Hog Island Inlet Remedial Action Project Report

November 2006

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EXECUTIVE SUMMARY

The U.S. Environmental Protection Agency's (U.S. EPA) Great Lakes National Program Office (GLNPO) and the Wisconsin Department of Natural Resources (WDNR) partnered under the Great Lakes Legacy Act of 2002 to effectively and efficiently remediate the contaminated sediment at Hog Island Inlet and Segment L of Newton Creek in the St. Louis River Area of Concern, City of Superior, Douglas County, Wisconsin.

The goal of the Hog Island Inlet Remediation Project was to remove the contaminated sediment and the risks posed to human health and the environment. The pollutant of concern at Hog Island is a group of chemicals known collectively as "total polynuclear aromatic hydrocarbons" (TPAHs). Acceptable levels of pollutants are typically set at two levels, chronic and acute, to protect human health and the environment. These levels serve as target levels or goals for remediation activities. The target levels for the Hog Island Inlet Remediation were determined based on project objectives, sediment quality guidelines and other site-specific information including previous environmental studies of Hog Island Inlet and Newton Creek. For this project, the chronic level of concern for TPAH is 2.6 mg/kg and the acute level is between 5.0 and 7.5 mg/kg.

Samples were collected and analyzed after completion of remediation activities to determine if these target levels were achieved. Based on geostatistical evaluation methods, the concentration of TPAH across the inlet was determined to be below the target chronic level of 2.6 mg/kg with more than 95% confidence. Post remediation monitoring is currently being conducted to evaluate the success of the remediation in improving the health of the aquatic system.

An additional benefit of the remediation activity is the site's ability to serve as a recreational resource for the surrounding community. The footpath is used by many for outdoor activities including biking, walking, and jogging. GLNPO is working with local stakeholders to develop an initiative to conduct additional habitat restoration of the Hog Island Inlet area.

1.0 INTRODUCTION

Together, the Great Lakes make up one fifth of the fresh water on the earth's surface, providing water, food, recreation and transportation to more than 35 million Americans. The quality of this resource is of great importance and, although the discharge of toxic and persistent chemicals from industrial and municipal wastes into the Great Lakes has been substantially reduced over the past 20 years, contaminated sediments remain at certain sites.

Contaminated sediments pose a potential risk to aquatic organisms, wildlife, and humans. The buried contaminants can be resuspended by storms, ship propellers, and bottom-dwelling organisms, many of whom ingest the chemical toxins as they feed. As these smaller animals are eaten by larger animals, the toxins move up the food web, with an increase in the concentrations of toxic chemicals. Advisories against consumption of fish and posting of signs banning swimming are often seen in these areas.

This link between contaminated sediment and water quality provided the basis for enactment of the Great Lakes Legacy Act of 2002. The Act provides for the remediation of contaminated sediment in 31 U.S. Great Lakes Areas of Concern (AOCs). Hog Island Inlet part of the St. Louis River AOC, was selected for cleanup under the act. The project documented in this report successfully completed the remediation phase in November of 2005; restoration and monitoring followed in 2006.

1.1 SITE HISTORY

Hog Island Inlet is a part of the St. Louis River watershed, draining into Lake Superior (Figure 1.1). The inlet is a 17-acre, shallow, protected embayment with emergent vegetation that is connected to Superior Bay by a 50-foot wide channel. The Hog Island Inlet and Newton Creek, which lies above the inlet, both provide the residents of Superior, Wisconsin, with an outdoor recreational area. The Osaugee Bike Trail and the bridge that traverses the waterway are used year round.

The Hog Island/Newton Creek area was investigated in 1995 and determined to have sustained severe ecological impact from historic releases. The principal contaminants were identified as polynuclear aromatic hydrocarbons (PAHs), oil and grease, and heavy metals. The WDNR developed a cleanup plan for Newton Creek, dividing the creek into 12 segments, identified as Segments A through L. As part of this cleanup plan, the Murphy Oil Refinery, situated near the beginning of Newton Creek, made improvements to their wastewater treatment facility to reduce or eliminate the release of contaminants. They also remediated contaminants in the upstream impoundment area of Newton Creek and Segment A of the creek. In 2003, the Wisconsin DNR removed and disposed of 500 cubic yards of contaminated sediment in Segments B-K. Segment L, the last part of Newton Creek to require cleanup, along with Hog Island Inlet, were remediated in 2005 as a part of the Great Lakes Legacy Act project described in this report.

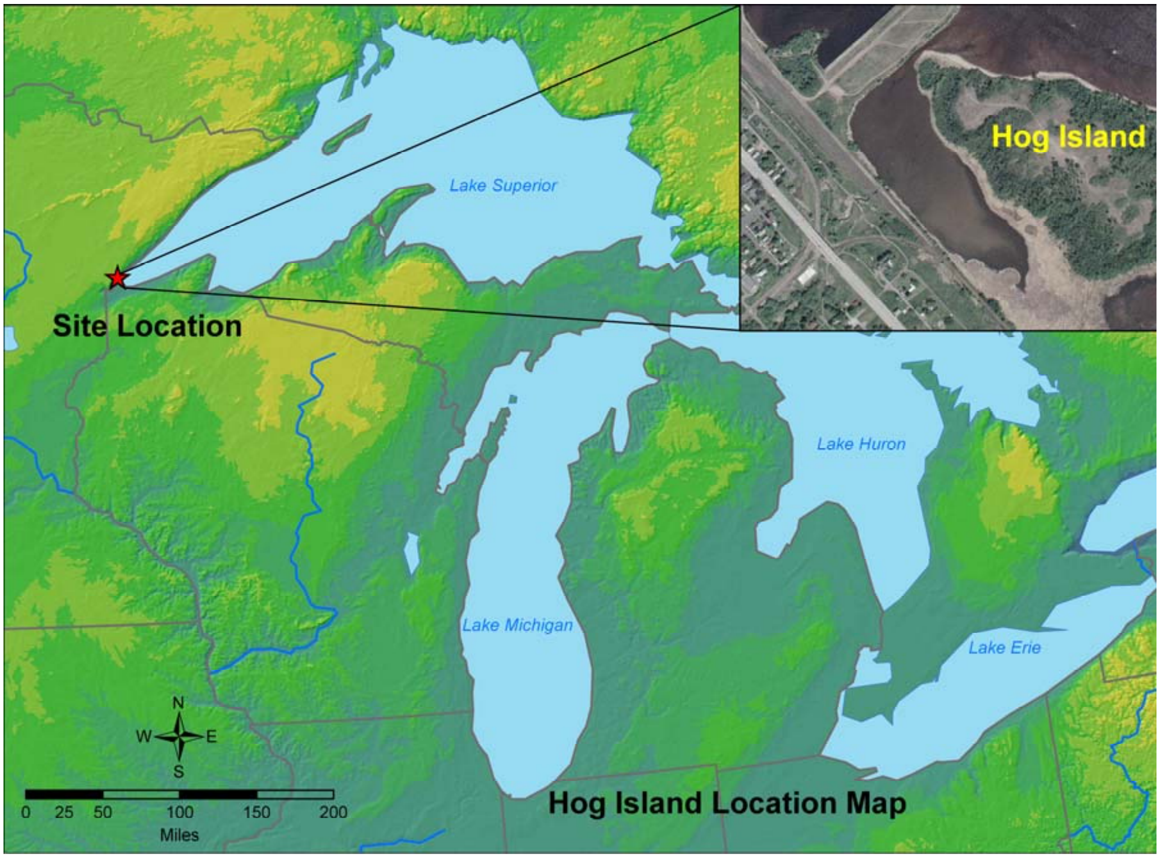

Figure 1.1 Hog Island location map.

1.2 PROJECT FUNDING

The Great Lakes Legacy Act of 2002 was signed into law on November 27, 2002, with an authorization for $270 million in funding over five years. The Act specifically addresses remediation of contaminated sediments in the 31 AOCs in the U.S. The Act is divided into three components: projects; research and development; and public information. Projects can be classified as either remediation (cleanup of sediments) or non-remediation (monitoring or prevention of further contamination). Eligible projects include those sites that will not suffer further contamination, that have completed or in-process site assessments, evaluations, analysis and design work; and that meet the acts requirements for non-federal match of funds. In order to be eligible for funds, states or communities must meet a requirement for a 35 percent non-federal match in funds. The $6.3 million Hog Island Inlet project was funded with $4.1 million from the Great Lakes Legacy Act and $2.2 million from the WDNR's Environmental Repair Fund and local sources.

2.0 REMEDIAL OBJECTIVES AND STRATEGIES

The general remedial objective for the Hog Island Inlet project was to remove contaminated sediments in Segment L of Newton Creek and in the 12 acre inlet. This project served as stage 3 of a cleanup initiative; stage 1 was completed by Murphy Oil in 1997 and focused on removing contaminated sediments from the Newton Creek impoundment area and Segment A; stage 2 was completed by WDNR in 2003 and focused on removing contaminated sediments from Segments B through K of Newton Creek. The result of this remedial action should be a healthier habitat for fish and other aquatic life, and the inlet will be safe for recreation.

The following strategies were employed for stage 3 of the remedial action:

1. **Newton Creek diversion and inlet dewatering** — In order to provide a creek bed dry enough for excavation, Newton Creek would need to be diverted, the inlet separated from the creek with temporary dams, and the remaining water pumped out.
2. **Excavation of sediment** — An excavation plan was designed to begin sediment removal at Segment L of Newton Creek, then to continue excavation at the drained Hog Island Inlet. It was proposed to remove approximately 42,000 cubic yards of contaminated sediment, to a maximum depth of 10 feet, from the inlet.
3. **Segregation, treatment, and disposal of sediment** — As sediments were removed, they were to be segregated and tested, with material containing less than 50 mg/kg lead beneficially reused at the landfill, and material containing greater than 50 mg/kg lead was disposed of as waste at Moccasin Mike Landfill.
4. **Site restoration** — Stabilization of the creek bed, erosion controls and replanting of shoreline vegetation were proposed as the final activities for restoring the site as a healthy habitat and recreation area.

The technical approach used to accomplish these activities is discussed in detail in Section 5.0.

3.0 PROJECT MANAGEMENT AND QUALITY SYSTEM OVERVIEW

The management program developed for the Hog Island Inlet project was designed to ensure that the project had a defined goal and that participants understood the goal and the approach to be used. To accomplish this, a detailed management strategy was defined to address all aspects of project management and the quality system. The key elements of this strategy are summarized in the following sections.

3.1 PROJECT AGREEMENT

The U.S. EPA, represented by the GLNPO, and the WDNR, the non-Federal sponsor, represented by its Secretary, P. Scott Hassett, entered into a Project Agreement to implement the Hog Island Inlet Contaminated Sediment Remediation Project. This Project Agreement details the financial, technical, and logistical obligations and responsibilities of EPA and WDNR, including the financial coordination processes that were used to jointly fund the project. GLNPO and WDNR, through this agreement, also developed a formal strategy of commitment and communication to facilitate successful completion of the project. The Hog Island Project Agreement can be found in the Project Record, described in section 7.4 of this report.

An engineering contractor, Short Elliot Hendrickson, Inc. (SEH®), entered into a separate agreement with WDNR in general accordance with current U.S. EPA Project Agreement guidelines. Earth Tech Inc. was the remedial contractor to the U.S. EPA.

3.2 ROLES AND RESPONSIBILITIES

The management roles and responsibilities for the Hog Island Inlet project, as undertaken in 2005-2006, were defined as a part of the general project management program and are described in Table 3.1.

Table 3.1 Roles and Responsibilities

Key Person	Responsibility	Authorized to
Scott Ireland U.S. EPA GLNPO Project Officer	• Serve as primary GLNPO contact for WDNR, SEH, and EarthTech. • Coordinate with WDNR on project requirements. • Financial and contractual monitoring. • Ensure that decision objectives are met at project completion.	• Negotiate and approve contract modifications for GLNPO. • Review and approve project plans for GLNPO.
John Robinson James Hosch WDNR Project Manager	• Serve as primary WDNR contact for U.S. EPA and SEH and • Coordinate with GLNPO on project requirements. • Financial and contractual monitoring. • Ensure that decision objectives are met at project completion.	• Coordinate negotiations and approval of contract modifications for WDNR. • Coordinate review and approval of project plans for WDNR. • Direct SEH oversight activities
Tom Alcamo U.S. EPA SD Federal On-scene Coordinator (FOSC)	• Serve as primary U.S. EPA Regional Project Manager contact for GLNPO, WDNR, SEH, and EarthTech. • Oversee site activities. • Approve modifications to project plans relating to site activities.	• Stop work if unsafe, noncompliant, or substandard quality exists. • Review and approve Daily Activity QC Report. • Approve all corrective actions impacting site activities. • Approve Contract QAPP and work plans (as delegate of EPA Region 5).

Table 3.1 Roles and Responsibilities

Key Person	Responsibility	Authorized to
Louis Blume GLNPO QA Manager	• Assist in the development of quality documentation and identification of project quality objectives. • Ensure that all environmental collection activities are covered by appropriate quality documentation. • Assist in solving QA-related problems.	• Review and approve the Project QAPP on behalf of GLNPO.
Ida Levin EPA Region 5 SuperFund QA Manager	• Assist in the review of quality related items. • Ensure contract required quality items are met.	• Review QAPP and make recommendations for QAPP approval.
Robert Koentop Earth Tech	• Identify delivery order resource requirements. • Assign technical, field, and administrative personnel to project teams. • Develop and monitor project budgets, cost tracking and reporting, schedules, etc. • Maintain close communication with U.S.EPA and WDNR, SEH, and EarthTech representatives. • Develop and implement field-related work plans, ensure schedule compliance, and adhere to management-developed study requirements. • Implement QC for technical data provided by the field staff including field measurement data. • Report QA deficiencies to Corporate QC Officer. • Participate in the preparation of the final report.	• Assign EarthTech technical, field, and administrative staff to project teams • Direct all Earth Tech delivery order-related technical, construction, and administrative activities.
Mark Broses SEH Inc. Project Engineer	• Identify delivery order resource requirements. • Assign technical, field, and administrative personnel to project teams. • Develop and monitor project budgets, cost tracking and reporting, schedules, etc. • Maintain close communication with U.S. EPA and WDNR, SEH, and EarthTech representatives. • Develop and implement field-related work plans, ensure schedule compliance, and adhere to management-developed study requirements. • Implement QC for technical data provided by the field staff including field measurement data. • Report QA deficiencies to Corporate QC Officer. • Participate in the preparation of the final report.	• Assign SEH technical, field, and administrative staff to project teams. • Direct all SEH delivery order-related technical, construction, and administrative activities.

Table 3.1 Roles and Responsibilities

Key Person	Responsibility	Authorized to
Gloria Chojnacki SEH Corporate QC Officer	• Assess program wide compliance with every aspect of SEH quality control. • Assign and direct all SEH QA staff. • Work with EPAs Regional QA and technical staff to define the best approach for meeting QA/QC requirements associated with completing tasks. • Plan site-specific QA activities in close coordination with site manager. • Lead or direct inspections and audits for each definable work feature. • Verify that all noted deficiencies are corrected. • Maintain QA management oversight, including audit reports. • Initiate, review, and follow up on QA reports and implement corrective actions as necessary. • Serve as a communication channel for QA information to/from EPA.	• Enforce corrective actions at any site to ensure compliance with QC requirements. • Perform system audits. • Coordinate submittal of PE samples, as necessary.

3.3 QUALITY SYSTEM OVERVIEW

Quality system planning was incorporated into the Hog Island project from the inception. Managers, planners and decision makers understood the importance of ensuring the reliability and validity of the data generated throughout the project, including the data collected to confirm restoration of the site. Environmental measurements are never true values and always contain some uncertainty. A comprehensive quality program was deemed critical to identifying, controlling, and quantifying uncertainty associated with project decisions.

Project planners employed systematic planning and the formal data quality objective (DQO) process to identify decisions, place limits on decision error, and optimize the sampling design for sediment confirmation analysis. The DQO process provided a clear understanding of the project objectives and a strategy to meet those objectives, implemented through the project design. Products of the DQO process are used to specify the quality control requirements for sampling, analysis, and data assessment.

In addition to systematic planning and the DQO process, other components of the quality system for the Hog Island project included:

- **Preparation and distribution of a quality assurance project plan (QAPP) —** The Quality Assurance Project Plan (QAPP) defined the procedures necessary to ensure project requirements would be adequately performed and documented to support the DQOs. Results of the DQO process and all of the associated project requirements were incorporated into the QAPP;
- **Communication Strategy —** Communication procedures were defined in the QAPP and included regularly scheduled conference calls, progress meetings, and project management meetings;
- **Project Team —** GLNPO assembled and chaired a project team comprised of representatives from involved parties. The role of the Project Team was to ensure communication among all parties involved in the project, address technical and logistical

issues as they arose, and communicate problem resolutions to all involved parties. All of the individuals listed in Table 3.1 served on the Project Team.

- **Statistical sampling design for sediment confirmation analysis —** Sediment confirmation analysis was designed to meet defined quality standards and support decision-making with a specified level of power and confidence;
- **Collection and analysis of quality control samples —** Collection of QC samples served to monitor error associated with the measurement system. QC requirements were specified in the QAPP, including frequency of field and laboratory quality control samples and associated acceptance criteria (i.e., measurement quality objectives);
- **Standard operating procedures (SOPs) —** Sampling procedures, analytical methods, data handling and documentation were specified in SOPs and included QC requirements, QC sample acceptance criteria and corrective action procedures associated with deviation from the protocol;
- **Documentation of field activities and use of chain-of-custody forms —** All information that should be recorded in the field and procedures for documenting this information were detailed in the SOPs and QAPP;
- **Data reporting requirements —** A detailed list of data reporting requirements for analytical data was provided to the laboratory and documented in the QAPP, and receipt of all required information was confirmed through data verification;
- **Independent data verification —** Data verification was performed by comparing all field and QC sample results with the measurement quality objectives and with overall project objectives; and
- **Quantitative data quality assessments —** Measurement quality objectives (MQOs) were developed by the project planners and defined in the QAPP. The MQOs are presented in Table 3.2. Samples collected after the completion of the remediation activities were used to verify success of the project. Section 8.3 details the data quality assessment of the samples against the six data attributes.

The MQOs were used as the basis for the data verification process. Data verification was performed by comparing all field and QC sample results with the MQOs and with overall project objectives. If a result failed to meet predefined criteria, the reviewer contacted the laboratory, through SEH, to discuss the result, verify that it was correctly reported, and determine if corrective actions were feasible. If the result was correctly reported and corrective actions were not feasible, the results were flagged to inform data users of the failure. These flags were not intended to suggest that data were not useable; rather they were intended to caution the user about an aspect of the data that did not meet the predefined criteria. Results of the data verification process are documented in a data quality narrative. This narrative is included in the project record discussed in Section 8.

Table 3.2 Measurement Quality Objective Attributes

Attribute	Description
Sensitivity/Detectability	The determination of the low-range critical value that a method-specific procedure can reliably discern for a given pollutant. Method detection limits (MDLs) were determined for the project contaminants of concern, PAHs. These MDLs were determined using the MDL procedures specified at 40 CFR Part 136, Appendix B.
Precision	A measure of the degree to which data generated from replicate or repetitive measurements differ from one another. Analysis of field split samples was used to assess precision.
Bias	The degree of agreement between a measured and actual value. Bias was expressed in terms of the recovery of spiked field samples.
Completeness	The measure of the number of samples successfully analyzed and reported compared to the number that were scheduled to be collected.
Comparability	The confidence with which one data set can be compared to other data sets.
Representativeness	The degree to which data accurately and precisely represents characteristics of a population, parameter variations at a sampling point, a process condition, or an environmental condition.

4.0 PUBLIC OUTREACH

A number of outreach activities were performed to notify and inform the public about the Hog Island Inlet remediation project and the intended benefits. The outreach programs included; community meetings, public announcements, newspaper articles in the local press such as the *Superior Daily Telegram* and the *Duluth News Tribune*, and project information available on the internet at the EPA Great Lakes Legacy Act website (http://www.epa.gov/glnpo/sediment/legacy). This site provides links to:

- Proposed Legacy Act project sites and assessment sites including Hog Island
- A Hog Island Fact Sheet and aerial shots of the Hog Island Inlet cleanup site with photographs of the site during and after remediation
- Significant activities reports for Hog Island

General background information is also available on the web site such as;

- Executive summaries for proposed Legacy Act projects and proposals
- Great Lakes Legacy Act Fact Sheet
- Text of the Great Lakes Legacy Act
- Strategy to restore and protect the Great Lakes (document)

A stakeholder project meeting with the U.S. EPA, WDNR, project contractors, City of Superior, Douglas County, Enbridge Energy, and Burlington Northern Santa Fe railroad took place on May 19, 2005 in Superior, Wisconsin, followed by additional project meetings with stakeholders on June 29 and 30, 2005. A public meeting was conducted on June 29, 2005.

On November 28, 2005, a ceremony was held to celebrate the successful sediment cleanup of Hog Island, Superior, Wisconsin. Great Lakes National Program Office Director Gary Gulezian joined Wisconsin Governor Jim Doyle and 85 residents, local, state, tribal, and federal officials to celebrate the event and to mark the beginning of the restoration of the site.

Figure 4.1 Photo of Hog Island ceremony, removing the no swimming sign.

5.0 TECHNICAL APPROACH

The technical approach for remediating the inlet was developed by the project team and was thoroughly documented in several planning documents including a workplan (U.S. EPA 2005) and project QAPP (SEH, 2005). This section provides an overview of the technical approach and project planning activities for the Hog Island remedial action.

The technical approach to the remedial action was based upon initial contaminant surveys conducted from 1993 through 2004 that indicated high levels of sediment pollution, necessitating removal of the contaminated sediments. Contamination in the creek and inlet included PAHs, oil and grease, mercury, lead, and chromium. Risk assessment studies focused on the concentration of total PAH (TPAH) in the sediments as the driving pollutant of concern. Acceptable TPAH levels were defined to protect human health and the environment based on acceptable chronic and acute exposure levels, project objectives, sediment quality guidelines and other site-specific information including previous environmental studies of Hog Island Inlet and Newton Creek. For this project, the chronic level of concern for TPAH was defined as 2.6 mg/kg and the acute level was defined to be between 5.0 and 7.5 mg/kg. The lowest of these levels, 2.6 mg/kg, served as the target level for remediation activities

The following plan describes the technical approach for remediating the site:

- Mobilization and Site Preparation,
- Water Diversion,
- Dewatering and treatment,
- Sediment excavation,
- Excavated material segregation and disposal (including segregation of the contaminated sediments into those that can be beneficially reused and those that required disposal as waste),
- Monitoring and processing of the water removed from the project area,
- Sediment confirmation analysis, and
- Revegetation of Newton Creek and Hog Island Inlet shorelines.

5.1 SEDIMENT EXCAVATION

The depth of contaminated sediments in Segment L of Newton Creek and Hog Island Inlet were determined from previous investigative studies undertaken from 1993 to 2004. These studies identified the lateral and vertical extent of sediments containing TPAH concentrations greater than 2.6 mg/kg, the project target level. The Hog Island Inlet was segregated into remediation management units (RMUs), composed of a 100-foot by 100-foot grid (Figure 5.1), for effective excavation of the sediment and for statistically verifiable achievement of target levels.

Diversion of the Newton Creek flow via pipes and a temporary flow redirection was required in order to provide a creek bed dry enough for excavation. Once the creek was redirected, the uncontaminated area of the inlet would need to be separated from the contaminated portion with temporary dams. A sheet-pile wall installed at the outlet of the inlet to St. Louis River would further confine the inlet. The uncontaminated surface water could then be pumped over the wall into the river. The approach developed for excavating the creek and the inlet is described in Section 5.1.1 and Section 5.1.2, respectively.

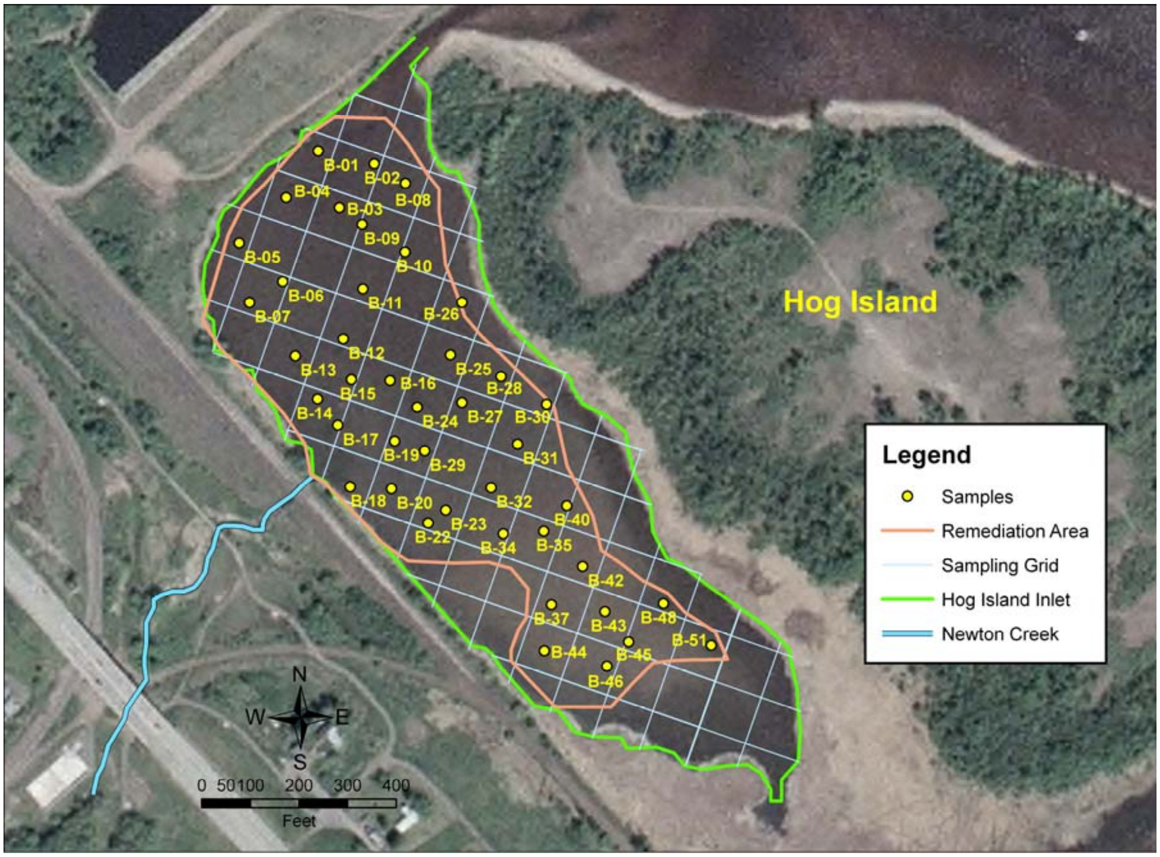

Figure 5.1 Sampling grid 100'x100' remediation management units.

5.1.1 Segment L of Newton Creek

In Segment L of Newton Creek, visually contaminated sediment within the channel was targeted for removal. Excavation was proposed to start at the upper most part of Segment L, where a culvert existed, and proceed to the remainder of the creek bed. Sediment from the culvert was to be removed to the red clay substratum. The sediment would then be excavated from the streambed of the creek with a tracked backhoe or equivalent. The excavation was planned with the goal to minimize disturbance of the stream banks with the exception of areas designated as temporary access roads. To facilitate this, the plan called for building the access roads sloped 2(horizontal):1(vertical) to the surrounding grade. To ensure that all contaminated sediments and soils were removed from the creek bed, confirmatory sampling was planned at two designated sites: between the railroad trestles and 80 feet upstream from the railroad trestles. Pace Analytical Services, Inc., was subcontracted through SEH to perform analyses of all sediment confirmation samples for TPAH.

5.1.2 Hog Island Inlet

The technical approach called for excavation of the Hog Island Inlet sediment down to a maximum depth of 10 feet, depending on the contaminant concentration from previous sediment sampling results. A hydraulic excavator was chosen for removal of the sediment. Following removal of the sediment, an additional survey was planned to verify that the designated sediment depth was met.

To further ensure that the contaminated sediment was sufficiently removed to meet project target levels, sediment confirmation samples were to be collected and analyzed for TPAH. If a single sample contained a concentration of TPAH greater than 7.5 mg/kg, an additional round of sediment removal was to be conducted.

Approximately 42,000 cubic yards of sediment were planned for removal from 12 acres of Hog Island Inlet. An additional 8,000 cubic yards was estimated for possible contingency purposes, for a total removal of up to 50,000 cubic yards of sediment. Following removal, the inlet bottom was to be resurveyed to verify that the sediment had been removed to the depth designated in the plan.

5.2 EXCAVATED MATERIAL SEGREGATION AND DISPOSAL

Excavated materials were to be managed as non-hazardous wastes. Depending on the concentration of lead in the material, the waste could be beneficially reused or would be disposed of as waste at a specified landfill. Excavated materials were to be segregated, stockpiled, tested for lead content, and disposed of at the Moccasin Mike Landfill according to the procedures detailed below.

Sediments were segregated based on estimates of lead concentrations determined in previous studies. Results of these studies indicated that the areas of lead contamination were continuous, resulting in relatively large areas with similar lead concentrations. Therefore, it was determined that excavated sediments would be initially segregated and stockpiled according to the lead concentrations observed in these prior studies. It was estimated that approximately 300 cubic yards would need to be excavated and stockpiled from Segment L of Newton Creek and 1150 cubic yards per day from the Hog Island Inlet.

As sediments were removed, they would be stockpiled, allowed to drain, and then dried as necessary. Free liquid content was to be determined using the paint filter test (Method 9095B). If the sediments failed the paint filter test and, therefore, were determined to contain free liquid, solidification agents such as wood dust, were proposed to solidify the material for handling and to minimize the spreading of contaminants due to spillage.

Confirmatory sampling and analysis to determine lead concentrations of the beneficial reuse stockpile was to be conducted prior to transport to the landfill. EPA's Method 6020, for determination of lead in soils and sediments, was chosen for analysis of the stockpile samples.

Upon completion of all excavation, stabilized sediments were to be loaded into trucks for transport to the Moccasin Mike Landfill. Material containing less than 50 mg/kg lead would be beneficially reused at the landfill. Material containing greater than 50 mg/kg lead would need to be disposed as waste at Moccasin Mike Landfill.

5.3 WATER MONITORING AND PROCESSING

Prior to sediment excavation and removal, the flow from Newton Creek would need to be diverted in order to provide a dry work area. Once temporary dams were in place, approximately 13 million gallons of water would need to be removed from the Hog Island Inlet. The plan included rescue measures for safely removing fish that were trapped in the inlet and returning them to open water. An estimated six days would be required for the water discharge phase.

Water in contact with soils or sediments at the construction site (construction contact water) would be treated as necessary to remove solids before discharge to the POTW. On a weekly basis, grab samples were to be collected for BOD, TSS, and total phosphorous. The first and monthly composite samples would be analyzed for BOD, PAHs, oil and grease, total suspended solids (TSS), total phosphorous, diesel range organics (DRO), and RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver).

5.4 SEDIMENT CONFIRMATION ANALYSIS

GLNPO's quality contractor, CSC, was responsible for developing a statistically based sampling design for sediment confirmation analysis that would be conducted to verify that project objectives were met. The U.S. EPA's systematic, seven-step Data Quality Objective (DQO) process was used to develop this statistically-designed plan for confirmatory sampling of the Newton Creek and Hog Island Inlet areas. A key element to the statistical design of the project was ensuring that the remedial actions achieved clean up goals. Use of the DQO process as a planning tool, resulted in a plan that would avoid collecting data that are inconsequential to verifying the success of the clean up and instead focused on ensuring that the confirmation data collected would be of sufficient quantity and quality to confirm the project's success with an acceptable degree of confidence. Results of the DQO process for sediment confirmation analysis are detailed in Table 5 of the project QAPP (SEH, 2005) and summarized below.

5.4.1 Decision Statements

As part of the DQO process, a decision statement was developed for the sediment confirmation sampling in the creek and the inlet. The decision statement was based on achievement of study objectives, specifically: "Has the excavation removed the contaminated sediment sufficiently based on the target levels for TPAHs or is additional excavation or other remedial activities required?" For Segment L of Newton Creek, it was decided that additional excavation may be warranted if the TPAH concentration measured in any single sediment confirmation samples was above 7.5 mg/kg. As discussed above, the Hog Island Inlet was segregated into RMUs composed of a 100-foot by 100-foot grid, for effective excavation of the sediment and for statistically verifiable sample collection. The decision statement for the inlet specified that additional excavation of an RMU within the inlet would be warranted:

- if the average concentration of TPAH in any of the 100x100 foot RMU's was greater than or equal to 2.6 mg/kg;
- if a single result was greater than 7.5 mg/kg; or
- if a single result was greater than 5 mg/kg, then additional excavation *may* be warranted based on observed concentrations in surrounding RMUs and available data from pre-remediation assessments.

These target levels for confirmatory sampling reflected the acceptable levels established for this project and described in Section 5.0.

5.4.2 Statistical Sampling Design

As part of the DQO process, a power curve for the sediment sampling was developed in the style recommended by US EPA (US EPA 1994). In developing the power curve, sediment contaminant data collected in the 2002 and 2004 pre-remediation assessments were used to estimate variability in TPAH concentrations that might be expected in the sediment confirmation samples. These data showed a strong lognormality of TPAH concentrations and a definable variogram (a key function in geostatistics characterizing roughness of a data set) with a non-symmetrical range. Data were log-transformed prior to use for development of the sampling design.

Based on results of the power curve, a final design was chosen that called for collection and analysis of 42 samples within the inlet. A systematic random sampling design for the 42 samples was developed based on the 100x100-foot grid system. At each sampling location, four surficial samples (0 to 6 inches in depth) were to be collected at pre-determined locations and combined to form one composite sample. Sampling locations were pre-determined and illustrated in Figure 6.1. An additional 6 field split samples were to be collected for QC purposes.

5.4.3 Limits on Decision Error

Confidence and power associated with addressing the decision statements were calculated for the sampling design and are provided below.

Power:

- A false negative (F^-) decision leads to inappropriately leaving contamination that has an average TPAH concentration above 2.6 mg/kg.
- This, in turn, may cause an inappropriate risk to human health and the environment.
- The present sampling design achieves an 80% power, i.e., the probability is 80% of detecting an exceedance of the target level of 2.6 mg/kg when the true average of TPAH is 5 mg/kg or greater within an RMU.

Confidence:

- A false positive (F^+) decision may cause an inappropriate rejection of the null hypothesis and the inappropriate cost of additional remedial activities.
- Due to the varied sampling pattern and densities for each RMU, the F^+ levels vary from 10% to 20% for a specific RMU, while power is maintained equal to or greater than 80%.
- Maximizing power maximizes protection to human health and the environment.

5.4.4 Decision Rules

After sediment confirmation samples were collected and analyzed, analytical results for each RMU would be compared to target levels. Depending on the observed concentrations, kriging may be necessary to evaluate average concentrations for each RMU, given that the sampling design called for samples from only a subset of the RMUs. Kriging is a spatial and variance interpolation method used to predict concentrations across the site in areas where samples were not collected. If observed concentrations were sufficiently above target levels, the kriged average for each RMU would be calculated and compared to the confirmatory TPAH target level of 2.6 mg/kg. If the kriged average concentration of TPAH within a RMU was greater than 2.6 mg/kg, or any single value exceeded 7.5 mg/kg, then additional remedial activities were planned. Additionally, if a single sample contained TPAH concentrations greater than 5.0 mg/kg, then additional sediment would be considered for removal. The removal decision was based on the observed concentration, observed concentrations in adjacent samples and surrounding RMUs, and pre-remediation assessments. Sediment residual results would be log-transformed prior to evaluation of the average against target levels.

Statistical tests were to be conducted on the sediment confirmation data to evaluate the arithmetic average as follows:

- Total TPAH average (kriged) concentration less than target level:
    - H0: total TPAH $\leq$ 2.6 mg/kg
    - H1: total TPAH > 2.6 mg/kg
- All single TPAH values are less than 7.5 mg/kg:
    - H0: TPAH $\leq$ 7.5 mg/kg
    - H1: TPAH > 7.5 mg/kg

5.5 RESTORATION

After sediment excavation and removal of the water diversion barriers, the last step in remediation for Newton Creek and Hog Island Inlet was to renew the damaged channel bed and replace vegetation. Segment L of Newton Creek would be backfilled with clean, graded rock, and topped with river stone. In order to prevent erosion, the northwest bank of Hog Island would be stabilized with riprap beneath the waterline. Grading, erosion mats, and seeding with grasses and other native vegetation would be used to stabilize the shoreline above the waterline.

The eventual result of the remediation and restoration project will be a healthier habitat for fish and other aquatic life, with a creek and inlet that is safe for recreation.

6.0 PROJECT IMPLEMENTATION

The following section summarizes the remedial action as implemented by SEH and their contractors. Additional details can be reviewed in the Construction Documentation Report (SEH, 2006).

6.1 PRE-REMEDIATION ACTIVITIES

SEH conducted a pilot study to evaluate whether Hog Island Inlet dewatering effluent could be discharged directly to the St. Louis River Bay Estuary without exceeding discharge limits for Lake Superior. Field turbidity readings were correlated with the mercury content and were used to establish criteria for discharge of the Hog Island Inlet dewatering effluent. Effluent with a turbidity reading of 18 or below would be discharged into the estuary, while effluent with a turbidity reading above 18 NTU would require discharge to POTW.

In accordance with the study plan, a combination of global positioning system (GPS) technology and on-site surveying techniques were used to establish a three-dimensional, 50-foot by 60-foot excavation grid representing the inlet topography. This grid was established to precisely locate excavation positions throughout the creek and inlet area; it established the pre-excavation channel bed contours for the project and was the foundation for all other work done at the site. The Resident Project Representative cross-checked GPS coordinates for the study data to determine the excavation depths needed to remove contaminants. Pre- and post-removal elevation measurements also were made, to verify that the target removal depth was achieved (SEH, 2006).

Staging areas for equipment were prepared and temporary utilities installed in a construction trailer. A haul road made from clean rock was constructed on the southwest side of the inlet to allow trucks to reach the excavation area. The road was elevated three feet above the sediment and was extended in stages to access the excavation areas.

6.2 NEWTON CREEK REMEDIATION

Cleaning of the Newton Creek culvert and excavation of the creek began on July 16, 2005 and was completed on August 10, 2005. The diversion, dewatering, and excavation processes performed in the creek during this period are described in Sections 6.2.1 and 6.2.2 below.

6.2.1 Diversion and Dewatering

Diversion of Newton Creek was the first operation conducted as part of the remediation project. To accomplish this, temporary water-inflated portable dams (aqua-barriers) were installed along the wetland isthmus and tied into solid ground on each end. Sheet piling was installed along the north-central portion of the Hog Island Inlet northeast shoreline, running southeast along the shore to the wetland isthmus. This effectively isolated the creek and the inlet. Effluent from the creek was pumped beyond the aqua-barriers during excavation and restoration of Newton Creek. Due to leakage in the sheet pile wall used to isolate and dewater the inlet, the creek diversion continued to be used until the Hog Island Inlet excavation was also complete

6.2.2 Excavation

Excavation was initiated at the upper-most part of the Segment L stream bed at a 278-foot long corrugated metal pipe culvert. A total of 187 cubic yards (y^3) of sediment were manually removed from the culvert until the red clay layer was exposed. After manually removing sediment from the culvert, 500 y^3 of sediment were excavated from the remainder of Newton Creek Segment L using a tracked backhoe. South of the Osaugee Trail, an additional large area of contamination was observed, and an additional 900 y^3 of sediment were excavated from this area.

6.3 HOG ISLAND INLET REMEDIATION

The Hog Island Inlet remediation began on July 15, 2005, with the dewatering project, with excavation completed on November 18, 2005. The diversion, dewatering, and excavation processes performed in the inlet during this period are described in Sections 6.3.1 and 6.3.2 below.

6.3.1 Diversion and Dewatering

Prior to excavation and removal of sediments in the inlet, the flow from Newton Creek was diverted as described in Section 6.2.1 in order to provide a dry work area. Once temporary aqua-barriers were in place, approximately 13 million gallons of water were pumped from the Hog Island Inlet. Fish that were trapped in the inlet were rescued with seines and dip nets and returned to open water. Over 1,700 fish were rescued, including game fish such as walleye, northern pike and catfish, as well as freshwater clams and turtles.

The effluent met the turbidity requirements and was discharged into the St. Louis River Bay for the first six days of dewatering. Except for a flood emergency between October 10 and October 14 during which waters were also discharged directly into the St. Louis River Bay, all subsequent discharges from the creek and the inlet were routed to POTW. In mid-August, lateral flow of groundwater beneath Hog Island Inlet was identified as infiltrating into the inlet, preventing a complete dewatering of the area. A 3 to 4-foot deep diversion trench along the southwest shoreline was constructed and water from the trench was pumped to the POTW. A total of 14,109,300 gallons from the inlet and another 22,062,900 gallons from the diversion trench were discharged into POTW. All water monitoring data associated with the diversion and dewatering process can be reviewed in the Construction Documentation Report (SEH, 2006).

6.3.2 Excavation

The remediation area was designated to cover 12 acres instead of the entire 15 acres of the inlet (see Figure 6.1), where water depths range from 1 to 5 feet and the sediment thickness ranged from 2 to 5 feet. A total of 44,340 y^3 of sediment were removed from the 12 acre remediation area of Hog Island Inlet. Two tracked backhoes placed the sediment in dump trucks that carried it to Ogdenburg Pier, where a third backhoe mixed the sediment with wood flour as needed to absorb free liquid. The amount of sediment removed from a particular area was dependant on the contaminant concentration at the sampling site (see Sections 6.4 and 6.7). Pre- and post-remediation contours can be found in the Construction Documentation Report (SEH, 2006).

6.3.3 Segregation, Stockpiling and Testing

Excavated material was segregated, stockpiled, tested, and disposed of according to target levels for lead of 50 mg/kg. Materials exceeding this target level were not eligible for beneficial reuse, but had to be disposed of as solid waste. Approximately 45% of the sediments excavated from the remediation area had a total lead concentration exceeding 50 mg/kg, leaving 55% of the sediment for utilization by the landfill as beneficial reuse material.

SEH requested, and WDNR granted, a modification to the beneficial reuse sediment confirmation testing requirement in September 2005. This permitted beneficial use testing of the sediment while still in the inlet and allowing sediment to be segregated as it was excavated. This action conserved space on the pier and eliminated project delays due to laboratory turnaround times. All material separated for beneficial reuse was also tested prior to disposal, ensuring permit requirements were met. Details on the segregation analyses can be reviewed in the Construction Documentation Report (SEH, 2006).

As sediments were removed and segregated, they were stockpiled, allowed to drain, and then dry. Free liquid content was determined using the paint filter test and, as necessary, solidification agents such as wood flour, or the equivalent, were used to solidify the material for handling and to minimize the spreading of contaminants due to spillage.

Moccasin Mike Landfill accepted all of the sediments from the Hog Island remediation project. Sediments were loaded into dump trucks for appropriate disposal at the landfill as either beneficial reuse material or solid waste. A total of 3,232 truckloads of sediment that exceeded the concentration for lead were brought to the Moccasin Mike Landfill to be buried in a lined cell as solid waste.

Water in contact with soils or sediments at the construction site (construction contact water) was treated as necessary to remove solids before discharge into the sanitary sewer. On a weekly basis, composite samples were collected by Earth Tech and were analyzed for TSS, BOD and total phosphorous. Monthly samples were analyzed for BOD, PAHs, oil and grease, TSS, total phosphorous, diesel range organics (DRO), and RCRA metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver).

6.4 SITE RESTORATION

As part of the St. Louis River AOC, the beneficial use impairments (BUIs) at Hog Island and Newton Creek must be mitigated in order for the St. Louis River to be delisted as an AOC. Restoration of the Hog Island Inlet and Newton Creek site will partially address the habitat-related BUIs. Plans for site restoration and revegetation (Hammarlund Nursery, September 21, 2005) were submitted to EPA and WDNR. A small portion of Newton Creek at the railroad crossing was not included in the restoration, as excavation in that area had been done by hand, resulting in less damage to the banks, with the existing railroad trestle timbers effectively stabilizing the bank.

The excavated portions of Segment L of Newton Creek were backfilled with clean, graded rock, and topped with river stone. The banks of the creek were graded with a backhoe to provide a sloping edge and to restore them to their pre-excavation elevations. The embankments were covered with coir material and hydro mulched, with the outer bends of the stream having coir logs staked in place at the flood elevation to further stabilize the creek. Grass and forbs (broadleaf herbs) were planted by hand seeding along the embankments.

Revegetation activities for the Hog Island Inlet work area were completed in the spring 2006. The work area was restored using the materials and methods outlined in the Revegetation Plan (Hammarlund, 2005).

6.5 SEDIMENT CONFIRMATION SAMPLING AND ANALYSIS

Sediment confirmation sampling was conducted in the Newton Creek Segment L streambed and Hog Island Inlet bed following the excavation of sediments to design depths. Samples were collected to confirm that excavation sufficiently removed the contamination prior to conducting the restoration activities.

6.5.1 Sediment Sampling Methods

Figure 6.1 illustrates the entire 15 acre inlet area and the 12 acre remediation area that was excavated as described in Section 6.3.2. Forty-two confirmatory sampling locations (Figure 5.1) were selected using statistical analysis and the DQO process described above in Section 5.4. These pre-selected sampling sites were located in the field using a GPS receiver.

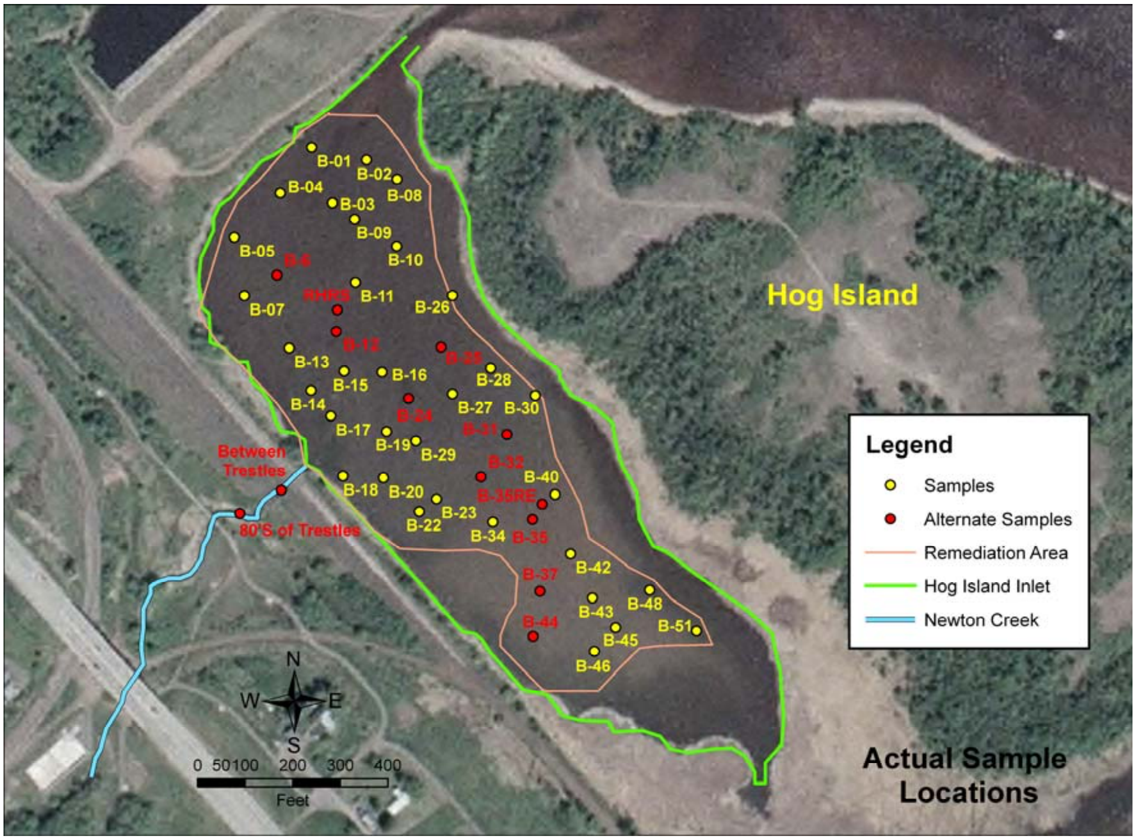

Figure 6.1 Actual sample locations.

Some of the original sample locations designated in Figure 5.1 and in the QAPP were moved due to logistical issues. Figure 6.1 shows the actual sample locations, including several additional samples that were collected. Samples B-12 Post-inundation and B-16 Post-inundation were collected at the same location as the original samples B-12 and B-16. The post-inundation samples were taken after a flooding event (October 10 to 14) to make sure the flood did not re-contaminate the previously excavated areas. The locations for samples B-12 and B-16 were chosen randomly to serve as the locations for this post-inundation sampling.

Sampling methods are described in detail in SEH SOP's (SEH, 2005) and summarized here for brevity. Routine field samples were collected from 0 to 6-inches below the surface as a composite of four grab samples for each sampling location shown in Figures 6.1. In addition, six field split samples were collected for quality control purposes. Two confirmatory samples were also collected from Newton Creek after the excavation was completed, as well as a sample from the rock haul road to ensure that the road was not adversely affected by either the flood or the truck movement. Each sample was thoroughly homogenized according to the SOP and then placed in appropriate laboratory clean bottles, preserved as necessary, chilled to 4^0C and shipped to the laboratory. Standard chain-of-custody documentation was maintained during all confirmatory sampling, and a complete description of the sediment confirmation sample data analysis is provided in Section 8 of this report.

Results from the sample collected at location B-35 indicated TPAH concentrations higher than the target level of 2.6 mg/kg. After considering this result, a field decision was made to remove an additional one foot of sediment from this area. Retesting at the same location indicated the contaminants had been removed. (Please refer to Section 8 for additional details regarding these results.)

6.5.2 Sediment Analytical Methods

Pace Analytical Laboratory analyzed all sediment confirmation samples utilizing US EPA SW846 Method 8270-SIM. Prior to analysis, all samples were prepared and extracted according to US EPA SW846 Method 3545.

Method 8270 is used to determine the concentration of semivolatile organic compounds in extracts prepared from many types of solid waste matrices, soils, air sampling media and water samples. Method 8270 can be used to quantitative most neutral, acidic, and basic organic compounds that are soluble in methylene chloride and capable of being eluted, without derivatization, as sharp peaks from a gas chromatographic fused-silica capillary column coated with a slightly polar silicone. Such compounds include polynuclear aromatic hydrocarbons, chlorinated hydrocarbons and pesticides, phthalate esters, organophosphate esters, nitrosamines, haloethers, aldehydes, ethers, ketones, anilines, pyridines, quinolines, aromatic nitro compounds, and phenols, including nitrophenols.

6.6 LOGISTICS AND COMMUNICATIONS

Logistics in the field required a few modifications to the outlined technical approach summarized in Section 5 of this report and set forth in the QAPP. The issue of moving a few sampling locations due to the obstructions in the field was raised and a contingency in the QAPP allowed for the samplers to move the sampling location using their best professional judgment to collect a sample at a location relatively close to the first, while avoiding the obstruction. When logistics issues arose they were brought to the project team in a timely manner and resolutions were discussed during the weekly meeting or immediately when the issue was urgent. Other logistical issues were dealt with in a timely manner and are discussed Section 9 of this report.

Communication strategies set forth by the team management proved to be appropriate and effective. Issues were either raised by the project team members during weekly meetings or immediately with the appropriate personnel if the issue was urgent. To facilitate the rapid dissemination of information between project stakeholders, SEH created an interactive project website. Ten organizations and 44 people accessed the website during the project. The website content and access were maintained by SEH and provided the following communication content and accomplishments:

- Copies of all access agreements, permits, project status meetings, field logs and public release statements were made available.
- Rapid updates were posted throughout the project.
- Team members were able to quickly review, download, and post documents.

The communication process also included public and stakeholder meetings as described in Section 4 of this report.

7.0 DATA MANAGEMENT

Information generated as part of the Hog Island project was managed by WDNR and GLNPO using procedures outlined in project planning documents. Management procedures included using standard protocols for recording field data and remedial activities, defined electronic data deliverables (EDDs) for laboratory data, chain of custody forms for transferred samples, and a data logging system that tracks all field and laboratory data submitted for independent data verification and final upload to a study database.

WDNR's contractor, SEH, was assigned responsibility for managing all field data, lab data, and other project information gathered during preparation and implementation of the project. This included all:

- Original planning documents developed for the project
- Laboratory data generated by Pace Analytical Laboratories during analysis of excavated material stockpile samples (used to determine disposal specifications)
- Field records, including sediment sampling and characterization records performed by SEH in the field after excavation for confirmation
- Laboratory records generated by Pace Analytical from analysis of the samples collected for confirmation sampling
- Results of the independent data verification performed by GLNPO's quality assurance support contractor, CSC
- A Construction Documentation Report developed by SEH upon completion of the project that includes an overview of the remediation

To ensure effective handling of such data, SEH developed and implemented field-related work plans and QC for technical data generated by field staff. Unless otherwise noted below, all data management activities were implemented as planned in the QAPP.

7.1 FIELD DATA COLLECTION

The primary method for recording field data and site activities was bound field logbooks. Field information was recorded in daily logbooks including weather conditions, personnel present, all field measurements and observations, and any deviations from original sampling plan. Entries into the logbooks were made as activities occurred or samples were collected. Calibrations of any field equipment were documented in the logbooks including results of the calibration. Instrument readings taken during the remediation were documented in boring logs, in the field logbook, or both. Daily logbooks were stored at the project site and were turned over for inclusion in the project file at the completion of field activities.

Upon collection, each sediment sample was classified in the field in accordance with the Unified Soil Classification System (ASTM D2487). Visual and olfactory observations also were recorded. Once samples were collected, a chain of custody record was created for each sample. This record then accompanied the sample until the analytical data had been accepted. After data quality was deemed acceptable, all chain of custody forms were archived in the project file maintained by SEH.

7.2 LABORATORY DATA COLLECTION

To minimize costs associated with delay of field activities, rapid analytical turnaround times, data review, and interpretation of the data and evaluation of achievement of target levels were required. The laboratory provided summary level data for the sediment confirmation results to facilitate these requirements. These data were provided in the form of summary-level data reports that included data qualifiers. For the sediment confirmation data, all laboratory data and records were included in final analytical reports submitted to the SEH Project Manager. Data were delivered in the form of EDDs (electronic data deliverables), as well as in the form of hard-copy data packages that included the analytical results, quality control sample results, data narratives from the analytical laboratory, and the chain of custody forms. These data packages were then provided to GLNPO's quality contractor, CSC, for data verification.

7.3 DATA TRACKING

Standard procedures were employed to receive and manage all incoming data. For sediment confirmation data, a comprehensive tracking system, the Legacy Act Data Logging System, was employed by CSC to track sample results through the entire data management process including sample collection and analysis, data receipt, verification, validation, upload to study databases, and reporting. As data were submitted for verification, information regarding the data was entered into database that included the filename, date received, and individual submitting the data, among other items. In addition, all electronic data were saved on a local area network (LAN) in project-specific "original" folders that are backed-up nightly. This data system is being used to track the status of the data from submittal, to verification, and final upload to an EPA database.

7.4 DATABASE

A database system is currently being developed by CSC for maintenance of Legacy Act sediment confirmation data. This database will contain sediment confirmation data, including location data, analytical results for project contaminants of concern, sample-specific QC information, field observations, and all relevant sample collection information. The final system will be designed to facilitate easy data retrieval and may be available for internet access in the future.

7.5 PUBLIC ACCESS

GLNPO intends to provide data generated for the Hog Island remedial action to stakeholders and other interested parties. To facilitate distribution, a comprehensive Project Record has been compiled for the project and is available to requestors. The record contains all relevant documentation concerning the project, including project planning and operational documents, fact sheets, analytical data, and all project reports. Interested parties can contact GLNPO's Sediment Assessment and Remediation Team to submit a request. In addition and as discussed in the previous section, GLNPO expects to upload the sediment confirmation data to a standard Legacy Act database and provide public access through written request or, if possible, via the Internet once the system is in place.

8.0 PROJECT RESULTS

8.1 SUMMARY OF SEDIMENT CONFIRMATION DATA

Sediment confirmation data were collected from Newton Creek and the 12 acre inlet to verify that contaminated sediments were sufficiently removed to proceed with restoration. All samples targeted for collection (two in Segment L of Newton Creek and 42 for Hog Island Inlet) were successfully sampled and analyzed. Three additional samples also were collected for one of two reasons: 1) two samples were collected to verify that a flood event did not contaminate the site and 2) one sample was collected from the access road as a check to make sure that the haul road was not adversely affected by either the flood or the truck movement occurring during the project. Finally, six field split samples also were collected for quality control purposes.

Specific information regarding final sampling locations is detailed in Section 6.5.1 with pre-defined sample locations shown in Figure 5.1 and final locations provided in Figure 6.1. Table 8.1 provides a summary of TPAH concentrations at each sampling location. Specific information regarding the results of the sediment confirmation samples for Segment L of Newton Creek and Hog Island Inlet are described below in Section 8.1.1 and 8.1.2, respectively. Results for the additional post-inundation samples and the samples collected along the road are presented in Section 8.1.3. Section 8.2 discusses the sample results in the context of the achievement of study objectives. An assessment of overall data quality is discussed in Section 8.3.

8.1.1 Segment L of Newton Creek

The two samples targeted for collection in Segment L of Newton Creek were successfully sampled and analyzed. The decision statement for Newton Creek was that additional excavation may be warranted if the TPAH concentration measured in any single sediment samples is above 7.5 mg/kg. Both samples collected in Newton Creek were below this target level. Based on these results, contaminated sediment was determined to be sufficiently removed from Segment L of the creek to proceed with restoration and additional excavation was not required.

8.1.2 Hog Island Inlet

Samples were collected from 42 locations (Figure 6.1) and included 6 duplicates for quality purposes. For the purposes of confirming successful remediation of the sediments, only the 42 routine field samples results were evaluated. Concentrations in the 42 samples ranged from 0.04 to 4.56 mg/kg with a mean concentration after the initial round of excavation of 0.55 mg/kg.

The decision statements specified that additional excavation of an RMU would be warranted:

- if the kriged average concentration of TPAH in any of the 100x100 foot RMUs was greater than or equal to 2.6 mg/kg;
- if a single result was greater than 7.5 mg/kg; or
- if a single result was greater than 5 mg/kg, then additional excavation *may* be warranted based on observed concentrations in surrounding RMUs and available data from pre-remediation assessments.

As analytical results were generated, the TPAH concentration observed in each individual sediment sample was reviewed against project target levels. Given that all sample concentrations were below the project target level of 2.6 mg/kg, except for one (B-35), kriging of the data for each RMU as it was remediated was deemed unnecessary. The maximum TPAH concentration observed at the site after the initial round of excavation was for sample B-35 with a concentration of 4.56 mg/kg. Additional excavation was conducted for this RMU and a second sediment confirmation sample was collected. The TPAH concentration for the second sample was 1.41 mg/kg, well below the project target levels.

To verify that the project decision criteria specified in the data quality objective statement was successful, kriging of the data across the site was conducted. Kriging is a spatial and variance interpolation method used to predict concentrations across the site in areas where samples were not collected. TPAH concentrations measured in the 42 routine field samples collected after the initial round of excavation were contoured using a block kriging method to estimate average concentrations for each RMU. In this approach, the sample concentrations are kriged to create contours across the site by estimating the average concentration within each 100'x100' RMU. These data showed lognormality of TPAH concentrations (based on the Shapiro-Wilks test for normality) and a definable variogram with a non-symmetrical range (anisotropy) and, therefore, were suitable for the kriging method. The Hog Island Inlet sediment confirmation data was block kriged based on the average log-transformed TPAH for each RMU. The block kriged concentration contours are illustrated in Figure 8.1. Based on this method of evaluation, the average concentration for each RMU was at or below 0.9 mg/kg TPAH, indicating that the initial round of excavation successfully removed the contaminated sediment.

8.1.3 Additional Samples Collected

The two post-inundation samples were collected to verify that a flood event did not contaminate the site. The third sample collected from the access road served as a check to make sure that the haul road was not adversely affected by either the flood or the truck movement. The decision rules for the site stipulated that additional remedial activities would be warranted if the TPAH concentrations exceeded 7.5 mg/kg. The same criteria apply to the post-inundation and rock haul road samples to validate that recontamination did not occur in the previously extracted areas. The concentrations measured in these samples were below the target level and remedial activity was not required.

8.2 ACHIEVEMENT OF STUDY OBJECTIVES

Project objectives included removing contaminated sediments with TPAH concentrations above 2.6 mg/kg in the inlet and above 7.5 mg/kg in Segment L of Newton Creek and restoring the site to preconstruction conditions. Sediment confirmation sampling in the creek verified that final concentrations in Segment L were well below the 7.5 mg/kg target level for a single sediment sample. Sediment confirmation sampling in the inlet demonstrated that contaminated sediments containing TPAH concentrations above 2.6 mg/kg were successfully removed.

Post remediation data collected from the site was compared to the investigation that formed the basis of the remedial design. Despite differences in the objectives and design of each event (e.g., the pre-remediation studies were intended to characterize the horizontal and vertical distribution of sediments whereas the post-remediation studies examined the horizontal distribution of surficial sediments only), it is possible to estimate the effectiveness of the remedial action by using the available data to estimate the contours of contamination before and after remediation. Contours of the original TPAH concentrations were generated from point-kriged averages of the pre-remediation study data and are shown in Figure 8.2.[1] Contours of the TPAH concentrations after remediation shown in Figure 8.3. These contours were generated using the same point-kriging approach but with data from 42 samples collected to confirm successful removal of the

[1] Point-kriging uses the sample concentrations at individual point locations to estimate the concentrations across the site based on spatial and statistical relationships between the points. This differs from block kriging, which uses the sample concentrations for RMUs as the basis for deriving the contours. Block-kriging addresses the DQOs that called for determining achievement of target levels as an average for each RMU.

contaminated sediments. Together, Figures 8.2 and 8.3 illustrate the extent of contamination removed from the inlet, and clearly show the elimination of localized hot spots as well as a widespread reduction across the inlet.

Finally, a t-test was conducted to confirm that the mean of the TPAH concentration in the inlet was below the 2.6 mg/kg target level. Because the sediment confirmation data were found to be log-normal, the analysis was conducted using log-normal statistics. Based on this analysis, the concentration of TPAH in the inlet was determined to be below 2.6 mg/kg with more than 95% confidence (i.e., the null hypothesis that the concentration was at or above 2.6 mg/kg was rejected with more than 95% confidence).

Once excavation was completed at the site, the rock haul road was removed and material was transported to the landfill for beneficial use. Site restoration included backfill of the excavated creek channel with breaker run and streambed stone, installation of coir roll at the stream/bank interface, vegetation of the creek bank and inlet shoreline, re-vegetation of the disturbed areas and replacement of cleared trees and bushes. Additional activities are being planned to further restore the habitat in the immediate area and enhance the ecological health of the inlet and creek. These activities are discussed in Section 10.

Table 8.1 Total PAHs by Sampling Site.

Field Sample ID	TPAH (mg/kg)	Field Sample ID	TPAH (mg/kg)
B-1	0.10	B-26	0.28
B-2	0.27	B-27	0.44
B-3	0.18	B-28	0.65
B-4	0.15	B-29	0.05
B-5	0.06	B-30	0.58
B-6	0.09	B-31	0.78
B-7	0.05	B-32	0.49
B-7 FS	0.04	B-34	0.55
B-8	2.46	B-34 BS	0.37
B-8 FS	1.78	B-35	4.56
B-9	0.17	B-35 RE	1.41
B-10	0.23	B-37	0.52
B-11	0.13	B-40	0.82
B-12	0.07	B-42	0.50
B-13	0.92	B-42 FS	0.51
B-13 FS	0.04	B-43	0.71
B-14	0.04	B-43 FS	0.74
B-15	0.04	B-44	0.27
B-16	0.08	B-45	0.95
B-17	0.06	B-46	0.80
B-18	0.07	B-48	0.28
B-19	0.04	B-51	1.48
B-20	0.43	Between Trestles 0-6IN (Newton Creek)	2.90
B-22	0.15	80' S. Of Trestle 0-6IN (Newton Creek)	1.50
B-23	0.05	B-12 Post Inundation	0.05
B-24	0.08	B-16 Post Inundation	0.04
B-25	2.24	Access Road Clay	1.09

Total PAHs were calculated as the sum of the results for the 18 individual PAHs listed. Half of the reporting limit was substituted for non-detect values.

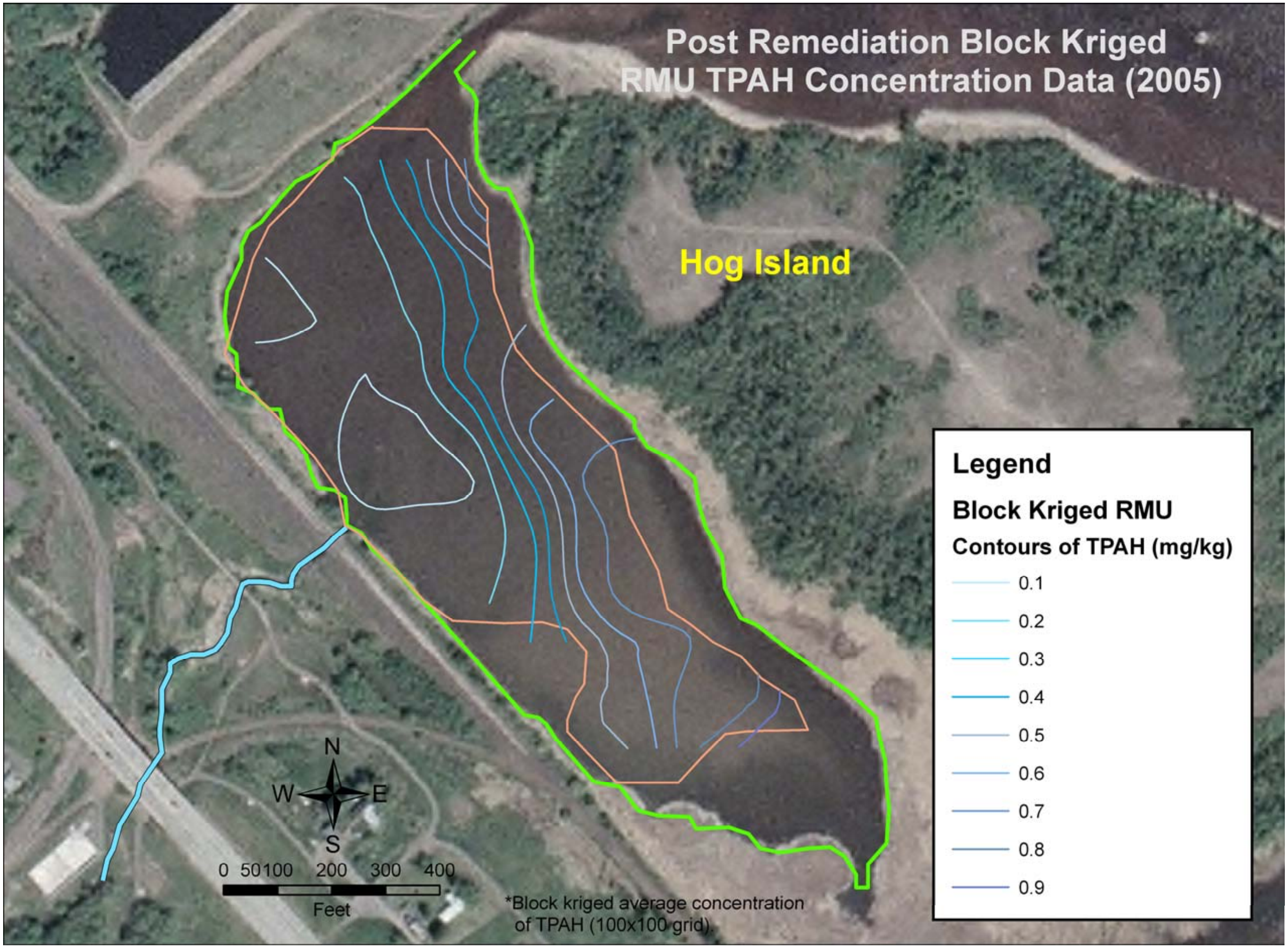

Figure 8.1 Block kriged average TPAH concentrations calculated using the RMU (100x100 blocks).

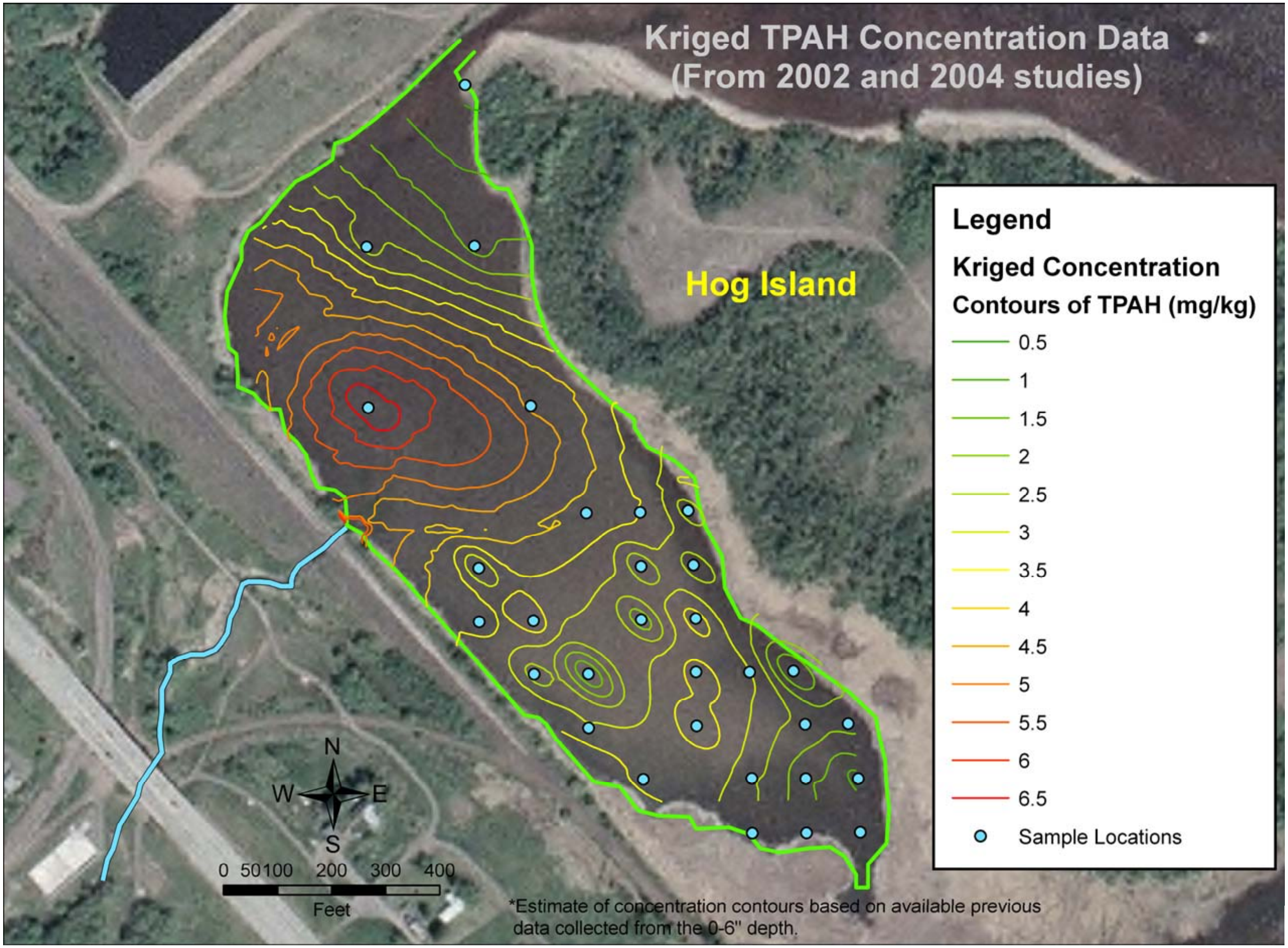

Figure 8.2 Previous study data point kriged across the inlet provides an estimate of TPAH concentrations.

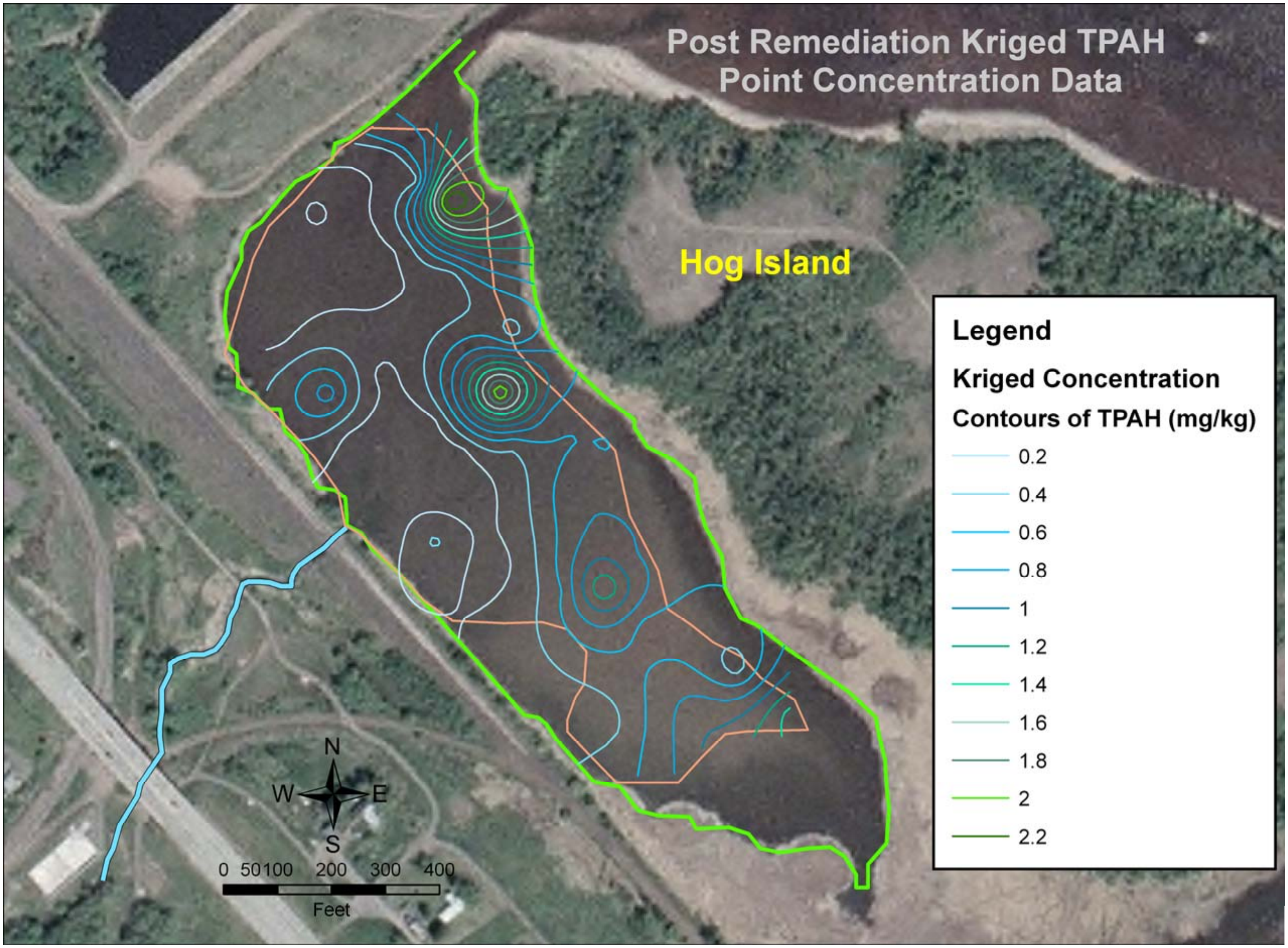

Figure 8.3 Post remediation point kriged average concentrations based on the individual sample concentrations.

8.3 QUALITY ASSESSMENT

A data quality assessment was conducted by evaluating several data quality attributes often termed PARCCS parameters (precision, accuracy, representativeness, completeness, comparability, and sensitivity). Quantitative data quality assessments were calculated based on sensitivity, precision, bias, and completeness. In addition qualitative assessments were determined for representativeness and comparability and are detailed below.

8.3.1 Sensitivity

Sensitivity was evaluated for Total PAHs by summing sample specific reporting limits of the 18 PAHs for each sample. Sample specific reporting limits ranged from 0.08 mg/kg to 0.262 mg/kg: all an order of magnitude or less than the project target level of 2.6 mg/kg for Total PAHs. Therefore, the resulting analytical sensitivity was deemed acceptable for the project.

8.3.2 Precision

System precision (field and analytical precision) was estimated as the pooled relative percent difference (RPD) between the results for field splits. Similarly, analytical precision was estimated as the pooled RPD between the results for the matrix spike/matrix spike duplicate (MS/MSD) samples. The pooled RPD was determined by calculating the square root of the mean of the individual squared RPDs between duplicate pair results. Precision is summarized in Table 8.2.

Pooled field split RPDs ranged from 9% for acenaphthylene to 68% for 1-methylnaphthalene. The median of the analyte-specific pooled field-split RPDs was 34%. The pooled MS/MSD RPDs ranged between 9% (for Benzo[g,h,i]perylene and Indeno[1,2,3-cd]pyrene) and 19% (for 2-Methylnaphthalene), with a median pooled RPD of 12%. Variability of laboratory control sample/laboratory control sample duplicates (LCS/LCSD) pairs also can be used to evaluate precision and do not reflect matrix effects that are reflected in field splits and MS/MSDs. Variability of LCS/LCSD pairs was similar to that of the MS/MSD pairs, with a range of 4% (for 6 analytes) to 17% (for acenaphthylene), with a median of 6%. The higher RPDs of the field splits suggest that sampling variability was much larger than analytical variability. However, it is worth noting that the field splits tended to be at lower concentrations than the spiked samples, and that RPDs tend to decrease with increasing concentration.

In addition to the quantitative data quality assessment of the individual PAHs, an assessment was performed on the total PAH results determined by calculating the sum of the individual PAH results for each sample. RPDs for the different QC samples were calculated as the RPD between the sums of the individual PAH results for the given sample pair. The total PAH pooled RPD among all field splits was 85%, greater than those of the individual PAH parameters. However, the analytical variability was much lower, and comparable to those of the individual PAH parameters, with pooled RPDs of 11% and 6% for the MS/MSD pairs and LC/LCSD pairs, respectively.

8.3.3 Bias

Bias was estimated for each analyte as mean percent recovery for MS/MSD samples. Bias is summarized in Table 8.2. Mean percent recoveries ranged from 70% for benzo[g,h,i]perylene to 101% for benzo[b]fluoranthene. There was a slight low bias for some of the analytes, including benzo[g,h,i]perylene and Indeno[1,2,3-cd]pyrene; however, the mean percent recovery was at least 90% for 14 of the 18 PAH parameters.

In addition to the quantitative data quality assessment of the individual PAHs, an assessment was performed on the total PAH results determined by calculating the sum of the individual PAH results for each sample. A total PAH percent recovery for each MS and MSD sample was calculated by dividing the sum of all 18 PAH results for that sample, divided by the sum of the spike levels of all PAH results for that sample. The mean percent recovery for Total PAH was 96%, comparable to the individual PAH recoveries.

Table 8.2 Quantitative Data Assessment.

Parameter	Precision			Bias
	System	Analytical		Analytical
	Field Splits Pooled RPD (%)[1]	MS/MSD Pooled RPD (%) n = 7 pairs	LCS/LCSD Pooled RPD (%) n = 11 pairs	MS/MSD Mean Recovery (%) n = 14
1-Methylnaphthalene	68 (n = 5)	18	12	95
2-Methylnaphthalene	66 (n = 5)	19	12	95
Acenaphthene	9 (n = 1)	11	14	91
Acenaphthylene	38 (n = 1)	11	17	94
Anthracene	28 (n = 4)	12	6	95
Benz[a]anthracene	39 (n = 4)	11	5	94
Benzo[a]pyrene	35 (n = 4)	11	4	95
Benzo[b]fluoranthene	27 (n = 4)	13	7	101
Benzo[g,h,i]perylene	36 (n = 4)	9	4	70
Benzo[k]fluoranthene	33 (n = 4)	12	4	92
Chrysene	18 (n = 4)	13	4	92
Dibenz[a,h]anthracene	35 (n = 2)	10	4	90
Fluoroanthene	37 (n = 4)	15	5	86
Fluorene	32 (n = 3)	11	12	99
Indeno[1,2,3-cd]pyrene	40 (n = 4)	9	4	82
Naphthalene	28 (n = 4)	15	11	86
Phenanthrene	26 (n = 4)	13	7	92
Pyrene	23 (n = 4)	12	5	96
Total PAH[2]	85 (n = 5)	11	6	96

[1] Only pairs where analyte was detected in both samples were used in this assessment
[2] Total PAHs were calculated as the sum of the results for the 18 individual PAHs listed. Zero was substituted for non-detect values.
RPD - relative percent difference

8.3.4 Completeness

Completeness was measured as the number of samples successfully analyzed and reported compared to the number that were scheduled to be collected. The completeness of the data generated for this project was 100%. All of the samples specified in the project design for collection in the inlet and Segment L of Newton Creek were successfully collected and analyzed. As specified in the QAPP, when sampling locations specified in the design were not accessible, the samplers used best professional judgment to select new locations that were as close as possible to the original location. These changes did not impact the usability of the sediment confirmation results.

8.3.5 Representativeness

Representativeness is the degree to which data accurately and precisely represents characteristics of a population, parameter variations at a sampling point, a process condition, or an environmental condition. The sampling design generated for the study was a systematic random design. This design ensures coverage of the site, but includes a random component to provide an unbiased estimate of chemical occurrence and concentration. This design is useful for determining concentrations of chemicals of potential concern in soil and sediment (EPA, 1992). The sampling confirmation design was statistically based and generated according to EPA's DQO process that facilitates development of appropriate decision criteria and optimized sampling designs.

8.3.6 Comparability

Comparability is the confidence with which one data set can be compared to other data sets. In order to meet project objectives, the sediment confirmation data did not need to be compared to other data sets. For future projects or other data uses, it is important to note specific information regarding the generation of these data. For example, the data were generated for surficial sediments and the analytical method focused on Total PAHs, calculated as the sum of 18 individual PAHs.

9.0 PROJECT SUCCESSES AND CHALLENGES

The remedial action of Hog Island Inlet and Segment L of Newton Creek included diverting water from the creek, confining the inlet, excavating contaminated sediments, disposing of the contaminated sediments, and conducting sediment confirmation sampling. Several components of the project were found to be notably challenging, including;

- Lateral flow of groundwater into the inlet despite the installation of the sheet piling wall
- Flooding event from October 3 to 7, 2005
- High liquid sediments

Several of the activities undertaken to complete the remedial action were especially successful.

- The coordination between all parties highlighted by weekly progress conference calls. This venue allowed for progress to be reported as well as resolving problems encountered.
- The upfront sampling and analysis of the contamination that allowed for very precise removal of the contaminated sediments.
- The sheet piling wall that was installed at the site to confine the inlet after diverting the creek.
- Contaminated sediments were removed.
- Swamp mats were used below the backhoes to keep them from becoming mired in the high liquid sediments.
- Diversion trench was installed along the southwest shoreline of Hog Island to intercept the lateral flow of groundwater into the excavation area.

The removal of contaminated sediment from Hog Island Inlet and Newton Creek Segment L significantly reduces ecological and human health risks at the site and limits future contamination of St. Louis River.

10.0 FUTURE OF THE SITE

The Hog Island Inlet is a recreational resource to the community as well as a diverse, productive, and healthy ecosystem. The footpath is used by many for outdoor activities including biking, walking, and jogging. GLNPO is working with the local governments in developing an initiative to conduct additional habitat restoration of the Hog Island Inlet area.

Post remediation monitoring is being conducted to determine the adequacy of the contaminant removal and to evaluate the restoration and health of the aquatic system habitat.

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