general tasks:

- Mobilization
- Soil boring installations
- Monitoring well installations
- Collection of soil samples during the advancement of the monitoring wells and soil borings
- Collection of groundwater samples
- Measurement of fluid levels
- Geophysical Survey
- Survey
- Decontamination
- Demobilization

3.2 Field Activities, Hazards, and Control Procedures

The following job safety analyses (JSAs) identify potential health, safety, and environmental hazards associated with each type of field activity. Because of the complex and changing nature of field projects, supervisors must continually inspect the site to identify hazards that may affect onsite personnel, the community, or the environment. The SS must be aware of these changing conditions and discuss them with the PM whenever these changes impact employee health, safety, the environment, or performance of the project. The SS will keep onsite personnel informed of the changing conditions, and the PM will write and/or approve addenda or revisions to this HASP as necessary.

3.2.1 Mobilization

Site mobilization will include establishing drilling and excavation locations, determining the location of utilities and other installations, and establishing work areas. A break area will be set up outside of regulated work areas. Mobilization may involve clearing areas for the SZ and CRZ. During this initial phase, project personnel will walk the site to confirm the existence of anticipated hazards, and identify safety and health issues that may have arisen since the writing of this plan.

The hazards of this phase of activity are associated with, manual materials handling and manual site preparation.

Manual materials handling and manual site preparation may cause blisters, sore muscles, and joint and skeletal injuries; and may present eye, contusion, and laceration hazards. The work area presents slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Rainy weather may cause wet, muddy, slick walking surfaces, and unstable soil. Freezing weather hazards include frozen, slick, and irregular walking surfaces.

Environmental hazards include plants, such as poison ivy and poison oak; aggressive fauna, such as ticks, fleas, mosquitoes, wasps, spiders, and snakes; weather, such as sunburn, lightning, rain, and heat- or cold-related illnesses; and pathogens, such as rabies, Lyme disease, and blood-borne pathogens.

Control procedures for these hazards are discussed in Section 4, General Safety Practices.

3.2.2 Installation of Soil Borings and Groundwater Monitoring Wells

This task includes the installation of groundwater monitoring wells, soil vapor points, and soil borings at specified locations. The hazards associated with the potential contact with impacted soils and groundwater during these installations are discussed in Sampling Sections 3.2.3, 3.2.4 and 3.2.5.

In general, the installation of soil borings and monitoring wells will involve the use of conventional drilling rigs and equipment. The collection of soil samples may also involve the use of direct push type boring equipment. The equipment poses a hazard if it is not properly operated. The equipment is hydraulically powered, and uses static force and dynamic percussion force to advance small-diameter sampling tools. The presence of overhead utilities and underground obstacles poses a hazard if boring equipment contacts them. As the hazards are similar to those encountered when using a conventional drill rig, the required control procedures are also the same as a conventional rig and are included in the following sections.

3.2.2.1 Drilling Hazards

The primary physical hazards for this activity are associated with the use of drilling equipment. Rig accidents can occur as a result of improperly placing the rig on uneven or unstable terrain, or failing to adequately secure the rig prior to the start of operations. Underground and overhead utility lines can create hazardous conditions if contacted by drilling equipment. Tools and equipment, such as elevators, cat lines, and wire rope, have the potential for striking, pinning, or cutting personnel.

Wire Rope - Worn or frayed wire rope presents a laceration hazard if loose wires protrude from the main bundle.

Cat Lines - Cat lines are used on drilling rigs to hoist material. Accidents that occur during cat line operations may injure the employee doing the rigging, as well as injure the operator. Minimal hoisting control causes sudden and erratic load movements, which may result in hand and foot injuries.

Working Surfaces - Slippery work surfaces can increase the likelihood of back injuries, overexertion injuries, and slips and falls.

Materials Handling - The most common type of accident that occurs in material handling operations is the "caught between" situation when a load is being handled and a finger or toe gets caught between two objects. Rolling stock can shift and/or fall from a pipe rack or truck bed.

3.2.2.2 Drilling Safety Procedures

Drill Crews - All drillers must possess required state or local licenses to perform such work. All members of the drill crew shall receive site-specific training prior to beginning work.

The driller is responsible for the safe operation of the drill rig, as well as the crew's adherence to the requirements of this HASP. The driller must ensure that all safety equipment is in proper condition and is properly used. The members of the crew must follow all instructions of the driller, wear all PPE, and be aware of all hazards and control procedures. The drill crews must participate in the Daily Safety Meetings and be aware of all emergency procedures.

Rig Inspection - Each day, prior to the start of work, the drill rig and associated equipment must be inspected by the driller and/or drill crew. Inspections will be documented. The following items must be inspected:

- Vehicle condition
- Proper storage of equipment
- Condition of all wire rope and hydraulic lines
- Condition of all drill rods and threads
- Fire extinguisher
- First aid kit

Drill Rig Set Up - The drill rig must be properly blocked and leveled prior to raising the derrick. The wheels that remain on the ground must be chocked. The leveling jacks shall not be raised until the derrick is lowered. The rig shall be moved only after the derrick has been lowered.

Site Drilling Rules - Before drilling activities commence, the existence and location of underground pipe, electrical equipment, and gas lines shall be determined. Dig Safely New York must be contacted at least one week, but no more than two weeks, prior to subsurface activities. ARCADIS's SS will meet with electrical and natural gas locators onsite prior to marking out the underground utilities. During this meeting, ARCADIS's SS will provide the electric and natural gas locators with a site figure that shows the locations where drilling activities will be completed. ARCADIS's SS will conduct a site walkover with the electrical and natural gas locators to visually identify each location where drilling activities are to be completed during site operations. The Underground/Overhead Utility Checklist (see Attachment G) shall be used to document that nearby utilities have been marked on the ground, and that the drilling areas have been cleared. The completed Underground/Overhead Utility Checklist will be in the possession of the SS prior to commencement of any intrusive investigation.

Overhead Electrical Clearances - If drilling is conducted in the vicinity of overhead power lines, the power to the lines must be shut off or the equipment must be positioned and blocked such that no part, including cables, can come within the minimum clearances as follows:

Nominal System Voltage	Minimum Required Clearance
0-50Kv	10 feet
51-100kV	12 feet
101-200kV	15 feet
201-300kV	20 feet
301-500kV	25 feet
501-750kV	35 feet
751-1,000kV	45 feet

When the drill rig is in transit, with the boom lowered and no load, the equipment clearance must be at least 4 feet for voltages less than 50kV, 10 feet for voltages of 50kV to 345kV, and 16 feet for voltages above 345kV.

Rig Set Up - All well sites will be inspected by the driller prior to the location of the rig to verify a stable surface exists. This is especially important in areas where soft, unstable terrain is common.

All rigs will be properly blocked and leveled prior to raising the derrick. Blocking provides a more stable drilling structure by evenly distributing the weight of the rig. Proper blocking ensures that differential settling of the rig does not occur.

When the ground surface is soft or otherwise unstable, wooden blocks, at least 24 inches by 24 inches and 4 inches to 8 inches thick, shall be placed between the jack swivels and the ground. The emergency brake shall be engaged, and the wheels that are on the ground shall be chocked.

Hoisting Operations - Drillers should never engage the rotary clutch without watching the rotary table, and ensuring it is clear of personnel and equipment.

Unless the drawworks is equipped with an automatic feed control, the brake should not be left unattended without first being tied down.

Auger strings or casing should be picked up slowly.

During instances of unusual loading of the derrick or mast, such as when making an unusually hard pull, only the driller should be on the rig floor; no one else should be on the rig or derrick.

The brakes on the drawworks of the drill rig should be tested by the driller each day. The brakes should be thoroughly inspected by a competent individual each week.

A hoisting line with a load imposed should not be permitted to be in direct contact with any derrick member or stationary equipment, unless it has been specifically designed for line contact.

Workers should never stand near the borehole whenever any wire line device is being run.

Hoisting control stations should be kept clean and controls labeled as to their functions.

Cat Line Operations - Only experienced workers will be allowed to operate the cathead controls. The kill switch must be clearly labeled and operational prior to operation of the cat line. The cathead area must be kept free of obstructions and entanglements.

The operator should not use more wraps than necessary to pick up the load. More than one layer of wrapping is not permitted.

Personnel should not stand near, step over, or go under a cable or cat line that is under tension.

Under no circumstances will personnel be permitted to ride the traveling block or elevators, nor will the cat line be used as a personnel carrier.

Employees rigging loads on cat lines shall:

- keep out from under the load.
- keep fingers and feet where they will not be crushed.
- be sure to signal clearly when the load is being picked up.
- use standard visual signals only and not depend on shouting to co-workers.
- make sure the load is properly rigged, since a sudden jerk in the cat line will shift or drop the load.

Wire Rope - When two wires are broken or rust or corrosion is found adjacent to a socket or end fitting, the wire rope shall be removed from service or resocketed. Special attention shall be given to the inspection of end fittings on boom support, pendants, and guy ropes.

Wire rope removed from service due to defects shall be cut up or plainly marked as being unfit for further use as rigging.

Wire rope clips attached with U-bolts shall have the U-bolts on the dead or short end of the rope; the clip nuts shall be re-tightened immediately after initial load carrying use and at frequent intervals thereafter.

When a wedge socket fastening is used, the dead or short end of the wire rope shall have a clip attached to it or looped back and secured to itself by a clip; the clip shall not be attached directly to the live end.

Protruding ends of strands in splices on slings and bridles shall be covered or blunted.

Except for eye splices in the ends of wires and for endless wire rope slings, wire rope used in hoisting, lowering, or pulling loads, shall consist of one continuous piece without knot or splice.

An eye splice made in any wire rope shall have not less than five full tucks.

Wire rope shall not be secured by knots. Wire rope clips shall not be used to splice rope.

Eyes in wire rope bridles, slings, or bull wires shall not be formed by wire clips or knots.

Auger Handling - Auger sections shall be transported by cart or carried by two persons. Individuals should not carry auger sections without assistance.

Workers should not be permitted on top of the load during loading, unloading, or transferring of rolling stock.

When equipment is being hoisted, personnel should not stand where the bottom end of the equipment could whip and strike them.

Augers stored in racks, catwalks, or on flatbed trucks should be secured to prevent rolling.

3.2.3 Groundwater Sampling and Monitoring

Groundwater sampling and water level monitoring will involve uncapping, purging (pumping water out of the well), and sampling and monitoring new and existing monitoring wells. A mechanical pump may be utilized to purge the wells and can be hand-, gas-, or electric-operated. Water samples taken from the wells are then placed in containers and shipped to analytical laboratory for analysis. The physical hazards of these operations are primarily associated with the sample collection methods and procedures utilized.

Hazards - Inhalation and absorption (contact) of COCs are the primary routes of entry associated with groundwater sampling due to the manipulation of sample media and equipment, manual transfer of media into sample containers, and proximity of operations to the breathing zone. During the course of this project, several different groundwater sampling methodologies may be utilized based on equipment accessibility and the types of materials to be sampled. These sampling methods may include hand or mechanical bailing. The primary hazards associated with these specific sampling procedures are not potentially serious; however, other operations in the area or the conditions under which samples must be collected may present chemical and physical hazards. The hazards directly associated with groundwater sampling procedures are generally limited to strains/sprains from hand bailing and potential eye hazards. Exposure to soil and water containing COCs is also possible.

The flora and fauna of the site may present hazards of poison ivy, poison oak, ticks, fleas, mosquitoes, wasps, spiders, and snakes. The work area presents slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Freezing weather hazards include frozen, slick, and irregular walking surfaces. Rainy weather may cause wet, muddy, slick walking surfaces and unstable soil.

Control - To control dermal exposure during groundwater sampling and monitoring activities, a minimum of Modified Level D will be worn. The well should be approached, opened and sampled from the upwind side. The photoionization detector (PID) will be used to determine exposure potential to the worker. If necessary, based on field observations and site conditions, air monitoring may be conducted during groundwater sampling and monitoring activities to assess the potential for exposure to airborne COCs. If the results of air monitoring indicate the presence of organic vapors in a concentration causing concern, personnel will upgrade to Level C protection. Refer to Section 6.1, Air Monitoring, for a description of air monitoring requirements and action levels. A description of each level of personal protection is included in Section 5, Personal Protective Equipment. Control procedures for environmental and general hazards are discussed in Section 4, General Site Safety Procedures.

3.2.4 Subsurface Soil Sampling

This task consists of collecting subsurface soil samples for subsequent analysis and evaluation of potential impact by COC. The physical hazards of these operations are primarily associated with the sample collection methods and procedures utilized. In addition, personnel may be exposed to hazards associated with working in or near excavations.

Hazards - Inhalation and absorption (contact) of COC are the primary routes of entry associated with soil sampling due to the manipulation of sample media and equipment, manual transfer of media into sample containers, and proximity of operations to the breathing zone. During the course of this project, several different soil sampling methodologies may be utilized based on equipment accessibility and the types of materials to be sampled. These sampling methods may include the use of hand-auger/sampling probes, sampling spoons, or trowels. The primary hazards associated with these specific sampling procedures are not potentially serious; however, other operations in the area or the conditions under which samples must be collected may present chemical and physical hazards. The hazards directly associated with soil sampling procedures are generally limited to strains/sprains and potential eye hazards. Exposure to soil and water containing COC is also possible. In addition to the safety hazards specific to sampling operations, hazards associated with the operation of vehicles, especially large vehicles with limited operator visibility, is a concern. Of particular concern will be the backing up of trucks, excavation equipment, and other support vehicles.

The flora and fauna of the site may present hazards of poison ivy, poison oak, ticks, fleas, mosquitoes, wasps, spiders, and snakes. The work area presents slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Freezing weather hazards include frozen, slick, and irregular walking surfaces. Rainy weather may cause wet, muddy, slick walking surfaces and unstable soil.

Control - To control dermal exposure during soil sampling activities, a minimum of Modified Level D protection will be worn. In addition, air monitoring will be conducted during soil sampling activities to assess the potential for exposure to airborne COC. Subsurface soil samples will be collected and screened for volatile organic compounds (VOCs) using a PID. If the results of air monitoring indicate the presence of organic vapors in a concentration causing concern, personnel will upgrade to Level C protection. Refer to Section 6.1, Air Monitoring for a description of air monitoring requirements and action levels. A description of each level of personal protection is included in Section 5, Personal Protective Equipment. Control procedures for environmental and general hazards are discussed in Section 4, General Safety Practices.

The following sections discuss hazards and control procedures for excavations.

3.3 Decontamination

All equipment will be decontaminated before leaving the site using visual inspection to verify that COCs have been removed. In addition, all operations that have the potential to generate or release hazardous material will be conducted in a controlled area using the appropriate engineering controls. Specific decontamination techniques will be established based on site conditions. Decontamination procedures will be reviewed with all personnel onsite. It is anticipated that a decontamination pad will be constructed on a suitable surface with polyethylene sheeting or other appropriate containment system. Pressure washing or manual scrub brushing will be used as needed to decontaminate equipment. COC-impacted equipment will be determined “clean” by using visual inspection of all equipment.

Personnel involved in decontamination activities may be exposed to skin contact with contaminated materials and chemicals brought to the site as part of the project work. All personnel will review the operating procedures and PPE prior to decontamination. The equipment used for decontamination and the decontamination containment facility will be inspected daily prior to use. Personnel involved in decontamination activities must wear PPE that is one level below the level worn by personnel working in the EZ.

3.3.1 Pressure Washing

Equipment will be decontaminated before leaving the site. Personnel involved in decontamination activities may be exposed to skin contact with residuals containing site constituents, volatile emissions from heavily soiled equipment, high pressure water spray, and noise.

Hydro blasting is the process of using a stream of water at high pressure to clean or prepare surfaces by removing foreign matter and contaminants. The hazards of high pressure water cleaning are related to the high pressure of the water, which may exceed 10,000 pounds per square inch (psi) at the nozzle. Contact with the water spray may cause severe lacerations, which may then be contaminated with hazardous material. Because of the high pressure involved, the opportunity for slicing or injecting the water stream through soft tissues of the body exists. Hydro blasters will also cut through bone at high enough pressures. A second hazard is repetitive motion, or cumulative trauma disorder. These serious disorders are related to repeatedly squeezing the trigger or constantly fighting the pressure of the spray gun with the forearm or wrist. When pressure washing, steaming, or hydro blasting, the health and safety precautions for hydro blasting outlined below must be observed.

Pressure washing presents a splash hazard. Protection against splash to face and skin is mandatory. The pressure washer is not to be pointed at a person at any time. Steam cleaning presents a thermal burn hazard in addition to the hazards presented by pressure washing. Adequate protection from the hot surfaces must be provided. Only persons trained in use and maintenance of a hydro blaster may use such equipment. Hydro blasting operations will conducted only by qualified subcontractor personnel.

The following general requirements are provided for high-pressure water cleaning activities:

- The gun, pressure piping, pressure hose ends, and couplings will have a burst pressure of at least four times the operating pressure.

- No equipment or component of such equipment will be operated beyond the manufacturer's specifications or beyond the rated working pressure.

- The maximum operating pressure will be permanently displayed on the pumping unit.

- Wear safety glasses, face-shield, hearing protection, and safety shoes.

- Alternate hands frequently during long periods of use.
- Rotate personnel periodically.
- Use a washer with a gun which supplies water to the wand in a straight line as opposed to supplying water through the grip. This eliminates the gun's twisting motion.
- Keep the equipment in good condition.
- Check to see that releasing the trigger stops the flow of water. Do not wire back the trigger.
- A hose safety shroud will be placed on hoses whenever operating pressure exceeds 2,000 psi.
- The pressure control will be a "deadman" type to safely reduce the nozzle discharge pressure when control is released.
- The pressure discharge gauge indicating pump pressure will be clearly visible for monitoring pump pressure.
- A pressure relief device set to relieve at 110% of the maximum working pressure of the unit or its components, whichever is lower, will be installed on the pump. The relief will be clearly marked and displayed on the device.
- A strainer or filter should be installed on the water supply system to prevent debris from entering the water blasting units and clogging the gun, control, or other device.

Pay close attention to the water line. It is under pressure, and may whip about if broken. If a water line breaks, relieve the pressure before trying to grab the line.

3.4 Demobilization

Demobilization involves the removal of all tools, equipment, supplies, and vehicles brought to the site. The hazards of this phase of activity are associated with heavy equipment operation and manual materials handling.

Manual materials handling may cause blisters, sore muscles, and joint and skeletal injuries; and may present eye, contusion, and laceration hazards. Heavy equipment operation presents noise and vibration hazards, and hot surfaces, to operators. Personnel in the vicinity of heavy equipment operation may be exposed to physical hazards resulting in fractures, contusions, and lacerations and may be exposed to high noise levels. The work area presents slip, trip, and fall hazards from scattered debris and irregular walking surfaces. Rainy weather may cause wet, muddy, slick walking surfaces, and unstable soil. Freezing weather hazards include frozen, slick, and irregular walking surfaces.

Environmental hazards include plants, such as poison ivy and poison oak; aggressive fauna, such as ticks, fleas, mosquitoes, wasps, spiders, and snakes; weather, such as sunburn, lightning, rain, and heat- or cold-related illnesses; and pathogens, such as rabies, Lyme disease, and blood-borne pathogens.

Control procedures for these hazards are discussed in Section 4, General Safety Practices.

3.5 Chemical Hazards

The chemical hazards associated with site operations are related to inhalation, ingestion, and skin exposure to site COCs. Concentrations of airborne COCs during site tasks may be measurable, and may require air monitoring during certain operations. Air monitoring requirements for site tasks are outlined in Section 6.1.

Site COCs may include: benzene, toluene, ethylbenzene, and xylenes (BTEX), polycyclic aromatic hydrocarbons (PAHs) and cyanide.

The potential for inhalation of site COCs is low. The potential for dermal contact with soils and groundwater containing site COCs during excavation, drilling, and sampling operations is moderate. Table 3-2 lists the chemical, physical, and toxicological properties of site COCs. Material Safety Data Sheets (MSDS) for the COCs is included in Attachment A.

4. General Safety Practices

4.1 General Safety Rules

General safety rules for site activities include, but are not limited to, the following:

- At least one copy of this HASP must be in a location at the site that is readily available to personnel, and all project personnel shall review the plan prior to starting work.

- Consume or use food, beverages, chewing gum, and tobacco products only in the SZ or other designated area outside the EZ and CRZ. Cosmetics shall not be applied in the EZ or CRZ.

- Wash hands before eating, drinking, smoking, or using toilet facilities.

- Wear all PPE as required, and stop work and replace damaged PPE immediately.

- Secure disposable coveralls, boots, and gloves at the wrists and legs and ensure closure of the suit around the neck.

- Upon skin contact with materials that may be impacted by COC, remove contaminated clothing and wash the affected area immediately. Contaminated clothing must be changed. Any skin contact with materials potentially impacted by COC must be reported to the SS or HSS immediately. If needed, medical attention should be sought.

- Practice contamination avoidance. Avoid contact with surfaces either suspected or known to be impacted by COC, such as standing water, mud, or discolored soil. Equipment must be stored on elevated or protected surfaces to reduce the potential for incidental contamination.

- Remove PPE as required in the CRZ to limit the spread of COC-containing materials.

- At the end of each shift or as required, dispose of all single-use coveralls, soiled gloves, and respirator cartridges in designated receptacles designated for this purpose.

- Removing soil containing site COC from protective clothing or equipment with compressed air, shaking, or any other means that disperses contaminants into the air is prohibited.

- Inspect all non-disposable PPE for contamination in the CRZ. Any PPE found to be contaminated must be decontaminated or disposed of appropriately.

- Recognize emergency signals used for evacuation, injury, fire, etc.

- Report all injuries, illnesses, near misses, and unsafe conditions or work practices to the SS or HSS.

- Use the “buddy system” during all operations requiring Level C PPE, and when appropriate, during Modified Level D operations.

- Obey all warning signs, tags, and barriers. Do not remove any warnings unless authorized to do so.

- Use, adjust, alter, and repair equipment only if trained and authorized to do so, and in accordance with the manufacturer’s directions.

- Personnel are to perform only tasks for which they have been properly trained and will advise their supervisor if they have been assigned a task for which they are not trained.

- The presence or consumption of alcoholic beverages or illicit drugs during the workday (including breaks) is strictly prohibited. Notify your supervisor if you must take prescription or over-the-counter drugs that indicate they may cause drowsiness or, that heavy equipment should not be operated while taking the medication.

- Remain upwind during site activities whenever possible.

4.2 Loss Prevention System (LPS)

LPS is a behavior based safety system meant to prevent or reduce the occurrence of injury, illness, or other incident. This program seeks the prevention or reduction of losses by:

- emphasizing proactive activities.
- capitalizing on the on-the-job expertise of field employees.

- maximizing the use of positive reinforcement.
- integrating with daily field operations.
- solving problems from the bottom up while providing direction from the top down.

4.2.1 Safe Performance Self-Assessment

All onsite personnel are required to perform a SPSA prior to beginning any activity. This three-step process requires each individual to:

- *Assess* the risk of the task to be performed. Ask the following questions:
    - What could go wrong?
    - What is the worst thing that could happen if something does go wrong?

- *Analyze* the ways the risk can be reduced. Ask the following questions:
    - Do I have all the necessary training and knowledge to do this task safely?
    - Do I have all the proper tools and PPE?

- *Act* to control the risk and perform the task safely.
    - Take the necessary action to perform the job safely.
    - Follow written procedures, and ask for assistance if necessary.

This process must be performed prior to beginning any activity, and must be performed after any near miss or other incident in order to determine if it is safe to proceed.

4.2.2 Incident Investigation

An incident is any of the following events: first aid cases, injuries, illnesses, near misses, spills/leaks, equipment and property damage, motor vehicle accidents, regulatory violations, fires, and business interruptions. All incidents shall be investigated within 24 hours and reported to the PM and the HSO.

The purpose of an II is to prevent the recurrence of a similar hazardous event. II investigates all incidents in the same manner. Using the information gathered during an II, appropriate measures will be taken to protect personnel from the hazard in question. The II form is included in Attachment B.

4.2.3 Loss Prevention Observation

The SS or the HSS will perform the LPO (see Attachment C for the LPO form). The purpose of the LPO is to identify and correct potential hazards, and to positively reinforce behaviors and practices that are correct. The SS or HSS must identify potential deviations from safe work practices that could possibly result in an incident, and take prompt corrective action. The LPO process steps are:

- Identify tasks that have the greatest potential for hazardous incidents.
- Review the standard procedure for completing the task.
- Discuss with the observed employee the task and the SS/HSS role in observing the task.
- Observe the employee completing the task.
- Reference the LPO form for criteria. Complete the form, documenting positive, as well as areas in need of improvement.
- Discuss the results of the LPO with the employee. Discuss corrective action necessary.
- Implement corrective action.
- Communicate the results of the LPO and corrective action to the PM and the HSO.

4.2.4 Job Safety Analysis

A JSA is a tool used of identifying potential hazards and developing corrective or protective systems to eliminate the hazard. A JSA lists all the potential hazards associated with an activity. Hazards may be physical, such as lifting hazards or eye hazards, or environmental, such as weather or biological (stinging insects, snakes, etc.). Following the identification of the hazards associated with an activity, control measures are evaluated and protective measures or procedures are then instituted. JSAs are reviewed periodically to ensure that the procedures and protective equipment specified for each activity are current and technically correct. Any changes in site conditions and/or the scope of work may require a review and modification to the JSA in question. During this review process, comments on the JSA and its procedures should be obtained from personnel associated with the activity being analyzed. JSAs will be developed and reviewed during SC implementation.

4.3 Buddy System

Onsite personnel must use the buddy system as required by operations. Use of the “buddy system” is required during all operations requiring Level C to Level A PPE, and when appropriate, during Level D operations. Crewmembers must observe each other for signs of chemical exposure, and heat or cold stress. Indications of adverse effects include, but are not limited to:

- changes in complexion and skin coloration.
- changes in coordination.
- changes in demeanor.
- excessive salivation and pupillary response.
- changes in speech pattern.

Crewmembers must also be aware of the potential exposure to possible safety hazards, unsafe acts, or non-compliance with safety procedures.

Field personnel must inform their partners or fellow crewmembers of non-visible effects of exposure to toxic materials that they may be experiencing. The symptoms of such exposure may include, but are not limited to:

- headaches.
- dizziness.
- nausea.
- blurred vision.
- cramps.
- irritation of eyes, skin, or respiratory tract.

If protective equipment or noise levels impair communications, prearranged hand signals must be used for communication. Personnel must stay within line of sight of another team member.

4.4 Heat Stress

Heat stress is caused by a number of interacting factors, including environmental conditions, clothing, workload, etc., as well as the physical and conditioning characteristics of the individual. Since heat stress is one of the most common illnesses associated with heavy outdoor work conducted with direct solar load and, in particular, because wearing PPE can increase the risk of developing heat stress, workers must be capable of recognizing the signs and symptoms of heat-related illnesses. Personnel must be aware of the types and causes of heat-related illnesses and be able to recognize the signs and symptoms of these illnesses in both themselves and their co-workers.

Heat rashes are one of the most common problems in hot work environments. Commonly known as prickly heat, a heat rash is manifested as red papules and usually appears in areas where the clothing is restrictive. As sweating increases, these papules give rise to a prickling sensation. Prickly heat occurs in skin that is persistently wetted by unevaporated sweat, and heat rash papules may become infected if they are not treated. In most cases, heat rashes will disappear when the affected individual returns to a cool environment.

Heat cramps are usually caused by performing hard physical labor in a hot environment. These cramps have been attributed to an electrolyte imbalance caused by sweating. It is important to understand that cramps can be caused both by too much or too little salt.

Cramps appear to be caused by the lack of water replenishment. Because sweat is a hypotonic solution (plus or minus 0.3% NaCl), excess salt can build up in the body if the water lost through sweating is not replaced. Thirst cannot be relied on as a guide to the need for water; instead, water must be taken every 15 to 20 minutes in hot environments.

Under extreme conditions, such as working for 6 to 8 hours in heavy protective gear, a loss of sodium may occur. Drinking commercially available carbohydrate electrolyte replacement liquids is effective in minimizing physiological disturbances during recovery.

Heat exhaustion occurs from increased stress on various body organs due to inadequate blood circulation, cardiovascular insufficiency, or dehydration. Signs and symptoms include pale, cool, moist skin; heavy sweating; dizziness; nausea; headache, vertigo, weakness, thirst, and giddiness. Fortunately, this condition responds readily to prompt treatment.

Heat exhaustion should not be dismissed lightly, however, for several reasons. One is that the fainting associated with heat exhaustion can be dangerous because the victim may be operating machinery or controlling an operation that should not be left unattended; moreover, the victim may be injured when he or she faints. Also, the signs and symptoms seen in heat exhaustion are similar to those of heat stroke, which is a medical emergency.

Workers suffering from heat exhaustion should be removed from the hot environment, be given fluid replacement, and be encouraged to get adequate rest.

Heat stroke is the most serious form of heat stress. Heat stroke occurs when the body's system of temperature regulation fails and the body's temperature rises to critical levels. This condition is caused by a combination of highly variable factors, and its occurrence is difficult to predict.

Heat stroke is a medical emergency. The primary signs and symptoms of heat stroke are confusion; irrational behavior; loss of consciousness; convulsions; a lack of sweating (usually); hot, dry skin; and an abnormally high body temperature, e.g., a rectal temperature of 41°C (105.8°F). If body temperature is too high, it causes death. The elevated metabolic temperatures caused by a combination of workload and environmental heat load, both of which contribute to heat stroke, are also highly variable and difficult to predict.

If a worker shows signs of possible heat stroke, professional medical treatment should be obtained immediately. The worker should be placed in a shady area and the outer clothing should be removed. The worker's skin should be wetted and air movement around the worker should be increased to improve evaporative cooling until professional methods of cooling are initiated and the seriousness of the condition can be assessed. Fluids should be replaced as soon as possible. The medical outcome of an episode of heat stroke depends on the victim's physical fitness and the timing and effectiveness of first aid treatment.

Regardless of the worker's protestations, no employee suspected of being ill from heat stroke should be sent home or left unattended unless a physician has specifically approved such an order.

Proper training and preventive measures will help avert serious illness and loss of work productivity. Preventing heat stress is particularly important because once someone suffers from heat stroke or exhaustion, that person may be predisposed to additional heat injuries.

Heat Stress Safety Precautions

Heat stress monitoring and work rest cycle implementation should commence when the ambient adjusted temperature exceeds 72°F. A minimum work rest regimen and procedures for calculating ambient adjusted temperature are described in Table 4-1.

Table 4-1. Work/Rest Schedule

Adjusted Temperature[b]	Work/Rest Regimen Normal Work Ensemble[c]	Work/Rest Regimen Impermeable Ensemble
90ºF (32.2ºC) or above	After each 45 minutes of work	After each 15 minutes of work
87.5º - 90ºF (30.8º-32.2ºC)	After each 60 minutes of work	After each 30 minutes of work
82.5º - 87.5ºF (28.1º - 30.8ºC)	After each 90 minutes of work	After each 60 minutes of work
77.5º - 82.5ºF (25.3º - 28.1ºC)	After each 120 minutes of work	After each 90 minutes of work
72.5º - 77.5ºF (30.8º - 32.2ºC)	After each 150 minutes of work	After each 120 minutes of work

Notes:

a. For work levels of 250 kilocalories/hour (Light-Moderate Type of Work).
b. Calculate the adjusted air temperature (ta adj) by using this equation: ta adj ºF = ta ºF + (13 x % sunshine). Measure air temperature (ta) with a standard mercury-in-glass thermometer, with the bulb shielded from radiant heat. Estimate percent sunshine by judging what percent time the sun is not covered by clouds that are thick enough to produce a shadow. (100 percent sunshine = no cloud cover and a sharp, distinct shadow; 0 percent sunshine = no shadows.)
c. A normal work ensemble consists of cotton coveralls or other cotton clothing with long sleeves and pants.
d. The information presented above was generated using the information provided in the ACGIH Threshold Limit Values (TLV) Handbook.

In order to determine if the work rest cycles are adequate for the personnel and specific site conditions, additional monitoring of individual heart rates will be conducted during the rest cycle. To check the heart rate, count the radial pulse for 30 seconds at the beginning of the rest period. If the heart rate exceeds 110 beats per minute, shorten the next work period by one third and maintain the same rest period.

Additionally, one or more of the following control measures can be used to help control heat stress and are mandatory if any site worker has a heart rate (measure immediately prior to rest period) exceeding 115 beats per minute:

- Site workers will be encouraged to drink plenty of water and electrolyte replacement fluids throughout the day.
- Onsite drinking water will be kept cool (50 to 60°F).
- A work regimen that will provide adequate rest periods for cooling down will be established, as required.
- All personnel will be advised of the dangers and symptoms of heat stroke, heat exhaustion, and heat cramps.
- Cooling devices, such as vortex tubes or cooling vests, should be used when personnel must wear impermeable clothing in conditions of extreme heat.

- Employees should be instructed to monitor themselves and co-workers for signs of heat stress and to take additional breaks as necessary.

- A shaded rest area must be provided. All breaks should take place in the shaded rest area.

- Employees must not be assigned to other tasks during breaks.

- Employees must remove impermeable garments during rest periods. This includes white Tyvek®-type garments.

All employees must be informed of the importance of adequate rest, acclimation, and proper diet in the prevention of heat stress disorders.

4.5 Cold Stress

Cold stress normally occurs in temperatures at or below freezing, or under certain circumstances, in temperatures of 40°F. Extreme cold for a short time may cause severe injury to exposed body surfaces or result in profound generalized cooling, causing death. Areas of the body that have high surface area-to-volume ratio, such as fingers, toes, and ears, are the most susceptible. Two factors influence the development of a cold weather injury: ambient temperature and the velocity of the wind. For instance, 10°F with a wind of 15 miles per hour (mph) is equivalent in chilling effect to still air at 18°F. An equivalent chill temperature chart relating the actual dry bulb temperature and wind velocity is presented in Table 4-2.

Table 4-2. Chill Temperature Chart

Estimated Wind Speed (in mph)	**Actual Temperature Reading (ºF)**											
	50	**40**	**30**	**20**	**10**	**0**	**-10**	**-20**	**-30**	**-40**	**-50**	**-60**
	Equivalent Chill Temperature (ºF)											
Calm	50	40	30	20	10	0	-10	-20	-30	-40	-50	-60
5	48	37	27	16	6	-5	-15	-26	-36	-47	-57	-68
10	40	28	16	4	-9	-24	-33	-46	-58	-70	-83	-95
15	36	22	9	-5	-18	-32	-45	-58	-72	-85	-99	-112
20	32	18	4	-10	-25	-39	-53	-67	-82	-96	-110	-121
25	30	16	0	-15	-29	-44	-59	-74	-88	-104	-118	-133
30	28	13	-2	-18	-33	-48	-63	-79	-94	-109	-125	-140
35	27	11	-4	-20	-35	-51	-67	-82	-98	-113	-129	-145
40	26	10	-6	-21	-37	-53	-69	-85	-100	-116	-132	-148
(Wind speeds greater than 40 mph have little additional effect.)	**LITTLE DANGER** **Maximum danger of false sense of security.**				**INCREASING DANGER** **Danger from freezing of exposed flesh within one minute.**			**GREAT DANGER** **Flesh may freeze within 30 seconds.**				
	Trench foot and immersion foot may occur at any point on this chart.											

[This chart was developed by the U.S. Army Research Institute of Environmental Medicine, Natick, MA (Source: ACGIH Threshold Limit Values for Chemical Substances and Physical Agents)].

Local injury resulting from cold is included in the generic term frostbite. There are several degrees of tissue damage associated with frostbite. Frostbite of the extremities can be categorized into:

- *Frost Nip or Incipient Frostbite* - characterized by sudden blanching or whitening of skin.
- *Superficial Frostbite* - skin has a waxy or white appearance and is firm to the touch, but tissue beneath is resilient.
- *Deep Frostbite* - tissues are cold, pale, and solid; extremely serious injury.

Systemic hypothermia is caused by exposure to freezing or rapidly dropping temperature. It can be fatal. Its symptoms are usually exhibited in five stages: 1) shivering; 2) apathy, listlessness, sleepiness, and (sometimes) rapid cooling of the body to less than 95°F; 3) unconsciousness, glassy stare, slow pulse, and slow respiratory rate; 4) freezing of the extremities; and 5) death. Trauma sustained in freezing or sub-zero conditions requires special attention because an injured worker is predisposed to secondary cold injury. Special provisions must be made to prevent hypothermia and secondary freezing of damaged tissues in addition to providing for first aid treatment. To avoid cold stress, site personnel must wear protective clothing appropriate for the level of cold and physical activity. In addition to protective clothing, preventive safe work practices, additional training, and warming regimens may be utilized to prevent cold stress.

Safety Precautions for Cold Stress Prevention

For air temperature of 0°F or less, mittens should be used to protect the hands. For exposed skin, continuous exposure should not be permitted when air speed and temperature results in a wind chill temperature of -25°F.

At air temperatures of 36°F or less, field personnel who become immersed in water or whose clothing becomes wet must be immediately provided with a change of clothing and be treated for hypothermia.

If work is done at normal temperature or in a hot environment before entering the cold, the field personnel must ensure that their clothing is not wet as a consequence of sweating. If wet, field personnel must change into dry clothes prior to entering the cold area.

If the available clothing does not give adequate protection to prevent hypothermia or frostbite, work must be modified or suspended until adequate clothing is made available or until weather conditions improve.

Field personnel handling evaporative liquid (e.g., gasoline, alcohol, or cleaning fluids) at air temperatures below 40°F must take special precaution to avoid soaking of clothing or gloves with the liquids because of the added danger of cold injury due to evaporative cooling.

Safe Work Practices

Direct contact between bare skin and cold surfaces (< 20°F) should be avoided. Metal tool handles and/or equipment controls should be covered by thermal insulating material.

For work performed in a wind chill temperature at or below 10°F, workers should be under constant protective observation (buddy system). The work rate should be established to prevent heavy sweating that will result in wet clothing. For heavy work, rest periods must be taken in heated shelters and workers should be provided with an opportunity to change into dry clothing if needed.

Field personnel should be provided the opportunity to become accustomed to cold-weather working conditions and required protective clothing.

Work should be arranged in such a way that sitting or standing still for long periods is minimized.

During the warming regimen (rest period), field personnel should be encouraged to remove outer clothing to permit sweat evaporation or to change into dry work clothing. Dehydration, or loss of body fluids, occurs insidiously in the cold environment and may increase susceptibility to cold injury due to a significant change in blood flow to the extremities. Fluid replacement with warm, sweet drinks and soups is recommended. The intake of coffee should be limited because of diuretic and circulatory effects.

4.6 Biological Hazards

Biological hazards may include poison ivy, snakes, thorny bushes and trees, ticks, mosquitoes, and other pests.

4.6.1 Tick Borne Diseases

Lyme Disease - The disease commonly occurs in summer and is transmitted by the bite of infected ticks. “Hot spots” in the United States include New York, New Jersey, Pennsylvania, Massachusetts, Connecticut, Rhode Island, Minnesota, and Wisconsin.

Erlichiosis - The disease also commonly occurs in summer and is transmitted by the bite of infected ticks. “Hot spots” in the United States include New York, Massachusetts, Connecticut, Rhode Island, Minnesota, and Wisconsin.

These diseases are transmitted primarily by the deer tick, which is smaller and redder than the common wood tick. The disease may be transmitted by immature ticks, which are small and hard to see. The tick may be as small as a period on this page.

Symptoms of Lyme disease include a rash or a peculiar red spot, like a bull’s eye, which expands outward in a circular manner. The victim may have headache, weakness, fever, a stiff neck, and swelling and pain in the joints, and eventually, arthritis. Symptoms of erlichiosis include muscle and joint aches, flu-like symptoms, but there is typically no skin rash.

Rocky Mountain Spotted Fever (RMSF) - This disease is transmitted via the bite of an infected tick. The tick must be attached 4 to 6 hours before the disease-causing organism (Rickettsia rickettsii) becomes reactivated and can infect humans. The primary symptom of RMSF is the sudden appearance of a moderate-to-high fever. The fever may persist for two to three weeks. The victim may also have a headache, deep muscle pain, and chills. A rash appears on the hands and feet on about the third day and eventually spreads to all parts of the body. For this reason, RMSF may be confused with measles or meningitis. The disease may cause death, if untreated, but if identified and treated promptly, death is uncommon.

Control - Tick repellant containing diethyltoluamide (DEET) should be used when working in tick-infested areas, and pant legs should be tucked into boots. In addition, workers should search the entire body every three or four hours for attached ticks, before going home and again when showering at night. Ticks should be removed promptly and carefully without crushing, since crushing can squeeze the disease-causing organism into the skin. A gentle and steady pulling action should be used to avoid leaving the head or mouth parts in the skin. Hands should be protected with surgical gloves when removing ticks.

4.6.2 Poisonous Plants

Poisonous plants may be present in the work area. Personnel should be alerted to their presence and instructed on methods to prevent exposure. Poison sumac grows as a shrub or small tree with large alternate, compound leaves having 7-13 leaflets without teeth. All plant parts are poisonous. The lack of 1) leaflet glands, 2) "wings" between the leaflets, and 3) teeth on the leaves, in addition to this species' red stems supporting the leaflets and leaves, help to distinguish this plant from similar-looking nonpoisonous species such as other sumacs and tree-of-heaven. Flowers are shades of green, white and yellow and appear in late spring. Fruits are small white berries that mature in late summer and may last through winter.

Poison ivy is a woody shrub or vine with hairy looking aerial roots. It grows to 10 feet or more, climbing high on trees, walls and fences or trails along the ground. All parts of poison ivy, including the roots, are poisonous at all times of the year.

Poison Sumac

Poison Ivy

The main control for both poison ivy and poison sumac is to avoid contact with the plant, cover arms and hands, and frequently wash potentially exposed skin. Particular attention must be given to avoiding skin contact with objects or protective clothing that have touched the plants. Treat every surface that may have touched the plant as contaminated, and practice contamination avoidance.

Poison ivy and sumac are very easy to treat if you identified your contact with the irritating plant within a few hours of the incident. The urushiol oil present in both plants chemically bonds with the proteins in your skin about 30 minutes after contact. Seventy-five percent (%) of the population is affected by contact with urushiol, although immunity to urushiol today does not assure immunity tomorrow, and vice versa. Rash symptoms can appear within a few hours but can take two to five days to appear. The rash starts as a red, annoyingly itchy area that starts to swell. The area then gets inflamed and will get covered in clusters of tiny pimples, the pimple eventually merge and turn into blisters. The fluid in the blisters turns yellow, dries up, and becomes crusty. Left completely untreated, this cycle can last as short as five days and in severe cases as long as five to six weeks.

If you come in contact with poison ivy, oak or sumac, or a animal exposed to any of these, or tools, gear, or clothing exposed to any of these, you should wash off with hot water (not so hot that it burns) and strong soap as soon as possible. If you can get washed up in the first six hours, before the first symptoms appear, you have a good chance of avoiding an out break, and an even better chance of minimizing the effects if you do have one.

4.6.3 Snakes

The possibility of encountering snakes exists, specifically for personnel working in wooded/vegetated areas. Snake venoms are complex and include proteins, some of which have enzymatic activity. The effects produced by venoms include neurotoxic effects with sensory, motor, cardiac, and respiratory difficulties; cytotoxic effects on red blood cells, blood vessels, heart muscle, kidneys, and lungs; defects in coagulation; and effects from local release of substances by enzymatic actions. Other noticeable effects of venomous snakebites include swelling, edema, and pain around the bite, and the development of ecchymosis (the escape of blood into tissues from ruptured blood vessels).

Control - To minimize the threat of snakebites, all personnel walking through vegetated areas must be aware of the potential for encountering snakes and the need to avoid actions potentiating encounters, such as turning over logs. If a snake bite occurs, an attempt should be made to identify the snake via size and markings. The victim must be transported to the nearest hospital within 30 minutes. First aid consists of applying a constriction band and washing the area around the wound to remove any unabsorbed venom.

4.6.4 Spiders

Personnel may encounter spiders during work activities.

Two spiders are of concern, the black widow and the brown recluse. Both prefer dark sheltered areas such as basements, equipment sheds and enclosures, and around woodpiles or other scattered debris. The black widow is shiny black, approximately one inch long, and found throughout the United States. There is a distinctive red hourglass marking on the underside of the black widows body. The bite of a black widow is seldom fatal to healthy adults, but effects include respiratory distress, nausea, vomiting, and muscle spasms. The brown recluse is smaller than the black widow and gets its name from its brown coloring and behavior. The brown recluse is more prevalent in the southern United States. The brown recluse has a distinctive violin shape on the top of its body. The bite of the brown recluse is painful and the bite site ulcerates and takes many weeks to heal completely.

Control - To minimize the threat of spider bites, all personnel walking through vegetated areas must be aware of the potential for encountering these arachnids. Personnel need to avoid actions that may result in encounters, such as turning over logs, and placing hands in dark places such as behind equipment or in corners of equipment sheds or enclosures. If a spider bite occurs, the victim must be transported to the nearest hospital as soon as possible; first aid consists of applying ice packs and washing the area around the wound to remove any unabsorbed venom.

4.7 Noise

Exposure to noise over the OSHA action level can cause temporary impairment of hearing; prolonged and repeated exposure can cause permanent damage to hearing. The risk and severity of hearing loss increases with the intensity and duration of exposure to noise. In addition to damaging hearing, noise can impair voice communication, thereby increasing the risk of accidents onsite.

Control - All personnel must wear hearing protection, with a Noise Reduction Rating (NRR) of at least 20, when noise levels exceed 85 dBA. When it is difficult to hear a co-worker at normal conversation distance, the noise level is approaching or exceeding 85 dBA, and hearing protection is necessary. All site personnel who may be exposed to noise must also receive baseline and annual audiograms and training as to the causes and prevention of hearing loss. Noise monitoring is discussed in Section 6.2, Noise Monitoring.

Whenever possible, equipment that does not generate excessive noise levels will be selected for this project. If the use of noisy equipment is unavoidable, barriers or increased distance will be used to minimize worker exposure to noise, if feasible.

4.8 Spill Control

All personnel must take every precaution to minimize the potential for spills during site operations. All onsite personnel shall immediately report any discharge, no matter how small, to the SS.

Spill control equipment and materials will be located on the site at locations that present the potential for discharge. All sorbent materials used for the cleanup of spills will be containerized and labeled appropriately. In the event of a spill, the SS will follow the provisions in Section 9, Emergency Procedures, to contain and control released materials and to prevent their spread to offsite areas.

4.9 Sanitation

Site sanitation will be maintained according to OSHA requirements.

4.9.1 Break Area

Breaks must be taken in the SZ, away from the active work area after site personnel go through decontamination procedures. There will be no smoking, eating, drinking, or chewing gum or tobacco in any area other than the SZ.

4.9.2 Potable Water

The following rules apply to all field operations:

- An adequate supply of potable water will be provided at each project site. Potable water must be kept away from hazardous materials or media, and contaminated clothing or equipment.

- Portable containers used to dispense drinking water must be capable of being tightly closed, and must be equipped with a tap dispenser. Water must not be consumed directly from the container (drinking from the tap is prohibited) nor may it be removed from the container by dipping.

- Containers used for drinking water must be clearly marked and shall not be used for any other purpose.

- Disposable drinking cups must be provided. A sanitary container for dispensing cups and a receptacle for disposing of used cups is required.

4.9.3 Sanitary Facilities

Access to facilities for washing before eating, drinking, or smoking, or alternate methods such as waterless hand-cleaner and paper towels will be provided.

4.9.4 Lavatory

If permanent toilet facilities are not available, an appropriate number of portable chemical toilets will be provided.

This requirement does not apply to mobile crews or to normally unattended site locations so long as employees at these locations have transportation immediately available to nearby toilet facilities.

4.10 Emergency Equipment

Adequate emergency equipment for the activities being conducted onsite and as required by applicable sections of 29 CFR 1910 and 29 CFR 1926 will be onsite prior to the commencement of project activities. Personnel will be provided with access to emergency equipment, including, but not limited to, the following:

- Fire extinguishers of adequate size, class, number, and location as required by applicable sections of 29 CFR 1910 and 1926
- Industrial first aid kits of adequate size for the number of personnel onsite
- Emergency eyewash and/or shower if required by operations being conducted onsite

4.11 Lockout/Tagout Procedures

Only fully qualified and trained personnel will perform maintenance procedures. Before maintenance begins, lockout/tagout procedures per OSHA 29 CFR 1910.147 will be followed.

Lockout is the placement of a device that uses a positive means, such as lock, to hold an energy or material-isolating device such that the equipment cannot be operated until the lockout device is removed. If a device cannot be locked out, a tagout system shall be used. Tagout is the placement of a warning tag on an energy or material isolating device indicating that the equipment controls may not be operated until the tag is removed by the personnel who attached the tag.

4.12 Electrical Safety

Electricity may pose a particular hazard to site workers due to the use of portable electrical equipment. If wiring or other electrical work is needed, a qualified electrician must perform it.

General electrical safety requirements include:

- All electrical wiring and equipment must be a type listed by Underwriters Laboratories (UL), Factory Mutual Engineering Corporation (FM), or other recognized testing or listing agency.

- All installations must comply with the National Electrical Safety Code (NESC), the National Electrical Code (NEC), or USCG regulations.

- Portable and semi-portable tools and equipment must be grounded by a multi-conductor cord having an identified grounding conductor and a multi-contact polarized plug-in receptacle.

- Tools protected by an approved system of double insulation, or its equivalent, need not be grounded. Double insulated tools must be distinctly marked and listed by UL or FM.

- Live parts of wiring or equipment must be guarded to prevent persons or objects from touching them.

- Electric wire or flexible cord passing through work areas must be covered or elevated to protect it from damage by foot traffic, vehicles, sharp corners, projections, or pinching.

- All circuits must be protected from overload.

- Temporary power lines, switchboxes, receptacle boxes, metal cabinets, and enclosures around equipment must be marked to indicate the maximum operating voltage.

- Plugs and receptacles must be kept out of water unless of an approved submersible construction.

- All extension cord outlets must be equipped with ground fault circuit interrupters (GFCI).

- Attachment plugs or other connectors must be equipped with a cord grip and be constructed to endure rough treatment.

- Extension cords or cables must be inspected prior to each use, and replaced if worn or damaged. Cords and cables must not be fastened with staples, hung from nails, or suspended by bare wire.

- Flexible cords must be used only in continuous lengths without splice, with the exception of molded or vulcanized splices made by a qualified electrician.

4.13 Lifting Safety

Using proper lifting techniques may prevent back strain or injury. The fundamentals of proper lifting include:

- Consider the size, shape, and weight of the object to be lifted. A mechanical lifting device or additional persons must be used to lift an object if it cannot be lifted safely alone.

- The hands and the object should be free of dirt or grease that could prevent a firm grip.

- Gloves must be used, and the object inspected for metal slivers, jagged edges, burrs, or rough or slippery surfaces.

- Fingers must be kept away from points that could crush or pinch them, especially when putting an object down.

- Feet must be placed far enough apart for balance. The footing should be solid and the intended pathway should be clear.

- The load should be kept as low as possible, close to the body with the knees bent.

- To lift the load, grip firmly and lift with the legs, keeping the back as straight as possible.

- A worker should not carry a load that he or she cannot see around or over.

- When putting an object down, the stance and position are identical to that for lifting; the legs are bent at the knees, and the back is straight as the object is lowered.

4.14 Ladder Safety

When portable ladders are used for access to an upper landing surface, the ladder side rails shall extend at least 3 feet (0.9 m) above the upper landing surface to which the ladder is used to gain access; or, when such an extension is not possible because of the ladder's length, then the ladder shall be secured at its top to a rigid support that will not deflect, and a grasping device, such as a grabrail, shall be provided to assist employees in mounting and dismounting the ladder. In no case shall the extension be such that ladder deflection under a load would, by itself, cause the ladder to slip off its support.

- Ladders shall be maintained free of oil, grease, and other slipping hazards.
- Ladders shall not be loaded beyond the maximum intended load for which they were built, or beyond their manufacturer's rated capacity.
- Ladders shall be used only for the purpose for which they were designed.
- Non-self-supporting ladders shall be used at an angle such that the horizontal distance from the top support to the foot of the ladder is approximately one-quarter of the working length of the ladder (the distance along the ladder between the foot and the top support).
- Wood job-made ladders with spliced side rails shall be used at an angle such that the horizontal distance is one-eighth the working length of the ladder.
- Fixed ladders shall be used at a pitch no greater than 90 degrees from the horizontal, as measured to the back side of the ladder.
- Ladders shall be used only on stable and level surfaces unless secured to prevent accidental displacement.
- Ladders shall not be used on slippery surfaces unless secured or provided with slip-resistant feet to prevent accidental displacement. Slip-resistant feet shall not be used as a substitute for care in placing, lashing, or holding a ladder that is used upon slippery surfaces, including, but not limited to, flat metal or concrete surfaces that are constructed so they cannot be prevented from becoming slippery.
- Ladders placed in any location where they can be displaced by workplace activities or traffic, such as in passageways, doorways, or driveways, shall be secured to

prevent accidental displacement, or a barricade shall be used to keep the activities or traffic away from the ladder.

- The area around the top and bottom of ladders shall be kept clear.
- The top of a non-self-supporting ladder shall be placed with the two rails supported equally unless it is equipped with a single support attachment.
- Ladders shall not be moved, shifted, or extended while occupied.
- Ladders shall have non-conductive siderails if they are used where the employee or the ladder could contact exposed energized electrical equipment.
- The top, top step, or the step labeled that it or any step above it should not be used as a step.
- Cross-bracing on the rear section of stepladders shall not be used for climbing unless the ladders are designed and provided with steps for climbing on both front and rear sections.
- Ladders shall be inspected by the HSS for visible defects on a daily basis and after any occurrence that could affect their safe use.
- Portable ladders with structural defects, such as, but not limited to, broken or missing rungs, cleats, or steps; broken or split rails; corroded components; or other faulty or defective components shall either be immediately marked in a manner that readily identifies them as defective, or be tagged with “Do Not Use” or similar language, and shall be withdrawn from service.
- Fixed ladders with structural defects, such as, but not limited to, broken or missing rungs, cleats, or steps; broken or split rails; or corroded components; shall be withdrawn from service.
- Ladder repairs shall restore the ladder to a condition meeting its original design criteria, before the ladder is returned to use.
- Single-rail ladders shall not be used.
- When ascending or descending a ladder, the user shall face the ladder.

- Each employee shall use at least one hand to grasp the ladder when progressing up and/or down the ladder.

- An employee shall not carry any object or load that could cause the employee to lose balance and fall.

4.15 Traffic Safety

The project site may be located adjacent to a public roadway where exposure to vehicular traffic is likely. Traffic may also be encountered as vehicles enter and exit the area. To minimize the likelihood of project personnel and activities being affected by traffic, the following procedures will be implemented.

Cones must be placed along the shoulder of the roadway starting 100 feet from the work area to alert passing motorists to the presence of personnel and equipment. A “Slow” or “Men Working” sign must be placed at the first cone. Barricades with flashing lights should be placed between the roadway and the work area.

During activities along a roadway, equipment will be aligned parallel to the roadway to the extent feasible, facing into the oncoming traffic so as to place a barrier between the work crew and the oncoming traffic. All crewmembers must remain behind the equipment and the traffic barrier.

All site personnel who are potentially exposed to vehicular traffic must wear an outer layer of orange warning garments, such as vests, jackets, or shirts. If work is performed in hours of dusk or darkness, workers will be outfitted with reflective garments, either orange, white (including silver-coated reflective coatings or elements that reflect white light), yellow, fluorescent red-orange, or fluorescent yellow-orange.

The flow of traffic into and out of the adjacent business must be assessed, and precautions taken to warn motorists of the presence of workers and equipment. Where possible, vehicles should be aligned to provide physical protection of people and equipment.

5. Personal Protective Equipment

5.1 Levels of Protection

PPE is required to safeguard site personnel from various hazards. Varying levels of protection may be required depending on the levels of COC and the degree of physical hazard. This section presents the various levels of protection and defines the conditions of use for each level. A summary of the levels is presented in Table 5-1 in this section.

5.1.1 Level D Protection

The minimum level of protection that is required of ARCADIS personnel and subcontractors at the site is Level D, which is worn when activities do not involve potential dermal contact with contaminants and air monitoring indicates that no inhalation hazard exists. Level D protection includes the following equipment:

- Work clothing as prescribed by weather
- Steel-toe work boots, meeting ANSI Z41
- Safety glasses with side shields or goggles, meeting ANSI Z87
- Hard hat, meeting ANSI Z89, when falling object hazards are present
- Hearing protection (if noise levels exceed 85 dBA, then hearing protection with a USEPA NRR of at least 20 dBA must be used)
- PFD if working on or near the water

5.1.2 Modified Level D Protection

Modified Level D will be used when airborne contaminants are not present at levels of concern, but site activities present the potential for skin contact with contaminated materials. Modified Level D consists of the following equipment:

- Nitrile outer gloves worn over nitrile surgical gloves
- Latex or PVC overboots when contact with COC-impacted media is anticipated
- Steel-toe work boots, meeting ANSI Z41
- Safety glasses with side shields or goggles, meeting ANSI Z87
- Face shield in addition to safety glasses or goggles when projectiles or splash hazards exist
- Tyvek® or KleenGuard® coveralls when skin contact with COC-impacted media is anticipated
- Hard hat, meeting ANSI Z89, when falling object hazards are present

- Hearing protection (if noise levels exceed 85 dBA, then hearing protection with a USEPA NRR of at least 20 dBA must be used)
- PFD if working on or near the water

5.1.3 Level C Protection

Level C protection will be required when the airborne concentration of COCs reaches one-half of the OSHA Permissible Exposure Limit (PEL) or ACGIH TLV. The following equipment will be used for Level C protection:

- Full-face, NIOSH-approved, air-purifying respirator with combination organic vapor cartridges
- Polyethylene-coated Tyvek® suit with ankles and cuffs taped to boots and gloves
- Nitrile outer gloves worn over nitrile surgical gloves
- Steel-toe work boots, meeting ANSI Z41
- Chemical-resistant boots with steel toes, or latex or polyvinyl chloride (PVC) overboots over steel-toe boots
- Hard hat, meeting ANSI Z89
- Hearing protection (if noise levels exceed 85 dBA, then hearing protection with a USEPA NRR of at least 20 dBA must be used)
- PFD if working on or near the water

5.2 Selection of PPE

Equipment for personal protection will be selected based on the potential for contact, site conditions, ambient air quality, and the judgment of supervising site personnel and health and safety professionals. The PPE used will be chosen to be effective against the COC present on the site.

5.3 Site Respiratory Protection Program

Respiratory protection is an integral part of employee health and safety at the site due to potentially hazardous concentrations of airborne COC. The site respiratory protection program will consist of the following (as a minimum):

- All onsite personnel who may use respiratory protection will have an assigned respirator.

- All onsite personnel who may use respiratory protection will have been fit tested and trained in the use of a full-face air-purifying respirator within the past 12 months.

- All onsite personnel who may use respiratory protection must within the past year have been medically certified as being capable of wearing a respirator. Documentation of the medical certification must be provided to the HSS, prior to commencement of site work.

- Only cleaned, maintained, NIOSH-approved respirators will be used.

- If respirators are used, the respirator cartridge is to be properly disposed of at the end of each work shift, or when load-up or breakthrough occurs.

- Contact lenses are not to be worn when a respirator is worn.

- All onsite personnel who may use respiratory protection must be clean-shaven. Mustaches and sideburns are permitted, but they must not touch the sealing surface of the respirator.

- Respirators will be inspected, and a negative pressure test performed prior to each use.

- After each use, the respirator will be wiped with a disinfectant, cleansing wipe. When used, the respirator will be thoroughly cleaned at the end of the work shift. The respirator will be stored in a clean plastic bag, away from direct sunlight in a clean, dry location, in a manner that will not distort the face piece.

5.4 Using PPE

Depending upon the level of protection selected, specific donning and doffing procedures may be required. The procedures presented in this section are mandatory if Modified Level D or Level C PPE is used. All personnel entering the EZ must put on the required PPE in accordance with the requirements of this HASP. When leaving the EZ, PPE will be removed in accordance with the procedures listed, to minimize the spread of COC.

5.4.1 Donning Procedures

These procedures are mandatory only if Modified Level D or Level C PPE is used on the site:

- Remove bulky outerwear. Remove street clothes and store in clean location.
- Put on work clothes or coveralls.
- Put on the required chemical protective coveralls.

- Put on the required chemical protective boots or boot covers.
- Tape the legs of the coveralls to the boots with duct tape.
- Put on the required chemical protective gloves.
- Tape the wrists of the protective coveralls to the gloves.
- Don the required respirator and perform appropriate fit check (Level C).
- Put hood or head covering over head and respirator straps and tape hood to facepiece (Level C).
- Don remaining PPE, such as safety glasses or goggles and hard hat.

When these procedures are instituted, one person must remain outside the work area to ensure that each person entering has the proper protective equipment.

5.4.2 Doffing Procedures

The following procedures are only mandatory if Modified Level D or Level C PPE is required for the site. Whenever a person leaves the work area, the following decontamination sequence will be followed:

- Upon entering the CRZ, rinse contaminated materials from the boots or remove contaminated boot covers.

- Clean reusable protective equipment.

- Remove protective garments, equipment, and respirator (Level C). All disposable clothing should be placed in plastic bags, which are labeled with contaminated waste labels.

- Wash hands, face, and neck (or shower if necessary).

- Proceed to clean area and dress in clean clothing.

- Clean and disinfect respirator for next use.

All disposable equipment, garments, and PPE must be bagged in plastic bags, labeled for disposal. See Section 7, Decontamination, for detailed information on decontamination stations.

5.5 Selection Matrix

The level of personal protection selected will be based on air monitoring of the work environment and an assessment by the SS and HSS of the potential for skin contact with COC. The PPE selection matrix is presented in Table 5-1. This matrix is based on information available at the time this plan was written. The Airborne Constituent Action Levels in Table 6-1 should be used to verify that the PPE prescribed in these matrices is appropriate.

Table 5-1. PPE Selection Matrix

Task	Anticipated Level of Protection
Mobilization	Level D
Installation of Groundwater Monitoring Wells and Soil Borings	Level D/Modified Level D
Groundwater Sampling and Monitoring	Level D/Modified Level D
Subsurface Soil Sampling	Level D/Modified Level D
Decontamination	Level D/Modified Level D
Demobilization	Level D

6. Air Monitoring

6.1 Air Monitoring

Air monitoring will be conducted continuously at the site during any land-based intrusive work to determine employee exposure to airborne constituents. The monitoring devices to be used are an MIE Mini RAM particulate monitor (or equivalent) and a Rae Systems MultiRAE detector (PID with a **11.7 eV** lamp/ oxygen/ LEL/ Hydrogen Sulfide Sensors). All work activity must stop where tests indicate the concentration of flammable vapors exceeds 10% of the LEL at a location with a potential ignition source. Such an area must be ventilated to reduce the concentration to an acceptable level. In areas where petroleum hydrocarbons are suspected, benzene detector tube readings may be taken if PID readings exceed 1part per million (ppm), and are sustained for 15 minutes in the breathing zone.

The ARCADIS HSS will be responsible for utilizing the air monitoring results to determine appropriate health and safety precautions for ARCADIS personnel and subcontractors. Air monitoring results will be recorded in the field notebook or on an air monitoring log (see Attachment F).

6.2 Noise Monitoring

Noise monitoring may be conducted as required. Hearing protection is mandatory for all employees in noise hazardous areas, such as around heavy equipment. As a general rule, sound levels that cause speech interference at normal conversation distance should require the use of hearing protection.

6.3 Monitoring Equipment Maintenance and Calibration

All direct-reading instrumentation calibrations should be conducted under the approximate environmental conditions the instrument will be used. Instruments must be calibrated before and after use, noting the reading(s) and any adjustments that are necessary. All air monitoring equipment calibrations, including the standard used for calibration, must be documented on a calibration log or in the field notebook. All completed documentation/forms must be reviewed by the HSS and maintained by the SS.

All air monitoring equipment will be maintained and calibrated in accordance with the specific manufacturer’s procedures. Preventive maintenance and repairs will be conducted in accordance with the respective manufacturer’s procedures. When applicable, only manufacturer-trained and/or authorized personnel will be allowed to perform instrument repairs or preventive maintenance.

If an instrument is found to be inoperative or suspected of giving erroneous readings, the HSS must be responsible for immediately removing the instrument from service and obtaining a replacement unit. If the instrument is essential for safe operation during a specific activity, that activity must cease until an appropriate replacement unit is obtained. The HSS will be responsible for ensuring a replacement unit is obtained and/or repairs are initiated on the defective equipment.

6.4 Action Levels

Table 6-1 presents airborne constituent action levels that will be used to determine the procedures and protective equipment necessary based on conditions as measured at the site.

6.5 Onsite Monitoring Plan and Response Activities

Soil borings will be completed at locations as part of the field investigation activities. These activities have the potential to generate organic vapors and particulates. As mentioned above, air monitoring will be conducted in the worker breathing zone to determine the level of protection required for personnel observing completion of monitoring well, soil vapor point, and soil boring installations. If action levels in the worker breathing zone are exceeded for organic vapors or particulates, air monitoring will be required at various onsite/perimeter locations to determine appropriate response activities that are protective of personnel onsite who are not directly involved with the investigation, personnel at adjacent commercial sites, and the surrounding community. If action levels for the remaining monitoring parameters listed in Table 6-1 are exceeded, work will stop, the HSO/HSM will be contacted, and perimeter monitoring will be performed. Additional monitoring (and appropriate response activities) to be implemented if the total organic vapor and particulate levels in the worker breathing zone exceed action levels as discussed below.

Total Organic Vapors

If the sustained level of total organic vapors in the worker breathing zone exceeds 1 ppm above background, then the level of total organic vapors will be manually recorded at the downwind perimeter of the work area (i.e., exclusion zone) at 15 minute intervals. If the sustained level of total organic vapors at the downwind perimeter of the work area exceeds 1 ppm above background, then work activities will be halted and additional downwind monitoring will be performed. Efforts will be undertaken to mitigate the source of organic vapors. The work area will be enlarged, if necessary, to mitigate the potential for people who are not involved with the investigation from being exposed to organic vapor levels exceeding 1 ppm above background.

During the investigation, it is possible that the downwind perimeter of the work area will coincide with the site perimeter. If, at any time, the sustained level of total organic vapors adjacent to the downwind site perimeter reaches 5 ppm above background, then the level of total organic vapors adjacent to the nearest downwind occupied building or property from the work zone will be monitored. If after 30 minutes, the total organic vapor level adjacent to the nearest occupied building or property has not subsided below 1 ppm above background, then the HSS will inform the local emergency response contacts [in addition to project managers from National Fuel, the NYSDEC, the New York State Department of Health (NYSDOH), and ARCADIS] listed in Section 11.5 and persons who may be exposed will be notified to evacuate occupied buildings or properties. These persons will not be permitted to return to the properties until after the level of total organic vapors on the properties subsides to below 1 ppm above background.

Particulates

If the level of particulates in the worker breathing zone exceeds 100 micrograms per cubic meter (µg/m^3) above background, then the level of particulates will be manually recorded at the downwind perimeter of the work area at 15 minute intervals. If the level of particulates at the downwind perimeter of the work area is 150 µg/m^3 or greater, then work activities will cease and dust suppression techniques must be employed to maintain particulate levels below 150 µg/m^3. In addition, the work area will be enlarged if necessary to keep the public from being exposed to particulate levels greater than 150 µg/m^3.

6.6 Odor Control

If any odor complaints are received from members of the surrounding community and are related to the field investigation activities described herein, then the potentially odor-causing activity will be suspended, subsurface openings will be covered, and onsite personnel (in consultation with National Fuel and ARCADIS PM) will evaluate an alternative course of action.

Table 6-1. Airborne Constituent Action Levels

Parameter	Reading in Breathing Zone (BZ)	Action
Total Organic Vapors	0 ppm to < 1 ppm	Normal operations; record breathing zone monitoring measurements every hour
	> 1 ppm to 5 ppm	Increase recording frequency to at least every 15 minutes and use benzene Drager tube to screen for the presence of benzene
	≥ 5 ppm to ≤ 50 ppm	Upgrade to level C PPE, continue screening for benzene
	> 50 ppm	Stop work; evacuate work area, investigate cause of reading, reduce through engineering controls, contact HSO
Benzene (as determined by colorimetric tube)	≥ 1 ppm to 10 ppm	Upgrade to Level C PPE
	>10 ppm	Stop work; evacuate confined spaces/work area, investigate cause of reading; contact HSO
Total Particulate	0 to 0.100 mg/m^3 above background	Normal operations
	> 0.100 mg/m^3 above background	Initiate wetting of work area to control dust; upgrade to Level C if dust control measures do not control dust within 15 minutes, monitor downwind impacts.
	> 0.15 mg/m^3 in breathing zone or at downwind perimeter of work area	Stop work; investigate cause of reading; contact PM and HSO
Oxygen	≤ 19.5 %	Stop work; evacuate confined spaces/work area, investigate cause of reading; ventilate area; contact HSO
	> 19.5% to < 23.5 %	Normal operations
	≥ 23.5 %	Stop work; evacuate confined spaces/work area, investigate cause of reading; ventilate area; contact HSO
Carbon Monoxide	0 ppm to ≤ 20 ppm	Normal operations
	> 20 ppm	Stop work; evacuate confined spaces/work area, investigate cause of reading; ventilate area; contact HSO

Parameter	Reading in Breathing Zone (BZ)	Action
Hydrogen Sulfide	0 ppm to ≤ 5 ppm	Normal operations
	> 5 ppm	Stop work; evacuate confined spaces/work area, investigate cause of reading; ventilate area; contact HSO
Flammable Vapors (LEL)	< 10% LEL	Normal operations
	≥ 10% LEL	Stop work; ventilate area; investigate source of vapors

Notes:

If action levels in the worker breathing zone are exceeded for organic vapors or particulates, air monitoring will be required at various onsite/perimeter locations to determine appropriate response activities that are protective of personnel onsite who are not directly involved with the investigation, personnel at adjacent commercial sites, and the surrounding community, as detailed in Section 6.5 of this HASP.

ppm= parts per million.

mg/m3= milligrams per cubic meter.

LEL= Lower explosive limit.

7. Work Zones and Decontamination

7.1 Work Zones

7.1.1 Authorization to Enter

Only personnel with the appropriate training and medical certifications (if respirators are required) will be allowed to work at the project site. The SS will maintain a list of authorized persons; only personnel on the authorized persons list will be allowed to enter the site work areas.

7.1.2 Site Orientation and Hazard Briefing

No person will be allowed in the work area during site operations without first being given a site orientation and hazard briefing. This orientation will be presented by the SS or HSS, and will consist of a review of this HASP. This review must cover the chemical, physical, and biological hazards, protective equipment, safe work procedures, and emergency procedures for the project. Following this initial meeting, daily safety meetings will be held each day before work begins.

All people entering the site work areas, including visitors, must document their attendance at this briefing, as well as the daily safety meetings on the forms included with this plan.

7.1.3 Certification Documents

A training and medical file may be established for the project and kept onsite during all site operations. Specialty training, such as first aid/cardiopulmonary resuscitation (CPR) certificates, as well as current medical clearances for all project field personnel required to wear respirators, will be maintained within that file. All ARCADIS and subcontractor personnel must provide their training and medical documentation to the HSS prior to starting work.

7.1.4 Entry Log

A log-in/log-out sheet will be maintained at the site by the SS. Personnel must sign in and out on a log sheet as they enter and leave the work area, and the SS may document entry and exit in the field notebook.

7.1.5 Entry Requirements

In addition to the authorization, hazard briefing, and certification requirements listed above, no person will be allowed in any ARCADIS work area unless they are wearing the minimum PPE as described in Section 5, Personal Protective Equipment.

7.1.6 Emergency Entry and Exit

People who must enter the work area on an emergency basis will be briefed of the hazards by the SS. All activities will cease in the event of an emergency. People exiting the work area because of an emergency will gather in a safe area for a head count. The SS is responsible for ensuring that all people who entered the work area have exited in the event of an emergency.

7.1.7 Contamination Control Zones

Contamination control zones are maintained to prevent the spread of contamination and to prevent unauthorized people from entering hazardous areas.

7.1.7.1 Exclusion Zone

An EZ may consist of a specific work area, or may be the entire area of potential contamination. All employees entering an EZ must use the required PPE, and must have the appropriate training and medical clearance for hazardous waste work. The EZ is the defined area where there is a possible respiratory and/or contact health hazard. Cones, caution tape, or a site diagram will identify the location of each EZ.

7.1.7.2 Contamination Reduction Zone

The CRZ or transition area will be established, if necessary, to perform decontamination of personnel and equipment. All personnel entering or leaving the EZ will pass through this area to prevent any cross-contamination. Tools, equipment, and machinery will be decontaminated in a specific location. The decontamination of all personnel will be performed onsite adjacent to the EZ. Personal protective outer garments and respiratory protection will be removed in the CRZ and prepared for cleaning or disposal. This zone is the only appropriate corridor between the EZ and the SZ.

7.1.7.3 Support Zone

The SZ is a clean area outside the CRZ located to prevent employee exposure to hazardous substances. Eating and drinking will be permitted in the support area only after proper decontamination. Smoking may be permitted in the SZ, subject to site requirements.

7.1.8 Posting

Work areas will be prominently marked on the ground and delineated using cones, caution tape. Work areas may also be shown on a site diagram.

7.1.9 Site Inspections

The SS will conduct a daily inspection of site activities, equipment, and procedures to verify that the required elements are in place. The Safety Inspection Form in Attachment D may be used as a guide for daily inspections. A monthly LPO must also be completed and forwarded to the PM for review.

7.2 Decontamination

7.2.1 Personnel Decontamination

All personnel wearing Modified Level D or Level C protective equipment in the EZ must undergo personal decontamination prior to entering the SZ. The personnel decontamination area will consist of the following stations at a minimum:

- *Station 1*: Personnel leaving the contaminated zone will remove the gross contamination from their outer clothing and boots.

- *Station 2*: Personnel will remove their outer garment and gloves and dispose of it in properly labeled containers. Personnel will then decontaminate their hard hats, and boots with an aqueous solution of detergent or other appropriate cleaning solution. These items are then hand carried to the next station.

- *Station 3*: Personnel will thoroughly wash their hands and face before leaving the CRZ. Respirators will be sanitized and then placed in a clean plastic bag.

7.2.2 Equipment Decontamination

All vehicles that have entered the EZ will be decontaminated at the decontamination pad prior to leaving the zone. If the level of vehicle contamination is low, decontamination may be limited to rinsing of tires and wheel wells with water. If the vehicle is significantly contaminated, steam cleaning or pressure washing of vehicles and equipment may be required.

7.2.3 Personal Protective Equipment Decontamination

Where and whenever possible, single-use, external protective clothing must be used for work within the EZ or CRZ. This protective clothing must be disposed of in properly labeled containers. Reusable protective clothing will be rinsed at the site with detergent and water. The rinsate will be collected for disposal.

When removed from the CRZ, the respirator will be thoroughly cleaned with soap and water. The respirator face piece, straps, valves, and covers must be thoroughly cleaned at the end of each work shift, and ready for use prior to the next shift. Respirator parts may be disinfected with a solution of bleach and water, or by using a spray disinfectant.

8. Training and Medical Surveillance

8.1 Training

8.1.1 General

All onsite project personnel who work in areas where they may be exposed to site contaminants must be trained as required by OSHA Regulation 29 CFR 1910.120 (HAZWOPER). Field employees exposed or potentially exposed over the PEL receive 40 hours of initial training and three days of actual field experience under the direct supervision of a trained, experienced supervisor. Field employees onsite for a specific limited task such as groundwater monitoring/sampling, surveying, etc. and who are unlikely to be exposed over the PEL receive 24 hours of initial training and one day of actual field experience under the direct supervision of a trained, experienced supervisor. Personnel who completed their initial training more than 12 months prior to the start of the project must have completed an eight-hour refresher course within the past 12 months. The SS must have completed an additional eight hours of supervisory training, and must have a current first-aid/CPR certificate.

8.1.2 Basic 40-Hour Course

The following is a list of the topics typically covered in a 40-hour HAZWOPER training course:

- General safety procedures
- Physical hazards (fall protection, noise, heat stress, cold stress)
- Names and job descriptions of key personnel responsible for site health and safety
- Safety, health, and other hazards typically present at hazardous waste sites
- Use, application, and limitations of PPE
- Work practices by which employees can minimize risks from hazards
- Safe use of engineering controls and equipment onsite
- Medical surveillance requirements
- Recognition of symptoms and signs which might indicate overexposure to hazards
- Worker right-to-know (Hazard Communication OSHA 1910.1200)
- Routes of exposure to contaminants
- Engineering controls and safe work practices
- Components of a health and safety program and a site-specific HASP
- Decontamination practices for personnel and equipment
- Confined-space entry procedures
- General emergency response procedures

8.1.3 Supervisor Course

Management and supervisors must receive an additional eight hours of training, which typically includes:

- general site safety and health procedures.
- PPE programs.
- air monitoring techniques.

8.1.4 Site-Specific Training

Site-specific training will be accomplished by onsite personnel reading this HASP, or through a thorough site briefing by the PM, SS, or HSS on the contents of this HASP before work begins. The review must include a discussion of the chemical, physical, and biological hazards; the protective equipment and safety procedures; and emergency procedures.

8.1.5 Daily Safety Meetings

Twice daily safety meetings will be held to cover the work to be accomplished, the hazards anticipated, the PPE and procedures required to minimize site hazards, and emergency procedures. The SS or HSS should present these meetings prior to beginning the day’s fieldwork and again after lunch. No work will be performed in an EZ before a safety meeting has been held. A safety meeting must also be held prior to new tasks, and repeated if new hazards are encountered. The Daily Safety Meeting Log is included in Attachment E.

8.1.6 First Aid and CPR

At least one employee current in first aid/CPR will be assigned to the work crew and will be on the site during operations. Refresher training in first aid (triennially) and CPR (annually) is required to keep the certificate current. These individuals must also receive training regarding the precautions and protective equipment necessary to protect against exposure to blood-borne pathogens.

8.2 Medical Surveillance

8.2.1 Medical Examination

All personnel who are potentially exposed to site contaminants must participate in a medical surveillance program as defined by OSHA at 29 CFR 1910.120 (f).

8.2.2 Pre-Placement Medical Examination

All potentially exposed personnel must have completed a comprehensive medical examination prior to assignment, and periodically thereafter as defined by applicable regulations. The pre-placement and periodic medical examinations typically include the following elements:

- Medical and occupational history questionnaire
- Physical examination
- Complete blood count, with differential
- Liver enzyme profile
- Chest X-ray, at a frequency determined by the physician
- Pulmonary function test
- Audiogram
- Electrocardiogram for persons older than 45 years of age, or if indicated during the physical examination
- Drug and alcohol screening, as required by job assignment
- Visual acuity
- Follow-up examinations, at the discretion of the examining physician or the corporate medical director

The examining physician provides the employee with a letter summarizing his findings and recommendations, confirming the worker’s fitness for work and ability to wear a respirator. Documentation of medical clearance will be available for each employee during all project site work.

Subcontractors will certify that all their employees have successfully completed a physical examination by a qualified physician. The physical examinations must meet the requirements of 29 CFR 1910.120 and 29 CFR 1910.134. Subcontractors will supply copies of the medical examination certificate for each onsite employee.

8.2.3 Other Medical Examinations

In addition to pre-employment, annual, and exit physicals, personnel may be examined:

- At employee request after known or suspected exposure to toxic or hazardous materials.

- At the discretion of the HSS, HSO, or occupational physician in anticipation of, or after known or suspected exposure to toxic or hazardous materials.

8.2.4 Periodic Exam

Following the placement examination, all employees must undergo a periodic examination, similar in scope to the placement examination. For employees potentially exposed over 30 days per year, the frequency of periodic examinations will be annual. For employees potentially exposed less than 30 days per year, the frequency for periodic examinations will be 24 months.

8.2.5 Medical Restriction

When the examining physician identifies a need to restrict work activity, the employee’s supervisor must communicate the restriction to the employee and the HSS. The terms of the restriction will be discussed with the employee and the supervisor.

9. Emergency Procedures

9.1 General

Prior to the start of operations, the work area will be evaluated for the potential for fire, contaminant release, or other catastrophic event. Unusual conditions or events, activities, chemicals, and conditions will be reported to the SS/HSS immediately.

The SS/HSS will establish evacuation routes and assembly areas for the site. All personnel entering the site will be informed of this route and the assembly area.

9.2 Emergency Response

If an incident occurs, the following steps will be taken:

- The SS/HSS will evaluate the incident and assess the need for assistance and/or evacuation.
- The SS/HSS will call for outside assistance as needed.
- The SS/HSS will ensure the PM is notified promptly of the incident.
- The SS/HSS will take appropriate measures to stabilize the incident scene.

9.2.1 Fire

In the case of a fire at the site, the SS/HSS will assess the situation and direct fire-fighting activities. The SS/HSS will ensure that the PM is immediately notified of any fires. Site personnel will attempt to extinguish the fire with available extinguishers, if safe to do so. In the event of a fire that site personnel are unable to safely extinguish with one fire extinguisher, the local fire department will be summoned.

9.2.2 Contaminant Release

In the event of a contaminant release, the following steps will be taken:

- Notify SS/HSS immediately.
- Evacuate immediate area of release.
- Conduct air monitoring to determine needed level of PPE.
- Don required level of PPE and prepare to implement control procedures.

The SS/HSS has the authority to commit resources as needed to contain and control released material and to prevent its spread to offsite areas.

9.3 Medical Emergency

All employee injuries must be promptly reported to the HSS/SS, who will:

- Ensure that the injured employee receives prompt first aid and medical attention.
- In emergency situations, the worker is to be transported by appropriate means to the nearest urgent care facility (normally a hospital emergency room).
- If the injured person is an ARCADIS employee, notify Pat Bullock, ARCADIS Workers Comp Administrator, at 1-720-344-3844 as soon as possible after the employee has been safely evacuated from the scene.

Emergency Care Steps

Survey the scene. Determine if it is safe to proceed. Try to determine if the conditions that caused the incident are still a threat. Protect yourself from exposure before attempting to rescue the victim.

- Do a primary survey of the victim. Check for airway obstruction, breathing, and pulse. Assess likely routes of chemical exposure by examining the eyes, mouth, nose, and skin of the victim for symptoms.
- Phone Emergency Medical Services (EMS). Give the location, telephone number used, caller’s name, what happened, number of victims, victim’s condition, and help being given.
- Maintain airway and perform rescue breathing as necessary.
- Perform CPR as necessary.
- Do a secondary survey of the victim. Check vital signs and do a head-to-toe exam.

Treat other conditions as necessary. If the victim can be moved, take him/her to a location away from the work area where EMS can gain access.

9.4 First Aid - General

All persons must report any injury or illness to their immediate supervisor or the SS. Trained personnel will provide first aid. Injuries and illnesses requiring medical treatment must be documented. The SS and HSS must conduct an II as soon as emergency conditions no longer exist and first aid and/or medical treatment has been ensured. IIs must be completed and submitted to the PM within 24 hours after the incident.

If first-aid treatment is required, first aid kits are kept at the CRZ. If treatment beyond first aid is required, the injured person(s) should be transported to the medical facility. If the injured person is not ambulatory, or shows any sign of not being in a comfortable and stable condition for transport, then an ambulance/paramedics should be summoned. If there is any doubt as to the injured worker’s condition, it is best to let the local paramedic or ambulance service examine and transport the worker.

9.4.1 First Aid - Inhalation

Any employee complaining of symptoms of chemical overexposure as described in Section 4, General Site Safety Procedures, will be removed from the work area and transported to the designated medical facility for examination and treatment.

9.4.2 First Aid - Ingestion

Call EMS and consult a poison control center for advice. If available, refer to the MSDS for treatment information. If the victim is unconscious, keep them on their side and clear the airway if vomiting occurs.

9.4.3 First Aid - Skin Contact

Project personnel who have had skin contact with contaminants will, unless the contact is severe, proceed through the CRZ, to the wash area. Personnel will remove any contaminated clothing, and then flush the affected area with water for at least 15 minutes. The worker should be transported to the medical facility if he/she shows any sign of skin reddening, irritation, or if he/she requests a medical examination.

9.4.4 First Aid - Eye Contact

Project personnel who have had contaminants splashed in their eyes or who have experienced eye irritation while in the EZ, must immediately proceed to the eyewash station in the CRZ. Do not decontaminate prior to using the eyewash. Remove whatever protective clothing is necessary to use the eyewash. Flush the eye with clean running water for at least 15 minutes. Arrange prompt transport to the designated medical facility.

9.5 Reporting Injuries, Illnesses, and Near Miss Incidents

Injuries and illnesses, however minor, will be reported to the SS immediately. The SS will complete an injury report and submit it to the HSM/HSO, PIC, National Fuel and the PM within 24 hours.

Near miss incidents are situations in which no injury or property damage occurred, but under slightly different circumstances an injury or property damage could have occurred. Near misses are caused by the same factors as injuries; therefore, they must be reported and investigated in the same manner. A SPSA must be done immediately after an injury, illness, near miss, or other incident to determine if it is safe to proceed with the work.

9.6 Non-Emergency, Non-Life Threatening Work Related Injury or Illness

For minor illnesses or injuries that may be work-related and are **not** life threatening or emergencies (e.g., you’re in your hotel room and your lower back tightens up, earlier in the day you hand-augured 50 borings; you cut your hand in the office, put a band-aid on the cut, and go back to work, but when you get home you realize the cut is deep and is still bleeding; you hit your head on a cabinet while loading paper, and later on that day you suddenly feel dizzy.) employees will take the following steps **before** seeking medical treatment at a medical treatment facility:

As soon as possible, contact WorkCare at (00) 1-800-455-6155 (Once you've spoken with WorkCare, you can let your supervisor know).

- WorkCare will discuss the medical issues with you and provide appropriate medical guidance.

- If WorkCare feels that you should see a physician:

  - They will help you locate a physician/clinic and will contact the clinic to discuss the treatment plan. If they have a concern about the treatment plan, one of the WorkCare physicians will attempt to contact the treating physician to discuss the plan and will keep you advised.

- If WorkCare feels that first-aid/self-treatment is medically appropriate:

  - They will provide the treatment information to you and will follow up with you to determine effectiveness.

- If the medical issue persists, WorkCare will advise alternative treatment or will refer you to a physician.

- Keep your supervisor informed on what action you will be taking. If you are seen by a physician, keep them advised as to your work status and upcoming medical appointments.

If an injury or illness is life-threatening or an emergency, please seek medical attention immediately. As soon as possible, notify your supervisor.

9.7 Emergency Information

The means to summon local public response agencies such as police, fire, and ambulance will be reviewed in the daily safety meeting. These agencies are identified in Table 9-1.

Table 9-1. Emergency Contacts

Local Emergency Contacts	Telephone No.
Fire	911
Police	911
Ambulance	911
Hospital: Brooks Memorial Hospital	716.366.1111
Project Emergency Contacts	**Telephone No.**
ARCADIS Project Manager: Scott Powlin	315.446.9120, ext. 19456
ARCADIS Site Supervisor: TBD	315.446.9120
ARCADIS Health and Safety Supervisor: TBD	315.446.9120
National Fuels: Tanya Alexander	716.857.7410
NYSDEC: William Ottaway	518.402.9686

9.7.1 Directions to Hospital (Non-Emergency)

Total Time: 1 minute **Total Distance: 0.51 miles**

A: 31 W 2nd St, Dunkirk, NY 14048-1503

START	1: Start out going EAST on W 2ND ST toward EAGLE ST.	0.1 mi
→	2: Turn RIGHT onto CENTRAL AVE.	0.4 mi
END	3: End at 529 Central Ave Dunkirk, NY 14048	

B: Brooks Memorial Hospital: 529 Central Ave, Dunkirk, NY 14048, (716) 366-1111

Total Time: 1 minute Total Distance: 0.51 miles

Appendix C
Health and Safety Plan

ATTACHMENTS

Attachment A

Material Safety Data Sheets

ScholAR™ Chemistry

MATERIAL SAFETY DATA SHEET

5100 W. Henrietta Rd.
West Henrietta, NY 14586
TEL: (866) 260-0501

MSDS No. 9609604 9609706
Effective Date: December 11, 2002

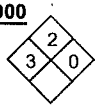
SECTION I NAME

Product	Aniline
Chemical Synonyms	N/A
Formula	$C_2H_5NH_2$
CAS No.	62-53-3

24 HOUR EMERGENCY ASSISTANCE

416-984-3000

NFPA



Health	3
Flammability	2
Reactivity	2

HAZARD RATING WHMIS

LEAST	SLIGHT	MODERATE	HIGH	EXTREME
0	1	2	3	4

SECTION II DANGEROUS INGREDIENTS

Name	%	TLV Units
Aniline	100%	N/A
DANGER! POISON!		

SECTION III PHYSICAL DATA

Melting Point (°C)	-6.2°C	Specific Gravity (H_2O = 1)	1.022
Boiling Point (°C)	184°C	Percent Volatile by Volume (%)	100%
Vapor Pressure (mm Hg)	0.5 mm @ 20°C	Evaporation Rate (n-Butyl acetate =1)	< 1
Vapor Density (Air=1)	3.22		
Solubility in Water	0.3 g/Lt. @ 20°c		
Appearance & Odor	Colorless oily liquid; amine odor.		

SECTION IV FIRE AND EXPLOSION HAZARD DATA

			Lower	Upper
Flash point	70°C (CC)	Flammable Limits in Air % by Volume	1.3%	20.0%

Firefighting Procedures

Use dry chemical, CO_2, alcohol foam, or water spray. In fire conditions, fire-fighters should wear an appropriate mask or a self-containing breathing apparatus.

Flammability and Explosion Hazards

Fire or excessive heat may produce hazardous decomposition products to be produced as dust or fume.

Auto-ignition temperature: 615°C

TDG	**Class 6.1 Toxic substance. UN1547**

SECTION V REACTIVITY DATA

AA0359

Chemical Stability	Yes	☒	If no, under what conditions?
	No	☐	
Incompatible with Other products	Yes	☒	Alkalies, acids, strong oxidizers, albumin, solutions of iron, zinc, aluminum.
	No	☐	
Hazardous Decomposition Products			Nitrogen and carbon oxides.
Reactive under what conditions			Volatile with steam. Ignites in presence of Nitric acid or Sodium.

SECTION VI TOXICOLOGICAL PROPERTIES

Route of Entry	Ingestion. Inhalation. Skin.
TLV	TWA: 2 ppm, 7.6 mg/m^3 (skin).
Toxicity for animals	Acute oral toxicity (LD50): 250 mg/kg (Rat).
Chronic effects on humans	The substance is toxic to the blood, kidneys, lungs and liver. Repeated or prolonged exposure to the substance can produce target organs damage. Target organs: Kidneys, red blood cells, central nervous system, liver.
Acute effects on humans	Harmful if swallowed, inhaled or absorbed through skin. Contact may cause irritation to the skin and eyes. May cause cyanosis.

SECTION VII PREVENTIVE MEASURES

Waste Disposal	Discharge, treatment, or disposal may be subject to local laws. Consult your local or regional authorities.
Storage	Keep container dry. Keep in a cool place. Keep container tightly closed. Toxic materials should be stored in a separate locked safety storage cabinet or room.
Precautions	Keep away from heat. Keep away from sources of ignition. DO NOT breathe gas, fumes, vapor or spray. Do not ingest. If ingested, seek immediate medical attention.
Spill or leak	Absorb with an inert dry material and place in an appropriate waste disposal container.
Protective Clothing	Safety goggles. Lab coat. Gloves. Anit-vapor respirator.

SECTION VIII FIRST AID MEASURES

Specific first aid measures

Ingestion: Call physician or Poison Control Center immediately. Induce vomiting only if advised by the appropriate medical personnel. Eye contact: Check for and remove any contact lenses. Immediately flush eyes with running water for at least 15 minutes, keeping eyelids open. Seek medical attention. Skin contact: Gently and thoroughly wash the contaminated skin with running water and non-abrasive soap. Inhalation: Move victim to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Allow victim to rest in a well ventilated area. Seek immediate medical attention.

SECTION IX PREPARATION OF THE MSDS

Rev. No.	2	Date	December 11, 2002	Approved	Michael Raszeja

Material Safety Data Sheet Collection
Genium Publishing Corp.
1171 RiverFront Center
Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2000-07

Benzene
MSDS 316
BEN2200

Section 1 - Chemical Product and Company Identification 54.1

Material Name: Benzene **CAS Number:** 71-43-2
Chemical Formula: C_6H_6
Structural Chemical Formula: C_6H_6
Synonyms: (6)ANNULENE; BENZEEN; BENZEN; BENZENE; BENZIN; BENZINE; BENZOL; BENZOL 90; BENZOLE; BENZOLENE; BENZOLO; BICARBURET OF HYDROGEN; CARBON OIL; COAL NAPHTHA; CYCLOHEXATRIENE; EPA PESTICIDE CHEMICAL CODE 008801; FENZEN; MINERAL NAPHTHA; MOTOR BENZOL; NITRATION BENZENE; PHENE; PHENYL HYDRIDE; POLYSTREAM; PYROBENZOL; PYROBENZOLE
General Use: Manufacture of chemicals including styrene, dyes, and many other organic chemicals. Has been used in artificial leather, linoleum, oil cloth, airplane dopes, lacquers; as solvent for waxes, resins, oils etc.
May also be a minor component of gasoline, petrol.
Exposure should be minimized by use in closed systems.
Handling procedures and control measures should be evaluated for exposure before commencement of use in plant operations.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
benzene	71-43-2	99.9

OSHA PEL
TWA: 1 ppm; 3 mg/m^3; STEL: 5 ppm; 15 mg/m^3; from Table Z-2.

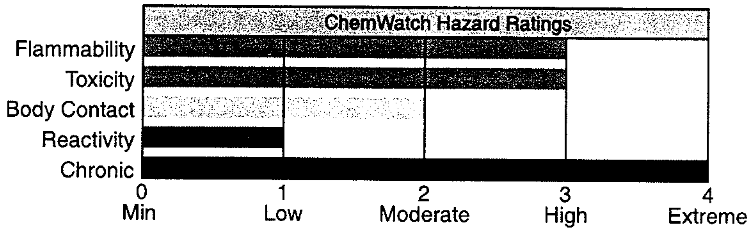
ACGIH TLV
TWA: 10 ppm; 32 mg/m^3.

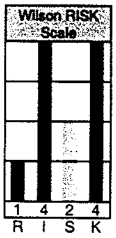
NIOSH REL
TWA: 0.1 ppm. STEL: 1 ppm.

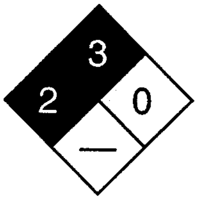
IDLH Level
500 ppm.

Section 3 - Hazards Identification

HMIS
③ Health
③ Flammability
⓪ Reactivity







Fire Diamond

ANSI Signal Word

Danger!

Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; sweet odor. Irritating to eyes/skin/respiratory tract. Toxic. Also causes: headache, dizziness, drowsiness. Absorbed through the skin. Chronic: dermatitis, leukemia, bone marrow damage. Carcinogen. Reproductive effects. Flammable.

Potential Health Effects

Primary Entry Routes: inhalation, skin contact
Target Organs: blood, central nervous system (CNS), bone marrow, eyes, upper respiratory system, skin
Acute Effects
Inhalation: The vapor is discomforting to the upper respiratory tract and lungs and may be harmful if inhaled.
If exposure to highly concentrated solvent atmosphere is prolonged this may lead to narcosis, unconsciousness, even coma and possible death.

Acute effects from inhalation of high concentrations of vapor are pulmonary irritation, including coughing, with nausea; central nervous system depression - characterized by headache and dizziness, increased reaction time, fatigue and loss of coordination.

Inhalation hazard is increased at higher temperatures.

The symptoms of acute exposure to high vapor concentrations include confusion, dizziness, tightening of the leg muscles and pressure over the forehead followed by a period of excitement. If exposure continues the casualty quickly becomes stupefied and lapses into a coma with narcosis.

Effects of inhalation may include nausea, vomiting headache, dizziness, drowsiness, weakness, sometimes preceded by brief periods of exhilaration, or euphoria, irritability, malaise, confusion, ataxia, staggering, weak and rapid pulse, chest pain and tightness with breathlessness, pallor, cyanosis of the lips and fingertips and tinnitus. Severe exposures may produce blurred vision, shallow, rapid breathing, delirium, cardiac arrhythmias, unconsciousness, deep anesthesia, paralysis and coma characterized by motor restlessness, tremors and hyperreflexia (occasionally preceded by convulsions). Polyneuritis and persistent nausea, anorexia, muscular weakness, headache, drowsiness, insomnia and agitation may also occur. Two-three weeks after the exposure, nervous irritability, breathlessness and unsteady gait may still persist; cardiac distress and an unusual dicoloration of the skin may be evident for up to four weeks.

Hemotoxicity is not normally a feature of acute exposures although anemia, thrombocytopenia, petechial hemorrhage, and spontaneous internal bleeding have been reported. Fatal exposures may result from asphyxia, central nervous system depression, cardiac and respiratory failure and circulatory collapse; sudden ventricular fibrillation may also be fatal.

Death may be sudden or may be delayed for 24 hours. Central nervous system, respiratory or hemorrhagic complications may occur up to five days after the exposure and may be lethal; pathological findings include respiratory inflammation with edema, and lung hemorrhage, renal congestion, cerebral edema and extensive petechial hemorrhage in the brain, pleurae, pericardium, urinary tract, mucous membrane and skin.

Exposure to toxic levels has also produced chromosome damage.

Eye: The liquid is highly discomforting to the eyes, may be harmful following absorption and is capable of causing a mild, temporary redness of the conjunctiva (similar to wind-burn), temporary impairment of vision and/or other transient eye damage/ulceration.

The vapor is moderately discomforting to the eyes.

The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Skin: The liquid may produce skin discomfort following prolonged contact.

Defatting and/or drying of the skin may lead to dermatitis. Open cuts, abraded or irritated skin should not be exposed to this material.

Toxic effects may result from skin absorption.

The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

Ingestion: The liquid is discomforting to the gastrointestinal tract and may be harmful if swallowed.

Ingestion may result in nausea, pain, vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.

Carcinogenicity: NTP - Class 1, Known to be a carcinogen; IARC - Group 1, Carcinogenic to humans; OSHA - Listed as a carcinogen; NIOSH - Listed as carcinogen; ACGIH - Class A2, Suspected human carcinogen; EPA - Class A, Human carcinogen; MAK - Class A1, Capable of inducing malignant tumors as shown by experience with humans.

Chronic Effects: Liquid is an irritant and may cause burning and blistering of skin on prolonged exposure.

Chronic exposure may cause headache, fatigue, loss of appetite and lassitude with incipient blood effects including anemia and blood changes.

Benzene is a myelotoxicant known to suppress bone-marrow cell proliferation and to induce hematologic disorders in humans and animals.

Signs of benzene-induced aplastic anemia include suppression off leukocytes (leukopenia), red cells (anemia), platelets (thromocytopenia) or all three cell types (pancytopenia). Classic symptoms include weakness, purpura, and hemorrhage. The most significant toxic effect is insidious and often irreversible injury to the blood forming tissue. Leukemia may develop.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Lay patient down. Keep warm and rested.

If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.

Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).

Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For acute or short-term repeated exposures to petroleum distillates or related hydrocarbons:

1.Primary threat to life from pure petroleum distillate ingestion and/or inhalation is respiratory failure.

2.Patients should be quickly evaluated for signs of respiratory distress (e.g. cyanosis, tachypnea, intercostal retraction, obtundation) and given oxygen. Patients with inadequate tidal volumes or poor arterial blood gases (pO_2 <50 mm Hg or pCO_2 >50 mm Hg) should be intubated.

3.Arrhythmias complicate some hydrocarbon ingestion and/or inhalation and electrocardiographic evidence of myocardial injury has been reported; intravenous lines and cardiac monitors should be established in obviously symptomatic patients. The lungs excrete inhaled solvents, so that hyperventilation improves clearance.

4.A chest x-ray should be taken immediately after stabilization of breathing and circulation to document aspiration and detect the presence of pneumothorax.

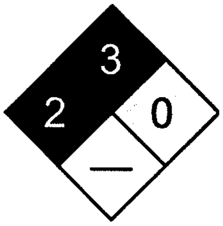
5.Epinephrine (adrenalin) is not recommended for treatment of bronchospasm because of potential myocardial sensitization to catecholamines.
Inhaled cardioselective bronchodilators (e.g. Alupent, Salbutamol) are the preferred agents, with aminophylline a second choice.

6.Lavage is indicated in patients who require decontamination; ensure use of cuffed endotracheal tube in adult patients.
Consider complete blood count. Evaluate history of exposure.

Section 5 - Fire-Fighting Measures

Flash Point: -11 °C Closed Cup
Autoignition Temperature: 562 °C
LEL: 1.3% v/v
UEL: 7.1% v/v

Extinguishing Media: Foam, dry chemical powder, BCF (where regulations permit), carbon dioxide.
Water spray or fog - Large fires only.



Fire Diamond

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable.
Severe fire hazard when exposed to heat, flame and/or oxidizers.
Vapor forms an explosive mixture with air.
Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion/decomposition with violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO).

Fire Incompatibility: Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear full body protective clothing with breathing apparatus. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
Fight fire from a safe distance, with adequate cover.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control fire and cool adjacent area.
Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.
Equipment should be thoroughly decontaminated after use.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.

Large Spills: Pollutant - contain spillage. Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
No smoking, bare lights or ignition sources. Increase ventilation.

Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.
Use only spark-free shovels and explosion proof equipment.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights, heat or ignition sources.
When handling, DO NOT eat, drink or smoke.
Vapor may ignite on pumping or pouring due to static electricity.
DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.
Avoid contact with incompatible materials.
Keep containers securely sealed. Avoid physical damage to containers.
Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.

Recommended Storage Methods: Metal can; metal drum. Packing as recommended by manufacturer.
Check all containers are clearly labeled and free from leaks.

Storage Requirements: Store in original containers in approved flame-proof area.
No smoking, bare lights, heat or ignition sources.
DO NOT store in pits, depressions, basements or areas where vapors may be trapped. Keep containers securely sealed.
Store away from incompatible materials in a cool, dry well ventilated area.
Protect containers against physical damage and check regularly for leaks.
Observe manufacturer's storing and handling recommendations.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area. Local exhaust ventilation usually required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection. NIOSH-approved self contained breathing apparatus (SCBA) may be required in some situations.
Provide adequate ventilation in warehouse or closed storage area.

Personal Protective Clothing/Equipment

Eyes: Chemical goggles. Full face shield.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Nitrile gloves; Neoprene gloves.
Safety footwear.
Do NOT use this product to clean the skin.

Respiratory Protection:
Exposure Range >1 to 10 ppm: Air Purifying, Negative Pressure, Half Mask
Exposure Range >10 to 100 ppm: Air Purifying, Negative Pressure, Full Face
Exposure Range >100 to 1000 ppm: Supplied Air, Constant Flow/Pressure Demand, Full Face
Exposure Range >1000 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: black
Note: must change cartridge at beginning of each shift

Other: Overalls. Eyewash unit. Barrier cream. Skin cleansing cream.

Glove Selection Index:

PE/EVAL/PE	A
PVA	A
TEFLON	A
VITON	A
VITON/NEOPRENE	A
NITRILE+PVC	C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

BUTYL C
NITRILE C
NEOPRENE C
PVC C
NATURAL RUBBER C
BUTYL/NEOPRENE C

Section 9 - Physical and Chemical Properties

Appearance/General Info: Clear, highly flammable liquid; floats on water. Characteristic aromatic odor. Highly volatile. Mixes with alcohol, chloroform, ether, carbon disulfide, carbon tetrachloride, glacial acetic acid, acetone and oils.

Physical State: Liquid
Vapor Pressure (kPa): 9.95 at 20 °C
Vapor Density (Air=1): 2.77
Formula Weight: 78.12
Specific Gravity (H_2O=1, at 4 °C): 0.879 at 20 °C
Water Solubility: 0.18 g/100 g of water at 25 °C
Evaporation Rate: Fast

pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 80.1 °C (176 °F)
Freezing/Melting Point Range: 5.5 °C (41.9 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Product is considered stable. Hazardous polymerization will not occur.
Storage Incompatibilities: Avoid reaction with oxidizing agents.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (man) LD_{Lo}: 50 mg/kg
Oral (rat) LD_{50}: 930 mg/kg
Inhalation (rat) LC_{50}: 10000 ppm/7h
Inhalation (human) LC_{Lo}: 2000 ppm/5m
Inhalation (man) TC_{Lo}: 150 ppm/1y - I
Inhalation (human) TC_{Lo}: 100 ppm
Reproductive effector in rats

IRRITATION
Skin (rabbit): 20 mg/24 hr - mod
Eye (rabbit): 2 mg/24 hr - SEVERE

See NIOSH, *RTECS* CY 1400000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released to soil, it will be subject to rapid volatilization near the surface and that which does not evaporate will be highly to very highly mobile in the soil and may leach to groundwater. It may be subject to biodegradation based on reported biodegradation of 24% and 47% of the initial 20 ppm in a base-rich para-brownish soil in 1 and 10 weeks, respectively. It may be subject to biodegradation in shallow, aerobic groundwaters, but probably not under anaerobic conditions. If released to water, it will be subject to rapid volatilization; the half-life for evaporation in a wind-wave tank with a moderate wind speed of 7.09 m/sec was 5.23 hours; the estimated half-life for volatilization from a model river one meter deep flowing 1 m/sec with a wind velocity of 3 m/sec is estimated to be 2.7 hours at 20 °C. It will not be expected to significantly adsorb to sediment, bioconcentrate in aquatic organisms or hydrolyze. It may be subject to biodegradation based on a reported biodegradation half-life of 16 days in an aerobic river die-away test. In a marine ecosystem biodegradation occurred in 2 days after an acclimation period of 2 days and 2 weeks in the summer and spring, respectively, whereas no degradation occurred in winter. According to one experiment, it has a half-life of 17 days due to photodegradation which could contribute to removal in situations of cold water, poor nutrients, or other conditions less conductive to microbial degradation. If released to the atmosphere, it will exist predominantly in the vapor phase. Gas-phase will not be subject to direct photolysis but it will react with photochemically produced hydroxyl radicals with a half-life of 13.4 days calculated using an experimental rate constant for the reaction. The reaction time in polluted atmospheres which contain nitrogen oxides or sulfur dioxide is accelerated with the half-life being reported as 4-6 hours. Products of photooxidation include phenol, nitrophenols, nitrobenzene, formic acid, and peroxyacetyl nitrate. It is fairly soluble in water and is removed from the atmosphere in rain.

Ecotoxicity: LC_{50} Clawed toad (3-4 wk after hatching) 190 mg/l/48 hr /Conditions of bioassay not specified; LC_{50} Morone saxatilis (bass) 5.8 to 10.9 ppm/96 hr /Conditions of bioassay not specified; LC_{50} Poecilia reticulata (guppy) 63 ppm/14 days /Conditions of bioassay not specified; LC_{50} Salmo trutta (brown trout yearlings) 12 mg/l/1 hr (static bioassay); LD_{50} Lepomis macrochirus (bluegill sunfish) 20 mg/l/24 to 48 hr /Conditions of bioassay not specified; LC_{100} Tetrahymena pyriformis (ciliate) 12.8 mmole/l/24 hr /Conditions of bioassay not specified; LC_{50} Cancer magister (crab larvae) stage 1, 108 ppm/96 hr /Conditions of bioassay not specified; LC_{50} Crangon franciscorum (shrimp) 20 ppm/96 hr /Conditions of bioassay not specified

Henry's Law Constant: 5.3×10^{-3}

BCF: eels 3.5

Biochemical Oxygen Demand (BOD): 1.2 lb/lb, 10 days

Octanol/Water Partition Coefficient: $\log K_{OW} = 2.13$

Soil Sorption Partition Coefficient: K_{OC} = woodburn silt loam 31 to 143

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: BENZENE
Hazard Class: 3.1
ID No.: 1114
Packing Group: II
Label: Flammable Liquid[3]

Additional Shipping Information:

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U019 Toxic Waste; Ignitable Waste
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4); per RCRA Section 3001; per CWA Section 307(a); per CAA Section 112 10 lb (4.535 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date:............................1999-11 **Review Date:** 2000-07

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Amsterdam, NY 12010
(518) 842-4111

Issue Date: 2003-02

Benzo[*b*]fluoranthene
BEN4520

Section 1 - Chemical Product and Company Identification

Material Name: Benzo[*b*]fluoranthene **CAS Number:** 205-99-2
Chemical Formula: $C_{20}H_{12}$
EINECS Number: 205-911-9
Synonyms: B B F; B E F; B (B) F; B(B)F; B(E)F; BBF; BEF; 3,4-BENZ(E)ACEPHENANTHRYLENE; BENZ(E)ACEPHENANTHRYLENE; 2,3-BENZFLUORANTHENE; 3,4-BENZFLUORANTHENE; BENZO(B) FLUORANTHENE; BENZO[*B*]FLUORANTHENE; 2,3-BENZOFLUORANTHENE; 3,4-BENZOFLUORANTHENE; BENZO(B)FLUORANTHENE; BENZO(E)FLUORANTHENE; BENZO[B]FLUORANTHENE; 2,3-BENZOFLUORANTHRENE
Derivation: No manufacturing information available; found in coal tar, coke oven emissions, cigarette smoke and automobile exhaust. There is no commercial production of this compound in the U.S.
General Use: Used as a research chemical.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
Benzo[*b*]fluoranthene	205-99-2	ca 100% wt

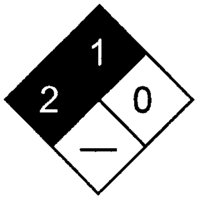
(Note that, except when in the form of a laboratory research chemical, benzo[*b*]fluoranthene is typically found in mixtures with other PAHs (polycyclic aromatic hydrocarbons), such as coal tar pitch).

OSHA PEL
No data found.

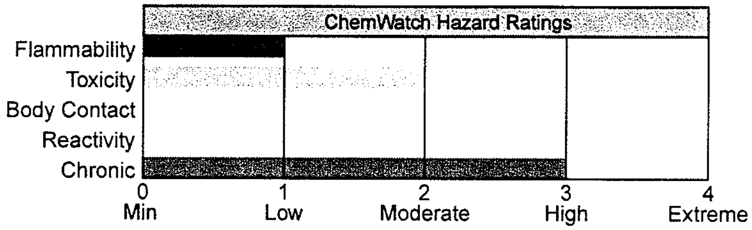
NIOSH REL
No data found.

ACGIH TLV
Exposure by all routes should be carefully controlled to levels as low as possible.

Section 3 - Hazards Identification



Fire Diamond



HMIS
② Health
① Flammability
⓪ Reactivity

ANSI Signal Word
Caution

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Benzo[*b*]fluoranthene is a solid in the form of colorless needles. It can be irritating to the respiratory tract, skin and eyes. Like some other PAHs (polycyclic aromatic hydrocarbons), benzo[b]fluoranthene is a possible human carcinogen and mutagen. Handle with care! When heated to decomposition, benzo[*b*]fluoranthene will emit carbon monoxide (CO) and carbon dioxide (CO_2).

Potential Health Effects

Target Organs: Eyes, skin, respiratory system, gastrointestinal (GI) system, blood, liver, kidneys
Primary Entry Routes: Inhalation, ingestion, skin and/or eye contact/absorption
Acute Effects
Inhalation: Irritation may result from inhalation of benzo[*b*]fluoranthene dust or fumes.
Eye: Contact may result in irritation.
Skin: Contact may cause irritation.
Ingestion: None reported.

Carcinogenicity: NTP - Class 2B, Reasonably anticipated to be a carcinogen, sufficient evidence of carcinogenicity from studies in experimental animals; IARC - Group 2B, Possibly carcinogenic to humans; OSHA - Not listed; NIOSH - Not listed; ACGIH - Class A2, Suspected human carcinogen; EPA - Class B2, Probable human carcinogen based on animal studies; MAK - Class A2, Unmistakably carcinogenic in animal experimentation only.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: Although there is no direct epidemiological evidence linking benzo[*b*]fluoranthene with cancer, it is frequently a component of mixtures associated with human cancer. Epidemiological studies demonstrate increased incidence of cancer (skin, lung, urinary tract, GI system) with exposure to mixed PAHs and substances that contain them. Coal tar pitch volatiles are reported to cause an excess of bronchitis. In animal studies, benzo[*b*]fluoranthene has been found to be tumorigenic and mutagenic.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain and/or irritation develop.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treat overexposure symptomatically and supportively. Medical surveillance may be necessary for high exposures (skin, mouth, GI, respiratory system). Animal testing suggests a synergism (combined effect greater than sum of parts) of mutagenicity between benzo[*b*]fluoranthene and other PAHs.

Section 5 - Fire-Fighting Measures

Flash Point: Probable combustible solid

Autoignition Temperature: None reported.

LEL: None reported.

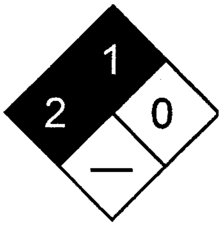
UEL: None reported.

Flammability Classification: Probable combustible solid

Extinguishing Media: Use water spray; carbon dioxide, dry chemical powder or appropriate foam.

General Fire Hazards/Hazardous Combustion Products: Heating benzo[*b*]fluoranthene to decomposition can produce carbon monoxide (CO) and carbon dioxide (CO_2).

Fire-Fighting Instructions: *Do not* release runoff from fire control methods to sewers or waterways. Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.



Fire Diamond

Section 6 - Accidental Release Measures

Spill/Leak Procedures: Notify safety personnel, isolate area and deny entry. Remove sources of ignition, and provide maximum ventilation.

Small Spills: Vacuum or carefully scoop up material and deposit in sealed containers. Absorb liquid containing benzo[*b*]fluoranthene with vermiculite, earth, sand or similar material.

Large Spills: Dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways. Stay upwind and have cleanup personnel protect against inhalation and contact.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid dust inhalation, and skin and eye contact. Avoid sunlight exposure of contaminated skin. Use only with ventilation sufficient to reduce airborne concentrations as low as possible. Wear protective gloves, goggles, and clothing (see Sec. 8). Keep away from heat and ignition sources.

Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Recommended Storage Methods: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Periodically inspect stored materials.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Work with benzo[*b*]fluoranthene only under an exhaust hood. Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Have employees with potential for exposure submit to preplacement and periodic medical examinations with emphasis on oral cavity (including sputum cytology), respiratory tract, skin (chronic disorders, lesions), blood (complete count), bladder and kidneys (urinalysis: specific gravity, albumin, glucose, microscopic examination of sediment; urinary cytology). Repeat medical exam on an annual basis, or on a semi-annual basis for employees 45 years or older or with 10 or more years of exposure to pitch volatiles. Periodically inspect lab atmospheres, and surfaces such as walls, floors, and benches and interior of fume hoods and air ducts for contamination. Post appropriate signs and labels on doors leading to areas where benzo[*b*]fluoranthene is used.

Personal Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Wear splash-proof chemical safety goggles, and face shield (8-inch minimum), per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For any detectable concentration (of coal tar pitch volatiles) use SCBA with full facepiece operated in pressure-demand or other positive pressure mode, or supplied-air respirator with full facepiece operated in pressure-demand or other positive pressure mode in combination with auxiliary SCBA operated in pressure-demand or other positive pressure mode; escape, air purifying full face respirator (gas mask) with a chin-style or a front- or back-mounted organic vapor canister and with a full facepiece and a fume or high-efficiency filter, or escape-type SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment. Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless needles
Physical State: Solid
Vapor Pressure (kPa): 5 x10^{-7} mm Hg at 68 °F (20 °C)
Formula Weight: 252.32
Freezing/Melting Point: 334.4 °F (168 °C)
Water Solubility: 0.0012 mg/L
Other Solubilities: 95% ethanol: <1 mg/mL at 66 °F (19 °C); acetone: 10-50 mg/mL at 66 °F (19 °C); benzene: slightly soluble; DMSO: 10-50 mg/mL at 66 °F (19 °C).

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Benzo[*b*]fluoranthene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Heat, sunlight.

Storage Incompatibilities: Include strong oxidizing agents.

Hazardous Decomposition Products: Thermal oxidative decomposition of benzo[*b*]fluoranthene will produce carbon monoxide (CO) and carbon dioxide (CO_2).

Section 11 - Toxicological Information

Other Effects:

Tumorgenicity, mouse, skin: 88 ng/kg/120 weeks intermittently produced toxic effects: tumorigenic - carcinogenic by RTECS criteria; skin and appendages - tumors; tumorigenic - tumors at site of application.

Hamster, lung cells: 100 µg/L produced morphological transformation.

Mouse, skin: 4037 µg/kg/20 days intermittently produced toxic effects: tumorigenic - equivocal tumorigenic agent by RTECS criteria; skin and appendages - tumors.

Rat, intraperitoneal: 100 mg/kg resulted in DNA adducts.

Mouse, skin: 72 mg/kg/60 weeks intermittently produced toxic effects: tumorigenic - equivocal tumorigenic agent by RTECS criteria; skin and appendages - tumors; tumorigenic - tumors at site of application.

Rat, intraperitoneal: 100 mg/kg induced sister chromatid exchange.

Rat, implant: 5 mg/kg produced toxic effects: tumorigenic - equivocal tumorigenic agent by RTECS criteria; lungs, thorax, or respiration - tumors; tumorigenic - tumors at site of application.

Human, lymphocyte cells: 55 µg/L produced mutation.

See NIOSH, *RTECS* CU1400000, for additional data.

Section 12 - Ecological Information

Environmental Fate: Benzo[*b*]fluoranthene has a low vapor pressure and Henry's Law Constant, and will not readily evaporate from water or soil. In surface water, it will partition from the water column to suspended sediments. Limited bioconcentration in aquatic organisms may occur (polychaete worms, BCF = 9.1); however, fish have an enzyme (microsomal oxidase) capable of rapidly metabolizing PAHs. Photolysis, photo-oxidation, and volatilization of dissolved benzo[*b*]fluoranthene may occur, but adsorption to suspended sediments is expected to inhibit these processes. Release to the soil may result in some biodegradation. Photolysis is not expected to be significant after release to soil. In the atmosphere it is likely to be adsorbed to particulate matter, and will be subject to wet and dry deposition. In the atmosphere, benzo[*b*]fluoranthene will rapidly degrade by reaction with photochemically produced hydroxyl radicals (half life 1.00 day). A high K_{oc} indicates significant sorption and low mobility in the soil column.

Ecotoxicity: Evidence suggests that PAHs in lake bottom sediments may cause tumors in fish.

Henry's Law Constant: 1.38×10^{-4} atm-m^3/mole, estimated

Octanol/Water Partition Coefficient: log $K_{ow} = 6.124$

Soil Sorption Partition Coefficient: $K_{oc} = 5.88$, estimated

Section 13 - Disposal Considerations

Disposal: Benzo[*b*]fluoranthene is a good candidate for rotary kiln incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Environmentally hazardous substances, solid, n.o.s.*
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: Class 9

Additional Shipping Information: *If in a quantity in one package which equals or exceeds the final reportable quantity of 1 lb (0.454 kg).

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed
CERCLA 40 CFR 302.4: Listed per CWA Section 307(a) 1 lb (0.454 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Not listed

Section 16 - Other Information

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Material Safety Data Sheet Collection
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Issue Date: 2003-02

Benz[a]anthracene
BEN2040

Section 1 - Chemical Product and Company Identification

55/ 57

Material Name: Benz[a]anthracene

CAS Number: 56-55-3

Chemical Formula: $C_{18}H_{12}$

EINECS Number: 200-280-6

Synonyms: B(A)A; BA; BAA; 1,2-BENZ(A)ANTHRACENE; 1,2-BENZANTHRACENE; BENZ(A)ANTHRACENE; BENZANTHRACENE; BENZ[A]ANTHRACENE; 1,2-BENZANTHRAZEN; 1,2-BENZANTHRENE; BENZANTHRENE; 1,2-BENZOANTHRACENE; BENZO(A)ANTHRACENE; BENZOANTHRACENE; 2,3-BENZOPHENANTHRENE; BENZO(A)PHENANTHRENE; BENZO(B)PHENANTHRENE; 2,3-BENZPHENANTHRENE; NAPHTHANTHRACENE; TETRAPHENE

General Use: research chemistry

Section 2 - Composition / Information on Ingredients

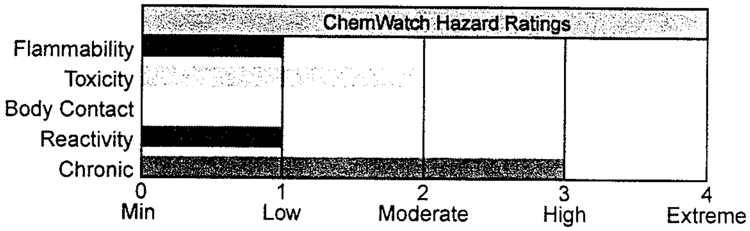
Name	CAS	%
benz[a]anthracene	56-55-3	>98

OSHA PEL
No data found.

NIOSH REL
No data found.

ACGIH TLV
Exposure by all routes should be carefully controlled to levels as low as possible.

Section 3 - Hazards Identification



ANSI Signal Word

Danger!

Poison

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless plates. May cause irritation. Poison. Other Acute Effects: may be fatal if inhaled, swallowed, or absorbed through skin. Chronic Effects: may cause heritable genetic damage; may alter genetic material. Carcinogen. Will burn.

Potential Health Effects

Target Organs: No data found.

Primary Entry Routes: accidental skin and eye contact, inhalation of generated dusts

Acute Effects

Inhalation: The dust is harmful and discomforting to the upper respiratory tract. Persons with impaired respiratory function, airway diseases, or conditions such as emphysema or chronic bronchitis may incur further disability if excessive concentrations of particulate are inhaled.

Eye: The dust may be discomforting to the eyes and is capable of causing a mild, temporary redness of the conjunctiva (similar to wind-burn), temporary impairment of vision and/ or other transient eye damage/ ulceration.

Skin: The material may be mildly discomforting to the skin. Open cuts and abraded or irritated skin should not be exposed to this material. Toxic effects may result from skin absorption.

Ingestion: The solid/dust is discomforting to the gastrointestinal tract and harmful if swallowed. Considered an unlikely route of entry in commercial/industrial environments.

Carcinogenicity: NTP - Class 2B, Reasonably anticipated to be a carcinogen, sufficient evidence of carcinogenicity from studies in experimental animals; IARC - Group 2A, Probably carcinogenic to humans; OSHA - Not listed; NIOSH - Not listed; ACGIH - Class A2, Suspected human carcinogen; EPA - Class B2, Probable human carcinogen based on animal studies; MAK - Class A2, Unmistakably carcinogenic in animal experimentation only.

Chronic Effects: Cited in many publications and by a number of regulatory authorities as a suspected human carcinogen. Subcutaneous injection produces sarcomas (soft tissue growths) in rats and mice. When administered by gavage benz[a]anthracene induced papillomas to the forestomach in mice and hamsters and mammary tumors in female rats.

Section 4 - First Aid Measures

Inhalation: • If dust is inhaled, remove to fresh air.
- Encourage patient to blow nose to ensure clear breathing passages.
- Rinse mouth with water. Consider drinking water to remove dust from throat.
- Seek medical attention if irritation or discomfort persist.
- If fumes or combustion products are inhaled, remove to fresh air.
- Lay patient down. Keep warm and rested.
- Other measures are usually unnecessary.

Eye Contact: • Immediately hold the eyes open and flush with fresh running water.
- Ensure complete irrigation of the eye by keeping eyelids apart and away from eye and moving the eyelids by occasionally lifting the upper and lower lids.
- Seek medical attention if pain persists or recurs.
- Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: • Immediately remove all contaminated clothing, including footwear (after rinsing with water).
- Wash affected areas thoroughly with water (and soap if available).
- Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center. If more than 15 minutes from a hospital:
- INDUCE vomiting with IPECAC SYRUP, or fingers down the back of the throat, ONLY IF CONSCIOUS. Lean patient forward or place on left side (head-down position, if possible) to maintain open airway and prevent aspiration. NOTE: Wear a protective glove when inducing vomiting by mechanical means.
- SEEK MEDICAL ATTENTION WITHOUT DELAY.
- In the meantime, qualified first-aid personnel should treat the patient following observation and employing supportive measures as indicated by the patient's condition.
- If the services of a medical officer or medical doctor are readily available, the patient should be placed in his/her care and a copy of the MSDS should be provided.
- If medical attention is not available on the worksite or surroundings send the patient to a hospital together with a copy of the MSDS.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Treat symptomatically.

Section 5 - Fire-Fighting Measures

Flash Point: Not available; probably combustible

Extinguishing Media: Foam. Dry chemical powder. BCF (where regulations permit). Carbon dioxide. Water spray or fog - Large fires only.

General Fire Hazards/Hazardous Combustion Products: • Solid which exhibits difficult combustion or is difficult to ignite.
- Avoid generating dust, particularly clouds of dust in a confined or unventilated space, as dust may form an explosive mixture with air and any source of ignition, e.g., flame or spark, will cause fire or explosion.
- Dry dust can also be charged electrostatically by turbulence, pneumatic transport, pouring, in exhaust ducts and during transport.
- Build-up of electrostatic charge may be prevented by bonding and grounding.
- Powder handling equipment such as dust collectors, dryers and mills may require additional protection measures such as explosion venting.

Fire Incompatibility: Avoid contamination with oxidizing agents i.e., nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.

Fire-Fighting Instructions: • Contact fire department and tell them location and nature of hazard.
- Wear breathing apparatus plus protective gloves for fire only.
- Prevent, by any means available, spillage from entering drains or waterways.
- Use fire fighting procedures suitable for surrounding fire.
- Do not approach containers suspected to be hot.
- Cool fire-exposed containers with water spray from a protected location.
- If safe to do so, remove containers from path of fire.
- Equipment should be thoroughly decontaminated after use.

Section 6 - Accidental Release Measures

Small Spills: • Clean up all spills immediately.
- Avoid contact with skin and eyes.
- Wear protective clothing, gloves, safety glasses and dust respirator.
- Use dry clean up procedures and avoid generating dust.
- Vacuum up or sweep up.
- Place in clean drum then flush area with water.

Large Spills: • Clear area of personnel and move upwind.
- Contact fire department and tell them location and nature of hazard.
- Wear breathing apparatus plus protective gloves.
- Prevent, by any means available, spillage from entering drains or waterways.
- No smoking, bare lights or ignition sources.
- Increase ventilation.
- Stop leak if safe to do so.
- Water spray or fog may be used to disperse/absorb vapor.
- Contain or absorb spill with sand, earth or vermiculite.
- Collect recoverable product into labeled containers for recycling.
- Collect solid residues and seal in labeled drums for disposal.
- Wash area and prevent runoff into drains.
- After clean up operations, decontaminate and launder all protective clothing and equipment before storing and reusing.
- If contamination of drains or waterways occurs, advise emergency services.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: • Avoid all personal contact, including inhalation.
- Wear protective clothing when risk of overexposure occurs.
- Use in a well-ventilated area.
- Prevent concentration in hollows and sumps.
- DO NOT enter confined spaces until atmosphere has been checked.
- Do not allow material to contact humans, exposed food or food utensils.
- Avoid smoking, bare lights or ignition sources.
- When handling, DO NOT eat, drink or smoke.
- Avoid contact with incompatible materials.
- Keep containers securely sealed when not in used.
- Avoid physical damage to containers.
- Always wash hands with soap and water after handling.
- Working clothes should be laundered separately. Launder contaminated clothing before reuse.
- Follow good occupational work practices.
- Observe manufacturer's storage/handling recommendations.
- Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.

Recommended Storage Methods: Glass container. Plastic container. Metal can. Metal drum. Check that all containers are clearly labeled and free from leaks.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Local exhaust ventilation usually required. If risk of overexposure exists, wear NIOSH-approved respirator. Provide adequate ventilation in warehouse or closed storage area.

Personal Protective Clothing/Equipment:

Eyes: Safety glasses with side shields or chemical goggles. Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Wear chemical protective gloves, e.g. PVC. Wear safety footwear.

Other: • Overalls.
- PVC Apron.
- PVC protective suit may be required if exposure severe.
- Eyewash unit.
- Ensure there is ready access to a safety shower.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Light yellow to tan crystalline powder.

Physical State: colorless plates **Vapor Pressure (kPa):** 5×10^{-9} torr at 20 °C

Formula Weight: 228.29
Evaporation Rate: Half life 89 hours
Boiling Point: Sublimes at 435 °C (815 °F)
Freezing/Melting Point: 162 °C (323.6 °F)
Volatile Component (% Vol): Negligible
Water Solubility: 0.014 mg/L in Water at 25 °C

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Product is considered stable. Hazardous polymerization will not occur.
Storage Incompatibilities: Avoid reaction with oxidizing agents.

Section 11 - Toxicological Information

Toxicity	Irritation
Intravenous (rat) LD_{50}: > 200 mg/kg	Nil reported

See NIOSH, *RTECS* CV9275000, for additional data.

Section 12 - Ecological Information

Environmental Fate: When released into water it will rapidly become adsorbed to sediment or particulate matter in the water column, and bioconcentrate into aquatic organisms. In the unadsorbed state, it will degrade by photolysis in a matter of hours to days. Its slow desorption from sediment and particulate matter will maintain a low concentration in the water. Because it is strongly adsorbed to soil it will remain in the upper few centimeters of soil and not leach into groundwater. It will very slowly biodegrade when colonies of microorganisms are acclimated but this is too slow a process (half-life ca 1 year to be significant). In the atmosphere it will be transported long distances and will probably be subject to photolysis and photooxidation although there is little documentation about the rate of these processes in the literature.
Ecotoxicity: Algae: Anabaena flos-aquae 2w EC_{50} growth +0.014 mg/l NOEC growth +0.003 mg/l
BCF: daphnia 4.0
Octanol/Water Partition Coefficient: log $K_{OW} = 5.61$
Soil Sorption Partition Coefficient: K_{OC} = sediments 55 to 1.87 $x10^6$

Section 13 - Disposal Considerations

Disposal: • Recycle wherever possible or consult manufacturer for recycling options.
- Follow applicable local, state, and federal regulations.
- Bury residue in an authorized landfill.
- Recycle containers if possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: TOXIC SOLID, ORGANIC, N.O.S.
Hazard Class: 6.1
ID No.: 2811
Packing Group: III
Label: Harmful[6]

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U018 Toxic Waste
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001, per CWA Section 307(a) 10 lb (4.535 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

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Issue Date: 2003-02

Benzo(a)pyrene
BEN5560

Section 1 - Chemical Product and Company Identification

43/57

Material Name: Benzo(a)pyrene **CAS Number:** 50-32-8
Chemical Formula: $C_{20}H_{12}$
EINECS Number: 200-028-5
Synonyms: B(A)P; BAP; BENZO(D,E,F)CHRYSENE; 3,4-BENZOPIRENE; 1,2-BENZOPYRENE; 3,4-BENZOPYRENE; 6,7-BENZOPYRENE; BENZO(A)PYRENE; 3,4-BENZPYREN; 3,4-BENZ(A)PYRENE; 3,4-BENZPYRENE; BENZ(A)PYRENE; BENZ[A]PYRENE; 3,4-BENZYLPYRENE; 3,4-BENZYPYRENE; 3,4-BP; BP; COAL TAR PITCH VOLATILES: BENZO(A)PYRENE
Derivation: Synthesized from pyrene and succinic anhydride.
General Use: Benzo(a)pyrene is no longer used or produced commercially in the US. In its pure form, benzo(a)pyrene may be used as a research laboratory reagent. It also occurs in combustion products of coal, oil, petroleum, wood and other biological matter; in motor vehicle and other gasoline and diesel engine exhaust; in charcoal-broiled foods; in cigarette smoke and general soot and smoke of industrial, municipal, and domestic origin. It occurs naturally in crude oils, shale oils, coal tars, gases and fly ash from active volcanoes and forest fires.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
Benzo(a)pyrene	50-32-8	ca 100% wt

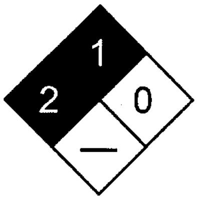
Except in laboratories, benzo(a)pyrene is usually mixed with other coal tar pitch chemicals. Consider exposure limits for coal tar pitch volatiles as a guideline. However, because benzo(a)pyrene is considered a probable carcinogen to humans, it is recommended that exposures to carcinogens be limited to the lowest feasible concentration.

OSHA PEL
TWA: 0.2 mg/m^3.

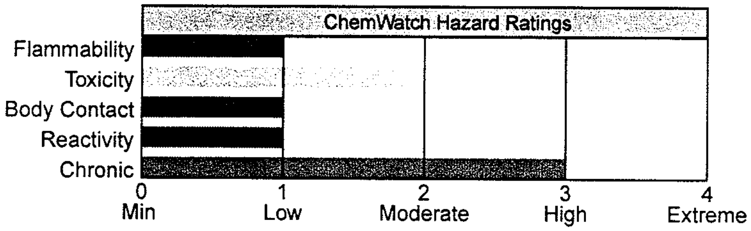
NIOSH REL
No data found.

ACGIH TLV
Exposure by all routes should be carefully controlled to levels as low as possible.

Section 3 - Hazards Identification



Fire Diamond



HMIS
② Health
① Flammability
⓪ Reactivity

ANSI Signal Word
Warning!

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Benzo(a)pyrene is a pale yellow, crystalline solid or powder that is irritating to the skin, eyes, and respiratory tract. It is a carcinogen and mutagen. Handle with extreme caution!

Potential Health Effects

Target Organs: Respiratory system, bladder, kidneys, skin.
Primary Entry Routes: Inhalation, ingestion.
Acute Effects
Inhalation: Respiratory tract irritation. Pregnant women may be especially susceptible to exposure effects of benzo(a)pyrene; exposure may damage the fetus. In general, polyaromatic hydrocarbons such as benzo(a)pyrene tend to localize primarily in body fat and fatty tissues (for ex. breasts) and are excreted in breast milk. Benzo(a)pyrene may also affect the male reproductive system (testes and sperm).
Eye: Irritation and/or burns on contact.

Skin: Irritation with burning sensation, rash, and redness; dermatitis on prolonged exposure. Sunlight enhances effects (photosensitization).

Ingestion: None reported.

Carcinogenicity: NTP - Class 2B, Reasonably anticipated to be a carcinogen, sufficient evidence of carcinogenicity from studies in experimental animals; IARC - Group 2A, Probably carcinogenic to humans; OSHA - Not listed; NIOSH - Listed as carcinogen; ACGIH - Class A2, Suspected human carcinogen; EPA - Class B2, Probable human carcinogen based on animal studies; MAK - Class A2, Unmistakably carcinogenic in animal experimentation only.

Medical Conditions Aggravated by Long-Term Exposure: Respiratory system, bladder, kidney, and skin disorders.

Chronic Effects: Inhalation: Cough and bronchitis. Eye: Photosensitivity and irritation. Skin: Skin changes such as thickening, darkening, pimples, loss of color, reddish areas, thinning of the skin, and warts. Sunlight enhances effects (photosensitization). Other: Gastrointestinal (GI) effects include leukoplakia (a pre-cancerous condition characterized by thickened white patches of epithelium on mucous membranes, especially of the mouth). Cancer of the lung, skin, kidneys, bladder, or GI tract is also possible. Smoking in combination with exposure to benzo(a)pyrene increases the chances of developing lung cancer. Persons with a high degree of inducibility of the enzyme aryl hydrocarbon hydroxylase may be a high risk population.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of tepid water for at least 15 min. Consult an ophthalmologist if irritation or pain persist.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water (less than 15 min). Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water to dilute. Inducing vomiting is not necessary since benzo(a)pyrene has a low acute toxicity and therefore, is generally an unnecessary procedure. Consider activated charcoal/cathartic.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Monitor CBC and arterial blood gases, conduct liver, renal, and pulmonary function tests (if respiratory tract irritation is present), and urinalysis. Biological monitoring techniques testing for metabolites in blood or urine, or DNA adducts in blood or tissues are useful for epidemiological studies that determine if exposure has occurred. Because neither normal nor toxic levels have been established, those techniques may not be useful for evaluating individual patients.

Special Precautions/Procedures: Emergency personnel should protect against exposure.

Section 5 - Fire-Fighting Measures

Flash Point: None reported. Benzo(a)pyrene may burn, but does *not* readily ignite.

Autoignition Temperature: None reported.

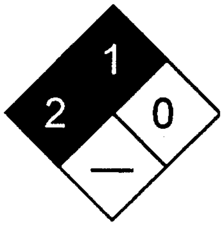
LEL: None reported.

UEL: None reported.

Extinguishing Media: For small fires, use dry chemical, sand, water spray, or foam. For large fires, use water spray, fog, or foam.

General Fire Hazards/Hazardous Combustion Products: Carbon monoxide and carbon dioxide.

Fire-Fighting Instructions: Isolate hazard and deny entry. If feasible and without undue risk, move containers from fire hazard area. Otherwise, cool fire-exposed containers with water spray until well after fire is extinguished. Do not release runoff from fire control methods to sewers or waterways. Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode and full protective clothing.



Fire Diamond

Section 6 - Accidental Release Measures

Spill/Leak Procedures: Notify safety personnel of large spills, remove heat and ignition sources, and provide adequate ventilation. Cleanup personnel should protect against dust inhalation and skin or eye contact. Clean up spills promptly.

Small Spills: Carefully scoop up spilled material and place into appropriate containers for disposal. For liquid spills, take up with a noncombustible, inert absorbent and place into appropriate containers for disposal.

Large Spills: For large spills, dike far ahead of liquid spill or contain dry spill for later disposal. Do not release into sewers or waterways. *Do not* dry sweep! Use a vacuum with a HEPA filter or a wet method to reduce dust. After cleanup is complete, thoroughly decontaminate all surfaces. *Do not* reuse contaminated cleaning materials.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Handle with extreme caution and take all necessary measures to avoid exposure to benzo(a)pyrene because it is a carcinogen and mutagen. Follow good personal hygiene procedures and thoroughly wash hands with soap and water after handling. Use safety pipettes for all pipetting.

Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Recommended Storage Methods: Store in tightly closed and properly labeled containers in a cool, well-ventilated area.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use a Class I, Type B, biological safety hood when working with benzo(a)pyrene in a laboratory. Decrease the rate of air extraction, so that benzo(a)pyrene can be handled without powder being blown around the hood. Keep glove boxes under negative pressure. Use vertical laminar-flow, 100% exhaust, biological safety cabinets for containment of in vitro procedures. The exhaust air flow should be sufficient to provide an inward air flow at the face opening of the cabinet. Ensure contaminated air sheaths that are under positive pressure are leak-tight. Never use horizontal laminar-flow hoods or safety cabinets where filtered air is blown across the working area towards the operator. Test cabinets before work begins to ensure they are functioning properly. Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Consider preplacement and periodic medical examinations with emphasis on the oral cavity, bladder, kidneys, skin, and respiratory tract. Conduct urinalysis including specific gravity, albumin, glucose, and microscopic examination of centrifuged sediment for red blood cells. Also, include 14" x 17" chest roentgenogram, FVC + FEV1, and CBC to detect any leukemia or aplastic anemia. It is recommended that this exam be repeated on an annual basis and semiannual basis for employees 45 yr of age or older or with 10 or more years of exposure to coal tar pitch volatiles. Train workers about the hazards of benzo(a)pyrene and the necessary protective measures to prevent exposure. Periodically inspect lab atmospheres, surfaces such as walls, floors, and benches, and interior of fume hoods and air ducts for contamination. Post appropriate signs and labels on doors leading into areas where benzo(a)pyrene is used.

Personal Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent prolonged or repeated skin contact. In animal laboratories, wear protective suits (disposable, one-piece and close-fitting at ankles and wrists), gloves, hair covering, and overshoes. In chemical laboratories, wear gloves and gowns. Wear protective eyeglasses or chemical safety, gas-proof goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Because contact lens use in industry is controversial, establish your own policy.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. The following respirator recommendations are for coal tar pitch volatiles. For any unknown concentration, wear any SCBA with a full facepiece and operated in a pressure- demand or other positive pressure mode, or any supplied-air respirator with a full facepiece and operated in a pressure-demand or other positive pressure mode in combination with an auxiliary SCBA operated in pressure-demand or other positive pressure mode. For escape, wear any air-purifying full facepiece respirator (gas mask) with a chin-style or front- or back-mounted organic vapor canister having a high-efficiency particulate filter, or any appropriate escape-type SCBA. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Shower and change clothes after exposure or at the end of the workshift. Separate contaminated work clothes from street clothes. Launder before reuse. Remove benzo(a)pyrene from your shoes and clean personal protective equipment. Use procedures to ensure laundry personnel are not exposed. Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Pale yellow monoclinic needles with a faint, aromatic odor.

Physical State: Solid

Vapor Pressure (kPa): >1 mm Hg at 68 °F (20 °C)

Formula Weight: 252.30

Specific Gravity (H_2O=1, at 4 °C): 1.351

Boiling Point: >680 °F (>360 °C); 540 °F (310 °C) at 10 mm Hg

Freezing/Melting Point: 354 °F (179 °C)

Water Solubility: Insoluble; 0.0038 mg (+/- 0.00031 mg) in 1 L at 77 °F (25 °C)

Other Solubilities: Ether, benzene, toluene, xylene, concentrated hydrosulfuric acid; sparingly soluble in alcohol, methanol.

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Benzo(a)pyrene is stable at room temperature in closed containers under normal storage and handling conditions. It undergoes photo-oxidation when exposed to sunlight or light in organic solvents and is also oxidized by chromic acid and ozone. Hazardous polymerization cannot occur. Avoid heat and ignition sources and incompatibles.

Storage Incompatibilities: Strong oxidizers (chlorine, bromine, fluorine) and oxidizing chemicals (chlorates, perchlorates, permanganates, and nitrates).

Hazardous Decomposition Products: Thermal oxidative decomposition of benzo(a)pyrene can produce carbon monoxide and carbon dioxide.

Section 11 - Toxicological Information

Acute Oral Effects:

Rat, oral: 15 mg/kg produced gastrointestinal and musculoskeletal tumors.

Irritation Effects:

Mouse: 14 µg caused mild irritation.

Other Effects:

Rat, oral: 40 mg/kg on the 14th day of pregnancy caused changes in the extra embryonic structures.

Rat, oral: 2 g/kg administered 28 days prior to mating and 1-22 days of pregnancy produced a stillbirth.

Tumorgenicity, mouse, oral: 75 mg/kg administered to the female during the 12- 14 day of pregnancy produced biochemical and metabolic effects on the newborn.

Mouse, inhalation: 200 ng/m^3/6 hr administered intermittently over 13 weeks produced tumors of the lungs.

Human, HeLa cell: 1500 nmol/L caused DNA inhibition.

Human, lung cell: 1 µmol/L caused DNA damage.

Human, liver cell: 100 nmol/L caused DNA damage.

Rabbit, skin: 17 mg/kg administered intermittently over 57 weeks produced tumors of the skin and appendages.

See NIOSH, *RTECS* DJ3675000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released to water, benzo(a)pyrene adsorbs very strongly to particulate matter and sediments, bioconcentrates in aquatic organisms which cannot metabolize it, but does not hydrolyze. Direct photolysis at the water surface, evaporation, or biodegradation may be important, but adsorption may significantly retard these processes. Adsorption to particulates may also retard direct photolysis when benzo(a)pyrene is released to air. Benzo(a)pyrene may be removed from air by reaction with nitrogen dioxide (half-life, 7 days) or ozone (half-life, 37 min), or photochemically produced hydroxyl radicals (estimated half-life, 21.49 hr). It will adsorb very strongly to the soil. Although it is not expected to appreciably leach to the groundwater, groundwater samples indicate that it can be transported there. It is not expected to significantly evaporate or hydrolyze from soils and surfaces. However, it may be subject to appreciable biodegradation in soils. It will adsorb very strongly to the soil. Although it is not expected to appreciably leach to the groundwater, groundwater samples indicate that it can be transported there. It is not expected to significantly evaporate or hydrolyze from soils and surfaces. However, it may be subject to appreciable biodegradation in soils.

Ecotoxicity: Oysters, BCF (bioconcentration factor): 3000; rainbow trout, BCF: 920; *Daphnia pulex*, BCF: 13,000.

BCF: Some marine organisms such as phytoplankton, certain zooplankton, scallops (*Placopecten sp*), snails (*Litternia littorea*), and mussels (*Mytilus edulis*) lack a metabolic detoxification enzyme system to metabolize benzo(a)pyrene and therefore, tend to accumulate benzo(a)pyrene. Humic acid in solution may decrease bioconcentration.

Octanol/Water Partition Coefficient: log K_{ow} = 6.04

Section 13 - Disposal Considerations

Disposal: Small quantities: 10 mL of a solution containing 0.3 mol/L of potassium permanganate and 3 mol/L of sulfuric acid will degrade 5 mg of benzo(a)pyrene. Also, can treat with sodium dichromate in strong sulfuric acid (1-2 days). Benzo(a)pyrene is also a good candidate for fluidized bed incineration at a temperature range of 842 to 1796 °F (450 to 980 °C) or rotary kiln incineration at 820 to 1600°C. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Environmentally hazardous substances, solid, n.o.s.*
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: Class 9

Additional Shipping Information: * If it is in a quantity, in one package, which equals or exceeds the reportable quantity (RQ) of 1 lb (0.454 kg).

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U022 Toxic Waste
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001, per CWA Section 307(a) 1 lb (0.454 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Material Safety Data Sheet Collection
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Issue Date: 2002-02

di-sec-Octyl Phthalate
DIE8100

Section 1 - Chemical Product and Company Identification 54

Material Name: di-sec-Octyl Phthalate **CAS Number:** 117-81-7
Chemical Formula: $C_{24}H_{38}O_4$
Structural Chemical Formula: $C_6H_4[COOCH_2CH(C_2H_5)(CH_2)_3]_2$
Synonyms: BEHP; 1,2-BENZENEDICARBOXYLIC ACID,BIS(2-ETHYLHEXYL) ESTER; 1,2-BENZENEDICARBOXYLIC ACID,BIS(ETHYLHEXYL) ESTER; BIS(2-ETHYLHEXYL) 1,2-BENZENEDICARBOXYLATE; BIS(2-ETHYLHEXYL)-1,2-BENZENEDICARBOXYLATE; BIS-(2-ETHYLHEXYL)-1,2-BENZENEDICARBOXYLATE; BIS-(2-ETHYLHEXYL)ESTER KYSELINY FTALOVE; BIS(2-ETHYLHEXYL)ESTER PHTHALIC ACID; BIS(2-ETHYLHEXYL)PHTHALATE; BIS-(2-ETHYLHEXYL)PHTHALATE; BISOFLEX 81; BISOFLEX DOP; COMPOUND 889; DAF 68; DEHP; DI(2-ETHYLHEXYL) PHTHALATE; DI(ETHYLHEXYL) PHTHALATE; DIETHYLHEXYL PHTHALATE; DI(2-ETHYLHEXYL)ORTHOPHTHALATE; DI(2-ETHYLHEXYL)PHTHALATE; DI-2-ETHYLHEXYLPHTHALATE; DI-SEC-OCTYL PHTHALATE; DIOCTYL PHTHALATE; DOF; DOP; ERGOPLAST FDO; ERGOPLAST FDO-S; 2-ETHYLHEXYL PHTHALATE; ETHYLHEXYL PHTHALATE; EVIPLAST 80; EVIPLAST 81; FLEXIMEL; FLEXOL DOP; FLEXOL PLASTICIZER DOP; GOOD-RITE GP 264; HATCOL DOP; HERCOFLEX 260; JAYFLEX DOP; KODAFLEX DOP; MOLLAN O; NUOPLAZ DOP; OCTOIL; OCTYL PHTHALATE; PALATINOL AH; PHTHALIC ACID DIOCTYL ESTER; PHTHALIC ACID,BIS(2-ETHYLHEXYL) ESTER; PITTSBURGH PX-138; PLATINOL AH; PLATINOL DOP; RC PLASTICIZER DOP; REOMOL D 79P; REOMOL DOP; SICOL 150; STAFLEX DOP; TRUFLEX DOP; VESTINOL AH; VINICIZER 80; WITCIZER 312
General Use: Used as a plasticizer for resins, elastomers, vinyl products, films for packaging, containers and electrical cables.
High purity grades used as electrical insulating (dielectric) fluid.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
di-sec-octyl phthalate	117-81-7	>99

OSHA PEL
TWA: 5 mg/m³.

OSHA PEL Vacated 1989 Limits
TWA: 5 mg/m³; STEL: 10 mg/m³.

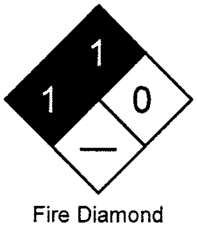
ACGIH TLV
TWA: 5 mg/m³.

NIOSH REL
TWA: 5 mg/m³; STEL: 10 mg/m³.

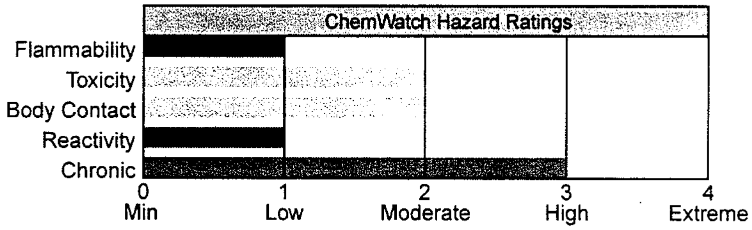
IDLH Level
5000 mg/m³.

DFG (Germany) MAK
TWA: 10 mg/m³; ceiling, substances with systemic effects, onset of effect greater than 2 hours, half-life greater than shift length, strongly cumulative.

Section 3 - Hazards Identification



Fire Diamond



HMIS
0 Health
1 Flammability
0 Reactivity

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Light colored liquid; slight odor. Mildly irritating to eyes/skin/respiratory tract. Also causes: conjunctivitis, keratitis, bronchial irritation, eczema, staggering, abdominal cramps, nausea, diarrhea, CNS depression. Possible cancer hazard.

Potential Health Effects

Target Organs: eyes, upper respiratory system, skin, central nervous system (CNS)
Primary Entry Routes: inhalation, ingestion

Acute Effects

Inhalation: Not normally a hazard due to nonvolatile nature of product. Inhalation hazard is increased at higher temperatures.

The mist is discomforting to the upper respiratory tract.

Inhalation of concentrated mists can cause coughing, sneezing, severe irritation, dizziness, headache and nausea.

Eye: The liquid may produce eye discomfort and is capable of causing temporary impairment of vision and/or transient eye inflammation, ulceration. The mist is moderately discomforting to the eyes.

The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Skin: The liquid is mildly discomforting to the skin if exposure is prolonged and may cause drying of the skin, which may lead to dermatitis.

Irritation and skin reactions are possible with sensitive skin.

The material may accentuate any pre-existing dermatitis condition.

The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.

The liquid is discomforting and is regarded as harmful if swallowed.

Ingestion may result in nausea, abdominal irritation, pain and vomiting.

Phthalates (aromatic dicarboxylic acid esters), in general, exhibit low toxicity, partly because of poor absorption but mainly as a result of rapid metabolism in which the esters are saponified to phthalic acid (which is rapidly excreted) and the parent alcohol (which is subsequently metabolized). The pathology of these compounds seems to be related to the released alcohol and its biological effects. Testicular atrophy produced in rats during feeding studies depends on the length and structure of the alcohol; in general the lower molecular weight esters produce the more severe effects.

The toxicity of phthalic acid isomers decreases in the order o-phthalic acid, isophthalic acid and terephthalic acid.

Phthalic acid is not metabolized but is excreted, unchanged, in the urine and feces.

Terephthalic acid appears to potentiate the biological effects of substances such as antibiotics, thiamine and sulfonamides.

Carcinogenicity: NTP - Class 2B, Reasonably anticipated to be a carcinogen, sufficient evidence of carcinogenicity from studies in experimental animals; IARC - Group 2B, Possibly carcinogenic to humans; OSHA - Not listed; NIOSH - Listed as carcinogen; ACGIH - Class A3, Animal carcinogen; EPA - Class B2, Probable human carcinogen based on animal studies; MAK - Not listed.

Chronic Effects: Oral studies of 90-days to 2-years in rat, 1-year in guinea pig and up to 1-year in dog have shown a no-effect level of about 60 mg/kg/day. Higher doses produced growth retardation and increased weights of livers and kidneys.

Rats and mice fed on diets containing 6000-12000 (rats) and 3000-6000 (mice) mg/kg body weight for 103 weeks showed an increased incidence of hepatocellular carcinomas in female rats and male and female mice, and an increased incidence of either hepatocellular carcinomas or neoplastic nodules in male rats. About 35% of the hepatocellular carcinomas in mice had metastasised to the lungs.

The substance can cause testicular damage in rats (dietary and gavage studies) with a no-effect level in 0.3% to 0.5% in the diet. Inhalation or dermal exposures did not produce testicular effects. When the substance was fed to pregnant rats (5 mL/kg) it produced slight effects on embryonic and fetal development with skeletal abnormalities more common.

A Russian study describes exposure by workers to mixed phthalates (and other plasticizers) - pain, numbness and spasms in the upper and lower extremities were related to duration of exposures. Symptoms usually developed after the sixth or seventh year of work. Neurological studies revealed the development of polyneuritis in about 30% of the workers involved in this study. About 30% of the workforce showed depression of the vestibular receptors. Because the study described mixed exposures it is difficult to determine what, if any, unique role was played by the phthalates.

Increased incidences of anovulatory reproductive cycles and low estrogen concentrations were reported among Russian women working with phthalate plasticizers; the abnormal cycles were associated with spontaneous abortion. The specific phthalates implicated, dose levels and other data were not reported.

It has been alleged that the phthalates mimic or interfere with sex hormones. Phthalates are added as plasticizers in plastics (including food packaging) and are used as ingredients in paints, inks and adhesives. Their potential for entering the human body is marked. They have been added to a list of chemicals (including alkyl phenolics, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs) and dioxins) which are implicated in reducing sperm counts and fertility in males a phenomenon which has apparently arisen since the mid 1960s.

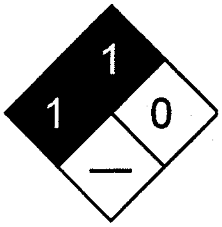
Although the human fetus is "bathed" in naturally occurring estrogens during pregnancy it is suggested that it has developed a protective mechanism against natural estrogens but is not safe from synthetic variants. These tend to accumulate in body fats which sets them apart from the natural product. During early pregnancy, fats are broken down and may flood the body with concentrated pollutants.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.
Eye Contact: Immediately hold eyes open and flush continuously with running water for at least 15 minutes. Ensure irrigation under eyelids.
Seek medical attention without delay.
Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).
Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.
Ingestion: Contact a Poison Control Center.
If more than 15 minutes from a hospital, induce vomiting, preferably using Ipecac Syrup APF.
Note: DO NOT INDUCE VOMITING in an unconscious person.
After first aid, get appropriate in-plant, paramedic, or community medical support.
Note to Physicians: Treat symptomatically.

Section 5 - Fire-Fighting Measures

Flash Point: 215 °C Open Cup
Autoignition Temperature: 391 °C
LEL: 0.3% v/v
Extinguishing Media: Water spray or fog; foam, dry chemical powder, or BCF (where regulations permit).
Carbon dioxide.
General Fire Hazards/Hazardous Combustion Products: Combustible. Slight fire hazard when exposed to heat or flame.
Heating may cause expansion or decomposition leading to violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO).
May emit acrid smoke.
Mists containing combustible materials may be explosive.
Hot organic vapors or mist are capable of sudden spontaneous combustion when mixed with air even at temperatures below their published autoignition temperatures. The temperature of ignition decreases with increasing vapor volume and vapor/air contact times and is influenced by pressure change.
Ignition may occur under elevated-temperature process conditions especially in processes performed under vacuum subjected to sudden ingress of air or in processes performed at elevated pressure, where sudden escape of vapors or mists to the atmosphere occurs.



Fire Diamond

Fire Incompatibility: Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.
Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control fire and cool adjacent area.
Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb spill with sand, earth, inert material or vermiculite.
Wipe up. Place in a suitable labeled container for waste disposal.
Large Spills: Contact fire department and tell them location and nature of hazard.
Clear area of personnel and move upwind.
Shut off all possible sources of ignition and increase ventilation.
Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
Stop leak if safe to do so.
Absorb or cover spill with sand, earth, inert material or vermiculite.
Recover liquid and place in labeled, sealable container for recycling.

Collect residues and seal in labeled drums for disposal.
Wash spill area with detergent and water.
If contamination of drains or waterways occurs, advise emergency services.
After clean-up operations, decontaminate and launder all protective clothing and equipment before storing and reusing.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Use good occupational work practices.
Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.
Use in a well-ventilated area.
Avoid generating and breathing mist and vapor.
Avoid contact with incompatible materials.
Avoid prolonged and repeated skin contact.
Avoid smoking, bare lights or ignition sources.
Avoid physical damage to containers.
Keep containers securely sealed when not in use.
Wear personal protective equipment when handling.
When handling, DO NOT eat, drink or smoke.
Always wash hands with soap and water after handling. Work clothes should be laundered separately.
Recommended Storage Methods: Metal can; metal drum. Packing as recommended by manufacturer.
Check all containers are clearly labeled and free from leaks.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: None under normal operating conditions. OTHERWISE: General exhaust is adequate under normal operating conditions.
If inhalation risk of overexposure exists, wear NIOSH-approved organic-vapor respirator.
If mist is present, use air supplied breathing apparatus.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Barrier cream and Nitrile rubber gloves or Neoprene rubber gloves.
Safety footwear.
Respiratory Protection:
Exposure Range >5 to 50 mg/m^3: Air Purifying, Negative Pressure, Half Mask
Exposure Range >50 to 500 mg/m^3: Air Purifying, Negative Pressure, Full Face
Exposure Range >500 to <5000 mg/m^3: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range 5000 to unlimited mg/m^3: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: dust/mist filter (use P100 or consult supervisor for appropriate dust/mist filter)
Other: Overalls. Eyewash unit.
Glove Selection Index:

BUTYL	Best selection
VITON	Best selection
NITRILE	Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Light-colored, odorless and oily liquid. Mixes with mineral oil and most organic solvents.
Physical State: Liquid
Vapor Pressure (kPa): 0.17 at 200 °C
Vapor Density (Air=1): 13.45
Formula Weight: 390.54
Specific Gravity (H_2O=1, at 4 °C): 0.99 at 20 °C
Water Solubility: < 0.01% at 25 °C
Evaporation Rate: Very Slow
pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 230 °C (446 °F) at 5 mm Hg
Freezing/Melting Point Range: -50 °C (-58 °F)

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Hazardous polymerization will not occur. Stable under normal storage conditions.
Storage Incompatibilities: Avoid storage with oxidizers.

Section 11 - Toxicological Information

TOXICITY
Oral (rat) LD_{50}: 30000 mg/kg
Oral (human) TD_{Lo}: 143 mg/kg
Oral (mouse) LD_{50}: 1500 mg/kg
Oral (rabbit) LD_{50}: 34000 mg/kg
Dermal (rabbit) LD_{50}: 25000 mg/kg
Intraperitoneal (rabbit) LD_{50}: >31 mL/kg
Oral (guinea pig) LD_{50}: 26000 mg/kg
Dermal (g.pig) LD_{50}: 10000 mg/kg
Gastrointestinal changes, respiratory system changes, somnolence, hemorrhage, necrotic changes in GI tract, lowered blood pressure, liver, endocrine tumors, feto toxicity, paternal effects, maternal effects, specific developmental abnormalities (hepatobiliary system, musculoskeletal system, cardiovascular system, urogenital system, central nervous system, eye/ear), fetolethality recorded.
NOTE: Substance has been shown to be mutagenic in various assays, or belongs to a family of chemicals producing damage or change to cellular DNA.

IRRITATION
Skin (rabbit): 500 mg/24 hr mild
Eye (rabbit): 500 mg/24 hr mild

See NIOSH, *RTECS* TI 0350000, for additional data.

Section 12 - Ecological Information

Environmental Fate: In water it will biodegrade (half-life 2-3 wk), adsorb to sediments and bioconcentrate in aquatic organisms. Atmospheric material will be carried long distances and be removed by rain.
Ecotoxicity: LC_{50} Gammarus pseudolimnaeus more than 32 mg/l/96 hr at 21 °C; juvenile /static bioassay; LC_{50} Ictalurus punctatus (channel catfish) more than 100 mg/l/96 hr at 20 °C; wt 1.5 g /static bioassay; EC_{50} Gymnodinium breve growth rate 3.1% vol/vol/96 hr /Conditions of bioassay not specified; LC_{50} Oncorhynchus kisutch (coho salmon) more than 100 mg/l/96 hr at 16 °C; wt 1.5 g /static bioassay; LC_{50} Daphnia magna: 1,000-5,000 ug/l/48 hr /Conditions of bioassay not specified; LC_{50} Chironomus plumosus (Midge): > 18,000 ug/l/48 hr /Conditions of bioassay not specified
Henry's Law Constant: 1×10^{-4}
BCF: fish 2
Biochemical Oxygen Demand (BOD): acclimated < 1 lb/lb, 5 days
Octanol/Water Partition Coefficient: log $K_{OW} = 4.89$
Soil Sorption Partition Coefficient: $K_{OC} = 4$ to 5

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: NONE
Hazard Class: None
ID No.: None
Packing Group: None
Label: No class label assigned

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U028 Toxic Waste
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001, per CWA Section 307(a) 100 lb (45.35 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

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Issue Date: 2003-02

Chrysene
CHR8920

Section 1 - Chemical Product and Company Identification 51/57

Material Name: Chrysene **CAS Number:** 218-01-9
Chemical Formula: $C_{18}H_{12}$
EINECS Number: 205-923-4
Synonyms: BENZO (A) PHENANTHRENE; BENZO[A|PHENANTHRENE; 1,2-BENZOPHENANTHRENE; BENZO(A)PHENANTHRENE; 1,2-BENZPHENANTHRENE; BENZ(A)PHENANTHRENE; CHRYSENE; COAL TAR PITCH VOLATILES: CHRYSENE; 1,2,5,6-DIBENZONAPHTHALENE
Derivation: Distilled from coal tar, coal tar pitch. A small amount is produced from the distillation or pyrolysis of many fats and oils. By heating hydrogen and acetylene. Chrysene is not produced commercially in the U.S. (except as a laboratory research chemical).
General Use: Used in organic synthesis; as a research chemical. Occurs in cigarette smoke.

Section 2 - Composition / Information on Ingredients

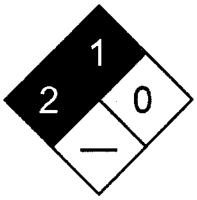
Name	CAS	%
No data found.		

OSHA PEL
TWA: 0.2 mg/m^3.

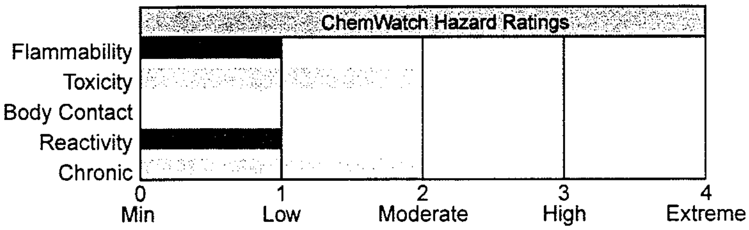
NIOSH REL
No data found.

ACGIH TLV
Exposure by all routes should be carefully controlled to levels as low as possible.

Section 3 - Hazards Identification



Fire Diamond



HMIS
② Health
① Flammability
⓪ Reactivity

ANSI Signal Word
Caution

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Chrysene exists as colorless to white crystals with reddish-blue fluorescence. This poycyclic aromatic hydrocarbon (PAH) is often present in mixtures of PAHs. May be irritating to skin, eyes, and respiratory system. It may be absorbed through the skin. Animal data indicate that chrysene may be cancer-causing in humans. Handle with care. Chrysene is combustible.

Potential Health Effects

Target Organs: Eyes, skin, respiratory system
Primary Entry Routes: Skin absorption
Acute Effects *There is no human evidence available for the acute health effects of chrysene alone. There is, however, considerable data indicating that it is carcinogenic in humans. Based on the chemical properties of chrysene, as a polynuclear aromatic hydrocarbon, the following acute effects may occur.*
Inhalation: May cause irritation.
Eye: . May cause irritation.
Skin: May cause irritation or be absorbed.
Ingestion: None reported.
Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Listed as carcinogen; ACGIH - Class A3, Animal carcinogen; EPA - Class B2, Probable human carcinogen based on animal studies; MAK - Class A2, Unmistakably carcinogenic in animal experimentation only.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: Animal data indicate that chronic exposure to chrysene and other coal tar pitch volatiles probably causes cancer. May also cause respiratory, skin, or eye irritation; cough, bronchitis, photosensitivity, "coal tar warts" (precancerous lesions enhanced by UV light exposure), erythema (skin inflammation), dermal burns, acneiform lesions, hematuria (blood in urine). May alter genetic material. Exposure to PAH's is believed to cause leukoplakia (precancerous patches on the tongue), lip and oral cavity cancers, and bladder cancer.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician or ophthalmologist if pain, irritation, swelling, or photophobia persist.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For high exposures, medical surveillance (skin, mouth, GI tract, respiratory system) may be necessary.

Section 5 - Fire-Fighting Measures

Flash Point: Combustible solid

Autoignition Temperature: None reported.

LEL: None reported.

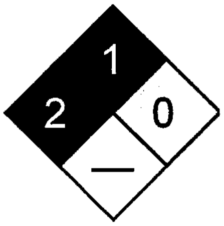
UEL: None reported.

Flammability Classification: Combustible solid

Extinguishing Media: Use water spray, carbon dioxide, dry chemical powder or appropriate foam.

General Fire Hazards/Hazardous Combustion Products: Acrid smoke and fumes, including carbon monoxide and carbon dioxide.

Fire-Fighting Instructions: *Do not* release runoff from fire control methods to sewers or waterways. Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.



Fire Diamond

Section 6 - Accidental Release Measures

Spill/Leak Procedures: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources. Isolate and ventilate area, deny entry, stay upwind. Tag container as defective and return to supplier. Use spark-proof tools and explosion-proof equipment.

Small Spills: *Do not* sweep! Carefully scoop up or vacuum (with a HEPA filter). Absorb liquid spill with an inert, noncombustible absorbent such as sand or vermiculite.

Large Spills: Large spills of chrysene are unlikely. *Do not* release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid dust inhalation and skin and eye contact. Use only with adequate ventilation to maintain concentrations at nonhazardous levels (see Sec. 2). Wear personal protective clothing and equipment to prevent contact with skin and eyes (see Sec. 8). Practice good personal hygiene procedures to prevent inadvertently ingesting this material.

Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Recommended Storage Methods: Store in tightly closed containers in a cool, well-ventilated area away from heat, ignition sources, and incompatibles.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose operations to avoid dust dispersion into the work area. Ventilate at the site of chemical release. To prevent static sparks, electrically ground and bond all containers and equipment. Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PEL (see Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Educate workers about the health and safety hazards associated with this material. Train in work practices which minimize exposure. Consider preplacement and periodic medical exams with emphasis on the skin and lungs.

Personal Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Wear protective eyeglasses or chemical safety goggles, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Air purifying respirators may be adequate for handling small amounts of chrysene in a laboratory setting. For unlimited exposure ranges, wear a pressure-demand, full-face SCBA. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Separate contaminated work clothes from street clothes. Launder clothing separately before reuse. Remove this material from your shoes and clean personal protective equipment. Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless to white rhombic plates with reddish-blue fluorescence.

Physical State: Solid

Vapor Pressure (kPa): 6.3 x10^{-7} mm Hg; 6.3 x10^{-9} mm Hg at 68 °F (20 °C)

Formula Weight: 228.28

Specific Gravity (H_2O=1, at 4 °C): 1.274 at 20 °C/4 °C

Refractive Index: 2610

Boiling Point: 838 °F (448 °C); sublimes easily in a vacuum

Freezing/Melting Point: 489 °F (254 °C) to 496 °F (258 °C)

Ionization Potential (eV): 7.59 +/- 0.2 eV

Water Solubility: Insoluble (0.0018 mg/kg)

Other Solubilities: Slightly soluble in 95% ethanol, acetone, carbon disulfide, ether, glacial acetic acid. Soluble in hot benzene, toluene.

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Chrysene is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Avoid contact with chemical incompatibles, heat and ignition sources.

Storage Incompatibilities: Include strong oxidizers.

Hazardous Decomposition Products: Thermal oxidative decomposition of chrysene can produce acrid smoke and fumes, including carbon monoxide and carbon dioxide.

Section 11 - Toxicological Information

Acute Skin Effects:\
Mouse, skin: 192 µmol/kg produced DNA adducts.\
Mouse, skin, TD_{Lo}: 3600 µg/kg.\
Other Effects:\
Tumorgenicity, mouse, skin: 23 mg/kg; toxic effects: tumorigenic - neoplastic by RTECS criteria; skin and appendages - tumors.\
Human, lymphocyte: 6 µmol/L produced mutation.\
Mouse, intraperitoneal, LD_{50}: >320 mg/kg.\
Tumorigenic Effects: Mouse, skin, 3600 mg/kg for 30 weeks, intermittent; toxic effects: tumorigenic - equivocal tumorigenic agent by RTECS criteria; skin and appendages - tumors.\
Hamster, intraperitoneal: 900 mg/24 hr induced sister chromatid exchange.\
Bacteria, *S typhimurium*: 5 mg/plate (-S9) produced mutation.

See NIOSH, *RTECS* GC0700000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released to water, it will adsorb very strongly to sediments and particulate matter, but will not hydrolyze or appreciably evaporate. It will bioconcentrate in species which lack microsomal oxidase. Calculated BCF: 4,230. K_{ow} indicates bioaccumulation, which could cause food-chain contamination. It will not hydrolyze or appreciably evaporate from soils or surfaces. The estimated biodegradation half-life in soil is 7 years. The estimated half-life of any gas phase in the atmosphere is 1.25 hours as a result of reaction with photochemically produced hydroxyl radicals. It will be subject to near-surface, direct photolysis with a half-life of 4.4 hours computed for exposure to sunlight at mid-day in midsummer at latitude 40°N. If released to air, it will be subject to direct photolysis, although adsorption to particulates may affect the rate of this process. If released to soil it will be expected to adsorb very strongly to the soil and will not be expected to leach appreciably to groundwater.

Ecotoxicity: *Anabaena flos-aquae* (algae), 2 weeks, EC_{35} growth: +/- 0.002 mg/L. *Daphnia magna* (crustaceans), 2 hr, LC_{50}: 1.9 mg/L. *Rana pipiens* (amphibians), 24 hr, LC_{50}: >6.7 mg/L. *Neanthes arenaceodentata* (fishes), 96 hr, LC_{50}: >1 mg/L.

Henry's Law Constant: 9.4×10^{-8}

Octanol/Water Partition Coefficient: $\log K_{ow} = 5.61$ to 5.91

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations. One method is to dissolve or mix the material with a combustible solvent and burn in an incinerator equipped with an afterburner and scrubber. Handle empty containers carefully as hazardous residues may still remain. Triple rinse containers and dispose of wash wastewater appropriately.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Environmentally hazardous substances, solid, n.o.s.*
Hazard Class: 9
ID No.: UN3077
Packing Group: III
Label: CLASS 9

Additional Shipping Information: *If in a quantity in one package which equals or exceeds the final reportable quantity (RQ) of 100 lb (45.4 kg)

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U050 Toxic Waste
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001, per CWA Section 307(a) 100 lb (45.35 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

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Issue Date: 2000-07

Ethylbenzene
MSDS 385
ETH3050

Section 1 - Chemical Product and Company Identification 54.1

Material Name: Ethylbenzene **CAS Number:** 100-41-4
Chemical Formula: C_8H_{10}
Structural Chemical Formula: $C_6H_5 \bullet C_2H_5$
Synonyms: AETHYLBENZOL; BENZENE,ETHYL-; EB; ETHYL BENZENE; ETHYLBENZEEN; ETHYLBENZENE; ETHYLBENZOL; ETILBENZENE; ETYLOBENZEN; PHENYLETHANE
General Use: Used in the manufacture of cellulose acetate, styrene and synthetic rubber; solvent or diluent; component of automotive and aviation gasoline.
Component of many petroleum hydrocarbon solvents, thinners.
The use of a quantity of material in an unventilated or confined space may result in increased exposure and an irritating atmosphere developing. Before starting consider control of exposure by mechanical ventilation.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
ethylbenzene	100-41-4	>95

OSHA PEL
TWA: 100 ppm; 435 mg/m^3.

OSHA PEL Vacated 1989 Limits
TWA: 100 ppm; 435 mg/m^3;
STEL: 125 ppm; 545 mg/m^3.

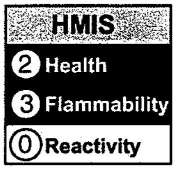
ACGIH TLV
TWA: 100 ppm; 434 mg/m^3;
STEL: 125 ppm; 543 mg/m^3.

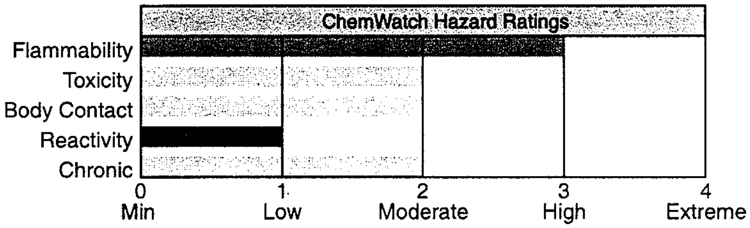
NIOSH REL
TWA: 100 ppm; 435 mg/m^3.
STEL: 125 ppm; 545 mg/m^3.

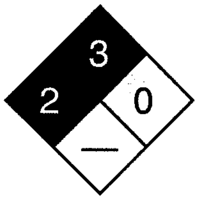
IDLH Level
800 ppm; LEL.

DFG (Germany) MAK
TWA: 100 ppm; 440 mg/m^3.

Section 3 - Hazards Identification







Fire Diamond

ANSI Signal Word
Warning!

Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; pungent odor. Irritating to eyes/skin/respiratory tract. Also causes: chest constriction, vertigo, narcosis, cramps, respiratory paralysis. Chronic: fatigue, sleepiness, headache, blood disorders, lymphocytosis. Flammable.

Potential Health Effects

Primary Entry Routes: inhalation, skin contact, eye contact
Target Organs: eyes, respiratory system, skin, central nervous system (CNS), blood
Acute Effects
Inhalation: The vapor is discomforting to the upper respiratory tract.
Inhalation hazard is increased at higher temperatures.

Acute effects from inhalation of high concentrations of vapor are pulmonary irritation, including coughing, with nausea; central nervous system depression - characterized by headache and dizziness, increased reaction time, fatigue and loss of coordination.

If exposure to highly concentrated solvent atmosphere is prolonged this may lead to narcosis, unconsciousness, even coma and possible death.

Inhalation of vapor may aggravate a pre-existing respiratory condition such as asthma, bronchitis, emphysema.

When humans were exposed to the 100 and 200 ppm for 8 hours about 45-65% is retained in the body. Only traces of unchanged ethyl benzene are excreted in expired air following termination of inhalation exposure.

Humans exposed to concentrations of 23-85 ppm excreted most of the retained dose in the urine (mainly as metabolites).

Guinea pigs that died from exposure had intense congestion of the lungs and generalized visceral hyperemia. Rats exposed for three days at 8700 mg/m^3 (2000 ppm) showed changes in the levels of dopamine and noradrenaline in various parts of the brain.

Eye: The liquid is highly discomforting to the eyes and is capable of causing a mild, temporary redness of the conjunctiva (similar to wind-burn), temporary impairment of vision and/or other transient eye damage/ulceration.

The vapor is discomforting to the eyes.

The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Two drops of the material in to the conjunctival sac produced only slight irritation of the conjunctival membrane but no corneal injury.

Skin: The liquid is discomforting to the skin if exposure is prolonged and is capable of causing skin reactions which may lead to dermatitis.

The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

The mean rate of absorption of liquid ethyl benzene applied to 17.3 cm2 area of the forearm of seven volunteers for 10-15 minutes was determined to be 38 mg/cm2/hr. Immersion of the whole hand in aqueous solutions of ethyl benzene (112-156 mg/l) for 1 hour yielded mean absorption rates of 118 and 215.7 ug/cm2/hr. The rate of absorption is thus greater than that of aniline, benzene, nitrobenzene, carbon disulfide and styrene.

Repeated application of the undiluted product to the abdominal area of rabbits (10-20 applications over 2-4 weeks) resulted in erythema, edema and superficial necrosis. The material did not appear to be absorbed through the skin in sufficient quantity to produce outward signs of toxicity.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.

The liquid may produce considerable gastrointestinal discomfort and may be harmful or toxic if swallowed. Ingestion may result in nausea, pain and vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Class D, Not classifiable as to human carcinogenicity; MAK - Not listed.

Chronic Effects: Chronic solvent inhalation exposures may result in nervous system impairment and liver and blood changes.

Prolonged or continuous skin contact with the liquid may cause defatting with drying, cracking, irritation and dermatitis following.

Industrial workers exposed to a maximum level of ethyl benzene of 0.06 mg/l (14 ppm) reported headaches and irritability and tired quickly. Functional nervous system disturbances were found in some workers employed for over 7 years whilst other workers had enlarged livers.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Lay patient down. Keep warm and rested.

If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.

Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).

Wash affected areas thoroughly with water (and soap if available).

Seek medical attention in event of irritation.

Ingestion: Rinse mouth out with plenty of water. DO NOT induce vomiting.

Observe the patient carefully. Never give liquid to a person showing signs of being sleepy or with reduced awareness; i.e. becoming unconscious.

Give water (or milk) to rinse out mouth. Then provide liquid slowly and as much as casualty can comfortably drink.

Transport to hospital or doctor without delay.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For acute or short-term repeated exposures to petroleum distillates or related hydrocarbons:

1. Primary threat to life from pure petroleum distillate ingestion and/or inhalation is respiratory failure.

2.Patients should be quickly evaluated for signs of respiratory distress (e.g. cyanosis, tachypnea, intercostal retraction, obtundation) and given oxygen. Patients with inadequate tidal volumes or poor arterial blood gases (pO$_2$ <50 mm Hg or pCO$_2$ >50 mm Hg) should be intubated.

3.Arrhythmias complicate some hydrocarbon ingestion and/or inhalation and electrocardiographic evidence of myocardial injury has been reported; intravenous lines and cardiac monitors should be established in obviously symptomatic patients. The lungs excrete inhaled solvents, so that hyperventilation improves clearance

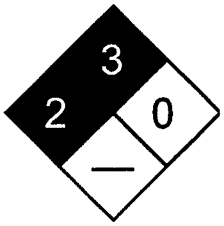
4.A chest x-ray should be taken immediately after stabilization of breathing and circulation to document aspiration and detect the presence of pneumothorax.

5.Epinephrine (adrenalin) is not recommended for treatment of bronchospasm because of potential myocardial sensitization to catecholamines.

Inhaled cardioselective bronchodilators (e.g. Alupent, Salbutamol) are the preferred agents, with aminophylline a second choice.

6.Lavage is indicated in patients who require decontamination; ensure use of cuffed endotracheal tube in adult patients.

Section 5 - Fire-Fighting Measures



Fire Diamond

Flash Point: 12.8 °C Closed Cup

Autoignition Temperature: 432 °C

LEL: 1.6% v/v

UEL: 7% v/v

Extinguishing Media: Foam, dry chemical powder, BCF (where regulations permit), carbon dioxide.

Water spray or fog - Large fires only.

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are flammable.

Moderate fire hazard when exposed to heat or flame.

Vapor forms an explosive mixture with air.

Moderate explosion hazard when exposed to heat or flame.

Vapor may travel a considerable distance to source of ignition.

Heating may cause expansion or decomposition leading to violent rupture of containers.

On combustion, may emit toxic fumes of carbon monoxide (CO).

May emit clouds of acrid smoke.

Fire Incompatibility: Avoid contamination with oxidizing agents i.e. nitrates, oxidizing acids, chlorine bleaches, pool chlorine etc. as ignition may result.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.

May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.

If safe, switch off electrical equipment until vapor fire hazard removed.

Use water delivered as a fine spray to control fire and cool adjacent area.

Avoid spraying water onto liquid pools.

Do not approach containers suspected to be hot.

Cool fire-exposed containers with water spray from a protected location.

If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.

Avoid breathing vapors and contact with skin and eyes.

Control personal contact by using protective equipment.

Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.

Large Spills: Clear area of personnel and move upwind.

Contact fire department and tell them location and nature of hazard.

May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.

No smoking, bare lights or ignition sources. Increase ventilation.

Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.

Use only spark-free shovels and explosion proof equipment.

Collect recoverable product into labeled containers for recycling.

Absorb remaining product with sand, earth or vermiculite.

Collect solid residues and seal in labeled drums for disposal.

Wash area and prevent runoff into drains.

If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid generating and breathing mist. Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights, heat or ignition sources.
When handling, DO NOT eat, drink or smoke.
Vapor may ignite on pumping or pouring due to static electricity.
DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.
Avoid contact with incompatible materials.
Keep containers securely sealed. Avoid physical damage to containers.
Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
Recommended Storage Methods: Metal can; metal drum. Packing as recommended by manufacturer.
Check all containers are clearly labeled and free from leaks.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: CARE: Use of a quantity of this material in confined space or poorly ventilated area, where rapid build-up of concentrated atmosphere may occur, could require increased ventilation and/or protective gear. Use in a well-ventilated area.
General exhaust is adequate under normal operating conditions.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection.
Provide adequate ventilation in warehouse or closed storage areas.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.
Hands/Feet: Barrier cream with polyethylene gloves or Nitrile gloves.
Protective footwear.
Respiratory Protection:
Exposure Range >100 to <800 ppm: Air Purifying, Negative Pressure, Half Mask
Exposure Range 800 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: black
Other: Overalls. Eyewash unit.
Glove Selection Index:

VITON	A
TEFLON	A

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Clear highly flammable liquid; floats on water. Aromatic solvent odor. Soluble in alcohol, benzene, carbon tetrachloride and ether.

Physical State: Liquid
Vapor Pressure (kPa): 1.333 at 25.9 °C
Vapor Density (Air=1): 3.66
Formula Weight: 106.17
Specific Gravity (H_2O=1, at 4 °C): 0.8670 at 20 °C
Water Solubility: 0.01% by weight
Evaporation Rate: Fast
pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 136.2 °C (277 °F) at 760 mm Hg
Freezing/Melting Point Range: -95 °C (-139 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Hazardous polymerization will not occur.

Storage Incompatibilities: Avoid storage with oxidizers.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY	IRRITATION
Oral (rat) LD_{50}: 3500 mg/kg	Skin (rabbit): 15 mg/24h mild
Inhalation (human) TC_{Lo}: 100 ppm/8h	Eye (rabbit): 500 mg - SEVERE
Inhalation (rat) LC_{Lo}: 4000 ppm/4h	
Intraperitoneal (mouse) LD_{50}: 2642 mg/kg~	
Dermal (rabbit) LD_{50}: 17800 mg/kg~	

Liver changes, utheral tract, effects on fertility, specific developmental abnormalities (musculoskeletal system) recorded.

NOTE: Substance has been shown to be mutagenic in various assays, or belongs to a family of chemicals producing damage or change to cellular DNA.

See NIOSH, *RTECS* DA 0700000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released to the atmosphere, it exist predominantly in the vapor phase based on its vapor pressure where it will photochemically degrade by reaction with hydroxyl radicals (half-life 0.5 to 2 days) and partially return to earth in rain. It will not be subject to direct photolysis. Releases into water will decrease in concentration by evaporation and biodegradation. The time for this decrease and the primary loss processes will depend on the season, and the turbulence and microbial populations in the particular body of water. Representative half-lives are several days to 2 weeks. Some may be adsorbed by sediment but significant bioconcentration in fish is not expected to occur based upon its octanol/water partition coefficient. It is only adsorbed moderately by soil. It will not significantly hydrolyze in water or soil.

Ecotoxicity: LC_{50} Cyprinodon variegatus (sheepshead minnow) 275 mg/l 96 hr in a static unmeasured bioassay; LC_{50} Pimephales promelas (fathead minnow) 12.1 mg/l/96 hr (confidence limit 11.5 - 12.7 mg/l), flow-through bioassay with measured concentrations, 26.1 °C, dissolved oxygen 7.0 mg/l, hardness 45.6 mg/l calcium carbonate, alkalinity 43.0 mg/l; Toxicity threshold (cell multiplication inhibition test): Pseudomonas putida (bacteria) 12 mg/l ; LC_{50} Palaemonetes pugio (grass shrimp, adult) 14,400 ug/l/24 hr in a static unmeasured bioassay; LC_{50} Palaemonetes pugio (grass shrimp, larva) 10,200 ug/l/24 hr in a static unmeasured bioassay; Toxicity threshold (cell multiplication inhibition test): Microcystis aeruginosa (algae) 33 mg/l; Scenedesmus quadricauda (green algae) > 160 mg/l

Henry's Law Constant: 8.44×10^{-3}

BCF: goldfish 1.9

Biochemical Oxygen Demand (BOD): theoretical 2.8%, 5 days

Octanol/Water Partition Coefficient: $\log K_{OW} = 3.15$

Soil Sorption Partition Coefficient: $K_{OC} = 164$

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: ETHYLBENZENE
Hazard Class: 3.1
ID No.: 1175
Packing Group: II
Label: Flammable Liquid [3]

Additional Shipping Information: PHENYL ETHANE

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4); per CWA Section 307(a) 1000 lb (453.5 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date:............................1999-11 **Review Date:** 2000-07

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Material Safety Data Sheet Collection

Diesel Fuel Oil No. 2-D **MSDS No. 470**

Date of Preparation: 10/81 Revision: B, 3/98

Section 1 - Chemical Product and Company Identification

Product/Chemical Name: Diesel fuel oil no. 2-D

Chemical Formula: Unspecified or variable

CAS Number: 68334-30-5

Synonyms: automotive diesel oil; diesel fuel; diesel oil (medium); diesel oil no. 2; diesel oil (petroleum); diesel oils; diesel test fuel; fuels, diesel; no. 2 diesel oil; olej napeldowy III (Polish)

Derivation: Fuel oil may be a distilled fraction of petroleum, a residuum from refinery operations, a crude petroleum or a blend of two or more of these.

General Use: This medium viscosity residual fuel oil has both light and heavy grades, and is used in furnaces and boilers of utility and industrial power plants, ships, locomotives, and metallurgical operations.

Vendors: Consult the latest *Chemical Week Buyers' Guide.* (73)

Section 2 - Composition / Information on Ingredients

Diesel fuel oil no. 2-D, ca 100% vol; diesel fuels consist primarily of aliphatic (64% vol), aromatic (35% vol), and olefinic (1-2% vol) hydrocarbons.

Trace Impurities: May contain sulfur (< 0.5), benzene (<100 ppm), and additives such as sulfurized esters.

OSHA PEL
As petroleum distillates
8-hr TWA: 500 ppm (2000 mg/m^3)

ACGIH TLV
As diesel fuel
Notice of impending change (1997):
TWA: 100 mg/m^3, *Skin*

NIOSH REL
As petroleum distillates
10-hr TWA: 350 mg/m^3
Ceiling (15 min): 1800 mg/m^3

IDLH Level
As petroleum distillates
1,100 ppm

DFG (Germany) MAK
None established

Section 3 - Hazards Identification

ANSI Signal Word: Caution

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Diesel fuel oil no. 2-D is a brown, slightly viscous liquid with a kerosene-like odor. It is irritating to the skin and respiratory tract. Inhalation of mist or vapor may result in headache, nausea, vomiting, diarrhea, central nervous system (CNS) depression, tachycardia (rapid heart beat), cyanosis (blue coloration of skin due to oxygen deficiency), pulmonary edema (fluid in the lungs), and liver or kidney injury. Diesel fuel oil no. 2-D is an environmental hazard when spilled. When exposed to heat or flame, this flammable liquid is a fire hazard. When heated to decomposition, diesel fuel oil no. 2-D will emit acrid smoke and irritating vapors.

Wilson Risk Scale
R 1
I 2
S 2*
K 2
*Skin absorption

HMIS
H 1*
F 2
R 0
PPE†
*Chronic effects
†Sec. 8

Potential Health Effects

Primary Entry Routes: Inhalation, ingestion, skin contact/absorption

Target Organs: Skin, CNS, cardiovascular system (CVS), respiratory system, liver, kidneys

Acute Effects

Inhalation: Euphoria, respiratory irritation, cardiac dysrhythmia, increased respiration rates, cyanosis, pulmonary edema, hemoptysis (spitting up blood from the respiratory tract), respiratory arrest, renal (kidney) and liver injury, and CNS toxicity can result from inhalation of diesel fuel oil no. 2-D mist or vapor.

Eye: Contact may result in irritation.

Skin: Contact may cause irritation, systemic effects (see Inhalation), and block the sebaceous (oil) glands, resulting in a rash of acne-like pimples and spots, usually on the arms and legs.

Ingestion: Gastrointestinal irritation, vomiting, diarrhea, and in severe cases, CNS depression progressing to coma and death and other systemic effects (see Inhalation) can result. Aspiration can result in transient CNS depression or excitement, hypoxia, infection, pneumatocele (abnormal cavities in lungs) formation, and chronic lung dysfunction.

Carcinogenicity: IARC lists occupational exposure in petroleum refining as Group 2A (Probable human carcinogen) and distillate light (diesel) fuels as Group 3 (Not classifiable as to carcinogenicity to humans). ACGIH lists a notice of impending change for diesel fuels as TLV-A3 (Animal carcinogen). NTP and OSHA do not list diesel fuel oil no. 2-D as a carcinogen.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: Prolonged or repeated skin contact causes dermatitis and possible systemic toxicity. Prolonged or repeated inhalation can cause CNS and peripheral nervous system damage.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain and/or irritation develops.

Skin Contact: Quickly remove contaminated clothing. Rinse with flooding amounts of water followed by washing the exposed area with soap and water. For reddened or blistered skin, consult a physician.

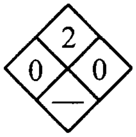
Ingestion: Never give anything by mouth to an unconscious or convulsing person. Have the *conscious and alert* person drink 1 to 2 glasses of water. Contact a poison control center. Because of aspiration risk, *do not* induce vomiting unless the poison control center advises otherwise.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Gastric lavage is contraindicated due to aspiration risk. Instead, consider administration of charcoal or milk. If ingestion amount is large, gastric emptying in the alert patient can be accomplished through administration of Syrup of Ipecac. Treat overexposure symptomatically and supportively.

Section 5 - Fire-Fighting Measures

NFPA



Flash Point: 100.4 °F (38 °C)

Flash Point Method: CC

Autoignition Temperature: 351-624 °F (177-329 °C)

LEL: 1.3% v/v

UEL: 75% v/v

Flammability Classification: OSHA Class II Combustible Liquid

Extinguishing Media: Use dry chemical, carbon dioxide, foam, low velocity water fog or spray. Use a smothering technique to extinguish fire. Water may be ineffective in putting out a fire involving diesel fuel oil no. 2-D, and a solid water stream may spread the flames; however, a water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources.

Unusual Fire or Explosion Hazards: Vapor or mist can form explosive mixtures in air. In still air, the heavier-than-air vapors of diesel fuel oil no. 2-D from a large source may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Containers may explode in heat of fire.

Hazardous Combustion Products: Heating diesel fuel oil no. 2-D to decomposition can produce acrid smoke and irritating vapors.

Fire-Fighting Instructions: *Do not* release runoff from fire control methods to sewers or waterways.

Fire-Fighting Equipment: Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill /Leak Procedures: Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Ground all equipment used when handling this product. *Do not* touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A fire fighting foam may be used to suppress vapors. Absorb or cover with dry earth, sand or other non-combustible material and transfer to containers. Use clean non-sparking tools to collect absorbed material.

Small Spills: Absorb diesel fuel oil no. 2-D with vermiculite, earth, sand or similar material.

Large Spills

Containment: For large spills, consider downwind evacuation of at least 1000 ft (300 m). Dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.

Cleanup: Ground all equipment. Use non-sparking tools. Spills can be absorbed with materials such as peat, activated carbon, polyurethane foam, or straw. Sinking agents, gelling agents, dispersants, and mechanical systems can also be use to treat oil spills.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor or mist inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations to non-hazardous levels (see Sec. 2). Wear protective gloves (or use barrier cream), and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers.

Storage Requirements: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Periodically inspect stored materials. Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.106) for Class II Combustible Liquid.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations.

Ventilation: Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Enclose operations and/or provide local exhaust ventilation appropriately designed for flammable mist and vapor at the site of chemical release. Where possible, transfer diesel fuel oil no. 2-D from drums or other storage containers directly to process containers. Minimize sources of ignition in surrounding low-lying areas.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), use an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets. Wear protective eyeglasses, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Safety Stations: Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Contaminated Equipment: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment.

Comments: Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance and Odor: Brown, slightly viscous; kerosene-like odor
Odor Threshold: 0.7 ppm
Vapor Pressure: < 0.1 mm Hg at 68 °F (20 °C)
Vapor Density (Air=1): > 6
Formula Weight: N/A

Specific Gravity (H_2O=1, at 4 °C): < 0.86
Water Solubility: Insoluble
Boiling Point: 340-676 °F (171-358 °C)
Freezing Point: -29.2 °F (-34 °C)
Viscosity: 1.9-4.1 centistoke at 104 °F (40 °C)
Surface Tension: 23-32 dynes/cm at 68 °F (20 °C)

Section 10 - Stability and Reactivity

Stability: Diesel fuel oil no. 2-D is stable at room temperature in closed containers under normal storage and handling conditions.

Polymerization: Hazardous polymerization cannot occur.

Chemical Incompatibilities: Include strong oxidizing agents.

Conditions to Avoid: Exposure to heat and ignition sources.

Hazardous Decomposition Products: Thermal oxidative decomposition of diesel fuel oil no. 2-D can produce low molecular weight hydrocarbons, hydrocarbon derivatives, carbon oxides (CO_x), and sulfur oxides (SO_x).

Section 11- Toxicological Information

Toxicity Data:*

Acute Oral Effects:
Rat, oral, LD_{50}: 7500 mg/kg

Acute Dermal Effects:
Rabbit, skin, LD: > 5 mL/kg

Skin Effects:
Rabbit, skin, standard Draize test: 500 µL/24 hr, resulted in severe reaction.

Other Multiple Dose Toxicity Data:
Rat, inhalation: 2 g/m^3/6 hr/3 weeks, intermittently, resulted in changes in blood erythrocyte (RBC) count, and focal fibrosis (pneumonoconiosis) and other changes in the lung, thorax or respiration.
Rat, inhalation: 400 µg/m^3/16 hr/2.5 years, intermittently, caused other changes in the blood, and biochemical effects - transaminases.
Rabbit, skin: 80 mL/kg/12 days, continuously, resulted in other changes in the liver, kidney, ureter, and bladder, and death.

* See NIOSH, *RTECS* (HZ1800000), for additional toxicity data.

Section 12 - Ecological Information

Ecotoxicity: Juvenile American shad, salt water TLm: 204 mg/L/24 hr; mallard duck, LD_{50}=20 mg/kg.

Environmental Fate: Diesel fuel oil no. 2-D will evaporate from water or soil. In surface water, it may partition from the water column to suspended sediments.

Environmental Degradation: Biodegradation may occur in soil and water.

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Diesel fuel
Shipping Symbols: D
Hazard Class: 3
ID No.: NA1993
Packing Group: III
Label: None
Special Provisions (172.102): B1

Packaging Authorizations
a) **Exceptions:** 173.150
b) **Non-bulk Packaging:** 173.203
c) **Bulk Packaging:** 173.242

Quantity Limitations
a) **Passenger, Aircraft, or Railcar:** 60 L
b) **Cargo Aircraft Only:** 220 L

Vessel Stowage Requirements
a) **Vessel Stowage:** A
b) **Other:** –

Section 15 - Regulatory Information

EPA Regulations:
Classified as RCRA Hazardous Waste (40 CFR 261.21): Characteristic of Ignitability
RCRA Hazardous Waste Number: D001
Listed as a CERCLA Hazardous Substance (40 CFR 302.4), Unlisted Hazardous Waste, Characteristic of Ignitability per RCRA Sec. 3001
CERCLA Final Reportable Quantity (RQ): 100 lb (45.4 kg)
SARA Toxic Chemical (40 CFR 372.65): Not listed
SARA EHS (Extremely Hazardous Substance) (40 CFR 355): Not listed

OSHA Regulations:
Listed as an Air Contaminant (29 CFR 1910.1000, Table Z-1-A, as petroleum distillates)

Section 16 - Other Information

References: 73, 103, 136, 190, 209, 222, 230, 231

Prepared By................................ HM Spliethoff, MS
Industrial Hygiene Review......... PA Roy, MPH, CIH
Medical Review.......................... T Thoburn, MD, MPH

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Material Safety Data Sheet Collection

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Issue Date: 2003-02

Methanol
MET1440

Section 1 - Chemical Product and Company Identification 51/57

Material Name: Methanol

CAS Number: 67-56-1

Chemical Formula: CH_4O

Structural Chemical Formula: CH_3OH

EINECS Number: 200-659-6

Synonyms: ALCOHOL,METHYL; ALCOOL METHYLIQUE; ALCOOL METILICO; CARBINOL; X-CIDE 402 INDUSTRIAL BACTERICIDE; COAT-B1400; COLONIAL SPIRIT; COLONIAL SPIRITS; COLUMBIAN SPIRIT; COLUMBIAN SPIRITS; EPA PESTICIDE CHEMICAL CODE 053801; EUREKA PRODUCTS CRIOSINE DISINFECTANT; EUREKA PRODUCTS,CRIOSINE; FREERS ELM ARRESTER; IDEAL CONCENTRATED WOOD PRESERVATIVE; METANOL; METANOLO; METHANOL; METHYL ALCOHOL; METHYL HYDRATE; METHYL HYDROXIDE; METHYLALKOHOL; METHYLOL; METYLOWY ALKOHOL; MONOHYDROXYMETHANE; PMC REJEX-IT F-40ME; PYROLIGNEOUS SPIRIT; PYROXYLIC SPIRIT; PYROXYLIC SPIRITS; SURFLO-B17; WILBUR-ELLIS SMUT-GUARD; WOOD ALCOHOL; WOOD NAPHTHA; WOOD SPIRIT

Derivation: Prepared by wood pyrolysis; non-catalytic oxidation of hydrocarbons; as a by-product in the fisher-tropsch synthesis; or by reduction of carbon monoxide.

General Use: Used as an industrial solvent; starting material for organic synthesis; antifreeze for windshield washer fluid; in fuel antifreezes; gasoline octane booster; fuel for stoves; extractant for oils; denaturing ethanol; softening agent; food additive; in paint, varnish removers, and embalming fluids; in the manufacture of photographic film, celluloid, textile soap, wood stains, coated fabrics, shatterproof glass, paper coating, waterproofing formulations, artificial leather, dyes.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
Methanol	67-56-1	ca 100% vol

Trace Impurities: (Grade A): Acetone and aldehydes < 30 ppm, acetic acid < 30 ppm

OSHA PEL
TWA: 200 ppm; 260 mg/m^3.

OSHA PEL Vacated 1989 Limits
TWA: 200 ppm; 260 mg/m^3; STEL: 250 ppm; 325 mg/m^3.

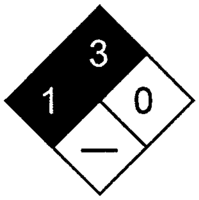
ACGIH TLV
TWA: 200 ppm, 262 mg/m^3; STEL: 250 ppm, 328 mg/m^3; skin.

NIOSH REL
TWA: 200 ppm, 260 mg/m^3; STEL: 250 ppm, 325 mg/m^3; skin.

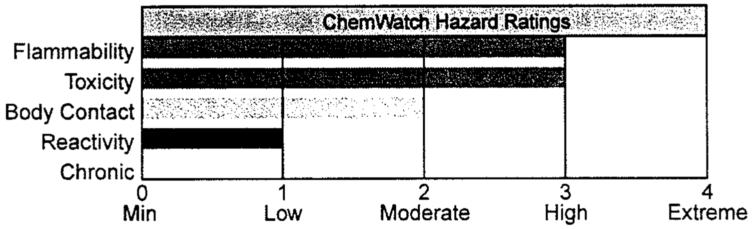
IDLH Level
6000 ppm.

DFG (Germany) MAK
TWA: 200 ppm, 270 mg/m^3; skin, ceiling, substances with systemic effects, onset of effects within 2 hours, half-life two hours to shift length.

Section 3 - Hazards Identification



Fire Diamond



HMIS
② Health
③ Flammability
⓪ Reactivity

ANSI Signal Word
Warning!

Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Methanol is a colorless liquid with a slight alcohol odor when pure, or disagreeably pungent odor when crude. It is irritating to the eyes, skin, and respiratory tract. Exposure may result in headache, visual disturbance, blindness, and respiratory failure. Reproductive effects have been reported in animal testing. This flammable liquid is a moderate explosion hazard. When heated to decomposition, methanol emits carbon oxides (CO_x), formaldehyde, acrid smoke, and irritating fumes.

Potential Health Effects

Target Organs: Eyes, skin, central nervous system (CNS), gastrointestinal (GI) tract, respiratory system

Primary Entry Routes: Inhalation, ingestion, skin and/or eye contact/absorption

Acute Effects

Inhalation: Irritation, breathing difficulty, headache, drowsiness, vertigo, light-headedness, nausea, vomiting, acidosis (decreased blood alkalinity), visual disturbance, and at high concentrations, CNS damage, convulsions, circulatory collapse, respiratory failure, coma and blindness can result from inhalation of methanol vapor. Concentration >= 200 ppm may cause headache; 50,000 ppm can cause death within 1-2 hrs.

Eye: Contact with liquid may result in irritation, inflamed lids, light sensitization, and superficial lesions.

Skin: Contact may cause irritation, dermatitis, swelling, scaling, and systemic effects listed under inhalation.

Ingestion: GI irritation and systemic effects (see Inhalation). Symptoms may be delayed 18-48 hours. Fatal dose - 2 to 8 ounces.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Not listed; MAK - Not listed.

Medical Conditions Aggravated by Long-Term Exposure: None reported.

Chronic Effects: Exposure to methanol vapors has caused conjunctivitis, headache, giddiness, insomnia, GI disturbance, impaired vision. CNS damage is also likely. Methanol is slowly eliminated from the body; exposure is considered cumulative over the short term.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 minutes. Consult a physician or ophthalmologist if pain or irritation develops.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area with soap and water. For reddened or blistered skin, consult a physician.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Follow emesis with rehydration, correction of acidosis, and folate to enhance formate oxidation. Consider IV administration of ethanol (if blood methanol >20 mg/dL) to show metabolic oxidation of methanol. Assay formic acid in urine, blood pH and plasma bicarbonate.

Section 5 - Fire-Fighting Measures

Flash Point: 54 °F (12 °C), Closed Cup

Burning Rate: 1.7 mm/min

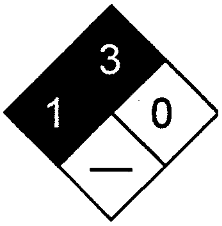
Autoignition Temperature: 867 °F (464 °C)

LEL: 6.0% v/v

UEL: 36% v/v

Flammability Classification: OSHA Class IB Flammable Liquid.

Extinguishing Media: Use dry chemical, carbon dioxide, water spray, fog or alcohol-resistant foam. A water spray may be used to cool fire-exposed containers, and flush spills away from ignition sources.



Fire Diamond

General Fire Hazards/Hazardous Combustion Products: Heating methanol to decomposition can produce carbon oxides (CO_x), formaldehyde, acrid smoke, and irritating fumes. Can form explosive mixtures in the air. The heavier-than-air vapors of methanol may travel along low-lying surfaces to distant sources of ignition and flash back to the material source. Containers may explode in heat of fire.

Fire-Fighting Instructions: *Do not* scatter material with any more water than needed to extinguish fire. *Do not* release runoff from fire control methods to sewers or waterways. Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode.

Section 6 - Accidental Release Measures

Spill/Leak Procedures: Isolate spill area for at least 330-660 feet (100-200 m) in all directions. Fully encapsulating, vapor protective clothing should be worn for spills and leaks with no fire. Eliminate all ignition sources (no smoking, flares, sparks or flames in immediate area). Ground all equipment used when handling this product. *Do not* touch or walk through spilled material. Stop leak if you can do it without risk. Prevent entry into waterways, sewers, basements or confined areas. A vapor suppressing foam may be used to reduce vapors.

Small Spills: Absorb with earth, sand or other non-combustible material and transfer to containers for later disposal. Use clean non-sparking tools to collect absorbed material.

Large Spills: Dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways. Ground all equipment. Use non-sparking tools.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid vapor inhalation, and skin and eye contact. Use only with ventilation sufficient to reduce airborne concentrations to non-hazardous levels (see Sec. 2). Wear protective gloves, goggles, and clothing (see Sec. 8). Keep away from heat and ignition sources. Ground and bond all containers during transfers to prevent static sparks. Use non-sparking tools to open and close containers.

Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Recommended Storage Methods: Store in tightly closed container in cool, well-ventilated area, away from heat, ignition sources and incompatibles (see Sec. 10). Equip drums with self-closing valves, pressure vacuum bungs, and flame arrestors.

Regulatory Requirements: Follow applicable OSHA regulations. Also 29 CFR 1910.106 for Class 1B Flammable Liquids.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: To prevent static sparks, electrically ground and bond all containers and equipment used in shipping, receiving, or transferring operations. Provide general or local exhaust ventilation systems to maintain airborne concentrations as low as possible. Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Enclose operations and/or provide local explosion-proof exhaust ventilation at the site of chemical release. Where possible, transfer methanol from drums or other storage containers to process containers. Minimize sources of ignition in surrounding areas.

Personal Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets of butyl rubber, Teflon, Viton, Saranex, 4H, Responder, Trellchem HPS, or Tychem 10000 (Breakthrough Time (BT) >8 hr) to prevent skin contact. Natural rubber, neoprene, nitrile rubber, polyethylene, polyvinyl alcohol and CPF 3 may degrade after contact and are not recommended. Wear splash-proof chemical safety goggles, and face shield, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/ NIOSH-approved respirator. For concentrations <= 2000 ppm, use a supplied air respirator; <= 5000 ppm, supplied air (SA) respirator in continuous flow mode; <= 6000 ppm, SA respirator with tight-fitting face mask operated in continuous flow mode, or SCBA with full facepiece, or SA respirator with full facepiece; > IDLH/unknown/emergency, SCBA with full facepiece operated in pressure-demand or other positive-pressure mode, or SA respirator with full facepiece operated in pressure-demand or other positive-pressure mode in combination with auxiliary SCBA operated in pressure-demand or other positive-pressure mode. For escape, use an appropriate escape-type SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen- deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Separate contaminated work clothes from street clothes. Launder before reuse. Remove this material from your shoes and clean personal protective equipment. Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Section 9 - Physical and Chemical Properties

Appearance/General Info: Colorless; slight alcohol odor when pure, disagreeably pungent odor when crude.

Physical State: Liquid
Vapor Pressure (kPa): 127 mm Hg at 77 °F (25 °C)
Vapor Density (Air=1): 1.11
Bulk Density: 6.59 lbs/gal at 68 F (20 °C)
Formula Weight: 32.04

Density: 0.796 g/mL at 59 °F (15 °C)
Specific Gravity (H_2O=1, at 4 °C): 0.81 at 0 °C/4 °C
Refractive Index: 1.3292 at 68 °F (20 °C)
pH: Slightly acidic
Boiling Point: 148 °F (64.7 °C) at 760 mm Hg

Freezing/Melting Point: -144.04 °F (-97.8 °C)
Viscosity: 0.614 mPa sec
Surface Tension: 22.61 dynes/cm
Ionization Potential (eV): 10.84 eV
Water Solubility: Miscible
Other Solubilities: Ethanol, acetone, benzene, chloroform, DMSO, ether, ketones, most organic solvents.

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Methanol is stable at room temperature in closed containers under normal storage and handling conditions. Hazardous polymerization cannot occur. Vapor inhalation, oxidizers.

Storage Incompatibilities: Include beryllium dihydride, metals (potassium, magnesium), oxidants (barium perchlorate, bromine, chlorine, hydrogen peroxide, sodium hypochlorite, phosphorus trioxide), potassium tertbutoxide, carbon tetrachloride and metals, chloroform and heat, diethyl zinc, alkyl aluminum salts, acetyl bromide, chloroform and sodium hydroxide, cyanuric chloride, nitric acid, chromic anhydride, lead perchlorate.

Hazardous Decomposition Products: Thermal oxidative decomposition of methanol can produce carbon oxides (CO_x), formaldehyde, acrid smoke, and irritating fumes.

Section 11 - Toxicological Information

Acute Oral Effects:

Rat, oral, LD_{50}: 5628 mg/kg.

Human, oral, LD_{Lo}: 428 mg/kg produced toxic effects: behavioral - headache; lungs, thorax, or respiration - other changes.

Human, oral, LD_{Lo}: 143 mg/kg produced optic nerve neuropathy, dyspnea, nausea or vomiting.

Acute Inhalation Effects:

Rat, inhalation, LC_{50}: 64000 ppm/4 hr.

Human, inhalation, TC_{Lo}: 300 ppm produced visual field changes, headache; lungs, thorax, or respiration - other changes.

Acute Skin Effects:

Rabbit, skin, LD_{50}: 15800 mg/kg.

Monkey, skin, LD_{Lo}: 393 mg/kg.

Irritation Effects:

Rabbit, standard Draize test: 100 mg/24 hr resulted in moderate irritation.

Rabbit, standard Draize test: 20 mg/24 hr resulted in moderate irritation.

Other Effects:

Rat, oral: 10 μmol/kg resulted in DNA damage.

Rat, inhalation: 50 mg/m^3/12 hr/13 weeks intermittently produced degenerative changes to brain and coverings; muscle contraction or spasticity.

Rat, inhalation: 2610 ppm/6 hr/4 weeks intermittently produced toxic effects: endocrine - changes in spleen weight.

Multiple Dose Toxicity Effects - Rat, oral: 12 g/kg/8 weeks intermittently produced toxic effects: behavioral - ataxia; behavioral - alteration of operant conditioning.

Human, lymphocyte: 300 mmol/L resulted in DNA inhibition.

Rat (female), oral: 7500 mg/kg, administered during gestational days 17-19 produced effects on newborn - behavioral.

Rat (female), oral: 35295 mg/kg administered during gestational days 1-15 produced effects on the fertility index; pre implantation mortality; and post-implantation mortality.

Rat (female), inhalation: 20000 ppm/7 hr, administered during gestational days 1-22 produced specific developmental abnormalities - musculoskeletal system; cardiovascular (circulatory) system; urogenital system.

Rat (male), oral: 200 ppm/20 hr, 78 weeks prior to mating produced paternal effects - testes, epididymis, sperm duct.

See NIOSH, *RTECS* PC1400000, for additional data.

Section 12 - Ecological Information

Environmental Fate: Bioconcentration (BCF, estimated at 0.2) is not expected to be significant. Physical removal from air can occur via rainfall. Relatively rapid evaporation from dry surfaces is likely to occur. If released to the atmosphere, it degrades via reaction with photochemically produced hydroxyl radicals with an approximate half-life of 17.8 days. If released to water or soil, biodegradation is expected to occur. A low K_{oc} indicates little sorption and high mobility in the soil column.

Ecotoxicity: Trout, LC_{50}: 8,000 mg/L/48 hr; *Pimephales promelas* (fathead minnow) LC_{50}: 29.4 g/L/96 hr.

Henry's Law Constant: 4.55×10^{-6} atm-m^3/mole at 77 °F (25 °C)

Octanol/Water Partition Coefficient: $\log K_{OW} = -0.77$

Soil Sorption Partition Coefficient: $K_{OC} = 0.44$

Section 13 - Disposal Considerations

Disposal: Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Methanol
Hazard Class: 3
ID No.: UN1230
Packing Group: II
Label: FLAMMABLE LIQUID

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U154 Ignitable Waste
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001 5000 lb (2268 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

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Issue Date: 2003-02

Naphthalene
NAP1620

Section 1 - Chemical Product and Company Identification 50/57

Material Name: Naphthalene **CAS Number:** 91-20-3
Chemical Formula: $C_{10}H_8$
EINECS Number: 202-049-5
Synonyms: ALBOCARBON; CAMPHOR TAR; DEZODORATOR; FAULDING NAPHTHALENE FLAKES; MIGHTY 150; MIGHTY RD1; MOTH BALLS; MOTH FLAKES; MOTHBALLS; NAFTALEN; NAPHTHALENE; NAPHTHALIN; NAPHTHALINE; NAPHTHENE; TAR CAMPHOR; WHITE TAR
Derivation: From coal tar; from petroleum fractions after various catalytic processing operations.
General Use: Used as a moth repellent, an antiseptic, toilet bowl deodorant, heat transfer agent, fungicide, smokeless powder, cutting fluid, lubricant, wood preservative; an intermediate for naphthol, phthalic anhydride, chlorinated naphthalenes, Tertralin, Decalin, naphthyl and naphthol derivatives, and dyes; in synthetic resins, synthetic tanning, textile chemicals, scintillation counters, and emulsion breakers.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
Naphthalene	91-20-3	ca 100% wt.

Grade - By melting point, 165 °F (74 °C) min (crude) to greater than 174 °F (79 °C) (refined); scintillation 176-177 °F (80-81 °C)

OSHA PEL
TWA: 10 ppm; 50 mg/m^3.

OSHA PEL Vacated 1989 Limits
TWA: 10 ppm; 50 mg/m^3; STEL: 15 ppm; 75 mg/m^3.

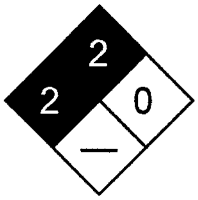
ACGIH TLV
TWA: 10 ppm, 52 mg/m^3; STEL: 15 ppm, 79 mg/m^3; skin.

NIOSH REL
TWA: 10 ppm, 50 mg/m^3; STEL: 15 ppm, 75 mg/m^3.

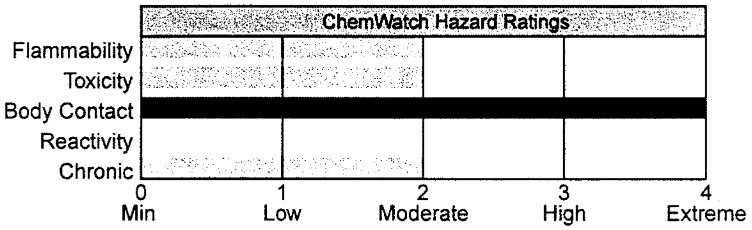
IDLH Level
250 ppm.

DFG (Germany) MAK
Skin

Section 3 - Hazards Identification



Fire Diamond



HMIS
② Health
② Flammability
⓪ Reactivity

ANSI Signal Word
Warning!

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Naphthalene is a white crystalline solid with a 'moth ball' or coal-tar odor. It is toxic by ingestion. Irritating to skin, eyes, and respiratory system. Naphthalene is a combustible solid. Dust may form explosive mixtures in air if subjected to an ignition source.

Potential Health Effects

Target Organs: Blood (red blood cell effects), eyes, skin, central nervous system (CNS), liver and kidneys
Primary Entry Routes: Inhalation, skin absorption, skin and/or eye contact
Acute Effects
Inhalation: Vapor inhalation causes headache, confusion, nausea, sometimes vomiting, loss of appetite, extensive sweating, dysuria (painful urination), hematuria (blood in the urine), and hemolysis (destruction of red blood cells).
Eye: Irritation, conjunctivitis, and corneal injury upon prolonged contact.
Skin: Irritation and hypersensitivity dermatitis.

Ingestion: Unlikely. However, ingestion causes irritation of the mouth and stomach, hemolytic anemia with hepatic and renal lesions and vesical congestion, kidney failure, hematuria, jaundice, depression of CNS, nausea, vomiting, abdominal pain, blue face, lips, or hands, rapid and difficult breathing, headache, confusion, excitement, malaise, fever, perspiration, urinary tract pain, dizziness, convulsions, coma, and death. Symptoms may appear 2 to 4 hours after exposure.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Class A4, Not classifiable as a human carcinogen; EPA - Class D, Not classifiable as to human carcinogenicity; MAK - Not listed.

Medical Conditions Aggravated by Long-Term Exposure: Diseases of the blood, liver and kidneys; individuals with a hereditary deficiency of the enzyme glucose-6-phosphate dehydrogenase in red blood cells are particularly susceptible to the hemolytic properties of naphthalene metabolites.

Chronic Effects: May cause optical neuritis, corneal injuries, cataracts, kidney damage. There are two reports of naphthalene crossing the placenta in humans.

Section 4 - First Aid Measures

Inhalation: Remove exposed person to fresh air and support breathing as needed. Contact a physician immediately if symptoms of systemic poisoning are present.

Eye Contact: *Do not* allow victim to rub or keep eyes tightly shut. Gently lift eyelids and flush immediately and continuously with flooding amounts of water for at least 15 min. Consult a physician or ophthalmologist if pain, irritation, swelling, or photophobia persist.

Skin Contact: *Quickly* remove contaminated clothing. Rinse with flooding amounts of water for at least 15 min. Wash exposed area thoroughly with soap and water. For reddened or blistered skin, consult a physician. Contact a physician immediately if symptoms of systemic poisoning are present.

Ingestion: Never give anything by mouth to an unconscious or convulsing person. Contact a poison control center. Unless the poison control center advises otherwise, have the *conscious and alert* person drink 1 to 2 glasses of water, then induce vomiting. Contact a physician immediately.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Obtain baseline CBC, electrolytes, liver and renal function rests, glucose-6-phosphatase dehydrogenase level, urinalysis, and benzidine dipstick to check for hemoglobinuria. Urinary metabolite, 1-naphthol or mercapturic acid, may help confirm the diagnosis.

Section 5 - Fire-Fighting Measures

Flash Point: 174 °F (79 °C) OC; 190 °F (88 °C) CC

Autoignition Temperature: 979 °F (526 °C)

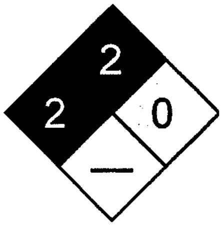
LEL: 0.9% v/v

UEL: 5.9% v/v

Flammability Classification: Combustible solid

Extinguishing Media: Use dry chemical, foam, carbon dioxide (CO_2), or water spray. Water or foam may cause frothing. Use water spray to keep fire-exposed containers cool.

General Fire Hazards/Hazardous Combustion Products: Toxic vapors including carbon monoxide. Volatile solid that gives off flammable vapors when heated. Dust may explode in air if an ignition source is provided.



Fire Diamond

Fire-Fighting Instructions: Move containers from the fire area if it can be done without risk. Otherwise cool fire-exposed containers until well after the fire is extinguished. *Do not* release runoff from fire control methods to sewers or waterways. Because fire may produce toxic thermal decomposition products, wear a self-contained breathing apparatus (SCBA) with a full facepiece operated in pressure-demand or positive-pressure mode. Wear full protective clothing (see Sec. 8). Structural clothing is permeable, remain clear of smoke, water fall out, and water run off.

Section 6 - Accidental Release Measures

Spill/Leak Procedures: Notify safety personnel, evacuate all unnecessary personnel, remove heat and ignition sources. Isolate and ventilate area, deny entry, stay upwind. Stop leak if you can do it without risk. Use spark-proof tools and explosion proof equipment. Cleanup personnel should wear personal protective equipment to protect against exposure (see Sec. 8).

Small Spills: *Do not* sweep! Carefully scoop up or vacuum (with a HEPA filter). Absorb liquid spill with an inert, noncombustible absorbent such as sand or vermiculite.

Large Spills: For large spills, dike far ahead of liquid spill for later disposal. *Do not* release into sewers or waterways.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: To avoid vapor inhalation use only with ventilation sufficient to reduce airborne concentrations to nonhazardous levels. Avoid skin and eye contact. Wear personal protective clothing and equipment to prevent any contact with skin and eyes (see Sec. 8). Practice good personal hygiene procedures to prevent inadvertently ingesting this material.

Never eat, drink, or smoke in work areas. Practice good personal hygiene after using this material, especially before eating, drinking, smoking, using the toilet, or applying cosmetics.

Recommended Storage Methods: Store in tightly closed, explosion-proof containers in a cool, well-ventilated area away from heat, ignition sources, and incompatibles (see Sec. 10). May be stored under nitrogen gas. Protect containers against physical damage. Use monitoring equipment to measure the extent of vapor present in any storage facility containing naphthalene because of potential fire and explosion hazards.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Where feasible, enclose operations to avoid vapor and dust dispersion into the work area. Ventilate at the site of chemical release. During the fractional distillation of naphthalene and in any operation entailing the heating or volatilization of naphthalene, enclosed apparatus should be employed. Provide general or local exhaust ventilation systems to maintain airborne concentrations below OSHA PELs (Sec. 2). Local exhaust ventilation is preferred because it prevents contaminant dispersion into the work area by controlling it at its source.

Administrative Controls: Educate workers about the health and safety hazards associated with naphthalene. Train in work practices which minimize exposure. Consider preplacement and periodic medical exams with emphasis on the eyes, skin, liver, kidneys, CBC (RBC count, WBC count, differential count of a stained smear, hemoglobin, and hematocrit), and urinalysis including at a minimum specific gravity, albumin, glucose, and a microscopic examination on centrifuged sediment.

Personal Protective Clothing/Equipment: Wear chemically protective gloves, boots, aprons, and gauntlets to prevent skin contact. Teflon is recommended. *Do not* use butyl rubber, natural rubber, neoprene or polyvinyl chloride. Wear chemical dust-proof safety goggles and face shield, per OSHA eye- and face-protection regulations (29 CFR 1910.133). Contact lenses are not eye protective devices. Appropriate eye protection must be worn instead of, or in conjunction with contact lenses.

Respiratory Protection: Seek professional advice prior to respirator selection and use. Follow OSHA respirator regulations (29 CFR 1910.134) and, if necessary, wear a MSHA/NIOSH-approved respirator. Select respirator based on its suitability to provide adequate worker protection for given working conditions, level of airborne contamination, and presence of sufficient oxygen. For emergency or nonroutine operations (cleaning spills, reactor vessels, or storage tanks), wear an SCBA. *Warning! Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.* If respirators are used, OSHA requires a written respiratory protection program that includes at least: medical certification, training, fit-testing, periodic environmental monitoring, maintenance, inspection, cleaning, and convenient, sanitary storage areas.

Other: Separate contaminated work clothes from street clothes. Launder before reuse. Remove naphthalene from your shoes and clean personal protective equipment. Make emergency eyewash stations, safety/quick-drench showers, and washing facilities available in work area.

Section 9 - Physical and Chemical Properties

Appearance/General Info: White volatile flakes, cakes, cubes, spheres, or powder; strong coal-tar or moth ball odor.

Physical State: Crystalline solid

Odor Threshold: 0.084 ppm to 0.3 ppm

Vapor Pressure (kPa): 0.05 mm Hg at 68 °F (20 °C); 1.0 mm Hg at 127 °F (53 °C)

Formula Weight: 128.2

Density: 1.145 g/cm^3 at 68 °F (20 °C)

Boiling Point: 424 °F (218 °C)

Freezing/Melting Point: 176 °F (80.2 °C)

Water Solubility: Insoluble [31.7 mg/L at 68 °F (20 °C)]

Other Solubilities: Benzene, absolute alcohol; very soluble in ether, chloroform, carbon disulfide, hydronaphthalenes, fixed and volatile oils

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Naphthalene is stable at room temperature in closed containers under normal storage and handling conditions. It volatilizes at room temperature. Hazardous polymerization cannot occur. Exposure to heat and ignition sources, incompatibles.

Storage Incompatibilities: Include aluminum chloride, benzoyl chloride, chromic acid, chromium trioxide, oxidizers. Explosive reaction with dinitrogen pentaoxide. Melted naphthalene will attack some forms of plastics.

Hazardous Decomposition Products: Thermal oxidative decomposition of naphthalene can produce toxic fumes including carbon monoxide.

Section 11 - Toxicological Information

Acute Oral Effects:\
Rat, oral, LD_{50}: 490 mg/kg.\
Mouse, oral, LD_{50}: 533 mg/kg.\
Human (child), oral, LD_{Lo}: 100 mg/kg.\
Acute Inhalation Effects:\
Rat, inhalation, LC_{50}: >340 mg/m^3 produced lacrimation and somnolence.\
Irritation Effects:\
Rabbit, eye, standard Draize test: 100 mg produced mild irritation.\
Rabbit, skin, open Draize test: 495 mg produced mild irritation.\
Other Effects:\
Rat, oral: 4500 mg/kg administered on gestational days 6-15 produced fetotoxicity and other developmental abnormalities. \
Man, unreported, LD_{Lo}: 74 mg/kg.\
Mouse, inhalation: 30 ppm/6 hr/2 yr administered intermittently produced toxic effects: tumorigenic - neoplastic by RTECS criteria; lungs, thorax, or respiration - tumors.\
Hamster, ovary: 15 mg/L induced sister chromatid exchange.

See NIOSH, *RTECS* QJ0525000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released to the atmosphere, naphthalene rapidly photodegrades with a half-life of 3-8 hr. Volatilization, photolysis, adsorption, and biodegradation are important loss mechanisms for naphthalene discharged into water. Depending on local conditions, the half-lives range from a couple of days to a few months. If released on land, it is adsorbed moderately to soil, undergoes biodegradation; but in some cases biodegradation may still occur if conditions are aerobic. Bioconcentration occurs to a moderate extent, but is a temporary problem since depuration and metabolism readily proceed in aquatic organisms.

Ecotoxicity: *Oncorhynchus gorbuscha* (pink salmon): 1.37 ppm/96 hr at 39 °F (4 °C). *Pimephales promelas* (fathead minnow): 7.76 mg/L/24 hr.

Octanol/Water Partition Coefficient: log $K_{OW} = 3.30$

Section 13 - Disposal Considerations

Disposal: Consider rotary kiln or fluidized bed incineration. Contact your supplier or a licensed contractor for detailed recommendations. Follow applicable Federal, state, and local regulations. Handle empty containers carefully as hazardous residues may still remain.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: Naphthalene, crude or
Naphthalene, refined
Hazard Class: 4.1
ID No.: UN1334
Packing Group: III
Label: FLAMMABLE SOLID

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U165 Toxic Waste
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4), per RCRA Section 3001, per CWA Section 307(a) 100 lb (45.35 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

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Issue Date: 2002-02

n-Hexane
HEX6400

Section 1 - Chemical Product and Company Identification

54

Material Name: n-Hexane **CAS Number:** 110-54-3
Chemical Formula: C_6H_{14}
Structural Chemical Formula: $H_3C(CH_2)_4CH_3$
Synonyms: DIPROPYL; ESANI; GETTYSOLVE-B; HEKSAN; HEXANE; N-HEXANE; N-HEXANE; HEXANEN; HEXYL HYDRIDE; NORMAL HEXANE; NORMAL-HEXANE; SKELLYSOLVE-B; SKELLYSOLVE B
General Use: An incidental component of many aliphatic solvent mixes used as lacquer, paint and enamel thinners, also in ink reducers and cleaning solvents.
Also used for solvent extraction of oil seeds and in pesticide residue analysis and gas chromatography.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
n-hexane	110-54-3	> 95

OSHA PEL
TWA: 500 ppm; 1800 mg/m^3.

OSHA PEL Vacated 1989 Limits
TWA: 50 ppm; 180 mg/m^3.

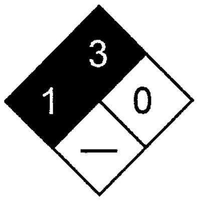
ACGIH TLV
TWA: 50 ppm, 176 mg/m^3; skin.

NIOSH REL
TWA: 50 ppm, 180 mg/m^3.

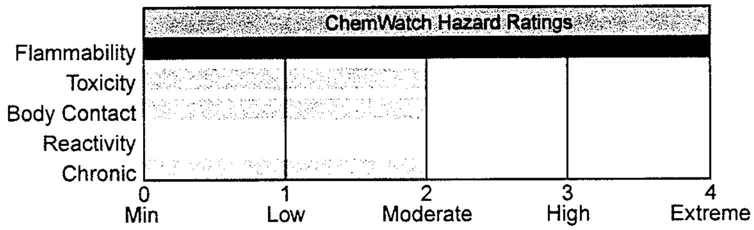
IDLH Level
1100 ppm; 10% LEL.

DFG (Germany) MAK
TWA: 50 ppm, 180 mg/m^3; PEAK: 400 ppm, 1440 mg/m^3; skin, ceiling, substances with systemic effects, onset of effect within 2 hours.

Section 3 - Hazards Identification



Fire Diamond



HMIS
2 Health
3 Flammability
0 Reactivity

ANSI Signal Word
Danger!

Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless, volatile liquid; sweet/gasoline odor. Irritating to eyes/skin/respiratory tract. Also causes: dizziness, fatigue, muscle weakness, hallucinations. Chronic: peripheral neuropathy (muscle weakness, motor loss, sensory disturbances). Flammable.

Potential Health Effects

Target Organs: eyes, skin, respiratory system, central nervous system (CNS), peripheral nervous system
Primary Entry Routes: inhalation, skin contact/absorption, eyes, ingestion
Acute Effects
Inhalation: The vapor is discomforting and harmful to the upper respiratory tract.
Acute effects from inhalation of high concentrations of vapor are pulmonary irritation, including coughing, with nausea; central nervous system depression - characterized by headache and dizziness, increased reaction time, fatigue and loss of coordination.
If exposure to highly concentrated solvent atmosphere is prolonged this may lead to narcosis, unconsciousness, even coma and possible death.
Eye: The liquid is highly discomforting to the eyes and is capable of causing a mild, temporary redness of the conjunctiva (similar to wind-burn), temporary impairment of vision and/or other transient eye damage/ulceration.
The vapor is irritating to the eyes and may cause smarting, painand redness.

The material may be irritating to the eye, with prolonged contact causing inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Skin: The liquid is discomforting to the skin and is capable of causing skin reactions which may lead to dermatitis. Toxic effects may result from skin absorption.

Ingestion: The liquid is highly discomforting and harmful if swallowed.
Ingestion may result in nausea, pain, vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.
Considered an unlikely route of entry in commercial/industrial environments.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Not listed; MAK - Not listed.

Chronic Effects: Chronic inhalation or skin exposure to n-hexane may cause peripheral neuropathy, which is damage to nerve ends in extremities, e.g. fingers, with loss of sensation and characteristic thickening. Nerve damage has been documented with chronic exposures of greater than 500 ppm.
Improvement in condition does not immediately follow removal from exposure and symptoms may progress for two or three months. Recovery may take a year or more depending on severity of exposure, and may not always be complete.
Exposure to n-hexane with methyl ethyl ketone (MEK) will accelerate the appearance of damage, but MEK alone will not cause the nerve damage.
Other isomers of hexane do not cause nerve damage.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.
Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).
Wash affected areas thoroughly with water (and soap if available).
Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center.
Do NOT induce vomiting. Give a glass of water.

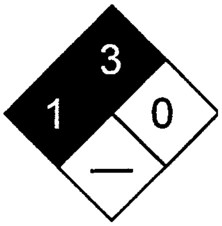
After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Following acute or short-term repeated exposures to n-hexane:
1.Large quantities of n-hexane are expired by the lungs after vapor exposure (50-60%). Humans exposed to 100 ppm demonstrate an n-hexane biological half life of 2 hours.
2. Initial attention should be directed towards evaluation and support of respiration. Cardiac dysrhythmias are a potential complication.
INGESTION:
1.Ipecac syrup should be considered for ingestion of pure hexane exceeding 2-3 mL/kg. Extreme caution must be taken to avoid aspiration since small amounts of n-hexane intratracheally, produce a severe chemical pneumonitis
BIOLOGICAL EXPOSURE INDEX - BEI
BEIs represent the levels of determinants which are most likely to be observed in specimens collected in a healthy worker who has been exposed to chemicals to the same extent as a worker with inhalation exposure to the Exposure Standard (ES or TLV):

Determinant	Index	Sampling Time	Comments
2,5-hexanedione in urine	5 mg/gm creatinine	End of shift	NS
n-Hexane in end-exhaled air			SQ

NS: Non-specific determinant; Metabolite observed following exposure to other materials.
SQ: Semi-quantitative determinant; Interpretation may be ambiguous - should be used as a screening test or confirmatory test.

Section 5 - Fire-Fighting Measures



Fire Diamond

Flash Point: -22 °C

Autoignition Temperature: 225 °C

LEL: 1.1% v/v

UEL: 7.5% v/v

Extinguishing Media: Dry chemical powder. Foam.

Carbon dioxide.

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable.

Severe fire hazard when exposed to heat, flame and/or oxidizers.

Vapor forms an explosive mixture with air.

Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition.

Heating may cause expansion/decomposition with violent rupture of containers.

On combustion, may emit toxic fumes of carbon monoxide (CO). May emit clouds of acrid smoke.

Fire Incompatibility: Avoid reaction with oxidizing agents.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.

May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.

Fight fire from a safe distance, with adequate cover.

If safe, switch off electrical equipment until vapor fire hazard removed.

Use water delivered as a fine spray to control the fire and cool adjacent area. Avoid spraying water onto liquid pools.

Do not approach containers suspected to be hot.

Cool fire-exposed containers with water spray from a protective location.

If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.

Avoid breathing vapors and contact with skin and eyes.

Control personal contact by using protective equipment.

Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.

Large Spills: Pollutant - clear area of personnel and move upwind.

Contact fire department and tell them location and nature of hazard.

May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.

No smoking, bare lights or ignition sources. Increase ventilation.

Stop leak if safe to do so.

Water spray or fog may be used to disperse/absorb vapor.

Contain spill with sand, earth or vermiculite.

Use only spark-free shovels and explosion proof equipment.

Collect recoverable products into labeled containers for recycling.

Absorb remaining product with sand, earth or vermiculite.

Collect solid residues and seal in labeled drums for disposal.

Wash area and prevent runoff into drains.

If contamination of drains or waterways occurs, advise emergency services.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid generating and breathing mist. Avoid all personal contact, including inhalation.

Wear protective clothing when risk of exposure occurs.

Use in a well-ventilated area. Prevent concentration in hollows and sumps.

DO NOT enter confined spaces until atmosphere has been checked.

Avoid smoking, bare lights, heat or ignition sources.

When handling, DO NOT eat, drink or smoke.

Vapor may ignite on pumping or pouring due to static electricity.

DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.

Avoid contact with incompatible materials.

Keep containers securely sealed. Avoid physical damage to containers.

Always wash hands with soap and water after handling.

Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
Avoid concurrent exposure to materials containing Methyl Ethyl Ketone MEK

Recommended Storage Methods: Metal can; metal drum. Packing as recommended by manufacturer.
Check all containers are clearly labeled and free from leaks.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area.
General exhaust is adequate under normal operating conditions.
Local exhaust ventilation may be required in specific circumstances.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection.
Provide adequate ventilation in warehouse or closed storage areas.

Personal Protective Clothing/Equipment

Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Polyethylene gloves. Wear chemical protective gloves, eg. PVC.
Wear safety footwear.
Do NOT use this product to clean the skin.

Respiratory Protection:
Exposure Range >500 to <1100 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask
Exposure Range 1100 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Note: poor warning properties

Other: Overalls. Eyewash unit. Barrier cream. Skin cleansing cream.

Glove Selection Index:

PE/EVAL/PE	Best selection
PVA	Best selection
SARANEX-23 2-PLY	Best selection
VITON	Best selection
VITON/CHLOROBUTYL	Best selection
TEFLON	Satisfactory; may degrade after 4 hours continuous immersion
NITRILE	Satisfactory; may degrade after 4 hours continuous immersion
NEOPRENE	Poor to dangerous choice for other than short-term immersion
NEOPRENE/NATURAL	Poor to dangerous choice for other than short-term immersion
NITRILE+PVC	Poor to dangerous choice for other than short-term immersion
PVC	Poor to dangerous choice for other than short-term immersion
BUTYL	Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Clear highly flammable liquid with typical paraffinic odor; floats on water. Mixes with most other organic solvents, chloroform, ether, alcohol. A very volatile liquid, it readily forms explosive vapor /air mixes.

Physical State: Liquid
Vapor Pressure (kPa): 13.33
Vapor Density (Air=1): 2.97
Formula Weight: 86.17
Specific Gravity (H_2O=1, at 4 °C): 0.6603 at 20 °C
Water Solubility: 0.002% by weight
pH: Not applicable

pH (1% Solution): Not applicable
Boiling Point Range: 68.89 °C (156 °F)
Freezing/Melting Point Range: -100 °C (-148 °F) to -95 °C (-139 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization/Conditions to Avoid: Presence of heat source and ignition source. Hazardous polymerization will not occur.

Storage Incompatibilities: Avoid storage with oxidizers.

Section 11 - Toxicological Information

TOXICITY	IRRITATION
Oral (rat) LD_{50}: 28710 mg/kg	Eye (rabbit): 10 mg - mild
Inhalation (human) TC_{Lo}: 190 ppm/8W	
Inhalation (rat) LD_{50}: 48000 ppm/4h	

See NIOSH, *RTECS* MN9275000, for additional data.

Section 12 - Ecological Information

Environmental Fate: Photolysis, hydrolysis or bioconcentration are not expected to be an important environmental fate processes. Biodegradation may occur in soil and water; however, volatilization and adsorption are expected to be far more important fate processes. A K_{oc} range of 1250 to 4100 indicates a low to slight mobility class in soil. In aquatic systems it may partition from the water column to organic matter contained in sediments and suspended materials. A Henry's Law constant of 1.81 atm-cu m/mole at 25 °C suggests rapid volatilization from environmental waters. The volatilization half-lives from a model river and a model pond, the latter considers the effect of adsorption, have been estimated to be 2.7 hr and 6.8 days, respectively. It is expected to exist entirely in the vapor-phase in ambient air. Reactions with photochemically produced hydroxyl radicals in the atmosphere have been shown to be important (average estimated half-life of 2.9 days). Data also suggests that nighttime reactions with nitrate radicals may contribute to atmospheric transformation, especially in urban environments.

Ecotoxicity: No data found.

Henry's Law Constant: calculated at 1.81

BCF: estimated at 2.24 to 2.89

Biochemical Oxygen Demand (BOD): theoretical 0%, 7 days

Octanol/Water Partition Coefficient: log K_{ow} = 4.11

Soil Sorption Partition Coefficient: K_{oc} = estimated at 1250 to 4100

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: HEXANES
Hazard Class: 3.1
ID No.: 1208
Packing Group: II
Label: Flammable Liquid[3]

Additional Shipping Information: METHYLPENTANES

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Listed per RCRA Section 3001 5000 lb (2268 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Disclaimer: Judgments as to the suitability of information herein for the purchaser's purposes are necessarily the purchaser's responsibility. Although reasonable care has been taken in the preparation of such information, Genium Publishing Corporation extends no warranties, makes no representations, and assumes no responsibility as to the accuracy or suitability of such information for application to the purchaser's intended purpose or for consequences of its use.

Material Safety Data Sheet Collection
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Nitric Acid
MSDS 7
NIT1080

Section 1 - Chemical Product and Company Identification 54.1

Material Name: Nitric Acid **CAS Number:** 7697-37-2
Chemical Formula: HNO_3
Structural Chemical Formula: HNO_3
Synonyms: ACIDE NITRIQUE; ACIDO NITRICO; AQUA FORTIS; AZOTIC ACID; AZOTOWY KWAS; ENGRAVER'S ACID; ENGRAVERS ACID; HYDROGEN NITRATE; KYSELINA DUSICNE; NITAL; NITRIC ACID; NITRIC ACID OTHER THAN RED FUMING WITH >70% NITRIC ACID; NITRIC ACID OTHER THAN RED FUMING WITH NOT >70% NITRICACID; NITROUS FUMES; NITRYL HYDROXIDE; RED FUMING NITRIC ACID (RFNA); SALPETERSAURE; SALPETERZUUROPLOSSINGEN; WHITE FUMING NITRIC ACID (WFNA)
General Use: Manufacture of organic and inorganic nitrates and nitro compounds for fertilizers, dye intermediates and many organic chemicals.
Used for etching and cleaning metals.
Operators should be trained in procedures for safe use of this material.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
nitric acid	7697-37-2	>95

OSHA PEL
TWA: 2 ppm; 5 mg/m^3.

OSHA PEL Vacated 1989 Limits
TWA: 2 ppm; 5 mg/m^3; STEL: 4 ppm; 10 mg/m^3.

ACGIH TLV
TWA: 2 ppm; 5.2 mg/m^3; STEL: 4 ppm; 10 mg/m^3.

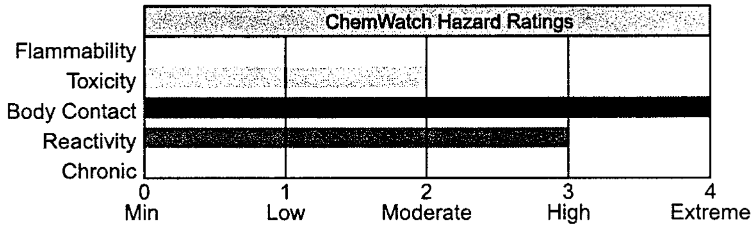
NIOSH REL
TWA: 2 ppm; 5 mg/m^3. STEL: 4 ppm; 10 mg/m^3.

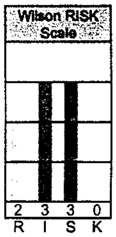
IDLH Level
25 ppm.

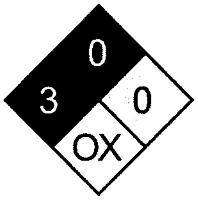
DFG (Germany) MAK
TWA: 2 ppm; 5 mg/m^3.

Section 3 - Hazards Identification

HMIS
③ Health
⓪ Flammability
⓪ Reactivity







Fire Diamond

ANSI Signal Word
Danger!


Corrosive

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Clear to yellow fuming liquid; acrid, suffocating odor. Corrosive, causes severe burns to eyes/skin/respiratory tract. Also causes: heavy exposures: lung damage. Chronic: tooth erosion, bronchitis. Strong oxidizer capable of igniting combustibles.

Potential Health Effects

Primary Entry Routes: inhalation, ingestion, skin contact, eye contact
Target Organs: eyes, skin, respiratory system, teeth

Acute Effects

Inhalation: The vapor is extremely discomforting and corrosive to the upper respiratory tract and lungs and the material presents a hazard from a single acute exposure or from repeated exposures over long periods.
Inhalation hazard is increased at higher temperatures.
Reactions may occur following a single acute exposure or may only appear after repeated exposures.
Reactions may not occur on exposure but response may be delayed with symptoms only appearing many hours later.
The material may produce respiratory tract irritation which produces an inflammatory response involving the recruitment and activation of many cell types, mainly derived from the vascular system. Unlike most organs the lung can respond to a chemical insult or agent by first trying to remove or neutralize the irritant and then repairing the damage. The repair process, which initially developed to protect mammalian lungs from foreign matter and antigens, may however, cause further damage the lungs when activated by hazardous chemicals. The result is often the impairment of gas exchange, the primary function of the lungs.
Inhalation of nitric acid mist or fumes at 2 to 25 ppm over an 8 hour period may cause pulmonary irritation and symptoms of lung damage.
Only several minutes of exposure to concentrated atmosphere i.e. 200 ppm may cause severe pulmonary damage and even fatality. Death may be delayed for several days.
Exposure to nitric acid fumes (with concurrent inhalation of nitrogen dioxide and nitric oxide) may elicit prompt irritation of the upper respiratory tract leading to coughing, gagging, chest pain, dyspnea, cyanosis if concentrations are sufficiently high and duration of exposure sufficiently long, pulmonary edema.

Eye: The liquid is extremely corrosive to the eyes and contact may cause rapid tissue destruction and is capable of causing severe damage with loss of sight.
The vapor is extremely discomforting to the eyes and is capable of causing pain and severe conjunctivitis.
Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.
The material may produce moderate eye irritation leading to inflammation.
Repeated or prolonged exposure to irritants may produce conjunctivitis.
Eye contact with concentrated acid may give no pain, whilst diluted solution causes intense pain and both can cause permanent eye damage or blindness. Burns may result in shrinkage of the eyeball, symblepharon (adhesions between tarsal and bulbar conjunctivae), permanent corneal opacification, and visual impairment leading to blindness.

Skin: The liquid is extremely corrosive to the skin and contact may cause tissue destruction with severe burns.
Bare unprotected skin should not be exposed to this material.
The vapor is highly discomforting to the skin.
The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.
Skin contact causes yellow discoloration of the skin, blisters and scars that may not heal. The skin may be stained bright-yellow or yellowish brown due to the formation of xanthoproteic acid. Dilute solutions may harden the epithelium without producing overt corrosion.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.
The material is extremely corrosive if swallowed and is capable of causing burns to mouth, throat, esophagus, with extreme discomfort, pain and may be fatal.
Even a small amount causes severe corrosion of the stomach, burning pain, vomiting and shock, possibly causing non-healing scarring of the gastrointestinal tract and stomach. Death may be delayed 12 hours to 14 days or to several months. Such late fatalities are attributed to a chemical lobular pneumonitis secondary to aspiration. Survivors show stricture of the gastric mucosa and subsequent pernicious anemia.

Carcinogenicity: NTP - Not listed; IARC - Not listed; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Not listed; MAK - Not listed.

Chronic Effects: Prolonged or repeated overexposure to low concentrations of vapor may cause chronic bronchitis, corrosion of teeth, even chemical pneumonitis.

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.
Lay patient down. Keep warm and rested.
If available, administer medical oxygen by trained personnel.
If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor, without delay.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.
Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.
Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.
Immediately transport to hospital or doctor. DO NOT delay.

Skin Contact: Immediately flush body and clothes with large amounts of water, using safety shower if available.
Quickly remove all contaminated clothing, including footwear.

Wash affected areas with water (and soap if available) for at least 15 minutes. Transport to hospital or doctor. DO NOT delay.

Ingestion: Contact a Poison Control Center.

Do NOT induce vomiting. Give a glass of water.

Immediately transport to hospital or doctor. DO NOT delay.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For acute or short-term repeated exposures to strong acids:

1.Airway problems may arise from laryngeal edema and inhalation exposure.
Treat with 100% oxygen initially.

2.Respiratory distress may require cricothyroidotomy if endotracheal intubation is contraindicated by excessive swelling.

3. Intravenous lines should be established immediately in all cases where there is evidence of circulatory compromise.

4.Strong acids produce a coagulation necrosis characterized by formation of a coagulum (eschar) as a result of the desiccating action of the acid on proteins in specific tissues.

INGESTION:

1.Immediate dilution (milk or water) within 30 minutes post-ingestion is recommended.

2.Do not attempt to neutralize the acid since exothermic reaction may extend the corrosive injury.

3.Be careful to avoid further vomiting since re-exposure of the mucosa to the acid is harmful. Limit fluids to one or two glasses in an adult.

4.Charcoal has no place in acid management.

5.Some authors suggest the use of lavage within 1 hour of ingestion.

SKIN:

1.Skin lesions require copious saline irrigation. Treat chemical burns as thermal burns with non-adherent gauze and wrapping.

2.Deep second-degree burns may benefit from topical silver sulfadiazine.

EYE:

1.Eye injuries require retraction of the eyelids to ensure thorough irrigation of the conjunctival cul-de-sacs. Irrigation should last at least 20-30 minutes. Do not use neutralizing agents or any other additives. Several liters of saline are required.

2.Cycloplegic drops (1% cyclopentolate for short-term use or 5% homatropine for longer term use), antibiotic drops, vasoconstrictive agents, or artificial tears may be indicated dependent on the severity of the injury.

3.Steroid eye drops should only be administered with the approval of a consulting ophthalmologist.

Section 5 - Fire-Fighting Measures

Flash Point: Nonflammable

Autoignition Temperature: Not applicable

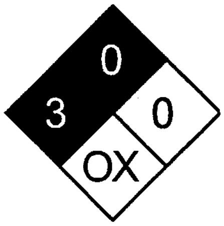
LEL: Not applicable

UEL: Not applicable

Extinguishing Media: Water spray or fog; foam, dry chemical powder, or BCF (where regulations permit).

Carbon dioxide.

General Fire Hazards/Hazardous Combustion Products: Will not burn but increases intensity of fire.



Fire Diamond

Heating may cause expansion or decomposition leading to violent rupture of containers. Heat affected containers remain hazardous.

Contact with combustibles such as wood, paper, oil or finely divided metal may cause ignition, combustion or violent decomposition.

May emit irritating, poisonous or corrosive fumes.

Decomposes on heating and produces toxic fumes of nitrogen oxides (NO_x) and nitric acid.

Fire Incompatibility: Oxidizing agents as a class are not necessarily combustible themselves, but can increase the risk and intensity of fire in many other substances.

Reacts vigorously with water and alkali.

Avoid reaction with organic materials/compounds, powdered metals, reducing agents and hydrogen sulfide (H_2S) as ignition may result.

Reacts with metals producing flammable/explosive hydrogen gas.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.

May be violently or explosively reactive. Wear full body protective clothing with breathing apparatus. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.

Fight fire from a safe distance, with adequate cover.

Extinguishers should be used only by trained personnel.

Use water delivered as a fine spray to control fire and cool adjacent area.

Avoid spraying water onto liquid pools.

Do not approach containers suspected to be hot.

Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.
If fire gets out of control withdraw personnel and warn against entry.
Equipment should be thoroughly decontaminated after use.

Section 6 - Accidental Release Measures

Small Spills: Dangerous levels of nitrogen oxides may form during spills of nitric acid.
Wear fully protective PVC clothing and breathing apparatus.
Clean up all spills immediately. No smoking, bare lights, ignition sources.
Avoid all contact with any organic matter including fuel, solvents, sawdust, paper or cloth and other incompatible materials, as ignition may result.
Avoid breathing dust or vapors and all contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb spill with dry sand, earth, inert material or vermiculite. DO NOT use sawdust as fire may result.
Scoop up solid residues and seal in labeled drums for disposal.
Neutralize/decontaminate area.
Use soda ash or slaked lime to neutralize.
Large Spills: DO NOT touch the spill material. Restrict access to area.
Clear area of personnel and move upwind. Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear full body protective clothing with breathing apparatus. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
No smoking, flames or ignition sources. Increase ventilation.
Contain spill with sand, earth or other clean, inert materials.
NEVER use organic absorbents such as sawdust, paper, cloth; as fire may result. Avoid any contamination by organic matter.
Use spark-free and explosion-proof equipment.
Collect any recoverable product into labeled containers for possible recycling. DO NOT mix fresh with recovered material.
Collect residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains. Decontaminate equipment and launder all protective clothing before storage and reuse.
If contamination of drains or waterways occurs advise emergency services.
DO NOT USE WATER OR NEUTRALIZING AGENTS INDISCRIMINATELY ON LARGE SPILLS.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid generating and breathing mist. Do not allow clothing wet with material to stay in contact with skin.
Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area.
WARNING: To avoid violent reaction, ALWAYS add material to water and NEVER water to material.
Avoid smoking, bare lights or ignition sources.
Avoid contact with incompatible materials.
When handling, DO NOT eat, drink or smoke.
Keep containers securely sealed when not in use. Avoid physical damage to containers. Always wash hands with soap and water after handling. Work clothes should be laundered separately.
Launder contaminated clothing before reuse.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions are maintained.
Recommended Storage Methods: Stainless steel drum. Check that containers are clearly labeled.
Packaging as recommended by manufacturer.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area.
Local exhaust ventilation may be required for safe working, i.e., to keep exposures below required standards; otherwise, PPE is required.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection.
In confined spaces where there is inadequate ventilation, wear full-face air supplied breathing apparatus.

Personal Protective Clothing/Equipment

Eyes: Chemical goggles. Full face shield.

DO NOT wear contact lenses. Contact lenses pose a special hazard; soft contact lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Bare unprotected skin should not be exposed to this material. Impervious, gauntlet length gloves i.e., butyl rubber gloves or Neoprene rubber gloves or wear chemical protective gloves, e.g. PVC.

Wear safety footwear or safety gumboots, e.g. Rubber.

Respiratory Protection:

Exposure Range >2 to <25 ppm: Supplied Air, Constant Flow/Pressure Demand, Half Mask

Exposure Range 25 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face

Other: Operators should be trained in procedures for safe use of this material.

Acid-resistant overalls or Rubber apron or PVC apron.

Ensure there is ready access to an emergency shower.

Ensure that there is ready access to eye wash unit.

Ensure that there is ready access to breathing apparatus.

Glove Selection Index:

BUTYL	A
HYPALON	A
NEOPRENE	A
NEOPRENE/NATURAL	A
PE/EVAL/PE	A
SARANEX-23	A
NATURAL RUBBER	B
NATURAL+NEOPRENE	B
PVC	C
NITRILE+PVC	C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Clear, colorless to slightly yellow liquid. Sharp strong odor.
CAUTION: exothermic dilution hazard.
HIGHLY CORROSIVE. Corrosive to most metals. Powerful oxidizing agent.
Darkens to brownish color on aging and exposure to light.

Physical State: Liquid
Vapor Pressure (kPa): 8.26
Vapor Density (Air=1): 1.5
Formula Weight: 63.02
Specific Gravity (H_2O=1, at 4 °C): 1.3-1.42
Water Solubility: Soluble in all proportions

pH: < 1
pH (1% Solution): 1
Boiling Point Range: 83 °C (181 °F) at 760 mm Hg
Freezing/Melting Point Range: -42 °C (-43.6 °F)
Volatile Component (% Vol): 100 (nominal)
Decomposition Temperature (°C): Not applicable

Section 10 - Stability and Reactivity

Stability/Polymerization: Presence of heat source and direct sunlight. Storage in unsealed containers. Hazardous polymerization will not occur.

Storage Incompatibilities: Segregate from reducing agents, finely divided combustible materials, combustible materials, sawdust, metals and powdered metals.

Avoid contamination of water, foodstuffs, feed or seed.

Segregate from alkalies, oxidizing agents and chemicals readily decomposed by acids, i.e. cyanides, sulfides, carbonates.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (human) LD_{Lo}: 430 mg/kg
Inhalation (rat) LC_{50}: 2500 ppm/1 hr
Unreported (man) LD_{Lo}: 110 mg/kg

IRRITATION
Nil reported

See NIOSH, *RTECS* QU 5775000, for additional data.

Section 12 - Ecological Information

Environmental Fate: No data found.

Ecotoxicity: LC_{50} Starfish 100-300 mg/l/48 hr /Aerated water conditions; LC_{50} Shore crab 180 mg/l/48 hr /Static, aerated water conditions; LC_{50} Cockle 330-1000 mg/l/48 hr /Aerated water conditions

BCF: no food chain concentration potential

Biochemical Oxygen Demand (BOD): none

Section 13 - Disposal Considerations

Disposal: Recycle wherever possible. Special hazards may exist - specialist advice may be required.
Consult manufacturer for recycling options.
Follow applicable federal, state, and local regulations.
Treat and neutralize at an approved treatment plant.
Decontaminate empty containers. Observe all label safeguards until containers are cleaned and destroyed.
Puncture containers to prevent reuse and bury at an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: NITRIC ACID
Hazard Class: 8
ID No.: 2031
Packing Group: I
Label: Corrosive[8],Oxid.Agent

Additional Shipping Information:

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Not listed
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4) 1000 lb (453.5 kg)
SARA 40 CFR 372.65: Listed 1000 lb
SARA EHS 40 CFR 355: Listed 1,000 lb
TSCA: Listed

Section 16 - Other Information

Research Date:............................1999-11 **Review Date:** 2000-07

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Issue Date: 2000-07

Toluene
MSDS 317
TOL2320

Section 1 - Chemical Product and Company Identification

Material Name: Toluene **CAS Number:** 108-88-3
Chemical Formula: C_7H_8
Structural Chemical Formula: $C_6H_5CH_3$
Synonyms: ANTISAL 1A; BENZENE,METHYL-; CP 25; METHACIDE; METHANE,PHENYL-; METHYL BENZENE; METHYL BENZOL; METHYLBENZENE; METHYLBENZOL; PHENYL METHANE; PHENYLMETHANE; TOLUEEN; TOLUEN; TOLUENE; TOLUENO; TOLUOL; TOLUOLO; TOLU-SOL
General Use: Used as a solvent for paint, resins, lacquers inks & adhesives. Component of solvent blends and thinners; in gasoline and aviation fuel. Used in the manufacture of chemicals, dyes, explosives, benzoic acid.
Some grades of toluene may contain traces of xylene and benzene.
Odor threshold: 2 ppm approx. Odor is not a reliable warning property due to olfactory fatigue.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
toluene	108-88-3	> 99.5

OSHA PEL
TWA: 200 ppm; STEL: 300 ppm; from Table Z-2. Other Values: 500 mg/m^3; 10 min peak 8hr ppm.

OSHA PEL Vacated 1989 Limits
TWA: 100 ppm; 375 mg/m^3; STEL: 150 ppm; 560 mg/m^3.

ACGIH TLV
TWA: 50 ppm; 188 mg/m^3.

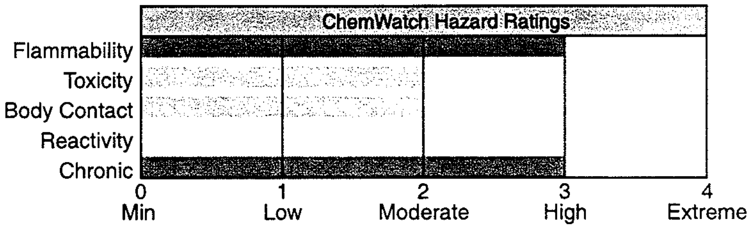
NIOSH REL
TWA: 100 ppm; 375 mg/m^3. STEL: 150 ppm; 560 mg/m^3.

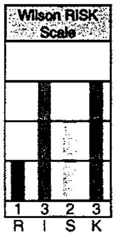
IDLH Level
500 ppm.

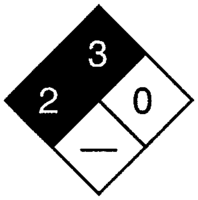
DFG (Germany) MAK
TWA: 50 ppm; 190 mg/m^3.

Section 3 - Hazards Identification

HMIS
② Health
③ Flammability
⓪ Reactivity







Fire Diamond

ANSI Signal Word
Danger!

Flammable

☆☆☆☆☆ Emergency Overview ☆☆☆☆☆

Colorless liquid; sickly, sweet odor. Irritating to the eyes/skin/respiratory tract. Also causes: weakness, headache, dizziness, confusion, and insomnia. Chronic: liver and kidney damage. May cause birth defects. Flammable.

Potential Health Effects

Primary Entry Routes: Inhalation, skin contact/absorbtion.
Target Organs: Skin, liver, kidneys, central nervous system.
Acute Effects
Inhalation: The vapor is highly discomforting to the upper respiratory tract. Inhalation hazard is increased at higher temperatures.

Acute effects from inhalation of high concentrations of vapor are pulmonary irritation, including coughing, with nausea; central nervous system depression - characterized by headache and dizziness, increased reaction time, fatigue and loss of coordination.

If exposure to highly concentrated solvent atmosphere is prolonged this may lead to narcosis, unconsciousness, even coma and possible death.

Central nervous system (CNS) depression may include nonspecific discomfort, symptoms of giddiness, headache, dizziness, nausea, anesthetic effects, slowed reaction time, slurred speech and may progress to unconsciousness.

Serious poisonings may result in respiratory depression and may be fatal.

Eye: The liquid produces a high level of eye discomfort and is capable of causing pain and severe conjunctivitis.

Corneal injury may develop, with possible permanent impairment of vision, if not promptly and adequately treated.

The vapor is discomforting to the eyes if exposure is prolonged.

The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Skin: The liquid may produce skin discomfort following prolonged contact.

Defatting and/or drying of the skin may lead to dermatitis and it is absorbed by skin.

Toxic effects may result from skin absorption.

Open cuts, abraded or irritated skin should not be exposed to this material.

The material may accentuate any pre-existing skin condition.

The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.

The liquid may produce gastrointestinal discomfort and may be harmful if swallowed. Ingestion may result in nausea, pain and vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.

Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Not listed; ACGIH - Class A4, Not classifiable as a human carcinogen; EPA - Class D, Not classifiable as to human carcinogenicity; MAK - Not listed.

Chronic Effects: Chronic solvent inhalation exposures may result in nervous system impairment and liver and blood changes.

Chronic toluene habituation occurs following intentional abuse (glue-sniffing) or from occupational exposure. Ataxia, incoordination and tremors of the hands and feet (as a consequence of diffuse cerebral atrophy), headache, abnormal speech, transient memory loss, convulsions, coma, drowsiness, reduced color perception, frank blindness, nystagmus (rapid, involuntary eye-movements), decreased hearing leading to deafness and mild dementia have all been associated with chronic abuse.

Peripheral nerve damage, encephalopathy, giant axonopathy, electrolyte disturbances in the cerebrospinal fluid and abnormal computer tomographic (CT) scans are common amongst toluene addicts. Although toluene abuse has been linked with kidney disease, this does not commonly appear in cases of occupational toluene exposures. Cardiac and hematological toxicity are however associated with chronic toluene exposure. Cardiac arrhythmia, multifocal and premature ventricular contractions and supraventricular tachycardia are present in 20% of patients who abused toluene-containing paints.

Previous suggestions that chronic toluene inhalation produced human peripheral neuropathy have largely been discounted. However central nervous system (CNS) depression is well documented where blood toluene levels exceed 2.2 mg%. Toluene abusers can achieve transient circulating concentrations of 6.5 mg%. Amongst workers exposed for a median time of 29 years to toluene no subacute effects on neurasthenic complaints and pyschometric test results could be established.

The prenatal toxicity of very high toluene concentrations has been documented for several animal species and man. Malformations indicative of specific teratogenicity have not generally been found. The toxicity described in the literature takes the form of embryo death or delayed fetal growth and delayed skeletal system development. Permanent damage of children has been seen only when mothers had suffered from chronic intoxication as a result of "sniffing".

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Lay patient down. Keep warm and rested.

If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.

Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).

Wash affected areas thoroughly with water (and soap if available).

Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center.

Do NOT induce vomiting. Give a glass of water.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: Following acute or short-term repeated exposures to toluene:

1. Toluene is absorbed across to alveolar barrier, the blood/air mixture being 11.2/15.6 (at 37 °C) The order of toluene, in expired breath, is of the order of 18 ppm following sustained exposure to 100 ppm.
The tissue/blood proportion is 1/3 except in adipose where the proportion is 8/10.
2.Metabolism by microsomal mono-oxygenation, results in the production of hippuric acid. This may be detected in the urine in amounts between 0.5 and 2.5 g/24hr which represents, on average 0.8 gm/gm of creatinine.
The biological half life of hippuric acid is in the order of 1-2 hours.
3.Primary threat to life from ingestion and/or inhalation is respiratory failure.
4.Patients should be quickly evaluated for signs of respiratory distress (e.g. cyanosis, tachypnea, intercostal retraction, obtundation) and given oxygen. Patients with inadequate tidal volumes or poor arterial blood gases (pO_2 <50 mm Hg or pCO_2 >50 mm Hg) should be intubated.
5.Arrhythmias complicate some hydrocarbon ingestion and/or inhalation and electrocardiographic evidence of myocardial injury has been reported; intravenous lines and cardiac monitors should be established in obviously symptomatic patients. The lungs excrete inhaled solvents, so that hyperventilation improves clearance.
6.A chest x-ray should be taken immediately after stabilization of breathing and circulation to document aspiration and detect the presence of pneumothorax.
7.Epinephrine (adrenalin) is not recommended for treatment of bronchospasm because of potential myocardial sensitization to catecholamines.
Inhaled cardioselective bronchodilators (e.g. Alupent, Salbutamol) are the preferred agents, with aminophylline a second choice.
8.Lavage is indicated in patients who require decontamination; ensure use of cuffed endotracheal tube in adult patients.

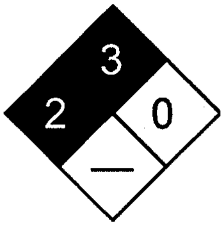
BIOLOGICAL EXPOSURE INDEX - BEI

These represent the determinants observed in specimens collected from a healthy worker exposed at the Exposure Standard (ES or TLV):

Determinant	Index	Sampling Time	Comments
Hippuric acid in urine	2.5 gm/gm creatinine	End of shift Last 4 hrs of shift	B,NS
Toluene in venous blood	1 mg/L	End of shift	SQ
Toluene in end-exhaled air		End of shift	SQ

NS: Non-specific determinant; also observed after exposure to other material
SQ: Semi-quantitative determinant - Interpretation may be ambiguous; should be used as a screening test or confirmatory test.
B: Background levels occur in specimens collected from subjects NOT exposed.

Section 5 - Fire-Fighting Measures



Fire Diamond

Flash Point: 4 °C Closed Cup
Autoignition Temperature: 480 °C
LEL: 1.2% v/v
UEL: 7.1% v/v
Extinguishing Media: Foam, dry chemical powder, BCF (where regulations permit), carbon dioxide.
Water spray or fog - Large fires only.
General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are highly flammable.
Severe fire hazard when exposed to heat, flame and/or oxidizers.
Vapor forms an explosive mixture with air.
Severe explosion hazard, in the form of vapor, when exposed to flame or spark. Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion/decomposition with violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO) and carbon dioxide (CO_2).
Fire Incompatibility: Avoid contamination with strong oxidizing agents as ignition may result.
Nitric acid with toluene, produces nitrated compounds which are explosive.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
Fight fire from a safe distance, with adequate cover.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control the fire and cool adjacent area. Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protective location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.
Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways. Consider evacuation.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.
Use only spark-free shovels and explosion proof equipment.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.
Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid all personal contact, including inhalation.
Wear protective clothing when risk of exposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights, heat or ignition sources.
When handling, DO NOT eat, drink or smoke.
Vapor may ignite on pumping or pouring due to static electricity.
DO NOT use plastic buckets. Ground and secure metal containers when dispensing or pouring product. Use spark-free tools when handling.
Avoid contact with incompatible materials.
Keep containers securely sealed. Avoid physical damage to containers.
Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Use good occupational work practices. Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.
Recommended Storage Methods: Metal can; Metal drum; Metal safety cans. Packing as supplied by manufacturer.
Plastic containers may only be used if approved for flammable liquid.
Check that containers are clearly labeled and free from leaks.
Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area; local exhaust ventilation may be required for safe working, i.e., to keep exposures below required standards; otherwise, PPE is required.
General exhaust is adequate under normal operating conditions.
Local exhaust ventilation may be required in special circumstances.
If risk of overexposure exists, wear NIOSH-approved respirator. Correct fit is essential to ensure adequate protection.
Provide adequate ventilation in warehouses and enclosed storage areas.
In confined spaces where there is inadequate ventilation, wear full-face air supplied breathing apparatus.
Personal Protective Clothing/Equipment
Eyes: Safety glasses with side shields; chemical goggles. Full face shield.

DO NOT wear contact lenses. Contact lenses pose a special hazard; soft contact lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Wear chemical protective gloves, eg. PVC. Wear safety footwear.

Respiratory Protection:
Exposure Range >200 to <500 ppm: Air Purifying, Negative Pressure, Half Mask
Exposure Range 500 to unlimited ppm: Self-contained Breathing Apparatus, Pressure Demand, Full Face
Cartridge Color: black

Other: Overalls. Barrier cream. Eyewash unit.

Glove Selection Index:

PE/EVAL/PE	A
VITON/CHLOROBUTYL	A
VITON	A
PVA	A
TEFLON	B
SARANEX-23 2-PLY	C
CPE	C
VITON/NEOPRENE	C
SARANEX-23	C
NEOPRENE/NATURAL	C
NITRILE+PVC	C
NITRILE	C
BUTYL	C
PVC	C
NEOPRENE	C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

Section 9 - Physical and Chemical Properties

Appearance/General Info: Clear highly flammable liquid with a strong aromatic odor; floats on water. Mixes with most organic solvents.

Physical State: Liquid
Vapor Pressure (kPa): 2.93 at 20 °C
Vapor Density (Air=1): 3.2
Formula Weight: 92.14
Specific Gravity (H_2O=1, at 4 °C): 0.87 at 20 °C
Water Solubility: < 1 mg/mL at 18 °C
Evaporation Rate: 2.4 (BuAc=1)

pH: Not applicable
pH (1% Solution): Not applicable.
Boiling Point Range: 111 °C (232 °F) at 760 mm Hg
Freezing/Melting Point Range: -95 °C (-139 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Product is considered stable. Hazardous polymerization will not occur.
Storage Incompatibilities: Segregate from strong oxidizers.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY
Oral (human) LD_{Lo}: 50 mg/kg
Oral (rat) LD_{50}: 636 mg/kg
Inhalation (human) TC_{Lo}: 100 ppm
Inhalation (man) TC_{Lo}: 200 ppm
Inhalation (rat) LC_{50}: > 26700 ppm/1h
Dermal (rabbit) LD_{50}: 12124 mg/kg
Reproductive effector in rats

IRRITATION
Skin (rabbit): 20 mg/24h-moderate
Skin (rabbit): 500 mg - moderate
Eye (rabbit): 0.87 mg - mild
Eye (rabbit): 2 mg/24h - SEVERE
Eye (rabbit): 100 mg/30sec - mild

See NIOSH, *RTECS* XS 5250000, for additional data.

Section 12 - Ecological Information

Environmental Fate: If released to soil, it will be lost by evaporation from near-surface soil and by leaching to the groundwater. Biodegradation occurs both in soil and groundwater, but it is apt to be slow especially at high concentrations, which may be toxic to microorganisms. The presence of acclimated microbial populations may allow rapid biodegradation. It will not significantly hydrolyze in soil or water under normal environmental conditions. If released into water, its concentration will decrease due to evaporation and biodegradation. This removal can be rapid or take several weeks, depending on temperature, mixing conditions, and acclimation of microorganisms. It will not significantly adsorb to sediment or bioconcentrate in aquatic organisms. If released to the atmosphere, it will degrade by reaction with photochemically produced hydroxyl radicals (half-life 3 hr to slightly over 1 day) or be washed out in rain. It will not be subject to direct photolysis.

Ecotoxicity: LC_{50} Aedes aegypti-4th instar (mosquito larvae) 22 mg/l /Conditions of bioassay not specified; LC_{50} Cyprinodon variegatus (sheepshead minnow) 277-485 mg/l 96 hr /Conditions of bioassay not specified; LC_{50} Calandra granaria (grain weevil) 210 mg/l /in air; LC_{50} Cancer magister (crab larvae stage I) 28 ppm/96 hr /Conditions of bioassay not specified; LC_{50} Crangon franciscorum (shrimp) 4.3 ppm 96 hr /Conditions of bioassay not specified; LC_{50} Artemia salina (brine shrimp) 33 mg/l 24 hr /Conditions of bioassay not specified; LC_{50} Morone saxatilis (striped bass) 7.3 mg/l 96 hr /Conditions of bioassay not specified; LC_{50} Pimephales promelas (fathead minnows) 55-72 mg/l (embryos), 25-36 mg/l (1-day posthatch protolarvae), and 26-31 mg/l (30-day-old minnows)/ 96 hour /Conditions of bioassay not specified

Henry's Law Constant: 0.0067

BCF: eels 13.2

Biochemical Oxygen Demand (BOD): 0%, 5 days

Octanol/Water Partition Coefficient: log $K_{OW} = 2.69$

Soil Sorption Partition Coefficient: K_{OC} = silty loam 37

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: TOLUENE
Hazard Class: 3.1
ID No.: 1294
Packing Group: II
Label: Flammable Liquid[3]

Additional Shipping Information: TOLUOL

Section 15 - Regulatory Information

EPA Regulations:
- **RCRA 40 CFR:** Listed U220 Toxic Waste
- **CERCLA 40 CFR 302.4:** Listed per CWA Section 311(b)(4); per RCRA Section 3001; per CWA Section 307(a) 1000 lb (453.5 kg)
- **SARA 40 CFR 372.65:** Listed
- **SARA EHS 40 CFR 355:** Not listed
- **TSCA:** Listed

Section 16 - Other Information

Research Date:............................1999-11 **Review Date:** 2000-07

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Issue Date: 2000-07

Xylene
MSDS 318
XYL2260

Section 1 - Chemical Product and Company Identification 54.1

Material Name: Xylene **CAS Number:** 1330-20-7
Chemical Formula: C_8H_{10}
Structural Chemical Formula: $C_6H_4(CH_3)_2$
Synonyms: BENZENE,DIMETHYL-; COMPONENT 1 (83%): XYLENES; COMPONENT 2 (17%): ETHYL BENZENE; DIMETHYLBENZENE; DIMETHYLBENZENES; EPA PESTICIDE CHEMICAL CODE 086802; KSYLEN; METHYL TOLUENE; METHYLTOLUENE; VIOLET 3; XILOLI; XYLENE; XYLENEN; XYLOL; XYLOLE
General Use: A strong solvent for general use in the manufacture of paints, varnishes, lacquers, thinners, inks, rubber, pesticides, herbicides and paint strippers.

Section 2 - Composition / Information on Ingredients

Name	CAS	%
xylene	1330-20-7	> 95

OSHA PEL
TWA: 100 ppm; 435 mg/m^3.

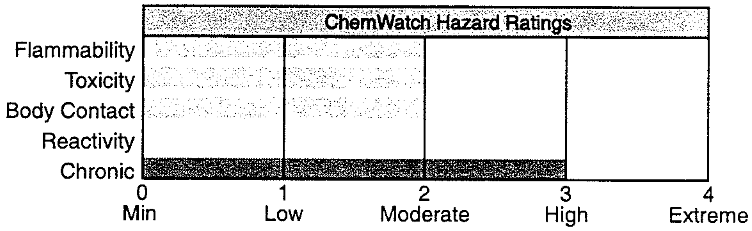
ACGIH TLV
TWA: 100 ppm; 434 mg/m^3;
STEL: 150 ppm; 651 mg/m^3.

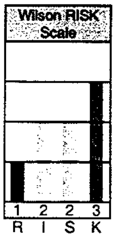
NIOSH REL
TWA: 100 ppm; 435 mg/m^3.
STEL: 150 ppm; 655 mg/m^3.

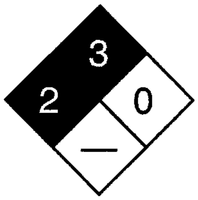
DFG (Germany) MAK
TWA: 100 ppm; 440 mg/m^3.

Section 3 - Hazards Identification

HMIS
2 Health
3 Flammability
0 Reactivity







Fire Diamond

ANSI Signal Word
Warning!


Flammable

☆☆☆☆☆ **Emergency Overview** ☆☆☆☆☆
Clear, sweet smelling liquid. Irritating to the eyes/skin/respiratory tract. Also causes: dizziness, nausea, and drowsiness. Chronic: dermatitis, kidney/liver/peripheral nerve damage. May cause birth defects based on animal data. Flammable.

Potential Health Effects

Primary Entry Routes: inhalation, skin absorption (slight), eye contact, ingestion
Target Organs: central nervous system (CNS), eyes, gastrointestinal (GI) tract, liver, kidneys, skin
Acute Effects
Inhalation: Xylene is a central nervous system depressant. The vapor is discomforting to the upper respiratory tract and may be harmful if inhaled.
Inhalation hazard is increased at higher temperatures.
Toxic effects are increased by consumption of alcohol.
Acute effects from inhalation of high concentrations of vapor are pulmonary irritation, including coughing, with nausea; central nervous system depression - characterized by headache and dizziness, increased reaction time, fatigue and loss of coordination.

If exposure to highly concentrated solvent atmosphere is prolonged this may lead to narcosis, unconsciousness, even coma and possible death.

Headache, fatigue, lassitude, irritability and gastrointestinal disturbances (e.g., nausea, anorexia and flatulence) are the most common symptoms of xylene overexposure. Injury to the heart, liver, kidneys and nervous system has also been noted among workers. Transient memory loss, renal impairment, temporary confusion and some evidence of disturbance of liver function was reported in three workers overcome by gross exposure to xylene (10000 ppm). One worker died and autopsy revealed pulmonary congestion, edema, and focal alveolar hemorrhage.

Volunteers inhaling xylene at 100 ppm for 5 to 6 hours showed changes in manual coordination, reaction time and slight ataxia. Tolerance developed during the workweek but was lost over the weekend. Physical exercise may antagonize this effect. Xylene body burden in humans exposed to 100 or 200 ppm xylene in air depends on the amount of body fat with 4% to 8% of total absorbed xylene accumulating in human adipose tissues.

Eye: The liquid is highly discomforting to the eyes and is capable of causing a mild, temporary redness of the conjunctiva (similar to wind-burn), temporary impairment of vision and/or other transient eye damage/ulceration.

The vapor is highly discomforting to the eyes.

The material may produce severe irritation to the eye causing pronounced inflammation. Repeated or prolonged exposure to irritants may produce conjunctivitis.

Corneal changes have been reported in furniture polishers exposed to xylene.

Skin: The liquid is highly discomforting to the skin and may cause drying of the skin, which may lead to dermatitis and it is absorbed by the skin.

Toxic effects may result from skin absorption.

Open cuts, abraded or irritated skin should not be exposed to this material.

The material may accentuate any pre-existing skin condition.

The material may cause skin irritation after prolonged or repeated exposure and may produce a contact dermatitis (nonallergic). This form of dermatitis is often characterized by skin redness (erythema) and swelling (edema) which may progress to vesiculation, scaling and thickening of the epidermis. Histologically there may be intercellular edema of the spongy layer (spongiosis) and intracellular edema of the epidermis.

Ingestion: Considered an unlikely route of entry in commercial/industrial environments.

The liquid may produce gastrointestinal discomfort and may be harmful if swallowed. Ingestion may result in nausea, pain and vomiting. Vomit entering the lungs by aspiration may cause potentially lethal chemical pneumonitis.

Carcinogenicity: NTP - Not listed; IARC - Group 3, Not classifiable as to carcinogenicity to humans; OSHA - Not listed; NIOSH - Not listed; ACGIH - Not listed; EPA - Class D, Not classifiable as to human carcinogenicity; MAK - Not listed.

Chronic Effects: Chronic solvent inhalation exposures may result in nervous system impairment and liver and blood changes.

Prolonged or continuous skin contact with the liquid may cause defatting with drying, cracking, irritation and dermatitis following.

Small excess risks of spontaneous abortion and congenital malformation was reported amongst women exposed to xylene in the first trimester of pregnancy. In all cases however the women had also been exposed to other substances.

Evaluation of workers chronically exposed to xylene has demonstrated a lack of genotoxicity. Exposure to xylene has been associated with increased risks of hemopoietic malignancies but, again simultaneous exposure to other substances (including benzene) complicate the picture. A long-term gavage study of mixed xylenes (containing 17% ethyl benzene) found no evidence of carcinogenic activity in rats and mice of either sex.

Exposure to the material for prolonged periods may cause physical defects in the developing embryo (teratogenesis).

Section 4 - First Aid Measures

Inhalation: Remove to fresh air.

Lay patient down. Keep warm and rested.

If available, administer medical oxygen by trained personnel.

If breathing is shallow or has stopped, ensure clear airway and apply resuscitation. Transport to hospital or doctor, without delay.

Eye Contact: Immediately hold the eyes open and flush continuously for at least 15 minutes with fresh running water.

Ensure irrigation under eyelids by occasionally lifting the upper and lower lids.

Transport to hospital or doctor without delay. Removal of contact lenses after an eye injury should only be undertaken by skilled personnel.

Skin Contact: Immediately remove all contaminated clothing, including footwear (after rinsing with water).

Wash affected areas thoroughly with water (and soap if available).

Seek medical attention in event of irritation.

Ingestion: Contact a Poison Control Center.

Do NOT induce vomiting. Give a glass of water.

After first aid, get appropriate in-plant, paramedic, or community medical support.

Note to Physicians: For acute or short-term repeated exposures to xylene:

1.Gastrointestinal absorption is significant with ingestions.

For ingestions exceeding 1-2 mL (xylene)/kg, intubation and lavage with cuffed endotracheal tube is recommended. The use of charcoal and cathartics is equivocal.

2.Pulmonary absorption is rapid with about 60-65% retained at rest.

3.Primary threat to life from ingestion and/or inhalation is respiratory failure.

4.Patients should be quickly evaluated for signs of respiratory distress (e.g. cyanosis, tachypnea, intercostal retraction, obtundation) and given oxygen. Patients with inadequate tidal volumes or poor arterial blood gases (pO_2 <50 mm Hg or pCO_2 >50 mm Hg) should be intubated.

5.Arrhythmias complicate some hydrocarbon ingestion and/or inhalation and electrocardiographic evidence of myocardial injury has been reported; intravenous lines and cardiac monitors should be established in obviously symptomatic patients. The lungs excrete inhaled solvents, so that hyperventilation improves clearance.

6.A chest x-ray should be taken immediately after stabilization of breathing and circulation to document aspiration and detect the presence of pneumothorax.

7.Epinephrine (adrenalin) is not recommended for treatment of bronchospasm because of potential myocardial sensitization to catecholamines.

Inhaled cardioselective bronchodilators (e.g. Alupent, Salbutamol) are the preferred agents, with aminophylline a second choice.

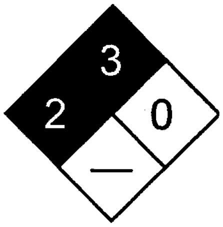
BIOLOGICAL EXPOSURE INDEX - BEI

These represent the determinants observed in specimens collected from a healthy worker exposed at the Exposure Standard (ES or TLV):

Determinant	Index	Sampling Time	Comments
Methylhippuric acids in urine	1.5 gm/gm creatinine	End of shift	
	2 mg/min	Last 4 hrs of shift.	

Section 5 - Fire-Fighting Measures

Flash Point: 25.6 °C
Autoignition Temperature: 241 °C
LEL: 1.0% v/v
UEL: 7.0% v/v



Fire Diamond

Extinguishing Media: Alcohol stable foam; dry chemical powder; carbon dioxide.
Water spray or fog - Large fires only.

General Fire Hazards/Hazardous Combustion Products: Liquid and vapor are flammable.
Moderate fire hazard when exposed to heat or flame.
Vapor forms an explosive mixture with air.
Moderate explosion hazard when exposed to heat or flame.
Vapor may travel a considerable distance to source of ignition.
Heating may cause expansion or decomposition leading to violent rupture of containers.
On combustion, may emit toxic fumes of carbon monoxide (CO).
Other combustion products include carbon dioxide (CO_2).

Fire Incompatibility: Avoid contamination with strong oxidizing agents as ignition may result.

Fire-Fighting Instructions: Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
If safe, switch off electrical equipment until vapor fire hazard removed.
Use water delivered as a fine spray to control fire and cool adjacent area.
Avoid spraying water onto liquid pools.
Do not approach containers suspected to be hot.
Cool fire-exposed containers with water spray from a protected location.
If safe to do so, remove containers from path of fire.

Section 6 - Accidental Release Measures

Small Spills: Remove all ignition sources. Clean up all spills immediately.
Avoid breathing vapors and contact with skin and eyes.
Control personal contact by using protective equipment.
Contain and absorb small quantities with vermiculite or other absorbent material. Wipe up. Collect residues in a flammable waste container.

Large Spills: Clear area of personnel and move upwind.
Contact fire department and tell them location and nature of hazard.
May be violently or explosively reactive. Wear breathing apparatus plus protective gloves. Prevent, by any means available, spillage from entering drains or waterways.
No smoking, bare lights or ignition sources. Increase ventilation.
Stop leak if safe to do so. Water spray or fog may be used to disperse/absorb vapor. Contain spill with sand, earth or vermiculite.

Use only spark-free shovels and explosion proof equipment.
Collect recoverable product into labeled containers for recycling.
Absorb remaining product with sand, earth or vermiculite.
Collect solid residues and seal in labeled drums for disposal.
Wash area and prevent runoff into drains.
If contamination of drains or waterways occurs, advise emergency services.

Regulatory Requirements: Follow applicable OSHA regulations (29 CFR 1910.120).

Section 7 - Handling and Storage

Handling Precautions: Avoid all personal contact, including inhalation.
Wear protective clothing when risk of overexposure occurs.
Use in a well-ventilated area. Prevent concentration in hollows and sumps.
DO NOT enter confined spaces until atmosphere has been checked.
Avoid smoking, bare lights or ignition sources.
Avoid generation of static electricity. DO NOT use plastic buckets.
Ground all lines and equipment. Use spark-free tools when handling.
Avoid contact with incompatible materials.
When handling, DO NOT eat, drink or smoke.
Keep containers securely sealed when not in use. Avoid physical damage to containers. Always wash hands with soap and water after handling.
Work clothes should be laundered separately.
Observe manufacturer's storing and handling recommendations. Atmosphere should be regularly checked against established exposure standards to ensure safe working conditions.

Recommended Storage Methods: Metal can; metal drum. Packing as recommended by manufacturer.
Check all containers are clearly labeled and free from leaks.
Plastic containers may only be used if approved for flammable liquids.

Regulatory Requirements: Follow applicable OSHA regulations.

Section 8 - Exposure Controls / Personal Protection

Engineering Controls: Use in a well-ventilated area. Local exhaust ventilation may be required for safe working, i.e., to keep exposures below required standards; otherwise, PPE is required.
CARE: Use of a quantity of this material in confined space or poorly ventilated area, where rapid build-up of concentrated atmosphere may occur, could require increased ventilation and/or protective gear.
General exhaust is adequate under normal operating conditions.
Local exhaust ventilation may be required in specific circumstances.
If risk of overexposure exists, wear NIOSH-approved respirator.
Correct fit is essential to obtain adequate protection.
Provide adequate ventilation in warehouse or closed storage areas.
In confined spaces where there is inadequate ventilation, wear full-face air supplied breathing apparatus.

Personal Protective Clothing/Equipment

Eyes: Safety glasses with side shields; or as required, chemical goggles.
Contact lenses pose a special hazard; soft lenses may absorb irritants and all lenses concentrate them.

Hands/Feet: Barrier cream with polyethylene gloves; Butyl rubber gloves or Neoprene gloves or PVC gloves.
Safety footwear.
Do NOT use this product to clean the skin.

Other: Overalls. Impervious protective clothing.
Eyewash unit.
Ensure there is ready access to an emergency shower.

Glove Selection Index:

PE/EVAL/PE	A
PVA	A
VITON	A
TEFLON	A
PVDC/PE/PVDC	C
NATURAL+NEOPRENE	C
NEOPRENE/NATURAL	C
NITRILE+PVC	C
HYPALON	C
NAT+NEOPR+NITRILE	C
BUTYL	C
BUTYL/NEOPRENE	C
NITRILE	C
NEOPRENE	C

A: Best selection
B: Satisfactory; may degrade after 4 hours continuous immersion
C: Poor to dangerous choice for other than short-term immersion

PVC...C

Section 9 - Physical and Chemical Properties

Appearance/General Info: Clear colorless flammable liquid with a strong aromatic odor; floats on water. Mixes with most organic solvents.

Physical State: Liquid
Vapor Pressure (kPa): 0.5 at 15 °C
Vapor Density (Air=1): 3.66 at 15 °C
Formula Weight: 106.18
Specific Gravity (H_2O=1, at 4 °C): 0.87 at 15 °C
Water Solubility: Practically insoluble in water
Evaporation Rate: 0.7 Bu Ac=1
pH: Not applicable

pH (1% Solution): Not applicable.
Boiling Point Range: 137 °C (279 °F) to 140 °C (284 °F)
Freezing/Melting Point Range: -47 °C (-53 °F)
Volatile Component (% Vol): 100

Section 10 - Stability and Reactivity

Stability/Polymerization: Product is considered stable. Hazardous polymerization will not occur.
Storage Incompatibilities: Avoid storage with oxidizers.

Section 11 - Toxicological Information

Unless otherwise specified data extracted from RTECS - Registry of Toxic Effects of Chemical Substances

TOXICITY	IRRITATION
Oral (human) LD_{Lo}: 50 mg/kg	Skin (rabbit):500 mg/24h moderate
Oral (rat) LD_{50}: 4300 mg/kg	Eye (human): 200 ppm irritant
Inhalation (human) TC_{Lo}: 200 ppm	Eye (rabbit): 87 mg mild
Inhalation (man) LC_{Lo}: 10000 ppm/6h	Eye (rabbit): 5 mg/24h SEVERE
Inhalation (rat) LC_{50}: 5000 ppm/4h	
Reproductive effector in rats	

See NIOSH, *RTECS* ZE 2100000, for additional data.

Section 12 - Ecological Information

Environmental Fate: Most of the xylenes are released into the atmosphere where they may photochemically degrade by reaction with hydroxyl radicals (half-life 1-18 hr). The dominant removal process in water is volatilization. Xylenes are moderately mobile in soil and may leach into groundwater where they are known to persist for several years, despite some evidence that they biodegrade in both soil and groundwater. Bioconcentration is not expected to be significant.
Ecotoxicity: LC_{50} Rainbow trout 13.5 mg/l/96 hr /Conditions of bioassay not specified; LD_{50} Goldfish 13 mg/l/24 hr /Conditions of bioassay not specified
Henry's Law Constant: 0.22
BCF: estimated at 2.14 to 2.20
Octanol/Water Partition Coefficient: log K_{ow} = 3.12 to 3.20
Soil Sorption Partition Coefficient: K_{oc} = 48 to 68

Section 13 - Disposal Considerations

Disposal: Consult manufacturer for recycling options and recycle where possible.
Follow applicable federal, state, and local regulations.
Incinerate residue at an approved site.
Recycle containers where possible, or dispose of in an authorized landfill.

Section 14 - Transport Information

DOT Transportation Data (49 CFR 172.101):

Shipping Name: XYLENES
Hazard Class: 3.2
ID No.: 1307
Packing Group: III
Label: Flammable Liquid[3]

Additional Shipping Information: XYLOLS

Section 15 - Regulatory Information

EPA Regulations:
RCRA 40 CFR: Listed U239 Toxic Waste; Ignitable Waste
CERCLA 40 CFR 302.4: Listed per CWA Section 311(b)(4); per RCRA Section 3001 100 lb (45.35 kg)
SARA 40 CFR 372.65: Listed
SARA EHS 40 CFR 355: Not listed
TSCA: Listed

Section 16 - Other Information

Research Date:.............................1999-11 **Review Date:** 2000-07

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Attachment B

Incident/Near Miss Investigation Form

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Incident / Near-Miss Investigation Report

☐ OSHA Recordable
☐ Lost Workday Injury
☐ Restricted Duty Injury
☐ First Aid Injury
☐ Vehicle Accident
☐ Equipment Damage
☐ Fire
☐ Spill / Leak
☐ Near Miss

Date of Incident:

Incident Number:

Every employee injury, accident, and near miss must be reported within 24 hours of the injury. If the incident results in hospitalization, an immediate report must be made by telephone to the Project Manager and the Health and Safety Officer.

Project Information

Project Name: | Project #

Location of Incident:

Employee

Name: | Employee Number:

Employment Status: ☐ Regular ☐ Part Time | How long in present job?

Injury or Illness Information

Where did the incident / near miss occur? (number, street, city, state, zip):

Employee's specific activity at the time of the incident / near miss:

Equipment, materials, or chemicals the employee was using when the incident / near miss occurred (e.g., the equipment employee struck against or that struck the employee; the vapor inhaled or material swallowed; what the employee was lifting, pulling, etc.):

Describe the specific injury or illness (e.g., cut, strain, fracture, etc.):

Body part(s) affected (e.g., back, left wrist, right eye, etc.):

Name and address of treatment provider (e.g., physician or clinic): | Phone No.:

If hospitalized, name and address of hospital: | Phone No.:

Date of injury or onset of illness: / / | Time of event or exposure: ☐ AM ☐ PM

Did employee miss at least one full shift's work? ☐ No ☐ Yes, 1st date absent (MM/DD/YYYY) / /

Has employee returned to work? ☐ Regular work ☐ Restricted work ☐ No
☐ Yes, date returned (MM/DD/YYYY) / /

To whom reported: | Other workers injured / made ill in this event? ☐ Yes ☐ No

Description of Incident / Near Miss: (Describe what happened and how it happened.)

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Incident / Near-Miss Investigation Report

Motor Vehicle Accident (MVA)				Company Vehicle?	☐ Yes ☐ No		
Accident Location (street, city, state)							
Vehicle Towed?	☐ Yes ☐ No	Other Vehicle?	☐ Yes ☐ No	# Vehicles Towed:		# of Injuries:	

Spill

Material Spilled:	Quantity:	Source:
Agency Notifications:		
Cost of Incident $		

Third Party Incidents

Name of Owner:	Address:	Telephone:
Description of Damage:		
Witness Name:	Address:	Telephone:
Witness Name:	Address:	Telephone:

#	Root Cause and Contributing Factors: Conclusion (Describe in Detail Why Incident / Near Miss Occurred)
1	
2	
3	
4	
5	

Root Cause(s) Analysis (RCA):

1. Lack of skill or knowledge.
2. Lack of or inadequate operational procedures or work standards.
3. Inadequate communication of expectations regarding procedures or work standards.
4. Inadequate tools or equipment.
5. Correct way takes more time and / or requires more effort.
6. Short-cutting standard procedures is positively reinforced or tolerated.
7. Person thinks there is no personal benefit to always doing the job according to standards.
8. Uncontrollable.

#	RCA #	Solution(s): How to Prevent Incident / Near Miss From Reoccurring	Person Responsible	Due Date	Closure Date

Investigation Team Members

Name	Job Title	Date

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Incident / Near-Miss Investigation Report

Results of Solution Verification and Validation

Reviewed By

Name	Job Title	Date
	Project Manager	
	Health and Safety Reviewer	

Attachment C

Loss Prevention Observation Form

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Loss Prevention Observation

Observer Name	Observer Title	Project/Project Number

Date ________________ Time ____ ☐ AM ☐ PM	Project Type / Task Observed

Background Information

List Critical Work Procedures

List Issue/Items Requiring Corrective Action

Root Cause Analysis

1. Employee lacks the skill or knowledge to carry out duties
2. Procedures, work standards, or expectations were not communicated
3. Procedures or work standards were not developed or were inadequate
4. Equipment, systems, or tools were inadequate
5. Employee chose not to take the time or put forth the effort to do the job properly
6. Supervisor did not require the employee to follow the standard procedure
7. Employee doesn't see any advantage to doing the job to standard.
8. Uncontrollable.

Criterion #	RCA #	Corrective Action Identified	Responsible Individual	Due Date	Closure Date

Results of Corrective Action

Reviewed by	Date	Reviewed by	Date

Environmental Operations

	PRE-TASK PREPARATION	Correct	Questionable	Comments
1.	Health and Safety Plan / MSDSs on site			
2.	Employee familiar / trained on task			
3.	OSHA-required training/medical surveillance			
4.	Utility mark out / check performed			
5.	Traffic hazard addressed / work area marked			
6.	Walking / working surfaces free of hazards			
7.	Tailgate safety meeting performed			
8.	Impact on nearby residence/business evaluated			
9.	Communicates intentions to other personnel			
10.	Knowledge of emergency procedures			
11.	Distance between equipment and power lines			
12.	Personal protective equipment			
13.	Air monitoring equipment on site, calibrated			
14.	First aid kit / fire extinguisher on site			
15.	One person trained in first aid / CPR			
16.	Work zones established and marked			
	PERFORMING TASK			
17.	Employee trained in task to be performed			
18.	Correct body positioning			
19.	Proper lifting / pushing / pulling techniques			
20.	Keep hands / body away from pinch points			
21.	Walking / working surfaces kept clear of debris			
22.	Faces traffic as appropriate			
23.	Vehicles/ barricades to protect against traffic			
24.	Drill rig located properly, blocked / chocked			
25.	Drill rig moved only with derrick lowered			
26.	Excavator located on stable ground			
27.	Eye contact made with equipment operator			
28.	Spoil at least 2 feet back from edge of excavation			
29.	Excavation shored/sloped/benched			
30.	Excavation entry controlled			
31.	Equipment/tools used properly			
32.	Electrical equipment connected through GFCI			
33.	Power tools handled properly			
34.	Electrical cords inspected / in good condition			
35.	Follows lockout / tagout procedures			
36.	Air monitoring conducted/action levels understood			
37.	Equipment decontaminated properly			
38.	Personnel decon prior to eating/drinking/smoking			
39.	Decontamination effective			
	POST – TASK			
40.	Procedures / JSA adequate			
41.	Equipment / tools stored properly			
42.	Proper storage of soil / water / waste material			
43.	Work area secured			
44.	Other			

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Attachment D

Health and Safety Inspection Form

Health and Safety Inspection Form

Project Name:	**Date:**
Project Number:	**Location:**
Prepared By:	**Project Manager:**
Auditor:	**HSS On Site:**

	YES	NO	N/A	COMMENTS
GENERAL				
Is the HASP on site?				
Is the HASP finalized and approved?				
Is the OSHA poster displayed?				
Are emergency telephone numbers posted?				
Is emergency eyewash immediately available?				
Is an emergency shower immediately available?				
Are emergency notification means available (radio, telephone)?				
Is a first-aid kit immediately available?				
Is the first-aid kit adequately stocked?				
Is there a proper sanitation facility on site?				
DOCUMENTATION AND RECORDKEEPING				
Are only personnel listed and approved in the HASP on site?				
Are all personnel properly trained? (Check company-issued wallet cards.)				
Is the daily field log kept by the Site Manager?				
Are levels of PPE recorded?				
Are contaminant levels recorded?				
Are site surveillance records kept by HSS?				
Is a copy of current fit test records on site?				
Are calibration records maintained for air monitoring equipment?				
Are accident / incident forms on site?				
Are field team review sheets signed?				
Are additional hospital route directions available?				
Is the visitors' logbook being accurately maintained?				
Are MSDSs available for all chemicals on site?				
Are HASP revisions recorded?				
Is the first-aid kit inspected weekly?				
Are daily safety meetings held?				
Are emergency procedures discussed during safety meetings?				

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Health and Safety Inspection Form

	YES	NO	N/A	COMMENTS
EMERGENCY RESPONSES				
Is a vehicle available on site for transportation to the hospital?				
Are fire extinguishers on site and immediately available at designated work areas?				
Is at least one person trained in CPR and first aid on site at all times during work activities?				
Do all personnel know who is trained in CPR / first aid?				
PERSONAL PROTECTIVE EQUIPMENT (PPE)				
Is proper PPE being worn as specified in HASP?				
Level of PPE being worn.				
Is PPE adequate for work conditions?				
If not, give reason.				
Upgrade/downgrade to PPE level.				
Does any employee have facial hair that would interfere with respirator fit?				
If yes, willing to shave, as necessary?				
Fit-tested within the last year? (Documentation present)				
If Level B, is a back-up / emergency person suited up (except for air)?				
Does the HSS periodically inspect PPE and equipment?				
Is the PPE not in use properly stored?				
Is all equipment required in the HASP on site?				
Properly calibrated?				
In good condition?				
Used properly?				
Other equipment needed?				
List.				
Is monitoring equipment covered with plastic to minimize contamination?				
PERSONNEL AND EQUIPMENT DECONTAMINATION				
Is the decontamination area properly designated?				
Is appropriate cleaning fluid used for known or suspected contaminants?				
Are appropriate decontamination procedures used?				
Are decontamination personnel wearing proper PPE?				
Is the equipment decontaminated?				

	YES	NO	N/A	COMMENTS
PERSONNEL AND EQUIPMENT DECONTAMINATION (continued)				
Are sample containers decontaminated?				
Are disposable items replaced as required?				
WORK PRACTICES				
Was proper collection and disposal of potentially contaminated PPE performed?				
Was proper collection and disposal of decontamination fluid performed?				
Is water available for decontamination?				
Is the buddy system used?				
Is equipment kept off drums and the ground?				
Is kneeling or sitting on drums or the ground prohibited?				
Do personnel avoid standing or walking through puddles or stained soil?				
Are work zones established?				
If night work is conducted, is there adequate illumination?				
Is smoking, eating, or drinking in the exclusion or CRZ prohibited?				
To the extent feasible, are contaminated materials handled remotely?				
Are contact lenses not allowed on site?				
Is entry into excavations not allowed unless properly shored or sloped?				
Is a competent person on site during excavation?				
Are all unusual situations on site listed in HASP?				
If not, when?				
Action taken?				
HASP revised?				
CONFINED SPACE ENTRY				
Are employees trained according to 1910.146 – Confined Space Entry?				
Are all confined spaces identified? If not, list:				
Is all appropriate equipment available and in good working order?				
Is equipment properly calibrated?				
Are confined space permits used?				
Are confined space permits completely and correctly filled out?				

*N/A = Not Applicable

Attachment E

Safety Meeting Log

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Safety Meeting Log

Project:	**Location:**
Date / Time:	**Activity:**

1. Work Summary

2. Physical / Chemical Hazards: Has JSA been reviewed/modified to address changing conditions?

3. Protective Equipment/Procedures

4. Emergency Procedures

Is there anyone with any medical conditions that they would like the team to know about? For example: Medic Alert, Allergic to bee stings, nitro for chest pains, etc.

Location of medical equipment: fire extinguishers, first aid kit, route to hospital, auto-injectors, etc.

5. Signatures of Attendees

Attachment F

Air Monitoring Log

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Air Monitoring Log

Project: **Date:**

Monitoring Instruments:

Air Monitor: **Activity:**

Level of Protection:

Time	Location	Instrument Reading	Comments

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Attachment G

Underground/Overhead Utilities Checklist

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Underground / Overhead Utility Checklist

Project Name:	**Date:**
Project Number:	**Location:**
Prepared By:	**Project Manager:**

This checklist must be completed for any intrusive subsurface work such as excavation or drilling. It documents that overhead and underground utilities in the work area are identified and located. The Project Manager shall request utility markouts before the start of field operations to allow the client and utility companies sufficient time to provide them. If complete information is not available, a magnetometer or other survey shall be performed to locate obstacles prior to intrusive subsurface activities.

Procedure: A diagram of the work area depicting the proposed location of intrusive subsurface work sites (i.e., boring locations, excavation locations) must be attached to this form. The diagram must clearly indicate the areas checked for underground structures / utilities, and overhead power lines. This form and the diagram must be signed by the BBL Project Manager (if present), the BBL Site Supervisor, and the client representative.

Type of Structure	Present	Not Present	Method of Markout
Electric Power Line			
Natural Gas Line			
Telephone Line			
Water Line			
Product Line			
Sewer Line			
Steam Line			
Drain Line			
Underground Tank			
Underground Cable			
Overhead Power Line			
Overhead Product Line			
Other (Specify)			

Reviewed By

Name	Job Title	Date
	Client Representative	
	BBL Project Manager	
	BBL Site Supervisor	

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Attachment 5

DNAPL Contingency Plan

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Imagine the result

National Fuel Gas Distribution Corporation

Appendix D
DNAPL Contingency Plan

Dunkirk Former Manufactured Gas Plant Site
(Site No. 9-07-035)
Dunkirk, New York

February 2009

I. Scope and Application

This document has been prepared to guide drilling activities at sites where there is a reasonable expectation that dense, non-aqueous phase liquid (DNAPL) may be present, and provide procedures to be implemented in the event that DNAPL is encountered during subsurface investigations. These procedures are proposed to limit the potential of remobilizing DNAPL, if any, in response to drilling and sampling activities. In addition, the procedures are designed to optimize the recovery of encountered DNAPL (if any) in a safe and efficient manner. This DNAPL Contingency Plan was developed based on a similar document prepared by DNAPL expert Bernard H. Kueper, Ph.D., P.Eng., of Queens University, for an EPA Region 1 Superfund Site (Kueper, May 1995).

Downward DNAPL mobilization from overburden into the bedrock may occur in response to drilling activities (short-circuiting along drill stem and/or completed well screen) and groundwater extraction (creation of downward hydraulic gradient in excess of previously measured downward gradients). This DNAPL Contingency Plan addresses drilling-related issues.

II. Personnel Qualifications

DNAPL contingency field activities will be performed by persons who have been trained in proper drilling and well installation procedures under the guidance of an experienced field geologist, engineer, or technician.

III. Equipment List

The following materials will be available during soil boring and monitoring well installation activities, as required:

- Work Plan, Field Sampling Plan (FSP), and site Health and Safety Plan (HASP)
- personal protective equipment (PPE), as required by the HASP
- equipment specified under drilling and well installation SOPs
- hydrophobic dye (Oil Red O or Sudan IV), pertinent at chlorinated solvent sites

- disposable polyethylene pans for performing soil-water pan tests
- clean, empty jars for performing soil-water shake tests

IV. Cautions

The presence or absence of DNAPL at a site can have significant implications in terms of site management, health and safety, and the feasibility of potential remedial alternatives. Therefore, field personnel must be attentive to the potential for DNAPL, recognize when DNAPL is encountered during drilling, and accurately document field observations indicating the presence of DNAPL and interpreted DNAPL depth. In addition, opportunities to characterize DNAPL, when present, may be rare. When practicable, DNAPL samples should be collected and analyzed for physical and chemical characteristics.

V. Health and Safety Considerations

Field activities associated with this DNAPL Contingency Plan will be performed in accordance with the site HASP, a copy of which will be present on site during such activities.

VI. Procedure

DNAPL Screening During Overburden Drilling

To screen for the potential presence of DNAPL in soil, drilling procedures must allow for high-quality porous media samples to be taken. Split-spoon samples or direct-push samplers should be taken continuously in 2-foot intervals ahead of the auger or drill casing. Upon opening each split-spoon sampler or direct-push plastic liner sleeve, the soil will immediately be screened for the presence of organic vapors using a portable photoionization detector (PID) or organic vapor analyzer (OVA). During screening, the soil will be split open using a clean spatula or knife and the PID or OVA probe will be placed in the opening and covered with a gloved hand. Such readings will be obtained along the entire length of the sample.

If the PID or OVA examination reveals the presence of organic vapors above 100 parts per million (ppm), the sample will undergo further detailed evaluation for visible non-aqueous phase liquid (NAPL). The assessment for NAPL will include a combination of the following tests/observations:

- Evaluation for Visible NAPL Sheen or Free-Phase NAPL in Soil Sampler – The NAPL sheen will be a colorful iridescent appearance on the soil sample. NAPL may also appear as droplets or continuous accumulations of liquid with a color typically ranging from yellow to brown to black, depending on the type of NAPL. Creosote DNAPL (associated with wood-treating sites) and coal-tar DNAPL (associated with manufactured gas plant [MGP] sites) are typically black and have a characteristic, pungent odor. Pure chlorinated solvents may be colorless in the absence of hydrophobic dye. Solvents mixed with oils may appear brown.

- Soil-Water Pan Test – A portion of the selected soil interval with the highest PID or OVA reading > 100 ppm will be placed in a disposable polyethylene dish along with a small volume of potable or distilled water. The dish will be gently tilted back and forth to mix the soil and water, and the surface of the water will be viewed in natural light to observe the development of a sheen, if any. A small quantity of Oil Red O or Sudan IV hydrophobic dye powder will be added and the soil and dye will be manually mixed for approximately 30 to 60 seconds and smeared in the dish to create a paste-like consistency using a new nitrile glove-covered hand. A positive test result will be indicated by a sheen on the surface of the water and/or a bright red color imparted to the soil following mixing with dye.

- Soil-Water Shake Test – A small quantity of soil (up to 15 cc) will be placed in a clear, colorless, 40-mL vial containing an equal volume of potable or distilled water. After the soil settles into the water, the surface of the water will be evaluated for a visible sheen. The jar will be closed and gently shaken for approximately 10 to 20 seconds. Again, the surface of the water will be evaluated for a visible sheen or a temporary layer of foam. A small quantity (approximately 0.5 to 1 cc) of Oil Red O or Sudan IV powder will be placed in the jar. The sheen layer will be evaluated for a reaction to the dye (change to bright red color). The jar will be closed and gently shaken for approximately 10 to 20 seconds. The contents in the closed jar will be examined for visible bright red dyed liquid inside the jar. A positive test result will be indicated by the presence of a visible sheen and foam on the surface of water, a reaction between the dye and the sheen layer upon first addition of the dye powder, a bright red coating the inside of the vial (particularly above the water line), or red-dyed droplets within the soil.

- Estimation of Relative Degree of NAPL Saturation – When NAPL is interpreted as present in a particular portion of soil, the field geologist will attempt to estimate the relative degree of NAPL saturation in the soil. Specifically, based on the apparent, visible continuity of NAPL within the soil, an interpretation will be made as to whether the observed NAPL is pooled (continuous section of soil across entire diameter of soil sample in which the pore spaces are filled with a mixture of

NAPL and water) or residual (isolated droplets or blebs of NAPL, surrounded by pore spaces containing only water).

If NAPL is obviously present upon opening the soil sampler or evaluating the soil sample within the split-spoon sampler or direct-push liner sleeve, it is not necessary to perform a soil-water pan test or soil-water shake test. In addition, it is not necessary to perform both a soil-water pan test and a soil-water shake test. Either test method is acceptable. The pan test may be preferred in some circumstances because the presence of a sheen may be easier to see on a wider surface.

The results of each test or observation will be recorded in the field notebook.

DNAPL Screening During Bedrock Drilling

To screen for the potential presence of DNAPL in bedrock, drilling fluids, rock cuttings, and/or core samples are monitored for the presence of sheens. During drilling using rotary methods (coring or roller bit drilling with water or drilling mud), the return fluid will be screened with a PID or OVA and evaluated continuously for the presence of a sheen in the recirculation tub. Where core samples are obtained, they will be carefully evaluated for the presence of a sheen on fracture surfaces. During drilling using air-rotary methods, rock cuttings will be continuously screened using a PID or OVA and evaluated for the presence of a sheen. During drilling with rotary methods, the positive head level at the borehole will reduce the potential for DNAPL short-circuiting via the borehole.

If a sheen is observed with any of these methods, drilling will be temporarily discontinued and an evaluation will be undertaken to determine whether pooled DNAPL is present. The drill stem will be retracted to a few feet above the apparent depth where the sheen was first encountered. Groundwater will be extracted from the borehole to produce a drawdown of 5 to 10 feet below the approximate static, non-pumping water level for a period of 20 minutes to test for the presence of pooled, mobilizable DNAPL in the fractures surrounding the open borehole. The bottom of the borehole will then be evaluated for the presence of DNAPL using an interface probe or bottom-loading bailer. If no DNAPL is observed, the interpretation will be made that the sheen was not produced by pooled DNAPL. In this case, if drilling by the rotary method, the recirculation water will be replaced by clean water and drilling will continue. Replacing the recirculation water reduces the potential for cross-contamination and facilitates observation of a newly created sheen, if any, at a deeper interval. Accumulation of DNAPL in the bottom of the borehole, however, indicates that the boring has encountered pooled DNAPL. If DNAPL has accumulated, it will be removed using a bottom-loading bailer or pump.

Data Collection Below Zone Containing Pooled DNAPL

If pooled DNAPL is encountered in a borehole and deeper drilling is required to collect data below a zone containing pooled DNAPL, one of the following actions will be taken.

1. Adjustment of Drilling Location - The boring where pooled DNAPL was encountered will be abandoned by tremie grouting using neat cement grout and a replacement boring will be re-attempted at a nearby location.

2. DNAPL Sump Installation - A DNAPL collection well will be installed with a blank sump properly grouted in place below the screen and the boring will be re-attempted at a nearby location. In this case, after removing the DNAPL in the borehole, the boring may be advanced an additional 2 to 3 feet to accommodate a blank sump below the interval with apparent pooled DNAPL.

3. Casing Off DNAPL Layers - If pooled DNAPL is found to be present throughout an area where deeper drilling is essential, a permanent, grouted casing should be installed. The bottom of the pooled DNAPL likely coincides with the top of a relatively fine-grained, low permeability, stratum (capillary barrier). Permanent casing will be installed to the bottom of the borehole and grouted in place using the displacement method prior to advancing the borehole any further. In this case, after removing any DNAPL that may have accumulated in the borehole, the boring may be advanced a few feet into the top of the underlying confining layer or up to 5 feet in bedrock prior to grouting the casing to assist in isolating the zone containing apparently pooled DNAPL. When the casing is grouted in place and the grout has set, the drilling recirculation water will be replaced with clean water to prevent cross-contamination and facilitate observation of a newly created sheen (if any) at a deeper interval, and drilling will continue.

DNAPL Monitoring

New wells installed in borings where DNAPL was encountered during drilling will be monitored for DNAPL accumulation in the DNAPL sump using an oil-water interface probe or bottom-loading bailer within approximately one day following initial installation. If DNAPL is encountered, a bottom-loading bailer or pump will be used to remove the DNAPL, the final DNAPL thickness will be recorded, and the DNAPL thickness will be reassessed after another day of accumulation (if any). This process will be repeated until DNAPL no longer accumulates overnight, at which point the accumulation monitoring and removal period will extend to one-week intervals. If no DNAPL accumulation is observed over a period of one week, further DNAPL monitoring may be continued with a longer period between monitoring events.

Any DNAPL recovered during drilling and monitoring activities should be analyzed for chemical composition, DNAPL-water interfacial tension, density, and viscosity. The physical tests should be performed at the approximate groundwater temperature at the site where the DNAPL sample was obtained, typically between 10ºC and 20ºC. These parameters will allow for correlation of groundwater chemistry with suspected DNAPL locations and will allow an estimate to be made of the volume and potential mobility of DNAPL, if any, in the formation.

VII. Waste Management

DNAPL removed from wells will be temporarily stored on-site in metal drums for subsequent appropriate off-site disposal. The locations and volumes of recovered DNAPL will be noted.

VIII. Data Recording and Management

Any occurrence of DNAPL encountered during subsurface investigations will be documented in an appropriate field notebook in terms of the drilling location (boring or well identification), depth below surface, type of geologic material DNAPL was observed within, field screening and testing results, and apparent degree of DNAPL saturation (pooled or residual). DNAPL locations and depths will be recorded on subsurface log forms, as appropriate.

IX. Quality Assurance

DNAPL can be mobilized downward as a result of drilling operations. It is very difficult to drill through DNAPL without bringing about vertical DNAPL mobilization. This opinion is stated by USEPA (1992): “In DNAPL zones, drilling should generally be minimized and should be suspended when a potential trapping layer is first encountered. Drilling through DNAPL zones into deeper stratigraphic units should be avoided.” The DNAPL screening procedure outlined in this plan should, therefore, be implemented while drilling at all locations and depths within overburden or bedrock where potential DNAPL presence is suspected. If data collection is required below a zone containing DNAPL, the interval containing DNAPL will be cased off prior to drilling deeper.

X. References

Kueper, B.H., May 11, 1995. DNAPL Contingency Plan. [Prepared at the request of *de maximis, inc*.].

United States Environmental Protection Agency (USEPA), 1992. Memorandum from D. Clay: Considerations in Ground-Water Remediation at Superfund Sites and RCRA Facilities – Update. OSWER Directive No. 9283.1-06.

ARCADIS

Attachment 6

Community Air Monitoring Plan

ARCADIS
Infrastructure · Water · Environment · Buildings

Imagine the result

National Fuel Gas Distribution Corporation

Community Air Monitoring Plan

Dunkirk Former Manufactured Gas Plant Site
Dunkirk, New York

March 2012

Community Air Monitoring Plan

Dunkirk Former Manufactured
Gas Plant Site
Dunkirk, New York

Prepared for:
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B0023301.0001.00002

Date:
March 2012

Attachments

1. Introduction

1.1 General

This *Community Air Monitoring Plan* (CAMP) has been prepared to support the implementation of investigation activities at the Dunkirk Former Manufactured Gas Plant (MGP) site (hereafter referred to as "site"), in Dunkirk, Chautauqua County, New York. The purpose of this CAMP is to describe the activities that will be conducted to monitor for potential airborne releases of constituents of concern during investigation activities. This CAMP fulfills the requirements set forth in the New York State Department of Environmental Conservation's (NYSDEC's) DER-10/Technical Guidance for Site Investigation and Remediation (May 2010) (DER-10). The DER-10 CAMP requirements are identified in DER-10 Appendix 1A, New York State Department of Health (NYSDOH) Generic Community Air Monitoring Plan, dated December 2009; and Appendix 1B, Fugitive Dust and Particulate Monitoring. DER-10 Appendices 1A and 1B are provided in Attachment A to this CAMP. The intent of this CAMP is to provide for a measure of protection of the downwind communities from potential airborne releases of constituents of concern during investigation activities. As such, this CAMP specifies the potential air emissions, air monitoring procedures, monitoring schedule and data collection and reporting for the investigation activities to be conducted, as described below.

1.2 Site Description

The approximately three-acre site is located at 31 West 2nd Street at the southeastern corner of the intersection of Swan Street and West 2nd Street in Dunkirk, Chautauqua County, New York. The site comprises a generally rectangular piece of land that is located in a mixed commercial and residential area. Lake Erie is located about 600 feet north of the site. The site is bordered by Swan Street to the west, West 2nd Street to the north, Eagle Street to the east, and an elevated railroad bed to the south. A Baptist Church is located near the southeastern corner of the site; however, a narrow strip of National Fuel property borders the church property to the south.

A National Fuel Service Center building sits on the northeastern quadrant of the site. The Service Center building consists of a high-bay garage located south of the attached office area. Two other buildings are present at the property – a small metal sided storage building and a brick gas regulator building, which are both located south-south west of the Service Center building. A fuel pump island is located west of the metal sided storage building and consists of a pump island supported by an above ground storage tank (AST) containing diesel and an underground storage tank (UST) containing gasoline.

Refer to Figure 2 of the Site Characterization Work Plan (ARCADIS, 2009) for a visual depiction of site features.

1.3 Summary of Investigation Activities

As defined in the NYSDOH's Generic CAMP (included as Attachment A), investigation activities to be performed at the site have the potential to generate localized impacts to air quality. Activities covered by this CAMP may include:

- drilling soil borings
- excavating test pits or trenches
- sampling soil
- sampling groundwater from monitoring wells

1.4 Air/Odor Emissions and Control Measures

Air emissions control and fugitive dust suppression techniques will be used during the investigation activities identified above, as necessary, to limit the air/odor emissions from the site. Air monitoring for the specific purpose of protecting the community from site activity impacts (and verification thereof) will take place during both intrusive and non-intrusive investigation activities. Odor and dust control measures will be available at the site and used when necessary during these activities. The following vapor and dust control measures may be used during these activities, depending upon specific circumstances, visual observations, and air monitoring results:

- Polyethylene sheeting (for covering drill cuttings, etc.)
- Water/BioSolve® spray
- Minimizing excavation surface area to be exposed at any given time.
- Vapor suppression foam

Polyethylene sheeting/BioSolve®/foam would be used to control nuisance odors and volatile organic compound (VOC) emissions, as needed. Also, dust emissions at the site will be controlled by spraying water on exposed dry surface soil areas (e.g. stockpiled drill cuttings, etc., as appropriate), through the use of silt fences, and by covering soil stockpiles. Odor and dust control measures will be implemented based on visual or olfactory observations, and the results of airborne particulate and VOC monitoring.

2. Air Monitoring Procedures

2.1 General

Real-time air monitoring will be implemented at the site for VOCs, and particulate matter less than 10 microns in diameter (PM_{10}). A site boundary will be established for the purpose of air monitoring. Upwind and downwind monitoring locations will be determined through visual observation (wind vane, windsock, or similar technique). Monitoring will occur at each sample location and will include the use of hand-held direct-reading survey instruments.

2.2 Monitoring Location Selection

Monitoring activities will be determined daily based on visual observation of a wind direction. One upwind and one downwind monitoring location will be selected daily where both VOC and PM_{10} will be recorded. This upwind location will be established at the start of the workday, each day before the start of activities. Sampling activities will continue in the downwind direction throughout the day. If wind direction during the workday shifts greater than approximately +/-60 degrees from original upwind, then new upwind and downwind monitoring locations will be established. Any location changes will be documented in the field logbook.

2.3 VOCs Monitoring

As required by the NYSDOH guidance for community air monitoring during intrusive activities, VOCs will be monitored continuously during ground intrusive activities (installation of soil borings and excavating test pits/trenches) with instrumentation that is equipped with electronic data-logging capabilities. A MiniRAE 2000 (or equivalent) will be used to conduct the real-time VOC monitoring. Attachment B provides detailed information on the MiniRAE 2000. All 15-minute readings will be recorded in the field logbook, as well as any instantaneous readings taken to facilitate activity decisions.

During non-intrusive site activities (collection of soil samples, well development, collection of groundwater samples), VOCs will be monitored periodically. Periodic monitoring may include monitoring upon arrival at the sample location, monitoring while opening a well cap, monitoring during well bailing and/or purging, and/or monitoring prior to leaving a sample location. However, if a sampling location is near potentially exposed individuals, VOCs will be monitored continuously during sampling activities at that location.

2.4 Particulate Matter Monitoring

As required by the NYSDOH guidance (Attachment A), real-time particulate matter will be monitored continuously during intrusive site activities using instrumentation equipped with electronic data-logging capabilities. A MIE DataRAM (or equivalent) will be used to conduct the real-time PM_{10} monitoring. Attachment B provides detailed information on the MIE DataRAM. All 15-minute readings will be recorded in the field logbook, as well as any instantaneous readings taken to facilitate activity decisions.

Fugitive dust migration will be visually assessed during all work activities, and reasonable dust suppression techniques will be used during any site activities that may generate fugitive dust. These activities and their design controls were discussed previously in Section 1.4 of this plan.

2.5 Action Levels

The action levels provided below are to be used to initiate response actions, if necessary, based on real-time monitoring.

2.5.1 Action Levels for VOCs

As outlined in the NYSDOH guidance document (Attachment A), if the ambient air concentration of total VOCs exceeds 5 parts per million (ppm) above the background (upwind location) for the 15-minute average, intrusive site activities will be temporarily halted while monitoring continues. If the total VOC concentration readily decreases (through observation of instantaneous readings) below 5 ppm above background, then intrusive site activities can resume with continuous monitoring.

If the ambient air concentrations of total VOCs persist at levels in excess of 5 ppm above background but less than 25 ppm above background, intrusive site work activities will be halted, the source of the elevated VOC concentrations identified, corrective actions to reduce or abate the emissions undertaken, and air monitoring will be continued. Once these actions have been implemented, intrusive site work activities can resume provided the following two conditions are met:

- The 15-minute average VOC concentrations remain below 5 ppm above background.

- The VOC level 200 feet downwind of the sample location or half the distance to the nearest potential receptor or residential/commercial structure (whichever is less but in no case less than 20 feet) is below 5 ppm over background for the 15-minute average.

If the ambient air concentrations of total VOCs are above 25 ppm above background, the intrusive site activities must cease, and emissions control measures must be implemented.

Periodic monitoring for VOCs is required during non-intrusive activities such as collection of soil samples, well development, and the collection of groundwater samples from monitoring wells. If these activities are undertaken at the site, ambient direct-reading (instantaneous) VOC data will be periodically collected at the location of the non-intrusive activity and recorded in the field activity logbooks.

2.5.2 Action Level for PM_{10}

As required by the NYSDOH guidance (Attachment A), if the ambient air concentration of PM_{10} at any one (or more) of the sampling locations is noted at levels in excess of 100 micrograms per cubic meter ($\mu g/m^3$) above the background (upwind location), or if airborne dust is observed leaving the work area, intrusive site activities will be temporarily halted. The source of the elevated PM_{10} concentration is to be identified, corrective actions to reduce or abate the emissions will be undertaken, and air monitoring will continue. Work may continue following the implementation of dust suppression techniques provided the PM_{10} levels do not exceed 150 $\mu g/m^3$ above background.

If, after implementation of dust suppression techniques, PM_{10} levels are greater than 150 $\mu g/m^3$ above background, work must be stopped and site activities must be re-evaluated. Work may only resume provided that the dust suppression measures and other controls are successful in reducing PM_{10} levels less than 150 $\mu g/m^3$ above background and in preventing visible dust from leaving the site.

If the ambient air concentration of PM_{10} is above 150 $\mu g/m^3$ above background, the intrusive site activities must cease and emissions control measures must be implemented.

2.6 Meteorological Monitoring

Wind direction is the only meteorological information considered relevant for the investigation activities and CAMP. Meteorological monitoring will be conducted periodically at the site using a windsock, wind vane, or other appropriate equipment. Wind direction will be established at the start of each work day and may be re-established at any time during the work day if a significant shift in wind direction is noted.

2.7 Instrument Calibration

Calibration of the VOC and PM_{10} instrumentation will occur in accordance with each of the equipment manufacturer's calibration and quality assurance requirements. The VOC and PM_{10} monitors will be calibrated at least daily, and calibrations will be recorded in the field activity logbook.

3. Monitoring Schedule and Data Collection and Reporting

3.1 General

The proposed monitoring schedule and data collection and reporting requirements are discussed below.

3.2 Monitoring Schedule

Real-time VOC and PM_{10} monitoring will be performed continuously throughout the remedial action during intrusive site/materials handling activities. VOC monitoring will also be performed during non-intrusive sampling-type activities. Wind direction will be determined at the start of each day and at any other appropriate time during investigation activities.

3.3 Data Collection and Reporting

Air monitoring data will be collected continuously from VOC and PM_{10} monitors during intrusive site activities by an electronic data-logging system. The data management software will be set up so that instantaneous observed readings would be recorded by the electronic data acquisition system and averaged over 15-minute time periods. The 15-minute readings and instantaneous readings taken to facilitate activity decisions will be recorded and archived for review by NYSDOH and NYSDEC personnel.

Attachment A

NYSDOH Generic Community Air Monitoring Plan (from NYSDEC DER-10/Technical Guidance for Site Investigation and Remediation [May 2010])

APPENDIX 1A

New York State Department of Health
Generic Community Air Monitoring Plan

A Community Air Monitoring Plan (CAMP) requires real-time monitoring for volatile organic compounds (VOCs) and particulates (i.e., dust) at the downwind perimeter of each designated work area when certain activities are in progress at contaminated sites. The CAMP is not intended for use in establishing action levels for worker respiratory protection. Rather, its intent is to provide a measure of protection for the downwind community (i.e., off-site receptors including residences and businesses and on-site workers not directly involved with the subject work activities) from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, the CAMP helps to confirm that work activities did not spread contamination off-site through the air.

The generic CAMP presented below will be sufficient to cover many, if not most, sites. Specific requirements should be reviewed for each situation in consultation with NYSDOH to ensure proper applicability. In some cases, a separate site-specific CAMP or supplement may be required. Depending upon the nature of contamination, chemical- specific monitoring with appropriately-sensitive methods may be required. Depending upon the proximity of potentially exposed individuals, more stringent monitoring or response levels than those presented below may be required. Special requirements will be necessary for work within 20 feet of potentially exposed individuals or structures and for indoor work with co-located residences or facilities. These requirements should be determined in consultation with NYSDOH.

Reliance on the CAMP should not preclude simple, common-sense measures to keep VOCs, dust, and odors at a minimum around the work areas.

Community Air Monitoring Plan

Depending upon the nature of known or potential contaminants at each site, real-time air monitoring for volatile organic compounds (VOCs) and/or particulate levels at the perimeter of the exclusion zone or work area will be necessary. Most sites will involve VOC and particulate monitoring; sites known to be contaminated with heavy metals alone may only require particulate monitoring. If radiological contamination is a concern, additional monitoring requirements may be necessary per consultation with appropriate NYSDEC/NYSDOH staff.

Continuous monitoring will be required for all ground intrusive activities and during the demolition of contaminated or potentially contaminated structures. Ground intrusive activities include, but are not limited to, soil/waste excavation and handling, test pitting or trenching, and the installation of soil borings or monitoring wells.

Periodic monitoring for VOCs will be required during non-intrusive activities such as the collection of soil and sediment samples or the collection of groundwater samples from existing monitoring wells. “Periodic” monitoring during sample collection might reasonably consist of taking a reading upon arrival at a sample location, monitoring while opening a well cap or overturning soil, monitoring during well baling/purging, and taking a reading prior to leaving a sample location. In some instances, depending upon the proximity of potentially exposed individuals, continuous monitoring may be required during sampling activities. Examples of such situations include groundwater sampling at wells on the curb of a busy urban street, in the midst of a public park, or adjacent to a school or residence.

VOC Monitoring, Response Levels, and Actions

Volatile organic compounds (VOCs) must be monitored at the downwind perimeter of the immediate work area (i.e., the exclusion zone) on a continuous basis or as otherwise specified. Upwind concentrations should be measured at the start of each workday and periodically thereafter to establish background conditions. The monitoring work should be performed using equipment appropriate to measure the types of contaminants known or suspected to be present. The equipment should be calibrated at least daily for the contaminant(s) of concern or for an appropriate surrogate. The equipment should be capable of calculating 15-minute running average concentrations, which will be compared to the levels specified below.

- If the ambient air concentration of total organic vapors at the downwind perimeter of the work area or exclusion zone exceeds 5 parts per million (ppm) above background for the 15-minute average, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

- If total organic vapor levels at the downwind perimeter of the work area or exclusion zone persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions, and monitoring continued. After these steps, work activities can resume provided that the total organic vapor level 200 feet downwind of the exclusion zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less **-** but in no case less than 20 feet, is below 5 ppm over background for the 15-minute average.

- If the organic vapor level is above 25 ppm at the perimeter of the work area, activities must be shutdown.

All 15-minute readings must be recorded and be available for State (DEC and DOH) personnel to review. Instantaneous readings, if any, used for decision purposes should also be recorded.

Particulate Monitoring, Response Levels, and Actions

Particulate concentrations should be monitored continuously at the upwind and downwind perimeters of the exclusion zone at temporary particulate monitoring stations. The particulate monitoring should be performed using real-time monitoring equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) and capable of integrating over a period of 15 minutes (or less) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level. In addition, fugitive dust migration should be visually assessed during all work activities.

- If the downwind PM-10 particulate level is 100 micrograms per cubic meter (mcg/m^3) greater than background (upwind perimeter) for the 15-minute period or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 mcg/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

- If, after implementation of dust suppression techniques, downwind PM-10 particulate levels are greater than 150 mcg/m^3 above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures and other controls are successful in reducing the downwind PM-10 particulate concentration to within 150 mcg/m^3 of the upwind level and in preventing visible dust migration.

All readings must be recorded and be available for State (DEC and DOH) personnel to review.

NEW YORK STATE
DEPARTMENT OF
ENVIRONMENTAL CONSERVATION

Fugitive Dust Suppression and Particulate Monitoring Program (TAGM - 4031)

To:	Regional Hazardous Waste Remediation Engrs., Bur. Directors & Section Chiefs
From:	Michael J. O'Toole, Jr., Director, Division of Hazardous Waste Remediation (signed)
Subject:	Technical and Administrative Guidance Memorandum -- Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites
Date:	Oct 27, 1989

1. Introduction

Fugitive dust suppression, particulate monitoring, and subsequent action levels for such must be used and applied consistently during remedial activities at hazardous waste sites. This guidance provides a basis for developing and implementing a fugitive dust suppression and particulate monitoring program as an element of a hazardous waste site's health and safety program.

2. Background

Fugitive dust is particulate matter--a generic term for a broad class of chemically and physically diverse substances that exist as discrete particles, liquid droplets or solids, over a wide range of sizes--which becomes airborne and contributes to air quality as a nuisance and threat to human health and the environment.

On July 1, 1987, the United States Environmental Protection Agency (USEPA) revised the ambient air quality standard for particulates so as to reflect direct impact on human health by setting the standard for particulate matter less than ten microns in diameter (PM_{10}); this involves fugitive dust whether contaminated or not. Based upon an examination of air quality composition, respiratory tract deposition, and health effects, PM_{10} is considered conservative for the primary standard--that requisite to protect public health with an adequate margin of safety. The primary standards are 150 ug/m^3 over a 24-hour averaging time and 50 ug/m^3 over an annual averaging time. Both of these standards are to be averaged arithmetically.

There exists real-time monitoring equipment available to measure PM_{10} and capable of integrating over a period of six seconds to ten hours. Combined with an adequate fugitive dust suppression program, such equipment will aid in preventing the off-site migration of contaminated soil. It will also protect both on-site personnel from exposure to high levels of dust and the public around the site from any exposure to any dust. While specifically intended for the protection of on-site personnel as well as the public, this program is not meant to replace long-term monitoring which may be required given the contaminants inherent to the site and its air quality.

3. Guidance

A program for suppressing fugitive dust and monitoring particulate matter at hazardous waste sites can be developed without placing an undue burden on remedial activities while still being protective of health and environment. Since the responsibility for implementing this program ultimately will fall on the party performing the work, these procedures must be incorporated into appropriate work plans. The following fugitive dust suppression and particulate monitoring program will be employed at hazardous waste sites during construction and other activities which warrant its use:

1. Reasonable fugitive dust suppression techniques must be employed during all site activities which may generate fugitive dust.

2. Particulate monitoring must be employed during the handling of waste or contaminated soil or when activities on site may generate fugitive dust from exposed waste or contaminated soil. Such activities shall also include the excavation, grading, or placement of clean fill, and control measures therefore should be considered.

3. Particulate monitoring must be performed using real-time particulate monitors and shall monitor particulate matter less than ten microns (PM_{10}) with the following minimum performance standards:

   Object to be measured: Dust, Mists, Aerosols
   Size range: <0.1 to 10 microns
   Sensitivity: 0.001 mg/m^3
   Range: 0.001 to 10 mg/m^3
   Overall Accuracy: ±10% as compared to gravimetric analysis of stearic acid or reference dust

Operating Conditions:
Temperature: 0 to 40^{o}C
Humidity: 10 to 99% Relative Humidity

Power: Battery operated with a minimum capacity of eight hours continuous operation

Automatic alarms are suggested.

Particulate levels will be monitored immediately downwind at the working site and integrated over a period not to exceed 15 minutes. Consequently, instrumentation shall require necessary averaging hardware to accomplish this task; the P-5 Digital Dust Indicator as manufactured by MDA Scientific, Inc. or similar is appropriate.

4. In order to ensure the validity of the fugitive dust measurements performed, there must be appropriate Quality Assurance/Quality Control (QA/QC). It is the responsibility of the entity operating the equipment to adequately supplement QA/QC Plans to include the following critical features: periodic instrument calibration, operator training, daily instrument performance (span) checks, and a record keeping plan.

5. The action level will be established at 150 ug/m^3 over the integrated period not to exceed 15 minutes. While conservative, this short-term interval will provide a real-time assessment of on-site air quality to assure both health and safety. If particulate levels are detected in excess of 150 ug/m^3, the upwind background level must be measured immediately using the same portable monitor. If the working site particulate measurement is greater than 100 ug/m^3 above the background level, additional dust suppression techniques must be implemented to reduce the generation of fugitive dust and corrective action taken to protect site personnel and reduce the potential for contaminant migration. Corrective measures may include increasing the level of personal protection for on-site personnel and implementing additional dust suppression techniques (see Paragraph 7). Should the action level of 150 ug/m^3 be exceeded, the Division of Air Resources must be notified in writing within five working days; the notification shall include a description of the control measures implemented to prevent further exceedences.

6. It must be recognized that the generation of dust from waste or contaminated soil that migrates off-site, has the potential for transporting contaminants off-site. There may be situations when dust is being generated and leaving the site and the monitoring equipment does not measure PM_{10} at or above the action level. Since this situation has the potential to migrate contaminants off-site, it is unacceptable. While it is not practical to quantify total suspended particulates on a real-time basis, it is appropriate to rely on visual observation. If dust is observed leaving the working site, additional dust suppression techniques must be employed. Activities that have a high dusting potential--such as solidification and treatment involving materials like kiln dust and lime--will require the need for special measures to be considered.

7. The following techniques have been shown to be effective for the controlling of the generation and migration of dust during construction activities:

    1. Applying water on haul roads.
    2. Wetting equipment and excavation faces.
    3. Spraying water on buckets during excavation and dumping.
    4. Hauling materials in properly tarped or watertight containers.
    5. Restricting vehicle speeds to 10 mph.
    6. Covering excavated areas and material after excavation activity ceases.
    7. Reducing the excavation size and/or number of excavations.

    Experience has shown that utilizing the above-mentioned dust suppression techniques, within reason as not to create excess water which would result in unacceptable wet conditions, the chance of exceeding the 150 ug/m^3 action level at hazardous waste site remediations is remote. Using atomizing sprays will prevent overly wet conditions, conserve water, and provide an effective means of suppressing the fugitive dust.

8. If the dust suppression techniques being utilized at the site do not lower particulates to an acceptable level (that is, below 150 ug/m^3 and no visible dust), work must be suspended until appropriate corrective measures are approved to remedy the situation. Also, the evaluation of weather conditions will be necessary for proper fugitive dust control--when extreme wind conditions make dust control ineffective, as a last resort remedial actions may need to be suspended.

There may be situations that require fugitive dust suppression and particulate monitoring requirements with action levels more stringent than those provided above. Under some circumstances, the contaminant concentration and/or toxicity may require appropriate toxics monitoring to protect site personnel and the public. Additional integrated sampling and chemical analysis of the dust may also be in order. This must be evaluated when a health and safety plan is developed and when appropriate suppression and monitoring requirements are established for protection of health and the environment.

Attachment B

Monitoring Equipment Specifications

MiniRAE 2000

Portable Handheld VOC Monitor

The rugged MiniRAE 2000 is the smallest pumped handheld volatile organic compound (VOC) monitor on the market. Its Photoionization Detector's (PID) extended range of 0 to 10,000 ppm makes it an ideal instrument for applications from environmental site surveying to HazMat/ Homeland Security.

AutoRAE Compatible

Wireless

Key Features

- **Proven PID technology** The patented sensor provides a 3-second response up to 10,000 ppm and sets a new standard for resistance to moisture and dirt.
- **Wireless communication enabled and certified**
- **Self-cleaning lamp and sensor** The patented self-cleaning lamp and sensor minimize the need for maintenance and calibration.
- **The MiniRAE 2000 lamp and sensor can be taken apart in seconds for easy maintenance without tools!**
- **Measure more chemicals than with any other PID.** With over 100 Correction Factors built into the MiniRAE 2000 memory and the largest printed list of Correction Factors in the world (300+), RAE Systems offers the ability to accurately measure more ionizable chemicals than any other PID. When a gas is selected from the MiniRAE 2000's library, the alarm points are automatically loaded into the meter.
- **User friendly** screens make it easy to use for simple applications and flexible enough for sophisticated operations.
- **Drop-in battery** When work schedules require putting in more than the 10 hours supplied by the standard NiMH battery, the drop-in alkaline pack supplied with every MiniRAE 2000 lets you finish the job.
- **Rugged Rubber Boot** The standard rubber boot helps assure that the MiniRAE 2000 survives the bumps and knocks of tough field use.
- **Strong, built-in sample pump** draws up to 100 feet (30 m) horizontally or vertically.
- **Tough, flexible inlet probe**
- **Large keys** operable with 3 layers of gloves.
- **Easy-to-read display** with backlight.
- **Stores up to 267 hours of data** at one-minute intervals for downloading to PC.
- **3-year 10.6 eV lamp warranty**

Applications

HazMat/Homeland Security

- Initial PPE (personal protective equipment) assessment
- Leak detection
- Safety perimeter establishment and maintenance
- Spill delineation
- Decontamination
- Remediation

Industrial Hygiene/Safety

- Confined Space Entry (CSE)
- Indoor Air Quality (IAQ)
- Worker exposure studies

Environmental

- Soil and water headspace analysis
- Leaking underground storage tanks
- Perimeter fenceline monitoring
- Fugitive emissions (EPA Method 21)
- Vapor recovery breakthrough
- Landfill monitoring

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MiniRAE 2000

Specifications*

Detector Specifications

Size	8.2" L x 3.0" W x 2.0" H (21.8 x 7.62 x 5.0 cm)
Weight	20 oz with battery pack (553 g) w/o rubber boot
Sensor	Photoionization sensor with standard 10.6 eV or optional 9.8 eV or 11.7 eV UV lamp
Battery	• Rechargeable, external, field-replaceable Nickel-Metal-Hydride (NiMH) battery pack • Alkaline battery holder (for 4 AA batteries)
Operating Period	10 hours continuous operation
Display	Large LCD, backlight activated manually, by alarms or by darkness
Keypad	1 operation and 2 programming keys
Direct Readout	• VOCs as ppm by volume • High and low values • STEL and TWA (in hygiene mode) • Battery and shut down voltage
Alarms	90 dB buzzer and flashing red LED to indicate exceeded preset limits: • High: 3 beeps and flashes per second • Low: 2 beeps and flashes per second • STEL and TWA: 1 beep and flash per second • Alarms automatic reset or latching with manual override • Optional plug-in pen size vibration alarm • User adjustable alarm limits
Calibration	Two-point field calibration of zero and standard reference gas. Calibration memory of 8 calibration gases, alarm limits, span values and calibration date
Datalogging	267 hours (at one-minute intervals) with date/time. Header information includes monitor serial number, user ID, site ID, date and time
Sampling Pump	• Internal, integrated flow rate of 400 cc/min • Sample from 100' (30 m) horizontally or vertically
Low Flow Alarm	Auto shut-off pump at low flow condition
Communication	Download data and upload instrument set-up from PC through RS-232 link to serial port. Wireless communication enabled and certified (requires RAELink2 and ProRAE Remote to use)
Temperature	14° F to 104° F (-10° C to 40° C)
Humidity	0% to 95% relative humidity (non-condensing)
EM/RFI	Highly resistant to EMI /RFI. Compliant with EMC Directive 89/336/EEC
IP-rating	IP-55: protected against dust, protected against low-pressure jets of water from all directions
Hazardous Area Approval	• **US and Canada:** UL and cUL, Classified for use in Class I, Division 1, Groups A, B, C and D hazardous locations • **Europe:** ATEX II IG EEx ia IIC T4
Attachment	Durable bright yellow rubber boot w/belt clip & wrist strap
Warranty	Lifetime on non-consumable components (per RAE Systems Standard Warranty), 3 years for 10.6.V PID lamp, 1 year for pump and battery

* Specifications are subject to change
** Performance based on isobutylene calibration

Default Sensor Settings**

Gas Monitor (ppm)	Range (ppm)	Resolution Time (T90)	Response
VOCs	0 to 99.9 ppm	0.1 ppm	< 3 sec
	100 to 10,000 ppm	1 ppm	< 3 sec

MiniRAE 2000 and Accessories

Monitor only includes:

- RAE Systems UV lamp: 10.6 eV, 9.8 eV or 11.7 eV as specified
- ProRAE Suite software package for Windows® 98, NT, 2000 and XP
- Computer interface cable
- 5-inch Flex-I-Probe
- External filter
- Rubber boot with belt clip
- Alkaline battery adapter
- Tool kit
- Lamp cleaning kit
- Nickel-Metal-Hydride (NiMH) battery
- 120/230 V AC/DC wall adapter (if specified)
- Operation and maintenance manual

Monitor with accessories kit adds:

- Hard transport case with pre-cut foam padding
- 5 porous metal filters and O-rings
- Organic vapor zeroing adapter
- Gas outlet port and tubing

Optional calibration kit adds:

- 10 ppm isobutylene calibration gas, 34L
- Calibration regulator and flow controller

Optional Guaranteed Cost of Ownership Program:

- 4-year repair and replacement guarantee
- Annual maintenance service

DISTRIBUTED BY:

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RAE SYSTEMS

Product Overview

All these applications in one small unit

- Indoor air quality monitoring
- Walk-through surveys
- Personal exposure monitoring
- Time & motion studies
- Workplace & plant monitoring
- Fixed-point continuous monitoring
- Remediation personal surveillance
- Remote alarming
- Mobile monitoring in vehicles & aircraft
- Toxicology & epidemiology studies
- Emergency response
- Testing air filtration efficiency

personalDataRAM™ Series

Measures airborne particulate concentration in real time

- pDR-1000AN
  For passive air sampling applications
- pDR-1200
  For active air sampling applications

Analyze • Detect • Measure • Control™

Thermo
ELECTRON CORPORATION

personalDataRAM™ Series
Features and Technical Specifications

pDR-1000AN
Hand-held and fixed-point, real-time aerosol monitor/datalogger

Measure airborne particulate concentration in real-time

The *personal*DataRAM (*p*DR-1000AN) measures mass concentrations of dust, smoke, mists, and fumes in real time, and sounds an audible alarm whenever the user-defined level is exceeded. Conventional filter-based monitoring methods cannot indicate dangerous, real-time dust levels. In contrast, the *p*DR-1000AN alerts you to a problem within seconds, allowing you to take immediate action. With the datalogging enabled, the instrument automatically tags and time stamps the data collected, and stores it for subsequent retrieval, printing, or graphing through a computer.

Highest performance of any real-time personal particulate monitor

With a measurement range from 0.001 to 400 mg/m^3 (auto-ranging), and an optical feedback stabilized sensing system, the *p*DR-1000AN sets the standard for sensitivity, long-term stability and reliability.

The palm-sized *p*DR-1000AN weighs only 18 oz (0.5 kg) for easy portability and attachment to a belt or a shoulder strap. The absence of any moving parts, such as pumps, motors and valves, and the use of low-power semiconductors housed in a ruggedized case ensures long life and dependable operation.

High correlation with gravimetric measurement

The *p*DR-1000AN is a light-scattering photometer (i.e., nephelometer) incorporating a pulsed, high output, near-infrared light emitting diode source, a silicon detector/hybrid preamplifier, and collimating optics and a source reference feedback PIN silicon detector. The intensity of the light scattered over the forward angle of 50^{o} to 90^{o} by airborne particles passing through the sensing chamber is linearly proportional to their concentration. This optical configuration produces optimal response to particles in the size range of 0.1-10 µm, achieving high correlation with standard gravimetric measurements of the respirable and thoracic fractions.

Simple zeroing and calibration

The *p*DR-1000AN arrives practically ready to use after the easy zeroing step. The unit comes gravimetrically calibrated in mg/m^3 (NIST traceable) using standard SAE Fine test dust (ISO Fine). Zeroing with particle-free air is accomplished quickly and effectively under field conditions using the zeroing kit included with the instrument. Internal firmware controls an automatic calibration check. To maximize efficiency in the field, gravimetric calibration can be performed by comparison with a filter sampler and programming of the calibration constant.

Standard Accessories

- Universal voltage power supply
- PC communications software
- Zeroing kit
- Belt clip kit
- Instruction manual
- Carrying case
- Signal output cables

Optional Accessories

- Rechargeable battery pack (NiMH)
- Active sampling kit (converts *p*DR-1000AN to *p*DR-1200)
- Portable pump unit
- Shoulder strap
- Remote alarm interface
- Wall mounting bracket

pDR-1200
Active aerosol monitor/datalogger, plus aerodynamic sizing

Designed for active particulate monitoring applications

The *personal*DataRam™ (model *p*DR-1200) performs active sampling applications and aerosol sizing. The *p*DR-1200 requires a vacuum pump module to perform particle size selective measurements under field conditions. The separate pump (not included) is required for active sampling and aerosol sizing. With optional inlet accessories, the *p*DR-1200 is excellent for ambient air measurements under variable wind and high humidity conditions. It is ideal for respirable, thoracic, and PM2.5 monitoring, as well as continuous emission and test chamber monitoring. With an isokinetic sampling set, the *p*DR-1200 can be used for stack and duct extractive sampling monitoring. Membrane filters can be used to capture particles for particles for subsequent laboratory analysis.

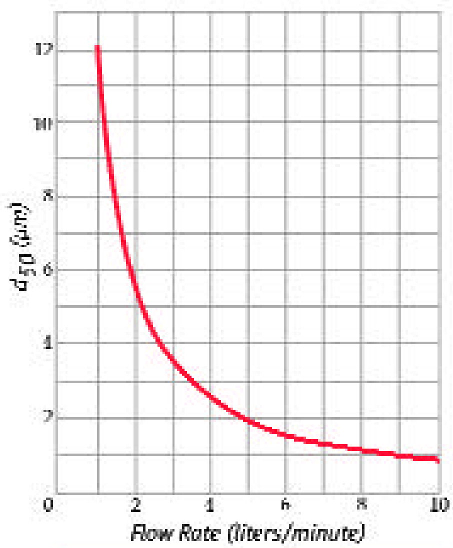
Aerodynamic particle sizing

The *p*DR-1200 incorporates an optimally designed metal cyclone (BGI Model GK 2.05) or the optional low flow cyclone (BGI Model Triplex SCC1.062-CUST) especially selected for PM2.5 collection at 1.5 LPM.

By operating the pump at specific sampling flow rates, the *p*DR-1200 cyclone preseparator provides precisely defined particle size cuts.

Primary calibration and particle samples by filter collection

An integral filter holder directly downstream of the photometric sensing stage accepts 37 mm filters. The calibration constant of the *p*DR-1200 is simply adjusted to coincide with the filter-determined concentration. Primary gravimetric calibration of the instrument concentration readout is easily accomplished under actual field conditions by means of this integral filter. Use membrane filters for chemical analysis or concurrent gravimetric measurements.



GK 2.05 Cyclone Cut Point (50%) as a Function of Flow Rate

pDR-PU Attachable Pump Module

This optional accessory is designed for use with the *personal*DataRAM Model *p*DR-1200. It incorporates a dual-chamber diaphragm pump, a volumetric flow sensing, and control unit. The pump module operates from either an optional, rechargeable NiMH battery pack or from AC line current using the power supply/charger supplied with the *personal*DataRAM. The *p*DR-PU is designed as a modular unit that can be used in various combinations.

- Flow rate (user adjustable): 1 to 4 liters/minute

- Typical Conditions: 2 LPM @ 10 in H_2O (25 mbar) for up to 4 hours

- Maximum Conditions: 2 LPM @ 30 in H_2O

- Precision of constant flow rate control: ±2%

- Power: 9 VDC, 200 mA at 4 liters/minute (approximate)

- Dimensions:
  4 in (100 mm) H x
  3.6 in (90 mm) W x
  1.8 in (45 mm) D

- Weight: 1 lb (0.45 kg)

personalDataRAM™ Series

At last,
a compact,
versatile,
real-time
aerosol monitor

Specifications

Concentration Measurement Range (auto-ranging)

Referred to gravimetric calibration with SAE Fine test dust (mmd = 2 to 3 mm sg = 2.5, as aerosolized)

0.001 to 400 mg/m^3

Scattering Coefficient Range

1.5 x 10^{-6} to 0.6 m^{-1}(approx) @ lambda = 880 nm

Precision/Repeatability Over 30 Days (2-sigma at constant temperature and full battery voltage)

- ±2% of reading or ±0.005 mg/m3, whichever is larger, for 1 second averaging time
- ±0.5 of reading or ±0.0015 mg/m^3, whichever is larger, for 10 second averaging time
- ±0.2% of reading or ±0.0005 mg/m^3, whichever is larger, for 60 second averaging time

Accuracy

Referred to gravimetric calibration with SAE Fine test dust (mmd = 2 to 3 mm, sg = 2.5, as aerosolized)

±5% of reading ±precision

Resolution

0.1% of reading or 0.001 mg/m^3, whichever is larger

Particle Size Range of Maximum Response

0.1 to 10 µm

Flow Rate Range (model pDR-1200)

1-10 liters/min (external pump required)

Aerodynamic Particle Sizing Range

1.0 to 10 µm (*p*DR-1200 only)

Concentration Display Updating Interval

1 second

Concentration Display Averaging Time (user selectable)

1 to 60 seconds

Alarm Level Adjustment Range (user selectable)

Selectable over entire measurement range

Alarm Averaging Time (user selectable)

Real-time (1 to 60 seconds) or STEL (15 minutes)

Datalogging Averaging Periods (user selectable)

1 second to 4 hours

Total Number of Data Points That Can Be Logged in Memory

More than 13,300

Number of Data Tags (data sets)

99 (maximum)

Logged Data

- Each data point: average concentration, time/date, and data point number
- Run summary: overall average and maximum concentrations, time/data of maximum, total number of logged points, start time/date, total elapsed time (run duration), STEL concentration, and time/date of occurrence, averaging (logging) period, calibration factor, and tag number

Analog Signal Output

0 to 5 V and 4 to 20 mA, with selectable full scale ranges between 0.1 and 400 mg/m^3

Power

- Internal battery 9 V alkaline, 20 hour run time (typical)
- Internal battery 9 V lithium, 40 hour run time (typical)
- AC source universal voltage adapter (included) 100-250 volts, 50-60 Hz (CE marked)
- Optional battery pack rechargeable NiMH, 72 hour run time typical (*p*DR-BP)

Readout Display

LCD 16 characters (4 mm height) x 2 lines

Serial Interface

RS232, 4800 baud

Computer Requirements

PC compatible, 486 or higher, Windows 95® or higher

Storage Environment

-20°C to 70°C (-4°F to 158°F)

Operating Environment

-10°C to 50°C (14°F to 122°F), 10 to 95% RH, non-condensing

Dimensions (max external)

153 mm (6.0 in) H x 92 mm (3.6 in) W x 63 mm (2.5 in) D (*p*DR-1000AN)
160 mm (6.3 in) H x 205 mm (8.1 in) W x 60 mm (2.4in) D (*p*DR-1200 including cyclone and filter holder)

Weight

0.5 kg (18 oz) (*p*DR-1000AN)
0.68 kg (24 oz) (*p*DR-1200)

Approvals

- Intrinsic safety approval by US Mine Safety & Health Administration (MSHA) coal-mining environments containing methane gas (the *p*DR-PU pump is not approved by MSHA)
- US FCC Rules (Part 15)
- CE certified

About Thermo

Thermo Electron Corporation, the world's leading maker of high-tech instruments, provides instruments, equipment, software, and solutions that help laboratory and industrial customers advance scientific knowledge, enable drug discovery, improve manufacturing processes, and protect people and the environment. With annual revenue exceeding $2 billion, Thermo is a global leader employing 11,000 people in 30 countries worldwide. The company is based in Waltham, Massachusetts.

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Attachment 7

SVI Standard Operating Procedures

ARCADIS
Infrastructure, environment, facilities

Imagine the result

Soil-Gas Sampling and Analysis Using USEPA Method TO-17 and TO-15

SOP #112409

Rev. #: 1

Rev Date: July 9, 2010

I. Scope and Application

This document describes the procedures to collect subsurface soil-gas samples from sub-slab sampling ports and soil vapor monitoring points for the analysis of volatile organic compounds (VOCs) including volatile polyaromatic hydrocarbons (PAHs) by United States Environmental Protection Agency (USEPA) Method TO-17 (TO-17) and USEPA Method TO-15.

The TO-17 method uses a glass or stainless steel tube packed with a sorbent material. Sorbents of increasing strength and composition are packed within the tube. The specific sorbent material packed within each tube is selected based on the target compounds and desired reporting limits. A measured volume of soil-gas is passed through the tube during sample collection.

The TO-15 method uses 1-liter 3-liter or 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA canister (less than 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5 liters when allowed to fill to a vacuum of approximately 6 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv). Optionally the canister sample can also be analyzed for fixed gasses such as Helium, Carbon dioxide and oxygen. .

Following sample collection the TO-17 tube and TO-15 canister is sent to the laboratory where the sampling media is analyzed for the target compounds.

The following sections list the necessary equipment and provide detailed instructions for the collection of soil-gas samples for analysis using TO-17 and TO-15.

Soil vapor samples can be collected from sub-slab sample probes or soil-vapor ports. Refer to the appropriate standard operating procedure (SOP) from the ARCADIS SOP library for a description of construction methods.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant standard operating procedures (SOPs) and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading soil-gas sample collection activities must have previous soil-gas sampling experience.

III. Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job loss analysis (JLA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. For sub-slab vapor probe installation, drilling with an electric concrete impact drill should be done only by personnel with prior experience using such a piece of equipment and with the appropriate health and safety measures in place as presented in the JLA

IV Equipment List

The equipment required for collect soil-gas samples for analysis using method TO-15 and TO-17 is presented below:

- Appropriate personal protective equipment (PPE; as presented in the site specific HASP and the JLA)
- TO-17 tubes pre-packed by the laboratory with the desired sorbent. Specific sorbents will be recommended by the laboratory considering the target compound list and the necessary reporting limits;
- TO-17 sample flow rate calibration tubes (provided by the laboratory);
- Stainless steel SUMMA® canisters (1-liter, 3-liter, or 6-liter; order at least 5% extra, if feasible) (batch certified canisters or individual certified canisters as required by the project)
- Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g., 30 minutes, 8 hours, 24 hours) or flow rate (e.g., 200 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least 5% extra, if feasible). Flow rate should be selected based on expected soil type (see below).
- Two decontaminated Swagelok or stainless-steel or comparable two-way ball or needle valve (sized to match sample tubing).
- 1/4-inch outer diameter (OD) tubing (Teflon® or Teflon-lined polyethylene);
- Stainless steel or comparable Swagelok® or equivalent compression fittings for 1/4-inch OD tubing;

- Stainless steel “T” fitting (if sample train will be assembled with an inline vacuum gauge a four-way fitting will be needed);
- Three Stainless steel duplicate “T” fittings ;
- 2 Portable vacuum pumps capable of producing very low flow rates (e.g., 10 to 200 mL/min) with vacuum gauge;
- Vacuum gauge if monitoring vacuum reading during sample collection is necessary and portable vacuum pump is not equipped with a vacuum gauge;
- Rotameter or an electric flow sensor if vacuum pump does not have a flow gauge (Bios DryCal or equivalent);
- Tracer gas testing supplies (refer to Adminstering Tracer Gas SOP #41699);
- Photoionization Detector (PID) (with a lamp of 11.7 eV);
- Appropriate-sized open-end wrench (typically 9/16-inch, 1/2-inch , and 3/4-inch);
- 2 Tedlar bags;
- Portable weather meter, if appropriate;
- Chain-of-custody (COC) form;
- Sample collection log;
- Gel ice; and
- Field notebook.

V. Cautions

The following cautions and field tips should be reviewed and considered prior to collecting soil-gas samples.

- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens (sharpies), wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

- Care should be taken to ensure that the appropriate sorbent is used in the TO-17 tube preparation. Sorbent should be selected in consultation with the analytical laboratory and in consideration of the target compound list, the necessary reporting limits and the expected range of concentrations in field samples. The expected range of concentrations in field samples may be estimated from previous site data, release history and professional judgment informed by the conceptual site model.

- Flow rates for sample collection with TO-17 sorbent tubes should be determined well in advance of field work in consultation with the laboratory.

- A Shipping Determination must be performed, by DOT-trained personnel, for all environmental samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

- At the sampling location, keep the tubes in their storage and transportation container to equilibrate with ambient temperature prior to attaching to the sample train.

- Always use clean gloves when handling sampling tubes.

- Seal clean, blank sorbent tubes and sampled tubes using inert, Swagelok®-type fittings and PTFE ferrules. Wrap capped tubes individually in uncoated aluminum foil. Use clean, sealable glass jars or metal cans containing a small packet of activated charcoal or activated charcoal/silica gel for storage and transportation of multiple tubes. This activated charcoal is not analyzed, but serves as a protection for the analytical sorbent tube. Store the multi-tube storage container in a clean environment at 4ºC.

- Keep the sample tubes inside the storage container during transportation and only remove them at the monitoring location after the tubes have reached ambient temperature. Store sampled tubes in a refrigerator at 4ºC inside the multi-tube container until ready for analysis.

- The purge flow rate of 100 ml/min should be suitable for a variety of silt and sand conditions but will not be achievable in some clays without excessive vacuum. A low vacuum (<10” of mercury) should be maintained. Record the measured flow rate and vacuum pressure during sample collection.

The cutoff value for vacuum differs in the literature from 10” of water column (ITRC 2007) to 136” of water column or 10” of mercury (http://www.dtsc.ca.gov/lawsregspolicies/policies/SiteCleanup/upload/SMBR_ADV_activesoilgasinvst.pdf). A detailed discussion of the achievable flow rates in various permeability materials can be found in Nicholson 2007. Related issues of contaminant partitioning are summarized in ASTM D5314-92. Passive sampling approaches can be considered as an alternative for clay soils. However most passive sampling approaches are not currently capable of quantitative estimation of soil gas concentration.

- It is important to record the canister pressure, start and stop times and ID on a proper field sampling form. You should observe and record the time/pressure at a mid-point in the sample duration. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it isn’t stuck.

- Ensure that there is still measureable vacuum in the SUMMA® after sampling. Sometimes the gauges sent from labs have offset errors, or they stick.

- When sampling carefully consider elevation. If your site is over 2,000’ above sea level or the difference in elevation between your site and your lab is more than 2,000’ then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum left in them. http://www.uigi.com/Atmos_pressure.html.

- If possible, have equipment shipped a two or three days before the sampling date so that all materials can be checked. Order replacements if needed.

- Requesting extra canisters and extra sorbent tubes from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.

- Shallow exterior soil-gas sampling should not proceed within 5 days following a significant rain event (1/2-inch of rainfall or more).

VI. Procedure

Soil-Gas Sample Preparation

Selection of Sorbent and Sampling Volume (to be completed prior to sampling event)

1. Identify the necessary final reporting limit for the target compound(s) in accordance with the project quality assurance plan and/or in consultation with the data end user.

2. Identify the necessary method reporting limit(s). The laboratory will be helpful in providing this information as it is typically specific to the sensitivity of the instrumentation.

3. The minimum sampling volume is the volume of soil-gas sample that must be drawn through the sorbent in order to achieve the desired final reporting limit. Calculate the minimum sampling volume using the following equation:

$$Minimum\ Sampling\ Volume\ (L) = \frac{Final\ Reporting\ Limit\ (\mu g)}{Action\ Level\ (\mu g/m^3)} \times \frac{1{,}000\ L}{m^3}$$

Where:

L = liters

µg = microgram

m = meter

4. If a timed sample duration is specified in the work plan, calculate the minimum flow rate. The minimum flow rate is the flow rate necessary to achieve the minimum sampling volume using the following formula:

$$Minimum\ Flow\ Rate\ (L/min) = \frac{Minimum\ Sampling\ Volume\ (L)}{Sample\ Duration\ (min)}$$

Where:

min = minutes

Then compare the minimum flow rate calculated to the requirements for maximum soil gas sampling without excessive danger of short circuiting, normally stated as 0.2 liters/minute, although it can be lower in tight soils. Soil vapor sampling flow rates should not exceed 200 ml/min.

5. Compare the minimum sampling volume to the safe sampling volume (SSV) for the sorbents selected. SSV for specific sorbents can be provide by the manufacture or the laboratory, being used (Table 1 and Appendix 1 in Method TO-17). Ensure that the compound will not breakthrough when sampling the volume calculated above.

Soil-Gas Sample Collection

Calibration of the sample pump prior to assembly of sampling train

1. Attach the sample flow rate calibration tube provided by the laboratory to the inlet of the sample pump using a section of tubing. Attach the flow calibrator to the inlet of the sample flow rate calibration tube. The sample flow rate calibration tube should be clearly marked by the laboratory with an arrow indicating flow direction (or as otherwise specified by the laboratory).

2. Turn on the sample pump and adjust the flow rate on the sample pump to achieve the desired minimum flow rate (calculated above) as measured by the flow calibrator.

3. Repeat until each sampling pump has been properly calibrated to its appropriate flow rate.

Assembly of combined TO-17 and TO-15 sampling train

1. Record the following information in the field notebook, if appropriate (contact the local airport or other suitable information source [e.g., site-specific measurements, weatherunderground.com] to obtain the information):

   a. wind speed and direction;

   b. ambient temperature;

   c. barometric pressure; and

   d. relative humidity.

2. If samples are being collected from temporary or permanent soil vapor points simply remove the cap or plug and proceed to step 3. When collecting samples from a sub-slab port remove the cap or plug from the sampling port. Connect a short piece of Teflon or Teflon-lined tubing to the sampling port using a Swagelok or equivalent stainless-steel or comparable compression fitting.

3. Connect the Teflon or Teflon-lined tubing to a stainless steel T fitting using a Swagelok or equivalent stainless-steel or comparableompression fitting.

4. Remove the brass cap from the SUMMA® canister and connect the flow controller with in-line particulate filter and vacuum gauge to the SUMMA® canister. Do not open the valve on the SUMMA® canister. Record in the field notebook and COC form the flow controller number with the appropriate SUMMA® canister number.

5. Connect the flow controller to the stainless steel T fitting using a Swagelok or equivalent stainless-steel or comparable compression fitting. The TO-15 leg of the combined sampling train is now complete.

6. Attach a length of Teflon or Teflon-lined tubing to the free end of the stainless steel T fitting using a Swagelok or equivalent stainless-steel or comparble compression fitting.

7. Complete the remainder of the sampling train as depicted in Figure 1.

Purge Sampling Assembly and Sampling Point Prior to Sample Collection.

1. Ensure the two-way valve next to the flow rate calibration tube is open and the two way valve next to the TO-17 sampling tubes is closed. Purge three volumes of air from the vapor probe and sampling line using the portable pump. Measure organic vapor levels with the PID. Lower flow rates may be necessary in silt or clay to avoid excessive vacuum. Vacuum reading greater than 136 inches of water column are clearly excessive. Other available sources cite a cutoff of greater than 10 inches of water column.

2. Check the seal established around the soil vapor probe and the sampling train fittings by using a tracer gas (e.g., helium) or other method established in applicable regulatory guidance documents. [Note: Refer to ARCADIS SOP “Administering Tracer Gas,” adapted from NYSDOH 2005, for procedures on tracer gas use.]

3. When three volumes of air have been purged from the vapor probe and sampling line stop the purge pump and close the valve next to the flow rate calibration tube.

TO-15 Sample Collection

1. Open the SUMMA® canister valve to initiate sample collection. Record on the sample log (attached) the time sampling began and the canister pressure.

   If the initial vacuum pressure registered is not between -30 and -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

2. Take a photograph of the SUMMA® canister and surrounding area (unless photography is restricted by the property owner).

3. Check the SUMMA canister approximately half way through the sample duration and note progress on sample logs.

TO-15 Sample Termination

1. Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the sampling interval.

2. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valves. The canister should have a minimum amount of vacuum (approximately 6 inches of Hg or slightly greater).

3. Record the date and time of valve closing in the field notebook, sample collection log, and COC form.

TO-17 Sample Collection

1. Record in the field notebook and COC form the tube number on the TO-17 tube.

2. Open the two-way valve next to the TO-17 tubes

3. Turn on the sample pump to begin sample collection. Use a stopwatch to ensure accuracy in pumping time. Record in the field notebook and the field sample log the time sampling began and the flow rate from each of the sample pumps.

Termination of Sample Collection

1. Stop the sample pumps after the desired volume of soil-gas has passed through the sorbent, and close the two-way valves next to the TO-17 sample tubes.

2. Record the stop time.

3. Detach the Tedlar bag from each sample pump and measure the helium concentration in the soil-gas collected by the Tedlar bag. Record any detections in the field book and sample collection log.

4. Open the two-way valve to permit flow through the flow rate calibration tube. Reconnect each of the sampling pumps and measure the flow rate. Record the post-sampling flow rates in the field log book and the sample collection logs. The post-sampling flow rate should match within 10% of the pre-sample flow rate. Average the pre-sampling and post-sampling flow rate and record in the field log book, and the sample collection log.

5. Calculate the sample volume using the average of the pre-sample and post-sample flow rate. Record the sample volume in the field log book, the sample collection log, and on the COC.

6. Package the tubes according to laboratory protocol on gel ice and ship to the laboratory for analysis.

VII. Waste Management

The waste materials generated during sampling activities should be minimal. PPE, such as gloves and other disposable equipment (i.e., tubing), will be collected by field personnel for proper disposal.

VIII. Data Recording and Management

Measurements will be recorded in the field notebook at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location (e.g., GPS coordinates, distance from permanent structure), tube type and number and sample volume. Field sampling logs and COC records will be transmitted to the Project Manager.

IX. Quality Assurance

Duplicate samples should be collected in the field as a quality assurance step. Generally, duplicates are taken of 10% of samples, but project specific requirements should take precedence. Duplicate soil gas samples should be collected via a split sample train, allowing the primary and duplicate sample to be collected from the soil-gas probe simultaneously.

Quality assurance planning for method TO-17 should take careful note of the method requirement for distributed volume pairs. Although in some circumstances this requirement may be waived, this does constitute a deviation from the method as written. It is wise to discuss this decision with clients and/or regulators before sampling.

Soil-gas sample analysis will be performed using USEPA TO-17 methodology for a site specific constituent list defined in the work plan. Constituent lists and reporting limits must be discussed with the laboratory prior to mobilizing for sampling. Quality assurance parameters should be confirmed with the laboratory prior to sampling. Field quality assurance parameters should be defined in the site-specific work plan. A trip blank sample should accompany each shipment of soil-gas samples to the laboratory for analysis. Trip blanks assess potential sample contamination resulting from the transportation and storing of samples. Soil-gas sample analysis will generally be performed using USEPA TO-15 methodology or a project specific constituent list. Method TO-15 uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits (typically 0.5-ppbv for most VOCs).

X. References

New York State Department of Health (NYSDOH). 2005. DRAFT “Guidance for Evaluating Soil Vapor Intrusion in the State of New York” February 23, 2005.

AirToxics Ltd. “Sorbent & Solution Sampling Guide.”

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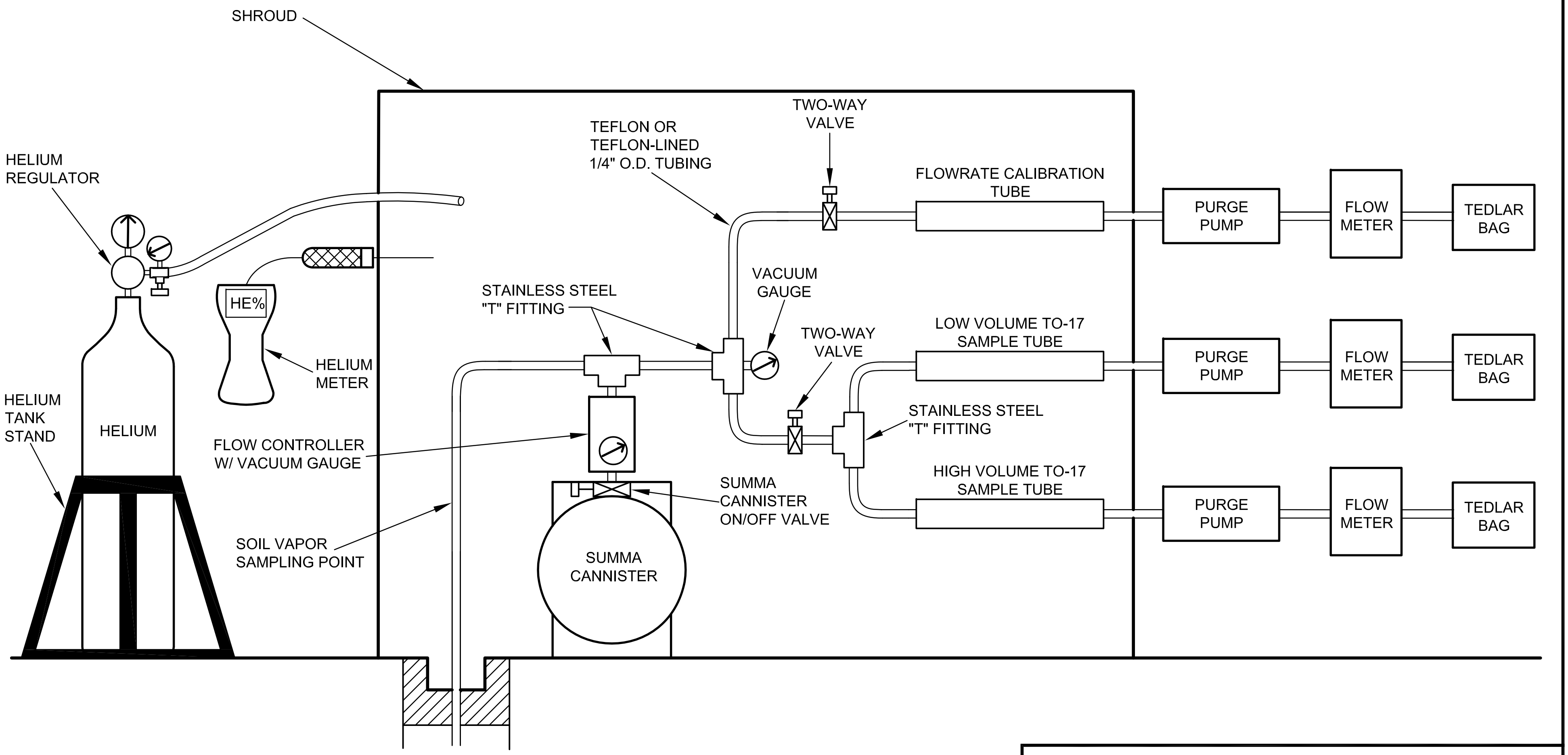

SOIL VAPOR SAMPLING EQUIPMENT ARRANGEMENT

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FIGURE
1

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Administering Helium Tracer Gas for Leak Checks of Soil Gas or Sub-slab Sampling Points

SOP #416199

Rev. #: 3

Rev Date: July 7, 2010

I. Scope and Application

When collecting subsurface vapor samples as part of a vapor intrusion evaluation, a tracer gas serves as a quality assurance/quality control method to verify the integrity of the vapor port seal and the numerous connections comprising the sample train. Without the use of a tracer, verification that a soil vapor sample has not been diluted by ambient or indoor air is difficult.

This standard operating procedure (SOP) focuses on using helium as a tracer gas. However, depending on the nature of the contaminants of concern, other compounds can be used as a tracer including sulfur hexafluoride (SF6), butane and propane (or other gases). In all cases, the protocol for using a tracer gas is consistent and includes the following basic steps: (1) enrich the atmosphere in the immediate vicinity of the sample port where ambient air could enter the sampling train during sampling with the tracer gas; and (2) measure a vapor sample from the sample tubing for the presence of elevated concentrations (> 10%) of the tracer. A plastic pail, bucket, garbage can or even a plastic bag can serve to keep the tracer gas in contact with the port during the testing.

There are two basic approaches to testing for the tracer gas:

1. Include the tracer gas in the list of target analytes reported by the laboratory; and/or

2. Use a portable monitoring device to analyze a sample of soil vapor for the tracer prior to sampling for the compounds of concern. (Note that tracer gas samples can be collected via syringe, Tedlar bag, etc. They need not be collected in SUMMA® canisters or minicans.)

This SOP focuses on monitoring helium using a portable sampling device, although helium can also be analyzed by the laboratory along with other volatile organic compounds (VOCs). Real-time tracer sampling is generally preferred as the results can be used to confirm the integrity of the port seals prior to formal sample collection.

During the initial stages of a subsurface vapor sampling program, tracer gas samples should be collected at each of the sampling points. If the results of the initial samples indicate that the port seals are adequate, the Project Manager can consider reducing the number of locations at which tracer gas samples are used in future monitoring rounds. At a minimum, at least 5% of the subsequent samples should be supported with tracer gas analyses. When using permanent soil vapor points as part of a long-term monitoring program, the port should be tested prior to the first sampling event. Tracer gas testing of subsequent sampling events may often be reduced or eliminated unless conditions have changed at the site. Soil gas port integrity should certainly be rechecked with Tracer gas if land clearing/grading activities, freeze thaw cycles, or soil dessication may have occurred. Points should also be rechecked if more than 2 years have elapsed since the last check of that port.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading the tracer gas testing must have previous experience conducting similar tests.

III. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances. All sampling personnel should review the appropriate health and safety plan (HASP) and job safety analysis (JSA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field staff should review the attachment on safely handling compressed gas cylinders prior to commencing field work.

IV. Equipment List

The equipment required to conduct a helium tracer gas test is presented below:

- Appropriate PPE for site (as required by the Health and Safety Plan)
- Helium (laboratory grade)
- Regulator for helium tank
- Shroud (plastic bucket, garbage can, etc)
    - The size of the shroud should be sufficient to fit over the sample port. It is worth noting that using the smallest shroud possible will miminze the volume of helium needed; this may be important when projects require a large number of helium tracer tests.
    - The shroud will need to have three small holes in it. These holes will include one on the top (to accommodate the sample tubing), and two

on the side (one for the helium detector probe, and one for the helium line).

  - The shroud should ideally enclose the sample port and as much as possible of the sampling train.

- Helium detector capable of measuring from 1 - 100% (Dielectric MGD-2002, Mark Model 9522, or equivalent)
- Tedlar bags
- Seal material for shroud (rubber gasket, modeling clay, bentonite, etc) to keep helium levels in shroud high in windy conditions. Although the sealing material is not in direct contact with the sample if leakage does not occur, sealing materials with high levels of VOC emissions should be avoided, since they could contaminate a sample if a leak occurs.
- Sample logs
- Field notebook

V. Cautions

Helium is an asphyxiant! Be cautious with its use indoors! Never release large volumes of helium within a closed room!

Compressed gas cylinders should be handled with caution; see attachment on the use and storage of compressed gasses before beginning field work.

Care should be taken not to pressurize the shroud while introducing helium. If the shroud is completely air tight and the helium is introduced quickly, the shroud can be over-pressurized and helium can be pushed into the ground. Provide a relief valve or small gap where the helium can escape.

Because minor leakage around the port seal should not materially affect the usability of the soil vapor sampling results, the mere presence of the tracer gas in the sample should not be a cause for alarm. Consequently, portable field monitoring devices with detection limits in the low ppm range are more than adequate for screening samples for the tracer. If high concentrations (> 10%) of tracer gas are observed in a sample, the port seal should be enhanced and fittings within the sampling train should be should be checked and/or tightened to reduce the infiltration of ambient air and the tracer test readministered. If the problem cannot be rectified, a new sample point should be installed or an alternate sampling train used.

VI. Procedure

The procedure used to conduct the helium tracer test should be specific to the shroud being used and the methods of vapor point installation. The helium tracer test can be conducted when using temporary or permanent sampling points and inside or outside a facility. When using the tracer gas within indoor areas you must provide adequate ventilation as helium is an asphyxiant.

1. Attach Teflon or nylon (Nylaflow) sample tubing to the sample point. This can be accomplished utilizing a number of different methods depending on the sample install (i.e., most typically Swage-Lok brand compression fittings, but some quick release fittings could also be used etc.).

2. Place the shroud over the sample point and tubing.

3. Pull the tubing through hole in top of shroud. Seal opening at top of shroud with modeling clay.

4. Place weight on top of shroud to help maintain a good seal with the ground.

5. Insert helium tubing and helium detector probe into side of shroud. Seal both with modeling clay to prevent leaks.

6. Fill shroud with helium. Fill shroud slowly, allowing atmospheric air to escape either by leaving a gap where the shroud meets the ground surface or by providing a release value on the side of the shroud.

7. Use the helium detector to monitor helium concentration within the shroud from the lowest hole drilled in the shroud (bottom of the shroud nearest where the sample tubing intersects the ground). Helium should be added until the environment inside the shroud has > 60% helium.

8. Purge the sample point through the sample tubing into a Tedlar bag using a hand held sampling pump. The purge rate should at least match the sample collection rate but not exceed 100 ml/min. Test the air in the Tedlar bag for helium using portable helium detector. If the point is free of leaks there should be very low helium in the purge air from the soil. The natural concentration of helium in the atmosphere is 0.00052% by volume and there are few if any natural sources of helium to soil gas.

9. If > 10% helium is noted in purge air, add more clay or other material to the seal the sample port and repeat the testing procedure. If the seal cannot be fixed, re-install sample point.

10. Monitor and record helium level in shroud before, during and after tracer test.

11. Monitor and record helium level in purge exhaust.

12. At successful completion of tracer test and sample point purging, the soil vapor sample can be collected (if the helium shroud must be removed prior to sample collection be mindful not disturb the sample tubing and any established seals).

VII. Data Recording and Management

Measurements will be recorded on the sample logs at the time of measurement with notations of the project name, sample date, sample start and finish time, sample location, and the helium concentrations in both the shroud and the purge air before, during, and after tracer testing. Any problems encountered should also be recorded in the field notes.

ATTACHMENT: Compressed Gases—Use and Storage

In general, a compressed gas is any material contained under pressure that is dissolved or liquefied by compression or refrigeration. Compressed gas cylinders should be handled as high-energy sources and therefore as potential explosives and projectiles. Prudent safety practices should be followed when handling compressed gases since they expose workers to both chemical and physical hazards.

Handling

- Safety glasses with side shields (or safety goggles) and other appropriate personal protective equipment should be worn when working with compressed gases.
- Cylinders should be marked with a label that clearly identifies the contents.
- All cylinders should be checked for damage prior to use. Do not repair damaged cylinders or valves. Damaged or defective cylinders, valves, etc., should be taken out of use immediately and returned to the manufacturer/distributor for repair.
- All gas cylinders (full or empty) should be rigidly secured to a substantial structure at 2/3 height. Only two cylinders per restraint are allowed in the laboratory and only soldered link chains or belts with buckles are acceptable. Cylinder stands are also acceptable but not preferred.
- Handcarts shall be used when moving gas cylinders. Cylinders must be chained to the carts.
- All cylinders must be fitted with safety valve covers before they are moved.
- Only three-wheeled or four-wheeled carts should be used to move cylinders.
- A pressure-regulating device shall be used at all times to control the flow of gas from the cylinder.
- The main cylinder valve shall be the only means by which gas flow is to be shut off. The correct position for the main valve is all the way on or all the way off.
- Cylinder valves should never be lubricated, modified, forced, or tampered with.
- After connecting a cylinder, check for leaks at connections. Periodically check for leaks while the cylinder is in use.
- Regulators and valves should be tightened firmly with the proper size wrench. Do not use adjustable wrenches or pliers because they may damage the nuts.
- Cylinders should not be placed near heat or where they can become part of an electrical circuit.
- Cylinders should not be exposed to temperatures above 50 °C (122 °F). Some rupture devices on cylinders will release at about 65 °C (149 °F). Some small cylinders, such as lecture bottles, are not fitted with rupture devices and may explode if exposed to high temperatures.

- Rapid release of a compressed gas should be avoided because it will cause an unsecured gas hose to whip dangerously and also may build up enough static charge to ignite a flammable gas.
- Appropriate regulators should be used on each gas cylinder. Threads and the configuration of valve outlets are different for each family of gases to avoid improper use. Adaptors and homemade modifications are prohibited.
- Cylinders should never be bled completely empty. Leave a slight pressure to keep contaminants out.

Storage

- When not in use, cylinders should be stored with their main valve closed and the valve safety cap in place.
- Cylinders must be stored upright and not on their side. All cylinders should be secured.
- Cylinders awaiting use should be stored according to their hazard classes.
- Cylinders should not be located where objects may strike or fall on them.
- Cylinders should not be stored in damp areas or near salt, corrosive chemicals, chemical vapors, heat, or direct sunlight. Cylinders stored outside should be protected from the weather.

Special Precautions

Flammable Gases

- No more than two cylinders should be manifolded together; however several instruments or outlets are permitted for a single cylinder.
- Valves on flammable gas cylinders should be shut off when the laboratory is unattended and no experimental process is in progress.
- Flames involving a highly flammable gas should not be extinguished until the source of the gas has been safely shut off; otherwise it can reignite causing an explosion.

Acetylene Gas Cylinders

- Acetylene cylinders must always be stored upright. They contain acetone, which can discharge instead of or along with acetylene. Do not use an acetylene cylinder that has been stored or handled in a nonupright position until it has remained in an upright position for at least 30 minutes.
- A flame arrestor must protect the outlet line of an acetylene cylinder.
- Compatible tubing should be used to transport gaseous acetylene. Some tubing like copper forms explosive acetylides.

Lecture Bottles

- All lecture bottles should be marked with a label that clearly identifies the contents.
- Lecture bottles should be stored according to their hazard classes.
- Lecture bottles that contain toxic gases should be stored in a ventilated cabinet.
- Lecture bottles should be stored in a secure place to eliminate them from rolling or falling.
- Lecture bottles should not be stored near corrosives, heat, direct sunlight, or in damp areas.
- To avoid costly disposal fees, lecture bottles should only be purchased from suppliers that will accept returned bottles (full or empty). Contact the supplier before purchasing lecture bottles to ensure that they have a return policy.
- Lecture bottles should be dated upon initial use. It is advised that bottles be sent back to the supplier after one year to avoid accumulation of old bottles.

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Sub-Slab Soil-Gas Sampling Using Method TO-15 – Temporary Probe Approach

SOP # 427199

Rev. #: 4

Rev Date: July 8, 2010

I. Scope and Application

This document describes the procedures for installing temporary sub-slab sampling probes and collect sub-slab soil gas samples for the analysis of volatile organic compounds (VOCs) by United States Environmental Protection Agency (USEPA) Method TO-15. Method TO-15 uses a 1-liter, 3-liter, or 6-liter SUMMA® passivated stainless steel canister. An evacuated 6-liter SUMMA canister (less than 28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5 liters when allowed to fill to a vacuum of 5 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GC/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

These procedures are not recommended if the probe is to be sampled more than once. Under those conditions refer to ARCADIS SOP for permanent sub-slab soil gas installations. The following sections list the necessary equipment and detailed instructions for installing temporary sub-slab soil gas probes and collecting soil-gas samples for VOC analysis.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour Hazardous Waste Operations and Emergency Response (HAZWOPER) training. Site supervisor training, site-specific training, first-aid, and cardiopulmonary resuscitation (CPR) may be appropriate at some sites. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading sub-slab soil-gas sample collection activities must have previous sub-slab soil-gas sampling experience.

III. Health and Safety Considerations

All sampling personnel should review the appropriate health and safety plan (HASP) and job loss analysis (JLA) prior to beginning work to be aware of all potential hazards associated with the job site and the specific task. Field sampling must be carefully conducted to minimize the potential for injury and the spread of hazardous substances. For sub-slab vapor probe installation, drilling with an electric concrete impact drill should be done only by personnel with prior experience using such a piece of equipment and with the appropriate health and safety measures in place as presented in the JLA. It is possible to encounter high concentrations of VOCs in sub-slab soil gas, so the amount of time the borehole remains open should be minimized. For the same reason, when installing sub-slab probes in spaces with minimal dilution potential, such as closets, it is advisable to provide local ventilation. Finally, sub-slab probe installation should be completed 24 hours in advance or after any indoor air sampling to avoid cross contamination of the indoor air samples.

IV. Equipment List

The equipment required to install a temporary sub-slab vapor probe is presented below. Modifications to account for project- or regulatory-specific requirements should be noted in the accompanying work plan:

- Appropriate personal protective equipment (PPE; as required by the HASP and the JLA);
- Hammer drill (Hilti, Bosch Hammer, or equilivant);
- 1/2 inch-diameter concrete drill bit (drill bit length contingent on slab thickness);
- Hand tools including open-end wrench (typically 9/16-inch), pliers, channel lock pliers, etc;
- 1/4-inch OD tubing (Teflon, nylon, or Teflon-lined); Note that Nylaflow tubing has a somewhat higher background level of BTEX and much poorer recovery of tirchlorobenzene and naphthalene then Teflon, so should not be used on sites where these compounds are a concern (Hayes, 2006).
- Teflon® tape;
- Work gloves;
- Nitrle gloves;
- Hydrated bentonite, VOC-free modeling clay that complies with ASTM D4236 (McMaster Carr 6102T11 recommended) or wax to seal drill hole (see cautions section);
- Whisk broom and dust pan;
- Bottle brush;
- Ground fault circuit interrupter (GFCI);
- Extension cords rated for amperage required for hammer drill;
- Plastic sheeting; and

- Shop vacuum with clean fine-particle filter.

The equipment required for sub-slab soil gas sample collection is presented below:

- 1, 3, or 6-liter stainless steel SUMMA® canisters (order at least one extra, if feasible) (batch certified canisters or individual certified canisters as required by the project) ;
- Flow controllers with in-line particulate filters and vacuum gauges; flow controllers are pre-calibrated to specified sample duration (e.g., 30 minutes, 8 hours, 24 hours) or flow rate (e.g., 200 milliliters per minute [mL/min]); confirm with the laboratory that the flow controller comes with an in-line particulate filter and pressure gauge (order at least one extra, if feasible);
- Extra 1/4-inch Swagelok front and back compression sleeves;
- Swage-Lok fittings;
- Decontaminated stainless steel Swagelok or comparable "T" fitting and needle valve for isolation of purge pump;
- Two 3-inch lengths of 1/4-inch OD Teflon tubing;
- Stainless steel duplicate "T" fitting provided by the laboratory (if collecting duplicate [i.e., split] samples);
- Portable vacuum pump capable of producing very low flow rates (e.g., 100 to 200 milliliters per minute [mL/min]); vacuum pump should also be equipped with a vacuum gauge;
- Rotameter or an electric flow sensor if vacuum pump does not have and accurate flow gauge;
- Tracer gas testing supplies if applicable (refer to SOP "Adminstering Tracer Gas" #416199);
- Appropriate-sized open-end wrench (typically 9/16-inch and1/2");

- Photo Ionization Detector (PID) with a lamp of 11.7 eV; detectable to ppb range (optional);
- Tedlar bag to collect purge air;
- Portable weather meter, if appropriate (temperature, barometric pressure, humidity, etc);
- Quick setting grout or sika flex to seal abandoned holes;
- Chain-of-custody (COC) form;
- Sample collection log (attached); and
- Field notebook.

V. Cautions

The following cautions and field tips should be reviewed and considered prior to installing or collecting a sub-slab soil gas sample.

- When drilling sample collection holes be mindful of utilities that may be in the area. Always complete utility location, identification and marking before installing subslab ports as required by the ARCADIS Utility Location Policy and Procedure. Be aware that public utility locator organizations frequently do not provide location information within buildings so alternative lines of evidence must be used. If the driller is concerned about a particular location, consult the project manager about moving it to another location. Don’t be hesitant to use your Stop Work Authority, if something doesn’t seem right stop and remedy the situation.

- Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

- Ensure that the flow controller is pre-calibrated to the proper sample collection duration (confirm with laboratory). Sample integrity can be compromised if sample collection is extended to the point that the canister reaches atmospheric pressure. Sample integrity is maintained if sample collection is terminated prior to the target duration and a measurable vacuum (e.g., 3–7 inches Hg) remains in the canister when sample collection is terminated. Do not let sample canister reach atmospheric pressure (e.g., 0-inches Hg).

- Field personnel will properly seal the vapor probe at the slab surface to prevent leaks of atmosphere into the soil vapor probe during purging and sampling. Temporary points should be fit snug into the pre-drilled hole using Teflon® tape or modeling clay and sealed with hydrated bentonite, clay or wax at the surface. If this is not done properly, the integrity of the sample port may be compromised.

- Modeling clay or other materials used to seal the hole should only be obtained from an approved ARCADIS source and should not be purchased off the shelf from an unapproved retail source. Data indicate that some modeling clays may contain VOCs that can affect sample results.

- It is important to record the canister pressure, start and stop times and sample identification on a proper field sampling form. Often Summa canisters are collected over a 24 hour period. The time/pressure should be recorded at the start of sampling, and then again one or two hours later. It is a good practice to lightly tap the pressure gauge with your finger before reading it to make sure it isn't stuck. If the canister is running correctly for a 24 hour period then the vacuum will have decreased slightly after an hour or two (for example from 29" to 27"). Consult your project manager (PM), risk assessor or air sampling expert by phone if the Summa canister does not appear to be working properly.

- Ensure that there is still measureable vacuum in the Summa after sampling. Sometimes the gauges sent from the lab have offset errors, or they stick.

- When sampling carefully consider elevation. If your site is over 2,000' above sea level or the difference in elevation between your site and your lab is more than 2,000' then pressure effects will be significant. If you take your samples at a high elevation they will contain less air for a given ending pressure reading. High elevation samples analyzed at low elevation will result in more dilution at the lab, which could affect reporting limits. Conversely low elevation samples when received at high elevation may appear to not have much vacuum left in them http://www.uigi.com/Atmos_pressure.html.

- If possible, have equipment shipped two to three days before the scheduled start of the sampling event so that all materials can be checked. Order replacements if needed.

- Requesting extra canisters from the laboratory should also be considered to ensure that you have enough equipment on site in case of an equipment failure.

- Check the seal around the soil-gas sampling port by using a tracer gas (e.g., helium) or other method established in the appropriate guidance document.

VI. Procedure

Temporary sub-slab soil vapor probes are installed using equipment and procedures that allows the point to be installed quickly and abandoned after an initial sample is collected. These procedures are not recommended if the probe is to be sampled more than once. Under those conditions refer to ARCADIS SOP for permanent sub-slab soil gas installations.

Sub-slab Soil Gas Point Installation

1. Complete the ARCADIS Utility Locate SOP prior to drilling activities.

2. Remove, only to the extent necessary, any covering on top of the slab (e.g., carpet).

3. Lay down plastic sheeting to keep the work area clean. Check to make sure shop vacuum is working properly and fine concrete particles will not pass through filter

4. Drill a 1/2-inch-diameter hole into the concrete slab using the electric drill. Do not fully penetrate the slab at this time. Stop drilling approximately 1 inch short of penetrating the slab.

5. Use the shop vacuum, bottle brush and dust broom to clean up the work area and material that may have fallen into and around the drill hole..

6. Advance the 1/2-inch drill bit the remaining thickness of the slab and approximately 3 inches into the sub-slab material to create an open cavity. Note (if possible) from the drill cuttings any evidence for the types of materials in the immediate sub-slab – i.e. moisture barriers, sand, gravel, shrinkage gap?

7. Use the bottle brush, whisk broom, and dust pan to quickly clean material around and within the hole. The hole should not be left open for any extended length of time to ensure that VOCs below the slab do not migrate into indoor air. Do not use the shop vacuum to clean up the drill hole after the full thickness of the slab has been penetrated.

8. Re-drill the 1/2 – inch hole to ensure it remains clear. This can also be accomplished using a piece of steel rod, sample tubing, or even a piece of heavy wire (coat hanger).

9. Wrap the tubing with Teflon® tape or modeling clay, to the extent necessary, for a snug fit of tubing and hole.

10. Insert the tubing approximately 2 to 3 inches into the slab; tubing should not contact material beneath the slab. Tubing should be capped with clay or other fitting so it does not provide a pathway for vapor movement.

11. Prepare a hydrated bentonite mixture and apply bentonite at slab surface around the tubing. Instead of hydrated bentonite, either VOC free modeling clay (McMaster-Carr #6102T11) or wax may be used for the temporary seal around the tubing where it enters the slab.

12. Proceed to soil gas sample collection after waiting a minimum of 1 hour for equilibration following probe installation.

Sub-Slab Soil Gas Sample Collection

Once the temporary sample probe is installed, the following procedure should be used to collect the sample in the Summa canister.

1. Record the following information on the sample log, if appropriate (contact the local airport or other suitable information source [e.g., site-specific measurements, weatherunderground.com] to obtain the information):

   a. wind speed and direction;

   b. ambient temperature;

   c. barometric pressure; and

   d. relative humidity.

2. Assemble the sample train by removing the cap from the SUMMA canister and connecting the Swagelok T-fitting to the can using a short length of 1/4-inch OD Teflon tubing. The flow controller with in-line particulate filter and vacuum gauge is then attached to the T-fitting. The Swagelok (or similar) two-way valve is connected to the free end of the T-fitting using a short length of ¼-inch OD Teflon tubing.

3. When collecting duplicate or other quality assurance/quality control (QA/QC) samples as required by applicable regulations and guidance, couple two SUMMA canisters using stainless steel Swagelok duplicate sample T-fitting supplied by the laboratory. Attach flow controller with in-line particulate filter and vacuum gauge to duplicate sample T-fitting provided by the laboratory.

4. Perform a leak-down-test by replacing the nut which secures sample tubing with the cap from the canister. This will create a closed system. Open the canister valve and quickly close it; the vacuum should increase approaching 30” Hg. If there are no leaks in the system this vacuum should be held. If vacuum holds proceed with sample collection; if not attempt to rectify the situation by tightening fittings.

5. Attach Teflon sample tubing from the temporary probe to the flow controller using Swagelok fittings.

6. Connect the two-way valve and the portable purge pump using a length of Teflon sample tubing.

7. Record on the sample log and COC form the flow controller number with the appropriate SUMMA® canister number.

8. If appropriate, the seal around the soil-gas sampling port and the numerous connections comprising the sampling train will be evaluated for leaks using helium as a tracer gas. The helium tracer gas will be administered according to the methods established in the appropriate guidance documents and SOP: Administering Helium Tracer Gas.

9. Open the two-way valve and purge the soil-gas sampling port and tubing with the portable sampling pump. Purge approximately three volumes of air from the soil-gas sampling port and sampling line using a flow rate of 200 mL/min or less. Purge volume is calculated by the following equation “purge volume = 3 x Pi x inner radius of tubing^2 x length of tubing. Purge air will be collected into a Tedlar bag to provide that VOCs are not released into interior spaces. Measure organic vapor levels and tracer gas within the Tedlar bag, as appropriate.

10. Close the two-way valve to isolate the purge pump.

11. Open the SUMMA® canister valve to initiate sample collection. Record on the sample log (attached) the time sampling began and the canister pressure.

If the initial vacuum pressure registers less than -25 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

Sampling flow rate should be 200 mL/min or less.

12. Take a photograph of the SUMMA® canister and surrounding area unless prohibited by the building owner.

13. Check the SUMMA canister approximately half way through the sample duration and note progress on sample logs.

Termination of Sample Collection

1. Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the required sampling interval in order to have sufficient time to terminate the sample collection.

2. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valves. The canister should have a minimum amount of vacuum (ideally 3-7 inches of Hg or slightly greater).

3. Record the date and local time (24-hour basis) of valve closing on the sample collection log and COC form.

4. Remove the particulate filter and flow controller from the SUMMA® canister, re-install the brass plug on the canister fitting, and tighten with the appropriate wrench.

5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

6. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with a string).

7. Complete the COC form and place the requisite copies in a shipping container. Close the shipping container and affix a custody seal to the container closure. Ship the container to the laboratory via overnight carrier (e.g., Federal Express) for analysis.

8. A Shipping Determination must be performed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

9. Remove the tubing and grout the hole in the slab with quick-setting hydraulic cement powder, Sika-Flex, or other material similar to the slab. This step must be done carefully to ensure that the abandoned sampling point does not become a preferential flow pathway.

10. Replace the surface covering (e.g., carpet) to the extent practicable. Sample collection location should be returned to pre-sampling conditions/

VII. Waste Management

The volume of waste materials generated by these activities should be minimal. Personal protective equipment, such as gloves and other disposable equipment (i.e., tubing) should be collected by field personnel for proper disposal.

VIII. Data Recording and Management

Information collected in the field should be recorded in the field notebook as well as written on the field sampling log and COC, as appropriate. The field notebook and sampling log must include the project name, sample date, sample start and finish time, sample location (e.g., global positioning system [GPS] coordinates, distance from permanent structure [e.g., two walls, corner of room]), canister serial number, flow controller serial number, initial vacuum reading, and final pressure reading. Field sampling logs and COC records will be transmitted to the PM.

IX. Quality Assurance

Duplicate samples should be collected in the field as a quality assurance step. Generally, duplicates are taken of 10% of samples, but project specific requirements should take precedence.

Soil-gas sample analysis will generally be performed using USEPA TO-15 methodology or a project specific constituent list. Method TO-15 uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits (typically 0.5-ppbv for most VOCs).

X. References

ASTM – “Standard Guide for Soil Gas Monitoring in the Vadose Zone”, D5314-92.

Hayes, H. C., D.J. Benton and N. Khan “Impact of Sampling media on Soil Gas Measurements” Presented with short paper at AWMA Vapor Intrusion Conference January 2006, Philadelphia PA.

ITRC “Vapor Intrusion Pathway: A Practical Guide”, January 2007, Appendix F: “regulators Checklist for Reviewing Soil Gas Data”

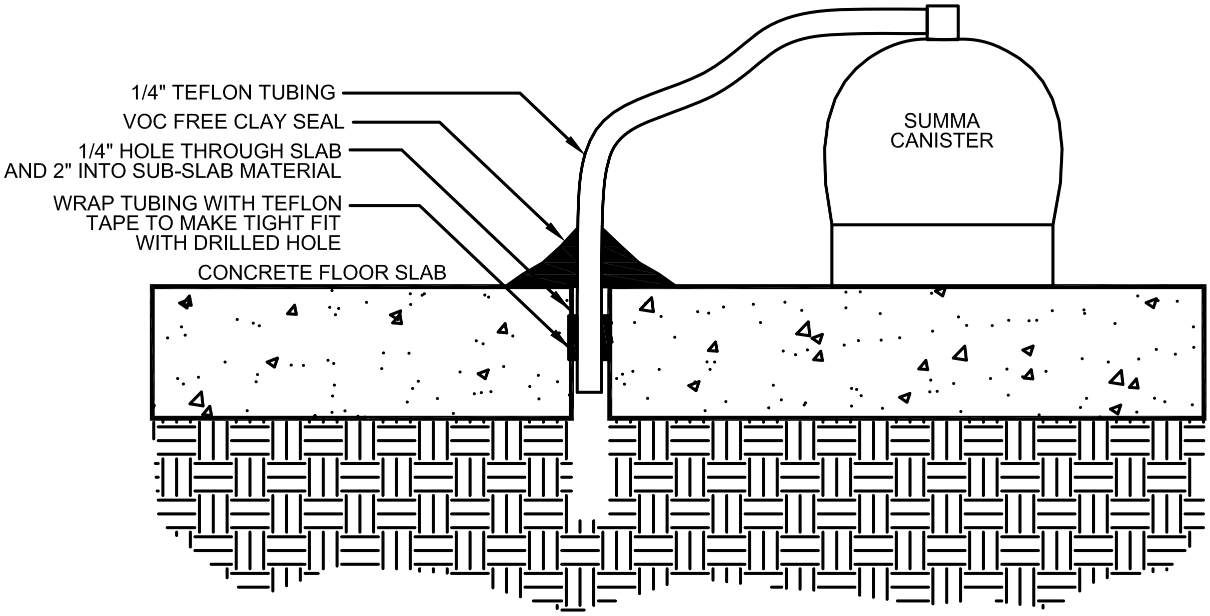

DIAGRAM OF TEMPORARY SUB-SLAB SAMPLE POINT

ARCADIS

Ambient Air Sampling and Analysis Using USEPA Method TO-15

Rev. #: 1

Rev Date: March 13, 2009

I. Scope and Application

This standard operating procedure (SOP) describes the procedures to collect ambient air samples for the analysis of volatile organic compounds (VOCs) using United States Environmental Protection Agency (USEPA) Method TO-15 (TO-15). The TO-15 method uses a 6-liter SUMMA® passivated stainless steel canister. An evacuated SUMMA® canister (<28 inches of mercury [Hg]) will provide a recoverable whole-gas sample of approximately 5.5 liters when allowed to fill to a vacuum of 2-7 inches of Hg. The whole-air sample is then analyzed for VOCs using a quadrupole or ion-trap gas chromatograph/mass spectrometer (GS/MS) system to provide compound detection limits of 0.5 parts per billion volume (ppbv).

The following sections list the necessary equipment and detailed instructions for placing the sampling device and collecting ambient air samples for VOC analysis.

II. Personnel Qualifications

ARCADIS field sampling personnel will have current health and safety training, including 40-hour HAZWOPER training, site supervisor training, site-specific training, first aid, and cardiopulmonary resuscitation (CPR), as needed. ARCADIS field sampling personnel will be well versed in the relevant SOPs and possess the required skills and experience necessary to successfully complete the desired field work. ARCADIS personnel responsible for leading ambient air sample collection activities must have previous ambient air sampling experience.

III. Equipment List

The equipment required for ambient air sample collection is presented below:

- 6-liter, stainless steel SUMMA® canisters (order at least one extra, if feasible);

- Flow controllers with in-line particulate filters and vacuum gauges (flow controllers are pre-calibrated by the laboratory to a specified sample duration [e.g., 8-hour]). Confirm with lab that flow controller comes with in-line particulate filter and pressure gauge (order an extra set for each extra SUMMA® canister, if feasible);

- Appropriate-sized open-end wrench (typically 9/16-inch);

- Chain-of-custody (COC) form;

- Field notebook;

- Sample collection log (attached);
- Camera;
- Lock and chain; and
- Ladder or similar to hold canister above the ground surface (optional).

IV. Cautions

Care must be taken to minimize the potential for introducing interferences during the sampling event. As such, care must be taken to keep the canister away from public roadways to prevent collection of automobile source pollutants (unless this is the objective of the study). Care must also be taken to keep the canister away from heavy pedestrian traffic areas (e.g., main entranceways, walkways). If the canister is not to be overseen for the entire sample duration, precautions should be taken to maintain the security of the sample (e.g., do not place in areas regularly accessed by the public, fasten the sampling device to a secure object using lock and chain, label the canister to indicate it is part of a scientific project, place the canister in secure housing that does not disrupt the integrity/validity of the sampling event). Sampling personnel should not handle hazardous substances (such as gasoline), permanent marking pens, wear/apply fragrances, or smoke cigarettes/cigars before and/or during the sampling event.

Care should also be taken to ensure that the flow controller is pre-calibrated to the proper sample collection time (confirm with laboratory). Sample integrity is maintained if the sampling event is shorter than the target duration, but sample integrity can be compromised if the event is extended to the point that the canister reaches atmospheric pressure.

A Shipping Determination must be performed, by DOT-trained personnel, for all environmental and geotechnical samples that are to be shipped, as well as some types of environmental equipment/supplies that are to be shipped.

V. Health and Safety Considerations

Field sampling equipment must be carefully handled to minimize the potential for injury and the spread of hazardous substances.

VI. Procedure

Preparation of SUMMA®-Type Canister and Collection of Sample

1. Record the following information in the field notebook (contact the local airport or other suitable information source [e.g., weatherunderground.com] to obtain the following information):

   - ambient temperature;

   - barometric pressure; and

   - relative humidity.

2. Choose the sample location in accordance with the sampling plan. If a breathing zone sample is required, place the canister on a ladder, tripod, or other similar stand to locate the canister orifice 3 to 5 feet above ground. If the canister will not be overseen for the entire sampling period, secure the canister as appropriate (e.g., lock and chain).

3. Record SUMMA® canister serial number and flow controller number in the field notebook and COC form. Assign sample identification on canister ID tag and record in the field notebook, sample collection log (attached), and COC form.

4. Remove the brass dust cap from the SUMMA® canister. Attach the flow controller with in-line particulate filter and vacuum gauge (leave swage-lock cap on the vacuum gauge during this procedure) to the SUMMA® canister with the appropriate wrench. Tighten with fingers first, then gently with the wrench.

5. Open the SUMMA® canister valve to initiate sample collection. Record the date and local time (24-hour basis) of valve opening in the field notebook, sample collection log, and COC form.

6. Record the initial vacuum pressure in the SUMMA® canister in the field notebook and COC form. If the initial vacuum pressure does not register less than -28 inches of Hg, then the SUMMA® canister is not appropriate for use and another canister should be used.

7. Take a photograph of the SUMMA® canister and surrounding area.

Termination of Sample Collection

1. Arrive at the SUMMA® canister location at least 10 to 15 minutes prior to the end of the sampling interval (e.g., 8-hour).

2. Stop collecting the sample when the canister vacuum reaches approximately 2-7 inches of Hg (leaving some vacuum in the canister provides a way to verify if the canister leaks before it reaches the laboratory) or when the desired sample time has elapsed.

3. Record the final vacuum pressure. Stop collecting the sample by closing the SUMMA® canister valve. Record the date and local time (24-hour basis) of valve closing in the field notebook, sample collection log, and COC form.

4. Remove the particulate filter and flow controller from the SUMMA® canister, re-install brass plug on canister fitting, and tighten with wrench.

5. Package the canister and flow controller in the shipping container supplied by the laboratory for return shipment to the laboratory. The SUMMA® canister does not require preservation with ice or refrigeration during shipment.

6. Complete the appropriate forms and sample labels as directed by the laboratory (e.g., affix card with string).

7. Complete COC forms and place requisite copies in shipping container. Close shipping container and affix custody seal to container closure. Ship to laboratory via overnight carrier (e.g., Federal Express) for analysis.

VII. Waste Management

No specific waste management procedures are required.

VIII. Data Recording and Management

Measurements will be recorded in the field notebook at the time of measurement, with notations of project name, sample date, sample start and finish times, sample location (e.g., GPS coordinates if available), canister serial number, flow controller number, initial vacuum reading, and final vacuum reading. Field sampling logs and COC records will be transmitted to the Project Manager.

IX. Quality Assurance

Ambient air sample analysis will be performed using USEPA Method TO-15. This method uses a quadrupole or ion-trap GC/MS with a capillary column to provide optimum detection limits. The GC/MS system requires a 1-liter gas sample (which can easily be recovered from a 6-liter canister) to provide a 0.5 ppbv detection limit. The 6-liter canister also provides several additional 1-liter samples in case subsequent reanalyses or dilutions are required. This system also offers the advantage of the GC/MS detector, which confirms the identity of detected compounds by evaluating their mass spectra in either the SCAN or SIM mode.

X. References

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ARCADIS
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Indoor/Ambient Air Sample Collection Log

Sample ID:

Client:		**Outdoor/Indoor:**	
Project:		**Sample Intake Height:**	
Location:		**Miscellaneous Equipment:**	
Project #:		**Time On/Off:**	
Samplers:		**Subcontractor:**	

Instrument Readings:

Time	Canister Pressure (inches of HG)	Temperature (F or C)	Relative Humidity (%)	Air Speed (ft/min)	Pressure Differential (inches of H20)	PID (ppm or ppb)

SUMMA Canister Information:

Size (circle one): 1 L 6 L

Canister ID:

Flow Controller ID: ___________________

General Observations/Notes:

Please record current weather information including wind speed and direction, ambient temperature, barometric pressure, and relative humidity via suitable information source (e.g., weatherunderground.com).