Plantasie Creek Ecological Impact Assessment Work Plan

Hercules, Inc. Site #356001

Port Ewen, New York

Prepared for:

Hercules Inc

Dyno Nobel Inc

Prepared by:

EHS Support

May 2023

EHS Support

I, Kristin A. VanLandingham, P.E., certify that I am currently a NYS-registered professional engineer and that this *Plantasie Creek Ecological Impact Assessment Work Plan* dated February 2023 for the Hercules, Inc. site located in Port Ewen, New York was prepared in accordance with all applicable statutes and regulations, and in conformance with the DER *Technical Guidance for Site Investigation and Remediation* (DER-10).

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05/25/2023
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Acronyms

µm	micrometer
$\mu mol/g_{OC}$	micromoles per gram organic carbon
ANOVA	analysis of variance
AUFs	area use factors
AVS	acid-volatile sulfide
AWQS	Ambient Water Quality Standards
BAP	Biological Assessment Profile
BAZ	biologically active zone
BTV	background threshold value
CBR	critical body residue
DFWMR	Division of Fish, Wildlife, and Marine Resources
DO	dissolved oxygen
DOC	dissolved organic carbon
DSB	dietary screening benchmarks
EDDs	estimated daily doses
EPC	exposure point concentration
EPT	Ephemeroptera, Plecoptera, and Tricoptera
EqP	equilibrium partitioning
FWRIA	Fish and Wildlife Resources Impact Analysis
GPS	global positioning system
IDW	investigation-derived waste
LOE	line of evidence
LOEC	lowest observed effect concentration
MS/MSD	matrix spike/matrix spike duplicate
NOEC	no observed effect concentration
NYSDEC	New York State Department of Environmental Conservation
OECD	Organisation for Economic Co-operation and Development
QA/QC	quality assurance/quality control
SCO	soil cleanup objectives
SE	sequential extraction
SEM	simultaneously extracted metals
SGV	sediment guidance values
SQT	sediment quality triad
SWAC	surface-weighted average concentration
SWMU	Solid Waste Management Unit
TAL	target analyte list
TCL	target compound list
TDS	total dissolved solids
TSS	total suspended solids

TOC	total organic carbon
TRV	toxicity reference value
UCL	upper confidence limit

1 Introduction

This *Plantasie Creek Ecological Impact Assessment Work Plan* ("Work Plan") has been developed on behalf of Hercules Incorporated ("Hercules"), a wholly owned subsidiary of Ashland, Inc. ("Ashland"), and Dyno Nobel, Inc. (Dyno Nobel) to present the approach for assessing potential ecological impacts in Plantasie Creek downstream of the Dyno Nobel Port Ewen, New York Site ("Site") in accordance with New York State Department of Environmental Conservation (NYSDEC) Administrative Order on Consent ("Consent Order") Index # CO 3-20180508-85 effective August 3, 2018. The Site is located at 161 Ulster Avenue, approximately one mile south of the Village of Port Ewen in Ulster County, New York (**Figure 1**) and is listed on the New York State Inactive Hazardous Waste Site Index as Site No. 356001.

The Work Plan has been prepared consistent with NYSDEC *Technical Guidance for Site Investigation and Remediation* ("DER-10"; NYSDEC, 2010) and supporting NYSDEC and federal guidance (NYSDEC, 2014; NYSDEC, 1994; USEPA, 2007; USEPA, 2005a). The technical approach presented in this Work Plan also incorporates comments provided by NYSDEC in a meeting on December 11, 2019, and comments on the Sediment Sampling Report (EHS Support, 2020) that were provided by NYSDEC in a letter dated April 19, 2021.

Ecological investigations have been on-going at the Site since 2007 as part of a NYSDEC Fish and Wildlife Resources Impact Analysis (FWRIA). The scope of FWRIA investigations includes the characterization and delineation of target metals, specifically copper, mercury[1], selenium, and zinc, that may have migrated from the Site and deposited in bed sediments within Plantasie Creek downstream of the Solid Waste Management Unit (SWMU) 1/22 Wetland Complex (**Figure 2**). The results of the phased sediment delineation sampling were reported to NYSDEC in the *Plantasie Creek Phase 1 and 2 Sediment Sampling Report* ("Sediment Sampling Report"; EHS Support, 2020).

Sediment sampling and substrate surveys results from multiple phases of investigation within Plantasie Creek provide the basis for the characterization and delineation of target metal concentrations in sediment exceeding NYSDEC Class C freshwater sediment guidance values (SGVs; EHS Support, 2020). The results of the downstream sediment delineation sampling indicated decreasing concentrations of target metals in sediment with increasing distance downstream of the Site. The greatest concentrations of target metals within the extent of sediment delineation sampling were observed in samples collected within the reach from the downstream Site boundary to Salem Street, approximately one mile downstream of the Site (**Figure 2**). The findings of these investigations were used to support an ecological conceptual site model (ECSM) regarding the potential transport and deposition of target metals in fine-grained sediments within Plantasie Creek downstream of SWMU 1/22 (EHS Support, 2020).

Sediment investigations conducted within Plantasie Creek have adequately characterized and delineated the extent of target metals based on concentrations exceeding NYSDEC Class C SGVs (EHS Support, 2020). However, the potential ecological impacts of target metal concentrations exceeding NYSDEC Class C SGVs have not been evaluated based on Site-specific exposure conditions, consistent with the procedures provided by NYSDEC from the Division of Fish, Wildlife, and Marine Resources (DFWMR) *Screening and Assessment of Contaminated Sediment* (2014). The Sediment Sampling Report

[1] References to mercury in previous investigations indicate the results of total mercury analyses in environmental matrices.

recommended further investigation of potential exposure to target metals within the reach from the Site boundary to Salem Street (**Figure 2**). No further investigation was recommended downstream of Salem Street due to the limited sediment depositional features present within the high-gradient reach between Salem Street and Mill Brook Drive and surface-weighted average concentration (SWAC) concentrations below Class C SGVs (copper and mercury) or Class A SGVs (selenium and zinc) in the reach downstream of Mill Brook Drive to Rondout Creek (EHS Support, 2020). However, based on NYSDEC comments[2], further evaluation of a station located immediately downstream of Mill Brook Drive will be included in the Work Plan to address potential uncertainty regarding target metal concentrations within Class B SGVs (copper and mercury).

The Sediment Sampling Report (EHS Support, 2020) recommended further investigations to assess potential ecological and human health exposure to target metals in sediments. Two primary considerations in the assessment of target metal exposure in sediment include:

- Metal bioavailability and toxicity: Delineation sampling results presented in the Sediment Sampling Report (EHS Support, 2020) represent total recoverable metals concentrations in sediments. However, metal concentrations in labile sediment fractions and pore water better represent metal bioavailability and toxicity. Therefore, a phased assessment approach was recommended to evaluate the bioavailability and toxicity of metals in sediments based on Site-specific exposure conditions.
- Mobility of target metals into food webs: Mercury, particularly in the form of methylmercury, has the potential to bioaccumulate or biomagnify in aquatic and terrestrial food webs. It was recommended that the evaluation of potential exposure to target metals in sediment include an assessment of potential mobility of metals from sediment into associated food webs.

Dermal and incidental ingestion exposure pathways were identified as the primary exposure pathways for human health exposure to sediments within Plantasie Creek (EHS Support, 2020). Primary considerations in the evaluation of potential human health exposure to target metals identified in the Sediment Summary Report included the frequency and duration of exposure and the rate of incidental sediment ingestion.

This Work Plan presents the approach for evaluating potential ecological impacts and human health exposure to target metals in Plantasie Creek downstream of the Site. The technical approach presented in the Work Plan to evaluate potential ecological impacts was developed consistent with the FWRIA process outlined in DER-10 (NYSDEC, 2010), with supporting guidance from NYSDEC DFWMR *Screening and Assessment of Contaminated Sediment* (2014), NYSDEC *Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites* (1994), and other federal technical guidance documents (USEPA, 2007; 2005a).

1.1 Investigation Objectives

The overall purpose of the investigations proposed in this Work Plan is to collect adequate data to support a FWRIA Part 2: Ecological Impact Assessment to further define and evaluate the potential for adverse effects to fish and wildlife resources within Plantasie Creek downstream of the Site. Specific objectives of the investigation include:

1. Assess the bioavailability of target metals, specifically copper, mercury, selenium, and zinc, at representative stations within the extent of downstream sediment delineation sampling from

[2] April 19, 2021 NYSDEC comment letter on the Sediment Sampling Report.

the Site to Salem Street where sediments exceeding NYSDEC Class C freshwater SGVs have been delineated (EHS Support, 2020).

2. Evaluate the potential for adverse ecological effects associated with direct contact and dietary exposure to target metals for aquatic and semi-aquatic receptors associated with Plantasie Creek.
3. Provide data to support potential risk-based remedial decision-making for sediments in Plantasie Creek downstream of the Site.

In addition to the FWRIA Part 2: Ecological Impact Assessment objectives, data collected as part of the investigation will be used to evaluate potential human health exposure to target metals in sediments within Plantasie Creek through dermal contact or incidental ingestion pathways.

1.2 Work Plan Organization

The Work Plan is organized into the following sections:

- **Section 2** provides background information of the site operational history and a summary of the Plantasie Creek ECSM based on investigations conducted to date.
- **Section 3** presents the technical approach for the Ecological Impact Assessment.
- **Section 4** details the data analysis procedures for data collected as part of the Ecological Impact Assessment.
- **Section 5** details the data analysis procedures for the human health exposure assessment.
- **Section 6** describes the reporting procedures to document the findings of the Ecological Impact Assessment and human health exposure evaluation.
- **Section 7** summarizes the administrative procedures for implementing the investigation presented in the Work Plan.
- **Section 8** lists the references cited in the Work Plan.

2 Investigation Background

Section 2.1 and **Section 2.2** provide information on the operational history of the Site and the ECSM for the potential transport and deposition of target metals from on-site sources in sediments within Plantasie Creek downstream of the Site.

2.1 Operational History

Historical manufacturing operations at the Site involved the manufacture of blasting cap components, consisting primarily of metal shells, insulated wire, and plastic tubing, and the assembly of these components into various types of blasting caps or initiating devices using purchased explosives. Raw materials procured from off-site sources included explosives, chemicals, uncoated wire, and metal sheets. Raw explosives were stored as powders under water (to reduce the possibility of explosion) in wooden vats located within an underground concrete vault in the Tank House. As of 1991, explosive materials used at the facility included pentaerythritol tetranitrate (PETN), diazodinitrophenol (DDNP), cyclotrimethylene trinitramine (RDX), cyclotetramethylene tetranitramine (HMX), polymer bound explosive (PBX), tetryl, tetrazene, black powder, nitrocellulose, double base propellant, lead azide, lead mononitro-resorcinol (LMNR), and lead styphnate. These explosive materials were combined with barium salts, chromates, lead oxides, perchlorates, molybdenum, tungsten, silicon, sirconium, and boron powders to make the desired product. Additional starting materials, including selenium, tellurium, and lead powders, were used in product designs prior to 1988. Mercury fulminate was formerly used on-site in the production of certain devices prior to the late 1950s.

During the 1980s and 1990s, production at the facility dropped sharply. In 2003, the number of employees was significantly reduced following a merger of Dyno Nobel with a subsidiary of Ensign-Bickford Industries. The detonator manufacturing ceased at the Site on June 28, 2010. Dyno Nobel personnel who supported other company operations continued to occupy the Site administrative buildings. In 2012, Dyno Nobel began leasing the facility to Maine Drilling and Blasting, a joint venture with Dyno Nobel, who provides blasting services for the construction and quarry markets. Maine Drilling and Blasting operations involve the blending of emulsions and ammonium nitrate, storage and distribution of packaged explosives and bulk blasting agents, and on-site maintenance and repairs to company delivery vehicles.

2.2 Plantasie Creek Ecological Conceptual Site Model

The ECSM presented in the *Fish and Wildlife Impact Analysis Step IIC Investigation Report* (URS, 2011) describes the conceptual migration of target metals from site operations to downstream areas of Plantasie Creek. A summary of the ECSM for relevant transport and ecological exposure pathways from the Site to Plantasie Creek is presented in **Sections 2.2.1** through **2.2.4**.

2.2.1 Potential Sources

The SWMU 1/22 Wetland Complex represents the primary source of target metals from Site operations to Plantasie Creek. The SWMU 1/22 Wetland Complex drains to Plantasie Creek, a tributary to Rondout Creek (**Figure 2**). The SWMUs located within and adjacent to the wetland are potential sources of target metals to the SWMU 1/22 Wetland Complex and subsequently to the off-site portion of Plantasie Creek. SWMU 22 is a former landfill located near the center of the wetland complex; waste material disposed in this landfill represents a potential source of target metals to the adjacent wetland. SWMU 1 is a former shooting pond used to detonate off-specification explosives. Underwater detonation of explosives in SWMU 1 represents a potential source of target metals to the surrounding areas. SWMUs located within the Active Plant Area of the Site represent secondary sources of target metals to the SWMU 1/22 Wetland Complex. Target metals may migrate from the SWMU 1/22 Wetland Complex to the downstream reach of Plantasie Creek primarily through transport via surface water erosion/runoff pathways.

2.2.2 Conceptual Migration and Disposition in Downstream Sediments

The findings from phased sediment sampling and substrate surveys conducted in the off-site reaches of Plantasie Creek further refined the ECSM regarding the distribution and exposure to target metals in sediment downstream of the Site (EHS Support, 2020). Substrate mapping survey findings indicate that the distribution of fine-grained depositional sediment within the extent of the delineation sampling is consistent with stream slope. As illustrated in the longitudinal stream profile of Plantasie Creek (**Figure 3**), the reach of Plantasie Creek from the Site boundary to Salem Street is a low-gradient (0.2 percent slope) depositional reach, resulting in the accumulation and storage of fine-grained sediment overlying a native clay layer. At Salem Street, there is an abrupt increase in gradient, with slope increasing to 3.9 percent between Salem Street and Mill Brook Drive. This high-gradient reach is erosional, with minimal sediment deposition and storage. The substrate in this reach is characterized primarily by bedrock, with boulder, cobble, gravel, and fine-medium sand substrates. Finer-grained sediments are limited to shallow, channel margin deposits that are spatially limited within the reach between Salem Street and Mill Brook Drive. The extent of the 100-year floodplain within this reach is relatively narrow, constrained by steep slopes adjacent to Plantasie Creek. The slope of Plantasie Creek decreases to 0.3 percent from Mill Brook Drive downstream to Rondout Creek, resulting in a depositional sediment environment, with fine-grained sediments overlying a native clay layer. The floodplain from Mill Brook Drive downstream to Rondout Creek broadens and is predominantly influenced by inundation by floodwater in Rondout Creek.

The findings of the phased sediment delineation sampling program indicate that the distribution of target metals is consistent with the distribution of fine-grained depositional sediment, as described above based on stream slope **(Figure 4A and Figure 4B**). Target metal concentrations decreased with increasing distance from the Site. The greatest concentrations of target metals were observed within the low-gradient reach (0.2 percent slope) from the Site boundary to Salem Street, which is characterized as a depositional reach containing predominantly fine-grained sediments overlying a native clay layer. There is limited sediment storage from Salem Street to Mill Brook Drive due to increased channel slope (3.6 percent slope) and increased flow velocity, resulting in spatially limited and shallow channel margin sediment deposits that contained lower target metal concentrations relative to concentrations observed between the Site boundary and Salem Street (**Figure 4A and Figure 4B**). In fine-grained sediments sampled in the low-gradient reach (0.3 percent slope) from Mill Brook Drive to the downstream extent of the delineation sampling, target metal concentrations were lower relative to the concentrations observed between the Site boundary and Salem Street.

The combined results of the phased sediment delineation sampling indicate that the extent of sediments in Plantasie Creek categorized as NYSDEC Class C has been delineated between the Site boundary and Salem Street in accordance with the *Sediment Delineation Sampling and Substrate Mapping Work Plan* (EHS Support, 2016) and subsequent discussions with NYSDEC DFWMR on October

13, 2016. As stated in the *Sediment Delineation Sampling and Substrate Mapping Work Plan* and confirmed through discussions with NYSDEC DFWMR, delineation would be deemed complete when target metal concentrations were below corresponding SGVs or background threshold values (BTVs) based on comparisons to the following statistics calculated for the area defined by the delineation: 1) the upper confidence limit of the mean concentration (UCL_{mean}) of the delineation dataset or 2) SWAC of the delineation dataset[3].

Downstream of Mill Brook Drive to SCD-20 (transects SCD18.7 to SCD-20), target metal concentrations were delineated to Class C SGVs based on SWAC or UCL_{mean} concentrations, consistent with the established delineation criteria. Results are provided in **Table 1** and summarized as follows:

- Copper concentrations in 8 of 10 samples collected downstream of Mill Brook Drive were below the Class C SGV. The SWAC for copper was below the Class C SGV, and the UCL_{mean} copper concentration slightly exceeded the Class C SGV.
- Mercury concentrations were below the Class C SGV in 9 of 10 delineation samples; SWAC and UCL_{mean} mercury concentrations calculated for the delineation dataset were below the Class C SGV.
- Selenium concentrations in delineation samples were below the sediment quality benchmark of 5 mg/kg and the BTV calculated based on the background dataset.
- Zinc concentrations in the delineation dataset were below the BTV in 9 of 10 samples; SWAC and UCL_{mean} concentrations for zinc were below the Class A SGV.

Based on the delineation sampling results and established criteria, copper and mercury UCL_{mean} or SWAC concentrations were within the range of Class B SGVs, and selenium and zinc UCL_{mean} or SWAC concentrations were within the range of Class A SGVs (and consistent with background concentrations) in samples collected downstream of Mill Brook Drive.

These results and updated ECSM indicate that the greatest potential in-stream exposure to target metals in Plantasie Creek sediments downstream of the Site is within the reach from the Site boundary to Salem Street (EHS Support, 2020). In addition, Salem Street is the downstream extent of the delineation to Class C SGV for target metals based on the criteria established *Sediment Delineation Sampling and Substrate Mapping Work Plan* (EHS Support, 2016):

- Target metal SWAC concentrations downstream of Mill Brook Drive were within Class B SGVs (copper and mercury) or Class A SGVs/BTVs (selenium and zinc). As stated above, the approved *Sediment Delineation Sampling and Substrate Mapping Work Plan* stated that delineation would be deemed complete if SWAC or UCL_{mean} concentrations of target metals were below corresponding SGVs or BTVs.
- Sediment deposits in the high-gradient reach between Salem Street and Mill Brook Drive were spatially limited; therefore, there is limited exposure to target metals within this reach.

[3] During the October 13, 2016 conference call to review the *Sediment Delineation Sampling and Substrate Mapping Work Plan* comments, NYSDEC DFWMR indicated that averaging downstream sampling results was acceptable to demonstrate complete delineation if the calculations of the UCL_{mean} and SWAC values were based on a minimum of 10 sediment samples collected within a depositional reach having consistent slope and geomorphology.

2.2.3 Receptors and Exposure Pathways

Based on previous investigations conducted as part of the FWRIA (URS, 2011), potential ecological receptor groups and representative receptor species that may be exposed to target metals in the downstream investigation area include:

- Benthic macroinvertebrate community
- Fish community
- Omnivorous mammals: raccoon (*Procyon lotor*)
- Small piscivorous birds: belted kingfisher (*Megaceryle alcyon*)
- Semi-aquatic aerial insectivorous birds: tree swallow (*Tachycineta bicolor*)
- Semi-aquatic aerial insectivorous mammals: little brown bat (*Myotis lucifugus*)

The routes by which representative ecological receptor groups may be exposed to target metals in the downstream investigation area are illustrated in the Aquatic Exposure Pathway ECSM (**Figure 5**). Primary exposure pathways that will be quantitatively evaluated are illustrated by solid circles in the ECSM and described below for each receptor category:

- Benthic invertebrates: direct contact
- Fish community: direct contact
- Aerial insectivorous wildlife: direct ingestion of biota (tree swallow and little brown bat)
- Piscivorous wildlife: direct ingestion of surface water and biota (belted kingfisher)
- Omnivorous wildlife: direct ingestion of surface water and biota and incidental ingestion of sediment (raccoon)

2.2.4 Assessment and Measurement Endpoints

The Ecological Impact Assessment approach described in subsequent sections of the Work Plan was developed to collect sufficient information, as warranted, to assess the potential for adverse effects to receptor groups and representative species identified in the Aquatic Exposure Pathway ECSM (**Figure 5**). Additionally, the floodplain exposure pathway will be evaluated based on the findings of the floodplain soil investigations (EHS Support, 2022). An assessment endpoint is an explicit expression of the environmental value that is to be protected (USEPA, 1997). Assessment endpoints for the Ecological Impact Assessment were focused on survival, growth, and reproduction endpoints because these endpoints are the primary lines of evidence (LOEs) used in the evaluation of ecological effects for risk management decision-making (USEPA, 1994). A summary of assessment endpoints selected for each receptor category is provided in **Table 2**.

Risk questions were formulated to identify specific measurable ecological characteristics that could be used to evaluate the selected assessment endpoints. These measurement endpoints represent numerical observations that will be measured in Plantasie Creek and compared to similar observations measured at reference sites or reported in the literature (e.g., effects thresholds). The selected measurement endpoints will be used in a weight-of-evidence assessment of risk to each representative receptor based on the identified assessment endpoints. A summary of the risk questions and measurement endpoints selected for each assessment endpoint is provided in **Table 2**.

3 Ecological Impact Investigation Approach

The approach for investigating the potential ecological impacts of downstream migration of target metals from on-site sources to sediments within the Plantasie Creek has been developed based on the ECSM described in **Section 2.2**. The Work Plan has been developed as a phased investigation to maximize the efficiency of the investigation in providing focused data to support risk assessment and potential remedial decision-making:

- Phase 1 – Preliminary Bioavailability Assessment: The purpose of the Preliminary Bioavailability Assessment is to provide a preliminary assessment of the bioavailability of target metals, specifically copper, mercury, selenium, and zinc, at representative stations where NYSDEC Class C sediments were identified during the phased delineation sampling based on total recoverable metals concentrations (EHS Support, 2020).
- Phase 2 – Comprehensive Ecological Impact Assessment: The purpose of the Comprehensive Ecological Impact Assessment is to collect data to support multiple lines-of-evidence to evaluate direct contact and bioaccumulative exposure pathways to aquatic and semi-aquatic ecological receptors.

Figure 6 illustrates the study elements and conceptual progression of the phased investigation approach. **Sections 3.1** and **3.2** present the investigation objectives, sampling design, and implementation of sampling activities for Phase 1 and Phase 2 of the Ecological Impact Assessment. **Sections 3.3** and **3.4** provide details regarding quality assurance/quality control (QA/QC) procedures and health and safety planning.

3.1 Phase 1: Preliminary Bioavailability Assessment

The Phase 1 Preliminary Bioavailability Assessment will be conducted as an initial investigation phase to evaluate the Site-specific bioavailability of target metals in sediments within Plantasie Creek downstream of the Site. The results of the preliminary bioavailability assessment will be used to inform the design of the Phase 2 Comprehensive Ecological Impact Assessment (**Figure 6**). **Sections 3.1.1** through **3.1.3** detail the sampling design and proposed sampling approach for the Preliminary Bioavailability Assessment.

3.1.1 Sampling Design

The Preliminary Bioavailability Assessment is designed to measure key indicators of metal bioavailability in sediments within Plantasie Creek downstream of the Site. The sampling design of the Preliminary Bioavailability Assessment is based on the widely accepted concept that the bioavailability and toxicity of metals is correlated with the fraction of metals available as free ions in sediment pore water and biological tissue, rather than total recoverable metals concentrations measured in bulk sediment (USEPA, 2007; USEPA, 2005a; Di Toro et al., 2005; Ankley et al., 2006; Hansen et al., 1996; Ankley et al., 1991; Di Toro et al., 1992; and Luoma, 1989). The Preliminary Bioavailability Assessment will include the analysis of methylmercury (MeHg), the more bioavailable and toxic form of mercury, in select matrices. In the conceptual Phase 1 sampling design, mercury analyses will be specified for MeHg or total mercury (THg) analyses in each matrix.

The Preliminary Bioavailability Assessment will include a limited analysis of five key indicators of the bioavailability of target metals in sediment at stations from the Site to Salem Street (**Figure 5**):

1. Forage fish tissue: Adult forage fish species with limited home and forage ranges will be targeted for tissue analysis to evaluate localized exposure to target metals (copper, THg, selenium, and zinc). Fish tissue analysis is a key indicator of the target metal bioavailability because fish tissue concentrations represent the integration of exposure to bioavailable metal fractions over time and varying environmental conditions. Target species for adult forage fish tissue sampling will be based on available catch; however, based on habitat conditions, it is anticipated that target adult forage fish species will be representative of the highest tropic group (e.g., invertivore) within the minnow family (Cyprinidae). The inclusion of adult forage fish tissue in the Preliminary Bioavailability Assessment is consistent with the recommendation of NYSDEC during a review of the Plantasie Creek sediment investigation in a meeting on December 11, 2019.
2. Surface water chemistry: Near bottom surface water chemistry samples will be analyzed to evaluate the potential mobility of target metals (copper, THg, MeHg, selenium, and zinc) into the water column that may be bioavailable to aquatic receptors.
3. Bulk sediment chemistry: Bulk sediment chemistry will be collected to provide consistent exposure point concentrations (EPCs) for comparison with SGVs for target metals (copper, THg, selenium, and zinc), consistent with previous sediment characterization and delineation efforts (EHS Support, 2020). Acid-volatile sulfide (AVS), simultaneously extracted metals (SEM), and total organic carbon (TOC) will be analyzed in bulk sediment samples to support the evaluation of metal bioavailability consistent with USEPA procedures (USEPA, 2005a), which evaluate the toxicity of divalent metals mixtures in sediment based on equilibrium partitioning (EqP) theory. A theoretical EqP model will be used to predict the toxicity of divalent metals based on the partitioning of SEM between AVS, TOC, and pore water (USEPA, 2005a; 2007).
4. Pore water chemistry: Target metal concentrations (copper, THg, MeHg, selenium, and zinc) will be directly measured in filtered pore water samples to provide empirical data for the dissolved fraction of metals, which is bioavailable and potentially toxic fraction (USEPA, 2005a; USEPA, 2007). Empirical pore water chemistry data will complement the theoretical EqP model based on AVS-SEM and TOC.
5. Sequential extraction (SE) procedure: A limited number of bulk sediment samples will be analyzed for SE analyses of target metals as part of the Preliminary Bioavailability Assessment. SE is an analytical procedure that has been developed to identify elements associated with solid phases in sediment based on their reactivity with specific solutions. The SE procedure applies a series of chemical reagents that are selected to release target metals associated with solid phases within the sediment matrix. Typically, the distribution of target metals in sediment can be apportioned to the following solid phase fractions (e.g., Tessier et al., 1979):
   - Exchangeable fraction (F-1) targets metals that are weakly adsorbed to sediment and susceptible to desorption by changes in pore water chemistry (i.e., ionic composition).
   - Carbonate-associated fraction (F-2) targets metals bound to carbonates in sediment, which are dissolved by changes in pH and release adsorbed metals.
   - Fe- and Mn-oxide associated fraction (F-3) that targets metals associated with iron and manganese oxides that are sensitive to changes in sediment redox; iron and manganese oxides will dissolve under anoxic conditions and release adsorbed metals.
   - Organic matter and sulfide-associated fraction (F-4) that targets metals bound by organic matter (e.g., humic and fulvic acids) and reduced sulfur functional groups, both of which are degraded under oxidizing conditions.
   - Residual fraction (F-5) of an extracted sediment particle contains primary and secondary minerals.

Bioavailable metals in sediment are generally associated with the F-1 and F-2 fractions, with decreasing bioavailability in fractions F-3 through F-5. SE fractionation of target metals in Plantasie Creek sediments will be used to evaluate the proportion of total metals in bioavailable fractions to support the interpretation of other key indicators of bioavailability in the Preliminary Bioavailability Assessment.

In addition to samples collected between the Site and Salem Street, a preliminary bioavailability station will be established immediately downstream of Mill Brook Drive to address potential uncertainty regarding Site-specific exposure to target metal SWAC concentrations downstream of Mill Brook Drive that are within Class B SGVs (copper and THg) (**Section 2.2.2**). The preliminary bioavailability elements that will be sampled at this station include surface water chemistry, bulk sediment chemistry, pore water chemistry, and forage fish tissue, as described above. Given the proximity of this forage fish tissue sampling location to the mouth of Rondout Creek, which contains sources of mercury and other target metals that are unrelated to Site activities, forage fish tissue data from this sampling location will be evaluated in the context of fish tissue concentration gradients from the Site to assess the potential influences from Rondout Creek (e.g., other contamination sources, tides, and fish migration).

Collectively, these key bioavailability indicators will provide a more accurate assessment of the potential bioavailability and toxicity of target metals in sediments to assess risks to aquatic and benthic receptors within Plantasie Creek than comparisons of total recoverable target metal concentrations to NYSDEC SGVs.

The approximate sampling station locations for the Preliminary Bioavailability Assessment are illustrated in **Figure 7**. Sampling stations where samples of different media types will be collected in the same location are referred to as "co-located" stations. Samples of different media types collected at co-located stations will be collected in the following order to minimize potential disturbance: 1) surface water, 2) pore water, and 3) bulk sediment. Actual sampling locations near the general locations presented in **Figure 7** will be selected based on field observations. In addition to the co-located samplings stations, four composite adult forage fish samples will be collected from the Site to below Mill Brook Drive as target species are encountered. **Section 3.2.1** details the sampling approach to for the key bioavailability indicators at the stations proposed for the Preliminary Bioavailability Assessment.

3.1.2 Sampling Approach and Methodology

Details regarding the collection of samples to support the Preliminary Bioavailability Assessment are provided in **Sections 3.1.2.1** through **3.1.2.4** for each data type.

3.1.2.1 Fish Tissue Sampling

Four composite adult forage fish tissue samples will be collected from the Site to below Mill Brook Drive in Plantasie Creek. Additionally, one composite sample from a representative background area will be collected as part of the Phase 1 assessment. Candidate background fish sampling stations will be reviewed with NYSDEC prior to sampling.

Collection of fish tissue across all stations will be attempted in the same sampling event to minimize confounding factors. Fish will be collected using a backpack-mounted electrofishing unit, passive traps (unbaited), cast nets, or equivalent gear. Unit output will be continuously monitored to maximize sampling efficiency while minimizing harmful effects to fish and other aquatic organisms. Target fish species will be netted as soon as they are affected by the electrical field and placed in temporary holding wells until enough target species are collected. The upstream and downstream limits of each sampling reach will be recorded using a sub-meter global positioning system (GPS) unit.

Fish tissue samples will consist of whole-body composite samples of five to ten fish of the same species within each sampling reach. Fish collected within sampling reaches will be kept in holding wells. Based on the catch within sampling reaches, the target species for tissue analysis will be selected based similarly sized samples common among both reaches. Samples will be considered similarly sized if the smallest fish is greater than or equal to 75 percent of the total length of the largest fish in the composite. Every attempt will be made to maintain consistency in the target species and size of fish included in samples between stations. If consistent species cannot be sampled within each sampling reach, alternate species with similar functional feeding groups will be targeted.

Adult forage fish tissue composite samples will be processed consistent with NYSDEC guidance (2003). Fish selected for tissue analysis will be placed in a clean plastic bag, labeled with the appropriate collection information. Samples will be placed on ice until the end of the sampling effort, when the samples will be frozen at -12^{o} to -18^{o} C. Samples will be shipped frozen to the designated laboratory under appropriate chain-of-custody (COC) forms. Fish tissue samples will be analyzed for target metals (copper, THg, selenium, and zinc) and percent moisture.

3.1.2.2 Surface Water Chemistry

Surface water samples will be collected from the four co-located stations identified in the Preliminary Bioavailability Assessment for analyses of other key bioavailability indicators (**Figure 7**). Near-bottom surface water samples will be collected by grab sampling procedures, using a dedicated, laboratory-supplied transfer container. Care will be exercised not to disturb bottom sediments when collecting surface water samples. The sampler will approach the surface water sampling location from down-current, if applicable, and collect the sample from up-current of the physical location of the sampler. If there is minimal flow, the area will be allowed to settle, and the sample will be collected from a location that is not visibly turbid.

Unfiltered and field-filtered surface water samples will be submitted to the designated laboratory for analysis. Surface water samples will be field-filtered using a 0.45-micrometer (µm) capsule filter. Unfiltered samples will be analyzed for copper, THg, MeHg, selenium, and zinc and ancillary parameters to support the calculation of water quality criteria and data interpretation. Ancillary parameters will include total hardness, TOC, alkalinity, major ions/anions, sulfide, and total suspended solids (TSS). Filtered samples will be analyzed for the list of target metals and ancillary parameters including total dissolved solids (TDS) and dissolved organic carbon (DOC). Surface water parameters, including temperature, pH, dissolved oxygen (DO), and specific conductivity will be measured *in situ* with a multi-parameter water quality meter (e.g., YSI ProDSS or equivalent). The position of surface water samples will be recorded in the field using a sub-meter GPS unit.

3.1.2.3 Bulk Sediment Chemistry

Bulk sediment samples will be collected at the four co-located stations identified for the Preliminary Bioavailability Assessment (**Figure 7**). Bulk sediment samples will be analyzed to provide the following key indicators of target metal bioavailability:

- AVS-SEM analyses

- SE determination of the distribution of target metals into solid phases
- Total recoverable target metals analysis (copper, THg, selenium, and zinc) for comparison with SGVs.

Consistent with data collected at the direction of DFWMR during the FWRIA and previous sediment sampling conducted as part of the downstream sediment investigation in Plantasie Creek, surficial sediment samples for chemical analyses will be collected from the 0-to-12-inch sediment interval[4]. This sampling interval is deeper than the 0-to-10 or 0-to-15-centimeter (0-to-3.9 to 0-to-5.9-inch) depth interval recommended in USEPA guidance, including *Determination of the Biologically Relevant Sampling Depth for Terrestrial and Aquatic Ecological Risk Assessments* (USEPA, 2015) and *Methods for the Collection, Storage, and Manipulation of Sediments for Chemical and Toxicological Analyses* (USEPA, 2001). Therefore, sediment samples from the 0-to-12-inch sediment interval will represent a highly conservative estimate of the biologically active zone (BAZ) where the predominant abundance and mass of biological activity is expected to occur within the benthic habitat of Plantasie Creek.

Bulk sediment samples will be collected with an AMS sludge sampler or equivalent coring device at proposed stations. Bulk sediment core samples will be processed to minimize the oxidation of AVS. Once the core for bulk sediment analysis is retrieved, the core liner will be removed from the core barrel and caps will be placed immediately on the ends of the core liner and placed in a sealed plastic bag to minimize oxidation of the sample within the core liner. The capped core liner will be transferred to an inert environment (e.g., glove bag with nitrogen atmosphere) for processing. Within the inert environment, the caps will be removed, and the core liner will be split lengthwise on opposite sides of the core. A decontaminated blade will be used to split the sediment core sample lengthwise, and the two halves of the core will be laid open within the inert environment. Non-homogenized sediment aliquots from the 0-to-12-inch interval will be transferred to laboratory-supplied airtight glass containers. Samples containers for AVS-SEM analysis will be filled such that no headspace remains and then capped immediately within the inert environment. The remaining sediment within the core will be composited and homogenized to similar color and texture and transferred to laboratory-supplied sample containers. Sediment samples will be immediately placed on ice and stored at 4 °C until receipt by the analytical laboratory.

Bulk sediment samples will be submitted to the designated analytical laboratory for analysis of AVS-SEM, target metals (copper, THg, selenium, and zinc), TOC, and sediment grain size distribution by sieve analysis (**Table 3**). An aliquot of the bulk sediment will also be submitted to a designated laboratory for SE determination of the distribution of target metals into solid phases.

3.1.2.4 Pore Water Chemistry

Pore water samples will be collected at the four co-located stations identified for the Preliminary Bioavailability Assessment (**Figure 7**). Pore water samples will be collected for target metals analysis for comparison with NYSDEC Ambient Water Quality Standards (AWQS).

Rhizon MOM samplers (Rhizosphere Research, 0.6 µm pore size) or equivalent samplers will be used in conjunction with an inline 0.45 µm polyethersulfone membrane filter to sample water from saturated sediment interstitial pore space. Rhizons are an effective active pore water sampling procedure because

[4] Note, this depth interval is not specified in NYSDEC *Screening and Assessment of Contaminated Sediment* (2014)

they can extract pore water *in situ* with minimal disturbance to redox chemistry (Seeberg-Elverfeldt et al., 2005).

Consistent with data collected at the direction of DFWMR during the FWRIA and previous sediment sampling conducted as part of the downstream sediment investigation in Plantasie Creek, pore water samples for chemical analyses will be from the 0-to-12-inch sediment interval[5]. As noted for sediment samples, this sampling interval is deeper than the depth interval recommended in USEPA (2015) and USEPA (2001), so pore water data will represent a highly conservative estimate of exposure in the BAZ of Plantasie Creek. Pore water samplers will be advanced to at least 6 inches or as deep as possible prior to refusal. An aliquot of pore water will be analyzed in the field for water quality parameters (e.g., temperature, ORP, conductivity, and pH) using a Myron Ultrameter II or equivalent and compared with contemporaneous measurements in surface water to assess the potential for surface water dilution of pore water samples.

Pore water samples will be submitted to the designated analytical laboratory for analysis of target metals (copper, THg, MeHg, selenium, and zinc; **Table 3**).

3.1.3 Phase 1 Data Analysis and Phase 2 Decision Point

The findings of the Preliminary Bioavailability Assessment will be evaluated to assess the potential utility of conducting the Phase 2 Comprehensive Ecological Impact Assessment to further support risk-based remedial decision-making for sediments within Plantasie Creek between the Site and immediately downstream of Mill Brook Drive. If the findings of the Preliminary Bioavailability Assessment indicate that target metals are not highly bioavailable and unlikely to be toxic, additional LOEs will be developed to support the Phase 2 Comprehensive Ecological Impact Assessment (**Figure 6**). If key bioavailability indicators in the Preliminary Bioavailability Assessment indicate that target metals in sediments are highly bioavailable and likely toxic to fish or wildlife resources, the collection of additional data to support the Phase 2 Comprehensive Ecological Impact Assessment may not be warranted to support remedial decision-making. If the findings of the Preliminary Bioavailability Assessment indicate that target metals in sediments are likely to be highly bioavailable and toxic in all or part of the stream reach, potential remedial alternatives will be re-evaluated for those stations and further risk assessment activities may not be conducted (**Figure 6**).

The findings of the Phase 1 data analysis and recommendations for proceeding to the Phase 2 Comprehensive Ecological Impact Assessment or re-evaluating potential remedial alternatives will be presented to NYSDEC in a technical meeting following the evaluation of the Phase 1 decision criteria. Decisions to perform further risk assessment activities as part of the Phase 2 assessment or to re-evaluate potential remedial alternatives will be made in consultation with NYSDEC. **Sections 3.1.3.1** and **3.1.3.2** describe the proposed analysis of Phase 1 data and decision criteria that will be used to determine whether to proceed to the Phase 2 Comprehensive Ecological Impact Assessment.

3.1.3.1 Data Analysis

Data collected to evaluate key indicators of target metal bioavailability in the Preliminary Bioavailability Assessment will be analyzed to support decision criteria to determine whether to proceed to the Phase

[5] Note, this depth interval is not specified in NYSDEC *Screening and Assessment of Contaminated Sediment* (2014)

2 Comprehensive Ecological Impact Assessment. The following data analyses will be conducted on Phase 1 datasets to support decision criteria:

- Forage fish tissue evaluation: Whole body concentrations of target metals in adult forage fish tissue composite samples will be evaluated relative to critical body residues (CBRs) and dietary screening benchmarks (DSBs) for wildlife to assess the potential for adverse effects to the growth, reproduction, or survival of fish and piscivorous wildlife, respectively (**Table 4**). Two levels of chronic endpoints representing no observed effect concentration (NOEC) and lowest observed effect concentration (LOEC) endpoints will be identified as CBRs and DSBs to evaluate the potential for adverse effects to invertebrates and fish potentially exposed within Plantasie Creek:
    - CBRs for the protection of fish (**Table 4**):
        - NOEC CBR (CBR_{NOEC}): Represents a chronic NOEC CBR for mortality, growth and reproduction endpoints identified in literature studies.
        - LOEC CBR (CBR_{LOEC}): Represents a LOEC CBR for mortality, growth and reproduction endpoints identified in literature studies.
    - DSBs for the protection of piscivorous wildlife (**Table 4; Appendix A**):
        - NOEC DSB (DSB_{NOEC}): Represents a chronic NOEC DSB for mortality, growth and reproduction endpoints for belted kingfisher derived based on no observed adverse effects level (NOAEL) toxicity reference values (TRVs) identified in literature studies.
        - LOEC DSB (DSB_{LOEC}): Represents a chronic LOEC DSB for mortality, growth and reproduction endpoints for belted kingfisher derived based on lowest observed adverse effects level (LOAEL) TRVs identified in literature studies.
- Surface water chemistry evaluation: 0.45 µm-filtered surface water chemistry results will be compared to NYSDEC AWQS derived for the dissolved metal form, as specified in 6 CRR-NY 703.5.
- Pore water chemistry evaluation: 0.45 µm-filtered pore water chemistry results will be compared to NYSDEC AWQS derived for the dissolved metal form, as specified in 6 CRR-NY 703.5.
- Bulk sediment chemistry: Total recoverable target metal concentrations in bulk sediment samples will be compared to NYSDEC SGVs to identify the NYSDEC sediment class (Class A, Class B, or Class C) for each sampling station (NYSDEC, 2014). In addition to total recoverable target metal concentrations, AVS, SEM, and TOC results will be used to evaluate the bioavailability and toxicity of divalent metals mixtures in sediment based on EqP (USEPA, 2005a; 2007). The EqP approach presented in USEPA guidance (2005a) and adopted in NYSDEC guidance (2014), establishes the following benchmarks for protection of benthic organisms based on the organic carbon-normalized difference in the molar concentrations of summed SEM and AVS (∑SEM-AVS/foc):
    - < 130 micromoles per gram organic carbon ($\mu mol/g_{OC}$): Toxicity is not likely
    - 130 – 3000 $\mu mol/g_{OC}$: Toxicity is uncertain
    - 3000 $\mu mol/g_{OC}$: Toxicity is likely.
- SE target metals fractionation: Target metals recovered in each solid phase fraction will be reported by concentration and as a percentage of the total target metal concentration recovered in all SE fractions.

The following sections describe the proposed analysis of Phase 1 data and decision criteria that will be used to determine whether to proceed to the Phase 2 Comprehensive Ecological Impact Assessment.

3.1.3.2 Decision Criteria

The decision to proceed with the Phase 2 Comprehensive Ecological Impact Assessment will be based on a weight-of-evidence evaluation of key bioavailability indicators from the Phase 1 Preliminary Bioavailability Assessment. Decision criteria that indicate highly bioavailable and likely toxic target metal concentrations include (**Figure 6**):

1. Whole body forage fish tissue concentrations exceeding:
   - CBR_{LOEC} values for target metals (**Table 4**).
   - DSB_{LOEC} values for target metals (**Table 4**).
2. Target metal concentrations in filtered surface water samples exceeding NYSDEC Acute AWQS.
3. (SEM-AVS)/f_{OC} values in bulk sediment exceeding 3,000 µmol/g_{OC}, the concentration at which USEPA indicates that metal toxicity is likely (USEPA, 2005a).
4. Target metal concentrations in filtered pore water samples exceeding NYSDEC Acute AWQS.
5. Greater than 50 percent of copper and THg in bulk sediment is associated with bioavailable SE fractions (F-1 and F-2).

Spatial patterns and consistency in bioavailability indicators along the identified concentration gradients of target metals in Plantasie Creek sediments will also be evaluated based on the decision criteria. If the preponderance of key bioavailability indicators indicates that target metals are not highly bioavailable and unlikely to be toxic based on the above criteria for a portion or the entire stream reach from the Site to below Mill Brook Drive, the phased investigation will proceed to the Phase 2 Comprehensive Ecological Impact Assessment (**Figure 6**). As stated in **Section 3.1.3**, the findings of the Phase 1 data analysis and the recommendation regarding whether to proceed to the Phase 2 Comprehensive Ecological Impact Assessment will be presented to NYSDEC in a technical meeting following the evaluation of the Phase 2 decision criteria. If the recommendation is to proceed to the Phase 2 Comprehensive Ecological Impact Assessment, a detailed Phase 2 sampling design based on the conceptual sampling design presented in **Section 3.2** will be proposed to NYSDEC in the technical meeting for review and comment prior to implementation.

3.2 Phase 2: Comprehensive Ecological Impact Assessment

Sections 3.2.1 and **3.2.2** detail the conceptual sampling design and sampling approach for the Phase 2 Comprehensive Ecological Impact Assessment.

3.2.1 Sampling Design

The specific sampling design for the Phase 2 Comprehensive Ecological Impact Assessment will be informed by the findings of the Preliminary Bioavailability Assessment (**Section 3.1.3**). This section presents the conceptual sampling design to identify additional LOEs and minimum sample sizes that will be incorporated into the Phase 2 sampling design to support the Comprehensive Ecological Impact Assessment. However, the specific number and placement of Phase 2 sampling stations will be determined following the evaluation of key bioavailability indicators from the Preliminary Bioavailability Assessment. As discussed in **Section 3.1.3.2**, a detailed Phase 2 sampling design will be proposed to NYSDEC in the technical meeting for review and comment prior to implementation.

The Comprehensive Ecological Impact Assessment will include the collection of multiple LOEs to support the evaluation of ecological impacts to receptor groups and representative receptor species identified in the downstream investigation area (**Section 2.2.3**).

3.2.1.1 Sediment Quality Triad

Consistent with the FWRIA for the SWMU 1/22 Wetland Complex (URS, 2011), a sediment quality triad (SQT) approach will be used to establish multiple LOEs to evaluate potential direct contact exposure to benthic invertebrates. This weight-of-evidence approach evaluates sediment quality by integrating spatially and temporally matched sediment chemistry, biological, and toxicological information (Long and Chapman, 1985; Chapman et al., 1987). The SQT approach will consist of the following LOEs:

- Benthic invertebrate community analyses
- Toxicity testing based on bulk sediment
- Chemical analyses of bulk sediment and pore water

The incorporation of benthic macroinvertebrate community data into the SQT investigation provides an empirical dataset for *in situ* evaluations of potential toxicity. Sediment toxicity testing provides an *ex situ* evaluation of toxicity by exposing laboratory-reared organisms to sediment from SQT stations under controlled laboratory conditions. Bulk sediment and pore water chemistry will be collected at SQT stations to provide representative analytical data for comparison to effects benchmarks and to evaluate the results of benthic community and sediment toxicity studies.

The SQT investigation will evaluate potential impacts to benthic invertebrate communities within Plantasie Creek downstream of the Site relative to the benthic invertebrate community in a suitable reference area that will be identified, in consultation with NYSDEC, as part of the Preliminary Bioavailability Assessment. Reference area SQT stations will be selected consistent with the following criteria:

- Target metal concentrations consistent with regional background, outside of known influences from the Site.
- Substrate characteristics (e.g., grain size distribution, organic content) qualitatively similar to SQT stations from the Site to below Mill Brook Drive.
- Water depths comparable to water depths at SQT stations from the Site to below Mill Brook Drive.

A total of 12 stations will be sampled as part of the SQT investigation, including 8 stations between the Site and Salem Street, 3 stations in a reference stream, and 1 station downstream of Mill Brook Drive. Preliminary SQT stations will be selected to capture the identified gradient of target metal concentrations from the Site to below Mill Brook Drive and to provide adequate spatial coverage of SQT stations within the reach. However, the sampling location downstream of Mill Brook Drive will be evaluated in the context of concentration gradients from the Site to understand other potential influences from Rondout Creek. Final SQT sampling stations will be selected following the Preliminary Bioavailability Assessment. The final SQT sampling design, including the selection of reference stations, will be proposed to NYSDEC in a technical meeting for review and comment prior to implementation.

3.2.1.2 Surface Water

Four additional surface water samples will be collected as part of the Comprehensive Ecological Impact Assessment to reduce temporal uncertainty in surface water exposure conditions and to provide a contemporaneous surface water dataset for the SQT investigation. Consistent with the Preliminary Bioavailability Assessment, near-bottom surface water chemistry samples will be analyzed to evaluate the potential mobility of target metals into the water column that may become bioavailable to aquatic receptors (**Section 3.1.2.2**).

3.2.1.3 Biological Tissue

As stated in **Section 3.1.1**, fish and other biological tissue analyses are a key indicator of the target metal bioavailability because tissue concentrations represent the integration of exposure to bioavailable metal fractions over time and varying environmental conditions. Biological tissue analyses will be incorporated into the Comprehensive Ecological Impact Assessment to assess potential exposure to fish and benthic invertebrates, as well as wildlife consumers of fish and benthic invertebrates.

Adult forage fish tissue analyses conducted within Plantasie Creek as part of the Phase 1 Preliminary Bioavailability Assessment will be assessed for use as representative fish tissue concentrations for the Comprehensive Ecological Impact Assessment (**Section 3.1.2.1**). Consistent with Greenberg et al. (2008) *Sediment Assessment and Monitoring Sheet (SAMS) #1: Using Fish Tissue Data to Monitor Remedy Effectiveness*, Phase 1 fish tissue data will be used to estimate the Site-specific coefficients of variation (standard deviation/mean) for target metals concentrations to estimate sufficient samples sizes (number of composites and individuals per composite) to support statistical comparisons. However, if additional fish sampling is warranted in Phase 2 based on the Phase 1 Preliminary Assessment, a sampling design, including additional background tissue samples, will be proposed to NYSDEC in the technical meeting for review and comment prior to implementation.

Benthic invertebrate tissue concentrations will be estimated based on laboratory bioaccumulation testing with sediments collected from three SQT stations between the Site and Salem Street that represent target metal concentration gradients, as well as a representative reference SQT station. Oligochaete (*Lumbriculus variegatus*) test organisms will be exposed to field-collected sediments in a 28-day exposure conducted in accordance with USEPA *Test Method 100.3 Lumbriculus variegatus Bioaccumulation Test for Sediments* (2000). Exposed test organisms will be analyzed for target metal concentrations following the 28-day exposure and the resulting whole body tissue concentrations will be used to estimate representative benthic invertebrate tissue concentrations for the Comprehensive Ecological Impact Assessment.

Analysis of tissue from laboratory-exposed test organisms is proposed in the Work Plan over the analysis of field-collected tissue samples due to anticipated challenges meeting minimum analytical mass requirements with the collection of *in situ* benthic invertebrate samples. However, sampling efficiency of field-collected benthic invertebrate tissue samples will be further evaluated during the Preliminary Bioavailability Assessment. Specifically, the feasibility of collecting sufficient benthic invertebrate tissue mass for tissue analyses in Phase 2 will be qualitatively evaluated using bucket sieves during the Preliminary Bioavailability Assessment, documenting tissue recovery versus sampling effort. Results of the qualitative invertebrate tissue evaluation, along with any changes to the proposed approach, will be communicated to NYSDEC in a technical meeting prior to implementation of Phase 2 laboratory bioaccumulation testing.

3.2.1.4 Sequential Extraction

A limited number of bulk sediment samples (n=3) will be analyzed for SE analyses of target metals to supplement the SE samples (n=3) collected as part of the Preliminary Bioavailability Assessment. The total number of samples between the Preliminary Bioavailability Assessment and Comprehensive Ecological Impact Assessment (n=6) will provide SE data for sediment samples representative of the target metal concentration gradient, as well as providing spatial coverage, between the Site and Salem Street.

3.2.2 Sampling Approach and Methodology

Additional data collection to support the Comprehensive Ecological Impact Assessment will be focused on the collection of bulk sediment to support the SQT investigation, bioaccumulation study, and bioavailability assessment, as well as additional surface water sampling. As stated in **Section 3.2.1.3**, the need for additional fish tissue data collection as part of the Phase 2 Comprehensive Ecological Impact Assessment will be evaluated based on the results of fish tissue sampling conducted as part of the Preliminary Bioavailability Assessment. Details regarding the collection of additional field data to support the Comprehensive Ecological Impact Assessment are included in **Sections 3.2.2.1** and **3.2.2.2**.

3.2.2.1 Bulk Sediment

A systematic sampling approach will be implemented to collect and analyze bulk sediment to generate the necessary data to support the multiple LOEs evaluated in the SQT investigation, bioaccumulation study, and bioavailability assessment. The following bulk sediment samples will be collected from the surface sediment interval (0 – 12 inches) using a Ponar dredge or equivalent sampler at SQT stations:

1. Discrete grab samples (n = 3) for benthic invertebrate community analysis (all SQT stations), conducted between May and October (NYSDEC, 2021)
2. Composite grab samples to obtain at least 9 liters of sediment for toxicity testing (all SQT stations)
3. Composite grab samples to obtain at least 3 liters of sediment for bioaccumulation testing (3 site SQT stations and 1 background SQT station only)
4. Composite grab samples to obtain at least 1 liter of sediment for bulk sediment analysis (all SQT stations)
5. Composite grab samples to obtain at least 500 milliliters of sediment for SE analyses (3 SQT stations)

Discrete samples for benthic invertebrate community analysis will be collected initially at each SQT station to minimize potential disturbances to benthic fauna at the station. Three replicate samples will be collected at each SQT station using a petite ponar grab sampler. Each replicate sample will be sieved through a 500-µm mesh sieve to remove fine-grained sediments; large vegetation and woody debris will be rinsed over the sieve and discarded. The inside of the petite ponar sampler will be thoroughly rinsed over the sieve to remove any remaining organisms. Material retained on the sieve will be transferred to a sampling container and preserved with 70 percent ethanol. Following the transfer of the sample material to the sample container, the sieve will be inspected to remove any residual organisms and add them to the sample container. Preserved samples will be submitted to a benthic laboratory for taxonomic analysis. In the laboratory, benthic community samples will be subsampled using a random 100-organism sub-count (minimum sub-count) in accordance with NYSDEC SOP-208 (NYSDEC, 2021) and Barbour et al. (1999). Organisms included in the sub-count will be identified to the lowest taxonomic level practical, typically genus or species.

Bulk sediment will be collected from the surface sediment interval (0 – 12 inches) to provide samples for sediment toxicity testing, bioaccumulation testing, and sediment chemistry analyses. Sediment toxicity testing and bioaccumulation testing will be conducted in accordance with the USEPA *Methods for Measuring the Toxicity and Bioaccumulation of Sediment-associated Contaminants with Freshwater Invertebrates* (USEPA, 2000). The following chronic sediment toxicity tests will be performed using sediments from SQT stations:

- 42-day *Hyalella azteca* test for Measuring the Effects of Sediment-Associated Contaminants on Survival, Growth, and Reproduction (USEPA Method 100.4; USEPA, 2000); and
- 28-day *Chironomus riparius* test evaluating survival, growth, and emergence consistent with Organisation for Economic Co-operation and Development (OECD) Guideline 218 (OECD, 2004).

The toxicity testing laboratory will perform the designated tests on SQT and laboratory control sediments in accordance with test protocols established in USEPA (2000) and OECD (2004). A laboratory control treatment will be established using natural sediments from uncontaminated areas or formulated sediments to evaluate test acceptability. Overlying water quality will be monitored daily for temperature, dissolved oxygen, pH, and conductivity. Alkalinity, ammonia, and hardness will be measured in a surrogate test chamber for each treatment at the start of the test and weekly thereafter. TOC concentration in overlying water will be measured in the surrogate chamber at the start and end of the test. At the conclusion of the sediment toxicity tests, the following endpoints will be reported:

- 42-day *Hyalella azteca*: Mean survival (Day 28, Day 35, and Day 42), growth as mean dry weight (Day 28 and Day 42), growth as mean dry biomass (Day 28 and Day 42), juvenile production on Day 35 and Day 42 (per surviving amphipod and per surviving female); and
- 28-day *Chironomus riparius*: Mean survival – Day 10, growth (ash free dry weight and ash free dry biomass), percent emergence and mean time to emergence.

As stated in **Section 3.2.1.3**, benthic invertebrate tissue will be estimated based on concentrations measured in oligochaete (*L. variegatus*) test organisms exposed to field-collected sediments in a 28-day exposure conducted in accordance with USEPA Test Method 100.3 (USEPA, 2000). Exposed test organisms will be analyzed for target metal concentrations following the 28-day exposure and the resulting whole body tissue concentrations will be used to estimate representative benthic invertebrate tissue concentrations for the Comprehensive Ecological Impact Assessment.

Bulk sediment samples will be analyzed to estimate target metal EPCs for comparison with SGVs and to aid in the interpretation of SQT results. Bulk sediment samples will be submitted to the designated analytical laboratory for analysis of AVS-SEM, target metals (copper, THg, selenium, and zinc), TOC, and sediment grain size distribution by sieve analysis (**Table 3**). An aliquot of the bulk sediment will also be submitted to a designated laboratory for SE determination of the distribution of target metals into solid phases at three select SQT stations.

Consistent with the FWRIA, bulk sediment samples from reference SQT stations will be analyzed for a broader suite of analytical parameters to adequately characterize potential chemical stressors other than target metals that may influence toxicity testing or benthic community results. The broader analytical suite will include target analyte list (TAL) metals, target compound list (TCL) volatile and semi-volatile organic compounds, and TCL pesticides.

3.2.2.2 Surface Water

Near-bottom surface water samples will be collected from four co-located SQT stations consistent with the approach specified for the Preliminary Bioavailability Assessment (**Section 3.1.2.2**). Unfiltered and field-filtered surface water samples will be submitted to the designated laboratory for analysis. Surface water samples will be field filtered using a 0.45 µm capsule filter. Unfiltered samples will be analyzed for copper, THg, MeHg, selenium, and zinc and ancillary parameters to support the calculation of water quality criteria and data interpretation. Ancillary parameters will include total hardness, TOC, alkalinity, major ions/anions, sulfide, and TSS. Filtered samples will be analyzed for the list of target metals and ancillary parameters including TDS and DOC. Surface water parameters, including temperature, pH, DO, and specific conductivity will be measured in situ with a multi-parameter water quality meter (e.g., YSI ProDSS or equivalent). The position of surface water samples will be recorded in the field using a sub-meter GPS unit.

3.3 Project Quality Control and Quality Assurance

Sections 3.3.1 through **3.3.7** provide information on sample management, laboratory analytical requirements, quality assurance/quality control (QA/QC) of samples and analyses, analytical data validation, and project documentation to support the data objectives.

3.3.1 Project Quality Control and Quality Assurance Organization

The project organization for QC and QA is provided below. A more detailed project organization is provided in **Section 7.1**.

Contractor Project Director/Project Engineer
Kristin A. VanLandingham, P.E.
EHS Support LLC
Telephone: (850) 251-0582
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Contractor Quality Assurance Officer
Chrissy Peterson
EHS Support LLC
Telephone: (412) 925-1385
Email: chrissy.peterson@ehs-support.com

Lab Contract
Eurofins Environment Testing US – multiple locations

3.3.2 Decontamination Procedures

Non-dedicated field sampling equipment will be decontaminated between samples, including both locations and depth intervals. Decontamination procedures are outlined in the *Field Equipment Decontamination Standard Operating Procedure* **(Appendix B)**. Additionally, investigation-derived wastes (IDW) created during sampling or decontamination will be placed in drums, characterized, and properly disposed of.

3.3.3 Sample Identification, Handling, and Chain-of-Custody

Analytical samples will be identified, handled, and recorded as described below. Each sample container will have a sample label affixed to the outside, and documentation will be completed in waterproof ink. Each label will be marked using waterproof ink with the following information:

- Project name
- Sample identification number
- Date and time of collection
- Initials of sampling technician
- Requested analysis
- Method of preservation

Sample containers will be packed in bubble wrap to minimize breakage and placed in plastic coolers. Ice will be placed around sample containers, and additional cushioning material will be added to the cooler, if necessary. A temperature blank will be included in each cooler. Paperwork will be placed in a sealable plastic bag and placed on top of the sample containers or taped to the inside lid of the cooler. The cooler will be sealed, and signed custody seals will be affixed to two sides of the cooler. Laboratory address labels will be placed on top of the cooler.

Sample coolers will be packaged and shipped as environmental samples in accordance with applicable federal and state regulations. Standard procedures applicable to the shipment of environmental samples to the analytical laboratory are outlined below:

- Environmental samples will be transported to the laboratory by field personnel, shipped through Federal Express or equivalent overnight service, or picked up by a laboratory courier. Shipments will be scheduled to meet holding time requirements.
- The laboratory will be notified prior to receipt of samples. If the number, type, or date of shipment changes due to site constraints or program changes, the laboratory will be informed in advance to allow adequate time to prepare.
- The transfer of custody of field collected samples will follow an established sample COC program. The primary purpose of COC procedures is to ensure that sample traceability is maintained from collection through shipping, storage, and analysis to data reporting and disposal.
- Tracking sample custody will be accomplished by using the COC record. A COC entry will be recorded for every sample, and a COC record will accompany every sample shipment to the laboratory. At a minimum, the COC record will contain the following information for each sample:
    - Project name and number
    - Sample number and identification of sampling point
    - Sample media

- Sample number and identification of sampling point
- Date and time of collection
- Sample type
- Number, type, and volume of sample container(s)
- Sample preservative
- Analysis requested
- Name, address, and phone number of laboratory or laboratory contact
- Signature, dates, and times of persons in possession
- Any necessary remarks or special instructions

Once the COC is complete and the samples are prepared for shipment, the COC will be placed inside the shipping container, and the container will be sealed. Samples are considered to be in custody if they are within sight of the individual responsible for their security or locked in a secure location. Each person who takes possession of the samples, except the shipping courier, is responsible for sample integrity and safekeeping. A copy of each COC form will be retained by the sampling team for the project file. Bills of lading will also be retained as part of the COC record.

3.3.4 Analytical Requirements

Media-specific analytical requirements have been established to confirm that laboratory reporting limits are adequate to satisfy the data objectives stated for the investigation. **Table 4** provides a comparison of media-specific analytical requirements to analytical reporting limits provided by the laboratory. Sediment-specific analytical requirements were based on Class A SGVs (NYSDEC, 2014). Surface water and pore water analytical requirements were based on NYSDEC chronic AWQS. Biological tissue analytical requirements were based on CBRs derived for fish and invertebrates in literature studies (**Table 4**). Additionally, Category B laboratory data deliverables will be provided by the laboratory.

3.3.5 Analytical QA/QC Samples

Field QA/QC samples are designed to help identify and minimize potential sources of sample contamination due to field procedures and to evaluate potential error introduced by sample collection and handling. Three types of QA/QC samples and a temperature blank will be collected as part of the proposed sediment delineation sampling effort:

- Field (rinsate) blank samples: A field blank sample is intended to indicate potential contamination from sampling equipment. A field blank sample will be collected by rinsing laboratory supplied organic-free deionized water over decontaminated sampling apparatus into a laboratory-supplied sample bottle. The field blank sample is assigned a distinct identification number and will be handled, transported, and analyzed in the same manner as the samples collected that day. Field blanks will be collected at a rate of one per day per sample matrix. A field blank does not need to be collected when dedicated or disposable sampling equipment is used.
- Duplicate samples: Blind field duplicate samples will be collected to evaluate the consistency of field techniques and laboratory analysis. Duplicate samples will be obtained by simultaneously filling aliquots of homogenized sample media into two sets of bottle ware: 1) the investigative set and 2) the duplicate set. The duplicate sample will be handled in the same manner as the primary sample, assigned distinct sample identification, and submitted to the laboratory with its primary sample. Duplicate samples will be collected at a rate of five (5) percent of the total

samples collected for each matrix. Locations selected for the collection of duplicates will be based on professional judgment of the field team leader.
- Matrix spike/matrix spike duplicate (MS/MSD) samples: MS/MSD samples are prepared at the laboratory by dividing a control sample into two aliquots, then spiking each with identical concentrations of specific analytes. The spike samples are then analyzed separately, and the results are compared to evaluate the effects of the sample matrix on the analytical accuracy and precision. At sampling locations where MS/MSD samples are to be collected, a sufficient volume of sampling material, as required by the laboratory will be collected. MS/MSD samples will be labeled and shipped to the laboratory along with the primary sample from which it was collected. MS/MSD samples will be collected at a rate of 5 percent of the total number of samples in each matrix.
- Temperature blank: A temperature blank will be included in each cooler shipped in wet ice. A temperature blank is a vial of water shipped with samples and is used by the laboratory to measure the temperature of the cooler upon receipt at the laboratory. The temperature blank is not analyzed.

3.3.6 Analytical Data Validation

Data quality and usability depend on many factors, including sampling method, sample preparation, analytical method, quality control, and documentation. Data quality will be evaluated through validation procedures that assess the accuracy, precision, representativeness, completeness, comparability (method compliance) and sensitivity of the sediment sample data to determine if it is adequate for its intended use. See **Table 4** for updated analytical requirements, laboratory reporting limits, and analytical methods. Upon completion of the validation effort, a report will be submitted covering the overall assessment of the data quality. The report will include:
- A general assessment of the data package as it pertains to completeness and compliance;
- Descriptions of any deviations from the required protocol;
- As assessment of outliers and the effect of outliers on overall usability of the data; and
- Identification of applicable data qualifiers.

3.3.7 Sediment Toxicity Testing Performance Standards

The performance of sediment toxicity testing will be evaluated consistent with test protocols provided by USEPA (2000) and OECD (2004). Test acceptability will be based on the performance of laboratory control samples through the duration of the test. Specific performance standards to evaluate test acceptability for the two proposed toxicity tests based on control treatments include:
- 42-day *Hyalella azteca* for survival and growth: Average survival in the control sediment of should be greater than or equal to 80 percent on Day 28; additional performance-based criteria are provided in Table 14.3 of Test Method 100.4 (USEPA, 2000); and
- 28-day *Chironomus riparius* test for survival, growth, and emergence: Emergence in the control sediment greater than or equal to 70 percent at the end of the test; additional performance-based criteria are provided in Table 14.3 of Test Method 100.4 (OECD, 2004).

3.3.8 Benthic Community Analysis QA/QC Procedures

Laboratory QA/QC for the processing and identification of benthic invertebrate samples will be consistent the approach used by NYSDEC (2021) and Barbour et al. (1999). Residual material from the sorted subsample will be re-examined and any organisms missed by the sorter will be enumerated. If greater than at least 10 percent of total organisms enumerated in the subsample are found in the sorted residual, a second 10 percent of the sample lot will be checked for sorting. At least 10 percent of identified samples will be reviewed entirely by a senior taxonomist to verify identification and enumeration; targeted reviews of the taxonomy of the remaining samples will be conducted. Targeted taxonomic reviews will focus on the verification of unique or uncommon taxa, if any, identified in the remaining samples.

3.3.9 Project Documentation

All information pertinent to the investigation will be recorded in a bound field logbook and/or field data sheets. Entries will include the following, as applicable:

- Project name and number
- Sampler's and field personnel names
- Date and time of sample collection
- Observations at the sampling site, such as weather conditions
- Sample number, location, and depth
- Sampling method
- Analyses requested
- Sampling media
- Sample type (grab or composite)
- Sample physical characteristics
- Summary of daily tasks and information concerning sampling changes and scheduling modifications dictated by field conditions

Field investigation situations vary widely. No general rules can include every type of information that must be entered in a logbook or data sheet for a particular site.

Laboratory and field data sheets will be included as an appendix to the Ecological Impact Assessment report. Site-specific recording will include sufficient information so that the sampling activity can be reconstructed without relying on the memory of field personnel. At the completion of the field activities, the logbooks will be maintained in the central project file.

3.4 Project Health and Safety Planning

Field activities will be conducted in accordance with the *Health and Safety Plan (HASP) Hercules, Inc. Site #356001* (EHS Support, 2021). A review of the proposed field investigation activities will be completed prior to the start of field sampling activities. Field activities will be conducted in accordance with the HASP and any addenda that are approved for the Site at the time of sampling.

A Project Safety Analysis (PSA) will be performed by the project manager prior to field mobilization to ensure that predictable hazards are identified and addressed before work begins. A PSA form will be completed by the project manager and sent to the field team prior to start of work. The project manager will hold a health and safety kickoff meeting with the field team before field mobilization to review the PSA form together and address any questions.

Once the field team mobilizes to the Site, a daily tailgate meeting will be held at the start of each field day. The field team leader will discuss work being performed that day, the potential hazards associated with those tasks, and how the field team will mitigate those hazards. The field team leader will also address any changes to methodology, based on observations from the previous day, to reduce potential hazards.

4 Ecological Impact Assessment

Data generated as part of the Phase 2 Comprehensive Ecological Impact Assessment will be used to evaluate potential ecological impacts based on the assessment and measurement endpoints presented in **Section 2.2.4** for direct contact and wildlife ingestion pathways. **Sections 4.1** through 4.4 describe the approach for data analysis and reporting to support the Ecological Impact Assessment for Plantasie Creek.

4.1 Direct Contact Exposure Evaluation

Direct contact exposure pathways will be evaluated based on the analysis of SQT results, surface water sampling, and critical body residues for fish and invertebrate tissues. The approach for evaluating each endpoint is discussed in **Sections 4.1.1**, **4.1.2**, and **4.1.3**.

4.1.1 Sediment Quality Triad

Procedures for evaluating each LOE in the SQT investigation are discussed in the following sections.

4.1.1.1 Benthic Invertebrate Community Analyses

Benthic invertebrate community data will be evaluated consistent with NYSDEC guidance (NYSDEC, 2021). A multi-metric approach will be utilized to evaluate relative differences between Plantasie Creek SQT and reference SQT stations. Benthic community metrics identified in the NYSDEC guidance that are applicable to Plantasie Creek and will be quantified in the evaluation include:

- Taxa richness
- Ephemeroptera, Plecoptera, and Tricoptera richness (EPT richness)
- Hilsenhoff Biotic Index
- Percent Model Affinity
- Species diversity
- Shannon-Weiner Diversity Index
- Percent dominance
- Non-Chironomidae and oligochaete (NCO) richness.

Additionally, the Macroinvertebrate Biological Assessment Profile (BAP) of Index Values for Ponar Sampling from Soft Sediments will be completed (NYSDEC, 2021). Additional metrics from NYSDEC (2021) and Barbour et al. (1999) may be considered, as appropriate, to characterize benthic communities at Plantasie Creek SQT and reference SQT stations.

Multivariate statistical techniques may also be used to evaluate differences between benthic communities at Plantasie Creek SQT and reference SQT stations if these procedures are supported by the data. Ordination analyses (e.g., correspondence analyses, non-metric multidimensional scaling) or other multivariate techniques used in quantitative community ecology (e.g., hierarchical cluster analysis) may be used to evaluate differences between benthic communities along gradients of sediment metals concentration or other environmental variables (McCune and Grace, 2002; Pielou, 1984). These statistical techniques will only be considered if supported by sufficiently robust benthic invertebrate datasets.

4.1.1.2 Sediment Toxicity Testing

Sediment toxicity testing will provide an *ex situ* evaluation of sediment toxicity at Plantasie Creek SQT stations relative to background SQT stations. Chronic test endpoints specified in **Section 3.2.2.1**that are measured throughout the exposure period will provide the basis for comparisons between Plantasie Creek SQT and reference SQT stations. Greater weight will be assigned to lethal endpoints (i.e., survival) relative to sublethal endpoints (e.g., growth, reproduction), because lethal endpoints will likely result in greater effects on population stability (McPherson et al., 2008). Quantitative comparisons between sediment toxicity endpoints will be conducted in accordance with USEPA (2000), using analysis of variance (ANOVA) as well as other tests for comparison of treatment group endpoints. A summary table of test endpoints (survival, growth, and reproduction) for each toxicity test performed will be provided.

4.1.1.3 Bulk Sediment and Pore Water Chemistry

The results of bulk sediment analyses will be evaluated in accordance with NYSDEC (2014). Bulk sediment sampling results will be categorized into one of three sediment classes based on comparisons of measured concentrations of copper, THg, and zinc to NYSDEC SGVs (2014):

- Class A: Metals concentrations below the Class A SGV threshold; concentrations associated with this class are considered to present little or no potential for risk to aquatic life.
- Class B: Metals concentrations between the Class A and Class C SGV thresholds; additional information is needed to evaluate the potential risk to aquatic life posed by sediments in this concentration range.
- Class C: Metals concentrations exceeding the Class C SGV thresholds; concentrations exceeding Class C thresholds have a higher potential to be toxic to aquatic life.

NYSDEC SGVs are not available for selenium; therefore, the screening benchmark of 5 mg/kg proposed by Nagpal et al. (1995) was used for comparison with sediment delineation sampling results, consistent with the FWRIA (URS, 2011) and the Plantasie Creek phased sediment investigation (EHS Support, 2020).

In addition to total recoverable target metal concentrations, AVS, SEM, and TOC results will be used to evaluate the bioavailability and toxicity of divalent metals mixtures in sediment based on EqP consistent with the Phase 1 Preliminary Bioavailability Assessment (USEPA, 2005a; USEPA, 2007). As stated in **Section 3.1.3.1**, the EqP approach presented by USEPA (2005a) and adopted in NYSDEC guidance (2014), establishes the following benchmarks for protection of benthic organisms based on the organic carbon-normalized difference in the molar concentrations of summed SEM and AVS (∑SEM-AVS/foc):

- < 130 µmol/g_{OC}: Toxicity is not likely
- 130 – 3000 µmol/g_{OC}: Toxicity is uncertain
- 3000 µmol/g_{OC}: Toxicity is likely.

Consistent with the Phase I Preliminary Bioavailability Assessment, 0.45 µm-filtered pore water chemistry results will be compared to acute and chronic NYSDEC AWQS derived for the dissolved metal form, as specified in 6 CRR-NY 703.5.

4.1.1.4 SQT Weight-of-Evidence Assessment

Consistent with the FWRIA (URS, 2011) and guidance provided by NYSDEC (2014), the multiple LOEs in the SQT investigation will be integrated into a weight-of-evidence evaluation of potential sediment toxicity within Plantasie Creek downstream of the Site. The approach for evaluating multiple LOEs will be consistent with approaches presented by NYSDEC (2014) and other guidance documents (e.g., Bay and Weisberg, 2010). The framework for the weight-of-evidence evaluation will be presented to NYSDEC in a technical meeting for approval prior to implementation of the Phase 2 field sampling program.

4.1.2 Surface Water

Consistent with the Phase I Preliminary Bioavailability Assessment, 0.45 µm-filtered surface water chemistry results will be compared to acute and chronic NYSDEC AWQS derived for the dissolved metal form, as specified in 6 CRR-NY 703.5.

4.1.3 Critical Body Residues

The potential for adverse effects associated with target metal exposures to benthic invertebrates and fish will be further evaluated based on the tissue residue approach through comparison of target metal concentrations in tissue to literature-based benchmarks representing CBR effects thresholds. The range of effects thresholds derived from these studies will focus on endpoints that are most relevant to the protection and maintenance of populations, including survival, growth, or reproduction. These endpoints are consistent with ecological risk assessment and risk management principles that are based on the protection of local populations and communities of biota except for protected resources where assessment at the individual level is appropriate (USEPA, 1999).

Potential ecological effects associated with target metal concentrations in benthic invertebrate and fish tissue will be evaluated based on comparisons to a range of CBR effects thresholds. Applicable CBRs have been identified through the review of primary and secondary literature sources (**Table 4**). The basis for the derivation of CBR effects thresholds for evaluation of benthic invertebrate and fish tissue will be presented in the effects analysis section of the Ecological Impact Assessment Report (**Section 6**). The report will also discuss the uncertainty of applying CBRs to some essential metals (e.g., copper, selenium, zinc) that may be regulated by benthic invertebrates and fish.

4.2 Ingestion Exposure Evaluation

The evaluation of potential exposure via direct and incidental ingestion pathways will be conducted using deterministic wildlife ingestion models to quantitatively assess potential risks to representative wildlife receptors. Deterministic exposure modeling scenarios will be based on conventional single point estimates of EPCs and typical exposure parameters. Deterministic exposure models will be developed using a tiered approach that incorporates preliminary and refined exposure estimates:

- Preliminary exposure estimates: Screening-level exposure assumptions based on maximum EPCs and conservative exposure assumptions.
- Refined exposure estimates: Refined exposure estimates using EPCs based on conservative estimates of the mean concentrations (e.g., upper confidence limit of the mean EPC [UCL_{mean}] concentration), assuming random foraging throughout each exposure area and more realistic exposure assumptions.

The following sections describe the basic model structure, receptor-specific exposure factors, exposure variables, bioaccumulation relationships, and area use factors (AUFs) that will be used for dietary exposure modeling in the Phase 2 Comprehensive Ecological Impact Assessment. Specific model parameters and TRVs will be presented to NYSDEC in a technical meeting for approval prior to implementation of the Phase 2 field sampling program.

4.2.1 Model Structure

Deterministic exposure estimates will be based on comparisons of receptor-specific estimated daily doses (EDDs) calculated from simple dose rate models to TRVs. Dietary exposure estimates consider receptor-specific exposure factors, including typical dietary composition, and exposure variables that represent Site-specific measurements of target metal concentrations in exposure media. The general form of the dose rate model used to calculate EDDs is:

$$EDD = \frac{1}{BW}\sum_{i=1}^{N}\left(FIR_{dw} \times \sum_{j=1}^{M}\left(f_j \times C_j\right) + SIR_{dw} \times C_{sed}\right)_i \times AUF_i$$

where:

- N = Number of exposure areas within the typical receptor home range
- M = Receptor-specific dietary items
- BW = Receptor-specific body weight (kg)
- FIR_{dw} = Receptor-specific daily food ingestion rate (kg/day, dry weight)
- f_j = Proportion of dietary item j to total dietary composition
- C_j = Target metal concentration in dietary item j (mg/kg tissue dry weight)
- SIR_{dw} = Receptor-specific incidental sediment ingestion rate (kg/day, dry weight)
- C_{sed} = Target metal concentration in sediment (mg/kg substrate, dry weight)
- AUF_i = Area use factor for a given exposure area and receptor

The drinking-water ingestion exposure pathway is not included in the dose rate model, as it is not a significant contributor to the total EDD relative to the dietary or incidental sediment ingestion component of the dose.

4.2.2 Exposure Point Concentrations

Preliminary EPCs for sediment and dietary inputs into dose rate models will be based on the maximum measured concentration in each exposure medium to represent the most conservative exposure scenario. Refined EPCs will include a conservative estimate of the central tendency of exposure (e.g., UCL_{mean} concentration) to reflect the average dose that a receptor may experience while foraging randomly within an exposure area.

4.2.3 Receptor Exposure Parameters

Dietary exposure models include parameters relating to receptor-specific exposure factors, EPCs, and AUFs. Exposure factors refer to receptor-specific variables (e.g., BW, FIR, SIR) derived from literature sources. Exposure variables refer to site-specific measurements, namely target metal concentrations estimated in exposure media. The approach for estimating exposure factors and variables for wildlife ingestion pathways is summarized below.

The USEPA *Wildlife Exposure Factors Handbook* (1993) will be the primary data source of exposure factors for the wildlife receptor species used to represent the receptor categories identified in the ECSM. Additional receptor-specific literature sources may also be used to supplement data compiled in

USEPA (1993). Deterministic exposure modeling uses exposure factors that are representative of typical or average (e.g., mean parameter) exposure conditions.

Dietary models will be developed to evaluate exposure to representative trophic categories of wildlife based on typical feeding behaviors. Receptors select dietary items based on species-specific foraging strategies and behaviors, which are also influenced by the availability and abundance of dietary items within an exposure area. Because it is impractical to sample each possible dietary item within an exposure area, only representative dietary items will be included in the dietary model. The relative composition of dietary items for select wildlife receptors will be estimated based on dietary studies obtained from the literature and summarized in the USEPA *Wildlife Exposure Factors Handbook* and other compilations.

4.3 Uncertainty Analysis

A critical component of the risk assessment process is the analysis of inherent uncertainty within the process. A thorough uncertainty analysis is necessary to understand how potential uncertainty may affect the risk estimates and associated risk characterization that may be used to support the conclusions of the risk assessment and potential risk management decision-making. Potential elements of uncertainty that will be addressed in the analysis include:

- Adequacy, representativeness, and quality of data
- Temporal variability in exposure (e.g., seasonal, stochastic event)
- Uncertainties associated with exposure pathways not quantified
- Potential exposure to target metals lacking ecotoxicity endpoints
- Confidence in ecological effects thresholds used in the risk estimation
- Potential synergistic or antagonistic toxicological effects associated with exposure to target metals
- Appropriateness of assumptions included in dose rate models, including exposure parameters, EPCs, and AUFs
- Variations in the responses of individuals and populations of ecological receptors
- Relative difference of *in situ* bioavailability compared to bioavailability in toxicological studies
- Potential population- and community-level impacts of non-metal stressors
- Confidence in the available LOE to support ecological risk conclusions

The analysis will assess the impact of these uncertainties on the overall conclusions and recommendations of the Comprehensive Ecological Impact Assessment.

4.4 Risk Characterization

Risk characterization will focus on establishing causal relationships, if present, between ecological effects and Site-specific exposure to target metals. A description of ecological risks will be included for each assessment endpoint based on the findings and interpretations of risk estimates from corresponding measurement endpoints. The risk description provides a weight-of-evidence evaluation of the likelihood and ecological significance of the estimated risks and may be used to support risk management decision-making (USEPA, 1997). Key elements included in the risk description will include:

- Identifying potential thresholds for ecological effects for observed exposure-response relationships
- Estimating the likelihood of adverse ecological effects

- Evaluating the spatial extent of unacceptable risk within Plantasie Creek
- Assessing the potential for identified risks to persist in the future, considering the potential for natural recovery once the sources of target metals or migration pathways to Plantasie Creek are mitigated

The output of the risk characterization process will provide the basis for the conclusions and recommendations that will be presented in the Comprehensive Ecological Impact Assessment Report. These recommendations may be used in risk management decision-making to determine the need, extent, and nature of potential remedial actions to address unacceptable ecological risks, if identified.

5 Human Health Exposure Assessment

The potential for human health exposure to sediments within Plantasie Creek will be evaluated based on likely scenarios for dermal and incidental ingestion exposure pathways. Target metal concentrations measured in sediments through the current and previous investigations will be initially compared to current NYSDEC Soil Cleanup Objectives (SCOs) for Unrestricted and Residential Use for the protection of human health (6 NYCRR Part 375). If the UCL_{mean} of target metal concentrations[6] are below Unrestricted Use SCOs for target metals, it is likely that no further assessment of human health exposure will be warranted for that metal (NYSDEC, 2010). However, point-by-point comparisons of individual sample results to SCOs will be conducted to evaluate the size of contiguous areas of SCO exceedance in the context of the exposure assumptions used to calculate the SCOs.

If sampling results indicate that the UCL_{mean} of target metal concentrations for one or more target metals exceeds Unrestricted Use SCOs, further assessment will be conducted consistent with DER-10 based on the following considerations, as stated in NYSDEC (2010):

1) *soil SCOs are applicable statewide and do not account for many site-specific considerations which could potentially result in higher levels (e.g., site-specific background conditions)*
2) *concentrations of contaminants which are higher than the soil SCGs for the current, future or reasonably anticipated future use of the site are not necessarily a health or environmental concern*
3) *should a soil SCG for the current, future or reasonably anticipated future use of the site be exceeded, the degree of public health and environmental concern depends on several factors, including:*
    - *the magnitude by which the concentration exceeds the SCG*
    - *the accuracy of the exposure assessments*
    - *other sources of exposure to the chemical*
    - *the strength and quality of the available toxicological information on the chemical*
    - *the level of concern associated with SCO concentrations for the current, future, and reasonably anticipated future us of the site depends on the likelihood of exposure to soil contamination at levels of potential concern to public health or ecological receptors.*

Key considerations in the Site-specific evaluation of potential human health exposure to target metal concentrations in sediments include the frequency and duration of exposure, the rate of incidental sediment ingestion and sediment adherence to the skin.

[6] UCL_{mean} concentrations will be calculated in USEPA ProUCL Version 5.2.0 or the most recent version based on a minimum of 8 observations.

6 Reporting

The findings of the phased Ecological Impact Assessment described in this Work Plan will be submitted to NYSDEC in a Comprehensive Ecological Impact Assessment Report. The report will be prepared consistent with DER-10 and FWRIA guidance (NYSDEC, 2010; NYSDEC, 2014; NYSDEC, 1994).

As stated in **Section 3.1**, the results of the Phase 1 Preliminary Bioavailability Assessment will be presented to NYSDEC in a technical meeting that will include recommendations regarding the need for implementation of the Phase 2 Comprehensive Ecological Impact Assessment. If the Phase 2 Comprehensive Ecological Impact Assessment is implemented, further details will be provided in the technical meeting regarding:

- Detailed Phase 2 sampling design based on the conceptual sampling design presented in **Section 3.2**
- Final SQT sampling design, including the selection of reference stations (**Section 4.1.1.4**)
- SQT Weight-of-Evidence Framework (**Section 4.1.1.4**)
- Specific model parameters to support the dietary ingestion exposure evaluation (**Section 4.1.1.4**).

Consultation with NYSDEC will be initiated upon review of the Phase 1 Preliminary Bioavailability Assessment data. If implementation of the Phase 2 scope is warranted, the specific elements of the study design and data evaluation procedures will be proposed to NYSDEC in the technical meeting for review and comment prior to field implementation.

Upon completion of the phased investigation approach, a Comprehensive Ecological Impact Assessment Report will be prepared and submitted to NYSDEC for review and approval. The report will incorporate the Phase 1 and Phase 2 investigation data and supporting ecological exposure evaluations outlined in this Work Plan. The evaluation of potential human health exposure to target metal concentrations sediments within Plantasie Creek will also be presented as a section within the Comprehensive Ecological Impact Assessment Report. The results of the ecological and human health exposure evaluations will be used to refine the conceptual exposure model for the downstream study area and support risk conclusions presented in the Comprehensive Ecological Impact Assessment Report. The conclusions of the Comprehensive Ecological Impact Assessment Report will be used to support risk management and remedial decision-making for Plantasie Creek downstream of the Site.

7 Work Plan Implementation

The following sections provide information on key contacts for the project, access agreements, and investigation schedule.

7.1 Project Organization

This Work Plan will be implemented for the Parties by EHS Support, an environmental contractor (“Contractor”), who will arrange for field investigation and analytical services and provide an on-site field representative(s) to oversee all subcontractors under the direction of the NYSDEC. Contractor will also perform the data interpretation and reporting tasks. Key contacts for this project are as follows:

Hercules Project Manager
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Contractor Client/Technical Manager
Andrew Patz, CHMM
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Email: andy.patz@ehs-support.com

Contractor Project Director/Project Engineer
Kristin A. VanLandingham, P.E.
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Email: k.vanlandingham@ehs-support.com

Contractor Quality Assurance Officer
Chrissy Peterson
EHS Support LLC
Telephone: (412) 925-1385
Email: chrissy.peterson@ehs-support.com

7.2 Access Agreements

Access to properties adjacent to the Plantasie Creek will be needed to carry out sampling to support the phased impact assessment, EHS Support will use its best efforts to obtain access agreements from the present owners. Once a property has been identified, county tax records will be reviewed to determine the current ownership and contact information. EHS Support will reach out the owners by mailing letters to request access, by reaching out in-person, or by other methods. If access agreements are unable to be obtained, EHS Support will notify NYSDEC. NYSDEC may need to assist in coordinating with property owners to obtain the access approval.

7.3 Investigation Schedule

Within 30 days of the NYSDEC approval of the final Work Plan, an estimated project schedule will be developed by the Parties in cooperation with the NYSDEC project manager and submitted to NYSDEC. This schedule will become part of the approved Work Plan. The Parties and their technical consultants will establish routine communication with the NYSDEC technical staff to assist resolving any issues that may delay the schedule. The Parties cannot be held responsible for any delays due to inclement weather, COVID-19 travel restrictions, NYSDEC review and approval time, applicable citizen participation requirements, or any other delays outside of the Parties' control.

Implementation schedule contingent upon securing access agreements as discussed in preceding section.

7.4 Investigation Permits and Licenses

Prior to benthic invertebrate or fish collection, a NYSDEC Scientific License to Collect and Possess will be obtained for qualified individuals involved with field collection activities. Additionally, an annual report of scientific collection activities performed under the Scientific License will be submitted to NYSDEC.

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Tables

Table 1
Sediment Delineation Sampling Results for Target Metals in Plantasie Creek Downstream of Mill Brook Drive
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

Sample	**Copper (mg/kg)**	**Mercury (mg/kg)**	**Selenium (mg/kg)**	**Zinc (mg/kg)**
	Class A: <32	Class A: <0.2	Class A: <5	Class A: <120
	Class B: 32-150	*Class B: 0.2-1*	***Class B/C: >5***	*Class B: 120-460*
	Class C: >150	**Class C: >1**		**Class C: >460**
	BTV: 23.8	BTV: 0.09	BTV: 1.6	BTV: 138.9
SCD-18.7-A	*105*	*0.37*	0.94	*128*
SCD-18.7-B	**371**	**1.1**	0.42	66.1
SCD-18.8-A	*47.8*	0.14	0.21	51.9
SCD-18.8-B	*138*	*0.46*	0.15	40.2
SCD-18.9-A	*34.4*	*0.61*	0.48	*126*
SCD-18.9-B	*141*	*0.42*	0.58	*158*
SCD-19-A	*66*	*0.24*	0.37	93.1
SCD-19-B	*62.6*	0.13	0.37	86.1
SCD-20-A	**176**	*0.45*	0.57	73.3
SCD-20-B	*53.8*	0.12	0.31	52.4
SWAC	*132.8*	*0.4*	0.5	94
UCL_{mean}	**177.6**	*0.58*	0.57	110

Notes:
For copper, mercury, and zinc, italicized font indicates exceedance of Class A SGV; **bold** font indicates exceedance of Class C SGV. For selenium, italicized/**bold** text indicates exceedance of Nagpal et al. (1995) criterion.
BTV = Background threshold value
NYSDEC sediment classes are defined based on NYSDEC (2014):
Class A = Metals concentrations below the Class A SGV threshold; concentrations associated with this class are considered to present little or no potential for risk to aquatic life.
Class B = Metals concentrations between the Class A and Class C SGV thresholds; additional information is needed to evaluate the potential risk to aquatic life posed by sediments in this concentration range.
Class C = Metals concentrations exceeding the Class C SGV thresholds; concentrations exceeding Class C thresholds have a higher potential to be toxic to aquatic life.

mg/kg = milligrams per kilogram
NYSDEC = New York State Department of Environmental Conservation
SGV = sediment guidance value
SWAC = Surface-weighted average concentration
UCL_{mean} = Upper confidence limit of the mean concentration

EHS Support

Table 2
Summary of Candidate Receptors, Risk Questions, Assessment/Measurement Endpoints, and Proposed Data Collections
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

Ecological Receptor Category	Focal Species / Level of Organization	Assessment Endpoints	Risk Questions	Candidate Measurement Endpoints	Proposed Data Collection(s) to Evaluate Measurement Endpoints
Benthic Invertebrates					
Benthic invertebrates	Population	Survival Growth Reproduction	Are target metal concentrations in Plantasie Creek sediments, pore water, and/or surface water greater than effects thresholds for survival, growth, and/or reproduction of benthic invertebrates?	SQT Lines of Evidence: 1) Comparison of target metal concentrations measured in Plantasie Creek surficial sediments to NYSDEC SGVs or literature-based ecological benchmarks for the protection of benthic invertebrates. 2) Comparison of target metal concentrations measured in Plantasie Creek pore water and surface water to NYSDEC AWQS or literature-based ecological benchmarks for the protection of benthic invertebrates.	Surficial sediment and pore water samples at approximately 8 co-located Plantasie Creek and 3 background area stations: • Bulk sediment analyses: copper, THg, selenium, zinc, TOC, grain size (sieve only) • Pore water analyses: copper, THg, MeHg, selenium, zinc, total hardness • *In situ* water quality parameters Surface water samples (filtered/unfiltered) from approximately 8 Plantasie Creek and 3 background area stations: • Unfiltered analyses: copper, THg, MeHg, selenium, zinc, total hardness, TOC, alkalinity, major ions/anions, sulfide, and TSS • Filtered analyses: copper, THg, MeHg, selenium, zinc, DOC, TDS • *In situ* water quality parameters
	Population	Survival Growth	Is survival or growth of benthic invertebrate test organisms exposed to bulk sediments from Plantasie Creek significantly lower than comparable endpoints for test organisms exposed to bulk sediments from the background area?	SQT Line of Evidence: Statistical comparisons of survival and growth endpoints from chronic, long-term sediment toxicity testing of whole sediments from the off-site study area to comparable endpoints for chronic, long-term exposures to whole sediment from the background area.	Sediment toxicity testing at approximately 8 co-located Plantasie Creek and 3 background area stations: • 42-day Hyalella azteca test for survival and growth (USEPA Method 100.4; USEPA, 2000) • 28-day Chironomus riparius test for survival and growth (OECD, 2004)
	Community	Structure Function	Is benthic community structure in Plantasie Creek different from benthic community structure in the background area with similar habitat? If differences in structure are observed, are those differences explained by target metal concentrations in abiotic or biotic exposure media or other habitat parameters?	SQT Line of Evidence: Statistical comparisons of multiple metrics (*e.g.*, richness, composition, tolerance measures) that measure structure and function of benthic invertebrate communities between Plantasie Creek and background area stations; statistical evaluation (*e.g.*, ANOVA, ANCOVA) of results of multi-metric community analyses with target metal concentrations in exposure media and other habitat parameters. SQT Line of Evidence: Multivariate statistical comparisons (*e.g.*, ordination) of benthic invertebrate taxa-abundance data to evaluate structure and function of benthic communities between Plantasie Creek and background area stations; statistical evaluation (*e.g.*, ANOVA, ANCOVA) of results of multivariate analyses of community data with target metal concentrations in exposure media or other habitat parameters.	Benthic community samples at approximately 8 Plantasie Creek and 3 background area stations: • 3 replicates per station (approximately 33 total samples) • Analysis: genus-level taxonomic identification, as practicable
Benthic invertebrates	Population	Survival Growth Reproduction	Are target metal concentrations in benthic invertebrate tissues from Plantasie Creek greater than: 1) CBRs for survival, growth, and/or reproduction of benthic invertebrates; or 2) benthic invertebrate tissue concentrations measured for the background area?	1) Comparisons of 95 percent upper confidence limit of the mean concentrations (UCL_{95}) of target metals measured in benthic invertebrate tissues or similar measure to CBRs representative of benthic invertebrates present in Plantasie Creek; and 2) Comparisons of target metal concentrations measured in benthic invertebrate tissues between Plantasie Creek and background areas.	Benthic invertebrate tissue samples based on laboratory bioaccumulation testing using sediments from 10 off-site study area and 6 background area SQT stations: • 28-day *Lumbriculus variegatus* bioaccumulation study (USEPA Test Method 100.3; USEPA, 2000) • Analyses: copper, THg, MeHg, selenium, zinc and percent moisture

Table 2
Summary of Candidate Receptors, Risk Questions, Assessment/Measurement Endpoints, and Proposed Data Collections
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

Ecological Receptor Category	Focal Species / Level of Organization	Assessment Endpoints	Risk Questions	Candidate Measurement Endpoints	Proposed Data Collection(s) to Evaluate Measurement Endpoints
Fish					
Forage fishes	Cyprinidae	Survival Growth Reproduction	Are target metal concentrations in surface water greater than effects thresholds for survival, growth, and/or reproduction of fish?	Comparison of target metal concentrations in surface water to NYSDEC AWQS or literature-based ecological benchmarks for the protection of fish.	Surface water samples (filtered/unfiltered) from approximately 8 Plantasie Creek and 3 background area stations: • Unfiltered analyses: copper, THg, MeHg, selenium, zinc, total hardness, TOC, alkalinity, major ions/anions, sulfide, and TSS • Filtered analyses: copper, THg, MeHg, selenium, zinc, DOC, TDS • *In situ* water quality parameters
			Are target metal concentrations in forage fish tissue greater than: 1) CBRs for survival, growth, and/or reproduction of fish; or 2) Forage fish tissue concentrations in the background area?	1) Comparisons of UCL_{95} target metal concentrations in forage fish tissue to CBRs; and 2) Comparisons of target metal concentrations in forage fish tissue between the Plantasie Creek and background area.	Forage fish tissue samples: • 4 whole body composite samples (min 5 individuals/composite sample) from Plantasie Creek and 3 whole body composite samples (min 5 individuals/composite sample) from the background area • Analyses: copper, THg, MeHg, selenium, zinc and percent moisture
Birds					
Small piscivorous birds	Belted kingfisher (*Megaceryle alcyon*)	Survival Growth Reproduction	Does the daily dose of target metals received by small piscivorous birds through direct ingestion of dietary items from Plantasie Creek exceed TRVs for survival, growth, and/or reproduction of birds?	Comparison of TRVs to dietary doses modeled using site-specific concentrations of target metals measured in forage fish tissue.	Apportionment of dietary items in dose model based on whole body forage fish tissue samples collected, as described above, and analyzed for target metals.
Aerial insectivorous songbirds	Tree swallow (*Tachycineta bicolor*)	Survival Growth Reproduction	Does the daily dose of target metals received by aeriel insectivorous songbirds through direct ingestion of dietary items from Plantasie Creek exceed TRVs for survival, growth, and/or reproduction of birds?	Comparison of TRVs to dietary doses modeled using concentrations of target metals estimated in emergent aquatic insect tissues based on site-specific measurements in benthic invertebrates in the bioaccumulation study.	Apportionment of dietary items in dose model based on data collected as described above and estimated for target metals.

Table 2
Summary of Candidate Receptors, Risk Questions, Assessment/Measurement Endpoints, and Proposed Data Collections
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

Ecological Receptor Category	Focal Species / Level of Organization	Assessment Endpoints	Risk Questions	Candidate Measurement Endpoints	Proposed Data Collection(s) to Evaluate Measurement Endpoints
Mammals					
Semi-aquatic omnivorous mammal	Racoon (*Procyon lotor*)	Survival Growth Reproduction	Does the daily dose of COPECs received by semi-aquatic piscivorous mammals through the direct ingestion of dietary items from the off-site study area exceed TRVs for survival, growth, and/or reproduction of mammals?	Comparison of TRVs to dietary doses modeled using site-specific concentrations of COPECs measured in fish tissue.	Apportionment of dietary items in dose model based on benthic invertebrate and fish tissue samples collected, as described above, and analyzed for target metals.
Aerial insectivorous mammals	Little brown bat (*Myotis lucifugus*)	Survival Growth Reproduction	Does the daily dose of COPECs received by aerial insectivorous mammals through the direct ingestion of dietary items from the off-site study area exceed TRVs for survival, growth, and/or reproduction of mammals?	Comparison of TRVs to dietary doses modeled using site-specific concentrations of COPECs estimated in emergent insect tissues based on marsh investigation area sediments.	Apportionment of dietary items in dose model based on data collected as described above and estimated for target metals.

Notes:
ANCOVA - Analysis of covariance
ANOVA - Analysis of variance
AVS/SEM - Acid volatile sulfides / simultaneously extracted metals
CBRs - Critical body residues
COPEC - Constituent of potential ecological concern
DOC - dissolved organic carbon
GWIA - Groundwater Investigation Area
MC - Main Channel
MeHg - Methylmercury
THg - Total mercury
TM - Tidal marsh
TOC - Total organic carbon
TRV - toxicity reference value
TSS - Total suspended solids
UCL - upper confidence limit
VOCs - Volatile organic compounds
WWIA - Wastewater Investigation Area

Table 3
Summary of Analytical Methods and Sample Handling Requirements
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

Analytical Group	Analytical and Preparation Method	Required Sample Mass	Sample Containers	Preservation Requirements	Maximum Holding Time
Solid media (bulk sediment) - Plantasie Creek Stations					
TAL Metals Copper Selenium Zinc	EPA Method 6020A	100 gram	Glass or plastic	Cool to 4°C	180 days to analysis
Total Mercury	EPA Method 7471B	100 gram	Glass or plastic	Cool to 4°C	28 days to analysis.
Methylmercury	EPA Method 1630	100 gram	Glass	Cool to 4°C	28 days to analysis.
AVS-SEM	EPA-821-R-91-100	113 g (4 oz.)	Glass with Teflon septa cap	Cool to 4°C	14 days
Total Organic Carbon	Lloyd Kahn	100 gram	Amber glass, Teflon cap	Cool to 4°C	14 days
Grain Size Distribution	ASTM D422	500 gram	Glass or plastic	None	No hold
% Moisture and Total Solids	SM 2540G	113 g (4 oz)	Glass	Freeze at less than -20 °C	1 year
Solid media (bulk sediment) - Background Stations					
TAL Metals	EPA Method 6020A	100 gram	Glass or plastic	Cool to 4°C	180 days to analysis
Total Mercury	EPA Method 7471B	100 gram	Glass or plastic	Cool to 4°C	28 days to analysis.
AVS-SEM	EPA-821-R-91-100	113 g (4 oz.)	Glass with Teflon septa cap	Cool to 4°C	14 days
TCL VOCs	EPA Method 8260C	100 gram	Amber Glass with Teflon cap	Cool to 4°C	40 days for analysis
TCL SVOCs	EPA Method 8270D	100 gram	Amber Glass with Teflon cap	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis
TCL Pesticides	EPA Method 8081B	100 gram	Amber Glass with Teflon cap	Cool to 4°C	14 days to extraction; 40 days from extraction to analysis
Total Organic Carbon	Lloyd Kahn	100 gram	Amber glass, Teflon cap	Cool to 4°C	14 days
Grain Size Distribution	ASTM D422	500 gram	Glass or plastic	None	No hold
% Moisture and Total Solids	SM 2540G	113 g (4 oz)	Glass	Freeze at less than -20 °C	1 year

Table 3
Summary of Analytical Methods and Sample Handling Requirements
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

Analytical Group	Analytical and Preparation Method	Required Sample Mass	Sample Containers	Preservation Requirements	Maximum Holding Time
Solid media (biological tissue) - Plantasie Creek and Background Stations					
TAL Metals Copper Selenium Zinc	EPA Method 6020A	100 gram	Glass or plastic	Cool to 4°C	180 days to analysis
Total Mercury	EPA Method 1631	100 gram	Glass or plastic	Cool to 4°C	1 year
Methylmercury	EPA Method 1630	100 gram	Glass	Cool to 4°C	28 days to analysis.
% Moisture and Total Solids	SM 2540G	113 g (4 oz)	Glass	Freeze at less than -20 °C	1 year
Aqueous media (surface water) - Plantasie Creek and Background Stations					
TAL Metals Copper Selenium Zinc	EPA Method 6020B	250 mL	Plastic	HNO_3, pH<2, 4°C	180 Days
Total Mercury	EPA Method 1631	250 mL	Fluoropolymer or Glass bottles with fluoropolymer cap	Cool to 4°C	90 days from extraction to analysis
Methylmercury	EPA Method 1630	250 mL	Plastic or Glass	H_2SO_4, pH<2, 4°C	180 days to analysis
TOC	EPA Method 5310C	40 mL vial	Amber glass	H_3PO_4, pH<2, 4°C	28 days
DOC	EPA Method 5310C	40 mL	Glass with Teflon septum	4°C (no headspace)	28 days
Alkalinity	SM 2320B	150 mL	Plastic or glass	Cool to 4°C	14 days
Hardness	SM 2320C	100 mL	Plastic or glass	Cool to 4°C	180 days
TSS	SM 2540D	1000 mL	Plastic or glass	Cool to 4°C	7 days
pH	EPA Method 9040C	50 mL	Plastic or glass	Cool to 4°C	as soon as possible

Table 3
Summary of Analytical Methods and Sample Handling Requirements
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

Analytical Group	Analytical and Preparation Method	Required Sample Mass	Sample Containers	Preservation Requirements	Maximum Holding Time
Aqueous media (pore water) - Plantasie Creek and Background Stations					
TAL Metals Copper Selenium Zinc	EPA Method 6020B	250 mL	Plastic	HNO_3, pH<2, 4°C	180 Days
Total Mercury	EPA Method 1631	250 mL	Fluoropolymer or Glass bottles with fluoropolymer cap	Cool to 4°C	90 days from extraction to analysis
Methylmercury	EPA Method 1630	250 mL	Plastic or Glass	H_2SO_4, pH<2, 4°C	180 days to analysis
Hardness	SM 2320C	100 mL	Plastic or glass	Cool to 4°C	180 days
pH	EPA Method 9040C	50 mL	Plastic or glass	Cool to 4°C	as soon as possible

Notes:
AVS-SEM = acid volatile sulfide/simultaneously extracted metals
DOC = Dissolved organic carbon
SM = Standard method
TAL = Target analyte list
TCL = Target compound list
TOC = Total organic carbon
TSS = Total suspended solids
H_2SO_4 = sulfuric acid
H_3PO_4 = phosphoric acid
HNO_3 = nitric acid
VOC = volatile organic compound
SVOC = semi-volatile organic compound
°C = degrees Celsius
g = gram
L = liter
mL = milliliter
oz = ounce
*holding times and volume requirements may vary by laboratory.

Table 4
Summary of Critical Body Residues and Dietary Screening Benchmarks for Target Metals
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

Analytical Group	Critical Body Residues CBRs (mg/kg ww)				Dietary Screening Benchmarks DSBs (mg/kg ww)			
	Fish Tissue		Benthic Invertebrate Tissue		Fish Tissue		Benthic Invertebrate Tissue	
	NOEC CBR_{Fish}	LOEC CBR_{Fish}	NOEC $CBR_{Inverts}$	LOEC $CBR_{Inverts}$	NOEC DSB_{Fish}	LOEC DSB_{Fish}	NOEC DSB_{Invert}	LOEC DSB_{Invert}
Biological Tissue								
Copper	3.92 a	4.48 a	2.0 h	9.9 i	16 o	28.9 o	3.8 o	6.8 o
Total mercury	0.2 b	0.77 c	1.53 j	2.33 j	0.045 o	0.136 o	0.39 o	0.79 o
Methylmercury	--- d	--- d	0.0367 k	--- l	---	---	0.02 o	0.08 o
Selenium	1.6 e	3.2 f	--- m	1 m	1 o	1.4 o	0.11 o	0.19 o
Zinc	287 g	403 g	182 n	--- n	95 o	164 o	57.5 o	99.2 o

Notes:
AWQS = Ambient Water Quality sTandard
NYSDEC = New York State Department of Environmental Conservation
CBR_{Fish} = Critical body residue for fish
$CBR_{Inverts}$ = Critical body residue for invertebrates
NOEC = No observed effect concentration
LOEC = Lowest observed effect concentration
SCO = Soil Cleanup Objective
SGV = Sediment Guidance Values

Sources:
a = Mount et al. (1994)
b = 5.5% injury from Dillon et al. (2010), consistent with Beckvar et al. (2005) tissue threshold effect level (t-TEL)
c = 20% injury from Dillon et al. (2010), consistent with tissue threshold for reproduction identified in Fuchsman et al. (2016)
d = CBR based on total mercury concentration, assuming >90% of total mercury concentration is methylmercury
e = DeForest and Adams (2011) EC_{10} assuming 80% moisture in fish tissue.
f = DeForest and Adams (2011) EC_{20} assuming 80% moisture in fish tissue.
g = Pierson (1981)
h = EC_{50} for number of empty oligochaete cocoons reported in Mendex-Fernandez et al. (2013) divided by a EC_{50} to EC_{10} conversion factor of 5.
i = EC_{50} for number of empty oligochaete cocoons reported in Mendex-Fernandez et al. (2013) divided by a EC_{50} to EC_{30} conversion factor of 2.5.
j = Biesinger et al. (1982)
k = Naimo et al. (2000)
l = Benthic invertebrate tissue LOEC not identifed in Naimo et al. (2000) for methylmercury.
m = Debruyn and Chapman (2007) identified a LOEC at 1 mg/kg ww.
n = Greatest zinc concentration in tissue associated with no observed adverse effects in freshwater oligochaetes, as reported in Lobo et al. (2021)
o = minimum value of dietary screening benchmarks for receptors calculated in Attachment A.

Table 5
Summary of Reporting Limits and Minimum Risk-Based Benchmarks by Medium
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

Analytical Group	Analytical and Preparation Method	Reporting Limit (µg/L)	Method Detection Limit (µg/L)	Target Risk-Based Concentrations		
				Minimum Target Risk-Based Concentration (µg/L)	NYSDEC Chronic AWQS (µg/L)	
Surface Water/Pore Water						
Copper	EPA Method 6020A	2	0.627	8.96	8.96	a
Total mercury	EPA Method 1631	0.0005	0.00014	0.77	0.77	b
Selenium	EPA Method 6020A	5	1.51	4.6	4.6	b
Zinc	EPA Method 6020A	5	3.22	82.6	82.6	a

Analytical Group	Analytical and Preparation Method	Reporting Limit (mg/kg)	Method Detection Limit (mg/kg)	Target Risk-Based Concentrations				
				Minimum Target Risk-Based Concentration (mg/kg)	NYSDEC Class A SGVs (mg/kg)		Unrestricted Human Health-Based SCOs (mg/kg)	
Bulk Sediment								
Copper	EPA Method 6020A	0.1	0.057	32	32	c	270	e
Total mercury	EPA Method 7471B	0.0165	0.0106	0.18	0.2	c	0.18 [1]	e
Selenium	EPA Method 6020A	0.25	0.061	5	5	d	18	e
Zinc	EPA Method 6020A	0.25	0.167	120	120	c	1100	e

Analytical Group	Analytical and Preparation Method	Reporting Limit (mg/kg)	Method Detection Limit (mg/kg)	Target Risk-Based Concentrations				
				Minimum Target Risk-Based Concentration (mg/kg)	NOEC CBR_{Fish} (mg/kg ww)		NOEC $CBR_{Inverts}$ (mg/kg ww)	
Biological Tissue								
Copper	EPA Method 6020A	0.1	0.057	3.92	3.92	f	6	j
Total mercury	EPA Method 7471B	0.0165	0.0106	0.2	0.2	g	1.53	k
Methylmercury	EPA Method 1630	0.0001	0.000073	0.0367	---		0.0367	l
Selenium	EPA Method 6020A	0.25	0.061	1	2.94	h	1	m
Zinc	EPA Method 6020A	0.25	0.167	87	287	i	87	n

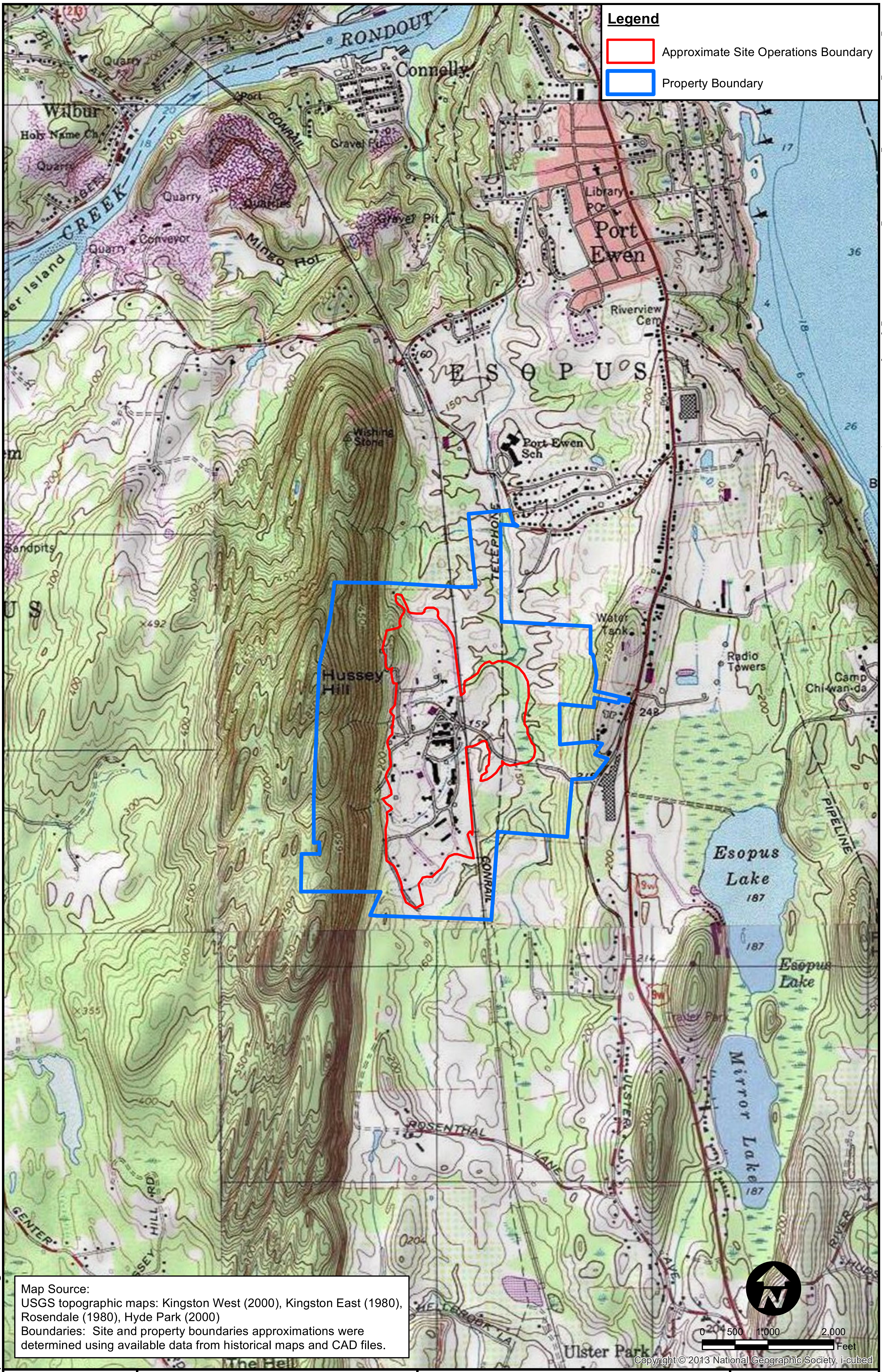
Notes:

1, Mercury SCO replaced by Rural Soil Background Concentration
AWQS = Ambient Water Quality Standard
CBR_{Fish} = Critical body residue for fish
$CBR_{Inverts}$ = Critical body residue for invertebrates
µg/L = micrograms per liter
mg/kg = milligrams per kilogram
NYSDEC = New York State Department of Environmental Conservation
NOEC = No observed effect concentration
SCO = Soil Cleanup Objective
SGV = Sediment Guidance Values
ww = wet weight

Sources:

a = NYSDEC Chronic AWQS (Division of Water Techincal and Operational Guidance Series 1.1.1, NYSDEC, 1998) at 100 mg/L hardness
b = NYSDEC Chronic AWQS (Division of Water Techincal and Operational Guidance Series 1.1.1, NYSDEC, 1998)
c = NYSDEC Class A Sediment Guidance Values (NYSDEC, 2014)
d = British Columbia Sediment Quality Guideline (Nagpal et al., 1995)
e = NYSDEC Unrestricted Human Health-Based Soil Cleanup Objectives (6 NYCRR Part 375-6.8)
f = Mount et al. (1994)
g = 5.5% injury from Dillon et al. (2010)
h = Tashjian et al. (2006)
I = Pierson (1981)
j = Absil et al. (1996)
k = Biesinger et al. (1982)
l = Naimo et al. (2000)
m = Debruyn and Chapman (2007)
n = King et al. (2004)

Figures



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EHS Support	DOWNSTREAM SEDIMENT INVESTIGATION DYNO NOBEL PORT EWEN SITE PORT EWEN, NEW YORK	SITE LOCATION MAP	FIGURE 1

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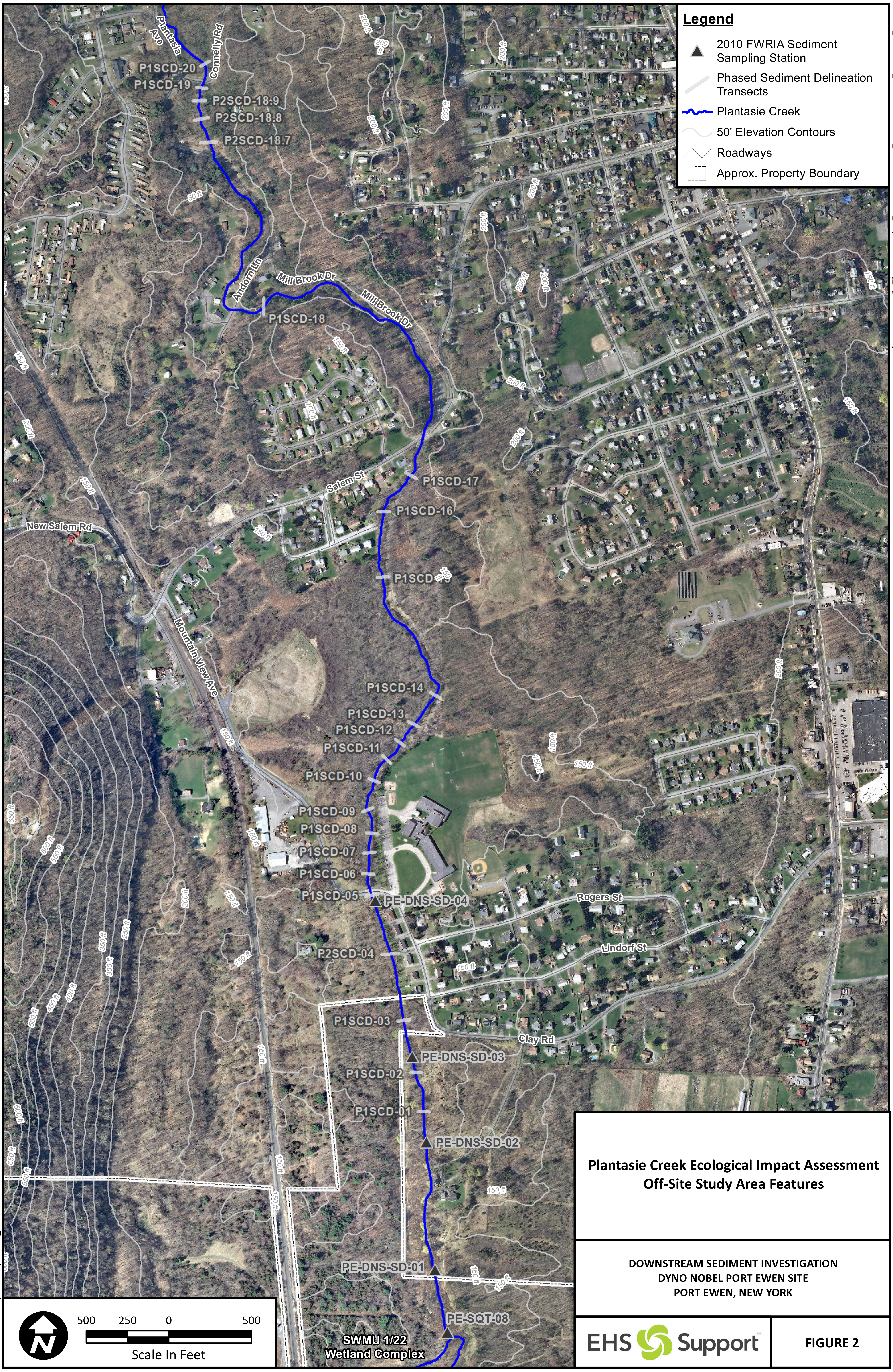
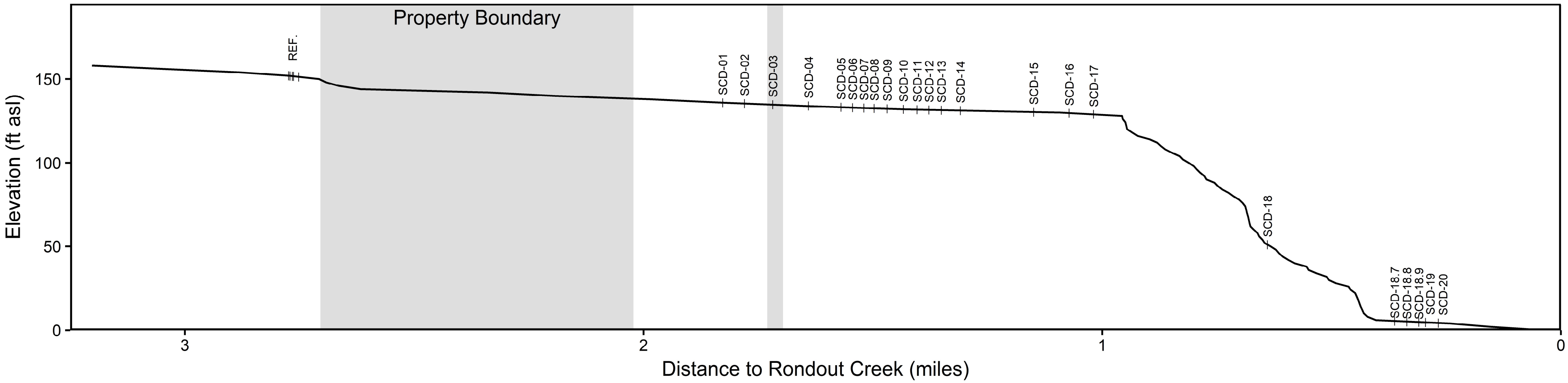


Plantasie Creek Ecological Impact Assessment
Off-Site Study Area Features

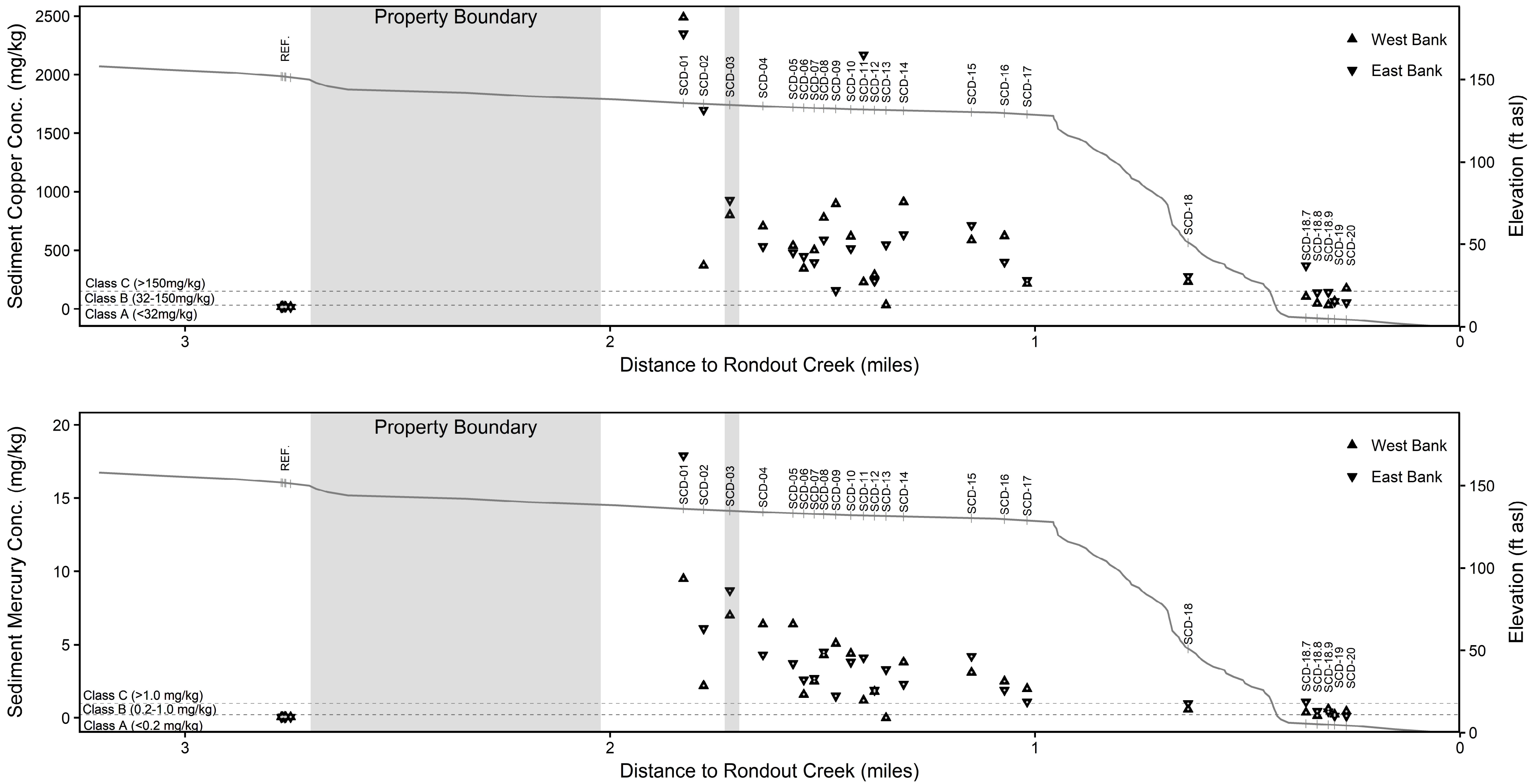
DOWNSTREAM SEDIMENT INVESTIGATION
DYNO NOBEL PORT EWEN SITE
PORT EWEN, NEW YORK

EHS Support

FIGURE 2



EHS Support	Downstream Sediment Investigation Dyno Nobel Port Ewen Site Port Ewen, New York	**Plantasie Creek Longitudinal Profile**	**FIGURE 3**

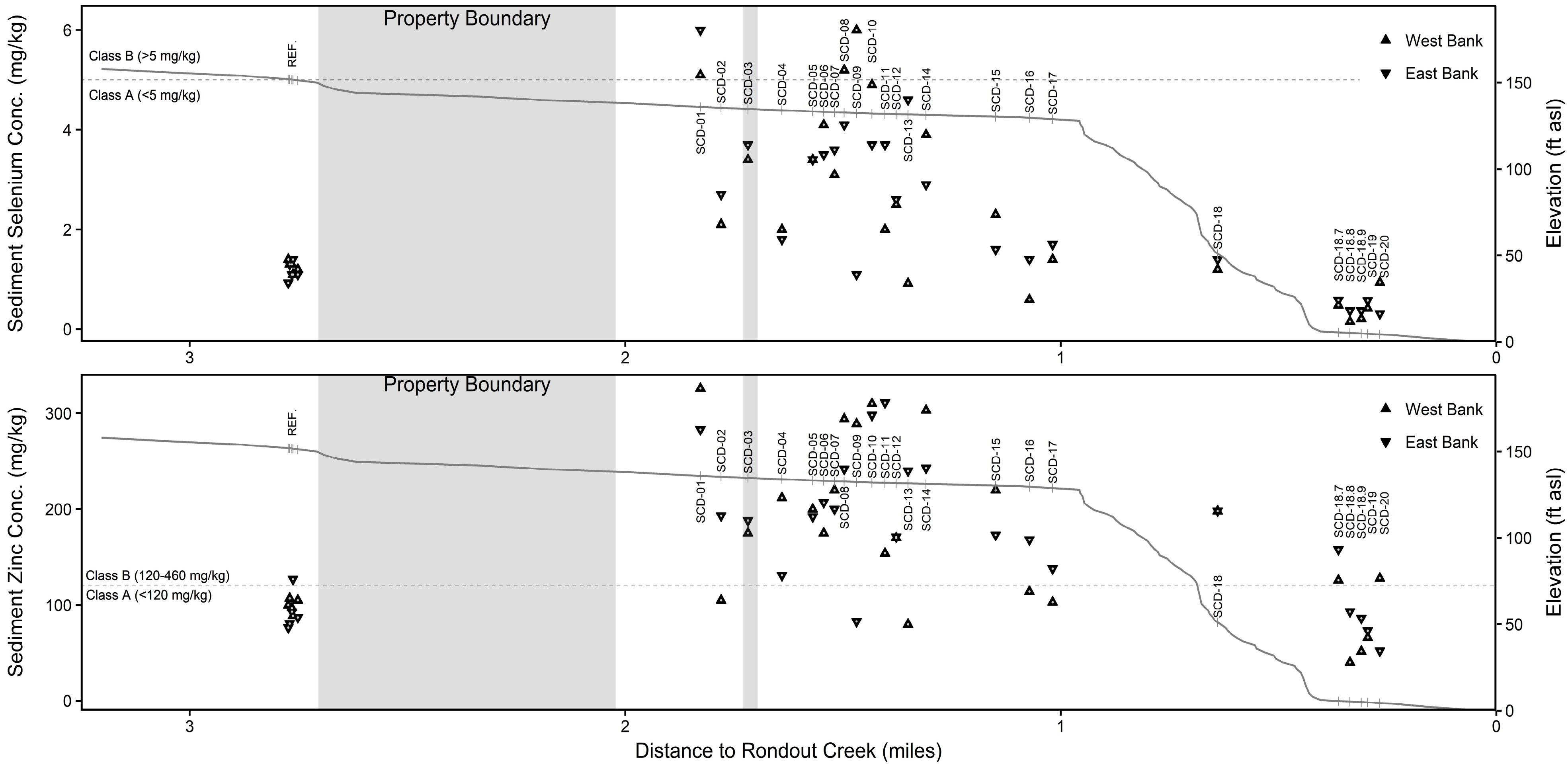


EHS Support

Downstream Sediment Investigation
Dyno Nobel Port Ewen Site
Port Ewen, New York

Longitudinal Profiles – Surface Copper and Mercury Sediment Concentrations and SGV Classes

FIGURE 4A

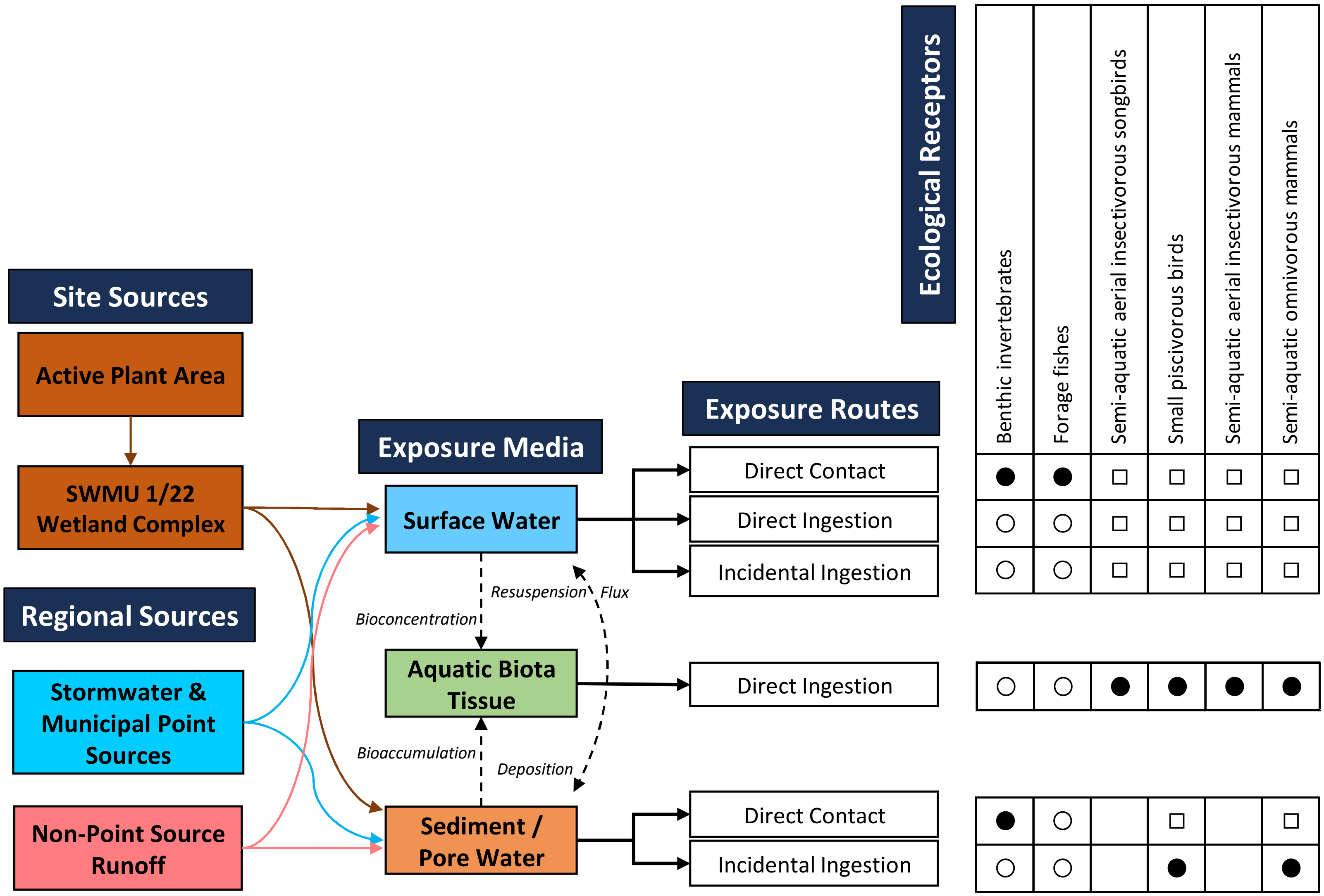


EHS Support

Downstream Sediment Investigation
Dyno Nobel Port Ewen Site
Port Ewen, New York

Longitudinal Profiles – Surface Selenium and Zinc Sediment Concentrations and SGV Classes

FIGURE 4B



Exposure Media	Exposure Routes	Benthic invertebrates	Forage fishes	Semi-aquatic aerial insectivorous songbirds	Small piscivorous birds	Semi-aquatic aerial insectivorous mammals	Semi-aquatic omnivorous mammals
Surface Water	Direct Contact	●	●	□	□	□	□
Surface Water	Direct Ingestion	○	○	□	□	□	□
Surface Water	Incidental Ingestion	○	○	□	□	□	□
Aquatic Biota Tissue	Direct Ingestion	○	○	●	●	●	●
Sediment / Pore Water	Direct Contact	●	○		□		□
Sediment / Pore Water	Incidental Ingestion	○	○		●		●

Notes:

● = Exposure pathways that are considered potentially complete.

○ = Potential exposure pathways that are not quantifiable.

□ = Potential exposure pathways that are likely insignificant.

Blank = Incomplete exposure pathway.

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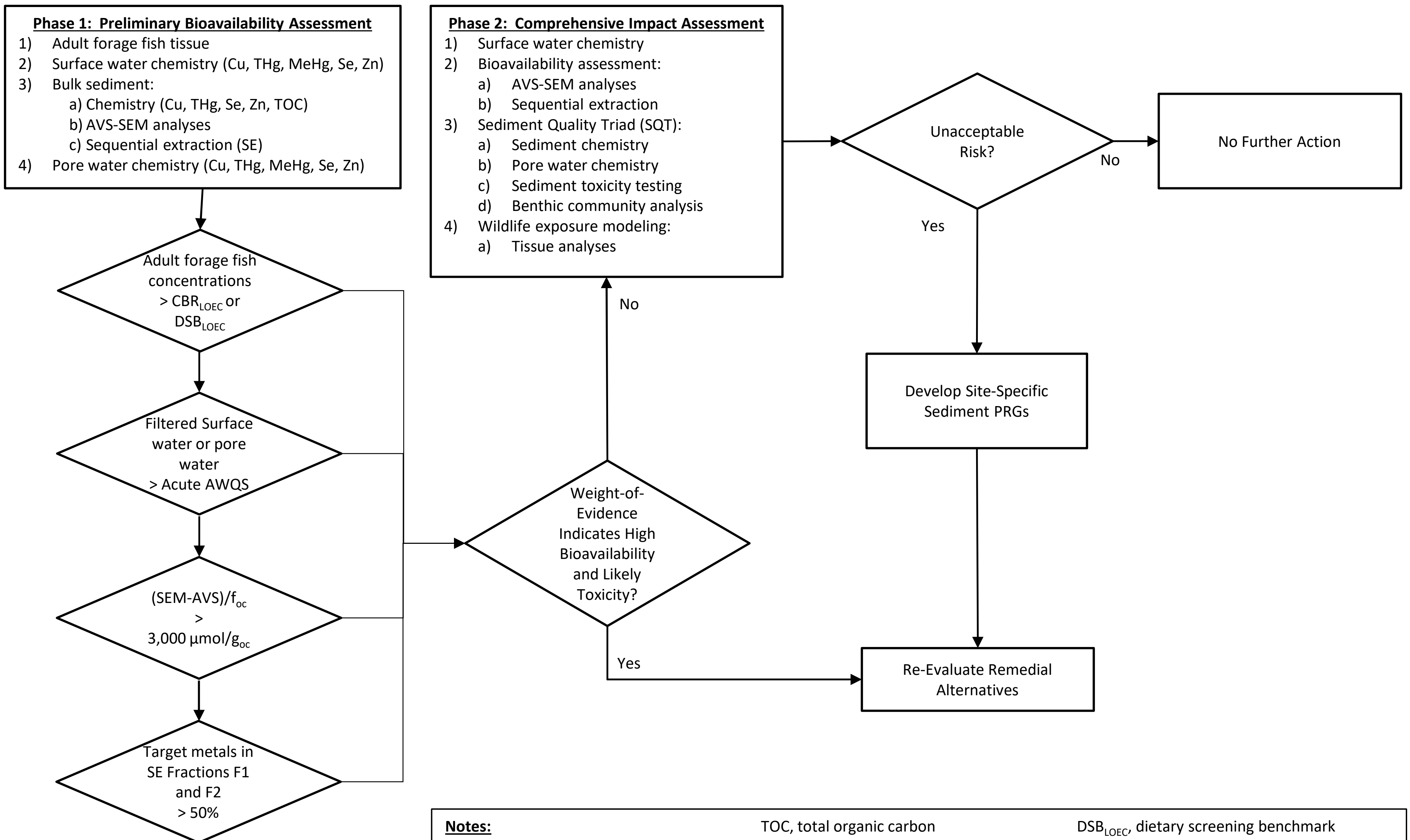
Downstream Sediment Investigation
Dyno Nobel Port Ewen Site
Port Ewen, New York

Plantasie Creek Aquatic Exposure Pathway Ecological Conceptual Site Model

FIGURE 5



Notes:

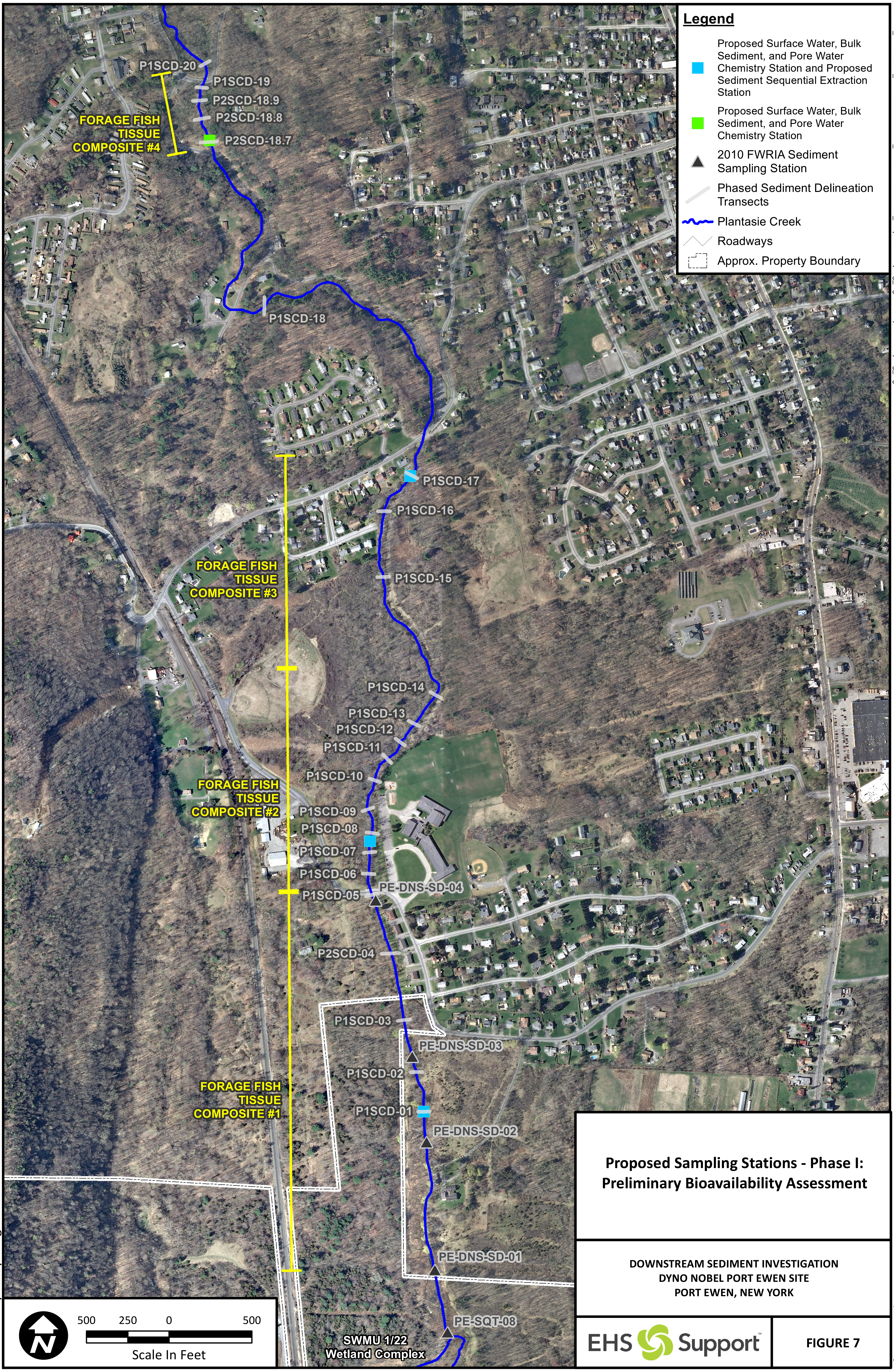
Cu, copper
THg, total mercury
MeHg, methylmercury
Se, selenium
Zn, zinc
TOC, total organic carbon
AVS, acid volatile sulfides
SEM, simultaneously extracted metals
SE, sequential extraction
SQT, sediment quality triad
CBR_{LOEC}, lowest effect critical body residue
DSB_{LOEC}, dietary screening benchmark
AWQS, ambient water quality standard
PRG, preliminary remediation goal
f_{OC}, fraction organic carbon

EHS Support

Downstream Sediment Investigation
Dyno Nobel Port Ewen Site
Port Ewen, New York

Conceptual Progression of Plantasie Creek Downstream Sediment Investigation

FIGURE 6



Proposed Sampling Stations - Phase I: Preliminary Bioavailability Assessment

DOWNSTREAM SEDIMENT INVESTIGATION
DYNO NOBEL PORT EWEN SITE
PORT EWEN, NEW YORK

EHS Support

FIGURE 7

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Appendix A Dietary Screening Benchmark Calculations

Appendix A
Calculation of Dietary Screening Benchmark Values
Plantasie Creek Ecological Impact Assessment Work Plan
Dyno Nobel Port Ewen Site
Port Ewen, NY

						Copper			Total Mercury			Methylmercury			Selenium			Zinc		
						MF = 1.389			MF = 0.663			MF = 0.592			MF = 1			MF = 0.543		
Receptor[r]	Effect Level	Body Weight (kg)		FIR (kg ww/day)		TRV (mg/kg BW/day)		DSB_{Invert}[p] (mg/kg ww)	TRV (mg/kg BW/day)		DSB_{Invert}[p] (mg/kg ww)	TRV (mg/kg BW/day)		DSB_{Invert}[p] (mg/kg ww)	TRV (mg/kg BW/day)		DSB_{Invert}[p] (mg/kg ww)	TRV (mg/kg BW/day)		DSB_{Invert}[p] (mg/kg ww)
Tree Swallow (*Tachycineta bicolor*)	NOAEL-Based DSB	0.0202	a	0.0352	e	9.1	i	3.8	0.45	k	0.39	0.026	n	0.025	0.4	i	0.23	54.4	i	57.5
	LOAEL-Based DSB					16.5	i	6.8	0.91	k	0.79	0.078	n	0.076	0.8	i	0.46	93.9	i	99.2
Little Brown Bat (*Myotis lucifugus*)	NOAEL-Based DSB	0.0077	b	0.00461	f	22.3	j	26.8	1.0	l	2.52	0.022	o	0.062	0.2	j	0.33	116	j	357
	LOAEL-Based DSB					40.8	j	49.0	7.0	m	17.6	0.18	o	0.508	0.33	j	0.55	635	j	1952

						Copper			Total Mercury Based on Methylmercury TRVs[t]			Selenium			Zinc		
Receptor[s]	Effect Level	Body Weight (kg)		FIR (kg ww/day)		TRV (mg/kg BW/day)		DSB_{Fish}[q] (mg/kg ww)	TRV (mg/kg BW/day)		DSB_{Fish}[q] (mg/kg ww)	TRV (mg/kg BW/day)		DSB_{Fish}[q] (mg/kg ww)	TRV (mg/kg BW/day)		DSB_{Fish}[q] (mg/kg ww)
Belted Kingfisher (*Megaceryle alcyon*)	NOAEL-Based DSB	0.148	c	0.085	g	9.1	i	16	0.026	k	0.045	0.4	i	0.7	54.4	i	95
	LOAEL-Based DSB					16.5	i	28.9	0.078	k	0.136	0.8	i	1.4	93.9	i	164
Raccoon (*Procyon lotor*)	NOAEL-Based DSB	3.855	d	0.363	h	22.3	j	237	0.022	l	0.233	0.2	j	2.1	116	j	1231
	LOAEL-Based DSB					40.8	j	433	0.18	m	1.91	0.33	j	3.5	635	j	6736

Notes:
a, Nagy (2001)
b, Dunning (1993), as cited in USACHPPM (2004)
c, Mean body weight in Dunning (2008)
d, Stuewer (1943), as cited in USEPA (1993)
e, FIR (kg/day wet weight) = 0.0352 kg based on assumed body weight of 0.0202 kg as reported in Nagy (2001)
f, FIR (kg/day wet weight) for Chiroptera = (1.219×[Body Weight in grams] 0.652)/1000 (Nagy 2001; Equation No. 8)
g, FIR (kg/day wet weight) for carnivorous birds = (3.048×[Body Weight in grams] 0.665)/1000 (Nagy 2001; Equation No. 64)
h, FIR (kg/day wet weight) for omnivorous mammals = (1.346×[Body Weight in grams] 0.678)/1000 (Nagy 2001; Equation No. 34)
i, geometric mean surivival, growth, and reproduction endpoints for birds in USEPA Eco-SSL (USEPA, 2005b)
j, geometric mean surivival, growth, and reproduction endpoints for mammals in USEPA Eco-SSL (USEPA, 2005b)
k, Hill and Shaffer (1976)
l, Aulerich et al. (1974)
m, Rizzo and Faust (1972)
n, Heinz (1979), as cited in USEPA (1997)
o, Wobeser et al. (1976a, 1976b)
p, Dietary screening benchmark for benthic invertebrates with consideration of changes in body burden during metamorphosis from aquatic to adult life stage calculated as:

$$DSB = \frac{TRV}{\left(\frac{FIR}{BW}\right) \times MF}$$

where:
DSB = Dietary screening benchmark (mg/kg ww)
TRV = Toxicity reference value (mg/kg bw/day): No observed adverse effects level (NOAEL) or Lowest observed adverse effects level (LOAEL)
FIR = Food ingestion rate (kg ww/day)
BW = Body weight (kg)
MF = Metamorphosis factor as reported in Kraus et al. (2014)

q, Dietary screening benchmark for fish calculated as:

$$DSB = TRV \div \left(\frac{FIR}{BW}\right)$$

where:
DSB = Dietary screening benchmark (mg/kg ww)
TRV = Toxicity reference value (mg/kg bw/day): No observed adverse effects level (NOAEL) or Lowest observed adverse effects level (LOAEL)
FIR = Food ingestion rate (kg ww/day)
BW = Body weight (kg)

r, assumes 100 percent dietary intake of emergent aquatic insects
s, assumes 100 percent dietary intake of adult forage fish
t, DSB derived based on TRVs for MeHg, but will be compared to THg analyses based on the assumption that nearly all (>90%) of THg in fish tissue is MeHg

Appendix B Field Equipment Decontamination Standard Operating Procedure

Field Equipment Decontamination SOP

Purpose

The purpose of this SOP is to provide procedures for field decontamination of environmental sampling equipment and personal protective equipment (PPE). Decontamination of equipment and PPE is designed to ensure that sample cross-contamination, human-health exposure, and contamination transport is minimized.

This SOP covers field decontamination of small re-useable equipment using a manual cleaning application. Procedural modifications may be warranted depending on field conditions, equipment limitations, or limitations imposed by the procedure.

Required Materials

- Field logbook and field documentation
- Site maps, site layouts, site plans
- Health and Safety Plan (HASP)
- Appropriate PPE
- Brushes and flat-blade scrapers
- Hand-held spray bottles
- Water: potable water, distilled water
- Laboratory-grade non-phosphate detergent
- Plastic waste bags or sheeting
- Waste containers (55-gallon drum or similar)
- Wash basins, buckets, pails, or tubs
- Paper towels and/or disposable drying cloths
- Drying shelves, as needed

1 Small Field Equipment Decontamination Guidelines

Decontamination is performed as a quality assurance measure. Improperly decontaminated sampling equipment can lead to misinterpretation of environmental data due to interference caused by cross-contamination between samples or sample locations through the use of contaminated equipment. Decontamination also protects field personnel from potential exposure to hazardous materials on equipment. Proper personal protective equipment (PPE) will be worn when conducting decontamination procedures.

1.1 Decontamination Area

The decontamination area should be located, if possible, where decontamination fluids and soil wastes can be easily discarded or discharged in accordance with the project plan or waste management plan. Select the decontamination area so decontamination investigation-derived wastes (IDW) can be managed in a controlled area with minimal risk to the surrounding environment.

The decontamination area may take place at the sampling location. In this case, required decontamination supplies and equipment must be mobilized to the location. Buckets and decontamination station supplies may be placed on plastic sheeting, in basins, or in tubs to capture decontamination IDW. Decontamination materials, including wastes, should be stored in a central location(s) to maintain control over the materials used or produced throughout the investigation program.

1.2 Decontamination Considerations

The following considerations should be made when decontaminating field equipment:

- No hand-to-mouth contact (e.g., eating, smoking, drinking, chewing) shall be permitted during decontamination activities.
- All contaminated equipment shall be disassembled to the extent practical to allow for thorough decontamination procedures.
- PPE shall be worn to avoid splashing, skin contact, and incidental ingestion during decontamination procedures.
- Quality assurance/quality control measures, if required, will be specified in the approved Project Work Plan or approved Quality Assurance Project Plan.

1.3 General Decontamination Procedures

Field equipment for decontamination may include a variety of items used in the field for monitoring and/or for collection of soil, sediment, and/or water samples, such as hand augers, trowels, scoops, spoons, and pumps. Dedicated equipment is not usually decontaminated, as a general rule. Disposable equipment (e.g., core liners) will be properly discarded after use.

Decontamination will occur before use, between sample locations, and prior to transporting off-site for re-used or non-disposable equipment. Rental equipment used in the field, which is being returned to the respective vendor, will be decontaminated prior to shipment. Conduct consistent decontamination of sampling equipment to ensure the quality of the samples collected.

Equipment decontamination is comprised of four general steps.

1. Remove gross (visible) contamination.
2. Remove residual contamination.
3. Prevent recontamination.
4. Dispose of wastes associated with the decontamination.

1.4 Small Equipment Decontamination Procedures

Small equipment generally includes soil sampling equipment (e.g., trowels, split spoon samplers, augers, water interface probes). Small equipment decontamination procedures will be generally conducted as follows:

1. Remove any gross contamination from the equipment. Gross contamination generally applies to soil or sediment sampling equipment that may have residue clinging to the equipment. The clinging residual sediment or soil can usually be removed by dry brushing or scraping, or in some cases using a pressure sprayer. Removal of gross contamination should be done close to the source of contamination.
2. Remove residual contamination including film or other particles. This generally consists of a series of sprayers, buckets, or basins used to wash and rinse the equipment.
3. Wash equipment vigorously with a bristle brush or similar in a bucket containing distilled water with non-phosphate lab-grade detergent such as Liquinox®, Alconox®, or equivalent.
4. Rinse equipment thoroughly in a second bucket containing distilled water (first rinse).
5. Rinse equipment thoroughly with distilled water (second rinse).
6. Allow equipment to air dry in an area free from contact with contaminants. All decontaminated equipment should be dry prior to use. A decontaminated metal drying rack may be used to aid in the drying process. Clean and new paper towels may also be used to dry equipment.
7. Decontamination equipment should be stored to preserve the clean status. This step will vary based on the nature of the equipment. Protection measures may include covering or wrapping the equipment in plastic or aluminum foil. Only personnel wearing clean protective gloves (e.g., nitrile, latex) should handle the decontaminated equipment to prevent recontamination.
8. If the decontaminated equipment will not be used immediately after cleaning, it should be covered or wrapped to protect the equipment from contaminants.
9. Replace dirty detergent water solution and rinsate(s) between sample locations, or as deemed appropriate to limit cross-contamination.
10. Document the procedure used, fluids used, and any changes in a bound field notebook or on project-specific forms.
11. Waste decontamination materials such as spent liquids and solids will be collected and managed in accordance with the work plan for IDW.

2 Records

Detailed records will be maintained about decontamination procedures in the field logbook. Required records may include details about:

- Decontamination personnel
- Decontamination solution types and methods
- Date and time of decontamination
- Decontamination station location
- Equipment type or identification numbers
- Decontamination solution Lot numbers
- Any problems encountered, observations, or alterations
- Safety data sheets for any specialized chemicals used in the decontamination process
- Volume of decontamination materials generated (IDW log)