FINAL

ECOLOGY TOXICS CLEANUP PROGRAM

EPA BROWNFIELDS PROGRAM

WORK PLANS

Little Squalicum Park Remedial Investigation/ Feasibility Study Bellingham, WA

Prepared for
City of Bellingham
Parks & Recreation Department
3424 Meridian Street
Bellingham, WA 98225

Prepared by
integral consulting inc.

1201 Cornwall Avenue, Suite 208
Bellingham, WA 98225

September 30, 2005

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EXECUTIVE SUMMARY

This Work Plan describes the activities that will be undertaken by Integral Consulting to conduct a remedial investigation and feasibility study (RI/FS) for Little Squalicum Park (the Park), located in Bellingham, Washington. The Work Plan includes project objectives and describes a project strategy to address these objectives. The Work Plan also describes the project background, regulatory framework, project schedule, reporting requirements, and project team and responsibilities. Elements and design of the RI/FS are detailed in the accompanying sampling and analysis plan (SAP), quality assurance project plan (QAPP), and health and safety plan (HASP). The Work Plan and accompanying SAP, QAPP and HASP have been prepared in general accordance with an *Agreed Order* negotiated between the City of Bellingham and the Washington State Department of Ecology and finalized on March 22, 2005.

The primary objectives of the RI/FS are to provide critical data necessary to understand the nature and extent of environmental problems at the Park, to assess potential risk to human health and the environment, to determine if cleanup actions are required, and to determine how these actions may be accomplished as part of specific wildlife enhancement and park development actions. These objectives will be met by sampling soil, groundwater, surface water, and sediments and evaluating the results with historical data.

The SAP presents an evaluation of data quality and usability for eight historical studies conducted within the boundaries of the Park. A five-step data quality objective (DQO) process was used to identify the adequacy of existing data and the need for additional data, to develop the overall sampling approach to each study element, and ultimately to develop the field sampling plan. The results of this review indicate the following spatial and temporal data gaps for the site:

- No recent soil data are available for the gravel pit areas on the south side of the Park, and only limited data are available in the vicinity of the Burlington Northern Santa Fe (BNSF) railroad tracks. Soil sampling at depth in these areas is necessary because of the possibility of rerouting the creek into these areas.
- Groundwater does not appear to be a medium of primary concern at the Park based on previous sampling and testing results. No additional wells are proposed within the boundaries of the Park. However, additional groundwater sampling of wells located downgradient of the OESER Company (OESER) site is warranted to provide current data verifying that groundwater is not a medium of primary concern.
- Data gaps for surface water are primarily temporal. Contaminant concentrations in the surface water of the creek are expected to vary over time, because of variable inputs from upstream sources and the discharges from Marine Drive, OESER, Bellingham Technical College, and the Birchwood neighborhood.

Additional surface water sampling is warranted to provide current data, focusing on discharge areas and identification of sources.

- Sediment concentrations in the creek are expected to vary to some extent over time because of interactions with surface water; therefore, historical data may not be entirely representative of current sediment conditions. Historical sediment sampling has covered most of the length of the creek, but it has not characterized the depth or width of the contaminated sediments. These spatial issues will be important in determining a requirement for sediment remediation.

The proposed sampling and testing program design includes stratification and tiering. Stratification places a greater density of sampling locations in areas for which little or no historical data are available. For example, additional soil samples are proposed in areas of the site where gravel mining was historically conducted but where few samples have been collected and analyzed in previous investigations. Tiering will be used to determine whether certain types of analyses will be necessary based on the results of initial sampling and testing. For example, if a surface sediment sample exceeds a chemical screening level, additional testing may be conducted on that sample and samples at greater depth for that location. An adequate volume of sample will be archived for each sample depth to allow analysis of all analytes for a given medium. The tiered sampling and testing approach will reduce the cost of conducting unnecessary sample analyses and may avoid the time and expense for remobilization to collect additional samples at a later date.

One prehistoric archaeological site (a shell midden) has been identified in the Little Squalicum Creek ravine and it is possible that additional sites could also be present. The presence of a potentially significant archaeological site requires that cultural resources be addressed before starting any intrusive sampling activities. These resources will be addressed using a staged approach. The cultural resource management activities planned for the Park RI/FS may have as many as three stages: 1) inventory of impact areas, 2) evaluation of the identified resources, and 3) development and implementation of a management plan.

The QAPP provides detailed direction to the analytical laboratories on analytical methods, data quality objectives, sample custody, quality assurance/quality control procedures, data deliverables, data management and reporting. The QAPP is provided to office personnel and each analytical laboratory.

The HASP describes the procedures and equipment that will be used to protect the health and safety of project staff and the public during sampling. The HASP identifies chemical and physical hazards, types of work zones, protective equipment and procedures, responsible individuals, and an emergency plan.

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ACRONYMS AND ABBREVIATIONS

ARARs	Applicable or Relevant and Appropriate Requirements
ARI	Analytical Resources, Inc.
BNSF	Burlington Northern Santa Fe Railway
BTC	Bellingham Technical College
CMT	Coast Millennium Trail
Creek	Little Squalicum Creek
DQO	data quality objectives
Ecology	Washington State Department of Ecology
EIM	Environmental Information Management
EPA	U.S. Environmental Protection Agency
FCR	Field Change Request
HASP	health and safety plan
MTCA	Model Toxics Control Act
NAS	Northwest Aquatics Services, Inc.
OESER	OESER Company
Park	Little Squalicum Park
PLP	potentially responsible party
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RI/FS	remedial investigation and feasibility study
SAP	sampling and analysis plan
SHA	site hazard assessment
SMS	Washington State Sediment Management Standards
SOPs	standard operating procedures
SOW	Statement of Work
SQVs	Sediment Quality Values
STL	Severn Trent Laboratories
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act
WQC	water quality criteria

1 INTRODUCTION

This document is the Work Plan for the remedial investigation and feasibility study (RI/FS) of Little Squalicum Park (the Park) located in Bellingham, Washington (Figure 1-1). The Work Plan describes the project management strategy for implementing and reporting on RI/FS activities for the site, including a description of individual RI/FS tasks and subtasks. The Work Plan also describes the RI/FS schedule, project team, project responsibilities, and reporting requirements. Elements and design of the RI/FS are detailed in the sampling and analysis plan (SAP) and quality assurance project plan (QAPP), which also describe specific field and laboratory procedures, respectively.

Integral Consulting Inc. (Integral) is conducting this work under contract No. 2004-014 with the City of Bellingham, Parks and Recreation Department (City), with direction from the Washington State Department of Ecology (Ecology) Toxics Cleanup Program and the U.S. Environmental Protection Agency, Region 10 (EPA) Brownfields Program.[1] This Work Plan has been prepared in general accordance with an *Agreed Order* and Statement of Work (SOW) negotiated between the City and Ecology on March 22, 2005 (Document No. DE 2016). The *Agreed Order* and SOW are presented in Attachment A of this Work Plan.

This Work Plan meets the requirements of the EPA Brownfields Program and represents an expanded revision of the August 26, 2004 interim version originally prepared for EPA (City of Bellingham 2004). The *Cooperative Agreement* between the City and EPA dated September 16, 2003 is presented in Attachment B of this Work Plan.

Several documents are cited repeatedly and accompany this Work Plan. Altogether, these documents are referred to as the Work Plans for the Park RI/FS:

- *Sampling and Analysis Plan for the RI/FS of Little Squalicum Park, Bellingham, Washington.* The SAP describes the sampling strategy and design to meet the data needs of the RI/FS and provides specific guidance for field methodology and quality assurance procedures that will be followed by Integral and its subcontractors.
- *Quality Assurance Project Plan for the RI/FS of Little Squalicum Park, Bellingham, Washington.* The QAPP describes laboratory methodology and quality assurance/quality control (QA/QC) procedures that will be used to complete the RI/FS for the Park site.
- *Project Health and Safety Plan, Little Squalicum Park RI/FS, Bellingham, Washington.* The HASP has been prepared in conformance with Integral’s Health and Safety

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[1] Funding for this work was received by the City of Bellingham (2004) from the EPA Brownfields Program. Additional funding is expected from the Ecology Remedial Action Grant Program (City of Bellingham 2005).

Plan guidelines and in accordance with Washington Administrative Code (WAC) 173-340-810, applicable Washington Industrial Safety and Health Act (WISHA) regulations, and project requirements. It addresses those activities associated with work to be performed in the Park.

- *Integral Standard Operating Procedures* (SOPs). These numbered documents provide specific, detailed information on conducting routine, repetitive field techniques (e.g., split-spoon sampling from a drill rig). These documents are found in Appendix A of the SAP.

1.1 PROJECT BACKGROUND

Little Squalicum Park consists of 32 publicly owned acres located within the Birchwood neighborhood and adjacent to Bellingham Technical College (BTC) (Figure 1-1). Little Squalicum Creek (the Creek) and the Park are currently used for passive recreational activities and as wildlife habitat. Since the 1980s, development plans by the City have called for enhancing the passive recreational activities at the Park by constructing trail and park facilities, realigning the Creek inside the park, and enhancing fish and wildlife habitat. Two major trails have been improved and presently pass through the park on old railroad and road corridors. Since the 1990s, local, state, and federal funds have been budgeted, but development plans were put on hold due to concerns voiced by EPA, Ecology, Whatcom County Health Department, and the public that the creek and adjacent areas may be contaminated. Public investments have been limited to maintaining the major historic trails that have been used by the public for over 25 years.

In 2002, EPA completed an RI/FS for the OESER Company Superfund site located approximately 500 ft upgradient from the park (E&E 2002a, b). Portions of the Park area were included in that study. EPA reported to the City that they did not find contamination on park property that would require cleanup actions under the Superfund Program. Further, it would be the City’s responsibility to conduct additional environmental studies necessary for the proposed park development.

Significant questions regarding the nature and extent of contaminants on the site remain unanswered and overshadowed decisions to enhance and develop the park and trail system. EPA Superfund Program staff recommended that the City seek EPA Brownfields assessment funds for any additional investigation within the park boundaries.

The City applied for an EPA Brownfields assessment grant in 2002/2003. This additional funding was to be used to determine the nature and extent of contamination within the Park area as it related to actual park development plans. As part of the assessment, four potential sources of contamination would be investigated:

- Wastewater and stormwater discharges from the OESER Company

- Non-point stormwater discharges from the Birchwood neighborhood and Marine Drive
- Reported pesticide use along the Burlington Northern Santa Fe (BNSF) railroad right-of-way
- Former gravel mining in the creek ravine.

The City was awarded Brownfields assessment funding in September 2003. The *Cooperative Agreement* between the City and EPA is presented in Attachment B.

The assessment work funded under the EPA Brownfields grant specifically excludes portions of the site owned by the City. EPA has determined that environmental assessment work on City-owned properties extends beyond the granting authority of the Brownfields program. Consequently, the City must limit the use of the Brownfields grant funds to the properties in the project area that are not owned by the City, such as the properties owned by Whatcom County, Port of Bellingham, and BNSF (refer to Figure 1-1). Eligible properties represent approximately 65% of the designated park area with the remaining 35% area owned by the City and considered ineligible.

The Park was listed on Ecology's Confirmed and Suspected Contaminated Sites List on January 14, 2004. It had been listed earlier as part of the Oeser Company site, located upgradient from the proposed Park (Ecology 2004). Whatcom County Health and Human Services completed a site hazard assessment (SHA) of the Park site in February 2004, as required under the Model Toxics Control Act (MTCA). The site's hazard ranking, an estimation of the potential threat to human health and/or the environment relative to other Washington State sites assessed at that time, was determined to be a 1, where 1 represents the highest relative risk and 5 the lowest (Ecology 2004). Based on the results of the SHA, Ecology and the City elected to enter into an agreement for the development of an RI/FS pursuant to WAC 173-340-350 and WAC 173-204-560. Ecology recently negotiated an *Agreed Order* (DE-2016) with the City to conduct an RI/FS of the Park site (dated March 22, 2005). The *Agreed Order* and *SOW* are presented in Attachment A.

The RI/FS will include an assessment of all properties within the Park, both eligible and ineligible under the Brownfields grant. Consequently, the City needed to find other (non-EPA Brownfields) sources of funding to complete the project. In March 2005, the City applied for an Ecology Remedial Action Grant to complete the RI/FS tasks for this project. Ecology approved the grant application on April 27, 2005. The EPA Brownfields award will be the source of matching funds required under the Ecology grant.

1.2 REGULATORY FRAMEWORK

The RI/FS for the Park will be conducted under MTCA (WAC 173-340), which addresses identification and cleanup of contamination in soils, surface water, and groundwater. For contamination in sediments, MTCA refers to the Sediment Management Standards (SMS) (WAC 173-204), which includes standards for marine sediments. Since standards for freshwater sediment are "Reserved" under WAC 173-204-340, the City has been coordinating with Ecology during the development of these project work plans in order to clarify site-specific requirements.

Additional regulations that are Applicable or Relevant and Appropriate Requirements (ARARs) include the following:

- Federal Clean Water Act and National Toxics Rule [40 Code of Federal Regulations (CFR) 131], which provide water quality criteria (WQC) for protection of human health and aquatic organisms
- Water Quality Standards for Surface Water of the State of Washington (WAC 173-201A), which also provides WQC for protection of aquatic organisms
- Ecology's (2003) Freshwater Sediment Quality Values (SQVs), which cover contamination of freshwater sediments. The SQVs are currently guidelines and do not replace bioassays as the definitive determination of sediment toxicity.
- Federal Safe Drinking Water Act (40 CFR 141), which provides maximum contaminant levels (MCLs) for protection of drinking water
- Washington State Department of health rules for Public Water Supplies (WAC 246-290-310), which also provides MCLs.

EPA's (1990) guidance on soil cleanup levels for PCBs could be an ARAR, although PCBs are not anticipated to be a chemical of concern in the Park. The Federal and State MCLs are listed as ARARs pending further investigation, which might conclude that hydrologic connections with Bellingham Bay render the groundwater unsuitable for drinking. Additional regulatory values used for screening data are discussed in the SAP.

MTCA addresses sites with contaminated soils, groundwater, or surface water in Washington State. The regulation establishes a process for managing contaminated sites, from the discovery phase through cleanup. The RI/FS, for which this Work Plan is designed, generates the data necessary to confirm whether the site requires cleanup and to design the cleanup action (if necessary). If it is determined during the RI/FS that cleanup is warranted, the next step is to develop a cleanup action plan that must comply with several requirements, including protection of human health and the environment, compliance with cleanup standards and ARARs, and provisions for compliance monitoring. The cleanup phase involves design, construction, operation, and monitoring of cleanup activities. At the Park, the cleanup phase would likely be performed in conjunction with park enhancement activities.

The SMS establish standards for the quality of surface sediments, apply those standards as the basis for management and reduction of pollutant discharges, and provide a management and decision process for the cleanup of contaminated sediments. Part V of the SMS, Sediment Cleanup Standards, establishes procedures and criteria to identify, prioritize, and clean up contaminated surface sediment sites.

1.3 WORK PLAN ORGANIZATION

The remaining sections of this Work Plan include the following sections and two appendices:

- **Section 2: Project Objectives.** Identifies the major project objectives for the RI/FS and the redevelopment of the Park.
- **Section 3: Project Management Strategy.** Describes the project tasks and subtasks for the RI/FS and the proposed schedule to complete these tasks.
- **Section 4: Project Team and Responsibilities.** Identifies the organizations and key individuals that will oversee and implement the RI/FS, along with their respective responsibilities.
- **Section 5: References.** Provides full citations for all references cited in the Work Plan.
- **Attachment A: Agreed Order – Little Squalicum Park – Signed March 2005.** Presents a copy of the *Agreed Order* and *SOW* negotiated between the City and Ecology.
- **Attachment B: Cooperative Agreement – EPA Brownfields Program.** Presents a copy of the *Cooperative Agreement* negotiated between the City and EPA.

Map Document: (C:\GIS\Projects\LittleSqualcumCr\Sample_Locations_Photo_w_Ownship_fix.mxd)
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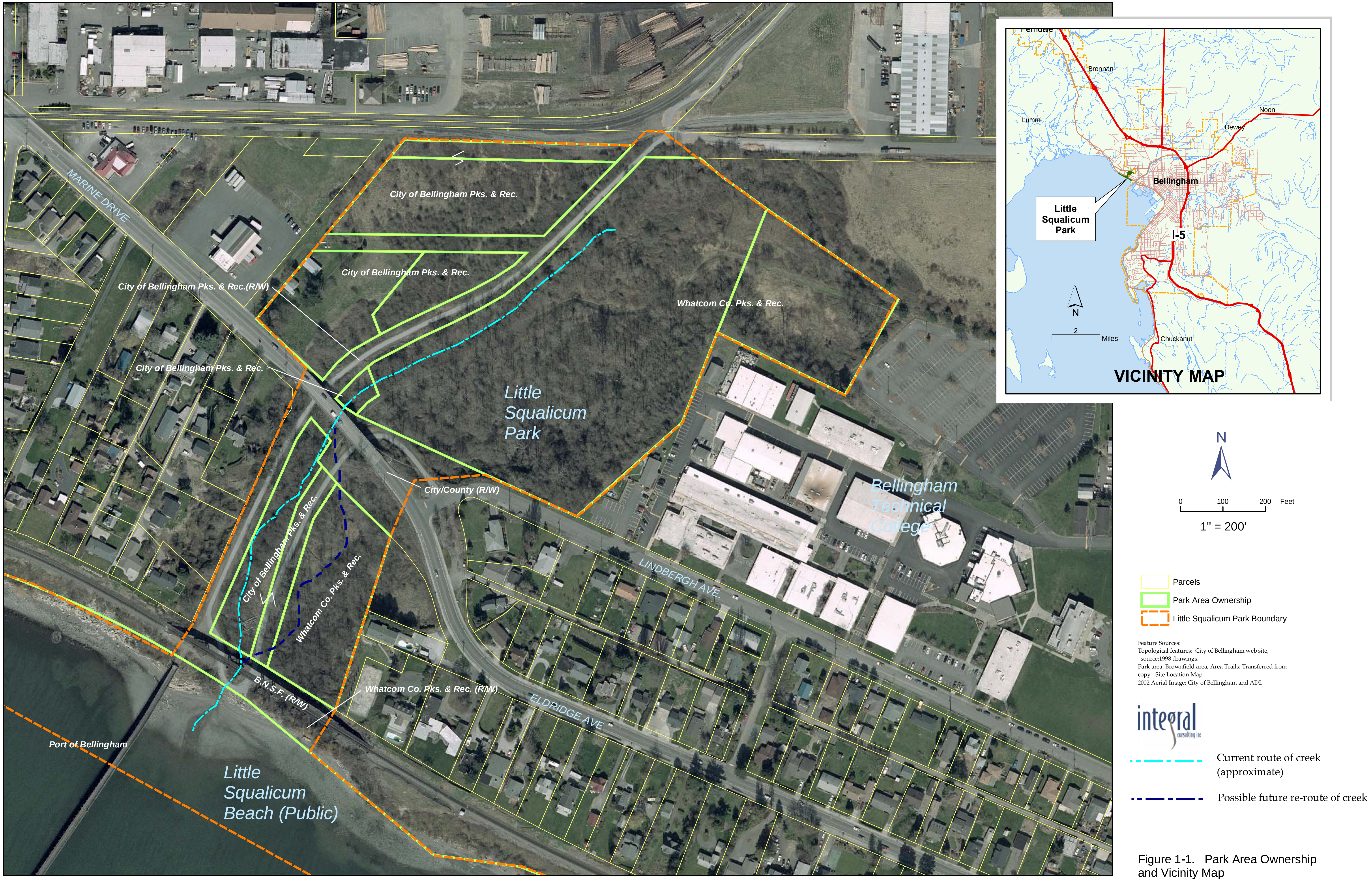

Feature Sources:
Topological features: City of Bellingham web site,
source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from copy - Site Location Map
2002 Aerial Image: City of Bellingham and ADI.

Figure 1-1. Park Area Ownership and Vicinity Map

2 PROJECT OBJECTIVES

This section of the Work Plan presents major project objectives for the RI/FS and potential redevelopment of the Park. The RI/FS is intended to provide sufficient data, analysis, and evaluations to enable Ecology to select a cleanup action alternative for the site (refer to the *Agreed Order* and Statement of Work in Attachment A). The selected cleanup action will be coordinated with potential redevelopment of the Park. Project objectives include the following:

- Provide critical data necessary to understand the nature and magnitude of environmental problems at the site, to determine if cleanup actions are required, and to determine how these actions may be accomplished along with specific wildlife enhancement and park development actions
- Provide pre-remedial design data, evaluate these data, develop and evaluate potential remediation alternatives, and generate final design/cleanup recommendations
- Provide a preferred remedial alternative in which the area can be cleaned up and, potentially, site redevelopment objectives can be achieved
- Inform the landowners (BNSF Railway and Whatcom County), stakeholders, and the public of the results of assessment work and solicit comments regarding the remediation of environmental problems and redevelopment of the area
- Provide information for decision-making by the City, landowners, stakeholders, and the public as a framework to future decision-making for anticipated upgrades to park facilities and trail construction
- Support the City's cost-recovery efforts including the identification of any additional potentially responsible parties (PLPs) in order to facilitate their participation in the process.

The questions under study are three-fold. First is the nature and extent of contamination. Second is whether the contamination presents a threat to human health and/or the environment. Third is how it might be remediated so that humans and wildlife can use the Park safely. It is possible that some media (e.g., surface water and sediments) might pose a threat while other media (e.g., soils and groundwater) do not. The threat might be to humans, ecological receptors, or both.

The nature and location of the threat would indicate the appropriate response action(s). For example, if contaminant concentrations in sediments in the Creek posed a threat to aquatic receptors in the creek, but contaminant concentrations in soils south of the creek did not, the creek could be rerouted along a more southern route (refer to Figure 1-1). If contaminant concentrations in the old creek bed posed a threat to human health or the terrestrial environment, the old sediments could be removed or covered to control exposures. Therefore, the RI/FS will include the collection and analysis of data adequate to evaluate these and other possible remedial alternatives within the Park.

Details on specific data quality objectives (DQOs) for the RI/FS of the Park are presented in the accompanying QAPP.

3 PROJECT MANAGEMENT STRATEGY

Characterization of environmental conditions in the soils, groundwater, surface water, and sediments is required for the Creek and the ravine before redevelopment begins in the Park. The RI/FS must examine current and future risks to workers, the general public, and the environment. A brief description of each of the proposed tasks under this work plan, followed by the proposed project schedule to complete these tasks, is provided below.

3.1 RI/FS TASKS

The following task and subtask descriptions are planned for the Park RI/FS. These tasks will be completed as required by the *Agreed Order* and SOW negotiated between the City and Ecology on March 22, 2005 (Attachment A) and the *Cooperative Agreement* with the EPA Brownfields Program dated September 16, 2003 (Attachment B).[2]

3.1.1 Task 1 – Project Planning and Management

Activities under this task include administration and management of the project, including establishment and maintenance of necessary files and records required under the *Agreed Order* with Ecology and the *Cooperative Agreement* with EPA; performance of administration functions; support of activities necessary to perform the project in accordance with this work plan and all required statutes, circulars, terms & conditions; and attendance at necessary project meetings. City staff will submit bi-monthly and final reports, manage the consultant contract, and coordinate with cooperative partners (Ecology and EPA), stakeholders, the public, and with other City departments. City staff will also provide outreach to area stakeholders in coordination with Ecology as outlined in the Public Participation Plan (Exhibit C to the *Agreed Order*). As per the *Agreed Order*, Ecology maintains the responsibility for public participation at the site.

The project management approach will ensure timely submission of high-quality documents by adhering to the schedule discussed in Section 3.3 and by using rigorous document quality control procedures. Regular contacts within the project team will ensure that the schedule is maintained and that, if unforeseen conditions necessitate changes to the schedule, the project team is apprised so it can respond accordingly. The draft Work Plans and RI/FS document will undergo internal quality control review by the consultant as well as public and stakeholder review. Responses to public and stakeholder comments will be provided in a responsiveness summary to be included in a stand-alone

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[2] This revised Work Plan meets the requirements of both the *Agreed Order* with Ecology and the *Cooperative Agreement* with EPA Brownfields program (City of Bellingham 2004). Task numbers and titles have been unified for consistency purposes.

document. A responsiveness summary is a summary of oral and/or written public comments received by Ecology during a comment period on key documents, and Ecology's responses to those comments (refer to the PPP in Attachment A for details).

The following two key subtasks will be completed as part of this task:

Subtask 1a – Project Management. The Integral project manager will support the City project manager in completing project progress reports and other administrative functions required under the *Agreed Order* and the *Cooperative Agreement* during Integral's period of performance.

Subtask 1b – Public Participation. Planning documents and investigation reports will be made available to the public for review and comment. The draft *Agreed Order* and public participation plan were made available for public review and comment in January/February 2005. Two public information meetings are scheduled during the RI/FS (refer to Section 3.3). The first public information meeting will be held to present the draft final Work Plans for the site, including the Work Plan, SAP, QAPP, and HASP. A draft RI/FS will be presented at the second public information meeting. The draft documents will be made available for review prior to and after the meetings. The meetings will be conducted in a manner to encourage substantive discussion and meaningful public input. Verbal and written comments on the documents will be accepted from the public, and responses will be incorporated into a responsiveness summary. In the event that significant changes are made to either document as a result of the public comments, the draft document could be reissued for another round of review and comments prior to finalization.

3.1.2 Task 2 – Work Plan

This document fulfills the requirements of Task 2, including an overall description and schedule of RI/FS activities, a description of project management strategy, and explanation of responsibility and authority of organizations and key personnel (see requirements of the *Agreed Order* in Attachment A).

3.1.3 Task 3 – Sampling and Analysis Plan (SAP)

The SAP provides specific guidance for field methodology and quality assurance procedures. A QAPP and HASP will also be submitted as companion documents to the SAP. Details of these plans are provided below.

The SAP has been prepared in accordance with WAC 173-340-820, WAC 173-204-600, and the Sediment Sampling and Analysis Appendix, as updated (Ecology 2003). The purpose of the SAP is to provide an overview of the RI sampling program that will obtain information needed to meet the data needs for the RI. The SAP describes the sampling objectives and the rationale for the sampling approach. A detailed description of sampling tasks is provided, including specifications for sample identifiers; the type, number, and location of samples to be collected; the analyses to be performed; descriptions of sampling equipment and collection methods to be used; description of sample documentation; sample containers, collection, preservation and handling. The SAP also describes sample custody and handling procedures, decontamination procedures, and the handling of investigative-derived wastes. Sampling methodology and QA requirements have been developed in accordance with Ecology guidance and the requirements of the Puget Sound Estuary Program (PSEP 1986, 1997a, b, c).

The QAPP identifies and describes laboratory methods and the QA/QC measures that will be implemented during the performance of all sampling and analysis tasks to ensure the fulfillment of project DQOs. Laboratory methodology and QA/QC requirements have been developed in accordance with Ecology and EPA guidance, and the requirements of the Ecology Laboratory Accreditation Program and PSEP (1986, 1997a, b, c).

A HASP has been prepared in accordance with WAC 173-340-810. The HASP is consistent with the requirements of WISHA of 1973, RCW 49.17. The HASP identifies specific monitoring and management responsibilities and activities to ensure the protection of human health activities associated with the RI.[3]

3.1.4 Task 4 – Remedial Investigation

The City will conduct an RI to delineate the area requiring cleanup and to identify sources that may need to be eliminated or reduced as part of the cleanup. Key components of the RI are as follows:

- Determination of nature and extent of contamination exceeding MTCA and the SMS standards
- Assessment of potential human health and ecological health concerns
- Characterization of natural resources
- Evaluation of source control and recontamination.

Three key subtasks will be completed under this task:

Subtask 4a – Field Work. This subtask encompasses all the labor, equipment, and supplies to complete all field work in support of the RI. Field work will include sampling groundwater, soil, and surface water and sediments in the Creek. A detailed description of the field tasks is presented in the project SAP. Workers in the field will follow health and safety procedures documented in the project HASP.

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[3] The HASP is not subject to Ecology or EPA approval.

Subtask 4b – Testing. This subtask includes chemical, biological, and physical testing of samples collected in support of the RI. A detailed description of laboratory methodology and QA/QC procedures is presented in the project QAPP.

Subtask 4c – RI Report*.* The RI report is outlined in Section 3.2.

3.1.5 Task 5 – Feasibility Study

The City will use the information obtained in the RI to conduct an FS. The FS will include the following components:

- Determination of cleanup standards and applicable laws
- Identification and screening of cleanup technologies
- Basis for assembly of cleanup action alternatives
- Description of cleanup alternatives
- Comparative evaluation of cleanup alternatives.

3.2 RI/FS REPORT OUTLINE

A draft RI document will be completed (refer to project schedule in Section 3.3). After an initial review by Ecology and EPA, the RI will be combined with the draft FS into a draft final RI/FS document for stakeholder and public review before the completion of the final RI/FS. A draft outline for the RI/FS document is presented below (from Ecology 2003, 1991).

Section 1.0	**Site Description** (includes operational and regulatory history, contaminants of concern, location, and detailed site maps)
Section 2.0	**Physical Characteristics** (hydrology and geology of surface water, groundwater, sediment, and upland areas associated with the site, including hydrogeologic cross-sections and water table contour maps)
Section 3.0	**Chemical and Biological Characteristics** (an evaluation and analysis of all contaminant data from previous studies and the RI, including sampling and testing methods, concentration contour maps [vertical and horizontal], biological effects data, discussion of historical and ongoing sources, potential for contaminant migration, potential for natural recovery, and other pertinent data for environmental media at the site)
Section 4.0	**Conceptual Site Model** (includes sources, transport pathways, potential receptors, and exposure pathways)

Section 5.0	**Development of Proposed Cleanup Standards** (cleanup levels [including ARARs and background levels], Indicator Hazardous Substances, points of compliance for each medium)
Section 6.0	**Recommended Remedial Action Objectives**
Section 7.0	**Development and Screening of Cleanup Alternatives** (description of technologies that were reviewed as part of the development of cleanup action alternatives)
Section 8.0	**Identification of Preferred Cleanup Action Option(s)**
Section 9.0	**References**
Appendix A	**Field Logs and Information** (includes all sampling logs, photographic record, etc.)
Appendix B	**Chemical, Biological and Physical Testing Results** (includes QA/QC data reviews, discussion and recommendations)
Appendix C	**Data Screening Backup**
Appendix D	**Screening of Technology Data**

In addition to a written RI/FS report, all chemical, biological, and physical data will be submitted to Ecology in electronic SEDQUAL and Environmental Information Management (EIM) formats.

3.3 PROJECT SCHEDULE

The schedule for all tasks described in Section 3.1, including major milestones, is summarized in Table 3-1. The project milestones are linked to the project objectives and measures of success as described below. As previously stated, the City and Ecology entered into an *Agreed Order* on March 22, 2005, which represents the first major milestone for the project (Task 1b). A basic schedule for the project is outlined in the *Agreed Order* Exhibit B (Scope of Work) and includes the following:

RI/FS Actions	Completion Time
Draft RI/FS Work Plan, SAP, QAPP, and HASP	60 days from effective date of Agreed Order
Draft Final RI/FS, Work Plan, SAP, QAPP, and HASP	30 days from receipt of Ecology comments on Draft RI/FS Work Plan, SAP, and QAPP
Public Review of Draft Final Work Plan, SAP, QAPP, and HASP	30 days minimum
Final Work Plan, SAP, QAPP, and HASP	30 days from the close of public comment period
Draft RI Report	210 days from Ecology approval of Final Work Plan, SAP, and QAPP
Draft FS Report	120 days from submission of Draft RI Report

RI/FS Actions	Completion Time
Draft Final RI/FS Report	30 days from receipt of Ecology comments on the draft RI/FS
Public Review of Draft Final RI/FS Report	30 days minimum
Final RI/FS Report	60 days from the close of public comment period

The project coordinators (for both the City and Ecology) will be responsible for overseeing implementation of the *Agreed Order*, including the development of the RI/FS.

Once the *Agreed Order* was signed and a public participation plan was drafted by Ecology, a review of existing studies was initiated to identify data gaps. This information shaped the development of the project Work Plan and SAP (Tasks 2 and 3).

An interim draft Work Plan was prepared by the City in December 2004 to fulfill EPA Brownfields requirements. The draft Work Plan had a limited scope in that it dealt only with portions of the Park not owned by the City. In addition, as the *Agreed Order* had not yet been signed, the draft document did not receive full review and final approval by Ecology.

Once the *Agreed Order* was finalized, the City drafted revised Work Plans in April 2005 (expanding on the pre-existing 2004 EPA Brownfields document). As specified in the *Agreed Order*, they were submitted to Ecology for review and comment. The completion of the draft final Work Plans after incorporation of EPA and Ecology comments represents the second major milestone for the project. The draft final Work Plans was available for review by the public during a public information meeting scheduled August 23, 2005. Agency approval of the final Work Plans (this document) represents the third major milestone for the project.

The RI/FS report (Tasks 4 and 5) will be produced following completion of the sampling and testing outlined in the SAP, including the receipt and review of the analytical results. The RI/FS report will include the critical environmental evaluation (including evaluation of cleanup levels) for project decision-making and selection of a preferred cleanup action for the site. The draft final RI/FS report represents the fourth major milestone in the project. Upon completion of the draft final RI/FS, there will be a public comment period and information meeting coordinated with EPA and Ecology to present the results of the RI/FS of the Park. Verbal and written comments on the documents will be accepted by the public and responses will be incorporated into the final RI/FS. The final RI/FS represents the fifth major milestone in the project. The final RI/FS is tentatively scheduled for completion in November 2006.

Table 3-1. Estimated Project Schedule.

RI/FS Task	Estimated Completion Date	Milestone
Agreed Order Signed	March 22, 2005	◆
Issue Revised Draft Work Plans	Spring 2005	
Issue Draft Final Work Plans	Summer 2005	◆
Public Comments and Information Meeting	Summer 2005	
Issue Final Work Plans	Fall 2005	
Agency Approval of Final Work Plans	Fall 2005	◆
Sampling and Testing	Winter/Spring 2006	
Draft RI Report	Spring 2006	
Draft FS Report	Summer 2006	
Draft Final RI/FS Report	Fall 2006	◆
Public Comments and Information Meeting	Fall 2006	
Final RI/FS Report	Fall/Winter 2006	◆

4 PROJECT TEAM AND RESPONSIBILITIES

The Park RI/FS will be implemented by the City's Parks & Recreation Department. Figure 4-1 shows the team and organization for the RI/FS; the roles of the team members are discussed below.

City of Bellingham, Park & Recreation Department. The project coordinators (for both the City and Ecology) will be responsible for overseeing implementation of the *Agreed Order*, including the development of the RI/FS. The Parks & Recreation Department will be responsible for overall project management for the City. Tim Wahl, Greenway Program Coordinator, is the designated City project manager and will coordinate all activities under this assessment grant with the EPA Project Officer and Ecology Project Manager. Sheila Hardy, Special Projects Manager with the Office of Neighborhoods & Community Development will assist with the project as appropriate and as possible. Mr. Wahl will be responsible for contracting with and directly supervising the environmental consultant(s) that will conduct the field, lab, analysis, and reporting tasks for the assessment. He will direct the consultant on a day-to-day basis and provide primary review of all reports and other work products. Mr. Wahl will also coordinate with Ecology through the *Agreed Order* for the assessment and cleanup of the site.

Washington State Department of Ecology. The City and Ecology, through its Toxics Cleanup Program, have entered into an *Agreed Order* to complete the RI/FS of the Park site area. Mary O'Herron is the designated project coordinator for Ecology and will be responsible for overseeing implementation of the *Agreed Order*, including the development of the RI/FS. Ecology will provide technical review of work plans and reports, and, through periodic meetings, provide input on the significance of results and modifications to the RI/FS program. Ecology scientists will also provide technical input into the project design, work plans, data interpretation, and reporting. Ecology will make the final determination regarding the satisfaction of all requirements called for in the *Agreed Order*.

EPA Region 10 Project Officer. EPA will manage a *Cooperative Agreement* for the assessment work in coordination with the City. The designated EPA Project Officer, Ravi Sanga, will be the contact for all activities under this agreement. Mr. Sanga will approve the scope of work, schedule, and reporting activities required for the EPA Brownfields program. EPA scientists will also provide technical input into the assessment design, and they will review work plans, data interpretation, and reporting.

Property Owners and Stakeholders. Residents of the Birchwood, Columbia, and Alderwood neighborhoods, the Port of Bellingham, public agency partners of the CMT, BNSF Railway, Washington State Department of Health, Whatcom County Health Department, and the general public will be apprised of the progress made by the City on the RI/FS of the Park. Planning documents and investigation reports will be made available to the public and to all other stakeholders for review and comment. Public information meetings will be scheduled after completion of the draft final Work Plans and once the draft final RI/FS document is complete.

Integral Consulting Inc. Integral was selected by the City to conduct the RI/FS of the Park and is responsible for writing the Work Plans and implementing the field program, including field sampling, laboratory analysis, data analysis, and reporting.

Mark Herrenkohl, a Licensed Engineering Geologist in Washington State, will be the Integral project manager for the Park investigation. He will be responsible for implementing and executing the technical, QA, and administrative aspects of the investigation, including the overall management of the project team. Mr. Herrenkohl is accountable for ensuring that the investigation is conducted in accordance with applicable plans and guidelines, including the Work Plan, SAP, QAPP, and HASP. He will communicate all technical, QA, and administrative matters to the City Project Manager. He will ensure that any deviations from the approved work plans are documented in field change record (FCR) forms, communicated to the City, and approved before implementation. Mr. Herrenkohl will ensure the quality and timeliness of Integral documents.

The overall management of the project-specific QA activities is the responsibility of the QA manager, Ms. Maja Tritt. Ms. Tritt, or her designee, is responsible for implementation of site-specific QA activities, including field and laboratory quality control. In addition, the QA manager or her designee will coordinate with the Integral project manager and other project staff, as applicable, during the reduction, review and reporting of analytical data.

The Integral Health and Safety Manager, Eron Dodak, is responsible for the implementation of the site-specific HASP. Mr. Dodak, through the cross-trained field manager, will advise the project staff on health and safety issues, conduct health and safety training sessions, and monitor the effectiveness of the health and safety program conducted in the field.

Ms. Priscilla Zieber will lead the risk assessment for the Park and assist the City and the Integral project manager with public participation throughout this program.

The field operations manager, Mr. Dodak or Ms. Susan Fitzgerald, will be responsible for managing and supervising the field investigation program and providing consultation and decision-making on day-to-day issues relating to the sampling activities. The field manager will monitor the sampling to ensure that operations are consistent with plans and procedures and that the data acquired meet the analytical and data quality needs. When necessary, the field manager will document any deviations from the plans and procedures for approval. The field operations manager will be assisted in the field by Ms. Deborah Rudnick, Ms. Sacha Maxwell, and other technical personnel to be determined.

The project engineer, Mr. Reid Carscadden, P.E., will assist the project manager with the FS activities of the project, including an evaluation of remediation alternatives for the site.

The services of several subcontractors (e.g., drilling contractor, land surveyors, laboratory services) will be necessary for the performance of the field investigation and implementation of project objectives. The project manager, with assistance from the field manager, as necessary and appropriate, will be the primary liaison between Integral, the City Project Manager, and each of the subcontractors. Subcontractors are responsible for performing work according to the requirements in these Work Plans.

Analytical Resources, Inc. (ARI) of Tukwila, Washington, will perform the chemical and physical analyses of water, soil, and sediment samples collected for this project. Northwestern Aquatic Sciences (NAS) of Newport, Oregon, will analyze the bioassay samples. The analytical laboratory for dioxin/furan analysis of samples will be Severn Trent Laboratories (STL), located in Sacramento, California. STL will be subcontracted by ARI. The drilling contractor will be Boretec Drilling Inc. of Valleyford, Washington. Surveying required on the site will be accomplished by David Evans & Associates, Inc., Bellingham, Washington. GeoEngineers, Inc. of Bellingham, Washington will provide geotechnical, fluvial geomorphology, and creek realignment/enhancement support for the redevelopment of the Park. The project manager for each subcontractor will be responsible for coordination with Integral, SAP implementation, and analytical data quality.

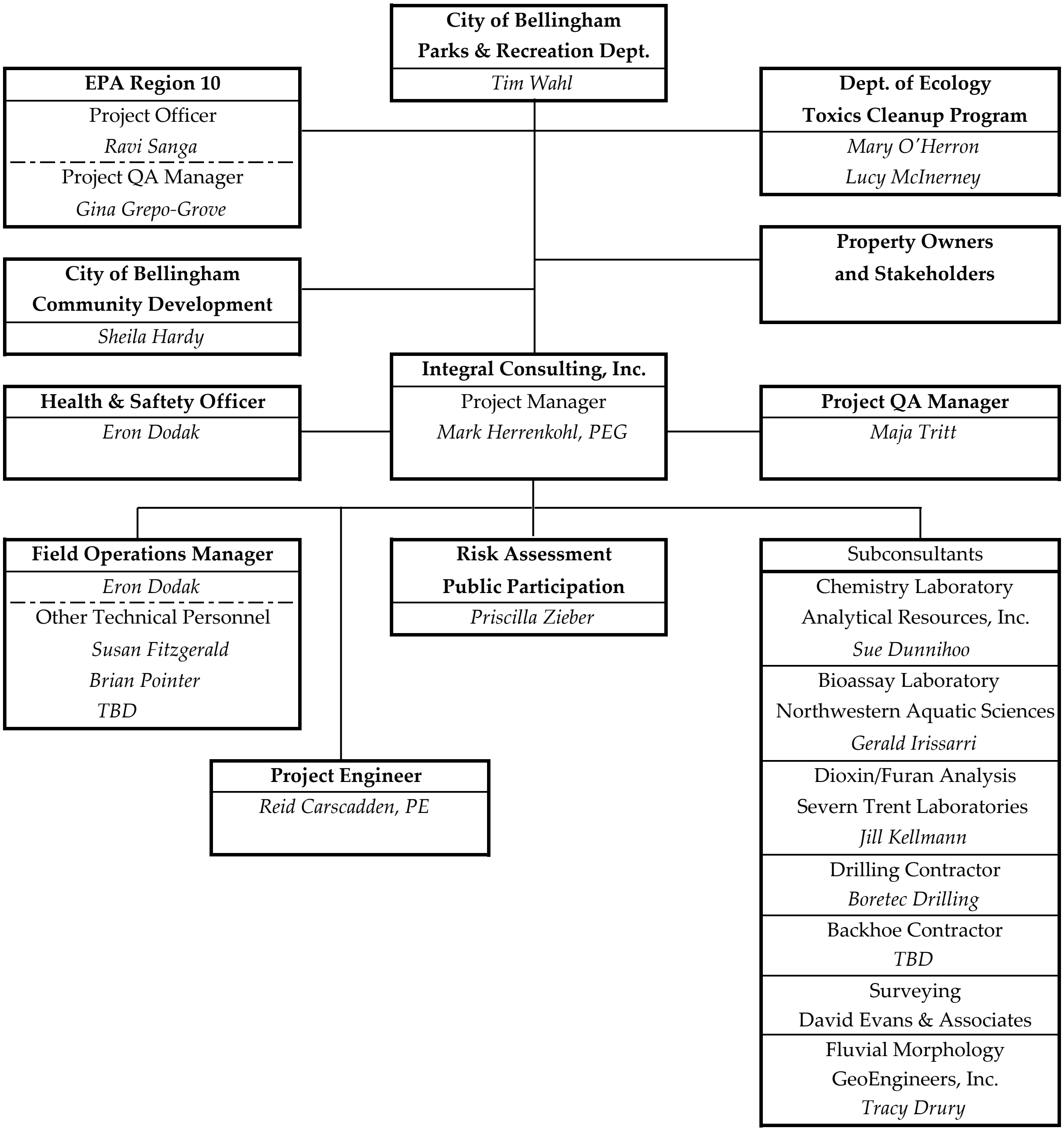

Figure 4-1. Program Organization Structure

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PSEP. 1997b. Puget Sound Estuary Program: Recommended guidelines for measuring metals in Puget Sound sediment and tissue samples. Final Report. Prepared for U.S. EPA, Region 10, Seattle WA and Puget Sound Water Quality Action Team, Olympia, WA. King County Water Pollution Control Division Environmental Laboratory, Seattle, WA.

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FINAL

ECOLOGY TOXICS CLEANUP PROGRAM
EPA BROWNFIELDS PROGRAM

SAMPLING AND ANALYSIS PLAN

Little Squalicum Park
Remedial Investigation/Feasibility Study
Bellingham, WA

Prepared for

City of Bellingham

Parks & Recreation Department
3424 Meridian Street
Bellingham, WA 98225

Prepared by

integral
consulting inc.

1201 Cornwall Avenue, Suite 208
Bellingham, WA 98225

September 30, 2005

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ACRONYMS AND ABBREVIATIONS

ARARs	Applicable or Relevant and Appropriate Requirements
ASTM	American Society for Testing and Materials
bgs	below ground surface
BNA	base neutral acid
BNSF	Burlington Northern Santa Fe Railway
BTC	Bellingham Technical College
CCC	Criterion Continuous Concentration
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CLARC	cleanup levels and risk calculations
COCs	chemicals of concern
CSL	Cleanup Screening Level
Creek	Little Squalicum Creek
CSM	conceptual site model
DEA	David Evans and Associates
DI	deionized
DRO	diesel-range organic hydrocarbons
E & E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology
EDM	Electronic Distance Meter
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon
ESI	expanded site inspection
ESL	Ecological Screening Levels
FCR	Field Change Request
GPS	Global Positioning System
GRO	gasoline-range organic hydrocarbons
GW	groundwater samples
HA	site hazard assessment
HASP	health and safety plan
ICP/MS	inductively coupled plasma/mass spectrometry
ICP-OES	inductively coupled plasma-optical emission spectrometry
IHSs	indicator hazardous substance
LAETs	Lowest Apparent Effect Thresholds
LSC	Little Squalicum Creek
LSP	Little Squalicum Park
MCL	maximum contaminant level
MCTA	Model Toxics Control Act

mg/kg	milligrams per kilogram
mg/L	milligrams per liter
NAD	North American Datum
NAPL	nonaqueous phase liquid
NAVD	North American Vertical Datum
NAWQC	National Ambient Water Quality Criteria
NWTPH	Northwest Total Petroleum Hydrocarbons
OCDD	octachlordibenzo-p-dioxin
OCDF	octachlordibenzo-p-furan
OESER	OESER Company
PAHs	polycyclic aromatic hydrocarbons
Park	Little Squalicum Park
PCP	pentachlorophenol
PID	photo-ionization detector
Port	Port of Bellingham
PRGs	Preliminary Remediation Goals
PPE	personal protective equipment
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RI/FS	remedial investigation and feasibility study
SAP	sampling and analysis plan
SHA	site hazard assessment
SI	site inspection prioritization report
SIM	Selective Ion Monitoring
SLs	screening levels
SMS	Washington State Sediment Management Standards
SOPs	standard operating procedures
SOW	Statement of Work
SQLs	Sample Quantitation Limits
SQS	Sediment Quality Standard
STL	Severn Trent Laboratories
SCV	Secondary Chronic Values
SW	surface water
SVOCs	semivolatile organic compounds
TCDD	tetrachlorodibenzo-p-dioxin
TEE	Terrestrial Ecological Evaluation
TEQs	toxicity equivalency quotients
TICs	tentatively identified compounds
TOC	total organic carbon
TP	test pit
TPH	total petroleum hydrocarbons
TSS	total suspended solids

U&I	Utah and Idaho Sugar Company
USCS	Unified Soil Classification System
VOCs	volatile organic compounds
VPH	volatile petroleum hydrocarbon
WAC	Washington Administrative Code
WISHA	Washington Industrial Safety and Health Act
WQC	water quality criteria

1 INTRODUCTION

This document is the sampling and analysis plan (SAP) for the remedial investigation and feasibility study (RI/FS) of Little Squalicum Park (the Park) located in Bellingham, Washington (Figure 1-1). This SAP describes the sampling strategy and design to meet the data needs of the RI/FS and provides specific guidance for field methodology and quality assurance procedures that will be followed by Integral Consulting, Inc. (Integral) and its subcontractors. Integral is conducting this work under contract No. 2004-014 with the City of Bellingham, Parks and Recreation Department (City), with direction from both the Washington State Department of Ecology Toxics Cleanup program (Ecology) and U.S. Environmental Protection Agency, Region 10 Brownfields program (EPA).[1] This SAP has been prepared for RI sampling and analysis activities in general accordance with Washington Administrative Code (WAC) 173-340-820, WAC 173-204-600, and the Sediment Sampling and Analysis Appendix, as updated (Ecology 2003).

Several documents are cited repeatedly and accompany this SAP. Altogether, these documents are referred to as the Work Plans for the Park RI/FS:

- *Work Plan for the RI/FS of Little Squalicum Park Bellingham, Washington.* The Work Plan describes program objectives, project organization, and project tasks to complete an RI/FS of the Park. This document also provides information on project background, history, and regulatory framework.
- *Quality Assurance Project Plan (QAPP) of Little Squalicum Park RI/FS Bellingham, Washington.* The QAPP describes laboratory methodology and quality assurance/quality control (QA/QC) procedures that will be used to complete a RI/FS for the Park site.
- *Project Health and Safety Plan (HASP), Little Squalicum Park RI/FS, Bellingham, Washington*. The HASP has been prepared in conformance with Integral's Health and Safety Plan guidelines and in accordance with WAC 173-340-810, applicable Washington Industrial Safety and Health Act (WISHA) regulations, and project requirements. It addresses those activities associated with work to be performed in the Park.
- *Integral Standard Operating Procedures* (SOPs). These numbered documents provide specific, detailed information on conducting routine, repetitive field techniques (e.g., split spoon sampling from a drill rig). These documents are found in Appendix A.

The Whatcom County Health and Human Services completed a site hazard assessment (SHA) of the Park site in February 2004, as required under the Model Toxics Control Act

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[1] Funding for this work was received by the City of Bellingham (2004) from the EPA Brownfields Program. Additional funding is expected from the Ecology Remedial Action Grant Program (City of Bellingham 2005).

(MTCA). The site's hazard ranking, an estimation of the potential threat to human health and/or the environment relative to other Washington State sites assessed at that time, was determined to be a 1, where 1 represents the highest relative risk and 5 the lowest (Ecology 2004). Based on the results of the SHA, Ecology has determined that a RI/FS should be developed for the Park site pursuant to WAC 173-340-350 and WAC 173-204-560. Ecology has negotiated an *Agreed Order* and Statement of Work (SOW) (dated March 22, 2005) with the City to conduct an RI/FS on the Park site (presented in Attachment A of the Work Plan). The RI/FS is intended to provide sufficient data, analysis, and evaluations to enable Ecology to select a cleanup action alternative for the site.

The primary objectives of the Park RI/FS are to provide critical data necessary to understand the nature and extent of environmental problems at the site, to assess potential risk to human health and the environment, to determine if cleanup actions are required, and to determine how these actions may be accomplished as part of specific wildlife enhancement and park development actions. These objectives will be met by sampling surface water, groundwater, soil and sediments and evaluating the results in concert with other existing data. Other major project objectives are provided in the accompanying Work Plan.

A summary of relevant historical activities within the boundaries of the Park are presented in Section 2. Section 3 presents a review of existing data, including a summary of previous environmental investigations and screening level criteria, a preliminary conceptual site model (CSM), and data gaps. Section 4 presents the sampling design and rationale for a tiered approach to complete the Park RI field and testing investigation. The overall sampling strategy for the Park is to place a greater density of sampling locations in areas for which little or no historical data are available and to limit the analyte list in well-studied areas by applying a tiered sampling and testing approach. An adequate volume of sample will be archived to allow analysis of all analytes for a given medium (including biological toxicity testing), if necessary. Section 5 discusses field methods for sample collection and sample handling methods. References are presented in Section 6. Referenced figures and tables are presented at the end of each section.

Appendix A contains Integral SOPs and field forms, and Appendix B contains the historical biological testing results for the site.

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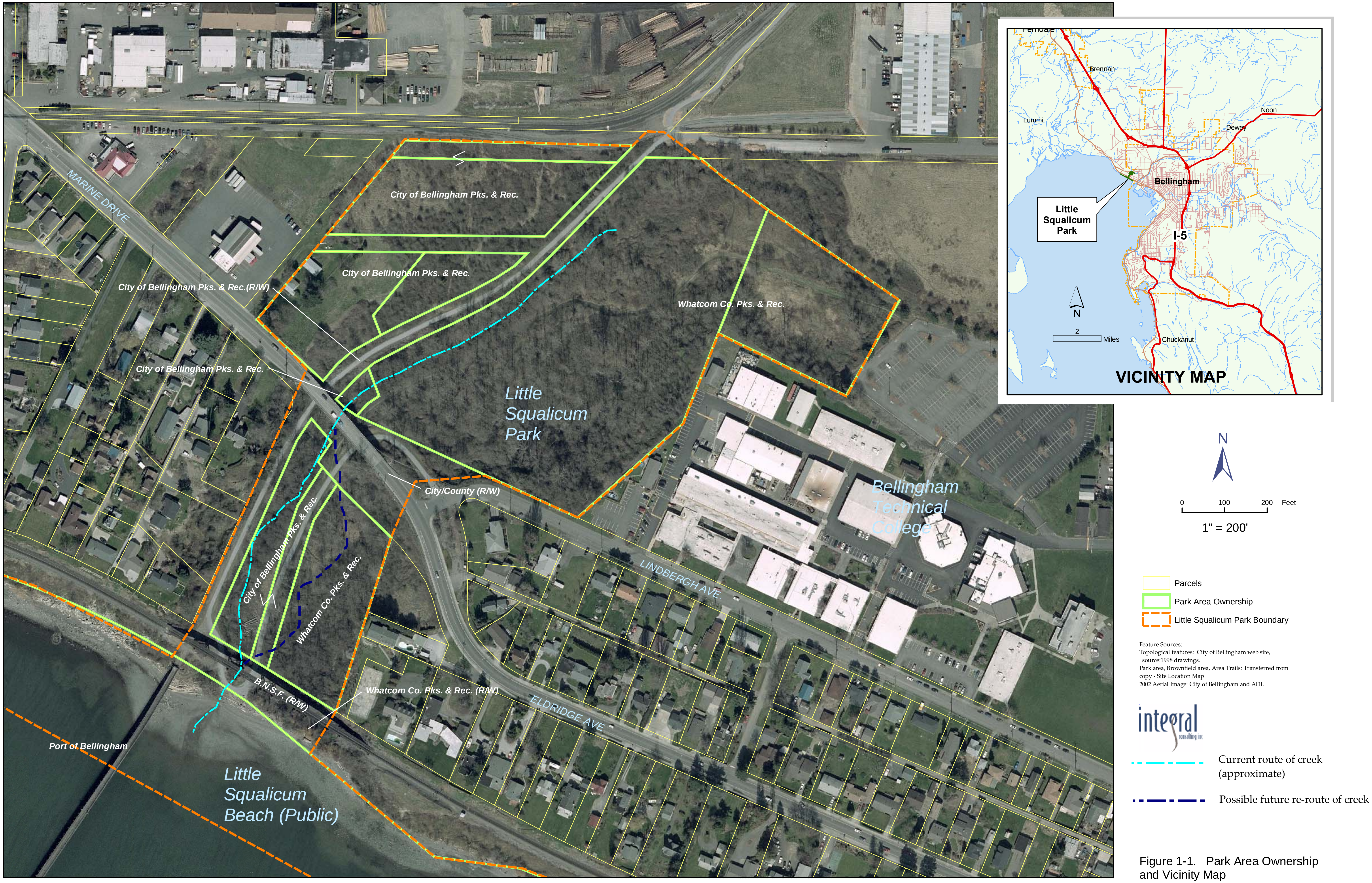

Feature Sources:
Topological features: City of Bellingham web site,
source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from copy - Site Location Map
2002 Aerial Image: City of Bellingham and ADI.

integral consulting inc

Figure 1-1. Park Area Ownership and Vicinity Map

2 SITE HISTORY

Site history information was obtained from the OESER Cedar Company RI report (E&E 2002a and references therein) and personal communication with City and Whatcom County personnel. Current property owners within the Park site area are shown on Figure 1-1. The approximate locations of relevant historical activities within the Park boundaries are shown on Figure 2-1.

Recent sampling activities in the Park by Ecology (2004) have uncovered a previously unknown shell midden deposit. The extent of the shell midden deposit, located downstream of the Marine Drive Bridge, is currently unknown. It is also possible that archaeological deposits could be present in other areas of the park.

The first reported development in the area of Little Squalicum Creek (the Creek) was by Edward Eldridge in 1853, under the 320-acre Eldridge Donation Claim. During the late 1800s, most of the area was used by the Eldridge family for dairy farming and ranching. The railway that runs along the shoreline of Bellingham Bay was first developed around 1890. The Eldridge family deeded portions of the uplands and tidelands to Olympic Cement Company in 1911 (now the Tilbury Cement Company). This deed included land for the pier and former rail bed that extends along the west side of the Creek ravine. An old pump house that supplied water from a spring along the creek to the cement plant is located downstream of the Marine Drive Bridge stormwater discharge point. The plant discontinued pumping of spring water for plant use in the 1950s. In 1925, the Eldridge family sold the property now occupied by the OESER Company to the Utah and Idaho Sugar Company (U&I). The sale included an easement for construction of a drain to convey sugar-processing wastes through the creek into the tidelands of Bellingham Bay. The plant remained in operation into the early 1940s, reportedly closing in 1942. During the 1940s and 1950s, a commercial plant nursery was located to the west of the Creek.

In 1932, the Eldridge family granted the Marietta Township mining rights to the gravel within the ravine. Sand and gravel were later mined by the Eiford Company until the late 1960s. In some places within the ravine over 20 ft of native soils were mined for its sand and gravel. Some of the ditches dug to facilitate drainage remain in place today. Much of the creek's original course was diverted into these ditches. The entire ravine was altered substantially from natural conditions with rerouting of the original creek bed and significant changes to the soils and lithology (e.g., backfilling of gravel pit and wash pond excavations, temporary road maintenance, and rail bed and track placement). Temporary basins were dug for gravel washing and reportedly filled with groundwater, both seasonally and, in some cases, year-round. After mining, the land was leased to Mt. Baker Plywood for raw log storage during the early 1970s. Logs were transported to and from the ravine via the beach.

In 1943, the Eldridge family sold a portion of the upper area of the creek ravine to the Tiscornia family who used the land for farming and grazing livestock. The land was obtained by the Bellingham School District in 1955, which subsequently deeded the land in 1993 to the Washington State Board for Community Colleges and Technical Colleges. Bellingham Technical College (BTC), formerly the Bellingham Vocational Technical Institute established here in 1957, is currently located on this 21-acre site. Various portions of the creek, including areas extensively mined for sand and gravel and used for log storage, were deeded to the Whatcom County Park Board by several individuals as well as the school district.

Hugh Eldridge deeded the tidelands onto which the Creek flows to the Port of Bellingham (Port) in 1927. A 60-ft right-of-way west of the Marine Drive Bridge was deeded to the Port in 1956, but was never developed or used by the Port. The fee to this right-of-way was purchased by the City in 2001. In the mid 1960s, construction debris and old furnishings were reportedly dumped in a small area near the east boundary of the ravine, which is now a BTC parking lot. Minor amounts of residential and commercial garbage and refuse may have also been placed in this area based on personal communication with City employees and information provided on a 1963 aerial photo.

In 1977, the City constructed an underground stormwater pipeline through the upper area of the ravine. Stormwater from approximately 3 square miles of the Birchwood neighborhood, including the BTC parking lot, is conveyed through the 36-inch underground pipeline and discharged into the creek. Since 2002, stormwater from the BTC parking lot is directed through a filtering system (reportedly composted leaf media) before discharging into the creek. Although water is diverted directly into the Birchwood neighborhood stormwater pipeline during larger rainstorms (greater than 6-month storm), most runoff (approximately 90%) is treated before discharging to the creek (Hunter 2004, pers. comm.).

The City owns 7.8 acres of the Park and leases 12.3 acres of County-owned property at the site. Currently, an agreement between the City Parks and Recreation Department and Whatcom County Parks Department stipulates that the City must manage and operate the area as a park site for 35 years (to about 2025), with a renewal provision for another 35 years.

The OESER Cedar Company (currently known as the OESER Company) purchased the nearby U&I property in 1943. The OESER Company manufactures poles for utility companies. In records dating back to 1953, the process included segregating poles by length and class, incising some or all of the poles, and subjecting them to "oil treatment" using creosote. Finished poles were shipped offsite by rail. In 1965, the company also started treating wood using 5% pentachlorophenol (PCP) in an oil-based solvent (Diesel No. 2). OESER stopped using creosote to treat wood in the early 1980s but PCP treatment continues to be utilized at the facility. A detailed description of the wood treatment processes used by the OESER Company is presented in the OESER RI (E&E 2002a).

The OESER site has discharged process wastewater or contaminated stormwater to the Creek since start of operations in the late 1940s. The water enters an underground stormwater line originating in the Birchwood neighborhood that crosses the OESER Company property and then discharges into the creek. This OESER/Birchwood neighborhood drainage enters the creek adjacent to the outfall from the Birchwood neighborhood drainage to the east (Figure 2-1). In addition to water, discharges from the OESER Company have been known to contain wastes such as creosote, PCP, dioxins/furans (associated with PCP), diesel fuels, and related oil products. The wastewater/stormwater permit history for the OESER site is also presented in the OESER RI (E&E 2002a). Currently, OESER has a National Pollutant Discharge Elimination System Waste Discharge Permit (NPDES No. WA 003081-3) that allows detectable levels of PCP and petroleum hydrocarbons in effluent discharged to local stormwater.[2]

In addition to the OESER outfall, surface water runoff has been observed originating from the OESER yard and pooling in an area upstream of the "head" of the Creek (Wahl 2004, pers. comm.). The event occurred approximately 15 years ago, and soils and vegetation appeared to be impacted at the time from the contents of the runoff.

Stormwater drainage from the Birchwood neighborhood may also be a source of petroleum hydrocarbons and heavy metals to the Creek. A likely source of these contaminants is from motor vehicle and mixed commercial/residential use throughout this drainage area.

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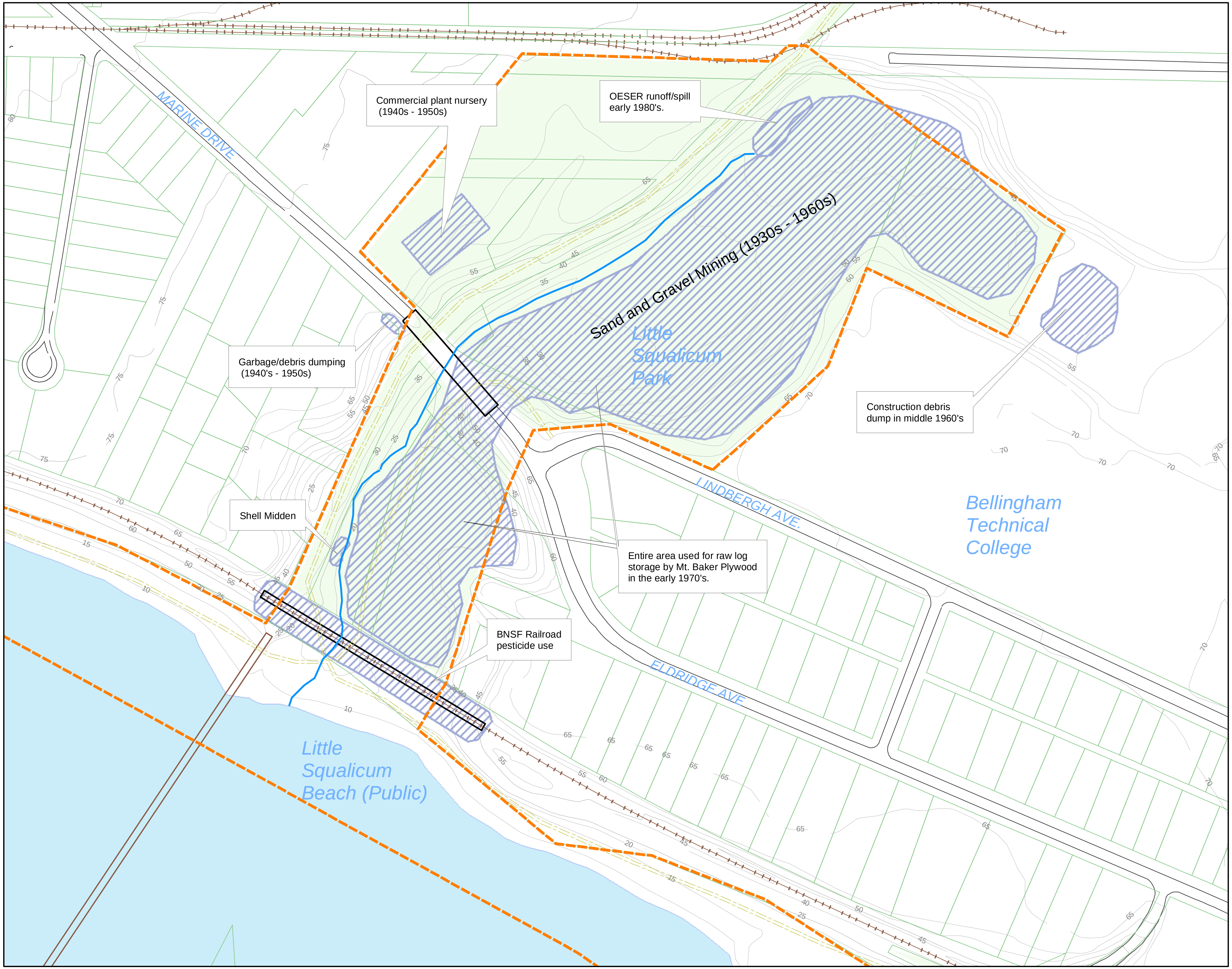
[2] The daily maximum effluent limitation is 9 μg/L for PCP.



▨ Approximate Location - Historical Activities

▭ Little Squalicum Park Boundary

🟩 Approx. Parcel Location

— Bridge

— Road

— Dock

+++ Railroad

Feature Sources:
Topological features: City of Bellingham web site, source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from copy - Site Location Map Appendix B Map of Brownfield Assessment Area.

Figure 2-1. Historical Activities

Map Document: (C:\GIS\Projects\LittleSqualicumCr\Historical_Activities.mxd)
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3 REVIEW OF EXISTING DATA

3.1 SUMMARY OF PREVIOUS INVESTIGATIONS

Historical data that were evaluated for possible inclusion in the current RI/FS originated from the following investigations:

- Site Inspection Report (E&E 1987)
- Site Hazard Assessment (Parametrix 1991)
- Wetland Mitigation Plan at Little Squalicum Creek (DEA 1993)
- Site Inspection Prioritization Report (URS 1994)
- Expanded Site Investigation (E&E 1996)
- Removal Assessment, Phase II (E&E 1998a,b)
- OESER Company RI/FS (E&E 2002a,b)
- Little Squalicum Creek Screening Level Assessment (Ecology 2004).

Site sampling locations from these previous investigations are shown on Figures 3-1 through 3-4. A Microsoft Database containing the analytical results for these historical investigations is included on the CD attached to the front cover.

This section briefly summarizes the types of data collected during each of these investigations and the data usability for the current RI/FS. Evaluation of data usability focused on the following five aspects of the data as recommended in *Guidance for Data Usability for Risk Assessment* (USEPA 1992):

1. ***Data Sources***—Evaluate the type of data collected (screening data, fixed laboratory data, etc.) and whether QA/QC samples are available for the data to provide data quality information
2. ***Analytical Methods and Detection Limits***—Evaluate methods for appropriateness and sensitivity and determine if detection limits are low enough for risk-based screening
3. ***Data Quality Indicators***—Review laboratory validation reports for data quality issues
4. ***Background Samples***—Assess whether appropriate quantity and location of background samples were collected
5. ***Consistency of Data Collection Methods***—Evaluate sample collection methods for appropriateness for the chemical, media, and analysis; review field trip notes

to assess quality of sample collection; and determine if differences in sample collection exist between different sampling events and investigations.

In the event that original reports were not available for evaluation of data quality, the data quality evaluation provided in the OESER RI/FS (E&E 2002a,b) was referenced for a summary of the data quality. Regarding data usability for risk assessment purposes, the following assumptions were made:

- Field screening data will not be used for risk assessment purposes.
- Unknown or tentatively identified compounds (TICs) will be excluded from consideration.
- If an analyte is not detected in any sample for a particular medium, then it will be assumed that the chemical is not present and it will be dropped from further consideration in the risk assessment. Note that sample quantitation limits (SQLs) will be compared to screening benchmarks as available, and a list of those compounds with SQLs above screening levels will be provided as part of the risk assessments.
- If an analyte has both detected and non-detect sample results (i.e., any results that include a "U" data qualifier), the assumed concentration in non-detect samples will be one-half of the SQL.
- For non-detect dioxin/furan congeners, two approaches will be followed for the calculation of 2,3,7,8-TCDD toxicity equivalency quotients (TEQs). In the first approach, one-half the SQL will be assumed for non-detects when calculating the TEQ for each sample. Under the second approach, non-detect concentrations will also be assumed to be present at a concentration of one-half the SQL, with the exception that if a congener is never detected in a particular medium, then it will be assumed to not be present, and it will be assigned a concentration of 0 when calculating TEQs (USEPA 2000a).
- For non-detect petroleum fractions, only the second of the above approaches will be used for calculating total volatile petroleum hydrocarbon (VPH)/extractable petroleum hydrocarbon (EPH). If a fraction is never detected in a particular medium, it will be assigned a concentration of 0. Otherwise, it will be assumed to be present at half the detection limit.

3.1.1 Site Inspection Report

Four sediment and two unfiltered surface water samples were collected in the vicinity of the Creek (locations JC-351 through JC-355, and JC-358) as part of the OESER facility investigation performed for EPA (E&E 1987). Semivolatile organic compounds (SVOCs) were analyzed in both media using EPA Method 8270. A data quality summary presented in the OESER RI indicated that there were only minor problems affecting data usability. However, other factors indicate that while these data can be used to assess data gaps, the data will not be included in the risk evaluation. These factors include: 1) age of the data – these data are approximately 17 years old and do not accurately represent current conditions in the creek, 2) media – sediment and surface water conditions are more likely to change over time than soil conditions, 3) analytes – SVOCs have the potential to volatilize or degrade over time, and 4) depth of sediment collection was not indicated in the database.

3.1.2 Site Hazard Assessment

Seven soil/sediment and five unfiltered groundwater/porewater samples were collected in the vicinity of the Creek (locations PMX-GW-10 through 15, PMX-SD-01 through 03, and PMX-SS-06 through 09) as part of the site hazard assessment (Parametrix 1991). SVOCs (EPA Methods 8270 and 8040) and total petroleum hydrocarbon (TPH) (EPA Methods 8015 and 418.1) were analyzed in both media. A data quality summary presented in the OESER RI indicated that there were several problems that affected data usability: 1) data quality was not addressed in detail, 2) holding times were exceeded, and 3) method blank detection limits were above sample detection limits. While these data will be cautiously used to assess data gaps, the data will not be included in the risk evaluation based on the following considerations: 1) age of the data – these data are approximately 13 years old and do not accurately represent current conditions in the creek, 2) media – sediment and porewater conditions are more likely to change over time than soil conditions, 3) analytes – SVOCs and TPH have the potential to volatilize or degrade over time, and 4) depth of sediment collection was not indicated in the database.

3.1.3 Wetland Mitigation Plan at Little Squalicum Creek

A total of 36 test or hand soil pits were dug within the boundaries of the Park as part of the Wetland Mitigation Plan (DEA 1993). Strata in each pit were classified and described using the Unified Soil Classification System (USCS). A note was made for each pit regarding whether groundwater was encountered and, if so, at what soil depth and relative volume. In 11 of the pits, soils from at least one strata were analyzed for moisture content and percent fines. These data will be carried forward for use in the RI/FS because soil strata and groundwater elevation levels are not likely to have changed since the data were collected. The only limiting factor regarding data interpretation is that location maps were hand drawn, and sample location coordinates were not provided in the report.

3.1.4 Site Inspection Prioritization Report

Eleven sediment samples were collected in the vicinity of the Creek (locations SI-BB01 through 03 and SI-LS01 through 08) as part of the Site Inspection Prioritization Report (URS 1994). SVOCs (EPA Method 8270) were analyzed. A data quality summary presented in the OESER RI indicated that there were no problems that affected data usability. These data will be used to assess data gaps; however, the data will not be included in the risk evaluation based on the following considerations: 1) age of the data – these data are approximately 10 years old and do not accurately represent current conditions in the creek, 2) media – sediment conditions are more likely to change over time than soil conditions, 3) analytes – SVOCs have the potential to volatilize or degrade over time, and 4) depth of sediment collection was not indicated in the database.

3.1.5 Expanded Site Investigation

Seven sediment, four unfiltered surface water, and three filtered surface water samples were collected in the vicinity of the Creek (locations OS01 through OS07) as part of the Expanded Site Investigation (ESI) (E&E 1996). SVOCs (Method Base Neutral Acid [BNA]) and metals (Methods AA, ICP/MS, and ICP-RAS) were analyzed in all media. A data quality summary presented in the OESER RI indicated that there were no problems that affected data usability. These data will be used to assess data gaps and will be included in the risk evaluation as part of the RI/FS.

3.1.6 Removal Assessment, Phase II

Three unfiltered surface water samples were collected in the vicinity of the Creek (locations 256, 320, and 343) as part of the Phase II Removal Assessment (E&E 1998a,b) conducted at the OESER site. SVOCs (EPA Methods 8270 and 8270 Selective Ion Monitoring [SIM]) and TPH (Method Northwest Total Petroleum Hydrocarbon [NWTPH]) were analyzed. A data quality summary presented in the OESER RI indicated that there were no problems that affected data usability. These data will be used to assess data gaps and will be included in the risk evaluation as part of the RI/FS.

3.1.7 OESER Company Remedial Investigation

The OESER RI (E&E 2002a) was the source for most of the historical data contained within the Park database. Types of data collected in the vicinity of the creek during the RI included groundwater (5 locations), berries (2 locations), seeps (2 locations), springs (1 location), subsurface soil leachate (1 location), surface water (7 locations), sediment (11 locations), bioaccumulation testing (3 locations), surface soil (87 locations), and subsurface soil (12 locations). Most of these media were analyzed for a full suite of analytes, including dioxins, EPA/VPH, TPH, volatile organic compounds (VOCs), SVOCs, metals, and conventionals. The data quality evaluation in the RI report indicated that all precision, accuracy, representativeness, completeness, and comparability goals were achieved for the RI field and analytical investigation. Validated analytical precision and accuracy showed that more than 99% of all target compound and target analyte data were acceptable for use. These data will be used both for data gaps analysis and for risk evaluation in the Park RI.

In addition to conventional and chemical analysis, biological testing was conducted as part of the OESER site RI (E&E 2002a) and included a 10-day toxicity test with the amphipod *Hyalella azteca,* and a 28-day bioaccumulation test with the aquatic oligochaete *Lumbriculus variegates*. Data quality of the biological testing results was deemed acceptable for use in the RI by EPA (refer to Section 3.6.5). These data will also be used both for data gaps analysis and for risk evaluation in the Park RI.

3.1.8 Little Squalicum Creek Screening Level Assessment

Ecology (2004) conducted the most recent investigation and evaluated six surface sediment samples (locations LSC01 through LSC06) and two surface soil samples (LSCS1 and LSCS2) in the vicinity of the Creek. All samples were analyzed for SVOCs using EPA Method 8270, and sediment samples were additionally submitted for bioassay testing. Bioassay tests conducted included a 10-day amphipod (*Hyalella azteca*), 20-day midge (*Chironomus tentans*), and Microtox® sediment porewater tests. The chemical data quality was of acceptable quality; however, some precision was lost in the analysis of SVOCs due to sample dilutions required because of hydrocarbon interference. Bioassay data were also of acceptable quality. These data will be used both for data gaps analysis and for risk evaluation in the Park RI.

3.2 HYDROGEOLOGIC DATA

Groundwater wells (MW-LSC-1 through MW-LSC-4) were installed along the old railroad grade located west of the Creek, and groundwater from these wells was evaluated during the OESER RI (E&E 2002a) (Figure 3-2). Groundwater was observed only a few feet below the ground surface and was characterized as a continuous aquifer with connections to the deeper of two zones identified on the OESER site located upgradient (north) of this Park area. Soils were described as primarily composed of coarse materials (i.e., sands and gravels).

Groundwater was measured over three sampling events in September 1999, December 1999, and February 2000. The data show that groundwater elevations were significantly higher in the middle well (MW-LSC-2), an anomalous mounding of groundwater. MW-LSC-2 appears to be located at the present terminus of the natural overland flow path toward the creek, designated by City staff as “Sugar Waste Gulch” on an old easement description. This area may represent a preferential groundwater flow path, such as a former stream bed to the Creek.

A mass balance of surface and storm drain water flowing into and out of the Creek was also conducted by E&E (2002a). They concluded the following:

- The headwaters of the creek originate with the storm drain outflows from the combined OESER/Birchwood outfall to the west (north) and the Birchwood/BTC outfall from the east.
- The creek terminates with the culvert that empties onto the beach at Bellingham Bay.
- During the dry season, tapped spring flows account for about one-third of the flow from the creek.
- During the rainy season, virtually all flow from the creek can be traced back to stormwater runoff entering the creek through the three storm drain systems that service the surrounding area (including Marine Drive storm drain).

3.3 GEOTECHNICAL AND OTHER PHYSICAL PARAMETERS

As part of the Creek Wetlands Compensation Project, Landau Associates conducted a geotechnical evaluation to assist in wetlands and stream channel design within the Park as compensation for wetlands lost during a planned expansion of the Bellingham International Airport (DEA 1993). Landau was a subconsultant to David Evans and Associates, who was contracted with the Port of Bellingham.

Subsurface conditions were evaluated on the site by excavating 22 backhoe test pits and 6 hand explorations in October 1992 (Figure 3-4). The depth of these excavations ranged from 1 to 6 ft below ground surface (bgs). Selected soil samples were analyzed for grain size and moisture content. The following observations and conclusions were made by Landau:

- Soil conditions were variable and included clean (low silt/clay content) sand and gravel, silty sand and gravel, and occasional silt and clay units.
- Fill materials including wood, metal, glass, and ash debris were encountered at several locations in the northeast to central portion of the site.
- One location, test pit SC-20, contained significant amounts of glass and other household refuse. This location is near the BTC parking lot.
- Groundwater was encountered at six test pit locations in the northeastern portion of the site ranging from approximately 2 to 5-1/2 ft bgs (October 1992).
- Most soil appears to be moderately to highly permeable. As a result, Landau recommended a low permeability liner within the new stream channel location and applicable wetland cells to reduce water loss by infiltration (DEA 1993).

3.4 HABITAT CHARACTERISTICS

The Creek begins at the Birchwood neighborhood outfall (underground pipe from the east) and ends approximately 1,500 ft downstream at Bellingham Bay. The creek channel ranges in width from approximately 5 to 10 ft, with water depths usually less than 1 ft in most places. The creek is fed by three stormwater outfalls (the east Birchwood neighborhood, Birchwood/OESER, and Marine Drive outfalls), two tapped springs, and several small seeps (E&E 2002a). Water flow is observed during the wetter season (October through May), but during the drier season the creek bed may be exposed.

As indicated by E&E (2002a), numerous benthic invertebrate taxa, including caddisfly larvae, midge larvae, amphipods, snails, and aquatic oligochates, were observed in the Creek during the OESER RI fieldwork. These observations suggest that the creek supports reproducing populations of benthic organisms. The Creek, however, does not support fish, although some salmonid fingerlings have been found as far upstream as the Marine Drive Bridge. It is assumed that they swam into this area of the creek during a high tide or storm event and that they remained in this area for only a short time before returning to Bellingham Bay. (An elevated cement culvert near the mouth of the creek provides an obstacle to fish that can only be overcome during such high-water events.)

The creek channel and other areas in the Park are shaded by a well-developed overstory of alder, willow, and black cottonwood trees. Common plant species in the understory include grasses, horsetail, blackberry, hawthorne, holly, and saplings of alder, willow, cottonwood, mountain ash, fir, and cedar (E&E 2002a).

3.5 SCREENING LEVEL CRITERIA

This section presents the ARARs for the purposes of selecting a screening benchmark for evaluating historical data and selecting analytes to carry forward for the RI/FS. Screening benchmarks were compiled based on human health toxicity, ecological toxicity, natural background conditions in Puget Sound, and available site-specific background concentrations. In general, if benchmarks were available from multiple sources for a single analyte, the lowest concentration was selected as the screening benchmark for the purposes of this data gaps analysis. The array of screening benchmarks considered and the selected screening levels for each medium are included with this document.[3] Sources of benchmarks evaluated for each medium are summarized below.

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[3] Tables presenting screening benchmarks for soil, groundwater, surface water, and soils are included on the CD attached to the front cover.

3.5.1 Soil

Available historical data for soil include onsite surface and subsurface soil data and background surface soil data. Given that some surface and subsurface soils onsite also have the potential to become sediment in the event that the creek is rerouted, screening benchmarks for sediment were considered in addition to screening benchmarks for soil. There are no human health sediment benchmarks, but there are ecological sediment benchmarks.[4] Screening benchmarks for soil were obtained from the following sources:

- MTCA Method B – Direct Human Contact to Soil, obtained from CLARC Version 3.1 (Ecology 2001a)
- U.S. EPA Region 9 Preliminary Remediation Goals (PRGs) for soil leaching to groundwater, obtained from http://www.epa.gov/region09/waste/sfund/prg/index.htm (October 2004)
- MTCA Terrestrial Ecological Evaluation (TEE) Indicator Soil Concentrations for plants, soil invertebrates and wildlife, obtained from MTCA Table 749-3 (Ecology 2001b)
- Freshwater Sediment Lowest Apparent Effect Thresholds (LAETs), obtained from Ecology (2003)[5]
- Marine Sediment Quality Standards, obtained from WAC 173-204 (Ecology 1995)[6]
- Puget Sound regional background soil concentrations (Ecology 1994)
- Site-specific background soil concentrations (surface and subsurface).

The screening levels (SL) were prioritized such that the minimum value of the screening values was used as the SL unless it was less than either of the background concentrations (site-specific or regional), in which case it was adjusted up to the maximum background concentration. For SL values that are normalized to total organic carbon (TOC), but were unavailable for a data set, a TOC value of 1.0% was assumed in normalizing these data. A TOC value of about 1.0% was typically measured in soils and sediments of the Park.

3.5.2 Groundwater

Available historical data for groundwater include unfiltered and filtered samples from onsite and background locations. Filtered samples were only analyzed for metals.

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[4] Human health benchmarks are based upon accumulation of all exposure pathways and the affected populations, but not upon strict direct numerical criteria.

[5] Freshwater LAETs are used for guidance only. Sediment bioassays are the definitive tool for evaluation of ecological risk in freshwater systems.

[6] Marine Sediment Quality Standards are screening criteria. Sediment bioassays are the definitive tool for evaluation of ecological risk in marine systems.

Screening benchmarks for groundwater came from the following human health and ecological sources:

- Washington State Criteria (WAC 173-201A-040)
- National Ambient Water Quality Criteria – freshwater chronic and human health consumption of water and organisms (USEPA 2002)
- Tier II Secondary Chronic Values (SCV) (Suter and Tsao 1996)
- EPA Region 5 Ecological Screening Levels (USEPA 2003)
- EPA Region 6 Ecological Screening Benchmarks (TNRCC 2001)
- MTCA Method B Surface Water – Ingestion of Fish, obtained from CLARC Version 3.1 (Ecology 2001a)
- Federal MCLs (USEPA 2005)
- State MCLs (WAC 246-290-310)
- MTCA Method B Groundwater.

The preliminary groundwater screening levels were developed in three steps. First, the ecological screening level was identified. The minimum (lower concentration) of the Washington State criterion and the National Ambient Water Quality criterion was selected. If no value was available from either of those sources, the SCV was selected. If no SCV was available, the EPA Region 5 ESL was selected. If no EPA Region 5 ESL was available, the EPA Region 6 benchmark was selected.

Second, the potable groundwater screening level was identified as follows. The state MCL was the preferred screening level. If no state MCL was available, the federal MCL was used. If no federal MCL was available, the MTCA Method B groundwater level was used.

Finally, the ecological and the potable groundwater screening levels were compared with the MTCA Method B surface water level, and the lowest of the three was selected as the risk-based screening level. If the background concentration exceeded the risk-based screening level, the background concentration was used as the final screening level. Background groundwater concentrations were evaluated using well MW-06D, located northeast of the OESER site near Cedarwood Avenue. MW-06D has been sampled on 12 different occasions since 1995, the most recent of which was during the OESER RI conducted by E&E on behalf of EPA (E&E 2002a).

An EPA equilibrium partitioning model will be used in the RI to evaluate groundwater concentrations that could re-contaminate sediments.

3.5.3 Surface Water and Porewater

Available historical data include unfiltered water analytical data for surface water, springs, seeps, and porewater, and filtered water analytical data for surface water, springs, and seeps. The sources and hierarchy of screening levels discussed in Section 3.5.2 for groundwater was used for surface water, except no acceptable background data were available for surface water and no screening levels associated with potable water (MCLs and MTCA Method B groundwater) were used. The screening levels for protection of aquatic life and for humans eating fish from the creek are considered at this time sufficiently protective for incidental and occasional consumption of creek water. The creek has insufficient flow to provide a year-round source of drinking water to meet daily needs.

3.5.4 Surface Sediment

Available historical data for sediment includes samples from onsite locations. Given that surface sediments onsite also have the potential to become soil in the event that the creek is rerouted, screening benchmarks for soil were considered in addition to screening benchmarks for sediment. There are no human health sediment benchmarks, but there are ecological sediment benchmarks.[7] Screening benchmarks for sediment were obtained from the following sources:

- MTCA Method B – Direct Human Contact to Soil, obtained from CLARC Version 3.1 (Ecology 2001a)
- U.S. EPA Region 9 PRGs for soil leaching to groundwater, obtained from http://www.epa.gov/region09/waste/sfund/prg/index.htm (October 2004)
- MTCA TE Indicator Soil Concentrations for plants, soil invertebrates and wildlife, obtained from MTCA Table 749-3 (Ecology 2001b)
- Freshwater Sediment LAETs, obtained from Ecology (2003)[8]
- Marine Sediment Quality Standards, obtained from WAC 173-204 (Ecology 1995)[9]
- Puget Sound regional background soil concentrations, obtained from Ecology (1994).

The screening levels were prioritized such that the minimum value of the screening values was used as the SL.

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[7] Human health benchmarks are based upon accumulation of all exposure pathways and the affected populations, but not upon strict direct numerical criteria.

[8] Freshwater LAETs are used for guidance only. Sediment bioassays are the definitive tool for evaluation of ecological risk in freshwater systems.

[9] Marine Sediment Quality Standards are screening criteria. Sediment bioassays are the definitive tool for evaluation of ecological risk in marine systems.

3.5.5 Biological Analyses

There are no screening levels associated with the biological analyses that were conducted at the site. Biological testing of site samples followed EPA, Ecology, and American Society for Testing and Materials (ASTM) Methods (USEPA 1994, Ecology 2003, ASTM 1997) and included 10-day toxicity testing of sediment with the freshwater amphipod *Hyalella azteca*, a 20-day test assessing mortality and growth of the midge *Chironomus tentans*, a 28-day sediment bioaccumulation test with the freshwater oligochaete *Lumbriculus variegates*, and the Microtox® sediment porewater test. Testing results are discussed further in Section 3.6.5.

Freshwater sediment biological assessment methods are outlined in Ecology's Sampling Analysis Plan Appendix (Ecology 2003). These include the following:

- 10-day and 20-day sediment toxicity test that assesses mortality and growth of the midge *Chironomus tentans*
- 96-hour sediment toxicity test that assesses mortality and developmental malformations in embryos of the frog *Xenopus laevis*
- Microtox® 100 percent sediment porewater extract test
- 10-day and 28-day sediment toxicity test that assesses mortality and growth of the amphipod *Hyalella azteca*.

3.6 DATA SCREENING

Analytes with detected concentrations exceeding SLs were considered as potential indicator hazardous substances (IHSs). This section summarizes the degree to which detected concentrations exceeded the thresholds presented in Section 3.5 for each medium. Raw analytical data have been assembled from historical reports into the Integral database for this project. The magnitude by which detected concentrations exceeded screening levels is presented for each media in Tables 3-1 through 3-7.

3.6.1 Soil

Both surface soil and subsurface soil data were available for comparison to screening levels. Results are discussed below.

3.6.1.1 Surface Soil

A total of 20 background samples collected during the OESER RI (E&E 2002a) and 102 site samples collected during the OESER RI (100 samples) and the Ecology (2004) investigation were evaluated. Most of the site surface samples (95) only had TPH field screening analysis performed (method used was laser-induced fluorescence or LIF). None of the detected compounds in background soil samples exceeded screening levels. Surface soils from the site, however, had 48 analytes with detected concentrations exceeding screening levels. Exceedances were found for the following analyte classes (number of individual analytes indicated in parentheses): dioxin (1), metals (12), SVOCs including polycyclic aromatic hydrocarbons (PAHs) and PCP (34), and petroleum hydrocarbons (1). The number of samples exceeding screening levels for these analytes is shown in Table 3-1. TPH had the most number of samples (50) exceeding screening levels. Several ubiquitous metals (barium, vanadium, and zinc) had more than 10 exceedances while many SVOCs only had one sample exceeding screening levels.

3.6.1.2 Subsurface Soil

A total of two background samples collected during the OESER ESI (E&E 1996) and 24 site samples collected during the OESER RI were evaluated. None of the detected compounds in background soil samples exceeded screening levels. Site subsurface soils, however, had six analytes (all metals) with detected concentrations exceeding screening levels. These metals included barium, copper, mercury, nickel, vanadium, and zinc. The number of samples exceeding screening levels for these metals is shown in Table 3-2.

3.6.2 Groundwater

Groundwater data available for screening include background data from one well (MW-06D) – 19 unfiltered samples and eight filtered samples, and site data from five wells – 11 unfiltered samples and six unfiltered samples. Filtered groundwater was only analyzed for metals. Background unfiltered groundwater had one analyte with a detected concentration exceeding its screening level – benzo(a)anthracene (Table 3-3). Background filtered groundwater had an exceedance for one metal – thallium (Table 3-4). Site filtered groundwater had exceedances for four metals – barium, cadmium, magnesium, and manganese (Table 3-4). Site unfiltered groundwater had 24 analytes with detected concentrations exceeding screening levels - 21 SVOCs and three metals (Table 3-3). Most of the exceedances for SVOCs occurred only in WP1.[10] Barium and magnesium had more exceedances than the other analytes (4 and 6, respectively).

3.6.3 Surface Water

A total of 32 site samples provided data for the concentration screening evaluation. These data include samples collected during the ESI (4 surface water samples; E&E 1996), the RA Phase II (3 surface water samples; E&E 1998a,b), the SI (2 surface water samples; E&E 1987), the OESER RI (13 surface water samples, 2 spring samples, and 3 seep samples; E&E 2002a), and the site hazard assessment (5 porewater samples; Parametrix 1991). Both unfiltered and filtered samples were analyzed; filtered samples were only analyzed for

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[10] WP-1 is a shallow well point; hand installed approximately 1 to 2 feet into the center of the creek channel.

metals. Site unfiltered surface water had 23 analytes with detected concentrations exceeding screening levels. Exceedances were found for the following analyte classes (number of individual analytes indicated in parentheses): dioxin (1), metals (8), and SVOCs (14). The number of analytes exceeding screening levels totaled 145, as shown in Table 3-5. Barium, magnesium, and arsenic had the most number of samples (20, 19, 15) exceeding screening levels. Site filtered surface water had exceedances for four metals – aluminum, arsenic, barium, and magnesium (Table 3-6).

3.6.4 Surface Sediment

Data from a total of 54 site surface sediment samples were available for comparison to screening levels; these data were generated as part of several of the historical investigations discussed above. Site samples had 54 analytes with detected concentrations exceeding screening levels. Exceedances were found for the following analyte classes (number of individual analytes indicated in parentheses): dioxins (1), SVOCs (38), petroleum hydrocarbons (1), and metals (14). The number of chemical screening level exceedences within the 54 surface samples totaled 584, as shown in Table 3-7. Eighty percent (471) of the screening level exceedances were for SVOCs and 15% (92) were for metals. Most of the SVOC exceedances (362) were for PAHs. The metals most frequently in exceedance were vanadium (19), zinc (16), and copper (8).

3.6.5 Biological Analyses

This section summarizes results of biological analysis that include sediment toxicity testing, sediment bioaccumulation testing, and berry analysis conducted as part of the OESER Site RI (E&E 2002a) and sediment toxicity testing that was conducted more recently by Ecology (2004). Results are presented in Appendix B.

3.6.5.1 Sediment Toxicity and Bioaccumulation (OESER RI)

Biological analytical results were conducted as part of the OESER site RI (E&E 2002a) and included a 10-day toxicity test with the amphipod *Hyalella azteca* and a 28-day bioaccumulation test with the aquatic oligochaete *Lumbriculus variegates.*[11]

Sediment toxicity testing with *H. azteca* was conducted on samples from eight locations (SD1 through SD8) in the Creek, one location in the channel that leads from the OESER outfall to the creek (SD10), and one location at the Birchwood outfall (SD9), which is considered a site-specific background sample. The Birchwood neighborhood outfall is upstream from the confluence of the OESER outfall channel with the creek. Results are contained in Appendix B, Table B-1.

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[11] It should be noted that the methods and number of tests performed as part of the OESER RI did not follow the requirements of the Washington State Sediment Management Standards, which is an ARAR for this site.

The two test endpoints evaluated were survival and growth. The average percent survival in samples from the creek and OESER outfall channel ranged from 78 to 93%; average percent survival in the background station was 91%. None of the site survival results differed significantly from the survival results in the background sample. The average dry-weight per organism (amphipod growth) in samples from the creek and OESER outfall channel ranged from 0.13 mg to 0.20 mg; average dry weight per organism in the background station was 0.24 mg. It is not known if the growth results in the site samples are significantly different from the growth in the background sample because it was not reported in the OESER RI, and the raw data are not available to make this comparison. It should be noted, however, that average amphipod growth in the laboratory control was only 0.10 mg per organism.

Sediment bioaccumulation testing with *L. variegatus*, was conducted on sediment from three locations in the Creek (SD2, SD5, and SD6). Results are contained in Appendix B, Table B-2 and B-3. Following the 28-day exposure period, the oligochaetes were removed from the sediment and analyzed for bioaccumulative chemicals of concern (COCs), which included several SVOCs (phenols, PAHs, benzoic acid, and benzyl alcohol), and dioxins/furans. At test termination, the average biomass per replicate in the site samples was 3.7 g, 2.9 g, and 11.2 g, respectively, for samples SD2, SD5, and SD6. The average biomass per replicate in the laboratory control was 8.9 g and biomass at test initiation for all samples was 10 g. These data indicate that growth only occurred in sample SD6, the other two site samples and the control each lost weight during the test. The weight loss in samples SD2 and SD5 was significantly greater than the weight loss in the control, suggesting either a toxic effect at these two locations, or significantly reduced food availability. Over the 28-day test period, the worms are not fed and instead must rely on available organic carbon in the sediment to sustain their dietary requirements. The percent TOC in the site samples were 1.3% (SD2), 1.8% (SD5), and 11% (SD6), suggesting that differences in food availability may have contributed to the differences in biomass between the site samples.

The limited biomass obtained from each of the site samples at test termination prevented the analysis of the entire analytical suite at each location, with the exception of the control sample. Rather, analyses were split between the samples: sample SD6 was analyzed for SVOCs, and the biomass from samples SD2 and SD5 was pooled and analyzed for dioxin. Results are summarized in Appendix B along with the corresponding sediment concentrations. Eleven PAHs, six phenols, and two other SVOCs (benzoic acid and benzyl alcohol) were detected in organisms exposed to sediment from location SD6. However, five of these analytes (2,4,6-trichlorophenol, 2-methylphenol, phenol, benzoic acid, and benzyl alcohol) were not detected in sediment from SD6. Seven dioxin/furan congeners were detected in the organisms exposed to sediment from locations SD-02 and SD-05. As compared to sediment dioxin concentrations at these two locations, each of the seven dioxin congeners was also detected in sediment at SD2 and SD5 except for 1,2,3,4,7,8-HxCDD, which was non-detect at both locations.

3.6.5.2 Berry Testing (OESER RI)

Four composite berry samples from Himalayan blackberry (*Rubus discolor*) bushes were collected from the following locations:

- Berry 1: collected by the railroad tracks immediately south of the OESER Company facility
- Berry 2: collected along the old railbed/path above the Creek
- Berry 3: collected from the ravine on the south side of the creek
- Berry 4: collected from a residential background area approximately at the intersection of Squalicum Parkway and Meridian Street in Bellingham, WA.

From all four locations, washed (rinsed with distilled water) and unwashed berries were analyzed for VOCs, SVOCs, and dioxin. Analytes that were detected at least once are presented in Appendix B (Table B-4) and include six PAHs, three other SVOCs (1,2,3-trichlorobenzene, benzoic acid, and benzyl alcohol), two VOCs (p-isopropyltoluene and styrene), and three dioxin/furan congeners (1,2,3,4,6,7,8-HpCDD, OCDD, and OCDF). As expected, in general, concentrations in unwashed berries were greater than concentrations in washed berries. The SVOC 1,2,3-trichlorobenzene was only detected in the washed background sample. All other SVOCs, except from fluoranthene and phenanthrene, were only detected in site samples. Concentrations of fluoranthene and phenanthrene in the berry samples from the site were within the range of concentrations observed in the background sample. The two VOCs were detected in all samples, and concentrations in berry samples from the site bracketed concentrations observed in the background sample. The compounds p-isopropyl toluene, benzoic acid, and benzyl alcohol are naturally occurring in berries. Of the three dioxin congeners detected, two (1,2,3,4,6,7,8-HpCDD and OCDF) were only detected in the site samples. Octachlordibenzo-p-dioxin (OCDD) was detected in all samples except for the washed berries from the background station; site concentrations bracketed the background concentration. Tetrachlorodibenzo-p-dioxin (TCDD) toxicity equivalency quotients (TEQ) concentrations in unwashed berries consistently exceeded concentrations in washed berries, and site concentrations exceeded background concentrations. Based on these results, the risk assessment in the OESER RI concluded that consumption of berries was not an exposure pathway of concern. No additional sampling of berries is planned for the Park RI.

3.6.5.3 Sediment Toxicity (Ecology)

In September of 2003, Ecology collected six surface sediment samples (locations LSC01 through LSC06) and two surface soil samples (LSCS1 and LSCS2) in the vicinity of the Creek (Ecology 2004). Only the sediment samples were submitted for bioassay analysis; however, all samples were analyzed for SVOCs. Three toxicity tests with three different species were conducted on the sediment samples including 10-day amphipod (*Hyalella* *azteca*), 20-day midge (*Chironomus tentans*), and Microtox® tests. Sediment toxicity results are presented in Appendix B (Table B-5).

Results indicated that five of the six sediment samples LSC02, LSC03, LSC04, LSC05, and LSC06 showed toxicity when compared to the control sediment[12] as follows:

- LSC02: mean survival was significantly reduced in the 20-day *C. tentans* test as compared to survival in the control sediment. Growth, however, was greater in this sample than in the control. The bioassay results at this station indicate exceedances of the recommended freshwater Cleanup Screening Level (CSL) endpoint.
- LSC03: mean survival was significantly reduced in the 10-day *H. azteca* test as compared to survival in the control sample. Mean survival and growth were significantly reduced in the 20-day *C. tentans* test as compared to survival and growth in the control sample. Microtox® light output was significantly reduced as compared to light output in the control sample. The bioassay results at this station indicate exceedances of the recommended freshwater CSL endpoint.
- LSC04: mean survival was significantly reduced in the 10-day *H. azteca* test as compared to survival in the control sample (an exceedance of the freshwater SQS endpoint).
- LSC05: Microtox® light output was significantly reduced as compared to light output in the control sample (an exceedance of the freshwater SQS endpoint).
- LSC06: mean survival was significantly reduced in the 10-day *H. azteca* test as compared to survival in the control sample. Microtox® light output was significantly reduced as compared to light output in the control sample. The results for LSC06 represent a CSL exceedance based on the combined results from the *H. azteca* and Microtox bioassays.

3.7 PRELIMINARY CONCEPTUAL SITE MODEL

At this phase of the RI/FS, the CSM presents a preliminary understanding of site conditions. Integral developed the CSM from the information presented in Section 3.6 and general knowledge of site conditions and contaminant transport behavior. Development of a CSM early in the RI/FS process helps identify data gaps and guide collection of data appropriate for assessing risks and remedial actions. The CSM will be refined throughout the project as additional data are collected and site conditions are better understood. The CSM, illustrated in Figure 3-5 and described in Table 3-8, includes

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[12] LSC05 was collected as a background sample for this study. Based on chemistry results, this sample was determined to be inadequate background or reference sediment for regulatory comparisons. Comparisons to control sediment were used in this summary.

sources of contaminants, transport pathways, and potential exposure pathways for human and ecological receptors.

3.7.1 Sources

Several potential contamination sources have been identified for surface soils and surface waters in the Park. OESER disposed of wood-treating wastes north of the creek near the OESER site boundary. In some cases, discharge of process wastewater or contaminated stormwater may have occurred directly into the creek bed and surrounding areas (refer to Section 2). A stormwater pipe combining discharge from OESER and portions of the Birchwood neighborhood (another potential source) discharges to the creek from the north side. Likely contaminants from these activities include the following:

- PCP, a wood treating chemical
- Diesel-range organic hydrocarbons (DRO), used as a carrier for PCP
- Dioxins and furans, common contaminants of PCP
- PAHs, components of both DRO and the wood treating mixture in creosote
- Gasoline-range organic hydrocarbons (GRO) from vehicular activities.

An outfall conveys nonpoint source runoff from Marine Drive into the Creek at the south end of the bridge. A stormwater pipe combining discharge from the BTC campus and portions of the Birchwood neighborhood discharges to the Creek from the south side. A culvert discharges from the BTC parking lot into the southeast corner of the Park. The petroleum released from vehicle runoff on Marine Drive and in the college could be GRO or DRO. Additional potential contaminants from these facilities include a variety of SVOCs including PAHs and phthalates, both of which are common in urban runoff, and metals from vehicular activities and general urban runoff.

A gravel pit operated south of the creek, both east and west of Marine Drive. Gravel operations could have been a source of petroleum hydrocarbons (DRO) from the use of motorized equipment (e.g., diesel fuel and motor oil).

Historically, a construction material landfill operated beneath what is now a portion of the BTC parking lot. Based on historical sampling, a debris field was documented in the southeast corner of the Park near BTC. The debris is believed to be primarily construction materials rather than municipal landfill materials.

The BNSF railroad tracks could be a source of pesticides and DRO, including PAHs, to the soils in the vicinity of the tracks. Pesticides and oily products have been reportedly used to treat the wood in the ties and to control vegetation along the tracks.

3.7.2 Transport Pathways

Infiltration from rainfall could cause contaminants in surface soils to leach to subsurface soils and eventually to groundwater. Shallow groundwater might discharge into the creek. The groundwater is also hydraulically connected to Bellingham Bay. Groundwater contaminants could eventually reach surface water and sediments in the creek, the bay, or both.

Soil contaminants could be carried in surface runoff to the surface water in the Creek. Some of the contaminants in surface water could bind to sediments in the creek. Other surface water contaminants could be carried down the creek to the beach and the surface water and sediments of Bellingham Bay.

Many of the contaminants that reach the mouth of the creek are likely to be dispersed into Bellingham Bay because the beach is a highly exposed area with a great deal of erosion. The shallow portions of the beach are primarily cobbles and gravel, with little fine-grained sediments to adsorb chemicals.

Soils in areas not covered by vegetation could become airborne and transported by wind. If GRO is present from urban runoff, some volatilization could occur. The other contaminants of interest are not volatile, so volatilization is not likely to be an important transport pathway for them.

Contaminants in surface and subsurface soil could be taken up by plants and soil-dwelling invertebrates. Contaminants in surface water and sediments of the creek or the bay could be ingested by benthic organisms (animals and plants living in the sediments).

In addition, if the creek were rerouted to another portion of the park, sediment would become soil and soil would become sediment, changing potential pathways for contamination at any given location. If excavation takes place to create a "new" creek bed for the rerouted creek, formerly buried contamination could be exposed and thus potentially transported elsewhere.

3.7.3 Potential Receptor Populations and Exposure Pathways

Potential human receptors include the following:

- Recreational Park users
- Maintenance workers working in the Park
- Residents near the Park
- Workers at BTC, OESER, and other work sites near the Park.

Potential ecological receptors include the following:

- Terrestrial and aquatic plants
- Soil-dwelling invertebrates (e.g., worms)
- Terrestrial animals (e.g., birds, mammals, amphibians, and reptiles)
- Domesticated animals (e.g., dogs)
- Various fish species (e.g., salmonids)
- Benthic invertebrates (e.g., snails).

Park users, maintenance and construction workers, and terrestrial animals could be exposed to contaminants in surface soil by direct contact (unintentional ingestion and absorption across the skin) with the soil or by inhalation of airborne particulates. Residents, workers, and terrestrial animals near the park could inhale dust blown out of the Park. Terrestrial plants could take up contaminants from surface and shallow subsurface soils and consume contaminated plants or soil-dwelling invertebrates while foraging for food in the park. Park users could be exposed to contaminants by ingesting local plants (e.g., berries).

If park development or maintenance activities uncovered subsurface soil, Park users, maintenance workers, and terrestrial animals could be exposed to the subsurface soil through direct contact or inhalation. The subsurface soil would be come available for windblown transport to residents, workers, and terrestrial animals near the Park. If the creek is re-routed, surface and subsurface soils could be converted to sediments with sediment/biota exposure routes.

Ecological receptors are not likely to be exposed directly to groundwater, because groundwater is likely deeper than the active zone for plant roots and burrowing animals (typically 6 ft). Pending future site investigations, the groundwater is assumed to be potable if a well were drilled; though it is unlikely a well will be drilled in the Park. If a well were drilled, users could be exposed through ingestion of the water, dermal contact with the water, and inhalation of vapors generated during household activities such as showering. As discussed in Section 3.7.2, groundwater contaminants could be transported from upgradient sources to the Creek, Bellingham Bay, or both.

Park users could be exposed to contaminants in surface water and sediments through direct contact while recreationally using the Creek. Park maintenance workers are unlikely to have much contact with the creek. Terrestrial animals could be exposed to surface water and sediments through direct contact while foraging for prey and through intentionally drinking the water. Terrestrial animals could also be exposed by eating contaminated prey in the creek.

If groundwater or surface water contaminants reach Bellingham Bay, humans could be exposed through direct contact with water and sediments while collecting shellfish or wading recreationally and through ingestion of shellfish caught locally. Birds or animals preying on shellfish and fish migrating into the Creek could also be exposed through direct contact with the surface water and the sediments and through ingestion of the shellfish and fish.

3.8 DATA GAPS

Data gaps can include the following issues:

- Poor data quality
- Inappropriate analytes
- Lack of data for an area or at depth (spatial)
- Lack of current data (temporal)
- Undefined media (sediment vs. soil) and exposure routes.

Section 3.1 discussed the quality of data collected previously at the site. Because of age, data quality problems, or both, this analysis will not use any of the chemical data collected prior to 1996. However, the physical data collected by Landau (DEA 1993) will be used. This eliminates only a small portion of the total data available. Most of the samples have been analyzed for the contaminants of interest (TPH, SVOCs, PAHs, metals, and dioxins/furans). The discussion of data gaps will focus on spatial and temporal issues, based on a review of available data and locations of site concentrations that exceed SLs (Section 3.6).

3.8.1 Soils

Soil data gaps are primarily spatial. Although soils along the slope north of the Creek near the OESER property have been studied, no recent soil data are available for the old gravel pit areas on the south side of the Creek. Limited data are available in the vicinity of the railroad tracks (BNSF) and the stormwater discharge from BTC. Soil sampling will focus on these three areas southeast of the Creek. A pattern regarding metals contamination in soils was noted during the OESER RI (E&E 2002a). Several metals appear to be elevated in the area of the Park, so metals analyses will be of interest in the Park RI/FS.

Soil sampling at depth in the areas south of the Creek is necessary because of the possibility of rerouting the Creek into these areas. It might be necessary to dig a new streambed or the re-routed stream might erode surface soils, either of which could expose deeper soils. An understanding of the chemical and physical characteristics of soils in these areas is important for completion of the RI.

Temporal issues are not expected to be an important concern for soils. VOCs detected in surface soil samples more than a couple years ago may have volatilized, so they would be present at lower or nondetectable concentrations now (presuming no additional deposition since the earlier sampling events). Risk estimates based on older soil VOC data could be biased high. However, few VOCs have exceeded their SLs in previous investigations. Since VOCs are not expected to be important chemicals of concern, this chemical group is not proposed for further soils testing.[13]

3.8.2 Groundwater

Groundwater does not appear to be a medium of primary concern at the Park based on sampling and testing results in the OESER RI. No additional wells are proposed within the boundaries of the Park. However, additional groundwater sampling of wells located downgradient of the OESER site is warranted to provide current data for evaluating potential risk to humans and the environment. Piezometers may be installed in selected soil/sediment sampling locations to monitor seasonal fluctuations in shallow groundwater and sample groundwater (refer to Section 4.1.2 and 4.4.2, respectively).

3.8.3 Surface Water

Data gaps for surface water are primarily temporal. Contaminant concentrations in the surface water of the Creek are expected to vary over time because of variable inputs from upstream sources and the discharges from Marine Drive, OESER, BTC, and the Birchwood neighborhood. Additional surface water sampling is warranted to provide current data, focusing on discharge areas and identification of sources.

3.8.4 Sediments

Sediment data gaps are both spatial and temporal. Sediment concentrations in the Creek are expected to vary to some extent over time because of interactions with surface water; therefore, older data may not be entirely representative of current sediment conditions. The sediment sampling in the Creek has encompassed most of the length of the creek, but it has not characterized the depth or width of the contaminated sediments. These spatial issues will be important if sediment remediation is warranted.

A round of sediment sampling, at both surface and depth, is warranted to provide current data, focusing on bounding areas of higher concentrations detected in previous sampling

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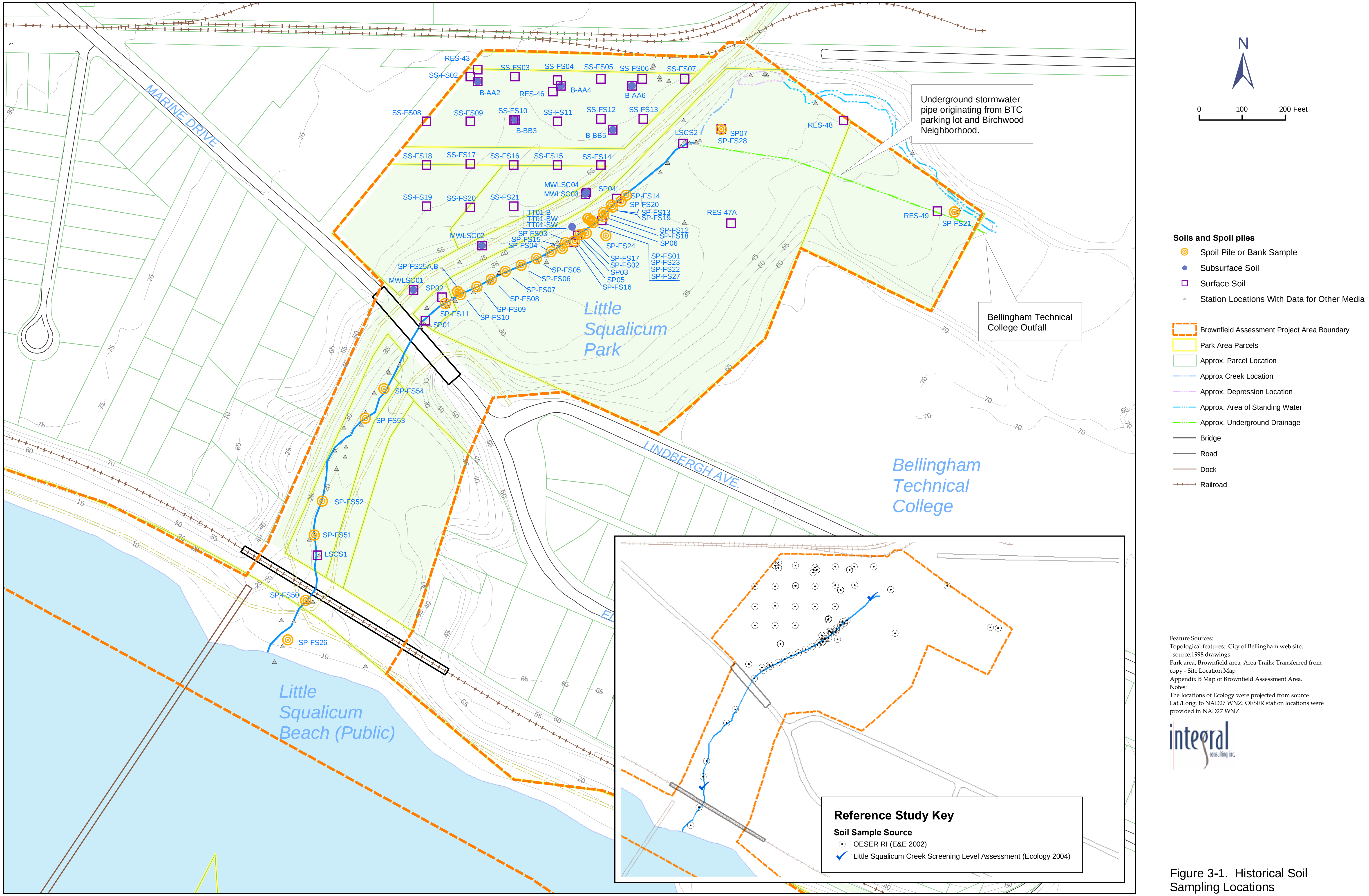
[13] Soil vapors are typically not a concern at levels historically detected at the site. This pathway will be evaluated in the RI pending the results of this sampling event.

efforts and conducting transects across the creek to identify the lateral and vertical extent of sediment contamination.

The highly eroded nature of the beach and the results of previous investigations indicate a low level of concern for the beach located at the mouth of the Creek. Nevertheless, since humans may collect shellfish at the beach, additional beach sediment samples (if sufficient fine-grained sediments can be found within the discharge area of the Creek) will be collected to verify that potential contamination does not pose a health threat.

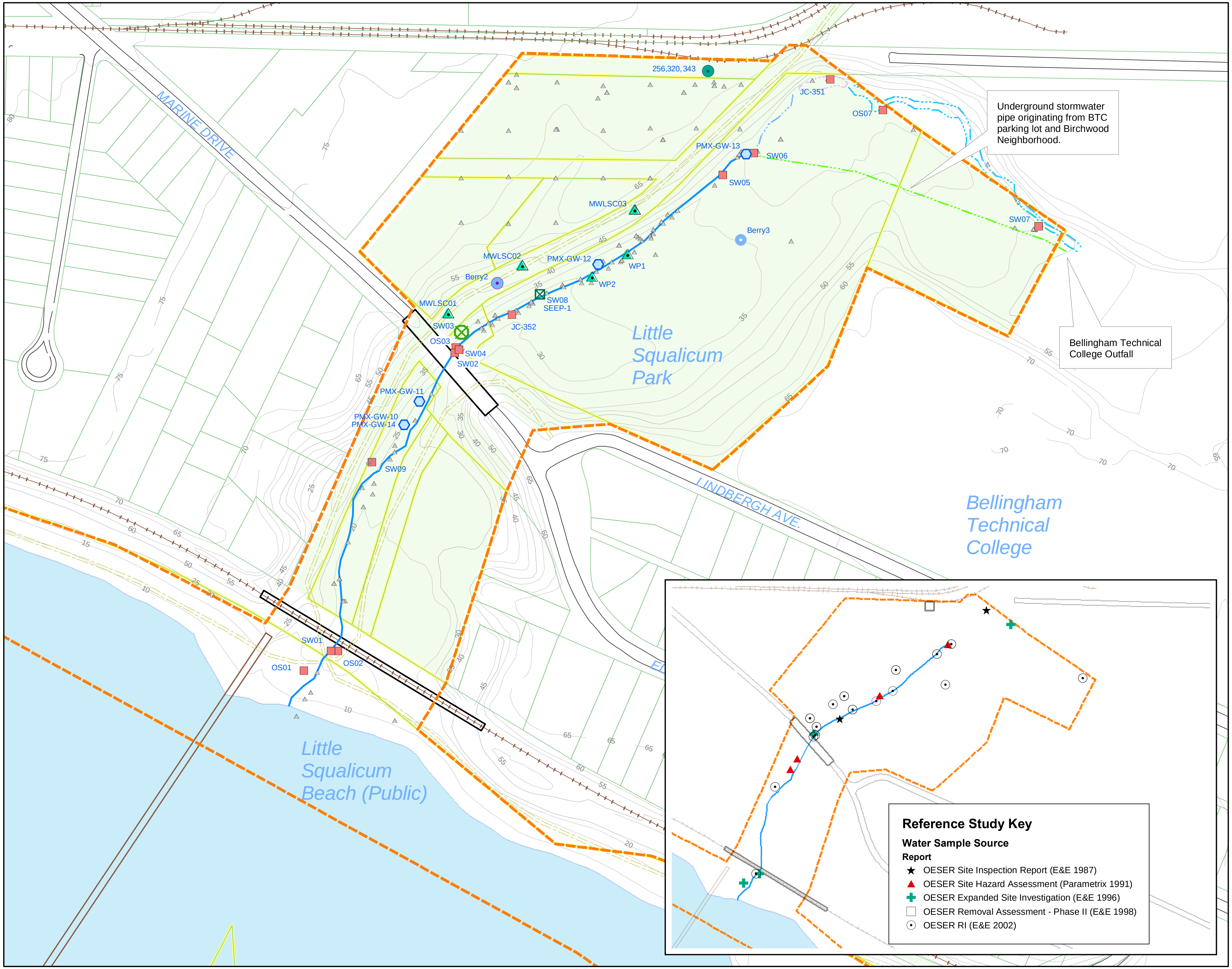
Sediment in the creek may potentially be reclassified as "soil" if the creek is rerouted to other areas of the Park. Consequently, sediment collected in the creek will be tested as if it will be soil. In addition, soil in the area where the creek could be rerouted will be tested as if it would (later) be sediment.



Feature Sources:
Topological features: City of Bellingham web site, source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from copy - Site Location Map
Appendix B Map of Brownfield Assessment Area.
Notes:
The locations of Ecology were projected from source Lat./Long. to NAD27 WNZ. OESER station locations were provided in NAD27 WNZ.

Map Document: (C:\GIS\Projects\LittleSqualcumCr\Sample_Locations_WORKMAP_V4_recov2.mxd)
10/21/2004 -- 8:26:13 AM

Figure 3-1. Historical Soil Sampling Locations



Feature Sources:
Topological features: City of Bellingham web site,
source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from copy - Site Location Map
Appendix B Map of Brownfield Assessment Area.
Notes:
The locations of Ecology were projected from source Lat./Long. to NAD27 WNZ. OESER station locations were provided in NAD27 WNZ.

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Figure 3-2. Historical Water Sampling Locations

Map Document: (C:\GIS\Projects\LittleSqualcumCr\Sample_Locations_WORKMAP_V4_recov2.mxd)
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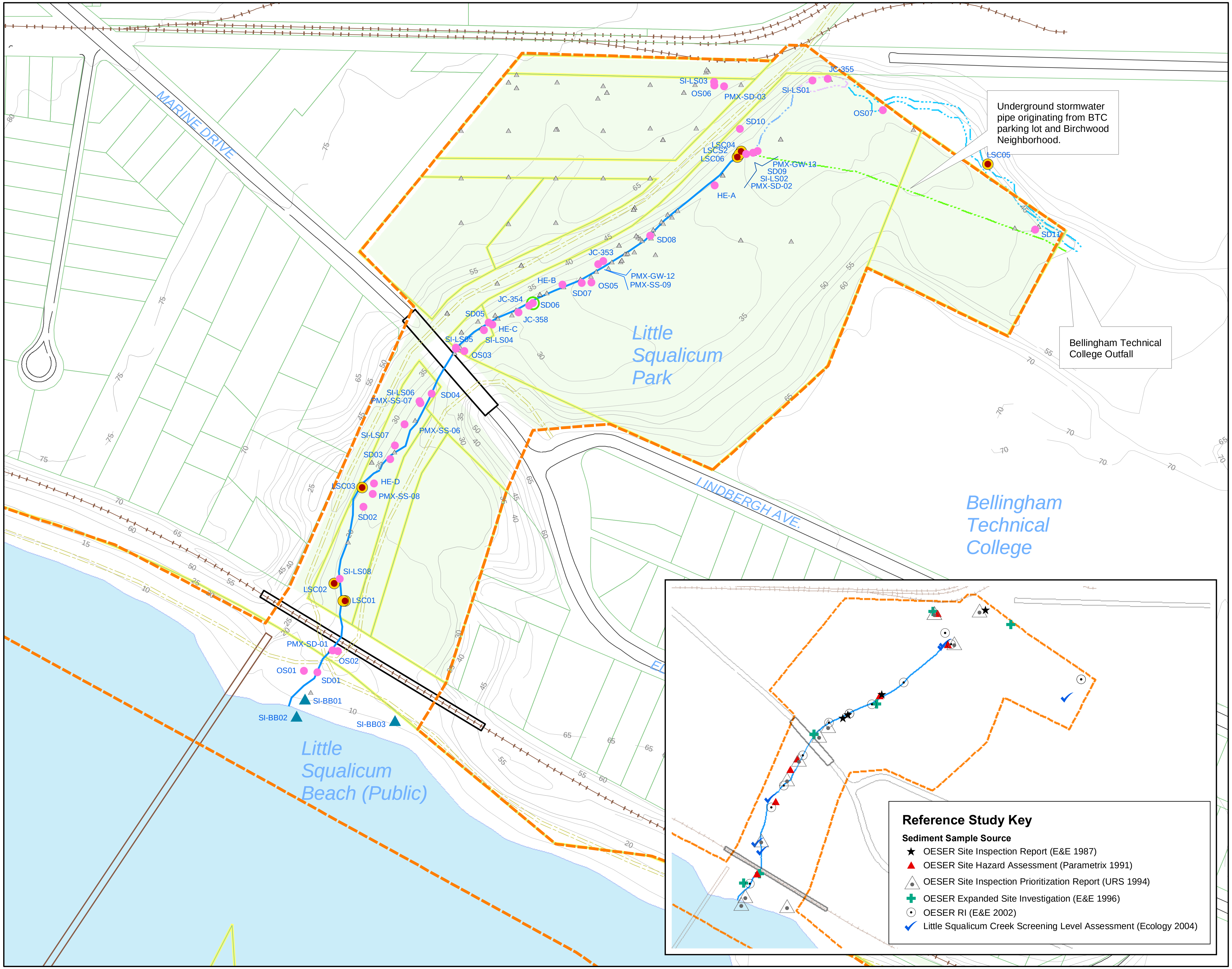

Feature Sources:
Topological features: City of Bellingham web site,
source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from copy - Site Location Map
Appendix B Map of Brownfield Assessment Area.
Notes:
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Map Document: (C:\GIS\Projects\LittleSqualicumCr\Sample_Locations_WORKMAP_V4_recov2.mxd)
10/21/2004 -- 8:26:13 AM

Figure 3-3. Historical Sediment Sampling Locations

Map Document: (C:\GIS\Projects\LittleSqualicumCr\Landau_Approx_1993_Test_Locs_BL.mxd)
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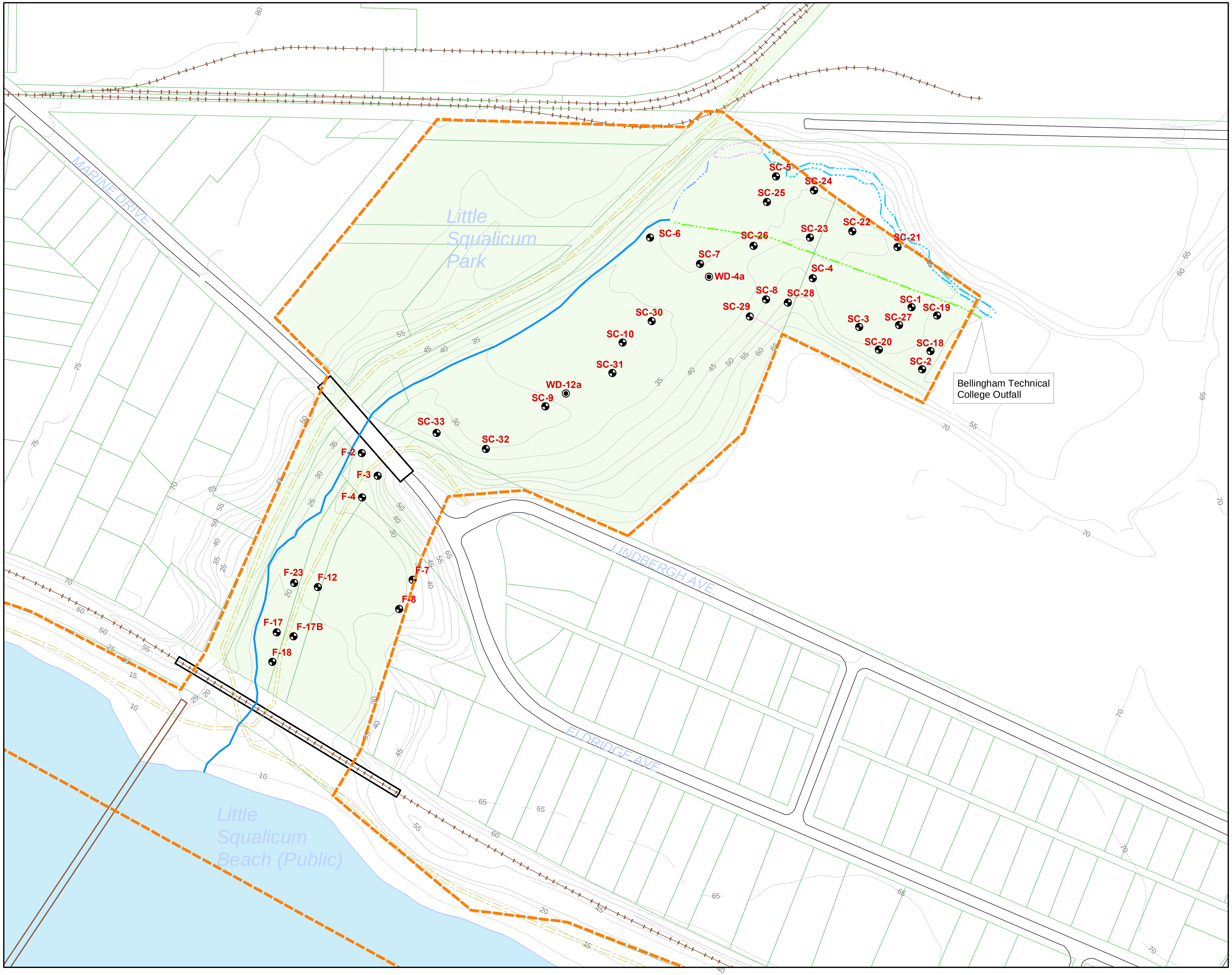


1993 Wetland Mitigation Plan Station References

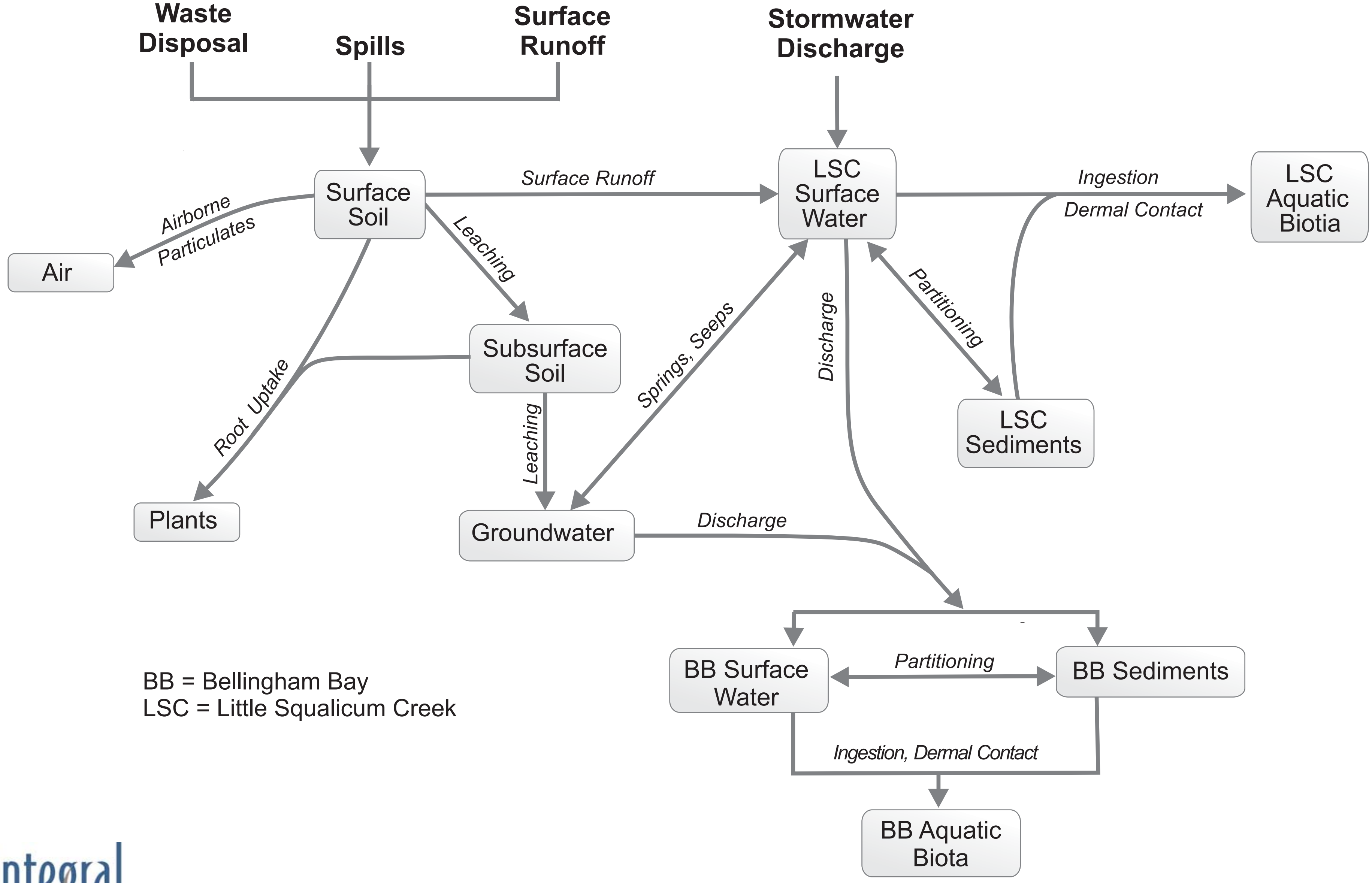
◉ Watershed Dynamics Piezometer Approximate Location and Identification; Water Observed in 10/92.

⊕ Landau Associates Test or Hand Pit Approximate Location and Identification.

- Little Squalicum Park Boundary
- Approximate Parcel Location
- Approx. Creek Location
- Approx. Depression Location
- Approx. Area of Standing Water
- Approx. Underground Drainage
- Bridge
- Road
- Dock
- Railroad

Feature Sources:
Topological features: City of Bellingham web site,
source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from copy - Site Location Map
Appendix B Map of Brownfield Assessment Area.
Notes:
The locations of Ecology were projected from source Lat./Long. to NAD27 WNZ. OESER station locations were provided in NAD27 WNZ.

Figure 3-4. Historical Geotechnical Sampling LocationsL



BB = Bellingham Bay
LSC = Little Squalicum Creek

Figure 3-5.
Conceptual Site Model

Table 3-1. Summary of Detected Analytes in Site Surface Soil Exceeding Screening Levels.

			Screening Level		Total Sample	Number of	Maximum	Location
	Analyte	**Units**	**Value**	**Basis**	**Number**	**Exceedances**	**Value**	**of Maximum**
Dioxins								
	TEQ (ND=0.5 DL)	ng/Kg	49.77	site-specific background	21	8	2415.97	SP07
SVOCs								
PAHs								
	2-Methylnaphthalene	mg/kg	0.38	Ecology SQS	23	2	11	SP02
	Acenaphthene	mg/kg	0.16	Ecology SQS	23	3	72	SP02
	Acenaphthylene	mg/kg	0.47	Ecology LAET	23	4	1.2	SP02
	Anthracene	mg/kg	1.23	Ecology LAET	23	4	78	SP02
	Fluorene	mg/kg	0.23	Ecology SQS	18	3	57	SP02
	Naphthalene	mg/kg	0.53	Ecology LAET	23	1	5.5	SP02
	Phenanthrene	mg/kg	1	Ecology SQS	23	3	200	SP02
	Total LPAH	mg/kg	3.7	Ecology SQS	23	4	413.7	SP02
	Benz[e]acephenanthrylene	mg/kg	0.14	MTCA Method B	1	1	14	SP02
	Benzo(a)anthracene	mg/kg	0.377	site-specific background	23	6	51	SP02
	Benzo(a)pyrene	mg/kg	0.455	site-specific background	23	8	35	SP02
	Benzo(b)fluoranthene	mg/kg	0.66	site-specific background	23	7	11	SP02
	Benzo(k)fluoranthene	mg/kg	0.24	site-specific background	23	8	11	SP02
	Total Benzo(b,k)fluoranthenes	mg/kg	2.3	Ecology SQS	23	5	22	SP02
	Benzo(g,h,i)perylene	mg/kg	0.422	site-specific background	23	8	7.3	SP02
	Chrysene	mg/kg	0.628	site-specific background	23	8	74	SP02
	Dibenzo(a,h)anthracene	mg/kg	0.376	site specific background	23	6	2.2	SP02
	Fluoranthene	mg/kg	1.6	Ecology SQS	23	3	150	SP02
	Indeno(1,2,3-cd)pyrene	mg/kg	0.612	site-specific background	23	8	9.2	SP02
	Pyrene	mg/kg	8.79	Ecology LAET	23	1	170	SP02
	Total HPAH	mg/kg	9.6	Ecology SQS	23	5	520.7	SP02
Other	2,4-Dimethylphenol	mg/kg	0.029	Ecology SQS	23	4	0.077	LSCS1
	2,4-Dinitrotoluene	mg/kg	0.0008	EPA Region 9 PRG	23	3	0.045	B-BB3
	2,6-Dinitrotoluene	mg/kg	0.0007	EPA Region 9 PRG	23	1	0.022	B-BB3
	2-Methylphenol	mg/kg	0.063	Ecology SQS	23	2	0.065	LSCS2
	Benzoic acid	mg/kg	2.03	Site-specific background	23	2	2.8	LSCS1
	Benzyl alcohol	mg/kg	0.057	Ecology SQS	23	4	1.1	SP03
	bis(2-Ethylhexyl)phthalate	mg/kg	0.47	Ecology SQS	23	4	6.18	LSCS2
	Butylbenzylphthalate	mg/kg	0.049	Ecology SQS	23	4	0.666	LSCS1
	Dibenzofuran	mg/kg	0.15	Ecology SQS	23	2	9.9	SP02
	Dimethylphthalate	mg/kg	0.311	Ecology LAET	23	1	3.13	LSCS1
	Hexachlorobenzene	mg/kg	0.004	Ecology SQS	23	2	0.014	LSCS2
	Pentachlorophenol	mg/kg	0.03	EPA Region 9 PRG	23	8	5.96	LSCS1
	Phenol	mg/kg	0.42	Ecology SQS	23	1	0.429	LSCS2
Petroleum Hydrocarbons								
	TPH Screen or EPH	mg/kg	200.00	MTCA TEE soil	95	50	5533	SP02
Metals								
	Antimony	mg/kg	0.6	Ecology LAET	16	7	36	MWLSC01
	Arsenic	mg/kg	9.09/7	site-specific background	21	4	150	MWLSC01
	Barium	mg/kg	102.00	MTCA TEE wildlife	16	15	510	MWLSC01
	Copper	mg/kg	50.00	MTCA TEE soil	16	3	92	MWLSC01
	Lead	mg/kg	50.00	MTCA TEE plant	16	5	170	MWLSC01
	Manganese	mg/kg	1200.00	Puget Sound Background	16	1	1400	SP05
	Mercury	mg/kg	0.10	MTCA TEE soil	16	9	0.33	SP07
	Nickel	mg/kg	48	Puget Sound Background	16	2	50	SP05
	Selenium	mg/kg	0.30	MTCA TEE wildlife	16	3	3.4	B-AA2
	Silver	mg/kg	0.545	Ecology LAET	16	1	0.7	B-AA2
	Vanadium	mg/kg	2	MTCA TEE plant	16	16	77	B-BB3
	Zinc	mg/kg	86.00	MTCA TEE plant	16	12	610	MWLSC01

Notes:

Ecology SQS - Values normalized to TOC were denormalized by multiplying 0.01 (1% TOC was assumed to be the average for site soils and sediments).

Table 3-2. Summary of Detected Analytes in Site Subsurface Soil Exceeding Screening Levels.

Analyte	Units	Screening Value Level	 Basis	Total Sample Number	Number of Exceedances	Maximum Value	Location of Maximum
Barium	mg/kg	102	MTCA TEE wildlife	11	5	260	B-BB5
Copper	mg/kg	50	MTCA TEE soil	11	1	58	B-AA4
Mercury	mg/kg	0.10	MTCA TEE soil	11	3	0.23	B-AA2
Nickel	mg/kg	59.4	Maximum Detected Background	11	1	94	B-AA4
Vanadium	mg/kg	62.5	site-specific background	11	4	83	B-AA4
Zinc	mg/kg	86	MTCA TEE plant	11	1	99	B-AA4

Table 3-3. Summary of Detected Analytes in Unfiltered Groundwater Exceeding Screening Levels.

				Background Unfiltered Groundwater				Site Unfiltered Groundwater			
Analyte	**Units**	**Level**	**Screening Value Basis**	**Samples Analyzed**	**Detections Exceeding SL**	**Maximum Detected Concentration**	**Location of Maximum**	**Samples Analyzed**	**Detections Exceeding SL**	**Maximum Detected Concentration**	**Location of Maximum**
SVOCs											
PAHs											
2-Methylnaphthalene	µg/L	329.55	EPA Region 5	--	--	--	--	11	1	340	WP1
Acenaphthene	µg/L	38	Region 5	--	--	--	--	11	1	930	WP1
Anthracene	µg/L	0.73	Tier II	--	--	--	--	11	2	430	WP1
Fluorene	µg/L	3.9	Tier II	--	--	--	--	11	1	940	WP1
Naphthalene	µg/L	12	Tier II	--	--	--	--	11	1	85	WP1
Phenanthrene	µg/L	3.6	EPA Region 5	--	--	--	--	11	1	1700	WP1
Benzo(a)anthracene	µg/L	0.0140	Site-specific background	16	1	0.014	MW06-D	11	3	380	WP1
Benzo(a)pyrene	µg/L	0.0076	Site-specific background	--	--	--	--	11	2	150	WP1
Benzo(b)fluoranthene	µg/L	0.0150	Site-specific background	--	--	--	--	5	2	100	WP1
Benzo(k)fluoranthene	µg/L	0.0120	MTCA GW Method B	--	--	--	--	5	2	100	WP1
Benzo(g,h,i)perylene	µg/L	7.64	Tier II	--	--	--	--	11	1	28	WP1
Chrysene	µg/L	0.0170	Site-specific background	--	--	--	--	11	2	300	WP1
Dibenzo(a,h)anthracene	µg/L	0.0038	EPA NAWQC	--	--	--	--	11	2	12	WP1
Fluoranthene	µg/L	1.9	EPA Region 5	--	--	--	--	11	2	1400	WP1
Indeno(1,2,3-cd)pyrene	µg/L	0.0038	EPA NAWQC	--	--	--	--	11	2	37	WP1
Pyrene	µg/L	0.3	EPA Region 5	--	--	--	--	11	2	1100	WP1
Other											
Benzyl alcohol	µg/L	8.6	Tier II	--	--	--	--	11	1	9.8	WP1
Dibenzofuran	µg/L	3.7	Tier II	--	--	--	--	11	1	490	WP1
Pentachlorophenol	µg/L	0.39	Site-specific background	--	--	--	--	11	1	0.84	WP2
2,4-Dinitrotoluene	µg/L	0.11	EPA NAWQC	--	--	--	--	11	1	25	WP1
3,3'-Dichlorobenzidine	µg/L	0.0210	EPA NAWQC	--	--	--	--	11	1	11	WP1
Metals (Total)											
Barium	µg/L	43.4	Site-specific background	--	--	--	--	6	4	86.8	MWLSC01
Magnesium	µg/L	16200	Site-specific background	--	--	--	--	6	6	21400	MWLSC02
Manganese	µg/L	282	Site-specific background	--	--	--	--	6	3	420	MWLSC01

Table 3-4. Summary of Detected Analytes in Filtered Groundwater Exceeding Screening Levels.

				Background Filtered Groundwater				Site Filtered Groundwater			
Analyte	**Units**	**Level**	**Screening Value Basis**	**Samples Analyzed**	**Detections Exceeding SL**	**Maximum Detected Concentration**	**Location of Maximum**	**Samples Analyzed**	**Detections Exceeding SL**	**Maximum Detected Concentration**	**Location of Maximum**
Metals											
Barium	µg/L	43.4	Site-specific background	--	--	--	--	6	3	89.2	MWLSC01
Cadmium	µg/L	0.25	EPA NAWQC	--	--	--	--	6	1	0.47	MWLSC03
Magnesium	µg/L	16200	Site-specific background	--	--	--	--	6	6	22900	MSLSC02
Manganese	µg/L	282	Site-specific background	--	--	--	--	6	3	400	MWLSC01
Thallium	µg/L	0.24	EPA NAWQC	7	1	2.7	MW06-D	--	--	--	--

Table 3-5. Summary of Detected Analytes in Unfiltered Surface Water Exceeding Screening Levels.

				Site Unfiltered Surface Water(1)			
Analyte	**Units**	**Level**	**Screening Value Basis**	**Samples Analyzed**	**Detections Exceeding SL**	**Maximum Detected Concentration**	**Location of Maximum**
Dioxins							
TEQ (ND=0.5 DL)	pg/L	0.003	Region 5 ESL	17	13	164.775	SW05
SVOCs							
PAHs							
Anthracene	µg/L	0.73	Tier II SCV (Suter and Tsao 1996)	32	6	25	GW-13
Benzo(a)anthracene	µg/L	0.027	Tier II SCV (Suter and Tsao 1996)	32	5	8	GW-13
Benzo(a)pyrene	µg/L	0.014	Tier II SCV (Suter and Tsao 1996)	32	14	14	GW-13
Benzo(b)fluoranthene	µg/L	0.0296	MTCA Method B	23	5	79	GW-13
Benzo(k)fluoranthene	µg/L	0.0296	MTCA Method B	23	1	0.04	256
Benzo(g,h,i)perylene	µg/L	7.64	EPA Region 5 ESL	32	1	89	GW-13
Chrysene	µg/L	0.0296	MTCA Method B	32	11	86	GW-13
Fluoranthene	µg/L	1.9000	EPA Region 5 ESL	32	4	12	GW-10
Fluorene	µg/L	3.9000	Tier II SCV (Suter and Tsao 1996)	32	1	4	GW-13
Indeno(1,2,3-cd)pyrene	µg/L	0.0296	EPA Region 5 ESL	32	3	0.2	SW08
Phenanthrene	µg/L	3.6000	EPA Region 5 ESL	32	1	7	GW-13
Pyrene	µg/L	0.3000	EPA Region 5 ESL	31	4	32	GW-10
Other							
bis(2-Ethylhexyl)phthalate	µg/L	3	Tier II SCV (Suter and Tsao 1996)	32	5	50	GW-13
Pentachlorophenol	µg/L	4.9102	MTCA Method B	32	6	112	GW-13
Metals (Total)							
Aluminum	µg/L	87	CCC (EPA 2002)	20	6	1610	SW08
Arsenic	µg/L	0.0982	MTCA Method B	20	15	1.1	SW06
Barium	µg/L	4	Tier II SCV (Suter and Tsao 1996)	20	20	112	SW08
Copper	µg/L	9	CCC (EPA 2002) 1	20	1	10.9	SW08
Iron	µg/L	1000	CCC (EPA 2002)	20	1	1530	SW08
Lead	µg/L	2.5	Ecology (WAC 173-201A-040) 1	20	1	4.15	SW05
Magnesium	µg/L	647	EPA Region 6	20	19	26200	OS03
Manganese	µg/L	120	Tier II SCV (Suter and Tsao 1996)	20	2	176	OS07

Notes:
(1) Includes surface water, spring, seep, porewater samples.

Table 3-6. Summary of Detected Analytes in Filtered Surface Water Exceeding Screening Levels.

Analyte	Units	Level	Screening Value Basis	Site Filtered Surface Water(1) Samples Analyzed	Detections Exceeding SL	Maximum Detected Concentration	Location of Maximum
Metals							
Aluminum	µg/L	87	CCC (EPA 2002)	12	2	126	SW06
Arsenic	µg/L	0.0982	MTCA Method B	12	9	0.92	SO01
Barium	µg/L	4	Tier II SCV (Suter and Tsao 1996)	12	12	33.3	SW06
Magnesium	µg/L	647	EPA Region 6	12	12	26800	OS03

Notes:
(1) Includes surface water, spring, seep, porewater samples.

Table 3-7. Summary of Detected Analytes in Site Sediment Exceeding Screening Levels.

Anatyte	Units	Screening Level		Total Sample Number	Number of Exceedances	Maximum Value	Location of Maximum
		Value	Basis				
Dioxins							
TEQ (ND=0.5 DL)	ng/Kg	19	Puget Sound Background	12	8	1012.063	SD10
SVOCs							
PAHs							
2-Methylnaphthalene	mg/kg	0.53	Ecology LAET	54	1	2.61	LSC03
Acenaphthene	mg/kg	0.16	Ecology SQS	54	13	12	LSC03
Acenaphthylene	mg/kg	0.47	Ecology LAET	50	1	0.608	SI-BB01
Anthracene	mg/kg	1.23	Ecology LAET	54	15	36.8	LSC03
Fluorene	mg/kg	0.23	Ecology SQS	54	14	17	LSC03
Naphthalene	mg/kg	0.53	Ecology LAET	54	1	3.82	LSC03
Phenanthrene	mg/kg	1	Ecology SQS	54	9	33	LSC03
Total LPAH	mg/kg	3.7	Ecology SQS	54	11	105.23	LSC03
Benzo(a)anthracene	mg/kg	0.137	MTCA Method B	54	33	30.2	LSC03
Benzo(a)pyrene	mg/kg	0.137	MTCA Method B	54	36	20.7	LSC03
Benzo(b)fluoranthene	mg/kg	0.137	MTCA Method B	54	34	21.9	LSC03
Benzo(k)fluoranthene	mg/kg	0.137	MTCA Method B	54	27	13.1	LSC03
Total Benz(bk)fluoranthenes	mg/kg	2.3	Ecology SQS	54	22	47.97	JC-358
Benzo(g,h,i)perylene	mg/kg	0.31	Ecology SQS	54	24	6.75	LSC03
Chrysene	mg/kg	0.137	MTCA Method B	54	36	55.5	LSC03
Dibenzo(a,h)anthracene	mg/kg	0.12	Ecology SQS	54	20	1.7	JC-353
Fluoranthene	mg/kg	1.6	Ecology SQS	54	11	86.3	LSC03
Indeno(1,2,3-cd)pyrene	mg/kg	0.137	MTCA Method B	54	28	10	LSC03
Pyrene	mg/kg	8.79	Ecology LAET	54	3	78	LSC03
Total HPAH	mg/kg	9.6	Ecology SQS	54	23	324.02	LSC03
Other							
2,4-Dimethylphenol	mg/kg	0.029	Ecology SQS	50	9	0.22	OS04
2,4-Dinitrotoluene	mg/kg	0.0008	Region 9 Leaching	50	1	0.038	PMX-SS-08
2,6-Dinitrotoluene	mg/kg	0.0007	Region 9 Leaching	50	1	1.09	PMX-SS-08
2-Methylphenol	mg/kg	0.063	Ecology SQS	50	2	0.198	LSC05
Benzoic acid	mg/kg	0.65	Ecology SQS	42	6	8.24	LSC05
Benzyl alcohol	mg/kg	0.057	Ecology SQS	42	7	6.29	LSC05
bis(2-Ethylhexyl)phthalate	mg/kg	0.47	Ecology SQS	54	13	2.04	PMX-SS-08
Butylbenzylphthalate	mg/kg	0.049	Ecology SQS	54	8	0.508	OS04
Carbazole	mg/kg	0.6	Region 9 Leaching	27	1	4.78	LSC03
Dibenzofuran	mg/kg	0.15	Ecology SQS	54	10	1.1	HE-B
Dimethylphthalate	mg/kg	0.311	Ecology LAET	54	12	4.91	PMX-SS-08
di-n-Butylphthalate	mg/kg	0.103	Ecology LAET	50	1	0.187	PMX-SS-08
di-n-Octylphthalate	mg/kg	0.011	Ecology LAET	50	3	0.142	PMX-SS-08
Hexachlorobenzene	mg/kg	0.004	Ecology LAET	50	1	0.076	LSC06
n-Nitrosodimethylamine	mg/kg	0.0196	MTCA Method B	14	1	0.173	LSC02
N-nitrosodiphenylamine	mg/kg	0.11	Ecology SQS	50	2	0.435	PMX-SD-01
Pentachlorophenol	mg/kg	0.03	Region 9 Leaching	54	29	4.73	PMX-SD-03
Phenol	mg/kg	0.42	Ecology SQS	50	2	2.11	LSC05
Petroleum Hydrocarbons							
TPH	mg/kg	200	MTCA TEE soil	24	13	1393	SD06
Metals							
Antimony	mg/kg	0.6	Ecology LAET	19	6	8.3	OS06
Arsenic	mg/kg	7	Puget Sound Bkgd	19	2	30.9	OS06
Barium	mg/kg	102	MTCA TEE wildlife	19	5	160	SD06
Chromium	mg/kg	48	Puget Sound Bkgd	19	7	249	OS01
Cobalt	mg/kg	20	MTCA TEE plant	19	6	115	OS07
Copper	mg/kg	50	MTCA TEE soil	19	8	104	OS04
Lead	mg/kg	50	MTCA TEE plant	19	3	70	SD06
Mercury	mg/kg	0.1	MTCA TEE soil	19	2	0.198	OS06
Nickel	mg/kg	48	Puget Sound Bkgd	19	7	139	OS01
Silver	mg/kg	0.545	LAET	19	1	30	SD04
Vanadium	mg/kg	2	MTCA TEE plant	19	19	69	SD11
Zinc	mg/kg	86	MTCA TEE plant	19	16	360	SD06
AVS/SEM							
Lead	mg/kg	50	MTCA TEE plant	12	1	58	SD06
Zinc	mg/kg	86	MTCA TEE plant	12	9	445	SD06

Notes:

Ecology SQS - Values normalized to TOC were denormalized by multiplying 0.01 (1% TOC was assumed to be the average for site soils and sediments).

Table 3-8. Receptors and Exposure Pathways, City of Bellingham, Little Squalicum Park.

		Human Receptors				Ecological Receptors		
Medium	**Exposure Pathway**	**Recreational Park User**	**Park Maintenance Worker**	**Offsite Resident**	**Offsite Worker**	**Terrestrial Plant**	**Terrestrial Animal**	**Aquatic Biota**
Surface soil	Ingestion	X	X				X	X
	Dermal contact	X	X				X	X
	Root uptake					X		X
Subsurface soil	Ingestion	(X)	(X)				(X)	
	Dermal contact	(X)	(X)				(X)	
	Root uptake					X		
Groundwater	Ingestion			X	X			
	Dermal contact			X	X			
	Root uptake							
Surface water	Ingestion	X					X	X
	Dermal contact	X					X	X
Sediments	Ingestion	X	X				X	X
	Dermal contact	X	X				X	X
	Root uptake					X		X
Air	Inhalation	O	O	O	O		O	
Terrestrial plants	Ingestion	X					X	
Aquatic biota	Ingestion	X					X	X

X = Pathway exists under normal site conditions.
(X) = Pathway exists only if subsurface soil is brought to the surface.
O = Pathway will be minor unless there are unvegetated areas.

4 FIELD INVESTIGATION APPROACH

This section presents the sampling design and rationale for a tiered approach to complete the Park RI field investigation (Figure 4-1). The design is based on an understanding of historical site data and best professional judgment. Specific issues related to sampling methods and sample handling procedures are addressed in Sections 5. Laboratory methodology and QA/QC procedures are presented in the accompanying QAPP.

Visual, sheen, and headspace screening will be conducted in the field on all soil and sediment samples collected during this investigation. Visual screening will consist of inspecting the soil/sediment for the presence of stains indicative of residual petroleum hydrocarbons. Sheen testing will involve immersion of a portion of the soil/sediment sample in water and observing the water surface for signs of petroleum sheen. Headspace screening will involve the semi-quantitative measurement of total volatile compounds in the air above the sample material using either a flame ionization detector (FID) or photo ionization detector (PID). This field screening approach will assist in selecting samples for laboratory analysis and provide real-time information on whether the proposed sampling program should be expanded to include the collection of additional samples at depth and/or at surrounding locations to further evaluate the nature and extent of contamination at the site.

Metals will be analyzed in all samples because several metals have commonly exceeded their SLs in samples from previous investigations throughout the Park. Chlorinated pesticides and PCBs will be analyzed only in soil samples from the BNSF, because this is the only area where pesticides/PCBs are expected to be present. No samples are proposed for analysis of VOCs because very few VOCs have exceeded their SLs in samples from previous investigations and because historical operations in the Park do not support significant VOC contamination. However, results from the headspace screening in the field may be followed by the laboratory analysis of samples for VOCs if it is deemed warranted.

There are two different laboratory methods of analysis for petroleum hydrocarbons. The NWTPH method provides one result with broad coverage of both aliphatic and aromatic GRO components (NWTPH-Gx) and DRO components (NWTPH-Dx). The petroleum mixture can also be fractionated into smaller carbon chain ranges, treating aliphatics and aromatics separately, to provide more comprehensive information on the composition of the mixture.[14] Fractionation data are necessary to calculate site-specific petroleum cleanup levels, rather than relying on default cleanup levels. GRO mixtures can be fractionated using the VPH analysis. DRO mixtures can be fractionated using the EPH analysis.

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[14] For soil and sediment samples, a silica gel cleanup can be used to remove natural organics before analysis.

VPH and EPH analyses are considerably more expensive than the NWTPH analysis. The extra expense of VPH/EPH analyses is unnecessary if the concentrations of petroleum in the sample are low or undetected. The soil and sediment samples will be analyzed initially using the NWTPH method, requesting the GRO analysis, the DRO analysis, or both depending on historical practices in the area. Only those soil and sediment samples that yield detected GRO/DRO results above the SL (100/200 mg/kg for soil and 50 mg/kg for sediment[15]) will be considered for fractionation analyses. In some cases, not all of the samples with GRO/DRO results above the SLs will be submitted for fractionation. Best professional judgment will be used based on the number of samples with GRO/DRO results above the SLs in an area and an understanding of historical practices, which would indicate how heterogeneous or homogeneous the petroleum compositions are likely to be in that area. If homogeneous compositions are expected, fewer samples will be selected for fractionation. When a sample is selected for fractionation, it will be analyzed by VPH if GRO was detected, by EPH if DRO was detected, or by both VPH and EPH if both GRO and DRO were detected above the corresponding SL.

Surface water and groundwater samples will be analyzed initially using the NWTPH method. Best professional judgment will be used in analyzing groundwater and surface water samples for VPH, EPH, or both as appropriate.

A few SVOCs have commonly exceeded their SLs in surface water, soil and sediment samples from previous investigations. The SVOCs of primary concern are PCP (from wood-treating operations), PAHs (components of petroleum and creosote), and phthalates (common in urban runoff). The NWTPH analysis can act as a screen for the SVOCs of concern, because PAHs are components of petroleum and because PCP and phthalates are expected to be co-located with petroleum to some degree. Soil and sediment samples for possible SVOC analyses will be archived, selecting for SVOC analysis those samples with detected GRO or DRO results above their SLs. A minimum of 20% of the soil and sediment samples will be analyzed for SVOCs, even if GRO and DRO are detected (or below the SL) in fewer than 20 percent of the samples. Because of the limited number of surface water and groundwater samples proposed, all of the samples will be analyzed for SVOCs.

Dioxin/furan analyses are substantially more expensive than the other analyses, so only select samples will be analyzed for these chemicals. Surface water samples collected at SW05 (representative of the OESER/Birchwood neighborhood outfall), SW06 and SW10 (representative of the Birchwood neighborhood), and background locations will be analyzed for dioxins and furans. No other surface water samples are planned for this

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[15] The MTCA Ecology Indicators for Soil Biota of 100 mg/kg (GRO) and 200 mg/kg (DRO) are the proposed SLs for NWTPH in soils in the Park. Based on discussions with Ecology, a lower SL of 50 mg/kg for GRO/DRO will be used for sediments. Samples exceeding 100/200 mg/kg and 50 mg/kg over reference or background levels will be analyzed for SVOCs in soils and sediments, respectively.

testing. All groundwater samples will be analyzed for dioxins and furans. Soil and sediment samples will be archived for possible dioxin/furan analyses, selecting for dioxin/furan analysis those samples with detected concentrations of PCP above its SL (0.360 mg/kg[16]).

The testing program for soils/sediment will consist of four tiers. The first tier is field screening for all collected samples. The second tier is the NWTPH analysis. A GRO or DRO result above its SL invokes the third tier, which is the SVOC analysis, which includes PCP, and possibly also VPH/EPH analyses. A PCP result above the SL invokes the fourth tier, which is the dioxin/furan analysis.

Throughout the tiered approach for analyzing archived samples, best professional judgment and common sense will dictate the choices of analyses. The goal is to improve the understanding of the nature and extent of contamination in the Park with the most cost-effective sampling and analytical strategy possible, not merely to adhere to a strictly proscribed protocol. Any deviations from the protocol described here will be made only with Ecology approval and documented with explanation.

Background or reference samples will be collected for each of the media planned for sampling in the Park (i.e., soils, groundwater, surface water, sediments). The background location for groundwater is a well located northeast of the OESER site near Cedarwood Avenue (MW-06D). The reference location for soils[17], surface water, and sediment is planned for a tributary of Whatcom Creek with similar characteristics as Little Squalicum Creek (an acceptable background location was not identified up-gradient of the project site). Selected reference locations must be upstream of any point sources (including the burn area of Whatcom Creek) and only be impacted by local stormwater runoff. The locations being considered include:

- Fever Creek near Roosevelt Park or north of Alabama Street
- Cemetery Creek near or within Bayview Cemetery.

More than one reference sample may be required to match varied physical characteristics (e.g., grain size) of the Park soil, surface water, and sediment samples.

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[16] The Ecology SQS for Marine Sediments is the proposed SL for pentachlorophenol in soils and sediments in the Park. Samples exceeding 0.360 mg/kg pentachlorophenol will be analyzed for dioxins.

[17] A total of 20 background soil samples were collected during the OESER RI. These samples will also be used for comparison to soil samples collected during this RI.

4.1 SOIL INVESTIGATION

4.1.1 Rationale

The primary goal of soil sampling is to fill in spatial data gaps at the gravel pit and BTC areas, which are not suspected of having high contaminant concentrations, and in the BNSF right-of-way. The sampling pattern will be approximately evenly spaced to provide broad coverage of these areas, with an equal likelihood of finding contamination throughout the areas. To make the most efficient use of budget, a tiered analytical approach will be used.

4.1.2 Sampling Strategy

The investigation will include the excavation of 12 test pits (TP), distributed as follows (Figure 4-2):

- TP-1 through TP-3 will be located in the southeast area of the Park near BTC
- TP-4 will be located on the east side of the Creek, north of the area where the underground stormwater pipeline enters the Creek
- TP-5 through TP-8 will be located south(east) of the Creek and east of Marine Drive in the area of the historical gravel pit operations
- TP-9 through TP-12 will be located south(east) of the Creek and west of Marine Drive in the area of the historical gravel pit operations.

The test pits will allow the collection of soil samples at depth in the areas of historical landfill and gravel pit operations, which might have disturbed soils and distributed contamination throughout a depth range up to several feet. Furthermore, TP-9 through TP-12 are located in areas considered for possible re-routing of the Creek (refer to Figure 1-1 in the Work Plan), and it is advisable to have chemical and physical soil data at depth in these locations. In each test pit, all samples will be screened in the field for petroleum hydrocarbons. A sample collected from surface to 1 ft bgs will be submitted for analyses. Additional samples will be collected at 1-2 ft bgs, 2-3 ft bgs, and the bottom of the test pit for archiving. The tiered approach for analyzing these samples is discussed in Section 4.1.3.

Using a hand auger,[18] nine locations will be investigated, as follows (Figure 4-2):

- HA-1 through HA-6 will be located along the BNSF right-of-way

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[18] A hand shovel or equivalent may be used if coarse soils are encountered prohibiting the use of the hand auger.

- HA-7 and HA-8 will be located northeast of the Creek in an area suspected to be impacted by a historical OESER spill or contaminated runoff
- Background locations planned for a Whatcom Creek tributary (either Fever Creek near Roosevelt Park or Cemetery Creek near Bayview Cemetery).

Hand augering is proposed for these locations because it is less intrusive than test pits. Samples will be collected at 0-1 ft bgs and 1-2 ft bgs and screened in the field for petroleum hydrocarbons. The tiered approach for analyzing these samples is discussed in Section 4.1.3.

Piezometers will be installed at three test pit locations (TP-3, TP-6, TP-12) to monitor seasonal changes in groundwater levels within the Park. Test pits may have to be excavated deeper, depending on time of year, to observe groundwater seepage at these locations. The depth and seasonal fluctuations in shallow groundwater will be important to understand if the creek is rerouted to other areas of the Park.

4.1.3 Analytical Strategy

Reference sample(s) will be analyzed for metals, GRO, DRO, pesticides/PCBs, SVOCs, and dioxins/furans and a sample will be archived for possible VPH/EPH analysis, if necessary.

Field screening results will be considered in the selection of soil samples for analysis. For planning purposes, 0-1 ft site samples from test pit and hand auger locations will be analyzed for the following chemical classes (refer to Table 4-1):

- Metals (all surface samples)
- NWTPH-GRO (some surface samples) and -DRO (all surface samples)
- Pesticides and PCBs (by the BNSF only)
- TOC (all surface samples)
- Physical testing including grain size, moisture content, specific gravity, bulk density, Atterburg Limits (if sample is primarily fine grained) (all surface samples/0-1 ft samples and 2-3 ft samples).

DRO analyses will be requested for all surface soil samples (0-1 ft). GRO analyses will also be requested for the following sample locations, which are most likely to be impacted by urban runoff containing GRO:

- TP-1 through TP-3 near BTC
- TP-9 near the Marine Drive Bridge.

Site surface soil samples (0-1 ft bgs) will be archived for possible VPH, EPH, SVOC, and dioxin/furan analyses, depending on the GRO/DRO results. For each 0-1 ft sample, if the GRO or DRO result exceeds its SL, an archived sample from the same location will be analyzed for SVOCs. If PCP is detected above its SL, the archived sample from the same location will be analyzed for dioxins/furans. If the GRO/DRO result exceeds the SL, an archived sample may be selected for VPH/EPH analysis, depending on the results of other samples from the same area and using the professional judgment discussed previously.

If any chemical exceeding its SL is detected in the 0-1 ft sample of a test pit or hand auger, the lab will be requested to analyze the archived 1-2 ft sample from that location for the appropriate chemical class. If the chemical exceeds its SL in the 1-2 ft sample, the lab will be requested to analyze the archived 2-3 ft sample (test pits only). Finally, if the chemical exceeds its SL in the 2-3 ft test pit sample, the lab will analyze the archived sample from the bottom of the test pit.

If the decision logic described above results in the selection of fewer than 20% of the site surface soil samples for SVOC analyses, additional samples will be selected for SVOCs until a minimum of 20% of the soil samples is reached. The selection of additional samples will rely on best professional judgment, with an effort to select samples from each of the three areas under investigation (BNSF, gravel pit, BTC).

This is a hypothetical example of the tiered soil testing program (all soil samples are screened in the field for petroleum hydrocarbons).

> Lead, cadmium, GRO, and DRO are detected above their SLs in the 0-1 ft sample from TP-6. The lab is requested to analyze an archived 0-1 ft sample from TP-6 for SVOCs and an archived 0-1 ft sample for VPH and EPH. PCP is detected by the SVOC analysis above a concentration of 0.360 mg/kg, so the lab is asked to analyze the archived 0-1 ft sample for dioxins/furans, which are detected.
>
> Based on the results of the 0-1 ft sample, the lab is requested to analyze an archived 1-2 ft sample from TP-6 for metals, GRO, DRO, and SVOCs. Lead and DRO are detected above their SLs in the 1-2 ft sample, but GRO and PCP are not detected above their SLs. The lab is then asked to analyze the archived 1-2 ft sample for EPH, but not VPH. Since PCP was not detected, the lab is not asked to perform a dioxin/furan analysis.
>
> Based on the results of the 1-2 ft sample, the lab is requested to analyze an archived 2-3 ft sample for metals and DRO. Lead is detected above its SL, but DRO is not. The lab is asked to analyze an archived sample from the bottom of the test pit for metals only.

4.2 GROUNDWATER INVESTIGATION

4.2.1 Rationale

The primary goal of groundwater sampling is to update existing data. The sampling pattern will focus on wells located downgradient from the OESER site that are potential sources of contamination to the creek.

4.2.2 Sampling Strategy

Integral will collect two rounds of groundwater samples (GW), both during the wet season. The wet season samples will be collected between November and May. The sampling will be conducted at the following times:

- Beginning wet season (November/December 2005)
- Wet season (January/February 2006).

The following four groundwater well locations will be sampled (Figure 4-3):

- MWLSC01 through MWLSC03 (located on the old railroad grade north of the creek and downgradient of the OESER site)
- MW-06D (Background well located northeast of OESER site).

These sampling locations have been sampled previously and are representative of potential sources of contamination to the creek. Sediment/soil sampling (refer to Section 4.4) will also be used to evaluate potential groundwater impacts adjacent to the creek. Results of that evaluation along with this well data will be used to develop a more complete CSM of area groundwater.

4.2.3 Analytical Strategy

All groundwater samples from the site and the background location will be analyzed for hardness, total suspended solids (TSS), TOC, metals (including calcium and magnesium), NWTPH-GRO/DRO, SVOCs, and dioxins/furans, and a sample will be archived for possible VPH/EPH analysis (refer to Table 4-2).

4.3 SURFACE WATER INVESTIGATION

4.3.1 Rationale

The primary goal of surface water sampling is to update existing data. The sampling pattern will focus on the discharge points to the Creek that are potential sources of contamination to the creek. Sampling will focus on the wet season rather than the dry season, since surface water contamination is more likely to be encountered during the wet season based on historical data (E&E 2002a).

4.3.2 Sampling Strategy

Integral will collect two rounds of surface water samples (SW), both during the wet season. The wet season samples will be collected between November and May. The sampling will be conducted at the following times:

- Beginning wet season (November/December 2005)
- Wet season (January/February 2006).

The following eight surface water locations will be sampled (Figure 4-3):

- SW01 (downgradient of all discharge points to the Creek)
- SW04 (potential discharge point from Marine Drive to the Creek)
- SW05 (discharge point from OESER/Birchwood neighborhood to the Creek)
- SW06 (discharge point from Birchwood neighborhood/BTC to the Creek)
- SW07 (near BTC parking lot)
- SW09 (spatial representation between Marine Drive bridge and BNSF Railroad bridge)
- SW10 (stormwater from Birchwood neighborhood, upgradient of OESER)
- Reference location planned for a Whatcom Creek tributary (either Fever Creek near Roosevelt Park or Cemetery Creek near Bayview Cemetery).

These sampling locations have been sampled previously (except for SW10) and are representative of potential sources of contamination to the creek.

4.3.3 Analytical Strategy

The surface water samples collected from the combined OESER/Birchwood neighborhood outfall (SW05), Birchwood neighborhood (SW06 and SW10), and the reference location will be analyzed for hardness, TSS, TOC, metals (including calcium and magnesium), NWTPH-GRO/DRO, SVOCs, and dioxins/furans, and a sample will be archived for possible VPH/EPH analysis (refer to Table 4-2). Other surface water samples will be analyzed for hardness, TSS, TOC, metals, NWTPH-GRO/DRO, and SVOCs, and samples will be archived for potential VPH/EPH. If GRO/DRO are detected above their SLs, an archived sample from the same location will be analyzed for VPH, EPH, or both as appropriate.

4.4 SEDIMENT INVESTIGATION

4.4.1 Rationale

The primary goal of sediment sampling is to define the extent of contamination detected during previous investigations (i.e., Ecology study) and to define the width and depth of contamination in the Creek including the identification of SQS and CSL cleanup boundaries. The sampling pattern will focus on bounding contaminated areas identified in previous investigations and performing transects across the creek. To make the most efficient use of budget, Integral will use a tiered analytical approach similar to the one described above for soil.

4.4.2 Sampling Strategy

Integral will collect surface sediment samples (0-4 inches [0-10 cm] bgs) from the following seven locations (Figure 4-4):

- LSC07
- LSC08
- LSC09
- LSC10 through LSC12 on the beach but within the discharge area of the Creek
- Reference location planned for a Whatcom Creek tributary (either Fever Creek near Roosevelt Park or Cemetery Creek near Bayview Cemetery).

These sample locations will assist in defining the boundaries of a hot spot identified upstream of these locations during the Ecology investigation (Ecology 2004) and verifying that the beach does not pose a health threat.

After surface samples have been collected, transects will be performed across the creek bed in the following six locations, evenly spaced over the length of this portion of the creek, using a track-mounted, portable, hollow stem auger to collect samples at depth (Figure 4-4):

- Near LSC04, immediately downstream of the OESER and BTC discharge points
- Near LSC07, midway downstream between the OESER and BTC discharges and the Marine Drive Bridge
- Near LSC08, at the lower end of this creek section
- Near LSC09, downstream of the Marine Drive bridge
- Near LSC03, midway downstream between the Marine Drive bridge and BNSF railroad bridge
- Near LSC01, just upstream of the BNSF railroad bridge.

Transects will allow Integral to investigate the depth and width of sediment contamination in this portion of the creek. Sediment/soil sampling will also be used to evaluate potential groundwater impacts to the creek. For example, borings located upgradient of the creek that show the presence of contamination would support groundwater as a pathway to the creek.

In the event sediment/soil samples are not collected from a proposed location(s) due to refusal (e.g., too gravelly), a temporary well may be installed to evaluate groundwater impacts at this location(s).

For each transect upstream of the Marine Drive bridge, sediment samples will be collected from 0-1 ft bgs, 1-2 ft, 2-3 ft bgs, 3-4 ft bgs, and 4-5 ft bgs at three individual locations as follows:

- A central location midstream
- 5-10 ft south of midstream at or near the stream bank
- 5-10 ft north of midstream at or near the stream bank.

For each transect downstream of the Marine Drive bridge, sediment samples will be collected from 0-1 ft bgs, 1-2 ft, 2-3 ft bgs, 3-4 ft bgs, and 4-5 ft bgs at five individual locations as follows:

- A central location midstream
- 5-10 ft south of midstream at or near the stream bank
- 25-30 ft south of midstream on the stream bank
- 5-10 ft north of midstream at or near the stream bank
- 25-30 ft north of midstream on the stream bank.

Fewer borings are planned for the upstream transects because this area of the creek is confined to a narrower and in some places steeper channel. The channel widens downstream past the Marine Drive Bridge.

Samples may be collected deeper than 5 ft bgs based on observations made in the field (i.e., field screening for visual contamination and headspace analysis).

4.4.3 Analytical Strategy

The analytical strategy for sediment samples will be similar to the analytical strategy for soil samples. The reference sample(s) will be analyzed for TOC, total sulfides, ammonia, metals, DRO, SVOCs, and dioxins/furans, and a sample will be archived for possible EPH analysis. Field screening results will be considered in the selection of site sediment samples for analysis. For planning purposes, all site surface (0-10 cm) and the 0-1 ft and

1-2 ft boring sediment samples will be analyzed for the following chemical classes (refer to Table 4-3):

- TOC
- Metals
- NWTPH-DRO.

Surface sediments (0-10cm) will also be analyzed for total sulfides and ammonia to assist in evaluating the bioassay tests. GRO will not be analyzed, as light end hydrocarbons are not expected to remain in the stream sediments. However, field screening results will be considered in the possible analysis of GRO and VOCs in some samples. Physical testing will also be analyzed for the surface (0-10cm), and 0-1 ft and 2-3 ft samples at depth from selected borings representative of each transect.

Site surface (0-10 cm), 0-1 ft, and 1-2 ft sediment samples will be archived for possible EPH, SVOC, and dioxin/furan analyses, depending on the DRO results. For each site surface or 0-1/1-2 ft sediment sample, if the DRO result exceeds its SL, an archived sample from the same depth will be analyzed for SVOCs. If PCP is detected above its SL, an archived sample from the same location will be analyzed for dioxins/furans. If the DRO result exceeds its SL, an archived sample may be selected for EPH analysis, depending on the results of other samples from the same area and using the professional judgment discussed in Section 4.2.

If any chemical exceeding its SL is detected in the 1-2 ft sediment sample of a transect location, the lab will be requested to analyze the archived 2-3 ft sample from the same transect location for the appropriate chemical class. If the chemical exceeds its SL in the 2-3 ft sample, the lab will be requested to analyze the archived 3-4 ft sample, and so on.
If the decision logic described above results in the selection of fewer than 20% of the site sediment samples for SVOC analyses, additional samples for SVOCs will be selected until a minimum of 20% of the samples for confirmation purposes is reached. The selection of additional samples will rely on best professional judgment, with an effort to select samples throughout the length and breadth of the creek.

Based on the chemical results of the surface sediment samples, toxicity testing will be performed at those locations where concentrations exceed SLs. The proposed tests are:

- Amphipod (*Hyalella azteca*) 10-day mortality test (USEPA 2000b; Test Method 100.1)
- Microtox® Sediment Porewater (*Vibrio fischeri*) (Ecology 2003)
- Midge (*Chironomus tentans*) 20-day mortality and growth test (USEPA 2000b; Test Method 100.2 modified).

Sediment for toxicity testing may be stored in the dark for a maximum of up to eight weeks. Sample bottles will be stored either with no headspace or headspace purged with nitrogen gas.

4.5 SHELL MIDDEN BOUNDARY SURVEY

One prehistoric archaeological site (shell midden) has been identified in the Creek ravine and it is possible that additional sites could also be present (Figure 2-1). The presence of a potentially significant archaeological site requires that cultural resources be addressed <u>before starting any intrusive sampling activities</u> (e.g., test pit excavations). These resources will be addressed using a staged approach. The cultural resource management activities planned for the Park RI/FS may have as many as three stages: 1) inventory of impact areas, 2) evaluation of the identified resources, and 3) development and implementation of a management plan.

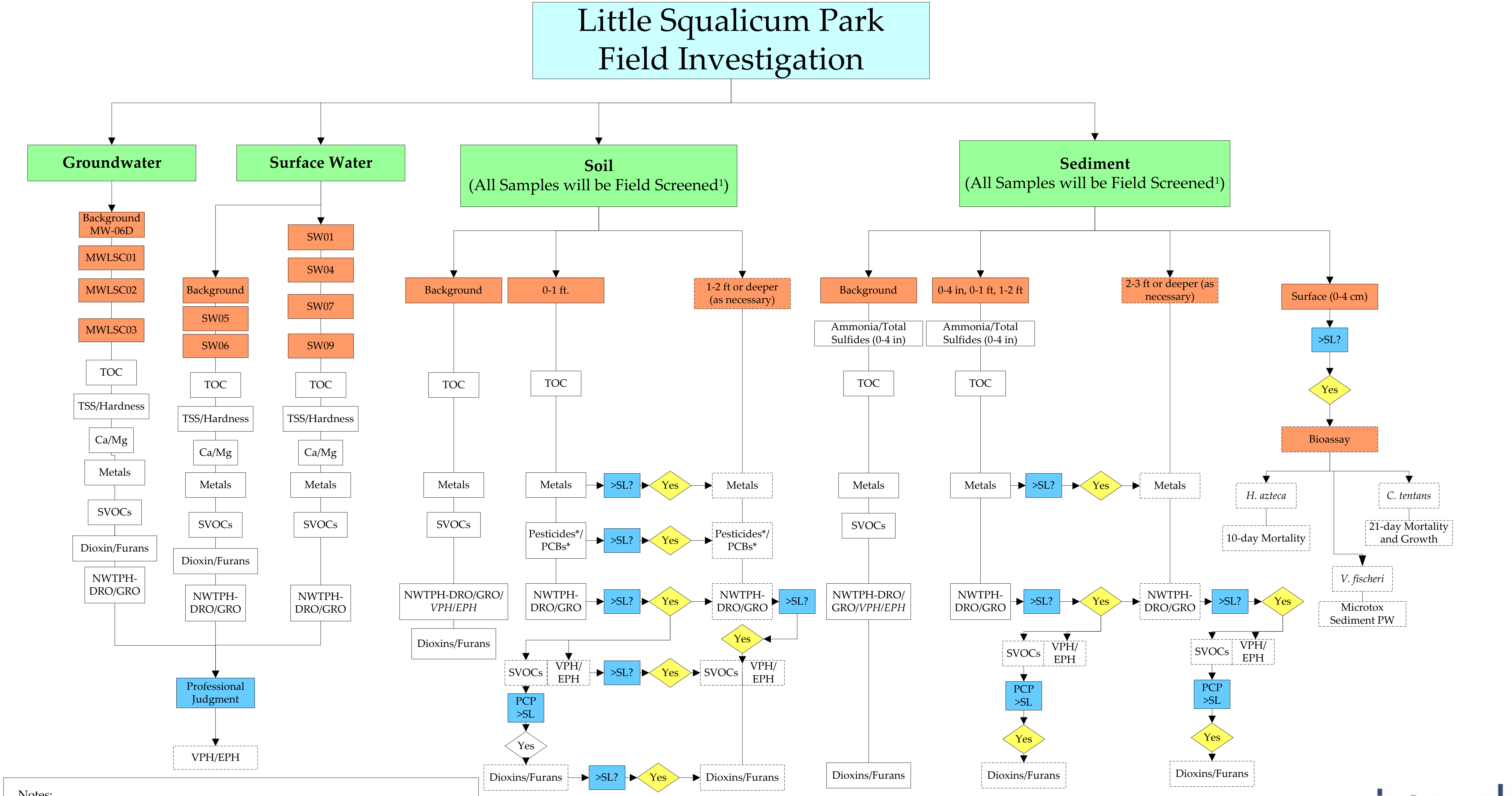
The first effort will be to inventory the area by a trained archaeologist/anthropologist. This effort will determine whether, and where, archaeological deposits are present. As noted, at least one site is known to be present. The presence of this site will be confirmed, and its boundaries will be determined and recorded. Other portions of the Park will also be investigated, and, if additional archaeological sites are located, they will also be mapped and recorded. The inventory effort will be accomplished using a combination of background research, and direct archaeological survey inspection, including the use of limited subsurface testing. Once the distribution of archaeological deposits in the project area is determined, it will be possible to assess whether any of these deposits are threatened by the planned environmental assessments and subsequent park developments.

If it appears that an archaeological site is threatened, it will be necessary to determine that site’s eligibility for listing with the National Register of Historic Places. A small-scale test excavation will be needed in order to perform this evaluation. If more than one site in the Park is threatened by this project, multiple evaluations will need to be conducted. If a threatened archaeological site is shown to be eligible for listing with the National Register of Historic Places, a management plan will be developed. The plan will seek to avoid or minimize damage to the site. Avoidance is always the preferred protection option, but this is not always possible. If avoiding damage to a site eligible for the National Register is not possible, it may be necessary to undertake data recovery excavations in order to document the cultural deposits that will be destroyed. The management plan could also address protection and interpretation of the site in the future park if this is desirable.

An inventory of the shell midden and other archaeological sites (if found) is planned for fall 2005, before fieldwork for the RI commences. The archaeological inventory will be conducted by Dr. Gary Wessen of Wessen & Associates, Inc., with the assistance of technical support personnel provided by the Lummi Indian Nation's Cultural Contract Services Department. Dr. Wessen will undertake the background literature review and together with the Lummi technical staff, will conduct the fieldwork. The boundaries of each site will be staked and surveyed. All intrusive activities will be avoided within these boundaries.

4.6 FIELD QC SAMPLES

Field duplicates will be collected periodically throughout the sampling program at a frequency of 1 per 20 field samples. Equipment rinse blanks will be collected once for each type of collection method (i.e., surface sediment, groundwater, borings, test pits, surface water). Refer to Section 5 for field QC sampling procedures.



Notes:

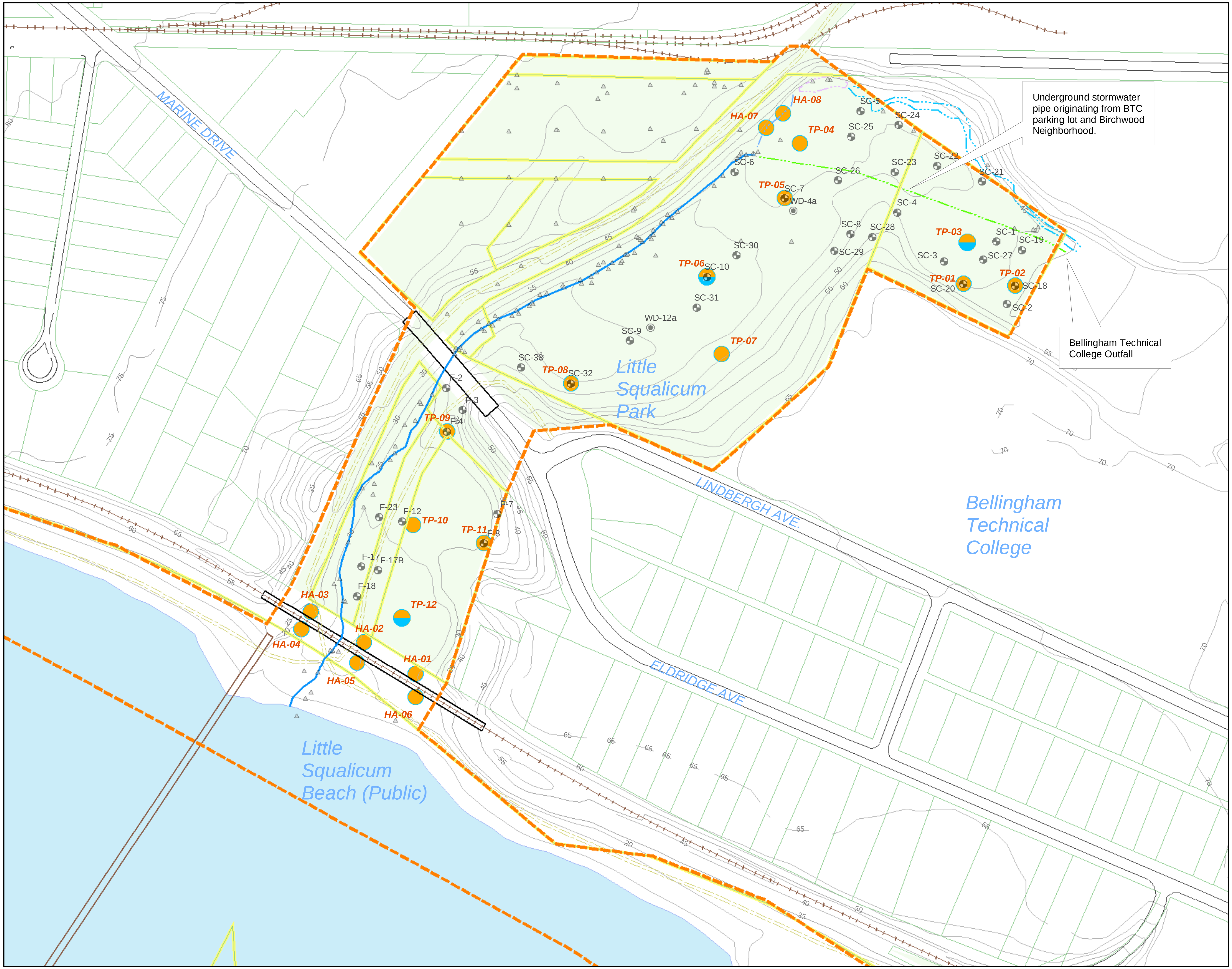
¹ Visual, sheen, and headspace screening will be conducted in the field on all soil and sediment samples collected during this investigation as described in SOP-8. Additional samples may be analyzed based on the results of this screening.

Physical parameters/TOC may be analyzed in other samples depending on results. (* Pesticides and PCBS only analyzed for hand auger samples collected along BNSF.)

☐ Analyses always conducted

⬚ Analyses only conducted if the sample exceeded the Screening Level (SL) and in some cases professional judgment

Figure 4-1. Tiered Sampling and Analysis Approach



1993 Wetland Mitigation Plan Station References

◉ Watershed Dynamics Piezometer Approximate Location and Identification; Water Observed in 10/92.

⊕ Landau Associates Test or Hand Pit Approximate Location and Identification.

Proposed Soil Sample

● Proposed Soil Sample Locations

◐ Test pit locations with Piezometer Installed

△ Station Locations With Data for Other Media

▭ Little Squalicum Park Boundary

▭ Park Area Parcels

▭ Approx. Parcel Location

--- Approx Creek Location

--- Approx. Depression Location

--- Approx. Area of Standing Water

--- Approx. Underground Drainage

— Bridge

— Road

— Dock

+++ Railroad

Note:
Proposed Soil Sample Locations are for Hand Auger (HA) and Test Pits (TP)

A background soil sample(s) will be collected from a Whatcom Creek Tributary (e.g., Fever Creek or Cemetery Creek).

Feature Sources:
Topological features: City of Bellingham web site,
source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from copy - Site Location Map
Appendix B Map of Brownfield Assessment Area.
Notes:
The locations of Ecology were projected from source Lat./Long. to NAD27 WNZ. OESER station locations were provided in NAD27 WNZ.

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Figure 4-2. Proposed Soil Sampling Locations, Little Squalicum Park Remedial Investigation

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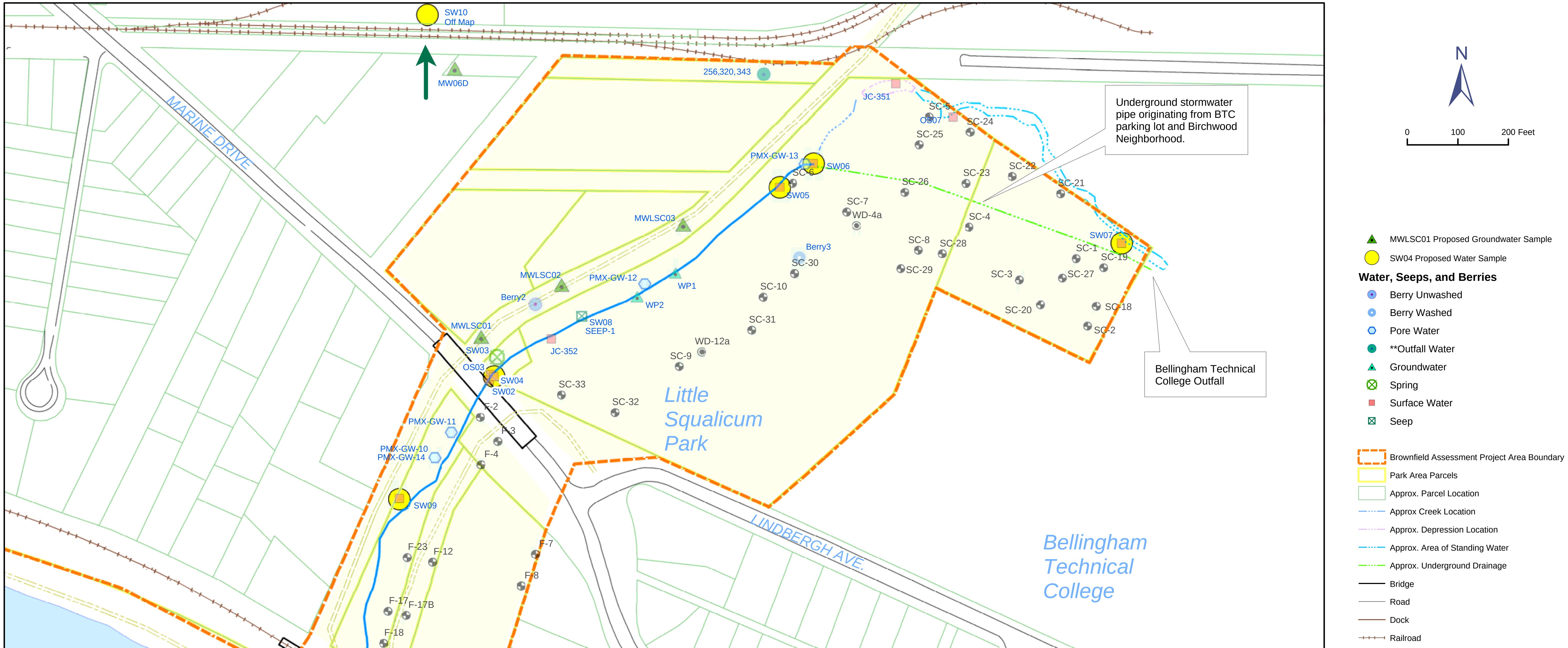

▲ MWLSC01 Proposed Groundwater Sample

● SW04 Proposed Water Sample

Water, Seeps, and Berries

- ● Berry Unwashed
- ● Berry Washed
- ⬡ Pore Water
- ● **Outfall Water
- ▲ Groundwater
- ⊗ Spring
- ■ Surface Water
- ⊠ Seep

- ▭ Brownfield Assessment Project Area Boundary
- ▭ Park Area Parcels
- ▭ Approx. Parcel Location
- Approx. Creek Location
- Approx. Depression Location
- Approx. Area of Standing Water
- Approx. Underground Drainage
- Bridge
- Road
- Dock
- Railroad

Note:
A background surface water location(s) will be collected from a Whatcom Creek Tributary (e.g., Fever Creek or Cemetery Creek)

Feature Sources:
Topological features: City of Bellingham web site,
source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from
copy - Site Location Map
Appendix B Map of Brownfield Assessment Area.
Notes:
The locations of Ecology were projected from source
Lat./Long. to NAD27 WNZ. OESER station locations were
provided in NAD27 WNZ.

Figure 4-3. Proposed Groundwater and Surface Water Sampling Locations, Little Squalicum Park Remedial Investigation

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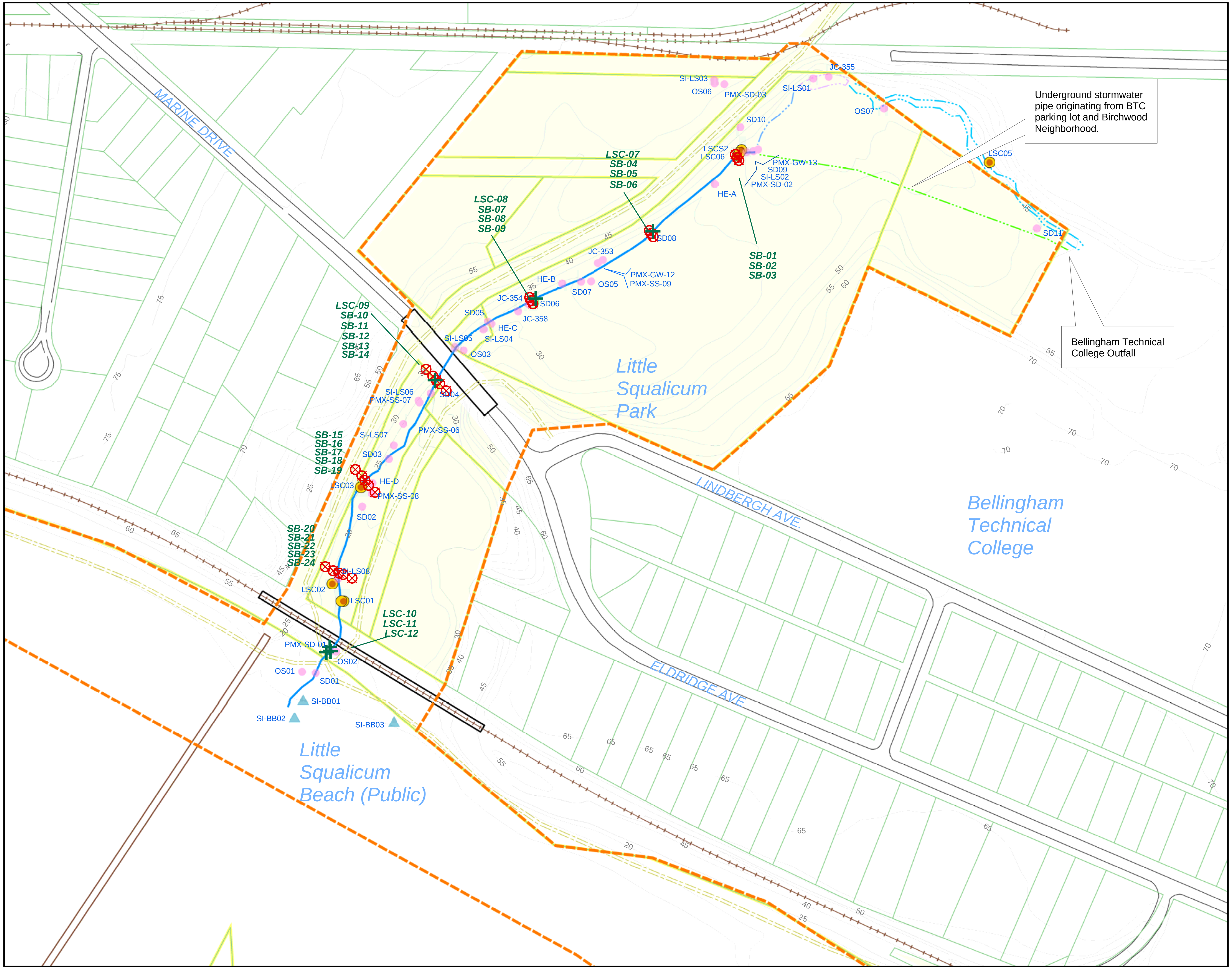

Map Document: (C:\GIS\Projects\LittleSqualcumCr\Sample_Locations_Proposed_Samples_v4.mxd)
Plot Date: 04/26/2005

Proposed Sediment Sample

- ⊗ Sediment Boring Location
- ✚ Surface Sediment Location

Historic Sediment, Bioaccumulation

- ▲ Bay Sediment
- ● (*Surface) Sediment
- ○ Sediment Bioaccumulation
- ● Surface Sediment
- ● Ecology Sediment Sample Location

- ▭ Brownfield Assessment Project Area Boundary
- ▭ Park Area Parcels
- ▭ Approx. Parcel Location
- ‑·‑ Approx Creek Location
- ‑·‑ Approx. Depression Location
- ‑·‑ Approx. Area of Standing Water
- ‑·‑ Approx. Underground Drainage
- — Bridge
- — Road
- — Dock
- ┼┼ Railroad

Note:
A background sediment location(s) will be collected from a Whatcom Creek Tributary (e.g., Fever Creek or Cemetery Creek)

Feature Sources:
Topological features: City of Bellingham web site, source:1998 drawings.
Park area, Brownfield area, Area Trails: Transferred from copy - Site Location Map
Appendix B Map of Brownfield Assessment Area.
Notes:
The locations of Ecology were projected from source Lat./Long. to NAD27 WNZ. OESER station locations were provided in NAD27 WNZ.

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Figure 4-4. Proposed Sediment Sampling Locations, Little Squalicum Park Remedial Investigation

Table 4-1. Soil Sample Locations and Testing.

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	TOC[1]	Metals[2]	NWTPH[3]	VPH/EPH[4]	SVOCs[5]	Dioxins/ Furans[6]	Pest/ PCBs[7]	Physical Testing[8]	Archive
TP-1	1235642.06	648967.49	0-1	✓	✓	DRO/GRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-2	1235752.63	648964.44	0-1	✓	✓	DRO/GRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-3	1235651.79	649056.33	0-1	✓	✓	DRO/GRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-4	1235291.30	649268.62	0-1	✓	✓	DRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-5	1235259.05	649150.18	0-1	✓	✓	DRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-6	1235093.14	648982.36	0-1	✓	✓	DRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓

Table 4-1. Soil Sample Locations and Testing. (continued)

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	TOC[1]	Metals[2]	NWTPH[3]	VPH/EPH[4]	SVOCs[5]	Dioxins/ Furans[6]	Pest/ PCBs[7]	Physical Testing[8]	Archive
TP-7	1235124.47	648816.83	0-1	✓	✓	DRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-8	1234800.37	648754.64	0-1	✓	✓	DRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-9	1234534.88	648651.54	0-1	✓	✓	DRO/GRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-10	1234461.25	648450.50	0-1	✓	✓	DRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-11	1234614.41	648412.46	0-1	✓	✓	DRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓
TP-12	1234439.28	648252.72	0-1	✓	✓	DRO					✓	✓
			1-2									✓
			2-3								✓	✓
			Bottom									✓

Table 4-1. Soil Sample Locations and Testing. (continued)

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	TOC[1]	Metals[2]	NWTPH[3]	VPH/ EPH[4]	SVOCs[5]	Dioxins/ Furans[6]	Pest/ PCBs[7]	Physical Testing[8]	Archive
HA-1	1234467.61	648131.65	0-1	✓	✓	DRO				✓	✓	✓
			1-2									✓
HA-2	1234355.99	648199.49	0-1	✓	✓	DRO				✓	✓	✓
			1-2									✓
HA-3	1234241.79	648265.60	0-1	✓	✓	DRO				✓	✓	✓
			1-2									✓
HA-4	1234222.04	648228.68	0-1	✓	✓	DRO				✓	✓	✓
			1-2									✓
HA-5	1234341.39	648156.56	0-1	✓	✓	DRO				✓	✓	✓
			1-2									✓
HA-6	1234467.60	648082.71	0-1	✓	✓	DRO				✓	✓	✓
			1-2									✓
HA-7	1235218.94	649301.95	0-1	✓	✓	DRO					✓	✓
			1-2									✓
HA-8	1235254.14	649332.86	0-1	✓	✓	DRO					✓	✓
			1-2									✓
Reference	TBD	TBD	0-1	✓	✓	GRO/DRO	✓	✓	✓	✓	✓	✓
Total Samples				**21**	**21**	**21**	**≤21[9]**	**≤21[9]**	**≤21[9]**	**7**	**33**	**65**

[1] Total organic carbon will be analyzed for all 0-1 ft soil samples by EPA Method SW 9060 Modified (Ecology).
[2] Metals analysis will include arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc (EPA Methods 6010/7471A).
[3] NWTPH analysis (Ecology 1997) will include both gasoline-range hydrocarbons (GRO) and diesel-range hydrocarbons (DRO) except where indicated.
[4] VPH/EPH petroleum fractionated analysis (Ecology 1997) will be analyzed for selected samples exceeding GRO/DRO SL's or, at a minimum, 20 percent of total samples analyzed.
[5] SVOCs will be analyzed for samples exceeding GRO/DRO SL's or, at a minimum, 20 percent of total samples analyzed for confirmation purposes (EPA Method SW 8270C low levels).
[6] Dioxins/Furans will be analyzed by EPA Method 1613B for samples with PCP concentrations exceeding SL.
[7] Chlorinated Pesticides/PCBs will be analyzed by EPA Method SW 8081/8082 for soil samples collected to evaluate BNSF.
[8] Physical testing will include grain size (ASTM D 422-63 w/hydrometer), Atterburg limits (ASTM D 4318-00), Specific Gravity (ASTM 854-02), and moisture content (ASTM 2216).
[9] Sample total is dependent on the number of samples exceeding SL's, with a minimum of 20 percent site samples analyzed for SVOCs and VPH/EPH.

Note: Field duplicate samples will be collected at a frequency of 1 per 20 field samples. Equipment rinse blank samples will be collected once per sampling method.

Table 4-2. Groundwater Sampling Locations and Testing (Each Sampling Cycle).

Station	**Easting (ft)**	**Northing (ft)**	**Conventional Testing**[1]	**Metals**[2]	**NWTPH** [3]	**SVOCs**[4]	**Dioxins/ Furans**[5]
MWLSC01	1235004.95	649061.29	✓	✓	GRO/DRO	✓	✓
MWLSC02	1234846.20	648959.04	✓	✓	GRO/DRO	✓	✓
MWLSC03	1235245.36	649180.57	✓	✓	GRO/DRO	✓	✓
MW06D	TBD	TBD	✓	✓	GRO/DRO	✓	✓
Total Samples			**4**	**4**	**4**	**4**	**4**

[1] Conventional testing will include TOC (EPA Method 415.1), TSS (EPA Method 160.2), and Hardness (SM 2340B).
[2] Metals analysis will include arsenic, cadmium, calcium, chromium, copper, lead, magnesium, mercury, nickel, silver, zinc (EPA Methods 200.8/6010B/7470).
[3] NWTPH analysis (Ecology 1997) will include both gasoline-range (GRO) and diesel-range (DRO) hydrocarbons. VPH/EPH petroleum fractionated analysis (Ecology 1997) will be analyzed for all samples exceeding GRO/DRO SLs.
[4] SVOCs will be analyzed by EPA Method SW 8270C low levels for comparison to State Surface Water Quality Criteria.
[5] Dioxins/Furans will be analyzed by EPA Method 1613B.

Note: Field duplicate samples will be collected at a frequency of 1 per 20 field samples. Equipment rinse blank samples will be collected once per sampling method.

Table 4-3. Surface Water Sampling Locations and Testing (Each Sampling Cycle).

Station	Easting (ft)	Northing (ft)	Conventional Testing[1]	Metals[2]	NWTPH [3]	SVOCs[4]	Dioxins/ Furans[5]
SW01	1234284.92	648180.64	✓	✓	GRO/DRO	✓	
SW04	1234560.86	648825.80	✓	✓	GRO/DRO	✓	
SW05	1235126.04	649199.25	✓	✓	GRO/DRO	✓	✓
SW06	1235192.89	649245.92	✓	✓	GRO/DRO	✓	✓
SW07	1235802.43	649088.81	✓	✓	GRO/DRO	✓	
SW09	1234373.48	648583.69	✓	✓	GRO/DRO	✓	
SW10	TBD	TBD	✓	✓	GRO/DRO	✓	✓
Reference	TBD	TBD	✓	✓	GRO/DRO	✓	✓
Total Samples			**8**	**8**	**8**	**8**	**4**

[1] Conventional testing will include TOC (EPA Method 415.1), TSS (EPA Method 160.2), and Hardness (SM 2340B).

[2] Metals analysis will include arsenic, cadmium, calcium, chromium, copper, lead, magnesium, mercury, nickel, silver, zinc (EPA Methods 200.8/6010B/7470).

[3] NWTPH analysis (Ecology 1997) will include both gasoline-range (GRO) and diesel-range (DRO) hydrocarbons. VPH/EPH petroleum fractionated analysis (Ecology 1997) will be analyzed for all samples exceeding GRO/DRO SLs.

[4] SVOCs will be analyzed by EPA Method SW 8270c low levels for comparison to State Surface Water Quality Criteria.

[5] Dioxins/Furans will be analyzed by EPA Method 1613B.

Note: Field duplicate samples will be collected at a frequency of 1 per 20 field samples. Equipment rinse blank samples will be collected once per sampling method.

Table 4-4. Sediment Sample Locations and Testing.

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	Metals[1]	NWTPH[2]	VPH/ EPH[3]	SVOCs[4]	Dioxins/ Furans[5]	Conventional Testing[6]	Physical Testing[7]	Bioassays[8]	Archive
SB-1	1235155.72	649233.07	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-2	1235151.90	649239.62	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-3	1235159.65	649226.84	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3									✓
			3-4									✓
			4-5									✓
SB-4	1234972.26	649071.63	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓

Table 4-4. Sediment Sample Locations and Testing. (continued)

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	Metals[1]	NWTPH[2]	VPH/ EPH[3]	SVOCs[4]	Dioxins/ Furans[5]	Conventional Testing[6]	Physical Testing[7]	Bioassays[8]	Archive
SB-5	1234968.54	649077.65	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-6	1234976.84	649064.48	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3									✓
			3-4									✓
			4-5									✓
SB-7	1234716.68	648928.47	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-8	1234713.47	648935.18	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓

Table 4-4. Sediment Sample Locations and Testing. (continued)

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	Metals[1]	NWTPH[2]	VPH/ EPH[3]	SVOCs[4]	Dioxins/ Furans[5]	Conventional Testing[6]	Physical Testing[7]	Bioassays[8]	Archive
SB-9	1234720.44	648921.77	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3									✓
			3-4									✓
			4-5									✓
SB-10	1234514.21	648759.37	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-11	1234506.72	648767.78	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3									✓
			3-4									✓
			4-5									✓
SB-12	1234521.79	648751.61	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓

Table 4-4. Sediment Sample Locations and Testing. (continued)

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	Metals[1]	NWTPH[2]	VPH/ EPH[3]	SVOCs[4]	Dioxins/ Furans[5]	Conventional Testing[6]	Physical Testing[7]	Bioassays[8]	Archive
SB-13	1234492.32	648782.09	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3									✓
			3-4									✓
			4-5									✓
SB-14	1234535.35	648736.45	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-15	1234362.11	648545.62	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-16	1234355.37	648555.39	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3									✓
			3-4									✓
			4-5									✓

Table 4-4. Sediment Sample Locations and Testing. (continued)

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	Metals[1]	NWTPH[2]	VPH/ EPH[3]	SVOCs[4]	Dioxins/ Furans[5]	Conventional Testing[6]	Physical Testing[7]	Bioassays[8]	Archive
SB-17	1234369.46	648535.28	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-18	1234341.44	648568.90	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3									✓
			3-4									✓
			4-5									✓
SB-19	1234383.43	648519.75	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-20	1234306.22	648348.52	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓

Table 4-4. Sediment Sample Locations and Testing. (continued)

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	Metals[1]	NWTPH[2]	VPH/ EPH[3]	SVOCs[4]	Dioxins/ Furans[5]	Conventional Testing[6]	Physical Testing[7]	Bioassays[8]	Archive
SB-21	1234294.21	648353.51	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3									✓
			3-4									✓
			4-5									✓
SB-22	1234315.78	648345.40	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓
SB-23	1234277.22	648362.15	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3									✓
			3-4									✓
			4-5									✓
SB-24	1234334.54	648337.63	0-1	✓	DRO				✓	✓		✓
			1-2									✓
			2-3							✓		✓
			3-4									✓
			4-5									✓

Table 4-4. Sediment Sample Locations and Testing. (continued)

Station	Easting (ft)	Northing (ft)	Depth (ft bgs)	Metals[1]	NWTPH[2]	VPH/ EPH[3]	SVOCs[4]	Dioxins/ Furans[5]	Conventional Testing[6]	Physical Testing[7]	Bioassays[8]	Archive
LSC-07	1234976.28	649075.89	0-0.3	✓	DRO				✓*	✓		✓
LSC-08	1234726.24	648932.79	0-0.3	✓	DRO				✓*	✓		✓
LSC-09	1234511.91	648758.82	0-0.3	✓	DRO				✓*	✓		✓
LSC-10	1234286.80	648190.76	0-0.3	✓	DRO				✓*	✓		✓
LSC-11	1234280.09	648179.77	0-0.3	✓	DRO				✓*	✓		✓
LSC-12	1234288.67	648182.18	0-0.3	✓	DRO				✓*	✓		✓
Reference	TBD	TBD	0-0.3	✓	DRO	✓	✓	✓	✓*	✓		✓
Total Samples				**31**	**31**	**≤31[9]**	**≤31[9]**	**≤31[9]**	**31**	**46**	**≤7[10]**	**127**

[1] Metals analysis will include arsenic, cadmium, chromium, copper, lead, mercury, nickel, silver, zinc (EPA Methods SW 6010/7471A).
[2] NWTPH analysis (Ecology 1997) will include both gasoline-range (GRO) and diesel-range (DRO) hydrocarbons except where indicated.
[3] VPH/EPH petroleum fractionated analysis (Ecology 1997) will be analyzed for selected samples exceeding GRO/DRO SL's or, at a minimum, 20 percent of total samples analyzed.
[4] SVOCs will be analyzed for samples exceeding GRO/DRO SL's or, at a minimum, 20 percent of total samples analyzed for confirmation purposes (EPA Method SW 8270C low levels).
[5] Dioxins/Furans will be analyzed by EPA Method 1613B for samples with PCP concentrations exceeding SL.
[6] Total organic carbon will be analyzed by EPA Method SW 9060 modified for sediment analysis. Samples (✓*) planned for bioassay testing will also be analyzed for total solids (PSEP 1986), ammonia (Plumb 1981/EPA Method 350.1) and total sulfides (PSEP 1986/EPA 376.2).
[7] Physical testing will include grain size (ASTM D 422-63 w/hydrometer), Atterburg limits (ASTM D 4318-00), Specific Gravity (ASTM 854-02), and moisture content (ASTM 2216).
[8] Bioassay testing will include the 10-day Amphipod (*Hyalella azteca*), Micortox Porewater (*Vibrio fischeri*), and 21-day Midge Larvae (*Chironomus tentans*).
[9] Sample total is dependent on the number of samples exceeding SL's, with a minimum of 20 percent site samples analyzed for SVOCs and EPH.
[10] LSC-07 through LSC-12 will be chemically analyzed first and compared to SL's. If samples exceed chemical SL's, bioassay testing will be conducted on those samples along with appropriate reference sediment.

Note: Field duplicate samples will be collected at a frequency of 1 per 20 field samples. Equipment rinse blank samples will be collected once per sampling method.

5 FIELD SAMPLING METHODS

This section presents the field sampling methods to be used by Integral and its subcontractors for the assessment of the Park. Appendix A contains standard operating procedures (SOPs) for most field methods discussed in this section. In general, field and sample processing methods will follow the Ecology Sediment Sampling and Analysis Appendix and the Puget Sound Estuary Program (PSEP) guidelines for marine and freshwater sediments and surface waters (Ecology 2003, PSEP 1986, 1997a,b,c).

5.1 HORIZONTAL AND VERTICAL CONTROL METHODS

5.1.1 Utility Survey

Proposed sampling locations within the Park will first be marked either by a handheld Global Positioning System (GPS) or contracted land surveyor. A clearly marked stake will be driven into each location. Prior to commencing intrusive field activities, Integral will conduct a utility survey to identify all known underground utilities within the study area. Integral will utilize all information provided by the City and Whatcom County as the baseline for the utilities survey, including the approximate location of the underground stormwater pipe located in the upper area of the park. Integral will also use the regional One-Call service (1-800-424-5555) for locating stations near Marine Drive. If proposed sample locations interfere with utilities, alternate locations will be marked.

5.1.2 Sample Locations

Once the utility survey has been completed, proposed sampling stations will be located by a contracted land surveyor (i.e., David Evans & Asssociates) using a Leica Electronic Distance Meter (EDM) Total Station positioning method. If it is necessary to move a station during the field work, the new location will be marked and staked as described above. At the conclusion of sampling, the land surveyors will survey changed station locations and provide x, y, and z data for all sampling locations. The boundaries of the shell midden and any other archaeological site within the Park will also be surveyed by DEA.

To maintain system accuracy, one or two accessible and recoverable survey control points will be established near or within the Park. Northing and easting coordinates will be provided in both NAD 27 and NAD 83 with 0.1-ft accuracy (City of Bellingham currently uses NAD 27 datum). After sampling is completed, using control points established by the land surveyor, the elevation of each sample point will be determined by differential leveling. Station elevations will be referenced to NAVD 88 and City of Bellingham coordinate system.

The following parameters will be documented at every sample location:

- Horizontal location in state plane coordinates NAD 1927 and 1983
- Depth to mudline (if overlying water)
- Time and date
- Surface elevation referenced to NAVD 88, 2001 Adjustment in U.S. Feet and City of Bellingham coordinate system.

Parameters listed above will be measured using combinations of the following:

- GPS Total Station
- Range-azimuth laser positioning methods
- Sounding lines or poles
- Back-up methods to survey control points (e.g., horizontal triangulation).

5.2 SAMPLING EQUIPMENT

5.2.1 Test Pits

Soil samples will be collected from test pits excavated using a backhoe to a depth of 4 ft bgs. SOP-1 presents the procedures planned for test pit excavations in the Park. Three of the test pits (TP-3, TP-6, TP-12) will be excavated deeper (~6 ft) for the installation of piezometers to monitor groundwater levels in the area (also described in SOP-1).

5.2.2 Hand Augers

Soil samples will be collected using a stainless-steel hand auger or equivalent to a depth of 2 ft bgs. SOP-2 presents the procedures planned for sampling with a hand auger in the Park.

5.2.3 Groundwater Sampling

Groundwater will be collected from each well using either a portable peristaltic pump equipped with Teflon-lined tubing or disposable bailer, as described in SOP-3.

5.2.4 Surface Water Sampling

Surface water will be collected from below the water surface using either a portable peristaltic pump equipped with Teflon-lined tubing or direct filling of sample bottles, as described in SOP-4.

5.2.5 Surface Sediment Sampling

Surface sediment samples (0 to 4 inches) will be collected from the Creek using a stainless-steel shovel, spoon, or trowel following methods described in SOP-5.

5.2.6 Sediment Borings

Sediment borings will be advanced using a portable, track-mounted, hollow-stem auger drill rig as described in SOP-6. A 2-ft long, 3-inch diameter split spoon will be used (or equivalent) to collect sediment samples at each sediment boring location.

5.2.7 Archeological Site Boundaries

The boundaries of archaeological sites (shell midden) will be evaluated within Little Squalicum Park following methods described in SOP-7.

5.3 SAMPLE IDENTIFICATION

Sediment/soil samples will be assigned an individual sample identification number in the following manner:

LSP-TP-## - ##
Where: = Little Squalicum Park (LSP)
Sample Type: TP, HA, SB, LSC = Test pit, Hand Auger, Sediment Boring, and Surface Sediment Sample
Sample Location and Depth Interval: ## - ## = top and bottom depth increment in feet

Sediment/soil sample processing will occur at a processing station as described in the following sections. Sample processing methods are intended to result in high-quality samples that meet the program's quality assurance objectives. Guidelines for sampling handling, and storage are presented in Table 5-1. All samples will be placed immediately in a cooler with ice to preserve them at 4°C and will be kept at this temperature at all times. All samples will be labeled and identified in accordance with Section 5.5.

Surface water samples will be assigned an individual sample identification number in the following manner:

LSP-SW-##
Where: Little Squalicum Park (LSP)
SW-## = Surface Water Sample Number

Groundwater samples will be assigned an individual sample identification number in the following manner:

LSP-GW-##
Where: Little Squalicum Park (LSP)
GW-## = Groundwater Sample Number

Field blank samples (i.e., equipment rinsates) will be assigned an individual sample identification number in the following manner:

LSP-FB-##
Where: Little Squalicum Park (LSP)
FB-## = Field Blank Sample Number

5.4 SOIL/SEDIMENT PROCESSING

Visual, sheen, and headspace screening will be conducted in the field on all soil and sediment samples collected during this investigation as described in SOP-8.

Compositing will only be performed within individual locations to ensure that adequate soil or sediment is available for the required analyses.[19] Split-spoon samples and test pit soils not used for analysis will be managed in accordance with applicable investigation-derived waste requirements as described in Section 5.8.

Soil/sediment composite samples will be processed according to the following step-by-step procedure:

1. Transfer sediment section from split-spoon or soil from test pit to a clean stainless steel bowl and cover with aluminum foil.
2. Stir the composite sample until the sample is of uniform color and texture. If any material (e.g., shells, rocks) has to be removed from the sample, note it in the field logbook or on the sample description sheet.
3. Fill jars for physical, chemical, and biological analyses.
4. Seal each glass container in a plastic bag in case of breakage. Place in ice chest and pack samples to minimize the chances of breaking.
5. Decontaminate the equipment as described in Section 5.7.
6. Collect excess sediment from the composite and dispose of as investigation derived waste, as discussed in Section 5.8.

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[19] Compositing and homogenizing is not appropriate for the analysis of volatile organics. Discrete samples will be collected only for analysis of volatile organics in soil and sediments.

5.5 SAMPLE CONTAINERS AND LABELS

Guidelines for sample handling and storage are presented in Table 5-1. All samples will be placed immediately in a cooler with ice to preserve them at 4±2° C and will be kept at this temperature at all times. All samples will be labeled and identified in accordance with Section 5.5.1.

5.5.1 Sampling Labels

The following sections describe documentation with sampling and handling procedures. Details are outlined in SOP-9 in Appendix A.

5.5.1.1 Sample Labels

Sample containers will be clearly labeled with waterproof black ink at the time of sampling. Sample labels will contain the following information:

- Sample identification numbers
- Sample date
- Sample time
- Preservation used, if any
- Analysis requested
- Initials of samplers.

The sample label will be attached to the sample container prior to, or just after, the container is filled and the lid secured. As an added measure of security, the finished label should be covered with clear packaging tape to protect the ink from moisture and to tightly secure the label to the sample container. Information on the sample label must match the information on the chain-of-custody form and in the site logbook for each sample.

5.5.1.2 Custody Seals

Custody seals will be used on sample shipping containers (coolers) that will either be shipped or sent by messenger to the laboratory. Custody seals will be attached to the lid and body of the coolers to detect any tampering during shipment. The custody seals will be signed and dated by the sampler or sample shipper. Custody seals are not required for samples delivered by hand directly to the lab unless left unattended.

5.5.1.3 Sample Summary Log

Sample summary logs will be maintained by the field team leader and used to keep track of all phases of the sampling and analysis process for all individual samples. The summary sample logs will include sample collection dates, sample delivery dates, dates analytical results are received, laboratory sample delivery group, and laboratory work order number.

5.5.1.4 Sample Custody/Tracking Procedures

The samples collected must be traceable from the time they are collected until they or their derived data are used in the final report. In general, the following provisions apply to sample handling:

- The field team leader, or sampler, will be responsible for the care and custody of the samples collected until they are properly transferred or dispatched to the laboratory.
- All appropriate documentation forms will be used, including sample labels, chain-of-custody forms, sample logs, and any other appropriate forms. Documentation will be completed neatly using waterproof, black ink.
- When transferring possession of samples, the individuals relinquishing and receiving them will sign, date, and note the time on the chain of custody form. Containers shipped by common carrier will have the chain-of-custody form enclosed in a watertight container (e.g., plastic resealable bag) and placed in the container prior to sealing.
- Samples will be packaged properly according to the current U.S. Department of Transportation requirements and promptly dispatched to the laboratory for analysis. Sample containers will be packed in coolers (or other shipping containers) with a low-density packing material, such as bubble wrap, and Blue Ice® or its equivalent. The coolers will be securely sealed.
- Each cooler will be accompanied by its own chain of custody form identifying its contents. A copy of the chain of custody form will be retained by the field team leader for inclusion in project records.
- For coolers shipped via express delivery service, custody seals will be affixed to the outside of the coolers (shipping containers). The field team leader, sampler, or shipper will sign and date the custody seals.
- All samples will be shipped via express delivery for overnight delivery or hand delivered to the laboratory.

5.6 FIELD DOCUMENTATION PROCEDURES

The primary types of documentation that will be used for this project include site logbook, photo logs, sample log forms, Field Change Request (FCR) forms, and sample tracking forms. The site logbooks are vital for documenting all onsite activities. Photo documentation will be used to provide an accurate account of the material sampled, sample locations, and environmental conditions. Sample log forms are used to summarize sampling data collected for various sample locations. The FCR forms are used to document any modifications made to the original project plans during field activities. Sample tracking forms include the chain of custody form, sample labels, and custody seals. The chain-of-custody form is used to track sample custody, which is an important aspect of field investigation activities that documents the proper handling and integrity of the samples. Sample labels are used to provide essential information and identification for all samples collected during field activities. Custody seals are used on all sample shipment containers to detect any tampering that may have occurred during transport or shipment. A description of each of these documentation methods is provided in the following sections. Example field forms are presented in Appendix A.

5.6.1 Field Logbooks

The field logbooks will be used to document all field sampling activities performed at the project site. The logbooks will contain the date, time, and description of all field activities performed; names of personnel; weather conditions; the names of visitors to the site; areas where photographs were taken; and any other data pertinent to the project. The site logbooks will also contain all sample collection and identification information and (if appropriate) a drawing of each area sampled, along with the exact location (coordinates) of where the sample was taken. The sampling information will be transferred to sample log forms when the sampler returns to the site office. The logbook is the official, legal record of site activities, and will serve as the key to sample designations and locations, and will include the date, time, site/sample location, sample identification number, sample matrix, how the sample was collected, any comments, and the sampler’s name.

Each page of the field logbook will be numbered, dated, and signed by the author. The logbooks will be sturdy, weatherproof, and bound to prevent the removal of pages. All writing will be done in waterproof, black, permanent ink. No pages may be removed from the site logbooks for any reason. Blank pages, if any, will be marked “page intentionally left blank.” Any mistakes will be crossed out with a single line, initialed, and dated. If multiple logbooks are used, they will be numbered sequentially.

5.6.2 Photo Documentation

Photographs will be taken at sampling locations and of selected samples. These photos will help identify the location and will provide an accurate visual record of the material being sampled. All photographs taken will be identified in the field logbooks (preferably in a separate section of the book set aside for that purpose). Photographic logs will contain, at a minimum, the film roll number, the photo number, the date, the time, the initials of the photographer, and a description of the image in the photograph.

5.6.3 Sample Collection Information Form

Sampling logs and collection forms will be used to document site and sample characteristic data, which should agree with the information recorded in the site logbooks. Field personnel are required to fill out one sample log form for each sample collected. A copy of these forms will be stored in the field office or field files, with the original stored in the project file. A copy of these forms will also be included in the final data report and other documents, as appropriate. At a minimum, the log for each sample will contain the sample number, the date and time of sample collection, and a description of the sampling site, as well as the physical characteristics of the sample, the planned analysis, and the initials of the sampler.

5.6.4 Field Change Request Form

The field team leader will be responsible for all environmental sampling activities, and will occasionally be required to adjust the field program, to accommodate site-specific needs after consultation with the project manager and/or QA Coordinator. When it becomes necessary to modify a program or task, the changes will be documented on a FCR form. If a field change is later found to be unacceptable, the action taken during the period of deviation will be evaluated to determine the significance of any departure from the established program practices and appropriate action taken. All field changes will be numbered consecutively starting with the number 001.

5.6.5 Sample Tracking Forms

Sample tracking is an important aspect of field investigation activities, as it documents the proper handling and integrity of the samples. Sample tracking forms to be used for the project will include chain-of-custody forms, sample labels, custody seals, and sample summary logs.

5.6.6 Chain-of-Custody Form

The chain-of-custody form is used to document the history of each sample and its handling from its collection through all transfers of custody until it reaches the analytical laboratory. Internal laboratory records will document custody of the sample from the time it is received in the lab through its final disposition. The chain-of-custody form will be filled out after the samples have been collected and will be double-checked prior to the transport of the samples to the laboratory. At a minimum, the chain-of-custody form will contain the following information:

- Name of project
- Names of samplers
- Sample identification numbers
- Sampling date
- Sampling time
- Number and type of containers per sample
- Sample matrix
- Sample preservation, if any
- Analysis requested.

The completed chain-of-custody form will be placed in a large capacity Ziploc® bag and secured to the sample transport container. If coolers are used to transport samples, the chain-of-custody form will be taped to the underside of the cooler lid.

5.7 DECONTAMINATION PROCEDURES

Equipment decontamination will be performed using procedures outlined below and in SOP-10 (Appendix A). Site personnel will perform decontamination of all equipment prior to removal from the site and between sample locations.

All non-disposable components of the sediment coring equipment (e.g., split spoons), or other equipment used to collect sediment samples that contacts the soils/sediments, will be decontaminated as follows:

- Potable water rinse
- Alconox/Liquinox detergent wash
- Potable water rinse
- Deionized (DI) water rinse
- Air dry.

If non-aqueous phase liquids are encountered in the soils/sediments, the following extra steps may be included in decontaminating equipment:

- Potable water rinse
- Alconox detergent wash
- Methanol to remove water
- Hexane to remove nonaqueous phase liquid (NAPL) film
- DI water rinse.

All sampling equipment that is used in sampling groundwater and surface water will be decontaminated as follows:

- Potable water rinse
- Alconox/Liquinox detergent wash
- Potable water rinse
- DI water rinse
- Air dry.

Rinsate blank samples will be collected as specified in Section 4.6 and SOP-11 (Appendix A) to document the level of decontamination.

All liquids generated as a result of decontamination processes will be containerized and handled as investigation derived wastes, as discussed in Section 5.8.

5.8 INVESTIGATION-DERIVED WASTES

The primary waste streams to be generated during this project and the proposed storage/disposal methods are provided in Table 5-2.

5.8.1 Excess/Rejected Sediment Samples

Sediment/soil samples that are rejected and/or determined to be in excess of what is required to conduct analytical sampling will be returned to the project area that it was collected.

5.8.2 Decontamination and Dewatering Wastewaters

Liquid wastes (i.e., dewatering water and decontamination waters) will be potentially contaminated with petroleum hydrocarbons and PAHs. The presence of any hazardous constituents in the wastewaters is expected to be diluted; therefore, the wastewaters are not expected to be classified as dangerous or hazardous waste. Therefore, the wastewaters are not likely to contain hazardous waste pursuant to the contained-in policy (i.e., environmental media that contain a listed hazardous waste are to be managed as a hazardous waste). Decontamination waters will be disposed of in the project area.

In the use of solvents (e.g., methanol and hexane), decontamination activities will be conducted so as to minimize the potential for spills/releases of wastewaters. Spent decontamination solvents must be stored in leak-proof container(s) with secured lid(s). The lid is to remain closed except when the container is being used for decontamination activities. It is anticipated that liquid wastes be placed in 5-gallon buckets or similar containers for offsite disposal or onsite evaporation (if applicable).

5.8.3 Personal Protective Equipment/Miscellaneous Debris

Personal Protective Equipment (PPE) and miscellaneous debris will be generated during sediment sampling activities. Interim storage of these materials in plastic bags is acceptable. The bags are to be disposed of at an appropriate solid waste facility dumpster after the completion of each sampling event.

Table 5-1. Required Sample Containers, Preservatives, and Holding Times.[1]

Analysis Type	**Matrix**	**Container Size**	**Holding Time[1]**	**Preservation**
NWTPH-GRO	Soil/Sediment	4 oz glass with Teflon coated/Septum lid	14 days extraction/analysis	Ice (4^oC)
NWTPH-DRO	Soil/Sediment	4 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4^oC) Frozen (-18^oC)
SVOCs	Soil/Sediment	8 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4^oC) Frozen (-18^oC)
Pesticides/PCBs	Soil/Sediment	8 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4^oC) Frozen (-18^oC)
Dioxins/Furans	Soil/Sediment	8 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4^oC) Frozen (-18^oC)
Metals	Soil/Sediment	4 oz glass	6 months/28 days* 2 years until analysis (except mercury)	Ice (4^oC) Frozen (-18^oC)
TOC	Soil/Sediment	4 oz glass	14 days 6 months	Ice (4^oC) Frozen (-18^oC)
Total Sulfides/Ammonia	Soil/Sediment	4 oz glass (zero headspace)	7 days	Ice (4^oC)
Grain size	Soil/Sediment	16 oz glass	6 months	Ice (4^oC)
Atterburg Limits	Soil/Sediment	Inc.	NA	Ice (4^oC)
Specific Gravity	Soil/Sediment	Inc.	NA	Ice (4^oC)
Moisture Content/Bulk Density	Soil/Sediment	Inc.	NA	Ice (4^oC)
NWTPH-GRO	Water	Two 40-mL glass with Teflon lined Septum lid	14 days extraction/analysis	1+1 HCl to a pH <2 Ice (4^oC)
NWTPH-DRO	Water	One 1-liter amber glass	14 days extraction/analysis	1+1 HCl to a pH <2 Ice (4^oC)
SVOCs	Water	Two 1-liter amber glass	7 days extraction/40 days analysis	Ice (4^oC)
Pesticides/PCBs	Water	Two 1-liter amber glass	7 days extraction/40 days analysis	Ice (4^oC)
Dioxins/Furans	Water	Two 1-liter amber glass	7 days extraction/40 days analysis	Ice (4^oC)
Metals	Water	One 1-liter HDPE	6 months/28 days*	Ice (4^oC), HNO_3 pH<2

Table 5-1. Required Sample Containers, Preservatives, and Holding Times. (continued)

Analysis Type	Matrix	Container Size	Holding Time[1]	Preservation
TOC	Water	One 500-mL HDPE	28 days	Ice (4^oC), H_2SO_4 pH<2
TSS	Water	One 1-liter HDPE	--	Ice (4^oC)
Hardness	Water	One 1-liter HDPE	--	Ice (4^oC)
Bioassays	Sediment	Three 1-liter amber glass	8 weeks	Ice (4^oC) No Headspace or Purged with Nitrogen Gas

1 Storage temperatures and maximum holding times for physical/chemical analyses and sediment toxicity tests (PSEP 1997a,b, Ecology 2003)

* Holding time for mercury is 28 days. Holding time for the other metals is 6 months.

Note: All holding times are from the date of sampling. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis without being qualified.

Table 5-2. Primary Waste Streams and Disposal Methods.

Waste Stream	**Estimated Quantity**	**Storage/Disposal Method**
Excess/Rejected Soil/Sediment Samples	*< 1000 lbs*	Returned to test pit location/bank of creek
Excess Surface Water/Groundwater Samples	*<20 gallons*	Returned to creek or poured on ground near location
Purged Groundwater before Sampling	*<200 gallons*	Poured on ground near location
Decontamination Wastewaters (except solvents)	*<100 gallons*	Poured onto ground near processing area
Personal Protective Equipment (PPE)/ Miscellaneous Debris	*<25 cubic ft*	Containerize/offsite disposal by Integral
Decontamination Solvents (methanol and hexane)	*<10 gallons*	Containerize and allow to evaporate/ offsite disposal by Integral if required

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Appendix A

Sampling and Analysis Plan
Standard Operating Procedures
and Field Forms

STANDARD OPERATING PROCEDURE 1

Test Pit Excavation and Sampling/Piezometer Installation/Water Level Measurements

Scope and Application

Test pits will be excavated at 12 locations within the Little Squalicum Park boundaries to further evaluate areas of historical landfill and gravel pit operations, which might have disturbed soils and distributed contamination throughout a depth range up to several feet. Soils will be collected from 1 ft intervals to an approximate depth of 3-4 ft using a stainless steel shovel, trowel, or spoon.

Three test pits (TP-3, TP-6, TP-12) will be excavated deeper (~6 ft) and piezometers will be installed while backfilling the hole to monitor groundwater levels at these locations. The piezometers will be 1-inch in diameter and made of PVC or stainless steel with slotted screens the entire depth of the installation.

Equipment and Reagents Required

- Sampling and Analysis Plan (SAP)
- Health and Safety Plan (HASP)
- Site logbook and test pit log
- Indelible black-ink pens and markers
- Camera
- Backhoe and operator
- PVC or stainless steel piezometer
- 10-20 Silica sands (if required)
- Well monument, concrete, cap and lock
- Electronic water level indicator
- Stainless steel spoons, trowel, shovel, bowls
- Photoionization detector (PID) and/or flame ionization detector (FID)
- Plastic sheeting
- Paper towels

- Sample containers
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample labels and appropriate documentation
- Assorted geology supplies (e.g., hand lens, grain size card, scales, etc.)
- Decontamination equipment (SOP-10)

Procedures

Test Pit Excavation

1. Using a backhoe, remove the upper 1-2 ft of soil from an area approximately [5 ft by 5 ft] square, and place to one side of the excavation.

2. Continue the excavation downward using the backhoe, placing the soils on the opposite side of the excavation. Extend the pit vertically and horizontally until the appropriate depth and width are obtained (3-4 ft depth proposed for this project).

3. Collect samples at 1 ft intervals to a depth of 3 feet, and from the bottom of the pit using a stainless steel shovel, trowel or spoon. Personnel shall not enter an excavation if it is more than 4 feet deep. If deeper than 4 ft, use the backhoe bucket to collect a sample.

4. A representative soil sample from each depth should be screened for volatiles using the PID/FID.

5. Once screening is complete, place representative soil from desired depth directly into a stainless steel bowl for compositing. Collect soil from all sides of the excavation for each sample depth to provide enough material for analysis.

6. Homogenize soil within bowl/pan with decontaminated stainless steel trowel or spoon. Remove rocks, twigs, leaves and other large debris as appropriate. Fill sample containers for analytical parameters. (Volatiles samples should not be composited but collected from a discrete location within the depth interval.)

7. If groundwater with sheen or odors is encountered, collect a water sample. A sample from less than 4 feet in depth may be obtained by direct fill into bottles (if possible) or by using a decontaminated stainless steel scoop. A sample from a deeper depth should be collected using a stainless steel beaker clamped to a pole (or equivalent). Care should be exercised when pouring the water into the

appropriate sample containers as not to aerate the sample. Personnel shall not enter an excavation if it is more than 4 feet deep.

8. Sketch a map of the trench showing the location (horizontally and vertically) of any stained soil layers, samples, buried wastes, etc. in the field notebook and/or on a test pit record form. Describe soil in accordance with ASTM D2488 on the sample log form.

9. Label and manage sample containers in accordance with SOP-9 for shipping and handling of samples.

10. Decontaminate sampling equipment in accordance with SOP-10.

11. Document activities in site logbook.

12. After completion of the trench or at the end of the day, whichever is more frequent, backfill the test trench(es). The soils from the deeper portion of the trench shall be returned to the trench first. If a trench was not completed and is backfilled at the end of a day, it may be restarted the next day from the point at which excavation ceased.

13. Mark the boundaries of the test pits and the ground surface location(s) of any soil/groundwater samples with stakes for subsequent surveying. Perform re-vegetation of the area as necessary and required.

Piezometer Installation

1. Once test pit has been sampled for chemical analysis as described above, excavate pit deeper until groundwater is encountered (~6 ft bgs).

2. Install 1-inch PVC or stainless steel piezometer with pre-packed slotted screen 2-3 feet below groundwater level if possible.

3. Backfill test pit around piezometer (soils are expected to be predominately coarse-grained materials (sands and gravels). If test pit soils are fine-grained, install 10-20 silica sand filter pack from 1 foot below the screen to a maximum of 3 feet above the screen, and then backfill test pit.

4. Cut PVC riser (for surface completions). Record cut length in site logbook.

5. Install concrete pad (minimum 3 feet by 3 feet by 6 inches) and locking protective monument (stand-pipe for each location). Install three bucking posts for standpipe completions, if necessary.

6. A lockable cap will be attached to the top of the casing. A protective cover, level with the ground surface, will be installed with a waterproof seal to prevent the inflow of surface water.

7. Decontaminate all equipment (SOP-10).

8. Document activities in the site logbook.

9. Ground surface at each piezometer will be surveyed to provide horizontal coordinates (northing/easting) and elevation.

Water Level Measurements

1. Rinse water level indicator probe and cable with deionized water and wipe dry with paper towels.

2. Holding cable reel atop casing, lower indicator probe gradually into well until tone and/or light indicates contact with water surface.

3. Grasp cable exactly at the measuring point marked at the top of the well casing with thumb and index finger. Pull cable out of well slowly to read measurement.

4. Record measurement depth to water surface to the nearest 0.01 ft as indicated on graduated cable.

5. Withdraw cable several feet then lower and repeat Steps 2-4. If readings differ by more than 0.2 ft, repeat until readings stabilize.

6. Remove cable and probe from well and rinse with deionized water.

STANDARD OPERATING PROCEDURE 2

Hand Auger Sampling

Scope and Application

Hand augers will be excavated at 8 locations within the Little Squalicum Park boundaries to evaluate soils along the Burlington Northern Santa Fe (BNSF) railroad right-of-way and an area northeast of Little Squalicum Creek suspected to be impacted by a historical OESER spill or contaminated runoff. Soils will be collected from 1 ft intervals to an approximate depth of 2 ft using a stainless steel hand auger or equivalent.

Equipment and Reagents Required

- Sampling and Analysis Plan (SAP)
- Health and Safety Plan (HASP)
- Site logbook and hand auger log
- Hand auger, drive sampler, or equivalent
- Indelible black-ink pens and markers
- Camera
- Stainless steel spoons, bowls
- Photoionization detector (PID) and/or flame ionization detector (FID)
- Sample bottles
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample labels and appropriate documentation
- Assorted geology supplies (e.g., hand lens, grain size card, scales, etc.)
- Decontamination equipment (SOP-10)

Procedures

1. Remove vegetation in area of station.
2. Use hand auger/drive sampler to bore into subsurface soil to a depth of 1 ft below ground surface (bgs).
3. Empty soil from hand-auger/drive sampler cuttings directly into a stainless steel bowl for compositing. Before compositing, a representative soil sample from each

depth should be screened for volatiles using the PID/FID. Collect enough soil from each depth interval for required analysis – this may require compositing up to 3 replicate samples at each station.

4. Describe soil in accordance with ASTM D2488 on the sample log form.
5. Homogenize soil within bowl/pan with decontaminated stainless steel trowel or spoon. Remove rocks, twigs, leaves and other large debris as appropriate. Fill sample containers for chemical parameters. (Volatiles samples should not be composited but collected from a discrete location within the depth interval from one auger sample.)
6. Collect the next depth interval (1-2 ft) and follow the same compositing procedures. Care should be taken in collecting representative soil from each depth interval.
7. Label and manage sample containers in accordance with SOP-9 for shipping and handling of samples.
8. Backfill sampling hole with remaining hand auger/drive sampler cuttings.
9. Decontaminate sampling equipment in accordance with SOP-10.
10. Document activities in site logbook.

STANDARD OPERATING PROCEDURE 3

Groundwater Sample Collection

Scope and Application

Groundwater samples will be collected from three locations within the Little Squalicum Park boundaries and one background location to be determined. There are two sampling rounds planned for this investigation, both during the wet season. The wet season samples will be collected between November and May.

Equipment and Reagents Required

- Sampling and Analysis Plan (SAP)
- Site logbook
- Indelible black-ink pens and markers
- Sample tags/labels and appropriate documentation
- Appropriate laboratory glassware
- Oil/water interface probe (if necessary)
- Water level meter
- Groundwater parameter multi-meter capable of measuring pH, reduction/oxidation (redox) potential, temperature, specific conductance, turbidity, and dissolved oxygen
- Flow-through cell
- Field alkalinity test kit
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample containers, coolers, and blue ice or equivalent
- Sampling equipment (one or more of the following): Peristaltic pump; disposable, dedicated bailers; Grundfos Redi-Flow submersible pump (or equivalent); Reel E-Z® system including control box; portable generator (5,000 watt minimum)
- Water Sampling Log Forms
- Decontamination equipment (SOP-10)

Typical Procedures

Preparation:

1. Record necessary data in site logbook.
2. Prepare sampling equipment including calibration of field meters prior to use.
3. Move equipment and supplies to sampling location.
4. Decontaminate equipment according to SOP 10.

Purging:

1. Remove well cap.
2. Measure light nonaqueous phase liquid (LNAPL) thickness (if present), measure static water level and total depth of well.
3. Remove the pump from the pump holder and rinse the pump off with distilled water. After consulting the well log to determine depth to the middle of the well screen, slowly lower the pump into the well. Position the pump at the middle of the well screen.
4. Connect the discharge hose and cable for the control box to the Reel E-Z® system. Start the generator and set it to 120 volts. Make sure the generator is kept downwind from the sampling system.
5. Place the discharge hose in the flow-through box. Place the probes for the calibrated field meters into the flow-through box. Place a bucket beneath the flow-through box to catch purged water.
6. Turn on the pump and adjust flow rate to approximately 2 liters per minute.
7. After approximately 4 liters of water have been purged from the well, adjust the flow rate to 1 liter per minute.
8. Start recording field parameters every 4 liters of water purged. Purging should continue at a constant rate until the selected parameters shown below have stabilized for three consecutive measurements.

Field Parameter	Stabilization Criteria
Temperature	± 1°C
pH	± 0.1 pH units
Specific Conductance	± 5 percent
Dissolved Oxygen	± 10 percent
Redox Potential (Eh)	± 50 mV
Turbidity	± 10 nephelometric turbidity units (NTUs)

Sampling:

1. After specified parameters have stabilized, turn down flow rate on control box so pressure is maintained in the system to stop water from entering well and minimize or stop water from exiting the well.
2. Disconnect discharge hose from Reel E-Z⊚ system.
3. Connect Teflon® sampling tube to Reel E-Z⊚ system. Place bucket beneath sampling tube to catch unsampled water.
4. Turn up flow rate slightly and fill necessary sample bottles. If sampling for volatile organic compounds (VOCs), flow rate should be just enough to create a trickle of water. If sampling for other analytes, adjust flow rate to 1 liter per minute.
5. Samples collected for dissolved metals shall be field filtered by connecting a 0.45 micron in-line filter to the sampling tube. Dispose of filter after each sample.
6. Label and manage sample containers in accordance with SOP 9 for shipping and handling of samples.

Documentation:

1. Fill out one Water Sampling Log Form for each sample collected with all necessary information recorded in the site logbook.

STANDARD OPERATING PROCEDURE 4

Shallow Surface Water Sample Collection

Scope and Application

Surface water samples will be collected from 7 locations within the Little Squalicum Park boundaries and a reference location to be determined. There are two sampling rounds planned for this investigation, both during the wet season. The wet season samples will be collected between October and May.

Equipment and Reagents Required

- Sampling and Analysis Plan (SAP)
- Health and Safety Plan (HASP)
- Site logbook and sample log
- Indelible black-ink pens and markers
- Camera
- Any of the following equipment may be used to collect samples:
    - A Teflon/stainless steel scoop with a Teflon/stainless steel handle
    - A stainless steel beaker clamped to a pole
    - Sample bottles (direct fill)
    - Portable peristaltic pump with Teflon tubing
- Water quality meter(s)
- pH paper
- Sample containers
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample labels and appropriate documentation
- Decontamination equipment (SOP-10)

Procedures

Surface water samples shall be collected moving in an upstream direction utilizing the following procedure:

1. Immediately before collecting the sample, record the temperature, dissolved oxygen, pH, turbidity, and specific conductance using a Horiba® water quality meter or equivalent and following the manufacturer's specifications.
2. Submerge the bottle, beaker or scoop and collect a sample. When pouring the water from a beaker or scoop into another bottle container, care should be exercised so as not to aerate the sample. VOC samples will be collected first.
3. A peristaltic pump can also be used if available.
4. Preserve containers as follows:
    a. VOCs - Determine the volume of 1:1 HCl preservative required to adjust the pH of the sample to less than 2 on an extra 40 ml glass vial prior to sampling. Pre-preserve sample bottles with the determined volume of HCl (if possible) and fill with sample. Check the bottle for the presence of trapped air by tapping the bottle when filled and capped.
    b. Other Parameters - Add appropriate volume of preservative (as specified in the SAP) to sample bottle. Verify pH by pouring a minimal portion of the sample onto broad range pH paper.
5. Complete sample logs, labels, custody seals, and chain of custody forms. Record sample information in the field notebook.
6. Place the analytical samples in a cooler for shipment and chill to 4°C (SOP-9).
7. Decontaminate sampling equipment in accordance with SOP-10.

STANDARD OPERATING PROCEDURE 5

Sediment Sampling – Shallow Water

Scope and Application

Surface sediment sampling will be conducted at 6 locations within Little Squalicum Creek to define the extent of hot spots detected during previous investigations (i.e., Ecology 2004 study). A reference sediment sample will also be collected at a location(s) to be determined. Surface sediments will be collected using a stainless steel shovel or trowel. Sediment samples will be obtained following the collection of surface water samples at each location, if possible, and will be collected moving in an upstream direction.

Equipment and Reagents Required

- Sampling and Analysis Plan (SAP)
- Health and Safety Plan (HASP)
- Site logbook and sample log
- Indelible black-ink pens and markers
- Camera
- Stainless steel shovel, trowel, or spoon
- Photoionization detector (PID)
- Ponar grab (or equivalent), in deeper water
- Sample containers
- Sample labels and appropriate documentation
- Assorted geology supplies (e.g., hand lens, grain size card, scales, etc.)
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Decontamination equipment (SOP-10)

Procedures

1. After collection of surface water samples at a location, use a decontaminated stainless steel shovel or trowel to scrape away surficial organic material (grass, leaves, etc.).

2. Obtain sediment for analysis using a stainless steel shovel, trowel or spoon from the surface to 4 inches below sediment surface. Fill sample container for volatile (e.g., H_2S) parameters as discrete grab samples. Then, empty remaining contents of shovel/trowel into a decontaminated stainless steel bowl or pan. Repeat until enough sediment is collected to fill all other required containers.

3. Homogenize sediment within bowl/pan with decontaminated stainless steel trowel or spoon. Remove rocks, twigs, leaves and other large debris as appropriate. Fill sample containers for remaining chemical parameters. (Volatiles samples should not be composited but collected from a discrete location within the depth interval.)

4. Describe soil in accordance with ASTM D2488 on the sample log form.

5. Complete sample logs, labels, custody seals, and chain of custody forms. Record sample information in the field notebook.

6. Place the analytical samples in coolers for shipment and chill to 4°C (SOP-9).

7. Decontaminate sampling equipment in accordance with SOP-10.

STANDARD OPERATING PROCEDURE 6

Hollow-Stem Auger Drilling/Sediment Sampling Piezometer Installation/Water Level Measurements

Scope and Application

Sediment borings will be advanced at 24 locations to define the width and depth of contamination in Little Squalicum Creek. After surface samples have been collected, sediment borings will be collected along three transects (3-5 borings each) across the creek bed, using a track-mounted, portable, hollow stem auger to collect samples at depth. The drill rig proposed for this work has a small foot-print allowing maneuverability within the creek bed without excessive disturbance of creek sediment, bank soils, and vegetation.

Selected borings may be excavated deeper (~6 ft) and piezometers will be installed while backfilling the hole to monitor groundwater levels and sample groundwater at these locations (see SOP-3 for sampling groundwater). The piezometers will be 2-inch in diameter and made of PVC or stainless steel with slotted screens the entire depth of the installation.

Required Equipment

- Sampling and Analysis Plan (SAP)
- Health and Safety Plan (HASP)
- Site logbook and boring log
- Indelible black-ink pens and markers
- Camera
- Hollow-stem auger drill rig
- Driller and helper
- Split-spoon samplers
- Photoionization detector (PID) and/or flame ionization detector (FID)
- PVC or stainless steel piezometer
- 10-20 Silica sands (if required)
- Well monument, concrete, cap and lock (if required)
- Electronic water level indicator

- Plastic sheeting
- 55-gallon drums (if required)
- Insulated cooler(s), chain-of-custody seals, Ziploc® bags
- Sample labels and appropriate documentation
- Assorted geology supplies (e.g., hand lens, grain size card, scales, etc.)
- Decontamination equipment (SOP-10)

Typical Procedures

Drilling Preparation:

1. Conduct site activity/health and safety briefing.
2. Calibrate field instrumentation.
3. Record necessary data in field logbook.
4. Obtain photograph(s) of site before drilling.
5. Place plastic sheeting and/or drums at drilling location to collect cuttings (if necessary).
6. Move equipment and supplies to drilling location.
7. Set up decontamination and sampling stations.

Drilling Construction:

1. Obtain surface soil samples, if required.
2. Drill to first sampling depth, as described in the SAP.
3. Place decontaminated split-spoon sampler on center rods.
4. Drive split-spoon sampler as described in American Society for Testing and Materials (ASTM) Method D-1586. Drive sampler to 18 inches or to refusal (no progress for 50 blows). Record blow counts on boring log form. Retrieve sampler.
5. A larger 3-inch diameter, 2-ft length split-spoon may be used to obtain more sediment from each depth interval.
6. Screen sampler with PID or FID (refer to SOP-8).
7. Describe soil in accordance with ASTM D2488 on the boring log form.
8. Composite soil sample as necessary. If volatile organic compound (VOC) samples are to be collected, collect sample prior to describing soil.

9. Continue drilling to next sample location. Collect samples as outlined above.
10. Label and manage sample containers in accordance with SOP-9 for shipping and handling of samples.
11. Decontaminate sampling equipment in accordance with SOP-10.
12. Document activities in site logbook.
13. Since the total depth of each boring will be only 5 ft below sediment surface, boreholes can be filled with cuttings after hole is complete. No grouting of borehole is required.
14. Move to next location.

Piezometer Installation:

1. Once a boring has been sampled for chemical analysis as described above, drill deeper until groundwater is encountered (~6 ft bgs) (if necessary).

2. Install 2-inch PVC or stainless steel piezometer with pre-packed slotted screen 2-3 feet below groundwater level if possible.

3. Backfill boring around piezometer (soils are expected to be predominately coarse-grained materials (sands and gravels). If boring soils are fine-grained, install 10-20 silica sand filter pack from 1 foot below the screen to a maximum of 3 feet above the screen, and then backfill boring.

4. Cut PVC riser (for surface completions). Record cut length in site logbook.

5. Install concrete pad (minimum 3 feet by 3 feet by 6 inches) and locking protective monument (stand-pipe for each location) (if necessary). Install three bucking posts for standpipe completions, if necessary.

6. A lockable cap will be attached to the top of the casing (if necessary). A protective cover, level with the ground surface, will be installed with a waterproof seal to prevent the inflow of surface water.

7. Decontaminate all equipment (SOP-10).

8. Document activities in the site logbook.

9. Ground surface at each piezometer will be surveyed to provide horizontal coordinates (northing/easting) and elevation.

Water Level Measurements:

1. Rinse water level indicator probe and cable with deionized water and wipe dry with paper towels.

2. Holding cable reel atop casing, lower indicator probe gradually into well until tone and/or light indicates contact with water surface.

3. Grasp cable exactly at the measuring point marked at the top of the well casing with thumb and index finger. Pull cable out of well slowly to read measurement.

4. Record measurement depth to water surface to the nearest 0.01 ft as indicated on graduated cable.

5. Withdraw cable several feet then lower and repeat Steps 2-4. If readings differ by more than 0.2 ft, repeat until readings stabilize.

6. Remove cable and probe from well and rinse with deionized water.

STANDARD OPERATING PROCEDURE 7

Archaeological Site Boundaries

Scope and Application

The boundaries of archaeological sites (shell midden) will be evaluated within Little Squalicum Park. There is one known site located upstream of the railroad bridge, in the lower reach of the creek. The following SOP will be followed by Integral and its subcontractor Dr. Gary Wessen during this investigation.

Equipment Required

- Shovel
- Screen box with ¼ inch mesh
- Pin flags
- EDM or 30 meter tape
- Hand-held GPS Receiver
- Camera
- Decontamination equipment (SOP-10)

Procedures

1. Careful visual inspection of all available horizontal and vertical exposures.
2. Establish the extent of the presently visible cultural materials and mark the boundaries of this area with pin flags.
3. Once the latter is done, shovel testing is used to further refine our knowledge of the site's boundaries. <u>(Washington State law forbids the knowing disturbance of an archaeological site - - including any type of sample collection - - without a permit, and so this effort will be conducted without actually impacting the site.)</u>
4. Radial transects will be established out from the marked site boundary. (Depending upon the site's size and shape, four to six transects will be established.)

5. Starting at a point 10 meters beyond the marked site boundary - - on one of the transects - - a small (i.e., 30 centimeter diameter) shovel test pit will be dug.
6. Digging will be done in 10 centimeter arbitrary levels and the sediments recovered from each level will be screened through ¼ inch mesh in order to facilitate the recognition of any cultural materials that might be present.
7. Digging will stop as soon as either potentially intact archaeological deposits or obvious glacial deposits are encountered.
8. Once the first pit is completed, additional pits will be dug at 3 meter intervals on the transect - - moving either toward or away from the site, as appropriate - - until the edge of the buried cultural deposit is located.
9. Steps 5 through 8 will be repeated on each transect.
10. When the shovel testing is completed, additional pin flags marking the extent of the buried cultural deposit will be placed and a map showing the distribution of both the exposed materials and the buried deposits will be prepared.
11. The site are will be photographed and its location recorded with a hand-held GPS receiver in both UTM and State Plane coordinates.
12. At the completion of the effort, all of the shovel test pits will be backfilled and all pin flags will be removed from the area. Wooden stakes or equivalent may be driven along the boundaries of each site for future reference.
13. Decontaminate sampling equipment in accordance with SOP-10.
14. Document activities in site logbook.

STANDARD OPERATING PROCEDURE 8

Hydrocarbon Field Screening for Soil and Sediment

Scope and Application

This SOP presents the qualitative field screening methods for hydrocarbons in soil and sediments.

Equipment and Reagents Required

- Clean stainless steel or plastic pan
- Camera
- Ziploc® bags
- Photo ionization detector (PID) or flame ionization detector (FID)

Procedures

Headspace Field Screening

1. Calibrate PID/FID in accordance with the manufacturer's specifications.
2. Label Ziploc® bag with the sample number.
3. Place representative soil/sediment sample in Ziploc® bag until bag is approximately one-half full. Seal Ziploc® bag and homogenize sample.
4. Allow bag to sit at ambient temperature for approximately 10 minutes. Place PID/FID wand into bag, being careful not to contact soil/sediment with probe.
5. Shake Ziploc® bag and record highest sustained reading in the field logbook.

Visual Screening

Visual screening consists of inspecting the soil/sediment for the presence of stains indicative of residual petroleum hydrocarbons. Visual screening is generally more effective in detecting the presence of heavier petroleum hydrocarbons, such as motor oil, or when hydrocarbon concentrations are high.

1. Visually inspect soil/sediment sample.

2. Indications of the presence of hydrocarbons typically include a mottled appearance or dark discoloration of the soil/sediment.

3. Record observations in logbook. Note: Visual observations do not definitively indicate the presence of hydrocarbons.

Sheen Screening

Sheen testing involves immersion of the soil/sediment sample in water and observing the water surface for signs of sheen.

1. A representative soil/sediment sample is placed into a clean stainless steel or plastic pan filled with deionized water with as little disturbance as possible.

2. Record observations in the logbook. Visual evidence of a sheen forming on the surface of the water is classified as follows:

   No sheen (NS)--No visible sheen on the water surface

   Colorless Sheen (CS)--Light, nearly colorless sheen; spread is irregular, not rapid; film dissipates rapidly (Note: light colorless sheens can be confused with sheens produced by organic content). Note that this sheen may or may not indicate the presence hydrocarbons.

   Heavy Sheen (HS)--Light to heavy colorful film with iridescence; stringy, spread is rapid; sheen flows off the sample; most or all of water surface is covered with sheen

Note: Samples used for field screening shall not be used for other analyses.

STANDARD OPERATING PROCEDURE 9

Shipping and Handling of Samples

Equipment and Reagents Required

- Sampling and Analysis Plan (SAP)
- Site logbook
- Sample logs
- Sample labels
- Indelible black ink pens
- Ziploc® bags
- Cooler
- Blue Ice® or other ice packs
- Strapping tape or duct tape
- Chain of custody forms
- Custody seals
- Bubble wrap, newspaper, or other packing material

Procedures

NOTE: Before packaging, all samples will be individually labeled and noted in the site logbook by the sampler. Labels will be completed with all required information (refer to SAP). The samples will be assigned individual numbers that describe sample type and sample location. The sample numbers will be used to complete the chain-of-custody forms and track the samples.

Samples to be hand-delivered to the laboratory:

1. Place each sample in a plastic Ziploc® bag and align the label so it can be easily read. Seal the bag.
2. Place individual samples into the cooler so that each container is safely secured.
3. Include enough (four or more) ice packs to maintain a temperature of 4ºC or lower.
4. Complete a chain-of-custody form for the containers and seal in a Ziploc® bag.

5. Tape bag containing the chain-of-custody form to the inside of the cooler lid. Always transport the cooler together with its accompanying chain-of-custody form.
6. Close and latch cooler and affix signed custody seals over the edge of the lid and the top of the cooler body at front and rear.
7. Deliver samples to the laboratory and obtain a signed copy of the chain-of-custody form for tracking purposes.

Samples to be shipped to the laboratory:

1. Place each sample in a plastic Ziploc® bag and align the label so it can be easily read. Seal the bag.
2. Wrap each sample with bubble wrap, newspaper, or other packing material.
3. Place individual samples into the cooler so that the addition of Blue Ice® and/or packing materials will prevent significant movement of samples during shipping. Keep in mind that we cannot predict in what position the cooler will be shipped. Each container has clearance on all sides.
4. Fill the void spaces with ice packs, bubble wrap, newspaper, or other packing material to ensure samples do not break during shipment.
5. Cover the head space inside the cooler with ice packs.
6. Tape bag containing the chain-of-custody form to the inside of the cooler lid. Remember to remove the last copy of the form for tracking purposes.
7. Close and latch cooler, and wrap cooler and lid with at least two turns of strapping, duct, or packaging tape. Affix signed custody seals over the edge of the lid and the top of the cooler body at front and rear.
8. Label coolers with up arrows and information to comply with Department of Transportation requirements.
9. Notify the laboratory approximately when and how many samples will arrive. The samples must be kept under refrigeration (or packed with ice) between sampling and analysis.

Note: If samples are to be stored overnight before shipping, they must be secured in a locked room or other inaccessible area. The cooler should be sealed with a signed and dated custody seal. Before shipping, the Blue Ice® in the cooler should be replaced and the cooler resealed according to the instructions in this SOP. Samples may be shipped in coolers or any other sturdy, water-tight, appropriate container. This SOP refers to coolers for simplicity and because they are the most common type of transport container.

STANDARD OPERATING PROCEDURE 10

Equipment Decontamination

Scope and Application

This SOP describes procedures for decontamination of sampling equipment, drilling equipment and other tools that could come in contact with contaminated media (Ecology 2003, PSEP 1997). Personnel performing the decontamination procedures will wear protective clothing as specified in the site-specific Health and Safety Plan.

Equipment and Reagents Required

- Plastic sheeting
- Steam cleaner and collection basin (if required)
- 55-gallon drums (if required)
- Non-phosphate detergent (e.g., Alconox or Liquinox).
- Acid Rinses (inorganic constituents) shall be reagent grade diluted nitric or hydrochloric acid (if required)
- Solvent Rinses (organic constituents) shall be pesticide grade methanol, hexane, isopropopanol or acetone (if required)
- Deionized or distilled water rinse available from retail stores. Note that distilled water generally contains low levels of organic contaminants and can not be used for field blanks (must receive reagent-grade from laboratory).
- Tap water rinse from local tap water.
- 5-gallon buckets, or other appropriate containers
- Scrub brushes
- Teflon squirt bottles
- Gloves (e.g., nitrile or polyethylene)
- Personal protective clothing

Procedures

Drill Rig or Test Pit Sampling Equipment Decontamination Procedures

1. Decontaminate sampling equipment before use, between samples and stations, and upon completion of sampling operations.

2. Equipment used during drilling/test pit operations should be decontaminated in the Exclusion Zone prior to transport to the Support Zone (refer to HASP).

3. If the steam cleaning location is in an area outside of the Exclusion Zone, remove loose sediment on the drill rig, augers, drill pipe and rods, and other large equipment at the drill site, then move the equipment directly to the steam cleaning decontamination area for more thorough cleaning.

4. To decontaminate a drill rig or backhoe, pressure wash with a steam cleaner using potable water rinse upon mobilization, between drilling locations, and upon demobilization. Cleaning water can be allowed to drain directly on the ground near the station.

5. To decontaminate auger, drill rods, and other downhole tools, pressure wash with a steam cleaner and potable water rinse upon mobilization, between drilling locations, and upon demobilization.

6. To decontaminate split-spoon and hand-auger samplers, wash with laboratory-grade detergent/water solution, rinse with tap water and a final distilled water rinse. If the samplers were exposed to visibly contaminated sediments (e.g. creosote, diesel, etc), include a methanol rinse followed by a hexane rinse. The hexane rinse would be followed by another distilled water rinse. To the extent possible, allow to air dry prior to sampling. If the split-spoon is not used immediately, wrap it in aluminum foil.

Decontamination of Sampling Implements and Processing Materials

1. Decontaminate sampling implements (e.g., spoons and knives) and other processing materials such as mixing bowls and pans, before use, between samples, and upon completion of sampling operations.

2. To decontaminate sampling spoons, mixing bowls and other hand-held tools, wash using a laboratory-grade detergent/water solution, rinse with tap water, followed by distilled water or ASTM Type II Reagent-grade water. As described above, if the sediment is visibly contaminated, a hexane rinse may be necessary

following a methanol rinse to remove water. To the extent possible, allow to air dry. Once decontaminated, this equipment will be wrapped in aluminum foil to prevent contamination by airborne contaminants during transportation to the sampling site.

3. To decontaminate sampling spoons used to collect volatile organics, wash the spoon using a laboratory-grade detergent/water solution, and rinse with distilled water. Wrap the spoon in aluminum foil. The solvent rinses are eliminated in order to avoid interference with the analysis.

4. If necessary, to decontaminate wash buckets, pressure wash with a steam cleaner using a laboratory-grade detergent/water solution and potable water rinse upon mobilization, between station locations, upon demobilization, or as needed during sampling operations.

References

Ecology. 2003. Sediment sampling and analysis plan appendix. Guidance on the development of sediment sampling and analysis plans meeting the requirements of the sediment management standards (Chapter 173-204 WAC). Prepared by Washington State Department of Ecology, Olympia, WA

PSEP. 1997. Recommended guidelines for sampling marine sediment, water columns, and tissue in Puget Sound. Final report. Prepared for the Puget Sound Estuary Program, U.S. Environmental Protection Agency, Region 10, Office of Puget Sound, Seattle, WA, and Puget Sound Water Quality Authority, Olympia, WA.

STANDARD OPERATING PROCEDURE 11

Quality Control Sample Preparation

Scope and Application

To establish procedures for preparation of field quality control samples collected during field investigations as described in the Sampling and Analysis Plan (SAP).

Equipment and Reagents Required

- Sample labels
- Indelible ink pens
- Master Sample Log and Chain-of-Custody Record forms
- Sample Bottles with preservatives (if required)

Procedures

The following procedures describe the preparation of various types of field quality control samples. Although general collection frequencies are given below, the type and number of quality control samples collected is dependent upon project specific requirements.

Trip Blanks

Trip blanks are 40-milliliter (40-mL) glass sample bottles (with septum lids) filled in the analytical laboratory with analyte-free water. They are shipped to the field with the empty sample coolers and stored with those bottles until they are used. One set of trip blank samples are enclosed in each sample cooler sent to the analytical laboratory which contains volatile organic compound samples for analysis. The field scientists do not open or otherwise disturb these samples except to label them with a sample number, if required, and prepare them for shipment with environmental samples. Trip blanks are analyzed for volatile organic compounds only.

Equipment Rinsates

Equipment rinsates are collected by capturing the final distilled water rinse from equipment cleaning. Decontamination procedures are detailed in SOP-10. These samples are collected during a sampling event by filling a full suite of environmental sample containers with rinse water using the same procedures employed for collection of environmental water samples. The results are used to flag analytical data and/or assess the concentrations of analytes in environmental samples during the data validation process. Rinsate samples are analyzed for the same compounds as related environmental samples.

Field Blanks

Field blanks are collected in the field during sampling activities by filling a full suite of environmental sample containers with analyte-free or distilled water, at the field sampling location, by pouring water from analyte-free water containers directly into the sample containers. At a minimum, one field blank will be collected during each sampling event. Field blanks are analyzed for the same compounds as related environmental samples.

Field Duplicates/Splits

Duplicates or splits, except for volatile organic compound analyses, are collected, homogenized, and split at the sampling location. Volatile organic compound sediment samples are collected from the length of the sediment grab or core, and placed immediately into appropriate sample containers for packaging and shipment to the analytical laboratory. Duplicate water samples are collected simultaneously by alternately filling similar sample bottles during the collection procedure. Duplicate samples may either be submitted to the analytical laboratory as a blind sample, or may be identified to the laboratory, depending on project objectives. Duplicate environmental samples are analyzed for the same suite of analytes.

Field Replicate Samples

Field replicate samples are collected as separate samples from the same location as the initial sample collected. Unlike duplicate/split samples, they are not subsamples of one homogenous sample. They are collected and processed according to the same procedures followed for the initial sample. Similar to the field duplicates, they may either be submitted to the analytical laboratory as blind samples, or may be identified as replicate samples, depending on project objectives. Replicate environmental samples are analyzed for the same suite of analytes as the initial sample.

Water Source Blanks

Water source blanks are collected in the field during sampling activities by filling a full suite of environmental sample containers with water from the source used for decontamination and steam cleaning using the same procedures employed for collection of environmental water samples. At a minimum, one water source blank will be collected during each sampling event (the time frame determined by the arrival of sampling personnel at a sampling area until those personnel leave for more than one day) and from each source of water used in decontamination and steam cleaning. Water source blanks are analyzed for the same compounds as the related environmental samples.

GROUNDWATER SAMPLE COLLECTION FORM

Well Number ____________________
Sample No. ____________________
Date ____________________

Project Name: Little Squalicum Park
Project Number: C075-02
Collector: ____________________.

Well Information

Monument Condition ☐Good ☐Needs Repair ____________________
Well Cap Condition ☐Good ☐Locked ☐Replaced ☐Needs Replacement
Elevation Mark ☐ Yes ☐ Added ☐other
Well Diameter ☐ 2-inch ☐4-inch ☐6-inch ☐Other
☐Odor Comments ____________________

Purge Data

Total Well Depth ________ ft ☐ Clean Bottom ☐Muddy Bottom ☐Not Measured
Depth to Water ________ ft
Casing Volume ________ ft (H20) X ________ gpf = ________ X 3 = ________ gallons
3/4 " = 0.02 gpf 1"= 0.04 2" = 0.16 gpf 4"=0.65 gpf 6"=1.47 gpf

Purge Method

Pump Type: Peristaltic Tubing: Disposable, dedicated LDPE Total volume purged ________
Sample Intake Depth ____________ Purge Rate ________
Purge Start Time ________ Purge Stop Time ________ Sample Rate ________

Field Parameters

Time	Gallons	pH	Temperature	Conductivity	D.O.	Comments

Sampling Device

Filter Type: ____________. Size: ____________.

Sample Containers Collection Time ________

Tag No.	Type		Preservative	Analytical Method	QA Remarks
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			
	☐Amber	☐Poly			

Samplers' Signature ____________________ Date ____________

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INTEGRAL CONSULTING INC.
SURFACE WATER SAMPLING FORM

PROJECT____________________________________ SAMPLE NO.______________________________

DATE _________________ TIME ______ SAMPLED BY_____________________________

WEATHER CONDITIONS____

SAMPLE LOCATION____

SAMPLE DEPTH ____

SURFACE WATER FLOW RATE ____

SURFACE WATER TYPE ____

SAMPLE CONDITION (i.e. turbidity, odor, oily)____

____

SAMPLE COLLECTION

COLLECTION METHOD ____

COLLECTION TIME_____

SAMPLE INFORMATION pH________ COND.________ T(C) _______ D.OXYGEN ___________

ANALYSIS	CONTAINERS	SAMPLE PREP/PRESERVATION

CHAIN OF CUSTODY FORM ______________________ COC TAPE ____________________________

SHIPPING CONTAINER ____

COMMENTS ____

____

____

EQUIPMENT CALIBRATION AND MAINTENANCE FORM (TYPICAL)

INSTRUMENT (NAME / MODEL NO. / SERIAL NO.): ____________________

MANUFACTURER: ____________________ DATE PURCHASED or LEASED: ____________________

CALIBRATION LOGSHEET

Calibration Date	Initial Settings	Standard(s) Used	Procedure	Adjustments Made	Final Settings	Signature of Operator	Comments

MAINTENANCE LOGSHEET

Maintenance Date	Reason for Maintenance	Maintenance Performed	Signature of Operator	Comments

FIELD CHANGE REQUEST (FCR) FORM (TYPICAL)

Project Name: ______________________________ Project No.: ____________________
Client: ____________________________________ Request No.: FCR-____________

To: ______________________________ Date: ______________________________

Field Change Request Title: ____

Description:

____
____
____

Reason for Change:

____
____
____

Recommended Disposition:

____
____

Field Operations Lead (or designee)	Signature	Date

Disposition:

____
____

Project Manager	Signature	Date

Approval:

Project Manager	Signature	Date

Distribution:

City of Bellingham Project Manager	QA Officer
Integral Project Manager	Project File
Field Operations Lead	Other:

integral consulting inc.

1201 Cornwall Avenue, Suite 208
Bellingham, WA 98225

(360) 756-9296 FAX (360) 756-7914

BORING NUMBER
PROJECT Little Squalicum Park RI/FS
LOCATION Bellingham, Washington
PROJECT NUMBER C075-02
LOGGED BY

Page___ of ___

SAMPLE INFORMATION								DESCRIPTION
Sample ID	Tag #	Blow Counts	% Recov.	PID/FID	Sheen	Depth (Feet)	STRATA	USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
						2--		
						4--		
						6--		
						8--		
						10--		
						12--		
						14--		

DRILLING CONTRACTOR
DILLING METHOD
SAMPLING EQUIPMENT
DRILLING STARTED
COORDINATES
SURFACE ELEVATION
DATUM

Location Sketch

integral
consulting inc.

1201 Cornwall Avenue, Suite 208
Bellingham, WA 98225
(360) 756-9296   FAX (360) 756-7914

TEST PIT NUMBER
PROJECT Little Squalicum Park RI/FS
LOCATION Bellingham, Washington
PROJECT NUMBER C075-02
LOGGED BY

Page___ of ___

SAMPLE INFORMATION							STRATA	DESCRIPTION
Sample ID	Tag #	PID	Sheen			Depth (Feet)		USCS group name, color, grain size range, minor constituents, plasticity, odor, sheen, moisture content, texture, weathering, cementation, geologic interpretation, etc.
						2--		
						4--		

ADDITIONAL NOTES / SKETCHES

EXCAVATING CONTRACTOR
EXCAVATION METHOD
SAMPLING EQUIPMENT
EXCAVATING STARTED
COORDINATES
SURFACE ELEVATION
DATUM

Location Sketch

CHAIN OF CUSTODY FORM

0190

Page ___ of ___

Project: ____________________

Samplers: ____________________

integral consulting inc.

Integral Contact: ____________________
Office ____________________
Phone ____________________

Ship to:
Lab Name ____________________
Address ____________________
____
____
Contact ____________________
Phone ____________________

Sample No.	Tag No.	Date	Time	Matrix	ANALYSES REQUESTED						Extra Container	Archive	Comments

Analysis Turn Time: Normal Rush Rush Results Needed By:

Shipped by: Shipping Tracking No.

Condition of Samples Upon Receipt: Custody Seal Intact?

Matrix Code:
SL - Soil
SD -Sediment
GW - Groundwater
SW - Surface water
Other:

Relinquished by: ____________________ *(signature)* Date/Time: ________ Received by: ____________________ *(signature)* Date/Time: ________

Relinquished by: ____________________ *(signature)* Date/Time: ________ Received by: ____________________ *(signature)* Date/Time: ________

Special Instructions:

Appendix B

Sampling and Analysis Plan
Biological Results

Table B-1. 10-day Amphipod Sediment Toxicity Test Results.

	Hyalella azteca	
Sample	**Mean Survival (%)**	**Mean Dry Weight per Organism (mg)**
Lab Control	88	0.1
SD9 (Reference)	91	0.24
SD1	88	0.18
SD2	90	0.13
SD3	93	0.15
SD4	78	0.18
SD5	81	0.14
SD6	93	0.2
SD7	83	0.2
SD8	93	0.16
SD10	93	0.15

Table B-2. 28-day Oligochaete Sediment Bioaccumulation Test Results.

	Lumbriculus varietagus			
Sample	**Replicate**	**Tissue Weight (g)**	**Mean Tissue Weight (g)**	**Sediment TOC (%)**
Lab Control	A	9.84	8.89	unknown
	B	9.79		
	C	9.75		
	D	7.99		
	E	7.1		
SD2	A	3.36	3.69	1.3
	B	3.69		
	C	5.24		
	D	3.3		
	E	2.85		
SD5	A	3	2.89	1.8
	B	2.47		
	C	3.08		
	D	4.64		
	E	1.24		
SD6	A	7.98	11.21	11
	B	6.19		
	C	10.26		
	D	14.24		
	E	17.36		

Table B-3. Sediment Oligochaete Tissue Concentrations.

		Lumbriculus variegatus			**Sediment**		
Analyte	**Location Study**	**SD2 & SD5 RI**	**SD6 RI**	**Laboratory Control RI**	**SD2 RI**	**SD5 RI**	**SD6 RI**
Dioxins							
1,2,3,4,7,8-HxCDD	ng/Kg	**7.394**	NA	0.203 U	3.81	4.95	**16.7**
1,2,3,6,7,8-HxCDD	ng/Kg	**119.97**	NA	0.14 U	**223**	**30**	**79.6**
1,2,3,4,6,7,8-HpCDD	ng/Kg	**1883.7 J**	NA	1.907 UJ	**10100**	**978**	**25100**
1,2,3,4,6,7,8-HpCDF	ng/Kg	**292.16**	NA	0.193 U	**1950**	**163**	**421**
1,2,3,4,7,8,9-HpCDF	ng/Kg	**15.07**	NA	0.275 UJ	**68.3**	**10.7**	**31.6**
OCDD	ng/Kg	**16282.4**	NA	20.121 UJ	**126000**	**60200**	**304000**
OCDF	ng/Kg	**856.7**	NA	0.801 UJ	**11500**	**1210**	**39400**
Total TCDD	ng/Kg	**11.2**	NA	0.128 U	**3.4**	0.345	**2.23**
Total TCDF	ng/Kg	**30.1**	NA	0.182 U	**23**	**0.558**	**1.74**
Total PeCDD	ng/Kg	**6.8**	NA	0.197 U	**5.6**	**1.25**	**9.85**
Total PeCDF	ng/Kg	**231.3**	NA	0.166 U	**337**	**31.9**	**90.9**
Total HxCDD	ng/Kg	**346.8**	NA	0.14 U	**820**	**130**	**381**
Total HxCDF	ng/Kg	**982.5**	NA	0.141 U	**1800**	**175**	**473**
Total HpCDD	ng/Kg	**3346.2**	NA	**1.36**	**18500**	**1780**	**43500**
Total HpCDF	ng/Kg	**307.2**	NA	**1.27**	**1950**	**174**	**453**
TEQ (ND=0.5 DL)	ng/Kg	**36.36**	NA	NA	**320.96**	**81.25**	**624.13**
SVOCs							
2,4,6-Trichlorophenol	mg/kg	NA	**0.74 J**	0.13 U	0.013	0.013	0.031
2-Methylphenol	mg/kg	NA	**1 J**	0.13 U	0.013	0.013	0.031
3&4-Methylphenol	mg/kg	NA	**3.3 J**	**0.27 J**	0.013	**0.012**	**0.1**
Anthracene	mg/kg	NA	**0.37**	0.027 U	**2.2**	**0.061**	**0.56**
Benzo(a)anthracene	mg/kg	NA	**0.17 J**	0.027 U	**3.7**	**0.12**	**1.7**
Benzo(a)pyrene	mg/kg	NA	**0.4**	0.027 U	**2.4**	**0.34**	**1.4**
Benzo(b)fluoranthene	mg/kg	NA	**0.28 J**	0.027 U	**0.82**	**0.15**	**0.7**
Benzo(j)fluoranthene	mg/kg	NA	**0.28 J**	0.27 U			
Benzo(k)fluoranthene	mg/kg	NA	**0.28 J**	0.027 U	**0.82**	**0.15**	**0.7**
Benzoic acid	mg/kg	NA	**5.3 J**	0.27 U	0.026	0.026	0.061
Benzyl alcohol	mg/kg	NA	**13 J**	**1.5 J**	0.013	0.013	0.031
Chrysene	mg/kg	NA	**0.46 J**	0.027 U	**8.3**	**0.23**	**2.2**
Fluoranthene	mg/kg	NA	**1.3**	0.027 U	**0.47**	**0.1**	**3.2**
Naphthalene	mg/kg	NA	**0.11**	0.027 U	**0.024**	**0.0058**	**0.025**
Pentachlorophenol	mg/kg	NA	**2.1 J**	0.13 UJ	**0.033**	**0.056**	**0.46**
Phenanthrene	mg/kg	NA	**0.48**	0.027 U	**0.61**	**0.041**	**0.41**
Phenol	mg/kg	NA	**0.34 J**	0.13 U	0.013	0.013	0.031
Pyrene	mg/kg	NA	**0.43 J**	0.027 U	**0.66**	**0.096**	**2.9**
Tetrachlorophenols	mg/kg	NA	**4 J**	0.13 U	**0.0054**	0.013	**0.079**

NA = not applicable
Bold font indicates detected concentrations

Table B-4. Berry Tissue Concentrations.

	Sample Location	**99070520 Berry 1**	**99070521 Berry 1**	**99070522 Berry 2**	**99070523 Berry 2**	**99070524 Berry 3**	**99070525 Berry 3**	**99070524 Berry 4 (Reference)**	**99070525 Berry 4 (Reference)**
Analyte	**Treatment Study Date**	**Washed RI 8/20/1999**	**Unwashed RI 8/20/1999**	**Washed RI 8/20/1999**	**Unwashed RI 8/20/1999**	**Washed RI 8/20/1999**	**Unwashed RI 8/20/1999**	**Washed RI 8/20/1999**	**Unwashed RI 8/20/1999**
Dioxins									
1,2,3,4,6,7,8-HpCDD	ng/Kg	1.50 U	3.19 U	1.59 U	**2.7**	2.21 U	**1.07**	0.92 U	0.92 U
OCDD	ng/Kg	**14.47**	**30.42**	**17.84**	**31.07**	**22.02**	**9.45**	10.89 U	**17.72**
OCDF	ng/Kg	1.36 U	**2.72**	1.46 U	**2.91**	1.04 U	2.52 U	0.91 U	0.87 U
Total HpCDD	ng/Kg	1.50 U	0.60 U	1.59 U	**5.04**	1.20 U	**1.07**	0.92 U	0.92 U
TEQ (ND=0.5 DL)	ng/Kg	**0.001**	**0.003**	**0.002**	**0.3**	**0.002**	**0.012**	NA	**0.002**
VOCs									
p-Isopropyltoluene	mg/kg	**0.003**	**0.0067**	**0.013**	**0.015 J**	**0.012 J**	**0.018**	**0.027 J**	**0.013**
Styrene	mg/kg	0.003 U	**0.00034 J**	**0.00018 J**	**0.00022 J**	**0.0013**	**0.0022**	**0.0045**	**0.00061**
SVOCs									
1,2,3-Trichlorobenzene	mg/kg	0.003 U	0.00036 U	0.00036 U	0.00032 UJ	0.00032 UJ	0.00034 U	**0.00033**	0.00035 U
2-Methylnaphthalene	mg/kg	0.0013 U	0.0019 U	**0.0017**	**0.002**	**0.0017**	**0.0011 J**	0.0013 U	0.0013 U
Benzoic acid	mg/kg	0.013 U	**0.032**	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U	0.013 U
Benzyl alcohol	mg/kg	**0.056**	**0.06**	0.0065 U	**0.04**	**0.063**	**0.063**	0.0063 U	0.0065 U
Fluoranthene	mg/kg	**0.0047**	**0.0058**	0.0013 U	0.0027 U	**0.0012 J**	0.0013 U	**0.0041**	0.0013 U
Fluorene	mg/kg	**0.0032**	**0.0033**	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U
Naphthalene	mg/kg	**0.0003**	**0.00036**	0.00036 U	0.00032 UJ	0.00032 UJ	0.00034 U	0.00033 U	0.00035 U
Phenanthrene	mg/kg	**0.015**	**0.016**	**0.0087**	**0.0072**	**0.0053**	**0.0053**	**0.0086**	**0.011**
Phenol	mg/kg	0.0066 U	**0.004 J**	0.0065 U	0.0065 U	0.0065 U	**0.009**	0.0063 U	0.0065 U
Pyrene	mg/kg	0.0013 U	**0.0037**	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U	0.0013 U

NA = not applicable
Bold font indicates detected concentrations

Table B-5. Ecology Sediment Toxicity Test Results.

	10-day Amphipod (*Hyalella azteca*)			20-day Midge (*Chironomus tentans*)						Microtox	
Site	Mean % Survival	Mean RPD % Survival	Control p-values [a] Survival	Mean % Survival	Mean RPD % Survival	Mean Weight per Org (mg)	T/C Mean Weight per Org (mg)	Control p-values [a] Survival	Control p-values [a] Growth	Light Reading $I_{(15)}/I_{(0)}$	Mean Change $T_{(15)}/C_{(15)}$
Control	88	NA	NA	96	NA	1.044	NA	NA	NA	0.89/0.93 [b]	NA
LSC-01	80	10	0.091	86	11	1.564	1.5	0.052	---	0.90	1.01
LSC-02	79	11	0.208	60	46	1.824	1.7	0.001	---	0.93	1.03
LCS-03	0	200	<0.001	0	200	NA	NA	<0.001	<0.001	1.08	0.42
LSC-04	70	23	0.029	80	18	2.005	1.9	0.100	---	0.97	1.03
LCS-05	84	5	0.327	84	13	1.927	1.8	0.210	---	0.95	0.78
LSC-06	67	27	0.015	82	16	2.113	2.0	0.093	---	0.99	0.78

[a] One-tailed t-test. Survival data arcsine square-root transformation prior to t-test.

[b] Microtox test were run in two batches. Test samples LSC01, LSC-02 and LSC-03 were run with a control in the first batch and test samples LSC-04, LSC-05, and LSC-06 were run with a control in the second batch. Only control batch results are presented.

NA-Not Available or Not Applicable

--- Site response greater than control sediment response.

$I_{(0)}$ is the light reading after the initial five minute incubation period

$I_{(15)}$ is the light reading fifteen minutes after $I_{(0)}$

$C_{(t)}$ and $T_{(t)}$ are the changes in light readings from the intial reading in each sample container for the control and test sites. $I_{(t)}/I_{(0)}$

T = test sample

C = Control sample

RPD = relative percent difference

RPD = ((T-C)/((T+C)/2))*100

FINAL

ECOLOGY TOXICS CLEANUP PROGRAM
EPA BROWNFIELDS PROGRAM

QUALITY ASSURANCE PROJECT PLAN

Little Squalicum Park
Remedial Investigation/Feasibility Study
Bellingham, WA

Prepared for

City of Bellingham
Parks & Recreation Department
3424 Meridian Street
Bellingham, WA 98225

Prepared by

integral consulting inc.

1201 Cornwall Avenue, Suite 208
Bellingham, WA 98225

September 30, 2005

SECTION A: PROJECT MANAGEMENT

A1 TITLE AND APPROVAL SHEET

QUALITY ASSURANCE PROJECT PLAN
LITTLE SQUALICUM PARK
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
BELLINGHAM, WASHINGTON

Quality Assurance Project Plan Approvals

Ecology Project Coordinator: Mary O'Herron ____________________ Date: __________

EPA Project Coordinator: Ravi Sanga ____________________ Date: __________

EPA QA Manager: Ginna Grepo-Grove ____________________ Date: __________

City of Bellingham Project Mgr: Tim Wahl ____________________ Date: __________

Integral Project Manager: Mark Herrenkohl ____________________ Date: __________

Integral Project QA Manager: Maja Tritt ____________________ Date: __________

ARI Project Manager: Sue Dunnihoo ____________________ Date: __________

ARI QA Manager: Dave Mitchell ____________________ Date: __________

STL Project Manager: Jill Kellmann ____________________ Date: __________

STL QA Manager: Pam Schemmer ____________________ Date: __________

NAS Project Manager: Gerald Irissarri ____________________ Date: __________

NAS QA Manager: Linda Nemeth ____________________ Date: __________

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ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
ARI	Analytical Resources Inc.
BTC	Bellingham Technical College
CFR	Code of Federal Regulations
COC	chain-of-custody
Creek	Little Squalicum Creek
CVAA	cold vapor atomic absorption spectrometry
DQO	data quality objective
DRO	diesel-range organic hydrocarbons
EDD	electronic data deliverable
EIM	electronic information management
EPA	U.S. Environmental Protection Agency
EPH	extractable petroleum hydrocarbon screen
EQuIS™	Environmental Quality Information System
FCR	field correction record
FID	flame ionization detector
GC	gas chromatography
GC/ECD	electron capture detector
GC/MS	gas chromatography with mass spectrometry
GPC	gel permeation chromatography
GRO	gasoline-range organic hydrocarbons
HASP	health and safety plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HDPE	high density polyethylene
HRGC/HRMS	high-resolution gas chromatography with high-resolution mass spectrometry
ICP/MS	inductively coupled plasma/mass spectrometry
ICP/OES	inductively coupled plasma-optical emission spectrometry
LCS	laboratory control sample
LIMS	laboratory information management system
mg/kg	milligrams per kilogram
µg/kg	micrograms per kilogram
MQO	measurement quality objective
MDL	method detection limit
MRL	method reporting limit
MTCA	Model Toxic Control Act
NAS	Northwestern Aquatic Sciences, Inc.
NWTPH	Northwest total petroleum hydrocarbons
PARCC	precision, accuracy or bias, representativeness, completeness, and comparability
Park	Little Squalicum Park

PCB	polychlorinated biphenyl
PID	photo-ionization detector
PSEP	Puget Sound Estuary Program
QA/QC	quality assurance/quality control
QAPP	quality assurance project plan
RPD	relative percent difference
SAP	sampling and analysis plan
SMS	Sediment Management Standards
SOP	standard operating procedure
STL	Severn Trent Laboratories, Inc.
SVOCs	semivolatile organic compounds
TOC	total organic carbon
TSS	total suspended solids
WISHA	Washington Industrial Safety and Health Act
WMG	wide mouth glass

A3 DISTRIBUTION LIST

Ecology Project Coordinator:	Mary O'Herron
EPA Project Coordinator:	Ravi Sanga
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STL QA Manager:	Pam Schemmer
NAS Project Manager:	Gerald Irissarri
NAS QA Manager:	Linda Nemeth

A4 INTRODUCTION AND PROJECT AND TASK ORGANIZATION

This quality assurance project plan (QAPP) describes quality assurance/quality control (QA/QC) procedures that will be used to complete a remedial investigation/feasibility study (RI/FS) for the Little Squalicum Park (the Park) site located in Bellingham, Washington. This QAPP has been prepared in accordance with EPA guidance for the preparation of QAPPs (USEPA 2002a).

The Park consists of 32 acres located within the Birchwood Neighborhood and lies adjacent to Bellingham Technical College (BTC) and the junction of Marine Drive, Eldridge Avenue and Lindbergh Avenue. Little Squalicum Creek (the Creek) flows through the middle of the park and discharges into Bellingham Bay. The field effort will include collection of surface water, surface sediment, and sediment borings from the Creek. Soil and groundwater samples will also be collected at selected stations within the Park boundaries as part of this characterization. Samples from each media will be analyzed for conventional parameters (e.g., total organic carbon, hardness), physical tests (e.g., grain size), heavy metals, petroleum hydrocarbons, semivolatile organic compounds (SVOCs), and dioxins/furans. Selected soil samples will also be analyzed for chlorinated pesticides and PCB Aroclors. Selected surface sediment samples may also be evaluated for toxicity using a suite of freshwater bioassay tests. Details are provided in the *Sampling and Analysis Plan* (SAP) which accompanies this document.

Integral Consulting Inc. (Integral) is conducting this work under contract to the City of Bellingham, Parks and Recreation Department (City), with direction from both the Washington State Department of Ecology (Ecology) and U.S. Environmental Protection Agency, Region 10 Brownfields program (EPA). The organizational structure for this project is illustrated in Figure A-1. Contact information is provided in Table A-1. Project and quality assurance responsibilities are described in detail in Section 4 of the accompanying Work Plan. Responsibilities are included for the following project roles:

- Project managers for Ecology, EPA, the City of Bellingham, Integral, and subcontractor laboratories
- Quality assurance managers for EPA, Integral, and the laboratories
- Task managers for the field effort and subcontractors supporting the sample collection effort.

A5 PROBLEM DEFINITION AND BACKGROUND

The Whatcom County Health and Human Services completed a site hazard assessment (SHA) of the Park site in February 2004, as required under the Model Toxics Control Act (MTCA). The site's hazard ranking, an estimation of the potential threat to human health and/or the environment relative to other Washington State sites assessed at that time, was determined to be a 1, where 1 represents the highest relative risk and 5 the lowest

(Ecology 2004). Based on the results of the SHA, Ecology has determined that a RI/FS should be developed pursuant to WAC 173-340-350 and WAC 173-204-560 for the Park site. Ecology has negotiated an *Agreed Order* (dated March 22, 2005) with the City to conduct an RI/FS on the Park site. The RI/FS is intended to provide sufficient data, analysis, and evaluations to enable Ecology to select a cleanup action alternative for the site.

The primary objective of the Park RI/FS is to provide critical data necessary to understand the nature and magnitude of environmental problems at the site, to determine if cleanup actions are required, and to determine how these actions may be accomplished as part of specific wildlife enhancement and park development actions. This objective will be met by sampling surface water, groundwater, soil and sediments and evaluating the results in concert with other existing data. A complete list of the project objectives are presented in the Work Plan.

Several historical studies of the Park have been completed, as described in Section 3.0 of the SAP. The overall sampling strategy for the Park is to place a greater density of sampling locations in areas for which little or no historical data are available and to limit the analyte list in well-studied areas by applying a tiered sampling and testing approach. An adequate volume of sample will be archived to allow analysis of all analytes for a given medium (including toxicity testing), if necessary. Section 4 of the SAP presents the sampling design and rationale for a tiered approach to complete the Park RI field and testing investigation.

A6 TASK DESCRIPTION

The tasks to be completed for this project include fieldwork, laboratory analyses, data quality evaluation, data management, data analysis, and report preparation. Tasks that will be completed in the field, including related documentation and QA/QC activities, are described in detail in Section 5.0 of the SAP. The following activities are addressed in the SAP:

- Horizontal and vertical control methods
- Sampling equipment and methods
- Sample identification
- Sample processing methods
- Documentation of sample information and field activities
- Sample handling and shipping procedures
- Chain-of-custody (COC) procedures
- Decontamination procedures
- Handling and disposal of investigation-derived wastes.

Integral will collect surface water, groundwater, soil, and sediment and prepare samples for delivery to the laboratories. Eron Dodak or Susan Fitzgerald of Integral will serve as Field Coordinator and will assume custody of samples as they are collected. A list of samples and analyses is provided in Table A-2. Sample locations are provided in Figures 4-1 through 4-4 of the SAP.

Samples will be analyzed by Analytical Resources, Inc. (ARI) of Tukwila, Washington for the following:

- Conventional parameters [total sulfides, ammonia, total solids, total organic carbon (TOC), total suspended solids (TSS), and hardness];
- Physical parameters (grain size, Atterberg limits, specific gravity, and moisture content/bulk density);
- Northwest total petroleum hydrocarbons (NWTPH) – diesel-range organic hydrocarbons (DRO) and gasoline-range organic hydrocarbons (GRO), volatile petroleum hydrocarbon screen (VPH), and extractable petroleum hydrocarbon screen (EPH);
- Total metals;
- SVOCs; and
- Chlorinated pesticides and PCB Aroclors.

ARI will subcontract the dioxins/furans analysis to Severn Trent Laboratories' (STL) facility located in Sacramento, California. A complete analyte list is provided in Tables A-3 through A-6. Analyses will be completed using EPA and Puget Sound Estuary Program (PSEP) methods (USEPA 2005, PSEP 1986, 1997a,b), as indicated in Table A-7. Full laboratory data reports will be provided in hard copy and electronic data deliverables (EDDs) will be provided in spreadsheet format as required for importing into the database. The Environmental Quality Information System (EQuIS™) database application will be used to manage the field and laboratory data. Data will also be submitted electronically to Ecology and EPA in SEDQUAL and EIM formats as required.

Bioassays will be conducted to determine whether anthropogenic contaminants of concern are present at concentrations which are toxic to biota. Biological testing will be conducted on selected sediment samples collected in the Creek based on the chemistry results (tiered sampling approach). The following freshwater sediment toxicity bioassays (2 acute and 1 chronic tests) will be conducted on each selected sample:

- 10-day Amphipod (*Hyalella azteca*)
- Microtox® Sediment Porewater (*Vibrio fischeri*)
- 20-day Midge Larvae (*Chironomus tentans*).

Northwestern Aquatic Sciences (NAS) of Newport, Oregon, an accredited laboratory by Ecology, will conduct the bioassay testing for this project.[1]

Data verification will be completed by Integral for data generated in the field and by ARI, STL, and NAS for data generated at the laboratories. The completeness of the final database will be verified by Integral. Data validation and data quality assessment will be completed by an independent validation firm, which will be selected at a later date. The validation firm will also complete data verification (i.e., verifying that analytical procedures and calculations were completed correctly and checking transcriptions of the laboratory data) for the first data package for each analysis as part of the full validation that will be completed for these packages. The validation firm will also verify the accuracy of the laboratory EDDs.

The start date for field sampling will be determined following Ecology and EPA approval of the project Work Plans. Currently, it is anticipated that field sampling will begin in November 2005. Sample analysis and data validation are each expected to require 4 to 6 weeks for completion, for a total of 8 to 12 weeks from the time analysis is authorized until finalization of the database. The field and reporting schedules are discussed further in Section 3.3 of the Work Plan.

Samples for conventional analyses, geotechnical, and bioassay testing will be stored under refrigeration (4±2° C). Bioassay samples will also be stored in the dark with sediment bottles either purged with nitrogen gas or with no headspace. Samples for analysis of metals and organic compounds will be stored under refrigeration for immediate analyses, and frozen (-20° C) when initiation of analysis will be delayed or samples archived. Samples will be analyzed or archived according to criteria described in Section 4 of the SAP.

A7 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

Although data have been collected at the study site during previous investigations, data gaps were identified during a review of existing data (refer to SAP). These data gaps described in Section 3.8 of the SAP will be addressed in this study. A tiered sampling design will be used for the sampling. The sampling design is described in Section 4.0 of the SAP.

Data Quality Objectives (DQOs) were developed for the Park RI/FS using EPA's DQO process (USEPA 2000a) to describe data and data quality needs for the project. Data quality indicators such as the PARCC parameters (i.e., precision, accuracy or bias, representativeness, completeness, comparability) (USEPA 2002a) and analytical sensitivity will be used to assess conformance of data with quality control criteria. DQOs and quality control criteria are described in this section.

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[1] Microtox testing will be subcontracted to CH_2M Hill in Corvallis, Oregon, an Ecology accredited lab.

A7.1 The Data Quality Objective Process

As part of the development of the sampling strategy, data needs were evaluated for assessing chemical distributions and developing remedial alternatives for the Park soil and sediments. The seven-step DQO process (USEPA 2000a) was used to identify the adequacy of existing data and the need for additional data, to develop the overall approach to each study element, and ultimately to develop the field sampling plan. The DQO processes for the various aspects of the site characterization are provided in Section 3 of the SAP.

Reporting limits for this study should ideally be below the screening benchmarks selected for each analyte and sample type. Selection of screening benchmark levels for soil, groundwater, surface water and pore water, and sediment are provided in Section 3.5 of the SAP. Although method reporting limits (MRLs) are below screening levels for most of the analytes, MRLs are above the screening levels in several cases. Screening levels and MRLs for the various sample types are provided in Tables A-3 through A-6. Analytical sensitivity is discussed further in the following section.

A7.2 Data Quality Indicators

The overall DQO for this project is to develop and implement procedures that will ensure the collection of representative data of known and acceptable quality. The QA procedures and measurements that will be used for this project are based on EPA, Ecology, and PSEP guidance (USEPA 2002a, 2005; Ecology 1997, 2003; PSEP 1986, 1997a,b). PARCC parameters are commonly used to assess the quality of environmental data. Measurement quality objectives (MQOs) for the quantitative PARCC parameters, bias, precision, and completeness, are provided in Table A-8.

Bias represents the degree to which a measured concentration conforms to the reference value. The results for matrix spikes, laboratory control samples, field blanks, and method blanks will be reviewed to evaluate bias of the data. The following calculation is used to determine percent recovery for a matrix spike sample:

$$\%R = \frac{M - U}{C} \times 100$$

%R = percent recovery
M = measured concentration in the spiked sample
U = measured concentration in the unspiked sample
C = concentration of the added spike

The following calculation is used to determine percent recovery for a laboratory control sample or reference material:

$$\%R = \frac{M}{C} \times 100$$

%R = percent recovery
M = measured concentration in the reference material
C = established reference concentration

Results for field and method blanks can reflect systematic bias that results from contamination of samples during collection or analysis. Any analytes detected in field or method blanks will be evaluated as potential indicators of bias.

Precision reflects the reproducibility between individual measurements of the same property. Precision will be evaluated using the results of matrix spike duplicates, laboratory duplicates, field splits, and field replicates. Precision is expressed in terms of the relative standard deviation for three or more measurements and the relative percent difference (RPD) for two measurements. The following equation is used to calculate the RPD between measurements:

$$RPD = \frac{|C_1 - C_2|}{(C_1 + C_2)/2} \times 100$$

C_1 = first measurement
C_2 = second measurement
RPD = relative percent difference

The relative standard deviation is the ratio of the standard deviation of three or more measurements to the average of the measurements, expressed as a percentage.

Completeness will be calculated as the ratio of usable data (i.e., unqualified data and J-qualified data) to requested data, expressed as a percentage.

Additional laboratory QC procedures will be evaluated to provide supplementary information regarding overall quality of the data, performance of instruments and measurement systems, and sample-specific matrix effects.

QC samples and procedures are specified in each method protocol (Table A-7). All QC requirements will be completed by the laboratories as described in the protocols, including the following (as applicable to each analysis):

- Instrument tuning
- Initial calibration

- Initial calibration verification
- Continuing calibration
- Calibration or instrument blanks
- Method blanks
- Laboratory control samples
- Internal standards
- Surrogate spikes
- Serial dilutions
- Matrix spikes
- Matrix spike duplicates or laboratory duplicates.

To alert the data user to possible bias or imprecision, data qualifiers will be applied to reported analyte concentrations when associated QC samples or procedures do not meet control limits. Laboratory control limits for the methods that will be used for this site investigation are provided in Appendix K of ARI's quality assurance plan (Attachment 1 of this QAPP) and, for STL, in Attachment 2 of this QAPP. Data validation criteria and procedures are described in Sections D1 and D2 of this QAPP.

MRLs reflect the sensitivity of the analysis. The methods and modifications selected for this study will incorporate modifications recommended by PSEP (1997a,b) to optimize MRLs. Target MRLs for this study are summarized in Tables A-3 through A-6. Method modifications are described in Section B4.

Method detection limits (MDLs) have been determined by ARI and STL for each analyte, as required by EPA (2003). MDLs are statistically derived and reflect the concentration at which an analyte can be detected in a clean matrix with 99 percent confidence that a false positive result has not been reported. ARI and STL have established MRLs at levels above the MDLs for the project analytes. These values are based on the laboratories' experience analyzing environmental samples and reflect the typical sensitivity obtained by the analytical system. The concentration of the lowest standard in the initial calibration curve for each analysis is at the level of the MRL. This allows reliable quantification of concentrations to the MRL. Analyte concentrations for this site investigation will be reported to the MDL. Analytes detected at concentrations between the MRL and the MDL will be reported with a J qualifier to indicate that the value is an estimate (i.e., the analyte concentration is below the calibration range). Non-detects will be reported at the MRL. The MRL will be adjusted by the laboratory as necessary to reflect sample dilution or matrix interference. For dioxin analyses, STL will determine and report sample-specific detection limits as described in EPA method 1613B.

Representativeness and comparability are qualitative QA/QC parameters. Representativeness is the degree to which data represent a characteristic of an environmental condition. In the field, representativeness will be addressed primarily in the sampling design, by the selection of sampling sites and sample collection procedures. In the laboratory, representativeness will be ensured by the proper handling and storage of samples and initiation of analysis within holding times.

Comparability is the qualitative similarity of one data set to another (i.e., the extent to which different data sets can be combined for use). Comparability will be addressed through the use of field and laboratory methods that are consistent with methods and procedures recommended by EPA and PSEP and are commonly used for sediment studies.

The overall quality objective for the toxicity testing is to produce data that meet EPA's and Ecology's acceptability criteria for the 10-day acute *H. azteca*, the Microtox® sediment porewater (*V. fischeri*), and the 20-day chronic *C. tentans* sediment toxicity tests. The toxicity data will be generated to address the objectives listed in Section B1. Acceptance criteria for the bioassay testing methods that will be used for this site investigation are summarized in Section IX of NAS's quality assurance plan (Attachment 3 of this QAPP). Details are provided in each toxicity test method protocol (USEPA 2000b, Ecology 2003).

A8 SPECIAL TRAINING/CERTIFICATION

The City has assembled a project team with the requisite experience and technical skills to successfully complete the RI/FS for the Park. All consultant team personnel involved in sample collection have extensive environmental sampling experience. Minimum training and certification requirements for laboratory personnel are described in the laboratory QA plans (Attachments 1 through 3 to this QAPP).

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations providing health and safety standards and guidelines for workers engaged in hazardous waste operations. In response to this requirement, the U.S. Occupational Safety and Health Administration developed regulation 29 CFR§1910.120, the "Hazardous Waste Operations and Emergency Response" standard (HAZWOPER). This standard includes requirements for workers engaged in hazardous waste operations to complete a 40-hour training course and annual 8-hour refresher courses. The training provides employees with knowledge and skills that enable them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour HAZWOPER training course and 8-hour refresher courses, as necessary. Training is also consistent with the requirements of the Washington Industrial Safety and Health Act (WISHA). Documentation of course completion will be maintained in personnel files.

A9 DOCUMENTS AND RECORDS

Records will be maintained documenting all activities and data related to field sampling, chemical, and biological analysis at the laboratories. Results of data verification and validation activities will also be documented. Procedures for documentation of these activities are described in this section. The components of field documentation are discussed in Sections 5.5 and 5.6 of the SAP.

The SAP, QAPP, and the health and safety plan (HASP), will be provided to every project participant listed in Section A3. Any revisions or amendments to any of the documents that comprise the SAP will also be provided to these individuals.

A9.1 Field Documentation

The Integral project manager will ensure that the field team receives the final approved version of the SAP (including the HASP and this QAPP) prior to the initiation of field activities. Field records that will be maintained include:

- Field log books
- Photo documentation
- Boring and test pit logs
- Field data and sample collection information forms
- Field change request forms (as needed)
- Sample tracking/chain of custody forms.

The content and use of these documents are described in Section 5.6 of the SAP.

A9.2 Laboratory Documentation

All activities and results related to sample analysis will be documented at each laboratory. Internal laboratory documentation procedures are described in the laboratory QA plans (Attachments 1 through 3 to this QAPP).

The chemistry laboratories will provide a data package for each sample delivery group or analysis batch that is comparable in content to a full Contract Laboratory Program package. It will contain all information required for a complete QA review, including the following:

- A cover letter discussing analytical procedures and any difficulties that were encountered
- A case narrative referencing or describing the procedures used and discussing any analytical problems and deviations from standard operating procedures (SOPs) and this QAPP
- Chain-of-custody and cooler receipt forms

- A summary of analyte concentrations (to two significant figures, unless otherwise justified), method reporting limits, and method detection limits
- Laboratory data qualifier codes appended to analyte concentrations, as appropriate, and a summary of code definitions
- Sample preparation, extraction, dilution, and cleanup logs
- Instrument tuning data
- Initial and continuing calibration data, including instrument printouts and quantification summaries, for all analytes
- Results for method and calibration blanks
- Results for all QA/QC checks, including surrogate spikes, internal standards, laboratory control samples (LCSs), matrix spike samples, matrix spike duplicate samples, and laboratory duplicate or triplicate samples
- Original data quantification reports for all analyses and samples
- All laboratory worksheets and standards preparation logs.

The biological testing laboratory will be responsible for internal checks on sample handling and toxicity data reporting and will correct errors. The laboratory data package will include the following:

- A cover letter or case narrative that identifies the procedures used and discusses any problems encountered and any deviations from the referenced test method, SOPs, and this QAPP
- Chain-of-custody and cooler receipt forms
- A description of the source and composition of water used for the tests
- Detailed information about the test organisms, including source and acclimation or culture conditions
- A description of the experimental design and test chambers
- Data related to water quality measurements and any aeration that may have been required
- Definition of the effect criteria and any other observations
- Responses in the control treatment
- Tabulation and statistical analysis of measured responses
- A description of statistical methods used

- Results associated with the reference toxicant tests.
- Photocopies of all the raw data generated by the laboratory.

Data will be delivered in both hardcopy and electronic format to the Integral laboratory coordinator, who will be responsible for oversight of data verification and validation and for archiving the final data and data quality reports in the project file. Electronic data deliverables will be compatible with Integral's EQuIS™ database.

A9.3 Data Quality Documentation

The first data package generated for each chemical analysis type will be fully validated.[2] If no problems are encountered, validation for the remaining data will be based on review of the summary forms for sample and QC data. Based on the total number of samples to be collected for this investigation (Table A-2), it is anticipated that approximately 25 percent (a minimum of 20 percent) of the data will be fully validated. Data validation reports will be prepared by the contracted validation firm and provided to the Integral laboratory coordinator.

The biological testing laboratory will perform the first data reduction by calculating average survival and biomass for each test sediment and the negative controls. An internal review of the data will be performed by the NAS QA/QC officer. For the external review process the laboratory will provide both the reduced and raw data. The data will be generated in a form amenable to review and evaluation. The raw (replicate) and reduced data will be reviewed and validated by Integral staff.

Results of the validation reports will be summarized in the RI report. Any limitations to the usability of the data will also be discussed in this report.

All database entries provided by the laboratories will be verified against the validated hard-copy data in the data package. All changes to the database will be recorded in the database change log. Any data tables prepared from the database for data users will include all qualifiers that were applied by the laboratories and during data validation.

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[2] A copy of the first data package that is fully validated will be provided to the EPA QA managers upon receipt from the laboratory.

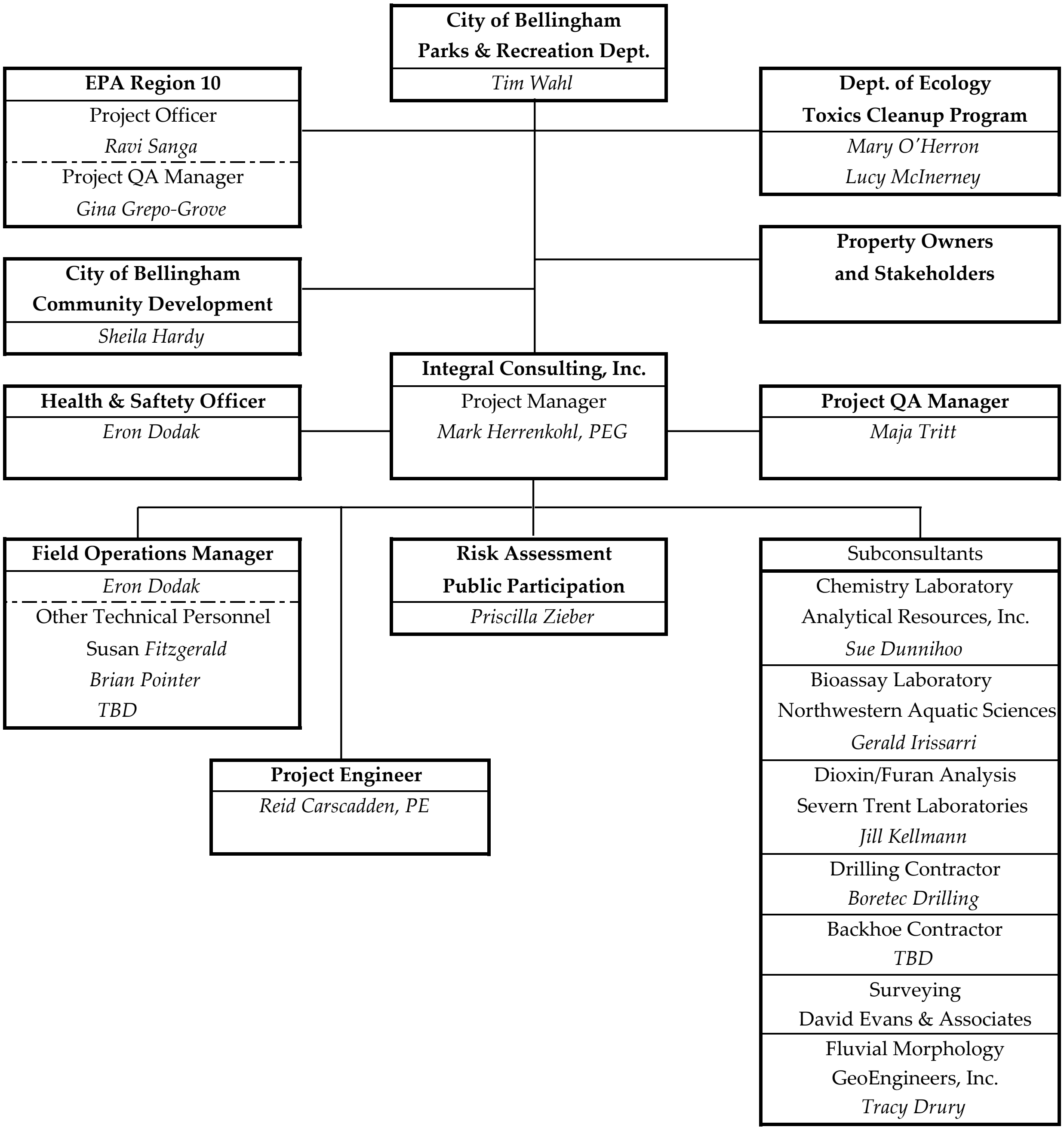

Figure A-1. Program Organization Structure

Table A-1. Project Team Contact Information.

Name	Project Role	Phone	Fax	Email
City of Bellingham				
Tim Wahl	Project Manager	360-676-6985	360-647-6367	twahl@cob.org
Sheila Hardy	Planning & Community Development	360-676-6880	360-738-7431	shardy@cob.org
EPA Region 10				
Ravi Sanga	Project Coordinator	206-553-4092	206-553-0124	Sanga.Ravi@epamail.epa.gov
Ginna Grepo-Grove	Quality Assurance Manager	206-553-1632	206-553-8210	Grepo-Grove.Gina@epamail.epa.gov
Department of Ecology				
Mary O'Herron	Ecology Project Coordinator	360-738-6246	360-738-6253	mohe461@ecy.wa.gov
Lucy McInerney	Toxics Cleanup Program	425-649-7272	na	lpeb461@ecy.wa.gov
Common Consultants				
Mark Herrenkohl (Integral)	Project Manager	360-756-9296 x10	360-756-9296	mherrenkohl@integral-corp.com
Maja Tritt (Integral)	Project QA Coordinator	206-230-9600 x21	206-230-9601	mtritt@integral-corp.com
Eron Dodak (Integral)	Heealth & Safety Officer	503-284-5545 x14	503-284-5755	edodak@integral-corp.com
Susan FitzGerald (Integral)	Field Manager	206-230-9600 x18	206-230-9601	sfitzgerald@integral-corp.com
Priscilla Zieber (Integral)	Risk Assessment/Public Participation	425-820-1739		pzieber@integral-corp.com
Reid Carscadden (Integral)	Project Engineer	206-230-9600 x29	206-230-9601	rcarscadden@integral-corp.com
Chemical Laboratories				
Sue Dunnihoo (Analytical Resources, Inc.)	Laboratory Project Manager	206-695-6207	206-695-6201	sued@arilabs.com
Dave Mitchell (Analytical Resources, Inc.)	Laboratory QA Manager	206-695-6205	206-695-6201	davem@arilabs.com
Jill Kellmann (STL/Sacramento)	Laboratory Project Manager	916-374-4402	916-372-1059	jkellmann@stl-inc.com
Pam Schemmer (STL/Sacramento)	Laboratory QA Manager	916-374-4441	916-372-1059	pschemmer@stl-inc.com
Bioassay Laboratory				
Gerald Irissarri (Northwest Aquatic Service	Laboratory Project Manager	541-265-7225	541-265-2799	girissarri@nwaquatic.com
Linda Nemeth (Northwest Aquatic Services	Laboratory QA Manager	541-265-7225	541-265-2799	lnemeth@intew.net

Table A-2. Estimated Numbers of Site and Field QC Samples by Sample Type.

	Number of Samples			
Analysis	**Field Samples**	**Field Replicates[1]**	**Equipment Rinse Blanks[2]**	**Total**
Soil Samples				
TOC	21	2	2	25
Metals	21	2	2	25
NWTPH-Gx	5	1	1	7
VPH[3]	≤5	≤1	0	≤6
NWTPH-Dx	21	2	2	25
EPH[4]	≤21	≤2	0	≤23
Physical testing	33	2	0	35
Pesticides	7	1	1	9
PCB Aroclors	7	1	1	9
SVOCs[5]	≤21	≤2	≤2	≤25
Dioxins/Furans	≤21	≤2	≤2	≤25
Archive (total)	65	0	0	65
Groundwater Samples				
Round 1				
Hardness	4	1	1	6
TSS	4	1	1	6
TOC	4	1	1	6
Metals (unfiltered)	4	1	1	6
Metals (filtered)	4	1	1	6
NWTPH-Gx	4	1	1	6
VPH[3]	≤4	≤1	0	≤5
NWTPH-Dx	4	1	1	6
EPH[4]	≤4	≤1	0	≤5
SVOCs	4	1	1	6
Dioxins/Furans	4	1	1	6
Round 2				
Hardness	4	1	1	6
TSS	4	1	1	6
TOC	4	1	1	6
Metals (unfiltered)	4	1	1	6
Metals (filtered)	4	1	1	6
NWTPH-Gx	4	1	1	6
VPH[3]	≤4	≤1	0	≤5
NWTPH-Dx	4	1	1	6
EPH[4]	≤4	≤1	0	≤5

Table A-2. Summary of Samples and Analyses. (continued)

	Number of Samples			
Analysis	**Field Samples**	**Field Replicates[1]**	**Equipment Rinse Blanks[2]**	**Total**
Groundwater Samples				
Round 1				
SVOCs	4	1	1	6
Dioxins/Furans	4	1	1	6
Surface Water Samples				
Round 1				
Hardness	8	1	1	10
TSS	8	1	1	10
TOC	8	1	1	10
Metals (unfiltered)	8	1	1	10
NWTPH-Gx	8	1	1	10
VPH[3]	≤8	≤1	0	≤9
NWTPH-Dx	8	1	1	10
EPH[4]	≤8	≤1	0	≤9
SVOCs	8	1	1	10
Dioxins/Furans	4	1	1	6
Round 2				
Hardness	8	1	1	10
TSS	8	1	1	10
TOC	8	1	1	10
Metals (unfiltered)	8	1	1	10
NWTPH-Gx	8	1	1	10
VPH[3]	≤8	≤1	0	≤9
NWTPH-Dx	8	1	1	10
EPH[4]	≤8	≤1	0	≤9
SVOCs	8	1	1	10
Dioxins/Furans	4	1	1	6
Sediment Samples				
Chemical Analysis				
TOC	31	2	2	35
TS, Sulfides, Ammonia	7	1	1	9
Metals	31	2	2	35
NWTPH-Dx	31	2	2	35

Table A-2. Summary of Samples and Analyses. (continued)

	Number of Samples			
Analysis	**Field Samples**	**Field Replicates**[1]	**Equipment Rinse Blanks**[2]	**Total**
Sediment Samples				
Chemical Analysis				
EPH[4]	≤31	≤2	0	≤33
Physical testing	46	3	0	49
SVOCs	≤31	≤2	2	≤35
Dioxins/Furans	≤31	≤2	2	≤35
Archive (total)	127	3	0	130
Toxicity testing[7]				
10-day Amphipod Mortality	≤7	NA	NA	≤7
20-Day Midge Mortality and Growth	≤7	NA	NA	≤7
Pore Water Microtox®	≤7	NA	NA	≤7

Notes:

[1] The collection frequency for field replicates and splits is 5% of natural samples.

[2] A field rinsate blank will be collected once for each sampling method.

[3] VPH analyses will be complete if screening levels are exceeded for TPH-GRO or, at a minimum, 20 percent of total samples will be analyzed.

[4] EPH analyses will be complete if screening levels are exceeded for TPH-DRO or, at a minimum, 20 percent of total samples will be analyzed.

[5] SVOCs will be analyzed for samples exceeding GRO/DRO SL's or, at a minimum, 20 percent of total samples will be analyzed.

[6] Dioxins/Furans will be analyzed in samples with pentachlorophenol concentrations exceeding SL.

[7] Toxicity tests will be completed on samples where concentrations exceed SLs.

Table A-3. Screening Benchmarks and MRLs for Soil Analytes.

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark [a]	Method Reporting Limit[b]	Method Detection Limit[c]
Dioxins					
1,2,3,4,6,7,8-HpCDD	ng/Kg	--	NV	50	--
1,2,3,4,6,7,8-HpCDF	ng/Kg	--	NV	50	--
1,2,3,4,7,8,9-HpCDF	ng/Kg	--	NV	50	--
1,2,3,4,7,8-HxCDD	ng/Kg	--	NV	50	--
1,2,3,4,7,8-HxCDF	ng/Kg	--	NV	50	--
1,2,3,6,7,8-HxCDD	ng/Kg	--	NV	50	--
1,2,3,6,7,8-HxCDF	ng/Kg	--	NV	50	--
1,2,3,7,8,9-HxCDD	ng/Kg	--	NV	50	--
1,2,3,7,8,9-HxCDF	ng/Kg	--	NV	50	--
1,2,3,7,8-PeCDD	ng/Kg	--	NV	50	--
1,2,3,7,8-PeCDF	ng/Kg	--	NV	50	--
2,3,4,6,7,8-HxCDF	ng/Kg	--	NV	50	--
2,3,4,7,8-PeCDF	ng/Kg	--	NV	50	--
2,3,7,8-TCDD	ng/Kg	--	NV	10	--
2,3,7,8-TCDF	ng/Kg	--	NV	10	--
OCDD	ng/Kg	--	NV	100	--
OCDF	ng/Kg	--	NV	100	--
Total HpCDD	ng/Kg	--	NV	--	--
Total HpCDF	ng/Kg	--	NV	--	--
Total HxCDD	ng/Kg	--	NV	--	--
Total HxCDF	ng/Kg	--	NV	--	--
Total PeCDD	ng/Kg	--	NV	--	--
Total PeCDF	ng/Kg	--	NV	--	--
Total TCDD	ng/Kg	--	NV	--	--
Total TCDF	ng/Kg	--	NV	--	--
TEQ (ND=0.5 DL)	ng/Kg	site-specific background/Puget Sound Background	49.77/19	--	--
SVOCs					
PAHs					
2-Methylnaphthalene	mg/kg	Ecology SQS	0.38	0.02	--
Acenaphthene	mg/kg	Ecology SQS	0.16	0.02	--
Acenaphthylene	mg/kg	Ecology LAET	0.47	0.02	--
Anthracene	mg/kg	Ecology LAET	1.23	0.02	--
Benzo(a)anthracene	mg/kg	site-specific background/MTCA Method B	0.377/0.137	0.02	--
Benzo(a)pyrene	mg/kg	site-specific background/MTCA Method B	0.455/0.137	0.02	--
Benzo(b)fluoranthene	mg/kg	site-specific background/MTCA Method B	0.663/0.137	0.02	--
Benz[e]acephenanthrylene	mg/kg	MTCA Method B	0.14	0.02	--
Benzo(g,h,i)perylene	mg/kg	site-specific background/Ecology SQS	0.422/0.31	0.02	--
Benzo(k)fluoranthene	mg/kg	site-specific background/MTCA Method B	0.241/0.137	0.02	--
Chrysene	mg/kg	site-specific background/MTCA Method B	0.628/0.137	0.02	--
Dibenzo(a,h)anthracene	mg/kg	site specific background/Ecology SQS	0.376/0.12	0.02	--
Fluoranthene	mg/kg	Ecology SQS	1.6	0.02	--
Fluorene	mg/kg	Ecology SQS	0.23	0.02	--
Indeno(1,2,3-cd)pyrene	mg/kg	site-specific background/MTCA Method B	0.612/0.137	0.02	--
Naphthalene	mg/kg	Ecology LAET	0.53	0.02	--
Phenanthrene	mg/kg	Ecology SQS	1	0.02	--
Pyrene	mg/kg	Ecology LAET	8.79	0.02	--
Other					--
1,2,3-Trichlorobenzene	mg/kg	MTCA TEE soil	20.00	0.02	--
1,2,4-Trichlorobenzene	mg/kg	Ecology SQS	0.81	0.02	--
1,2-Dichlorobenzene	mg/kg	Ecology SQS	0.02	0.02	--
1,3-Dichlorobenzene	mg/kg	MTCA Method B	16.00	0.02	--

Table A-3. Screening Benchmarks and MRLs for Soil Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark [a]	Method Reporting Limit[b]	Method Detection Limit[c]
Other					
1,4-Benzenediamine	mg/kg	MTCA Method B	15200.00	20 (estimated)	--
1,4-Dichlorobenzene	mg/kg	Ecology SQS	0.03	0.02	--
2,4,5-Trichlorophenol	mg/kg	MTCA TEE plant	4.00	0.1	--
2,4,6-Trichlorophenol	mg/kg	EPA Region 9 PRG	0.20	0.1	--
2,4-Dichlorophenol	mg/kg	EPA Region 9 PRG	1.00	0.1	--
2,4-Dimethylphenol	mg/kg	Ecology SQS	0.029	0.02	--
2,4-Dinitrophenol	mg/kg	EPA Region 9 PRG	0.30	0.2	--
2,4-Dinitrotoluene	mg/kg	EPA Region 9 PRG	0.0008	0.1	0.0103
2,6-Dinitrotoluene	mg/kg	EPA Region 9 PRG	0.0007	0.1	0.0122
2-Chloronaphthalene	mg/kg	MTCA Method B	4900.00	0.02	--
2-Chlorophenol	mg/kg	EPA Region 9 PRG	4.00	0.2	--
2-Methylphenol	mg/kg	Ecology SQS	0.063	0.02	--
2-Nitroaniline	mg/kg	MTCA Method B	1.70	0.1	--
3,3'-Dichlorobenzidine	mg/kg	EPA Region 9 PRG	0.007	0.1	0.0474
4-Chloroaniline	mg/kg	EPA Region 9 PRG	0.70	0.1	--
4-Methylphenol	mg/kg	Ecology SQS	0.67	0.02	--
4-Nitrophenol	mg/kg	MTCA TEE soil	7.00	0.1	--
Aniline	mg/kg	MTCA Method B	175.00	0.02	--
Benzidine	mg/kg	MTCA Method B	0.00435	0.2	0.0733
Benzoic acid	mg/kg	Site-specific background/Ecology SQS	2.03/0.65	0.2	--
Benzyl alcohol	mg/kg	Ecology SQS	0.057	0.02	--
bis(2-chloroisopropyl)ether	mg/kg	MTCA Method B	3200.00	0.02	--
bis(2-Chloroethyl)ether	mg/kg	EPA Region 9 PRG	0.0004	0.02	0.0119
bis(2-Ethylhexyl)phthalate	mg/kg	Ecology SQS	0.47	0.02	--
Butylbenzylphthalate	mg/kg	Ecology SQS	0.049	0.02	--
Carbazole	mg/kg	EPA Region 9 PRG	0.60	0.02	--
Dibenzofuran	mg/kg	Ecology SQS	0.15	0.02	--
Diethylphthalate	mg/kg	Ecology SQS	0.61	0.02	--
Dimethylphthalate	mg/kg	Ecology LAET	0.311	0.02	--
di-n-Butylphthalate	mg/kg	Ecology LAET	0.1	0.02	--
di-n-Octylphthalate	mg/kg	Ecology LAET	0.01	0.02	0.0102
Hexachlorobenzene	mg/kg	Ecology SQS	0.004	0.2	0.0104
Hexachlorobutadiene	mg/kg	Ecology SQS	0.04	0.02	--
Hexachlorocyclopentadiene	mg/kg	MTCA TEE plant	10.00	0.1	--
Hexachloroethane	mg/kg	EPA Region 9 PRG	0.50	0.02	--
Isophorone	mg/kg	EPA Region 9 PRG	0.50	0.02	--
Nitrobenzene	mg/kg	EPA Region 9 PRG	0.10	0.02	--
n-Nitrosodimethylamine	mg/kg	MTCA Method B	0.0196	0.1	0.0475
n-Nitroso-di-n-propylamine	mg/kg	EPA Region 9 PRG	0.00005	0.1	0.0103
N-nitrosodiphenylamine	mg/kg	Ecology SQS	0.11	0.02	--
Pentachlorophenol	mg/kg	EPA Region 9 PRG	0.03	0.1	0.0473
Phenol	mg/kg	Ecology SQS	0.42	0.02	--
Pyridine	mg/kg	MTCA Method B	80.00	0.1	--
Retene	mg/kg	Ecology LAET	6.02	0.04 (estimated)	--
Tetrachlorophenols	mg/kg	MTCA TEE soil	20	0.1	--
VPH					
C10-C12 Aliphatics	mg/kg	--	NV	5	--
C10-C12 Aromatics	mg/kg	--	NV	5	--
C12-C13 Aromatics	mg/kg	--	NV	5	--
C5-C6 Aliphatics	mg/kg	--	NV	5	--
C6-C8 Aliphatics	mg/kg	--	NV	5	--
C8-C10 Aliphatics	mg/kg	--	NV	5	--
C8-C10 Aromatics	mg/kg	--	NV	5	--

Table A-3. Screening Benchmarks and MRLs for Soil Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark [a]	Method Reporting Limit[b]	Method Detection Limit[c]
EPH					
C10-C12 Aliphatics	mg/kg	--	NV	5	--
C10-C12 Aromatics	mg/kg	--	NV	5	--
C12-C16 Aliphatics	mg/kg	--	NV	2	--
C12-C16 Aromatics	mg/kg	--	NV	2	--
C16-C18 Aliphatics	mg/kg	--	NV	2	--
C16-C18 Aromatics	mg/kg	--	NV	2	--
C18-C21 Aliphatics	mg/kg	--	NV	2	--
C18-C21 Aromatics	mg/kg	--	NV	2	--
C21-C28 Aliphatics	mg/kg	--	NV	2	--
C21-C28 Aromatics	mg/kg	--	NV	2	--
C28-C36 Aliphatics	mg/kg	--	NV	2	--
C28-C36 Aromatics	mg/kg	--	NV	2	--
Estimated Total EPH+VPH	mg/kg	MTCA TEE soil	200.00	59	--
TPH Screen					
TPH	mg/kg	MTCA TEE soil	200.00	20	--
Pesticides					
4,4'-DDD	ug/kg	MTCA TEE	0.75	2	0.095
4,4'-DDE	ug/kg	MTCA TEE	0.75	2	0.125
4,4'-DDT	ug/kg	MTCA TEE	0.75	2	0.199
Aldrin	ug/kg	MTCA Method B direct contact	0.06	1	0.044
alpha-BHC	ug/kg	MTCA Method B direct contact	0.16	2	0.051
alpha-Chlordane	ug/kg	MTCA TEE	1.00	1	--
beta-BHC	ug/kg	MTCA Method B direct contact	0.56	1	0.091
delta-BHC	ug/kg	MTCA TEE	6.00	1	--
Dieldrin	ug/kg	MTCA Method B direct contact	0.06	2	0.085
Endosulfan I	ug/kg	MTCA Method B direct contact	480.00	1	--
Endosulfan II	ug/kg	MTCA Method B direct contact	480.00	2	--
Endosulfan Sulfate	ug/kg	MTCA Method B direct contact	480.00	2	--
Endrin	ug/kg	MTCA TEE	0.20	2	0.082
Pesticides					
Endrin Aldehyde	ug/kg	MTCA TEE	0.20	2	0.184
Endrin Ketone	ug/kg	MTCA TEE	0.20	2	0.187
gamma-BHC (Lindane)	ug/kg	MTCA Method B direct contact	0.77	2	0.09
gamma-Chlordane	ug/kg	MTCA TEE	1.00	1	--

Table A-3. Screening Benchmarks and MRLs for Soil Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark [a]	Method Reporting Limit[b]	Method Detection Limit[c]
Pesticides					
Heptachlor	ug/kg	MTCA Method B direct contact	0.22	1	0.073
Heptachlor Epoxide	ug/kg	MTCA Method B direct contact	0.11	1	0.054
Methoxychlor	ug/kg	MTCA Method B direct contact	400.00	10	--
Toxaphene	ug/kg	MTCA Method B direct contact	0.91	100	1.92
PCBs					
Aroclor 1016	ug/kg	MTCA Method B direct contact	5.6	33	6.65
Aroclor 1221	ug/kg		NV	33	--
Aroclor 1232	ug/kg		NV	33	--
Aroclor 1242	ug/kg		NV	33	--
Aroclor 1248	ug/kg		NV	33	--
Aroclor 1254	ug/kg	MTCA Method B direct contact	1.6	33	6.65
Aroclor 1260	ug/kg		NV	33	--
Total PCBs	ug/kg	MTCA TEE	0.65	--	--
Metals					
Arsenic	mg/kg	Sound Background	9.09/7	5	--
Cadmium	mg/kg	Ecology LAET	2.39	0.2	--
Chromium	mg/kg	site-specific background	98.2/83	0.5	--
Copper	mg/kg	MTCA TEE soil	50.00	0.2	--
Lead	mg/kg	MTCA TEE plant	50.00	2	--
Mercury	mg/kg	MTCA TEE soil	0.10	0.05	--
Silver	mg/kg	Ecology LAET	0.545	0.3	--
Zinc	mg/kg	MTCA TEE plant	86.00	0.6	--
Conventionals					
<Sieve 200	percent	--	NV	0.1	--
Sieve 0.25	percent	--	NV	0.1	--
Sieve 0.5	percent	--	NV	0.1	--
Sieve 004	percent	--	NV	0.1	--
Sieve 010	percent	--	NV	0.1	--
Sieve 020	percent	--	NV	0.1	--
Sieve 040	percent	--	NV	0.1	--
Sieve 060	percent	--	NV	0.1	--
Sieve 140	percent	--	NV	0.1	--
Sieve 200	percent	--	NV	0.1	--
TOC	mg/kg	Ecology LAET	98200	100	--

[a] When a "/" is used to separate two values, the first value is for surface soil and the second is for subsurface soil.

[b] Detected chemicals will be reported to the MDL with J qualifiers applied below the MRL.

[c] The MDL will be used as the reporting limit for non-detects when the MRL is above the preliminary screening benchmark. The MDL is above the preliminary screening benchmark for the following analytes: 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, 3,3'-Dichlorobenzidine, bis(2-Chloroethyl)ether, Hexachlorobenzene, n-Nitrosodimethylamine, n-Nitroso-di-n-propylamine, and Dieldrin. The MDLs for benzidine and toxaphene are also expected to be greater than the preliminary screening benchmark.

Ecology SQS - Values normalized to TOC were denormalized by multiplying 0.01 (1% TOC was assumed to be the average for site soils and sediments).

NV = no value

tbd = to be determined

-- = not applicable

Table A-4. Screening Benchmarks and MRLs for Groundwater Analytes.

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
Dioxins					
1,2,3,4,6,7,8-HpCDD	pg/L	--	NV	50	--
1,2,3,4,6,7,8-HpCDF	pg/L	--	NV	50	--
1,2,3,4,7,8,9-HpCDF	pg/L	--	NV	50	--
1,2,3,4,7,8-HxCDD	pg/L	--	NV	50	--
1,2,3,4,7,8-HxCDF	pg/L	--	NV	50	--
1,2,3,6,7,8-HxCDD	pg/L	--	NV	50	--
1,2,3,6,7,8-HxCDF	pg/L	--	NV	50	--
1,2,3,7,8,9-HxCDD	pg/L	--	NV	50	--
1,2,3,7,8,9-HxCDF	pg/L	--	NV	50	--
1,2,3,7,8-PeCDD	pg/L	--	NV	50	--
1,2,3,7,8-PeCDF	pg/L	--	NV	50	--
2,3,4,6,7,8-HxCDF	pg/L	--	NV	50	--
2,3,4,7,8-PeCDF	pg/L	--	NV	50	--
2,3,7,8-TCDD	pg/L	EPA Region 5 ESL	0.003	10	--
2,3,7,8-TCDF	pg/L	--	NV	10	--
OCDD	pg/L	--	NV	100	--
OCDF	pg/L	--	NV	100	--
Total HpCDD	pg/L	--	NV	--	--
Total HpCDF	pg/L	--	NV	--	--
Total HxCDD	pg/L	--	NV	--	--
Total HxCDF	pg/L	--	NV	--	--
Total PeCDD	pg/L	--	NV	--	--
Total PeCDF	pg/L	--	NV	--	--
Total TCDD	pg/L	--	NV	--	--
Total TCDF	pg/L	--	NV	--	--
TEQ (ND=0.5 DL)	pg/L	Site-specific background	18.26	--	--
VPH					--
C5-C6 Aliphatics	ug/L	--	NV	50	--
C6-C8 Aliphatics	ug/L	--	NV	50	--
C8-C10 Aliphatics	ug/L	--	NV	50	--
C8-C10 Aromatics	ug/L	Site-specific background	36	50	NV[d]
Methyl tert-Butyl Ether	ug/L	EPA Region 6	11070	5	--
Benzene	ug/L	MTCA GW Method B	0.80	5	--
Ethylbenzene	ug/L	Tier II	7.30	5	--
m&p-Xylene	ug/L	Tier II	13	5	--
o-Xylene	ug/L	Tier II	13	5	--
Toluene	ug/L	Tier II	9.80	5	--
EPH					
C10-C12 Aliphatics	ug/L	Site-specific background	24	40	NV[d]
C10-C12 Aromatics	ug/L	Site-specific background	36	40	NV[d]
C12-C16 Aliphatics	ug/L	Site-specific background	24	40	NV[d]
C12-C16 Aromatics	ug/L	Site-specific background	24	40	NV[d]
C16-C21 Aliphatics	ug/L	--	NV	40	--
C16-C21 Aromatics	ug/L	Site-specific background	47	40	--
C21-C34 Aliphatics	ug/L	--	NV	40	--
C21-C34 Aromatics	ug/L	Site-specific background	47	40	--
C8-C10 Aliphatics	ug/L	--	NV	50	--
C8-C10 Aliphatics	ug/L	--	NV	50	--
SVOCs					
Routine and Detected					
2,4-Dimethylphenol	ug/L	EPA Region 5	100.17	1	--
2-Methylnaphthalene	ug/L	EPA Region 5	329.55	1	--
2-Methylphenol	ug/L	Tier II	13	1	--

Table A-4. Screening Benchmarks and MRLs for Groundwater Analytes. (continued)

Analyte	**Units**	**Screening Benchmark Source**	**Selected Screening Benchmark**	**Method Reporting Limit**[a]	**Method Detection Limit**[b]
Benzoic acid	ug/L	Tier II	42	10	--
Benzyl alcohol	ug/L	Tier II	8.6	5	--
Dibenzofuran	ug/L	Tier II	3.70	1	--
Diethylphthalate	ug/L	Tier II	210	1	--
di-n-Octylphthalate	ug/L	EPA Region 6	22	1	--
Pentachlorophenol	ug/L	Site-specific background	0.39	5	0.094
Other					
1,2,4-Trichlorobenzene	ug/L	MTCA GW Method B	35	1	--
1,2-Dichlorobenzene	ug/L	Tier II	14	1	--
1,2-Diphenylhydrazine[c]	ug/L	EPA NAWQC	0.036	1	0.395
1,3-Dichlorobenzene	ug/L	Tier II	71	1	--
1,4-Dichlorobenzene	ug/L	MTCA GW Method B	1.82	1	--
1-Methylnaphthalene	ug/L	Tier II	2.1	1	--
2,4,5-Trichlorophenol	ug/L	EPA Region 6	64	5	--
2,4,6-Trichlorophenol	ug/L	EPA NAWQC	1.4	5	0.202
2,4-Dichlorophenol	ug/L	EPA Region 5	11	5	--
2,4-Dinitrophenol	ug/L	EPA Region 5	19	10	--
2,4-Dinitrotoluene	ug/L	EPA NAWQC	0.11	5	--
2,6-Dinitrotoluene	ug/L	MTCA GW Method B	16	5	--
2-Chloronaphthalene	ug/L	EPA Region 5	0.396	1	0.396
2-Chlorophenol	ug/L	EPA Region 5	24	1	--
2-Nitrophenol	ug/L	EPA Region 6	1920	5	--
3,3'-Dichlorobenzidine	ug/L	EPA NAWQC	0.021	5	0.897
4-Bromophenyl-phenylether	ug/L	Tier II	1.5	1	--
4-Methylphenol	ug/L	EPA Region 6	543	1	--
4-Nitrophenol	ug/L	Tier II	300	5	--
7,12-Dimethylbenz(a)anthracer	ug/L	EPA Region 5	0.55	2 (estimated)	NV
Aniline	ug/L	EPA Region 5	4.1	1	--
Benzidine	ug/L	MTCA Method B	0.00032	10	4.22
bis(2-Chloroethyl)ether	ug/L	EPA NAWQC	0.03	1	0.440
bis(2-chloroisopropyl)ether	ug/L	MTCA GW Method B	320	1	--
bis(2-Ethylhexyl)phthalate	ug/L	Site-specific background	16.60	1	--
Butylbenzylphthalate	ug/L	Tier II	19	1	--
Dimethylphthalate	ug/L	EPA Region 6	330	1	--
di-n-Butylphthalate	ug/L	Tier II	35	1	--
di-n-Octylphthalate	ug/L	EPA Region 5	30	1	--
Hexachlorobenzene	ug/L	Region 5	0.0003	1	0.209
Hexachlorobutadiene	ug/L	Region 5	0.053	1	0.540
Hexachlorocyclopentadiene	ug/L	EPA MCL	50	5	--
Hexachloroethane	ug/L	EPA NAWQC	1.4	1	--
Isophorone	ug/L	EPA NAWQC	35	1	--
Nitrobenzene	ug/L	MTCA GW Method B	8	1	--
n-Nitrosodimethylamine	ug/L	EPA NAWQC	0.00069	5	0.245
n-Nitroso-di-n-propylamine	ug/L	EPA NAWQC	0.0005	5	0.410
N-nitrosodiphenylamine	ug/L	EPA NAWQC	3.3	1	--
Phenol	ug/L	EPA Region 5	180	1	--
Pyridine	ug/L	MTCA GW Method B	16	2	--
Tetrachlorophenols	ug/L	EPA Region 5	1.2	10	tbd
Acenaphthene	ug/L	Region 5	38	1	--
Acenaphthylene	ug/L	EPA Region 5	4840	1	--

Table A-4. Screening Benchmarks and MRLs for Groundwater Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
Anthracene	ug/L	Tier II	0.73	1	0.297
Fluorene	ug/L	Tier II	3.9	1	--
Naphthalene	ug/L	Tier II	12	1	--
Phenanthrene	ug/L	EPA Region 5	3.6	1	--
Benzo(a)anthracene	ug/L	Site-specific background	0.014	1	0.331
Benzo(a)pyrene	ug/L	Site-specific background	0.0076	1	0.303
Benzo(b)fluoranthene	ug/L	Site-specific background	0.015	1	0.252
Benzo(k)fluoranthene	ug/L	MTCA GW Method B	0.01	1	0.475
Benzo(g,h,i)perylene	ug/L	Tier II	7.64	1	--
Chrysene	ug/L	Site-specific background	0.017	1	0.398
Dibenzo(a,h)anthracene	ug/L	EPA NAWQC	0.0038	1	0.219
Fluoranthene	ug/L	EPA Region 5	1.9	1	--
Indeno(1,2,3-cd)pyrene	ug/L	EPA NAWQC	0.0038	1	0.257
Pyrene	ug/L	EPA Region 5	0.3	1	0.341
Petroleum Hydrocarbons					
Diesel	ug/L	--	NV	250	--
Gasoline	ug/L	--	NV	250	--
Motor Oil	ug/L	--	NV	500	--
Metals					
Arsenic	ug/L	Site-specific background	3.5	0.5	--
Cadmium	ug/L	EPA NAWQC	0.25	0.2	--
Calcium	ug/L	--	NV	50	--
Chromium	ug/L	EPA NAWQC	74	0.5	--
Copper	ug/L	Site-specific background	9.7	0.5	--
Lead	ug/L	Site-specific background	2.53	1	--
Magnesium	ug/L	Site-specific background	16200	50	--
Mercury	ug/L	WA State	0.012	0.1	--[e]
Silver	ug/L	Tier II	0.36	0.5	--[e]
Zinc	ug/L	WA State	104.5	4	--
Conventionals					
Hardness	mg/L	--	NV	-	--
TOC	mg/L	--	NV	1.5	--
TSS	mg/L	--	NV	0.1	--

[a] Detected chemicals will be reported to the MDL with J qualifiers applied below the MRL.

[b] The MDL will be used as the reporting limit for non-detects when the MRL is above the preliminary screening benchmark. The MDL is above the preliminary screening benchmark for the following analytes: Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, Indeno(1,2,3-cd)pyrene, Pyrene, 1,2-Diphenylhydrazine, 2-Chloronaphthalene, Benzidine, n-nitroso-di-n-propylamine, n-nitrodiphenylamine, Hexachlorobenzene, and Hexachlorobutadiene. The MDL for the tetrachlorophenols is also expected to be greater than the preliminary screening benchmark.

[c] 1,2-Diphenylhydrazine cannot be separated from azobenzene.

[d] Determination of MDLs is not required for VPH and EPH methodology. However, the methodology is expected to be sufficiently sensitive to allow detection of the hydrocarbon series if the analytes are present at the level of the screening benchmark.

[e] The reporting limits for metals were established by ARI based on their experience with these analyses. The reporting limits for mercury and silver are greater than the screening benchmarks.

NV = no value
tbd = to be determined
-- = not applicable

Table A-5. Screening Benchmarks and MRLs for Surface Water Analytes.

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
Dioxins					
1,2,3,4,6,7,8-HpCDD	pg/L		NV	50	--
1,2,3,4,6,7,8-HpCDF	pg/L		NV	50	--
1,2,3,4,7,8,9-HpCDF	pg/L		NV	50	--
1,2,3,4,7,8-HxCDD	pg/L		NV	50	--
1,2,3,4,7,8-HxCDF	pg/L		NV	50	--
1,2,3,6,7,8-HxCDD	pg/L		NV	50	--
1,2,3,6,7,8-HxCDF	pg/L		NV	50	--
1,2,3,7,8,9-HxCDD	pg/L		NV	50	--
1,2,3,7,8,9-HxCDF	pg/L		NV	50	--
1,2,3,7,8-PeCDD	pg/L		NV	50	--
1,2,3,7,8-PeCDF	pg/L		NV	50	--
2,3,4,6,7,8-HxCDF	pg/L		NV	50	--
2,3,4,7,8-PeCDF	pg/L		NV	50	--
2,3,7,8-TCDD	pg/L	Region 5 ESL	0.003	10	--
2,3,7,8-TCDF	pg/L		NV	10	--
OCDD	pg/L		NV	100	--
OCDF	pg/L		NV	100	--
Total HpCDD	pg/L		NV	--	--
Total HpCDF	pg/L		NV	--	--
Total HxCDD	pg/L		NV	--	--
Total HxCDF	pg/L		NV	--	--
Total PeCDD	pg/L		NV	--	--
Total PeCDF	pg/L		NV	--	--
Total TCDD	pg/L		NV	--	--
Total TCDF	pg/L		NV	--	--
TEQ (ND=0.5 DL)	pg/L	Region 5 ESL	0.003	--	--
SVOCs					
PAHs					
2-Methylnaphthalene	ug/L	EPA Region 5 ESL	330	1	--
Acenaphthene	ug/L	EPA Region 5 ESL	38	1	--
Acenaphthylene	ug/L	EPA Region 5 ESL	4840	1	--
Anthracene	ug/L	Tier II SCV (Suter and Tsao 1996)	0.73	1	0.297
Benzo(a)anthracene	ug/L	Tier II SCV (Suter and Tsao 1996)	0.027	1	0.331
Benzo(a)pyrene	ug/L	Tier II SCV (Suter and Tsao 1996)	0.014	1	0.303
Benzo(b)fluoranthene	ug/L	MTCA Method B	2.96E-02	1	0.252
Benzo(k)fluoranthene	ug/L	MTCA Method B	2.96E-02	1	0.475
Benzo(g,h,i)perylene	ug/L	EPA Region 5 ESL	7.64	1	--
Chrysene	ug/L	MTCA Method B	2.96E-02	1	0.398
Dibenzo(a,h)anthracene	ug/L	EPA Region 6	5	1	--
Fluoranthene	ug/L	EPA Region 5 ESL	1.9	1	--
Fluorene	ug/L	Tier II SCV (Suter and Tsao 1996)	3.9	1	--
Indeno(1,2,3-cd)pyrene	ug/L	EPA Region 5 ESL	2.96E-02	1	0.257
Naphthalene	ug/L	Tier II SCV (Suter and Tsao 1996)	12	1	--
Phenanthrene	ug/L	EPA Region 5 ESL	3.6	1	--
Pyrene	ug/L	EPA Region 5 ESL	0.3	1	0.341
Other					
1,2,4-Trichlorobenzene	ug/L	Tier II SCV (Suter and Tsao 1996)	110	1	--
1,2-Dichlorobenzene	ug/L	MTCA Method B	14	1	--
1,2-Diphenylhydrazine[c]	ug/L	MTCA Method B	0.325	1	0.395
1,3-Dichlorobenzene	ug/L	Tier II SCV (Suter and Tsao 1996)	71	1	--
1,4-Dichlorobenzene	ug/L	MTCA Method B	4.86	1	--
2,4,5-Trichlorophenol	ug/L	EPA Region 6	64	1	--

Table A-5. Screening Benchmarks and MRLs for Surface Water Analytes. (continued)

Analyte	**Units**	**Screening Benchmark Source**	**Selected Screening Benchmark**	**Method Reporting Limit**[a]	**Method Detection Limit**[b]
2,4,6-Trichlorophenol	ug/L	EPA Region 5 ESL	4.9	5	0.202
2,4-Dichlorophenol	ug/L	EPA Region 5 ESL	11	5	--
2,4-Dimethylphenol	ug/L	EPA Region 5 ESL	100.17	1	--
2,4-Dinitrophenol	ug/L	EPA Region 5 ESL	19	10	--
2,4-Dinitrotoluene	ug/L	EPA Region 5 ESL	44	5	--
2,6-Dinitrotoluene	ug/L	EPA Region 5 ESL	81	5	--
2-Chloronaphthalene	ug/L	EPA Region 5 ESL	0.396	1	0.433
2-Chlorophenol	ug/L	EPA Region 5 ESL	24	1	--
2-Methylphenol	ug/L	Tier II SCV (Suter and Tsao 1996)	13	1	--
2-Nitrophenol	ug/L	EPA Region 6	1920	5	--
3,3'-Dichlorobenzidine	ug/L	EPA Region 5 ESL	4.5	5	0.897
4-Bromophenyl-phenylether	ug/L	Tier II SCV (Suter and Tsao 1996)	1.5	1	--
4-Chloroaniline	ug/L	EPA Region 5 ESL	231.97	5	--
4-Methylphenol	ug/L	EPA Region 6	543	1	--
4-Nitrophenol	ug/L	Tier II SCV (Suter and Tsao 1996)	300	5	--
Dimethylbenz(a)anthracene	ug/L	EPA Region 5 ESL	0.548	2 (estimated)	NV
Aniline	ug/L	EPA Region 5 ESL	4.1	1	--
Benzidine	ug/L	MTCA Method B	3.22E-04	10	4.22
Benzoic acid	ug/L	Tier II SCV (Suter and Tsao 1996)	42	10	--
Benzyl alcohol	ug/L	Tier II SCV (Suter and Tsao 1996)	8.6	5	--
bis(2-Chloroethyl)ether	ug/L	MTCA Method B	8.54E-01	1	0.440
bis(2-Ethylhexyl)phthalate	ug/L	Tier II SCV (Suter and Tsao 1996)	3	1	--
Butylbenzylphthalate	ug/L	Tier II SCV (Suter and Tsao 1996)	19	1	--
Dibenzofuran	ug/L	Tier II SCV (Suter and Tsao 1996)	3.7	1	--
Diethylphthalate	ug/L	Tier II SCV (Suter and Tsao 1996)	210	1	--
Dimethylphthalate	ug/L	EPA Region 5 ESL	73	1	--
di-n-Butylphthalate	ug/L	Tier II SCV (Suter and Tsao 1996)	35	1	--
di-n-Octylphthalate	ug/L	EPA Region 5 ESL	30	1	--
Hexachlorobenzene	ug/L	EPA Region 5 ESL	0.0003	1	0.209
Hexachlorobutadiene	ug/L	EPA Region 5 ESL	0.053	1	0.540
Hexachlorocyclopentadiene	ug/L	EPA Region 5 ESL	77.04	5	--
Hexachloroethane	ug/L	MTCA Method B	5.33	1	--
Isophorone	ug/L	EPA Region 5 ESL	920	1	--
Nitrobenzene	ug/L	EPA Region 5 ESL	220	1	--
n-Nitrosodimethylamine	ug/L	EPA Region 5 ESL	4.89	5	0.245
n-Nitroso-di-n-propylamine	ug/L	MTCA Method B	0.82	5	0.410
N-nitrosodiphenylamine	ug/L	MTCA Method B	9.73	1	--
Pentachlorophenol	ug/L	MTCA Method B	4.91	5	0.914
Phenol	ug/L	EPA Region 5 ESL	180	1	--
Pyridine	ug/L	EPA Region 5 ESL	2380	0	--
Tetrachlorophenols	ug/L	EPA Region 5 ESL	1.2	10 (estimated)	tbd
Petroleum Hydrocarbons					
Gas-Range	mg/L		NV	0.25	--
Diesel-Range	mg/L		NV	0.5	--
VPH					
C5-C6 Aliphatics	ug/L		NV	50	--
C6-C8 Aliphatics	ug/L		NV	50	--

Table A-5. Screening Benchmarks and MRLs for Surface Water Analytes. (continued)

Analyte		Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
	C8-C10 Aliphatics	ug/L		NV	50	--
	C8-C10 Aromatics	ug/L		NV	50	--
EPH						
	C8-C10 Aliphatics	ug/L		NV	50	--
	C10-C12 Aliphatics	ug/L		NV	40	--
	C10-C12 Aromatics	ug/L		NV	40	--
	C12-C16 Aliphatics	ug/L		NV	40	--
	C12-C16 Aromatics	ug/L		NV	40	--
	C16-C21 Aliphatics	ug/L		NV	40	--
	C16-C21 Aromatics	ug/L		NV	40	--
	C21-C34 Aliphatics	ug/L		NV	40	--
	C21-C34 Aromatics	ug/L		NV	40	--
Metals						
	Arsenic	ug/L	MTCA Method B	9.82E-02	0.5	--[e]
	Cadmium	ug/L	CCC (EPA 2002)	0.25	0.2	--
	Calcium		--	NV	50	--
	Chromium	ug/L	CCC (EPA 2002)	74	0.5	--
	Copper	ug/L	CCC (EPA 2002)	9.00	0.5	--
	Lead	ug/L	Ecology (WAC 173-201A-040)	2.50	1	--
	Magnesium	ug/L	EPA Region 6	647	50	--
	Mercury	ug/L	Ecology (WAC 173-201A-040)	0.012	0.1	--[e]
	Silver	ug/L	Tier II SCV (Suter and Tsao 1996)	0.36	0.5	--[e]
	Zinc	ug/L	Ecology (WAC 173-201A-040)	104.50	4	--
Conventionals						
	Hardness	mg/L	--	NV	-	--
	TOC	mg/L	--	NV	1.5	--
	TSS	mg/L	--	NV	0.1	--

[a] Detected chemicals will be reported to the MDL with J qualifiers applied below the MRL.

[b] The MDL will be used as the reporting limit for non-detects when the MRL is above the screening benchmark. The MDL is below the screening benchmark for the following analytes: Benzo(a)anthracene, Benzo(a)pyrene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Chrysene, Indeno(1,2,3-cd)pyrene, Pyrene, 1,2-Diphenylhydrazine, 2-Chloronaphthalene, Benzidine, Hexachlorobenzene, and Hexachlorobutadiene. The MDL for the tetrachlorophenols is also expected to be greater than the screening benchmark.

[c] 1,2-Diphenylhydrazine cannot be separated from azobenzene.

[d] Determination of MDLs is not required for VPH and EPH methodology. However, the methodology is expected to be sufficiently sensitive to allow detection of the hydrocarbon series if the analytes are present at the level of the screening benchmark.

[e] The reporting limits for metals were established by ARI based on their experience with these analyses. The reporting limits for arsenic, mercury, and silver are greater than the screening benchmarks.

NV = no value
tbd = to be determined
-- = not applicable

Table A-6. Screening Benchmarks and MRLs for Sediment Analytes.

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
Dioxins					
1,2,3,4,6,7,8-HpCDD	ng/Kg	--	NV	50	--
1,2,3,4,6,7,8-HpCDF	ng/Kg	--	NV	50	--
1,2,3,4,7,8,9-HpCDF	ng/Kg	--	NV	50	--
1,2,3,4,7,8-HxCDD	ng/Kg	--	NV	50	--
1,2,3,4,7,8-HxCDF	ng/Kg	--	NV	50	--
1,2,3,6,7,8-HxCDD	ng/Kg	--	NV	50	--
1,2,3,6,7,8-HxCDF	ng/Kg	--	NV	50	--
1,2,3,7,8,9-HxCDD	ng/Kg	--	NV	50	--
1,2,3,7,8,9-HxCDF	ng/Kg	--	NV	50	--
1,2,3,7,8-PeCDD	ng/Kg	--	NV	50	--
1,2,3,7,8-PeCDF	ng/Kg	--	NV	50	--
2,3,4,6,7,8-HxCDF	ng/Kg	--	NV	50	--
2,3,4,7,8-PeCDF	ng/Kg	--	NV	50	--
2,3,7,8-TCDD	ng/Kg	--	NV	10	--
2,3,7,8-TCDF	ng/Kg	--	NV	10	--
OCDD	ng/Kg	--	NV	100	--
OCDF	ng/Kg	--	NV	100	--
Total HpCDD	ng/Kg	--	NV	--	--
Total HpCDF	ng/Kg	--	NV	--	--
Total HxCDD	ng/Kg	--	NV	--	--
Total HxCDF	ng/Kg	--	NV	--	--
Total PeCDD	ng/Kg	--	NV	--	--
Total PeCDF	ng/Kg	--	NV	--	--
Total TCDD	ng/Kg	--	NV	--	--
Total TCDF	ng/Kg	--	NV	--	--
TEQ (ND=0.5 DL)	ng/Kg	Puget Sound Background	19	--	--
SVOCs					
PAHs					
2-Methylnaphthalene	mg/kg	Ecology SQS	0.38	0.02	--
Acenaphthene	mg/kg	Ecology SQS	0.16	0.02	--
Acenaphthylene	mg/kg	Ecology LAET	0.47	0.02	--
Anthracene	mg/kg	Ecology LAET	1.23	0.02	--
Benzo(a)anthracene	mg/kg	MTCA Method B	0.137	0.02	--
Benzo(a)pyrene	mg/kg	MTCA Method B	0.137	0.02	--
Benzo(b)fluoranthene	mg/kg	MTCA Method B	0.137	0.02	--
Benzo(g,h,i)perylene	mg/kg	Ecology SQS	0.31	0.02	--
Benzo(j)fluoranthene	mg/kg	--	NV	0.02	--
Benzo(k)fluoranthene	mg/kg	MTCA Method B	0.137	0.02	--
Chrysene	mg/kg	MTCA Method B	0.137	0.02	--
Dibenzo(a,h)anthracene	mg/kg	Ecology SQS	0.12	0.02	--
Fluoranthene	mg/kg	Ecology SQS	1.6	0.02	--
Fluorene	mg/kg	Ecology SQS	0.23	0.02	--
Indeno(1,2,3-cd)pyrene	mg/kg	MTCA Method B	0.137	0.02	--
Naphthalene	mg/kg	Ecology LAET	0.529	0.02	--
Phenanthrene	mg/kg	Ecology SQS	1	0.02	--
Pyrene	mg/kg	Ecology LAET	8.79	0.02	--
Other					
1,2,4-Trichlorobenzene	mg/kg	Ecology SQS	0.0081	0.02	0.00953
1,2-Dichlorobenzene	mg/kg	Ecology SQS	0.023	0.02	--
1,2-Diphenylhydrazine	mg/kg	MTCA Method B	1.25	0.02	--
1,3-Dichlorobenzene	mg/kg	MTCA Method B	16	0.02	--

Table A-6. Screening Benchmarks and MRLs for Sediment Analytes. (continued)

Analyte	**Units**	**Screening Benchmark Source**	**Selected Screening Benchmark**	**Method Reporting Limit[a]**	**Method Detection Limit[b]**
1,4-Dichlorobenzene	mg/kg	Ecology SQS	*0.031*	0.02	--
2,4,5-Trichlorophenol	mg/kg	MTCA TEE plant	4	0.1	--
2,4,6-Trichlorophenol	mg/kg	Region 9 Leaching	0.2	0.1	--
2,4-Dichlorophenol	mg/kg	Region 9 Leaching	1	0.1	--
2,4-Dimethylphenol	mg/kg	Ecology SQS	0.029	0.02	--
2,4-Dinitrophenol	mg/kg	Region 9 Leaching	0.3	0.2	--
2,4-Dinitrotoluene	mg/kg	Region 9 Leaching	0.0008	0.1	0.0103
2,6-Dinitrotoluene	mg/kg	Region 9 Leaching	0.0007	0.1	0.0122
2-Chloronaphthalene	mg/kg	MTCA Method B	4900	0.02	--
2-Chlorophenol	mg/kg	Region 9 Leaching	4	0.2	--
2-Methylphenol	mg/kg	Ecology SQS	0.063	0.02	--
2-Nitroaniline	mg/kg	MTCA Method B	1.7	0.1	--
3&4-Methylphenol	mg/kg	MTCA Method B	310	0.02	--
3,3'-Dichlorobenzidine	mg/kg	Region 9 Leaching	0.007	0.1	0.0474
4-Chloroaniline	mg/kg	Region 9 Leaching	0.7	0.1	--
4-Methylphenol	mg/kg	Ecology SQS	0.67	0.02	--
4-Nitrophenol	mg/kg	MTCA TEE soil	7	0.1	--
Aniline	mg/kg	MTCA Method B	175	0.02	--
Benz[e]acephenanthrylene	mg/kg	MTCA Method B	0.137	0.02	--
Benzidine	mg/kg	MTCA Method B	0.00435	0.2	0.0733
Benzoic acid	mg/kg	Ecology SQS	0.65	0.2	--
Benzyl alcohol	mg/kg	Ecology SQS	0.057	0.04	--
bis(2-Chloroethyl)ether	mg/kg	Region 9 Leaching	0.0004	0.02	0.0119
bis(2-chloroisopropyl)ether	mg/kg	MTCA Method B	3200	0.02	--
bis(2-Ethylhexyl)phthalate	mg/kg	Ecology SQS	0.47	0.02	--
Butylbenzylphthalate	mg/kg	Ecology SQS	0.049	0.02	--
Carbazole	mg/kg	Region 9 Leaching	0.6	0.02	--
Dibenzofuran	mg/kg	Ecology SQS	0.15	0.02	--
Diethylphthalate	mg/kg	Ecology SQS	0.61	0.02	--
Dimethylphthalate	mg/kg	Ecology LAET	0.311	0.02	--
di-n-Butylphthalate	mg/kg	Ecology LAET	0.103	0.02	--
di-n-Octylphthalate	mg/kg	Ecology LAET	0.011	0.02	0.0102
Hexachlorobenzene	mg/kg	Ecology LAET	0.004	0.02	0.0104
Hexachlorobutadiene	mg/kg	Ecology LAET	0.039	0.02	--
Hexachlorocyclopentadiene	mg/kg	MTCA TEE plant	10	0.1	--
Hexachloroethane	mg/kg	Region 9 Leaching	0.5	0.02	--
Isophorone	mg/kg	Region 9 Leaching	0.5	0.02	--
Nitrobenzene	mg/kg	Region 9 Leaching	0.1	0.02	--
n-Nitrosodimethylamine	mg/kg	MTCA Method B	0.0196	0.02	0.0475
n-Nitroso-di-n-propylamine	mg/kg	Region 9 Leaching	0.00005	0.1	0.0103
N-nitrosodiphenylamine	mg/kg	Ecology SQS	0.11	0.02	--
Pentachlorophenol[a]	mg/kg	Region 9 Leaching	0.03	0.1	0.0473
Phenol	mg/kg	Ecology SQS	0.42	0.02	--
Pyridine	mg/kg	MTCA Method B	80	0.1	--
Retene	mg/kg	Ecology LAET	6.02	0.04 (estimated)	--
Tetrachlorophenols	mg/kg	MTCA TEE soil	20	0.1	--

Table A-6. Screening Benchmarks and MRLs for Sediment Analytes. (continued)

Analyte	Units	Screening Benchmark Source	Selected Screening Benchmark	Method Reporting Limit[a]	Method Detection Limit[b]
EPH					
C10-C12 Aliphatics	mg/kg	--	NV	5	--
C10-C12 Aromatics	mg/kg	--	NV	5	--
C12-C16 Aliphatics	mg/kg	--	NV	2	--
C12-C16 Aromatics	mg/kg	--	NV	2	--
C16-C18 Aliphatics	mg/kg	--	NV	2	--
C16-C18 Aromatics	mg/kg	--	NV	2	--
C18-C21 Aliphatics	mg/kg	--	NV	2	--
C18-C21 Aromatics	mg/kg	--	NV	2	--
C21-C28 Aliphatics	mg/kg	--	NV	2	--
C21-C28 Aromatics	mg/kg	--	NV	2	--
C28-C36 Aliphatics	mg/kg	--	NV	2	--
C28-C36 Aromatics	mg/kg	--	NV	2	--
Petroleum Hydrocarbons					
TPH	mg/kg	MTCA TEE soil	200	20	--
Metals					
Arsenic	mg/kg	Puget Sound Bkgd	7	0.2	--
Cadmium	mg/kg	LAET	2.39	0.2	--
Chromium	mg/kg	Puget Sound Bkgd	48	0.5	--
Copper	mg/kg	MTCA TEE soil	50	0.2	--
Lead	mg/kg	MTCA TEE plant	50	2	--
Mercury	mg/kg	MTCA TEE soil	0.1	0.05	--
Silver	mg/kg	LAET	0.545	0.3	--
Zinc	mg/kg	MTCA TEE plant	86	0.6	--
Conventionals			NV		
<Sieve 200	percent	--	NV	0.1	--
Sieve 0.25	percent	--	NV	0.1	--
Sieve 0.5	percent	--	NV	0.1	--
Sieve 004	percent	--	NV	0.1	--
Sieve 010	percent	--	NV	0.1	--
Sieve 020	percent	--	NV	0.1	--
Sieve 040	percent	--	NV	0.1	--
Sieve 060	percent	--	NV	0.1	--
Sieve 140	percent	--	NV	0.1	--
Sieve 200	percent	--	NV	0.1	--
TOC	mg/kg	LAET	98200	100	--

[a] Detected chemicals will be reported to the MDL with J qualifiers applied below the MRL.

[b] The MDL will be used as the reporting limit for non-detects when the MRL is above the preliminary screening benchmark. The MDL is above the preliminary screening benchmark for the following analytes: 1,2,4-trichlorobenzene, 2,4-Dinitrotoluene, 2,6-Dinitrotoluene, 3,3'-Dichlorobenzidine, bis(2-Chloroethyl)ether, Hexachlorobenzene, n-Nitrosodimethylamine, n-Nitroso-di-n-propylamine, and pentachlorophenol. The MDLs for benzidine and toxaphene are also expected to be greater than the preliminary screening benchmark.

Ecology SQS - Values normalized to TOC were denormalized by multiplying 0.01 (1% TOC was assumed to be the average for site soils and sediments).

NV = no value

tbd = to be determined

-- = not applicable

Table A-7. Target Analytes, Methods, and Method Reporting Limits.

Analytes	Laboratory	Sample Preparation		Quantitative Analysis	
		Protocol	Procedure	Protocol	Procedure
Soil and sediment samples					
Conventional Analyses	ARI				
Total sulfides[a]		EPA 376.2	Distillation	EPA 376.2	Colorimetry
Ammonia[a]		EPA 350.1 (Plumb)	KCl extraction	EPA 350.1	Colorimetry
Total organic carbon		Plumb 1981	Acid pretreatment	Plumb 1981	Combustion
Metals	ARI				
Arsenic, cadmium, chromium, copper, lead, nickel, silver, zinc		EPA 3050	Strong acid digestion	EPA SW 6010	ICP
Mercury		EPA 7471A	Acid digestion/oxidation	EPA 7471A	CVAA
Petroleum hydrocarbons	ARI				
Gasoline-range hydrocarbons[b]		NWTPH-Gx	Methanol extraction	NWTPH-Gx	GC/FID
			Purge and trap		
Diesel- and oil-range hydrocarbons		EPA 3545B or 3550B	ASE or Sonication	NWTPH-Dx	GC/FID
			Acid and Silica gel cleanup		
Volatile petroleum hydrocarbons[b]		WDOE VPH	Methanol extraction	WDOE VPH	GC/PID and FID
			Purge and trap		
Extractable petroleum hydrocarbons		WDOE EPH	Sonication	WDOE EPH	GC/FID
			Silica gel fractionation		
Organochlorine pesticides[b]	ARI	EPA 3550B	Sonication	EPA 8081A	Dual column GC/ECD
		EPA 3630C	Silica Gel Cleanup		
		EPA 3660B	Sulfur cleanup		
PCB Aroclors[b]	ARI	EPA 3550B	Sonication	EPA 8082	Dual column GC/ECD
		EPA 3665A	Sulfuric acid cleanup		
		EPA 3630C	Silica Gel Cleanup		
		EPA 3660B	Sulfur cleanup		
Semivolatile organic compounds	ARI	EPA 3550B	Sonication	EPA 8270C	GC/MS
		EPA 3640A	Gel permeation chromatography		

Table A-7. Target Analytes, Methods, and Method Reporting Limits. (continued)

Analytes	**Laboratory**	**Sample Preparation**		**Quantitative Analysis**	
		Protocol	**Procedure**	**Protocol**	**Procedure**
Chlorinated dioxins and furans	STL	EPA 1613B	Soxhlet/Dean Stark extraction	EPA 1613B	HRGC/HRMS
			Sulfuric acid cleanup		
			Silica/carbon column cleanup		
Toxicity tests [a]	NAS				
Microtox® test of sediment pore water		Ecology 2003	Pore water extraction	Ecology 2003	*V. fisheri* luminescence
Amphipod 10-day bioassay (*Hyalella azteca*)		Ecology 2003	--	ASTM 2000	10-d mortality
Midge 20-day bioassay (*Chironomus tentans*)		Ecology 2003	--	ASTM 2000	21-d mortality and growth
Geotechnical characteristics	ARI				
Grain Size		NA	--	ASTM-D422-63	Sieve/Hydrometer
Atterberg Limits		NA	--	ASTM-D4318-00	Wet method; moisture determination
Specific Gravity		NA	--	ASTM-D854-02	Water pycnometer
Moisture Content		NA	--	ASTM-D-2216	Gravimetric
Groundwater and surface water samples					
Conventional Analyses	ARI				
Total organic carbon		EPA 415.1	Acid pretreatment	EPA 415.1	Combustion
Total Suspended Solids		EPA 160.2	Filtration and drying	EPA 160.2	Gravimetric
Hardness (Ca, Mg)		--	--	SM 2340B	Calculation
Metals	ARI				
Cadmium, chromium, copper, lead, nickel, silver, zinc		EPA 3005	Acid digestion	EPA 200.8	ICP/MS
Calcium, magnesium		EPA 3005	Acid digestion	EPA 6010B	ICP/OES
Mercury		EPA 7470	Acid digestion/oxidation	EPA 7470	CVAA
Petroleum hydrocarbons	ARI				
Gasoline-range hydrocarbons		NWTPH-Gx	Purge and trap	NWTPH-Gx	GC/FID

Table A-7. Target Analytes, Methods, and Method Reporting Limits. (continued)

Analytes	**Laboratory**	**Sample Preparation**		**Quantitative Analysis**	
		Protocol	**Procedure**	**Protocol**	**Procedure**
Diesel- and oil-range hydrocarbons		EPA 3520C	Liquid-Liquid	NWTPH-Dx	GC/FID
Volatile petroleum hydrocarbons		WDOE VPH	Purge and trap	WDOE VPH	GC/PID and FID
Extractable petroleum hydrocarbons		WDOE EPH	Separatory Funnel or Liquid-Liquid	WDOE EPH	GC/FID
			Silica gel fractionation		
Semivolatile Organic Compounds	ARI	EPA 3510C	Separatory Funnel	EPA 8270C	GC/MS
Chlorinated dioxins and furans	STL	EPA 1613B	Extraction	EPA 1613B	HRGC/HRMS
			Sulfuric acid cleanup		
			Silica/carbon column cleanup		

[a] Will be analyzed in sediment samples only.

[b] Will be analyzed in selected soil samples only.

Table A-8. Measurement Quality Objectives.

Analysis	**Bias (percent)**	**Precision (RPD)**	**Completeness (percent)**
Soil and sediment samples			
Conventional analytes	75–125	±35	95
Physical charactersitics	NA	±35	95
Metals	75–125	±35	95
Organic compounds			
Petroleum hydrocarbons	50–150	±50	95
Semivolatile organic compounds	30-150	±50	95
Pesticides	30-150	±50	95
PCB Aroclors	30-150	±50	95
Dioxins and furans	50–150	±50	95
Groundwater and surface water samples			
Conventional analytes	75–125	±35	95
Metals	75–125	±35	95
Organic compounds			
Petroleum hydrocarbons	50–150	±50	95
Semivolatile organic compounds	30–150	±50	95
Dioxins and furans	50–150	±50	95

NA - not applicable
RPD - relative percent difference

SECTION B: DATA GENERATION AND ACQUISITION

B1 SAMPLING PROCESS DESIGN

This section presents the sampling design for a tiered approach to complete the Park RI field investigation (Section 4.0 in the SAP). The design is based on Integral's understanding of historical site data and professional judgment. Specific issues related to sampling methods and sample handling procedures are addressed in Section 5.0 of the SAP.

A total of 12 test pits are planned for excavation within the Park site boundary. The test pits will allow collection of soil samples at depth in the areas of historical landfill and gravel mining operations, which might have disturbed soils and distributed contamination throughout a depth range up to several feet. In each test pit, a sample collected from surface to 1 ft below ground surface (bgs) will be submitted for analyses. Additional samples will be collected at 1-2 ft bgs, 2-3 ft bgs, and the bottom of the test pit for archiving. Selected soil samples will be analyzed for TOC, grain size, Atterberg limits, specific gravity, moisture content/bulk density, metals, and NWTPH-DRO and -GRO. Depending on the results, archive samples may be analyzed for VPH/EPH, SVOCs and dioxins/furans.

Soil samples will also be collected at 9 locations using a hand auger. Hand augering is proposed for these locations because it is less intrusive than test pits. Soil samples will be collected at 0-1 ft bgs and 1-2 ft bgs. Selected soil samples will be analyzed for TOC, grain size, Atterberg limits, specific gravity, moisture content/bulk density, metals, chlorinated pesticides, PCBs, and NWTPH-DRO. Depending on the results, archive samples may be analyzed for EPH, SVOCs and dioxins/furans.

Surface water samples will be collected at 8 designated locations (including one reference location) using either a peristaltic pump or grab sampling equipment (e.g., sampled directly into bottles). Integral will collect two rounds of surface water samples, both during the wet season. Surface water samples will be analyzed for hardness, total suspended solids (TSS), TOC, metals (including calcium and magnesium), NWTPH-GRO/DRO, and SVOCs. Selected surface water samples may also be analyzed for VPH/EPH and dioxins/furans.

Surface sediment samples will be collected from 7 locations at a depth of 0 to 10 cm using a stainless steel, hand-held coring device or large spoon. After surface samples have been collected, sediment borings will be drilled along transects across the creek bed at six locations, evenly spaced over the length of the creek. The borings will be advanced using a track-mounted, portable, hollow stem auger to collect samples at depth. For each transect of 3 to 5 borings, sediment samples will be collected from 0-1 ft bgs, 1-2 ft, 2-3 ft bgs, 3-4 ft bgs, and 4-5 ft bgs. Site surface (0-10 cm) and the 0-1 ft and 1-

2 ft boring sediment samples will be analyzed for TOC, metals, and NWTPH-DRO. Surface sediments (0-10 cm) will also be analyzed for total sulfides and ammonia to assist in evaluating the bioassay tests, if required. Physical testing (grain size, Atterberg limits, specific gravity, moisture/bulk density) will also be analyzed for the surface (0-10 cm – grain size only), and 0-1 ft and 2-3 ft samples at depth from selected borings representative of each transect. Site surface (0-10 cm), 0-1 ft, and 1-2 ft sediment samples will be archived for possible EPH, SVOC, and dioxin/furan analyses, depending on the DRO results. Additional samples collected at depth may be analyzed for these chemical groups pending the results of shallow sediment samples.

Based on the chemical results of the surface sediment samples we will perform toxicity testing at those locations where concentrations exceed corresponding SLs. The proposed tests are:

- Amphipod (*Hyalella azteca*) 10-day mortality test (USEPA 2000b; Test Method 100.1)
- Microtox® Sediment Porewater (*Vibrio fischeri*) (Ecology 2003)
- Midge (*Chironomus tentans*) 20-day mortality and growth test (USEPA 2000b; Test Method 100.2 modified).

Groundwater samples will be collected at three wells in the Park and a background location (MW-06D[3]) using either a peristaltic pump or bailer. Integral will collect two rounds of groundwater samples, both during the wet season. Groundwater samples will be analyzed for hardness, TSS, TOC, metals (including calcium and magnesium), NWTPH-GRO/DRO, SVOCs, and dioxins/furans. Depending on the results of the NWTPH method, VPH/EPH may be analyzed.

Field replicates will be collected and analyzed at a frequency of 5 percent of samples. Equipment rinse blanks will be collected and analyzed once per sampling method. Field QC samples are described in Section 4.6 of the SAP.

B2 SAMPLING METHODS

Field sampling methods are described in Section 5.0 of the SAP and include the following activities:

- Horizontal and vertical control methods (utility survey and sample locations)
- Sampling equipment (test pits, hand augers, surface water sampling, surface sediment sampling, sediment borings, and groundwater sampling)

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[3] MW-06D is a background well located northeast of the OESER site near Cedarwood Avenue.

- Sample identification
- Sample containers and labels (sample labels, custody seals, sample summary log, sample custody/tracking procedures)
- Field documentation and procedures (field logbooks, photo documentation, sample collection form, field change request form, sample tracking form, chain-of-custody form)
- Decontamination procedures
- Investigation-derived wastes.

Standard operating procedures (SOPs) for each sampling method are provided in Appendix A of the SAP.

Soil samples will be collected from test pits excavated using a backhoe to a depth of 4 ft bgs. SOP-1 presents the procedures planned for test pit excavations in the Park.

Soil samples will be collected using a stainless steel hand auger or equivalent to a depth of 2 ft bgs. SOP-2 presents the procedures planned for sampling with a hand auger in the Park.

Groundwater will be collected from each well using either a portable peristaltic pump equipped with Teflon-lined tubing or disposable bailer. Refer to SOP-3 in the SAP.

Surface water will be collected from below the water surface using either a portable peristaltic pump equipped with Teflon-lined tubing or direct filling of sample bottles. See SOP-4.

Surface sediment samples (0 to 10 cm) will be collected from the Creek using a stainless steel shovel, spoon or trowel following methods described in SOP-5.

Sediment borings will be advanced using a portable, track-mounted, hollow-stem auger drill rig as described in SOP-6. A 2-ft long, 3-inch diameter split spoon will be used (or equivalent) to collect sediment samples at each sediment boring location.

Requirements for sample containers, sample preservation, storage temperature, and holding times are summarized in Table B-1. All sample containers will have screw-type lids to ensure adequate sealing of the bottles. Lids of the glass containers will have Teflon inserts to prevent sample reaction with the plastic lid and to improve the quality of the seal. When required, preservative will be added to containers at the laboratory prior to shipment to the sampling site.

Commercially available, pre-cleaned jars will be used, and the laboratory will maintain a record of certification from the suppliers. The bottle shipment documentation will record batch numbers for the bottles. With this documentation, bottles can be traced to the supplier, and bottle rinse blank results can be reviewed. The bottle documentation from the laboratory will be included in the Integral project file.

B3 SAMPLE HANDLING AND CUSTODY

The principal documents used to identify samples and to document possession will be field logbooks and chain-of-custody (COC) records. Custody will be documented for all samples at all stages of the analytical or transfer process. COC procedures for core and sample handling prior to delivery to the laboratories are outlined in Section 5.5 of the SAP.

Upon receipt of samples at each laboratory, the sample manager will check for physical integrity of the containers and seals and inventory the samples by comparing sample labels to those on the COC forms. The laboratory will include the COC and cooler receipt forms in the data package. Any breaks in the COC or non-conformances will be noted and reported in writing to the Integral laboratory coordinator within 24 hours of receipt of the samples. Each laboratory QA plan (Attachments 1 through 3 to this QAPP) includes procedures used for accepting custody of samples and documenting samples at the laboratory. The laboratory project manager will ensure that a sample-tracking record is maintained that follows each sample through all stages of sample processing at the laboratory.

All samples submitted to ARI for archival will be stored at -20° C. Sediment for toxicity testing will be stored in the dark for a maximum of 8 weeks. Sample bottles for toxicity testing will be stored either with no headspace or headspace purged with nitrogen gas. Each laboratory will maintain COC documentation and documentation of proper storage conditions for the entire time that the samples are in its possession. The chemical laboratories will store the excess samples for a minimum of 6 months following completion of data validation.

The laboratories will not dispose of the samples for this project until authorized to do so by the Integral laboratory coordinator. The laboratories will dispose of samples, as appropriate, based on matrix, analytical results, and information received from the client. If determined to be hazardous, remaining samples will enter the appropriate laboratory waste streams.

B4 ANALYTICAL METHODS

Samples of all matrix types collected for this study will be analyzed for chemical constituents. Toxicity tests will additionally be conducted for selected sediment and sediment pore water samples. Sediment and soil samples will also be tested for geotechnical characteristics. The laboratory methods that will be used to complete the chemical, biological, and geotechnical testing are described below.

B4.1 Chemical Analyses

Soil, groundwater, surface water, and sediment samples will be analyzed for metals, organic compounds, and conventional analytes. Detailed analyte lists and method reporting limits are provided in Tables A-3 through A-6, respectively, for each sample type. Method reporting limits are equivalent to the concentration of the lowest calibration standard (i.e., the practical quantitation limit) and represent the low end of the calibration range. Analytes that are detected at concentrations below the reporting limit will be reported, but will be qualified as estimated (a "J" qualifier will be applied to the result by the laboratory).

ARI will complete analyses for metals, organic compounds (except dioxins and furans), conventional analytes, and geotechnical characteristics. STL will complete analyses for dioxins and furans. Laboratory methods for sample preparation and analysis are summarized in Table A-7 and described in the following sections. Sample containers, preservation, and holding times are provided in Table B-1.

B4.1.1 Metals

Sediment and soil samples will be analyzed for metals by EPA Method 6010 and for mercury by EPA Method 7471A. Strong acid digestion with nitric acid and hydrogen peroxide will be used to prepare samples for analysis of metals other than mercury. Analysis will be completed by inductively coupled plasma/mass spectrometry (ICP/MS). Mercury samples will be digested with aqua regia and oxidized using potassium permanganate. Analysis will be completed by cold vapor atomic absorption spectrometry (CVAA).

Three methods will be used to analyze groundwater and surface water samples for total metals. Digestion with nitric and hydrochloric acids will be used to prepare samples for analysis of metals other than mercury. Analysis for these metals will be completed by ICP/MS. Calcium and magnesium analyses will be completed by inductively coupled plasma-optical emission spectrometry (ICP-OES). Calcium and magnesium concentrations will be used to calculate water hardness. Mercury samples will be digested with aqua regia, oxidized using potassium permanganate, and analyzed by CVAA.

B4.1.2 Petroleum Hydrocarbons

Soil, groundwater, sediment, and surface water samples will be analyzed for diesel- and oil- range petroleum hydrocarbons. These samples will additionally be analyzed for EPH if screening levels are exceeded. Soil, groundwater, surface water samples will also be analyzed for gasoline-range petroleum hydrocarbons (GRO). These samples will be analyzed for VPH if screening levels are exceeded. Details regarding the decision to analyze samples for VPH or EPH are provided in Section 4.0 of the SAP.

GRO and VPH will be extracted from soil samples using methanol, followed by purge and trap with a carbon-based trap. Groundwater and surface water samples will be purged directly without prior extraction. The contents of the trap will be analyzed by gas chromatography (GC) with a flame ionization detector (FID) for NWTPH-GRO. Samples for VPH will be analyzed using both FID and a photo-ionization detector (PID). The FID detects both aliphatic and aromatic hydrocarbons, whereas the PID detects only the aromatic hydrocarbons. The aliphatic hydrocarbons are calculated as the difference between the FID and PID responses.

For diesel- and oil-range petroleum hydrocarbons, samples will be extracted with methylene chloride and solvent-exchanged into hexane. Silica gel chromatography will be used to separate the aliphatic and aromatic hydrocarbons in the samples. The fractions will be analyzed separately by GC/FID.

B4.1.3 Semivolatile Organic Compounds

SVOCs in sediment and soil samples will be analyzed by EPA SW-846 Method 8270C, with modifications recommended by PSEP (1997a,b) to allow lower reporting limits. Modifications will include the use of a larger sample volume, corresponding to 50 g of dry sediment and a final extract volume of 0.5 mL. Samples will be extracted by sonication. Gel permeation chromatography will be used to clean up the sample extracts. Samples will be analyzed by gas chromatography with mass spectrometry (GC/MS).

Continuous liquid-liquid extraction will be used to extract SVOCs from groundwater and surface water samples. SVOCs will be analyzed by GC/MS with a large-volume injector to enhance sensitivity. TICs will not be reported for this study.

B4.1.4 Dioxins and Furans

Chlorinated dioxins and furans in sediment and soil samples will be extracted with toluene in a Soxhlet/Dean Stark extractor. Water samples will be extracted with methylene chloride. Cleanup procedures will include sulfuric acid cleanup and silica/carbon column cleanup. Additional cleanup procedures will be used if necessary to remove interferences. Samples will be analyzed by high-resolution gas chromatography with high-resolution mass spectrometry (HRGC/HRMS). EPA Method 1613B requires isotopically labeled analogs of target analytes to be spiked into each sample before extraction. Target analytes are quantified relative to the labeled analog and therefore their calculated concentration compensates for extraction and cleanup efficiencies.

As described in EPA Method 1613B, detection limits are calculated on an individual compound and sample basis and depend on the signal-to-background ratio for the specific labeled isomer. Concentrations will be reported to the sample-specific MDLs.

B4.1.5 Pesticides

Chlorinated pesticides in soil samples will be analyzed using EPA SW-846 Method 8081A. Samples will be extracted by sonication extraction. Gel permeation chromatography (GPC) will be used to remove large organic interferents, and sulfur cleanup will be completed if necessary using tetrabutylammonium sulfite. Samples will be analyzed by gas chromatography with an electron capture detector (GC/ECD).

B4.1.6 PCBs

PCB Aroclors in soil samples will be analyzed using EPA SW-846 Method 8082 with modifications recommended by PSEP (1997a) to allow lower reporting limits. Modifications will include the use of a larger sample volume, corresponding to 25 g of dry sediment, and a final extract volume of 5 mL. Samples will be extracted by sonication. Extracts will be cleaned using sulfuric acid cleanup, silica gel cleanup, and sulfur cleanup. Samples will be analyzed by GC/ECD.

B4.1.7 Conventional Analyses

Conventional analyses of sediment samples will include total solids, total sulfides, ammonia, and TOC. Soil samples will be analyzed for total solids and TOC. EPA and PSEP methods will be used as shown in Table A-7.

Total solids in soil and sediment samples will be determined according to PSEP (1986). These results will be used to calculate analyte concentrations on a dry-weight basis and will also be reported in the database.

Total sulfide analysis in sediment samples will include distillation of the sulfide into a sodium hydroxide trap and analysis by colorimetry (EPA 376.2).

Ammonia in sediment samples will be analyzed by EPA Method 350.1. The method, originally developed for use in water samples, will be modified for sediment samples by adding an extraction with a potassium chloride solution. Colorimetry will be used to determine ammonia concentrations.

TOC in sediment and soil samples will be analyzed as described in EPA Method SW 9060 (Ecology modified). Samples will be pretreated with hydrochloric acid to remove inorganic carbon, dried at 70° C, and analyzed by combustion in an induction furnace.

Conventional analyses of surface water samples will include total suspended solids, total organic carbon, and hardness. EPA methods will be used as shown in Table A-7.

For TSS determination, water samples will be filtered through a pre-weighed glass fiber filter. The filter will be dried and weighed and the TSS determined by difference.

Total organic carbon in surface water samples will be analyzed by EPA Method 415.1. Organic carbon in the samples will be oxidized and the evolved CO_2 will be analyzed using an infrared detector. Samples will be pretreated with hydrochloric acid to remove inorganic carbon.

The hardness of the water samples will be calculated using the results for calcium and magnesium which will be obtained by ICP/OES as described for metals.

B4.2 Biological Testing

Bioassays will be conducted on selected sediment samples to determine whether anthropogenic contaminants of concern are present at concentrations which are toxic to biota. The following freshwater sediment toxicity bioassays (2 acute tests and 1 chronic test) will be conducted:

- 10-day Amphipod (*Hyalella azteca*)
- Microtox® Sediment Porewater (*Vibrio fischeri*)
- 20-day Midge Larvae (*Chironomus tentans*).

Biological testing will be in compliance with *Methods for Measuring the Toxicity and Bioaccumulation of Sediment Associated Contaminants with Freshwater Invertebrates* (USEPA 2000b), ASTM Guideline E 1706-95b (ASTM 1997, 2000), and the *Sediment Sampling and Analysis Plan Appendix – Subappendicies C and D* (Ecology 2003) following requirements presented in the *Phase 1 Freshwater Sediment Quality Values in Washington State* (Ecology 2002). NAS, an accredited laboratory by Ecology, will conduct the bioassay testing for this project.

All samples for bioassay testing will be stored in 1-liter amber jars, at 4^{o}C, with no headspace (or headspace purged with nitrogen gas) until analysis by the laboratory. Toxicity tests will be initiated within 8 weeks of sample collection.

B4.3 Geotechnical Testing

A suite of physical tests are used to evaluate excavation, filling and capping methods, and capacity of existing soils and sediments to provide foundation support for filling/capping material. The following tests will be completed for selected samples collected in the cores (Table A-2).

B4.3.1 Grain Size

Grain size will be analyzed by the hydrometer and sieve method following ASTM Method D422-63 (ASTM 2003), and will provide information on site geologic character and engineering properties of soil/sediment proposed for remediation.

B4.3.2 Atterberg Limits

Atterberg limits will be determined for selected samples of soil and sediment samples in accordance with ASTM D4318-00 (includes organic determination). Atterberg limits, which include the liquid limit, plastic limit, and the plasticity index, are used to define plasticity characteristics of clays and other cohesive sediments.

B4.3.3 Specific Gravity

Specific gravity will be measured on samples selected for engineering properties in accordance with ASTM D854-02. The specific gravity of soil/sediment samples is used to determine sediment removal and the bed consolidation after filling/capping.

B4.3.4 Moisture Content

Moisture content will be measured on selected samples analyzed for engineering properties in accordance with ASTM D-2216. Moisture content is used to determine the initial *in situ* void ratio of the soil/sediment and to estimate the short-term bulking (or increase in volume) during excavation activities.

B5 QUALITY CONTROL

Quality control samples will be prepared in the field and at the laboratories to monitor the bias and precision of the sample collection and analysis procedures.

B5.1 Field Quality Control Samples

Field QC samples for this study will include field duplicates and equipment rinse blanks. These field QC samples will minimally be collected at a frequency of 5 percent of the sample total (field duplicates) and once per each type of sampling equipment (equipment rinse blank). The procedures for preparing field duplicates and rinse blanks are presented in Section 4.6 and Appendix A of the SAP. Validation criteria and procedures for field QC samples are described in Sections D1 and D2 of this QAPP.

B5.2 Laboratory Quality Control

Extensive and detailed requirements for laboratory QC procedures are provided in the EPA and PSEP protocols that will be used for this study (Table A-8). Every method protocol includes descriptions of QC procedures, and many incorporate additional QC requirements by reference to separate QC chapters. QC requirements include control limits and requirements for corrective action in many cases. QC procedures will be completed by the laboratories, as required in each protocol and as indicated in this QAPP.

The frequency of analysis for laboratory control samples, matrix spike samples, matrix spike duplicates or laboratory duplicates, and method blanks will be one for every 20 samples or one per extraction batch, whichever is more frequent. Surrogate spikes and internal standards will be added to every field sample and QC sample, as required. Calibration procedures will be completed at the frequency specified in each method description. As required for EPA SW-846 methods, performance-based control limits have been established by the laboratories. These and all other control limits specified in the method descriptions will be used by the laboratories to establish the acceptability of the data or the need for reanalysis of the samples. Laboratory control limits for recoveries of surrogate compounds, matrix spikes, and laboratory control samples, and for relative percent difference of matrix spike duplicates and laboratory duplicates, are provided in Appendix K of ARI's QA manual (Attachment 1 to this QAPP) and in Appendix 2 for STL.

Test acceptability for bioassays is based on the source and sensitivity of the test organisms and on the control of physical and chemical conditions in the culture chambers while the test is in progress. Quality control procedures will include negative and positive controls for the toxicity tests; acceptance conditions for the test organisms; and chemical monitoring of the overlying water in the culture chambers. Water quality monitoring for the various toxicity tests will include ammonia, hardness, alkalinity, conductivity, dissolved oxygen, pH, and temperature. Control criteria and procedures are described in Section IX of the QA/QC Manual for NAS (Appendix 3 of this QAPP). Details are provided in each testing protocol (Table A-7).

B6 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Analytical instrument testing, inspection, maintenance, setup, and calibration will be conducted by the laboratories in accordance with the requirements identified in the laboratories' SOPs and manufacturer instructions. In addition, each of the specified analytical methods provides protocols for proper instrument setup and tuning, and critical operating parameters. Instrument maintenance and repair will be documented in maintenance log or record books.

B7 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Laboratory instruments will be properly calibrated, and the calibration will be verified with appropriate check standards and calibration blanks for each parameter before beginning each analysis. Instrument calibration procedures and schedules will conform to analytical protocol requirements and descriptions provided in the laboratories' QA plans.

All calibration standards will be obtained from either the EPA repository or a commercial vendor, and the laboratories will maintain traceability back to the National Institute of Standards and Technology. Stock standards will be used to make intermediate standards and calibration standards. Special attention will be given to expiration dating, proper labeling, proper refrigeration, and prevention of contamination. Documentation relating to the receipt, mixing, and use of standards will be recorded in a laboratory logbook. All calibration and spiking standards will be checked against standards from another source.

B8 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The quality of supplies and consumables used during sample collection and laboratory analysis can affect the quality of the project data. All equipment that comes into contact with the samples and extracts must be sufficiently clean to prevent detectable contamination, and the analyte concentrations must be accurate in all standards used for calibration and quality control purposes.

During sample collection, solvents of appropriate, documented purity will be used for decontamination. Solvent containers will be dated and initialed when they are opened. The quality of laboratory water used for decontamination will be documented at the laboratory. As discussed in Section B2, cleaned and documented sample containers will be provided by the laboratory. All containers will be visually inspected prior to use, and any suspect containers will be discarded.

Reagents of appropriate purity and suitably cleaned laboratory equipment will also be used for all stages of laboratory analyses. Details for acceptance requirements for supplies and consumables at the laboratories are provided in the laboratory SOPs and QA plans. All supplies will be obtained from reputable suppliers with appropriate documentation or certification. Supplies will be inspected to confirm that they meet use requirements, and certification records will be retained by Integral (i.e., for supplies used in the field) or the laboratory.

B9 NON-DIRECT MEASUREMENTS

Existing chemical data from previous investigations in the Park will be used for this investigation. All historical data were reviewed for quality assurance. Details are provided in section 3.1 of the SAP.

B10 DATA MANAGEMENT

Data for this project will be generated in the field and at the laboratories. The final repository for sample information for the sample collection efforts described in the SAP will be an EQuIS™ database. Procedures to be used to transfer data from the point of generation to the EQuIS™ database are described in this section. Final data will be combined with historical data and summary tables will be created using EQuIS™.

B10.1 Field Data

Data that are generated during sediment collection and sample preparation will be manually entered into the field logbook, core logs, and COC forms. Data from these sources will be entered into the EQuIS™ database directly from the field logbook and core logs. These data include station location coordinates, station names, sampling dates, sample identification codes, and additional station and sample information (e.g., water depth, sample type, field replicate number). All entries will be reviewed for accuracy and completeness by a second individual, and any errors will be corrected before the data are approved for release to data users.

B10.2 Laboratory Data

A variety of manually entered and electronic instrument data are generated at the laboratories. Data are manually entered into:

- Standard logbooks
- Storage temperature logs
- Balance calibration logs
- Instrument logs
- Sample preparation and analysis worksheets
- Maintenance logs
- Individual laboratory notebooks
- Results tables for conventional analyses (e.g., grain-size distribution, total solids).

All manual data entry into the laboratory information management system (LIMS) is proofed at the laboratory. All data collected from each laboratory instrument, either manually or electronically, are reviewed and confirmed by analysts before reporting. At ARI, the sample information is electronically loaded to temporary files in LIMS and submitted for further review. Forms IV-X for validated data packages are generated in the laboratory and reviewed for correctness in interpretation, conformance with QA requirements, and completeness. Once the data have been accepted, the final results are released to the LIMS for reporting. The LIMS is used to generate the EDD as well as Forms I-III for the data package, providing a single source for reporting of chemical data. The EDD is further spot-checked against the hard copy to ensure that the correct data set is reported for both. A detailed description of procedures for laboratory data management and data review and verification are provided in the laboratory QA plans (Attachments 1 through 3).

Laboratory data will be entered directly into the EQuIS™ database from the EDD. A database printout will be used to verify database entries against the hard-copy laboratory data packages. Electronic data will also be provided to Ecology and EPA in SEDQUAL and EIM import formats, as required.

Table B-1. Required Sample Containers, Preservatives, and Holding Times.[1]

Analysis Type	**Matrix**	**Container Size**	**Holding Time[1]**	**Preservation**
NWTPH-GRO	Soil/Sediment	4 oz glass with Teflon coated/Septum lid	14 days extraction/analysis	Ice (4^{o}C)
NWTPH-DRO	Soil/Sediment	4 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4^{o}C) Frozen (-18^{o}C)
SVOCs	Soil/Sediment	8 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4^{o}C) Frozen (-18^{o}C)
Pesticides/PCBs	Soil/Sediment	8 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4^{o}C) Frozen (-18^{o}C)
Dioxins/Furans	Soil/Sediment	8 oz glass	14 days extraction/40 days analysis 1 year until analysis	Ice (4^{o}C) Frozen (-18^{o}C)
Metals	Soil/Sediment	4 oz glass	6 months/28 days* 2 years until analysis (except mercury)	Ice (4^{o}C) Frozen (-18^{o}C)
TOC	Soil/Sediment	4 oz glass	14 days 6 months	Ice (4^{o}C) Frozen (-18^{o}C)
Total Sulfides/Ammonia	Soil/Sediment	4 oz glass (zero headspace)	7 days	Ice (4^{o}C)
Grain size	Soil/Sediment	16 oz glass	6 months	Ice (4^{o}C)
Atterburg Limits	Soil/Sediment	Inc.	NA	Ice (4^{o}C)
Specific Gravity	Soil/Sediment	Inc.	NA	Ice (4^{o}C)
Moisture Content/Bulk Density	Soil/Sediment	Inc.	NA	Ice (4^{o}C)
NWTPH-GRO	Water	Two 40-mL glass with Teflon lined Septum lid	14 days extraction/analysis	1+1 HCl to a pH <2 Ice (4^{o}C)
NWTPH-DRO	Water	One 1-liter amber glass	14 days extraction/analysis	1+1 HCl to a pH <2 Ice (4^{o}C)
SVOCs	Water	Two 1-liter amber glass	7 days extraction/40 days analysis	Ice (4^{o}C)
Pesticides/PCBs	Water	Two 1-liter amber glass	7 days extraction/40 days analysis	Ice (4^{o}C)
Dioxins/Furans	Water	Two 1-liter amber glass	7 days extraction/40 days analysis	Ice (4^{o}C)
Metals	Water	One 1-liter HDPE	6 months/28 days*	Ice (4^{o}C), HNO_3 pH<2

Table B-1. Required Sample Containers, Preservatives, and Holding Times. (continued)

Analysis Type	**Matrix**	**Container Size**	**Holding Time**[1]	**Preservation**
TOC	Water	One 500-mL HDPE	28 days	Ice (4^oC), H_2SO_4 pH<2
TSS	Water	One 1-liter HDPE	--	Ice (4^oC)
Hardness	Water	One 1-liter HDPE	--	Ice (4^oC)
Bioassays	Sediment	Three 1-liter amber glass	8 weeks	Ice (4^oC) No Headspace or Purged with Nitrogen Gas

[1] Storage temperatures and maximum holding times for physical/chemical analyses and sediment toxicity tests (PSEP 1997a,b, Ecology 2003)

* Holding time for mercury is 28 days. Holding time for the other metals is 6 months.

Note: All holding times are from the date of sampling. Samples should be analyzed as soon as possible after collection. The times listed are the maximum times that samples may be held before analysis without being qualified.

SECTION C: ASSESSMENT AND OVERSIGHT

This project will rely heavily on the knowledge and experience of the project team. The field team and laboratories will stay in close verbal contact with the Integral project manager and QA manager during all phases of the project. This level of communication will serve to keep the management team appraised of activities and events, and will allow for informal but continuous project oversight. Few scheduled assessment activities are planned for this project because the scope of the sampling and analysis effort and the size of the project team are relatively small.

C1 ASSESSMENTS AND RESPONSE ACTIONS

Assessment activities will include readiness reviews prior to sampling and prior to release of the final data to the data users, and internal review while work is in progress. An informal technical systems audit may be conducted if problems are encountered during any phase of this project.

Readiness reviews are conducted to ensure that all necessary preparations have been made for efficient and effective completion of each critical phase of project work. The first readiness review will be conducted prior to field sampling. The field coordinator will verify that all field equipment is ready for transfer to the site. The field coordinator will also verify that the field team and subcontractor have been scheduled and briefed and that the contract for the subcontractor has been signed by both parties. Any deficiencies noted during this readiness review will be corrected prior to initiation of sampling activities.

The second readiness review will be completed before final data are released for use. The data manager will verify that all results have been received from the laboratories, data validation and data quality assessment have been completed for all of the data, and data qualifiers have been entered into the database and verified. Any deficiencies noted during this review will be corrected by the data manager, the Integral QA manager, or their designee. Data will not be released for final use until all data have been verified and validated. No report will be prepared in conjunction with the readiness reviews. However, the project manager and data users will be notified when the data are ready for use.

Technical review of intermediate and final work products generated for this project will be completed throughout the course of all sampling, laboratory, data validation, data management, and data interpretation activities to ensure that every phase of work is accurate and complete and follows the QA procedures outlined in this QAPP. Any problems that are encountered will be resolved between the reviewer and the person completing the work. Any problems that cannot be easily resolved or that affect the final quality of the work product will be brought to the attention of the Integral and City of Bellingham project managers. Ecology and EPA will be notified of any problems that may affect the final outcome of the project.

The laboratories have implemented a review system that serves as a formal surveillance mechanism for all laboratory activities. Each phase of work is reviewed by a supervisor before it is approved for release. Details are provided in the laboratory QA plans (Attachments 1 through 3 to this QAPP).

Technical system audits may be conducted if serious problems are encountered during sampling or analysis operations. If completed, these audits will be conducted by the Integral QA manager or designee or by the ARI, STL, or NAS QA manager. These audits may consist of onsite reviews of any phase of field or laboratory activities or data management. Results of any audits will be provided in the RI report.

Any project team member who discovers or suspects a non-conformance is responsible for reporting the non-conformance to the project manager, the Integral QA manager, or the laboratory project or QA manager, as applicable. The project manager will ensure that no additional work dependent on the non-conforming activity is performed until a confirmed non-conformance is corrected.

C2 REPORTS TO MANAGEMENT

Corrective actions will be required if deviations from the methods or QA requirements established in the SAP or this QAPP are encountered. When a non-conformance is identified, corrective action will be taken immediately, if possible. The project manager will be contacted and, if necessary, will provide assistance in resolving the issue. A formal corrective action plan is not likely to be required for a project of this limited scope. However, any non-conformance issue that ultimately affects the quality of the data or results in a change of scope in the work described in the SAP, including this QAPP, will be documented in the field log or field correction record (FCR) to the project manager. This documentation will serve as a Corrective Action Report. A description of the non-conformance issue, the attempted resolution, and any effects on data quality or usability will be provided in the RI report.

The laboratories have implemented routine systems of reporting non-conformance issues and their resolution. These procedures are described in the laboratory QA plans (Attachment 1 through 3 to this QAPP). Laboratory non-conformance issues will also be described in the RI report if they affect the quality of the project data.

SECTION D: DATA VALIDATION AND USABILITY

Data generated in the field and at the laboratories will be verified and validated according to criteria and procedures described in this section. Data quality and usability will be evaluated, and a discussion will be included in the RI report.

D1 CRITERIA FOR DATA REVIEW, VERIFICATION, AND VALIDATION

Field and laboratory data for this project will undergo a formal verification and validation process. All entries into the database will be verified. All errors found during the verification of field data, laboratory data, and the database will be corrected prior to release of the final data.

Data verification and validation for organic compounds and metals will be completed according to methods described in the EPA Region 10 SOP for validation of dioxins and furans (USEPA 1996) and in the functional guidelines for organic and inorganic data review (USEPA 1999, 2002b). Data will be qualified as estimated as necessary if results for laboratory control samples, matrix spike samples, and matrix spike or laboratory duplicates do not meet measurement quality objectives provided in Table A-8 or if control limits for any other QC sample or procedure do not meet performance-based control limits. Performance-based control limits are established periodically by the laboratories. Current values are provided in Appendix K of the laboratory QA plan (Attachment 1 to this QAPP) and, for STL, in Attachment 2 of this QAPP.

No guidelines are available for validation of data for TOC, grain size, Atterberg limits, moisture content, and specific gravity. These data will be validated using procedures described in the functional guidelines for inorganic data review (USEPA 2002b), as applicable. The MQOs for accuracy (Table A-8) will be used as control limits for matrix spike recovery, and the MQO for precision will be used as the control limit for laboratory duplicate or triplicate analyses. Performance-based control limits will be used to qualify these data if results for other quality control samples do not meet control limits.

Results for field duplicates will be evaluated using the MQOs provided in Table A-8. Data will not be qualified as estimated if the MQOs are exceeded, but RPD results will be tabulated, and any exceedances will be discussed in the RI report. Equipment rinse blanks will be evaluated and data qualifiers will be applied in the same manner as method blanks, as described in the functional guidelines for data review (USEPA 1996, 1999, 2002b).

Data will be rejected if control limits for acceptance of data are not met, as described in EPA (1996, 1999, 2002b).

D2 VERIFICATION AND VALIDATION METHODS

Field data will be verified during preparation of samples and COCs. Field data and COCs will be reviewed by the field coordinator after the field effort is complete. After field data are entered into the project database, 100 percent verification of the entries will be completed to ensure the accuracy and completeness of the database. Any discrepancies will be resolved before the final database is released for use.

Procedures for verification and validation of laboratory data and field QC samples will be completed as described in the functional guidelines and SOP for data validation (USEPA 1996, 1999, 2002b) and summarized in Section D1, above. The accuracy and completeness of the database will be verified at the laboratory when the EDDs are prepared and again as part of data validation. All entries to the database from the laboratory EDDs will be checked against the hard-copy data packages. Data validation will be completed by a subcontracted data validation firm.

In addition to verification of field and laboratory data and information, data qualifier entries into the database will be verified. Any discrepancies will be resolved before the final database is released for use.

Method reporting limit goals for this project are provided in Tables A-3 through A-7. Reporting limits for non-detects will be compared to the method reporting limit goals to evaluate method sensitivity for each sample. Any exceedance of actual MRLs over the target MRLs will be discussed in the RI report.

D3 RECONCILIATION WITH USER REQUIREMENTS

The goal of data validation is to determine the quality of each data point and to identify data points that do not meet the project MQOs. Nonconforming data may be qualified as estimated or rejected as unusable during data validation if criteria for data quality are not met. Rejected data will not be used for any purpose. An explanation of the rejected data will be included in the RI report.

Data qualified as estimated will be used to evaluate the site and will be appropriately qualified in the final project database. These data are less precise or less accurate than unqualified data. The data users, in cooperation with the Integral project manager and QA manager, are responsible for assessing the effect of the inaccuracy or imprecision of the qualified data on statistical procedures and other data uses for this study. The data quality discussion in the RI report will include all available information regarding the direction or magnitude of bias or the degree of imprecision for qualified data to facilitate the assessment of data usability. The RI report will also include a discussion of data limitations and their effect on data interpretation activities.

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ATTACHMENTS 1 - 3

Analytical Resources, Inc.
Quality Assurance Plan

Severn Trent Laboratories, Inc.
Quality Assurance Plan

Northwest Aquatic Sciences, Inc.
Quality Assurance Plan

(Attached CD)

FINAL

ECOLOGY TOXICS CLEANUP PROGRAM
EPA BROWNFIELDS PROGRAM

HEALTH AND SAFETY PLAN

Little Squalicum Park
Remedial Investigation/Feasibility Study
Bellingham, WA

Prepared for

City of Bellingham
Parks & Recreation Department
3424 Meridian Street
Bellingham, WA 98225

Prepared by

integral consulting inc.

1201 Cornwall Avenue, Suite 208
Bellingham, WA 98225

September 30, 2005

TABLE OF CONTENTS

LIST OF ATTACHMENTS

LIST OF ACRONYMS

Ca	carcinogen
Cor	corrosive
COPCs	constituents of potential concern
CRZ	contamination reduction zone
Decon	decontamination
DI	deionized
EZ	exclusion zone
FID	flame ionization detector
GW	groundwater
HA	hand auger borings
HASP	health and safety plan
HAZWOPER	Hazardous Waste Operations and Emergency Response
HS	hollow-stem auger borings
IDLH	immediately dangerous to life and health
Integral Consulting Inc.	Integral
IP(ev)	ionization potential
NAPL	non-aqueous phase liquid
OSHA	Occupational Safety and Health Administration
OVM	organic vapor monitor
P	poison
PAH	polycyclic aromatic hydrocarbons
the Park	Little Squalicum Park
PCP	pentachlorophenol
PEL	permissible exposure level
PID	photoionization detector
PPE	personal protective equipment
Pres.	preservative
R	reactive
REL	recommended exposure limits (NIOSH)
RI/FS	remedial investigation/feasibility study
SAP	sampling and analysis plan
SCa	suspected carcinogen
SD	sediment
SM	Archeological boundary survey (Shell Midden)
SS	surface and/or subsurface
SSHO	site safety and health officer
STEL	short-term exposure level
SW	surface water
SZ	support zone
TP	test pits using a backhoe

TPH	total petroleum hydrocarbons
WISHA	Washington Industrial Safety and Health Act

HEALTH AND SAFETY PLAN APPROVAL

This health and safety plan has been reviewed and approved for surface water sampling, groundwater sampling, surface sediment sampling, hand auger borings, hollow-stem auger borings, test pit excavations, and archaeological boundary surveying at the Little Squalicum Park site in Bellingham, Washington.

Mark J. Herrenkohl

Project Manager

September 30, 2005

Date

Corporate
Health and Safety Officer

September 30, 2005

Date

HEALTH AND SAFETY PLAN ACKNOWLEDGEMENT

I have reviewed the health and safety plan prepared by Integral Consulting, dated __________________ for the Little Squalicum Park (the Park) fieldwork. I understand the purpose of the plan, and I consent to adhere to its policies, procedures, and guidelines while an employee of Integral or its subcontractors.

Employee signature	Company	Date
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1 INTRODUCTION

This site health and safety plan (HASP) provides the general health and safety provisions to protect workers from potential hazards during field activities associated with the Remedial Investigation/Feasibility Study (RI/FS) at the Park Site in Bellingham, Washington. This HASP applies to the employees of Integral and its subcontractors while conducting the following field activities at the site:

- Groundwater sampling
- Surface water sampling
- Surface sediment sampling
- Hand auger borings
- Hollow-stem auger borings
- Test pit excavations
- Archeological boundary survey.

It is Integral's policy to provide a safe and healthful work environment. No aspect of the work is more important than protecting the health and safety of all workers.

Integral cannot guarantee the health or safety of any person entering this site. Because of the potentially hazardous nature of this site and the activity occurring thereon, it is not possible to discover, evaluate, and provide protection for all possible hazards that may be encountered. Strict adherence to the health and safety guidelines set forth herein will reduce, but not eliminate, the potential for injury and illness at this site. The health and safety guidelines in this plan were prepared specifically for this site and should not be used on any other site without prior evaluation by trained health and safety personnel.

A copy of this HASP will be with the field crew during field activities. All individuals performing fieldwork must read, understand, and comply with this plan before undertaking field activities. Once the information has been read and understood, the individual must sign the Acknowledgment Form provided above, which become part of the project file.

This plan may be modified at any time based on the judgment of the Integral site safety and health officer (SSHO) in consultation with the Corporate Health and Safety Officer and Integral project manager or Principal in Charge. Any modification will be presented to the onsite team during a safety briefing and will be recorded in the field notebook.

1.1 ORGANIZATION

This HASP covers seven field activities including groundwater, surface water and surface sediment sampling; hand auger and hollow-stem auger borings; test pit excavations; and archeological boundary survey. A brief description of each task is provided in the Work Zones and Task Descriptions section. Specific health and safety guidelines associated with each task are discussed in the Task-Specific Safety Procedure section. General health and safety guidelines associated with all activities at the Park site (e.g., physical and chemical hazard evaluation) are grouped together. Additional information on health and safety procedures is provided in the Field Safety Guidelines section (Attachment 6) of Integral's Corporate Health and Safety Plan.

1.2 ROLES AND RESPONSIBILITIES

All personnel and visitors on this site must comply with the requirements of this HASP. The specific responsibilities and authority of management, safety and health, and other personnel on this site are detailed in the following paragraphs.

1.2.1 Site Safety and Health Officer (SSHO) / Site Supervisor

The SSHO and Supervisor have full responsibility and authority to develop and implement this HASP and to verify compliance. They report to the Project Manager and are onsite or readily accessible to the site during all work operations. They have the authority to halt site work if unsafe conditions are detected and is responsible for assessing site conditions and directing and controlling emergency response activities. The specific responsibilities of the SSHO are:

- Managing the safety and health functions on this site
- Serving as the site's point of contact for safety and health matters
- Assessing site conditions for unsafe acts and conditions and providing corrective action
- Executing the sampling and analysis plan and schedule
- Ensuring that all Integral employees and subcontractors know and follow the HASP
- Ensuring that daily work schedules and tasks are appropriate for the required levels of effort and weather conditions
- Confirming local emergency response phone numbers and locations
- Conducting and documenting the initial and daily health and safety briefings
- Evaluating and modifying the level of protective apparel and safety equipment, as necessary, based on site conditions
- Ensuring that the field team observes all necessary decontamination procedures.

If the Site Supervisor determines that site conditions are unsafe, he or she has the authority to suspend field operations until the problem is corrected. The Site Supervisor can modify HASP procedures in consultation with the SSHO. Any changes must be documented in the field logbook and field staff must be immediately informed of the change. The project manager and Integral's corporate health and safety officer must be notified of any changes to the HASP within 12 hours.

1.2.2 Site Workers

Site workers are responsible for complying with this HASP, using the proper personal protective equipment (PPE), reporting unsafe acts and conditions, and following the work and safety and health instructions of the Project Manager and SSHO. All site workers have the authority and are encouraged to suspend field operations and leave the environment if they feel conditions have become unsafe.

1.3 REGULATORY FRAMEWORK

Workplace health and safety regulations within the state of Washington, with a few exceptions, are covered by the Washington Industrial Safety and Health Act (WISHA), which is administered by the Washington State Department of Labor and Industries. WISHA is the state equivalent of the federal government's Occupational Safety and Health Administration (OSHA). This site HASP follows both WISHA (Chapter 49.17 Revised Code of Washington) and federal OSHA HAZWOPER (29 CFR 1910.120) regulations.

1.4 SITE BACKGROUND

The Little Squalicum Park site consists of approximately 32 acres within the City of Bellingham, Washington. The land within and in the vicinity of the study area has been used for a number of operations since the land was developed in the 1850's including dairy farming and ranching, cement manufacturing, sugar processing, plant nursery, sand and gravel mining, raw log storage, and utility pole manufacturing and treating. A complete description of the background of the site is presented in the Sampling and Analysis Plan (SAP) for the site. Specific current information on the site is given below.

- **Owners/tenants:** City of Bellingham, Whatcom County, Burlington Northern Sante Fe railroad, Port of Bellingham
- **Current site use:** Little Squalicum Park includes trails and open areas
- **Hazardous waste site:** No (Oeser Company to the north of park is an EPA Superfund site)
- **Industrial waste site:** No (Oeser Company to the north of park is an EPA Superfund site)
- **NPDES discharge:** No (Oeser Company to the north of park has a NPDES permit for process wastewater and surface water discharges)

- **Topography:** Varies from flat to relatively steep slopes within the former sand and gravel quarry
- **Site access:** Several locations around the Park, main entrance at corner of Lindbergh Avenue and Eldridge Avenue
- **Site activity:** Public access
- **Nearest drinking water/sanitary facilities:** Drinking water used by residents in surrounding neighborhood are on public water. No drinking water wells in area.
- **Nearest telephone:** Cell phone coverage is available across most of the site

1.5 PROJECT MANAGER AND OTHER KEY CONTACTS

Title	Name (Affiliation)	Work Telephone	Home Telephone
Project manager	Mark Herrenkohl	(360) 756-9296 or cell (360) 319-0216	(360) 647-6980
Client/Facility contact	Tim Wahl	(360) 676-6985	(360) 671-2583

1.6 DEFINITIONS

Contamination Reduction Zone	Area between the exclusion and support zones that provides a transition between contaminated in clean zones (CRZ).
Exclusion Zone	Any portions of the site where hazardous substances are present, or are reasonably suspected to be present, and pose an exposure hazard to personnel (EZ).
HAZWOPER	Hazardous Waste Operations and Emergency Response standard, as described in 29 CFR 1910.120.
Support Zone	All areas of the site outside the exclusion and contaminant reduction zones (SZ).
WISHA	Washington Industrial Safety and Health Act, as described in Chapter 49.17 Revised Code of Washington.

2 CHEMICAL HAZARD EVALUATION

Potentially hazardous chemicals known to exist at the site in soil, surface sediments, groundwater, and surface water are polycyclic aromatic hydrocarbons (PAHs), pentachlorophenol (PCP) and associated total petroleum hydrocarbons (TPH), phthalates, dioxins/furans, and metals associated with previous operations at or in the vicinity of the site. In addition, nitric acid will be used to preserve some of the aqueous samples and methanol and hexane may be used in the equipment decontamination process. The chemicals of concern, applicable chemical properties, and exposure routes are presented in the following sections.

Chemical Properties

Chemical of Concern	Concentration (site maximum or expected)	Medium	OSHA PEL or NIOSHREL*	OSHA STEL or NIOSH STEL*	OSHA IDLH	Odor Threshold	IP(eV)	Carcinogen or Other Hazard
Aluminum	1.61 mg/L	SW	10 mg/m^3	----	----	Odorless	----	
Antimony	36 mg/kg 8.3 mg/kg	SS SD	0.5 mg/m^3	----	50 mg/m^3	----	----	
Arsenic	150 mg/kg 30.9 mg/kg 0.0011 mg/L	SS SD SW	0.002 mg/m^3	----	5 mg/m^3	Odorless	----	Ca, P
Barium	510 mg/kg 160 mg/kg 0.112 mg/L 0.0868 mg/L	SS SD SW GW	----	----	----	----	----	
Benzoic Acid	2.8 mg/kg 8.24 mg/kg	SS SD	----	----	----	----	----	
Benzyl Alcohol	1.1 mg/kg 6.29 mg/kg 0.0098 mg/L	SS SD GW	----	----	----	----	----	
Bis(2-ethylhexyl)phthalate	6.18 mg/kg 2.04 mg/kg	SS SD SW	5 mg/m^3	10 mg/m^3	5000 mg/m^3	Slight odor		Ca
Butylbenzylphthalate	0.666 mg/kg 0.508 mg/kg	SS SD	----	----	----	----	----	
Cadmium (dust)	0.00047 mg/L	GW	0.005 mg/m^3	----	9 mg/m^3	----	----	Ca
Chromium	249 mg/kg	SD	0.5 mg/m^3	----	250 mg/m^3	Odorless	----	Ca, P

Chemical Properties (continued)

Chemical of Concern	Concentration (site maximum or expected)	Medium	OSHA PEL or NIOSHREL*	OSHA STEL or NIOSH STEL*	OSHA IDLH	Odor Threshold	IP(eV)	Carcinogen or Other Hazard
Cobalt	115 mg/kg	SD	0.05 mg/m^3	----	20 mg/m^3	Odorless	----	
Copper	92 mg/kg 104 mg/kg 0.0109 mg/L	SS SD SW	1 mg/m^3	----	100 mg/m^3	Odorless	----	
Dibenzofuran	9.9 mg/kg 1.1 mg/kg 0.490 mg/L	SS SD GW	----	----	----	----	----	
2,4-Dimethylphenol	0.077 mg/kg 0.22 mg/kg	SS SD	----	----	----	----	----	
Dimethylphthalate	4.91 mg/kg	SD	5 mg/m^3	----	2000 mg/m^3	Aromatic odor	9.64	
Dioxins (TEQ)	0.0024 mg/kg 0.0010 mg/kg 1.65E-7 mg/L	SS SD SW	----	----	----	----	----	Ca
Hexane	Concentrated	Decon.	50 ppm	----	1,100 ppm	Gasoline-like odor	10.18	
Iron	24,700 mg/kg 1.53 mg/L	SD SW	----	----	----	----	----	
Lead	170 mg/kg 70 mg/kg 0.00415 mg/L	SS SD SW	0.050 mg/m^3	----	100 mg/m^3	Odorless	----	SCa, P
Magnesium	26.2 mg/L 21.4 mg/L	SW GW	----	----	----	----	----	

Chemical Properties (continued)

Chemical of Concern	Concentration (site maximum or expected)	Medium	OSHA PEL or NIOSHREL*	OSHA STEL or NIOSH STEL*	OSHA IDLH	Odor Threshold	IP(eV)	Carcinogen or Other Hazard
Manganese	1,400 mg/kg 0.176 mg/L 0.420 mg/L	SS SW GW	1 mg/m^3	3 mg/m^3	500 mg/m^3	----	----	
Mercury	0.33 mg/kg 0.198 mg/kg	SS SD	0.05 mg/m^3	----	10 mg/m^3	Odorless	----	P
Methanol	Concentrated	Decon.	200 ppm	250 ppm	6,000 ppm	Pungent odor	10.84	
Nickel	50 mg/kg 139 mg/kg	SS SD	0.015 mg/m^3	----	10 mg/m^3	Odorless	----	
Nitric Acid	Concentrated	Pres.	2 ppm	4 ppm	25 ppm	0.27-1.0 ppm	11.95	P, R, Cor
Pentachlorophenol	5.96 mg/kg 4.73 mg/kg 0.112 mg/L	SS SD SW	0.5 mg/m^3 (skin)	----	2.5 mg/m^3	Benzene-like odor	----	SCa
PAHs (total) coal tar pitch volatiles	934.4 mg/kg 429 mg/kg 0.400 mg/L 8.032 mg/L	SS SD SW GW	0.1 mg/m^3	----	80 mg/m^3	----	----	Ca
Selenium	3.4 mg/kg	SS	0.2 mg/m^3	----	1 mg/m^3	----	----	
Silver	0.7 mg/kg 30 mg/kg	SS SD	0.01 mg/m^3	----	10 mg/m^3	----	----	
Vanadium	77 mg/kg 69 mg/kg	SS SD	----	----	----	----	----	

Chemical Properties (continued)

Chemical of Concern	Concentration (site maximum or expected)	Medium	OSHA PEL or NIOSHREL*	OSHA STEL or NIOSH STEL*	OSHA IDLH	Odor Threshold	IP(eV)	Carcinogen or Other Hazard
Zinc	610 mg/kg 360 mg/kg	SS SD	----	----	----	----	----	

Notes:	--	none established or not applicable
	*	NIOSH REL or STEL listed if lower then OSHA PEL or STEL
	Ca	carcinogen
	Cor	corrosive
	Decon	decontamination
	P	poison
	GW	groundwater
	R	reactive
	IDLH	immediately dangerous to life and health
	NIOSH	National Institute for Occupational Safety and Health
	OSHA	Occupational Safety and Health Administration
	PEL	permissible exposure level
	REL	recommended exposure limits (NIOSH)
	Pres.	preservative
	IP(eV)	ionization potential
	SCa	suspected carcinogen
	SD	sediment
	SS	surface and/or subsurface soil
	STEL	short-term exposure level
	SW	surface water

Chemical Characteristics and Exposure Routes

The following table summarizes the chemical characteristics and potential chemical exposure routes at the site. The following abbreviations are used to denote the type of fieldwork:

SD	Surface sediment sampling
SW	Surface water sampling
GW	Groundwater sampling
HA	Hand auger borings
HS	Hollow-stem auger borings
TP	Test pits using a backhoe
SM	Archeological boundary survey (Shell Midden)

	Likely	**Possible**	**Unlikely**
Potential chemical exposure routes at the site:			
Inhalation		X (TP)	X (SW, GW, HA, SD, HS, SM)
Ingestion			X (SD, SW, GW, HA, HS, TP, SM)
Skin absorption		X (SD, SW, GW, HA, HS, TP, SM)	
Skin contact		X (SD, SW, GW, HA, HS, TP, SM)	
Eye contact		X (SD, SW, GW, HA, HS, TP, SM)	

Chemical characteristics:

	Likely	**Possible**	**Unlikely**
Corrosive	X (nitric acid)		X (site chemicals)
Ignitable			X (site chemicals)
Reactive	X (nitric acid,)		X (site chemicals)
Volatile	X (methanol, hexane)		X (site chemicals)
Radioactive			X (site chemicals)
Explosive			X (site chemicals)
Biological agent			X (site chemicals)
Particulates or fibers			X (site chemicals)

If likely, describe: Nitric acid (aqueous sample preservative) is corrosive and reactive. Care should be taken to avoid skin and eye contact. Wear the appropriate PPE when handling sample bottles containing nitric acid (do not overfill bottles). Methanol and hexane are volatile. Wear appropriate PPE when handling or using these chemicals and always use them in a well-ventilated area, preferably outside while standing upwind of the operation.

3 PHYSICAL HAZARD EVALUATION

The following table presents possible physical hazards that are expected to be present during field activities. The following abbreviations are used to denote the type of fieldwork:

SD	Surface sediment sampling
SW	Surface water sampling
GW	Groundwater sampling
HA	Hand auger borings
HS	Hollow-stem auger borings
TP	Test pits using a backhoe
SM	Archeological boundary survey (Shell Midden)

	Yes	**No**	**Proposed Safety Procedure**
Uneven terrain/tripping	**X** (SD, SW, GW, HA, HS, TP, SM)		Use caution, wear properly fitting shoes or boots, keep work area orderly
Heat stress	**X** (SD, SW, GW, HA, HS, TP, SM)		Follow heat stress information (Attachment 4) **Note:** potential for heat stress will depend on season
Cold/hypothermia	**X** (SD, SW, GW, HA, HS, TP, SM)		Keep warm and dry, bring changes of clothes, and do not work in extreme conditions without proper equipment or training. Follow cold stress information (Attachment 4). **Note:** potential for cold/hypothermia will depend on season
Drowning		**X** (HA, SD, HS, SW, GW, TP, SM)	Water onsite is shallow.
Falling objects	**X** (HS, TP)	**X** (SD, SW,GW, HA, SM)	Wear hard hat, stay away from overhead hazards
Noise	**X** (HS, TP)	**X** (SD, GW, SW, HA, SM)	Wear ear protection when working around heavy equipment and other noise sources

	Yes	No	Proposed Safety Procedure
Excavations	**X** (TP)	**X** (SD, SW, GW, HA, HS, SM)	Do not enter excavations greater than 4 ft in depth without evaluation by a qualified person and implementing applicable trenching and excavation safeguards as required by law
Heights		**X** (SD, SW, GW, HA, HS, TP, SM)	Use fall protection (harness, lanyard, or proper railings) when working above 6 ft
Heavy equipment	**X** (TP, HS)	**X** (SD, SW, GW, HA, SM)	Stay back from operating equipment, wear safety vests and hard hats, coordinate with operator
Material handling	**X** (SD, SW, GW, HA, HS, TP, SM)		Lift properly, seek assistance if necessary; do not overfill coolers or boxes
Compressed air equipment		**X** (SD, SW, GW, HA, HS, TP, SM)	Equipment must be equipped with pressure release valves, drains, and gauges
Confined spaces		**X** (SD, SW, GW, HA, HS, TP, SM)	No entry allowed without proper training and completed entry permit
Adverse weather	**X** (SD, SW, GW, HA, HS, TP, SM)		Seek shelter during electrical storms; work in adverse weather conditions only with proper training and equipment
Work in remote areas		**X** (SD, SW, GW, HA, HS, TP, SM)	Use buddy system, carry radio and/or cellular phone; bring sufficient equipment in case of accident or injury (first aid kit, shelter if appropriate)
Biohazard		**X** (SD, SW, GW, HA, HS, TP, SM)	Avoid contact with potential biological or infectious materials; wear gloves, coveralls, and respirator, as appropriate; wash hands and face as soon as possible after contact and before eating or drinking

		Yes	No	Proposed Safety Procedure
Plant/animal hazards		**X** (SD, SW, GW, HA, HS, TP, SM)		Know local hazards and take appropriate precautions
Other	Drill Rigs	**X** (HS)	**X** (SD, SW, GW, HA, TP, SM)	Avoid all pinch points, do not run in electrical storms, stay a safe distance (25 ft) from power lines, level rig

Note: If confined space entry is required, personnel must first obtain a confined space entry permit. Integral personnel are not trained or authorized for confined space entry.

Summary of potential physical hazards posed by proposed site activities:

Activity	Potential Hazard
Surface Water Sampling	Uneven terrain/tripping, heat stress, cold/hypothermia, drowning, material handling, adverse weather
Groundwater Sampling	Uneven terrain/tripping, heat stress, cold/hypothermia, drowning, material handling, adverse weather
Sediment Sampling	Uneven terrain/tripping, heat stress, cold/hypothermia, drowning, material handling, adverse weather
Hollow-stem auger borings	Uneven terrain/tripping, heat stress, cold/hypothermia, drowning, noise, material handling, falling objects, adverse weather
Hand auger borings	Uneven terrain/tripping, heat stress, cold/hypothermia, material handling, adverse weather
Test pit excavations	Uneven terrain/tripping, heat stress, cold/hypothermia, noise, material handling, falling objects, adverse weather
Archeological boundary survey	Uneven terrain/tripping, heat stress, cold/hypothermia, drowning, material handling, adverse weather

4 PERSONAL PROTECTIVE EQUIPMENT AND SAFETY EQUIPMENT

The following sections address personal protective equipment (PPE) and safety equipment required for completing the field activities.

4.1 PERSONAL PROTECTIVE EQUIPMENT

Based on the hazards identified above, the following table identifies the personal protective equipment required for the site activities.

	Level of Protection	
Task	**Initial**	**Contingency**
Hollow-stem auger borings	Modified D	Leave Site, assess situation
Hand auger borings	D	Modified D (Leave Site, assess situation)
Surface sediment sampling	Modified D	Leave Site, assess situation
Surface water sampling	Modified D	Leave Site, assess situation
Groundwater sampling	Modified D	Leave Site, assess situation
Test Pits	D	Modified D (Leave Site, assess situation)
Archeological boundary survey	D	Modified D
Sample processing	D	Modified D
Other activities (list)		

Each level of protection will incorporate the following personal protective equipment:

Level D:	☒	Long pants and shirt or work coveralls. Hard hat if there is overhead hazard, latex or nitrile gloves, work boots and eye protection. Hearing protection as needed.
Level Modified D:	☒	Same as Level D with addition of rain gear or chemical protective coveralls (coated Tyvek or equivalent) and steel-toed rubber boots.
Level C:	☐	Same as Level D with chemical protective coveralls **[coated tyvek]**, gloves **[latex or nitrile]**, and half face or full-face air purifying respirator with **[Particulate] cartridge.**

4.1.1 Respirator and Respirator Cartridge Information

Is there potential for a respirator to be donned during fieldwork? **No**

4.2 SAFETY EQUIPMENT

The following safety equipment will be onsite during the proposed field activities.

Air Monitoring (check the items required for this project)

☒ PID/FID
☐ CG/O_2 meter
☐ H_2S meter
☐ Detector pump and tubes
☐ Air sampling pumps
☐ Miniram
☐ Radiation meter
☐ Other: ____________________

First Aid Kit (mandatory, including adhesive band-aids, gauze, tape, gloves, CPR shield, triangle bandage)

(check additional items required for the site)

☒ Emergency blanket
☒ Insect repellent
☒ Sunscreen
☐ Other: ____________________
____

Other (check the items required for this project)

- ☒ Eyewash
- ☒ Drinking water
- ☐ Stopwatch for monitoring heart rate
- ☐ Thermoscan thermometer for heat stress monitoring
- ☐ Survival kit
- ☐ Personal flotation device
- ☐ Cool vests
- ☐ Fit test supplies
- ☒ Fire extinguisher (drill rigs and backhoes)
- ☐ Windsock
- ☒ Cellular phone
- ☐ Radio
- ☒ Global positioning system
- ☐ Other: ____________________

5 AIR MONITORING

Air monitoring will be conducted when entering previously uncharacterized sites, when working in the vicinity of uncontaminated chemicals or spills, when opening containers and well casings, and prior to opening and entering confined spaces. Air monitoring must be conducted to identify potentially hazardous environments and determine reference or background concentrations. Air monitoring will be used to define exclusion zones. Air monitoring may also be conducted to evaluate the concentration of chemicals in samples.

No air monitoring will be performed during hand augering, archeological boundary surveying, hollow-stem auger drilling, sediment sampling, groundwater sampling, or surface water sampling activities. The constituents of potential concern (COPCs) at the site are generally not volatile (i.e., PAHs, dioxins, PCP and associated TPH, and metals). There is virtually no chance for the COPCs to become airborne in a dust form during these activities because the work will be conducted in wet soils or sediments in or along Little Squalicum Creek. In addition, groundwater beneath the site is very close to the ground surface. If conditions are encountered that appear to be a health and safety risk, employees will evacuate the site and discuss the situation with the project manager and Integral's corporate health and safety officer. Air monitoring equipment will be available on site if required.

The test pit excavations will be conducted in the vicinity of the former sand and gravel quarry. COPCs are not expected to be present in this area. Shallow groundwater is also close to the ground surface in this area, so airborne dust is not expected to be an issue. Some municipal landfill materials could be present in the vicinity of the former sand and gravel quarry. As a precaution, periodic air monitoring with an OVM will be conducted while excavating the test pits. However, it is not anticipated that volatile organic compounds will be encountered in this area. If the action level listed below is exceeded, employees will evacuate the site and discuss the situation with the project manager and Integral's corporate health and safety officer.

Monitoring Instrument	**Calibration Frequency**	**Parameters of Interest**	**Monitoring Frequency**
OVM (test pit excavations only)	Daily	Organic vapors	Periodic

The following action levels have been established to determine the appropriate level of personal protection to be used during site investigation activities:

Instrument	**Reading**	**Action**[a]	**Comments**
OVM (test pit excavations only)	Sustained 5 ppm over background for over 1 minute	Retreat to upwind direction and assess situation	If readings do not decrease, leave site and reassess situation

[a] Examples: "upgrade to Level C" or "leave site."

6 HEALTH AND SAFETY TRAINING AND EMERGENCY PLANNING

6.1 HEALTH AND SAFETY TRAINING

State and federal laws establish training requirements for workers at uncontrolled hazardous waste sites (including areas where accumulations of hazardous waste create a threat to the health and safety of an individual, the environment, or both).

6.1.1 Training Requirements

Integral and subcontractor personnel will be required to complete the following training requirements prior to working at the site.

Task	No Training	24-hour	40-hour	8-Hour Supervisor	First Aid/CPR	Medical Monitoring
Field Scientists						
Surface Sediment Sampling			X	X*	X**	X
Surface Water Sampling			X	X*	X**	X
Groundwater Sampling			X	X*	X**	X
Hand auger borings			X	X*	X**	X
Hollow-Stem Auger Borings			X	X*	X**	X
Test Pits			X	X*	X**	X
Archeological Surveys			X	X*	X**	X
Contractors						
Excavators			X			X
Drillers			X			X

Comments

*At least one person onsite must be OSHA HAZWOPER supervisor trained.
**At least one person onsite must be first aid/CPR trained.

6.1.2 Medical Monitoring

OSHA and WISHA require medical monitoring for personnel potentially exposed to chemical hazards in concentrations in excess of the PEL for more than 30 days per year and for personnel who must use respiratory protection for more than 30 days per year. Integral requires medical monitoring for all employees potentially exposed to chemical hazards.

Will personnel working at this site be enrolled in a medical monitoring program? Yes __X__ No _____

6.2 SITE SAFETY MEETINGS

Site safety meetings must be held before beginning new tasks or when new staff enter the site. Site safety meetings should be held at a minimum of once a week and should be held daily on large projects. Additional meetings will be held anytime health and safety concerns are raised by any of the personnel. Attendance and topics covered are to be documented in the field logbook.

6.3 EMERGENCY PLANNING

In case of any emergency affecting the site, all affected personnel must immediately evacuate the work area and report to the site safety officer at the following predetermined location.

DESIGNATED ASSEMBLY LOCATION:

The intersection of Lindbergh Avenue and Eldridge Avenue (Entrance to Little Squalicum Park).

In case of injury, field personnel should take precautions to protect the victim from further harm and notify local or facility emergency services. In remote areas, it will be necessary to have first aid-trained personnel on the field team. The victim may require decontamination prior to treatment—requirements will vary based on site conditions.

Emergency medical care will be provided by:

☒ Local emergency medical provider (i.e., fire department)
☐ Facility emergency medical provider
☒ First aid-trained field staff (for remote areas only)

Local Resources	**Name**	**Telephone**	**Notified Prior to Work (Yes/No)?**
Fire	Bellingham Fire Department	911	No
Police	City of Bellingham Police Department	911	No
Ambulance		911	No
Hospital	St Joseph Hospital	360-734-5400	No
Site phone	Field cell phone	To be announced	N/A

Directions to hospital: Consult the map provided in Attachment 1. Start out going SOUTHEAST on Eldridge avenue toward Gilligan Way (1.2 miles). Turn LEFT onto Broadway (0.9 miles). Turn LEFT onto Cornwall Avenue (0.1 miles). Turn RIGHT onto Plymouth Drive (<0.1 miles). Turn LEFT onto Coolidge Drive (0.2 miles). Turn LEFT on Squalicum Parkway (<0.1 miles). End at St. Joseph Hospital (2901 Squalicum Parkway, Bellingham, WA).

Corporate Resources	**Name**	**Work Telephone**	**Home Telephone**
Integral Consulting Health and Safety Officer	Eron Dodak	(503) 284-5545 Ext. 14 Cell: (503) 407-2933	(503) 293-5471
Medical consultant	Dr. Calvin T. Jones	(425) 806-5758	NA

In case of serious injuries, death, or other emergency, the Integral Consulting health and safety officer must be notified immediately. To contact the Integral Consulting health and safety officer (or delegate), try calling the phone numbers listed above.

Other Resources	**Agency Name/Location**	**Telephone**
Local Fed OSHA office	OSHA/Bellevue Area Office	(206) 553-7520
State OSHA equivalent	Washington Industrial Safety and Health Act (WISHA)	(800) 423-7233

7 WORK ZONES AND TASK DESCRIPTIONS

Site control measures in work zones and task descriptions are listed below for each type of field activities. A full task description is presented in the SAP for the site.

7.1 SURFACE SEDIMENT SAMPLING

Shallow (4 inches deep) surface sediment samples will be collected from seven locations in Little Squalicum Creek and appropriate reference locations (e.g., Whatcom Creek) using a stainless steel shovel, trowel, or spoon.

Exclusion zone: The area immediately around the sampling activities will be marked (at the shoreline) with orange traffic cones (at an approximate 6 ft radius around the sediment sampling location).

Contamination reduction zone (CRZ): N/A. All activities will occur within the exclusion zone.

Support zone: N/A. All activities will occur within the exclusion zone.

Controls to be used to prevent entry by unauthorized persons: Sampling staff will police the area for people approaching the exclusion zone. All people will be instructed to remain outside of the marked area.

7.2 SURFACE WATER SAMPLING

Surface water samples will be collected from seven locations in Little Squalicum Creek and at least one reference sample (e.g., Whatcom Creek) by immersing the sample containers directly into the water or by peristaltic pump.

Exclusion zone: The area immediately around the sampling activities (at the shoreline) will be marked with orange traffic cones (at an approximate 6 ft radius around the surface water sampling location).

Contamination reduction zone (CRZ): N/A. All activities will occur within the exclusion zone.

Support zone: N/A. All activities will occur within the exclusion zone.

Controls to be used to prevent entry by unauthorized persons: Sampling staff will police the area for people approaching the exclusion zone. All people will be instructed to remain outside of the marked area.

7.3 GROUNDWATER SAMPLING

Groundwater samples will be collected from three locations in Little Squalicum Park and a background location by bailer or peristaltic pump.

Exclusion zone: The area immediately around the sampling activities will be marked with orange traffic cones (at an approximate 6 ft radius around the groundwater sampling location).

Contamination reduction zone (CRZ): N/A. All activities will occur within the exclusion zone.

Support zone: N/A. All activities will occur within the exclusion zone.

Controls to be used to prevent entry by unauthorized persons: Sampling staff will police the area for people approaching the exclusion zone. All people will be instructed to remain outside of the marked area.

7.4 HOLLOW-STEM AUGER BORINGS

Six transects of shallow (5 ft deep) borings will be advanced across the Little Squalicum Creek bed using a track-mounted hollow-stem auger drill rig.

Exclusion zone: The area immediately around the drilling activities (i.e., on the shore) will be marked with orange traffic cones (a minimum of 20 feet from the drill rig).

Contamination reduction zone (CRZ): N/A. All activities will occur within the exclusion zone.

Support zone: N/A. All activities will occur within the exclusion zone.

Controls to be used to prevent entry by unauthorized persons: Sampling staff will police the area for people approaching the exclusion zone. All people will be instructed to remain outside of the marked area.

7.5 HAND AUGER BORINGS

Shallow (2 ft deep) hand auger borings will be advanced at eight locations within Little Squalicum Park and one reference location (e.g., Whatcom Creek).

Exclusion zone: The area immediately around the hand augering activities will be marked with orange traffic cones (a minimum of 6 feet from the hand auger station).

Contamination reduction zone (CRZ): N/A. All activities will occur within the exclusion zone.

Support zone: N/A. All activities will occur within the exclusion zone.

Controls to be used to prevent entry by unauthorized persons: Sampling staff will police the area for people approaching the exclusion zone. All people will be instructed to remain outside of the marked area.

7.6 TEST PITS

Twelve shallow test pits (approximately 4 ft deep) will be advanced in the vicinity of the former sand and gravel quarry using a backhoe.

Exclusion zone: The area immediately around the excavating activities will be marked with orange traffic cones (a minimum of 20 feet from the backhoe).

Contamination reduction zone (CRZ): N/A. All activities will occur within the exclusion zone.

Support zone: N/A. All activities will occur within the exclusion zone.

Controls to be used to prevent entry by unauthorized persons: Sampling staff will police the area for people approaching the exclusion zone. All people will be instructed to remain outside of the marked area.

7.7 ARCHEOLOGICAL BOUNDARY SURVEY

Shallow (0.5-1 ft deep) holes will be excavated with a hand shovel surrounding a shell midden located in the western portion of Little Squalicum Park. Other archeological deposits may also be surveyed, if observed.

Exclusion zone: The area immediately around the sampling activities will be marked with orange traffic cones (a minimum of 6 feet from the shell midden).

Contamination reduction zone (CRZ): N/A. All activities will occur within the exclusion zone.

Support zone: N/A. All activities will occur within the exclusion zone.

Controls to be used to prevent entry by unauthorized persons: Sampling staff will police the area for people approaching the exclusion zone. All people will be instructed to remain outside of the marked area.

8 DECONTAMINATION

To prevent the distribution of contaminants outside the exclusion zone and to prevent the cross-contamination of samples, the following procedures will be used to decontaminate sampling equipment. In addition, personal hygiene guidelines should be followed to prevent personnel from coming into contact with contaminants during or after leaving the site.

8.1 DECONTAMINATION PROCEDURES

The procedures are broken into two categories of fieldwork, sediment/soil sampling/archeological surveying and surface water/groundwater sampling.

8.1.1 Soil and Sediment Sampling

After the soil or sediment sampling has been completed at each station, the exclusion zone will become the Contamination Reduction Zone. The hollow-stem augers and sampling equipment will be decontaminated prior to moving to a new station. All excess soil cuttings will be returned to the location where they were collected, in accordance with the SAP.

All non-disposable components of the soil and sediment sampling equipment (e.g., split spoon sampler, sediment samplers, etc.), or other equipment used to collect soil or sediment samples that contacts the soil will be decontaminated using the following steps:

- Potable water rinse
- Alconox/Liquinox detergent wash
- Potable water rinse
- Deionized (DI) water rinse
- Air dry.

If non-aqueous phase liquids are encountered in the soils/sediments, the following extra steps may be included in decontaminating equipment:

- Potable water rinse
- Alconox/Liquinox detergent wash
- Potable water rinse
- DI water rinse
- Methanol to remove water

- Hexane to remove non-aqueous phase liquid (NAPL) film
- Final DI water rinse.

If decontamination requiring the use of methanol and hexane is necessary, it will be performed in a well-ventilated area. To the extent possible, personnel will stand in an upwind direction while decontaminating with methanol and hexane to avoid exposure to these chemicals.

Decontamination wastewaters containing solvents (i.e., methanol and hexane) will be placed in properly labeled DOT-approved containers for offsite disposal, consistent with the SAP. The solvent waste will be disposed of in compliance with applicable regulations. Decontamination wastewaters that do not contain solvents (i.e., wash and rinse waters) will be poured directly on the ground surface near the processing area.

Gross contamination will be cleaned from PPE prior to removal from personnel and will be placed in a garbage bag for proper disposal at a solid waste landfill.

8.1.2 Surface Water and Groundwater Sampling

After the surface water and groundwater sampling is completed, the exclusion zone will become the CRZ. The sampling equipment will be decontaminated prior to moving to the next sample station.

All sampling equipment that is used in surface water and groundwater sampling will be decontaminated using the following steps:

- Potable water rinse
- Alconox/Liquinox detergent wash
- Potable water rinse
- DI water rinse
- Air dry

Decontamination wastewaters will be poured on the ground near the processing area, consistent with the SAP.

8.2 PERSONAL HYGIENE

The following personal hygiene practices will be used at the site to reduce exposure to chemicals.

- Long hair will be secured away from the face so it does not interfere with any activities.

- All personnel leaving potentially contaminated areas will wash their hands, forearms, and faces prior to entering any clean areas or eating areas.
- Personnel leaving potentially contaminated areas will shower (including washing hair) and change to clean clothing as soon as possible after leaving the site.
- No person will eat, drink, or chew gum or tobacco in potentially contaminated areas. Drink containers and drinking of replacement fluids for heat stress control will be permitted only in areas that are free from contamination. Smoking is prohibited in all areas of the site because of the potential for contaminating samples and for health and safety reasons.

9 VEHICLE SAFETY, SPILL CONTAINMENT, AND SHIPPING INSTRUCTIONS

9.1 VEHICLE SAFETY

Integral’s vehicle safety program requires the following:

- All vehicles are to be operated in a safe manner and in compliance with statutory traffic regulations and ordinances
- Operators are to practice defensive driving and drive in a courteous manner
- Operators are required to have a valid driver’s license and liability insurance (per local state laws)
- Seat belts are to be worn by the driver and all passengers
- No persons are allowed to ride in the back of any trucks or vans, unless equipped with seatbelts.
- Vehicles are to be driven in conformance with local speed limits
- Personnel who are impaired by fatigue, illness, alcohol, illegal or prescription drugs, or who are otherwise physically unfit, are not allowed to drive
- Personnel are to avoid using cellular phones or engaging in other distractions while driving
- All Integral-owned field vehicles are to be maintained in a safe and clean condition
- All Integral-owned field vehicles are to be equipped with the following:
  - First-aid kit
  - Fire extinguisher
  - Flares
  - Spare tire and jack
  - Other equipment as required for the project (e.g., tire chains, towing cable, tools, cellular phone or radio)
- Motor vehicle accidents are to be reported to the responsible law enforcement agency, the Integral Consulting Inc. human resources manager, and the Integral Consulting Inc. health and safety manager
- Employees who have experienced work-related vehicle accidents or citations may be required to complete a defensive driving program.

9.2 SPILL CONTAINMENT

Provisions must be made for spill containment at any site where bulk liquids will be handled.

Will the proposed fieldwork include the handling of bulk liquids, oil, or chemicals (other than water)?	Yes ______ No X
If yes, describe spill containment provisions for the site:	______

9.3 SHIPPING INFORMATION

Federal laws and international guidelines place restrictions on what materials may be shipped by passenger and cargo aircraft. In the course of this field investigation, the following items will be shipped to and from the site in the following manner:

Item	Hazardous Constituent	Quantity	Packaging	How Shipped
Samples	Dioxins, PAHs, TPH, PCP, Metals	Approx. 100 soil/sediment samples; 10 surface water samples; 10 groundwater samples	Coolers	Field vehicle or FedEx
Solvents (Hexane)	Hexane	4 liters	Glass jug in protective casing	Field vehicle
Solvents (Methanol)	Methanol	4 liters	Plastic jug	Field vehicle
Calibration gas (name)				
Preservatives (name)				
Other:				

A 24-hour emergency response number (on any shipping documents such as a Uniform Hazardous Waste Manifest, Shipper's Declaration of Dangerous Goods, etc.) is required for shipments of all dangerous or hazardous goods. Integral does not have a 24-hour emergency contact number for dangerous or hazardous goods shipment. No dangerous or hazardous goods may be shipped by Integral until an account is set up with a 24-hour emergency response service such as CHEM-TEL (1-813-248-0573). If any hazardous or dangerous goods need to be shipped for a project, they must be shipped directly to the site by the supplier. Any hazardous or dangerous goods that are not used in the course of the field effort must remain at the site.

10 TASK-SPECIFIC SAFETY PROCEDURES

The following sections contain additional safety procedures that are specific to some of the field tasks.

10.1 SURFACE WATER, SEDIMENT SAMPLING, ARCHEOLOGICAL SURVEYS

Some of the station locations may contain mud. If necessary, use a pole to probe ahead to assess the stability of the shoreline. If you get stuck in the mud, do not struggle because this will cause deeper sinking. If you get stuck in the mud, roll on your back and spread your weight evenly while trying slide to firmer ground.

Keep in contact with another person when collecting surface water samples through the buddy system (or a cell phone if working alone).

10.2 HOLLOW-STEM AUGER DRILLING

Confirm the absence of underground and overhead utilities before moving to a drilling location. Be sure that all utilities are marked or have a designation that they are not present in the area. The one-call (1-800-424-5555) utility locating representatives for Washington should have notified you of all utilities present in the area. Take a few minutes to examine the locations of fire hydrants, gas meters, etc. to make sure that the utility locating marks make sense. The borehole location must be at least 3 ft (greater for some utilities) from underground utilities. If there is any doubt as to the location of underground utilities, call the public or a private utility locator. Another precaution that can be used is to hand auger the first 3 ft of the borehole to confirm the absence of shallow utilities. Finally, check for overhead utilities and obstructions such as trees.

Set up the borehole logging table at least 20 ft from the drill rig and be aware of what the drillers are doing at all times. Always wear a hard hat, safety glasses, steel-toed boots, and earplugs when working around a drill rig. Avoid getting soil or groundwater on your clothes or skin. Exercise care when lifting, assembling, and decontaminating soil samplers, as they can be cumbersome to manipulate.

10.3 TEST PIT EXCAVATIONS

Confirm the absence of underground and overhead utilities before moving to an excavation station. Be sure that all utilities are marked or have a designation that they are not present in the area. The one-call (1-800-424-5555) utility locating representatives of Washington should have notified you of all utilities present in the area. Take a few minutes to examine the locations of fire hydrants, gas meters, etc. to make sure that the utility locating marks make sense. If there is any doubt as to the location of underground utilities, call the public or a private utility locator. Finally, check for overhead utilities and obstructions such as trees.

Avoid all backhoe pinch points and stay a safe distance from the backhoe. Always wear a traffic safety vest and be sure the backhoe operator is in visual contact with you at all times. Do not ride on the excavating equipment or ride in the backhoe bucket to collect samples. If materials need to be closely examined, ask the backhoe operator to collect a sample of the material with the backhoe bucket. Do not enter any excavations greater than 4 ft deep. All excavations are to be backfilled before leaving the site. It is critical to police the exclusion zone and keep all unauthorized individuals a safe distance away from the work.

10.4 GROUNDWATER SAMPLING

The groundwater sampling task includes water level collection, well purging, sample collection, and decontamination.

Drive as close to each monitoring well or piezometer as is practicable, and then approach on foot. Exercise care when carrying heavy equipment to the wells. If well purging is done with a bailer, keep your back straight during purging activities and take breaks as needed. Use proper lifting techniques when transferring purge water into 55 gallon drums or equivalent containers.

Always wear nitrile gloves when handling sampling equipment, samples, or purge/decontamination water. Avoid splashing purge or decontamination water onto your clothes or skin. Avoid getting sample container preservative (i.e., nitric acid) on your skin or clothes.

ATTACHMENT 1. SITE MAP AND HOSPITAL ROUTE

	Directions	**Distance**
START	**1.** Start out going SOUTHEAST on ELDRIDGE AVE toward GILLIGAN WAY.	1.2 miles
←	**2.** Turn LEFT onto BROADWAY.	0.9 miles
←	**3.** Turn LEFT onto CORNWALL AVE.	0.1 miles
→	**4.** Turn RIGHT onto PLYMOUTH DR.	<0.1 miles
←	**5.** Turn LEFT onto COOLIDGE DR.	0.2 miles
←	**6.** Turn LEFT onto SQUALICUM PKWY.	<0.1 miles
END	**End at St Joseph Hospital 360-734-5400** **2901 Squalicum Pkwy, Bellingham, WA 98225 US**	

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Start:
Lindbergh Ave & Eldridge Ave
Bellingham, WA
98225 US

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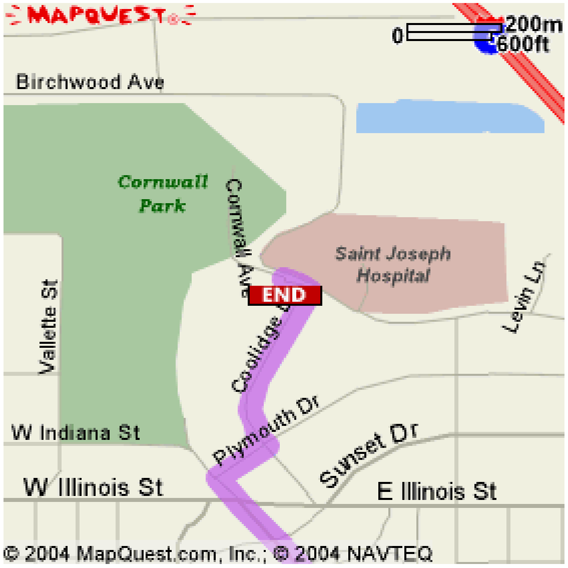
End:
St Joseph Hospital 360-734-5400
2901 Squalicum Pkwy
Bellingham, WA
98225 US



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ATTACHMENT 2. REGULATORY NOTICES

You Have a Right to a Safe and Healthful Workplace.

IT'S THE LAW!

- You have the right to notify your employer or OSHA about workplace hazards. You may ask OSHA to keep your name confidential.
- You have the right to request an OSHA inspection if you believe that there are unsafe and unhealthful conditions in your workplace. You or your representative may participate in the inspection.
- You can file a complaint with OSHA within 30 days of discrimination by your employer for making safety and health complaints or for exercising your rights under the *OSH Act.*
- You have a right to see OSHA citations issued to your employer. Your employer must post the citations at or near the place of the alleged violation.
- Your employer must correct workplace hazards by the date indicated on the citation and must certify that these hazards have been reduced or eliminated.
- You have the right to copies of your medical records or records of your exposure to toxic and harmful substances or conditions.
- Your employer must post this notice in your workplace.

The *Occupational Safety and Health Act of 1970 (OSH Act)*, P.L. 91-596, assures safe and healthful working conditions for working men and women throughout the Nation. The Occupational Safety and Health Administration, in the U.S. Department of Labor, has the primary responsibility for administering the *OSH Act*. The rights listed here may vary depending on the particular circumstances. To file a complaint, report an emergency, or seek OSHA advice, assistance, or products, call 1-800-321-OSHA or your nearest OSHA office: • Atlanta (404) 562-2300 • Boston (617) 565-9860 • Chicago (312) 353-2220 • Dallas (214) 767-4731 • Denver (303) 844-1600 • Kansas City (816) 426-5861 • New York (212) 337-2378 • Philadelphia (215) 861-4900 • San Francisco (415) 975-4310 • Seattle (206) 553-5930. Teletypewriter (TTY) number is 1-877-889-5627. To file a complaint online or obtain more information on OSHA federal and state programs, visit OSHA's website at **www.osha.gov**. If your workplace is in a state operating under an OSHA-approved plan, your employer must post the required state equivalent of this poster.

1-800-321-OSHA

www.osha.gov

U.S. Department of Labor • Occupational Safety and Health Administration • OSHA 3165

Usted Tiene el Derecho a un Lugar de Trabajo Seguro y Saludable.

¡LO ESTABLECE LA LEY!

- Tiene el derecho de notificar a su empleador o a la OSHA sobre cualquier peligro en su lugar de trabajo. Puede pedir a la OSHA que mantenga su nombre en reserva.
- Tiene el derecho de solicitar una inspección de la OSHA si considera que existen condiciones peligrosas y poco saludables en su lugar de trabajo. Usted o su representante puede participar en la inspección.
- Puede presentar un reclamo a OSHA durante un plazo de 30 días si su empleador lo discrimina por presentar reclamos de seguridad y sanidad o por ejercer sus derechos de acuerdo con la Ley.
- Tiene el derecho de ver las citaciones de la OSHA enviadas a su empleador. Su empleador debe colocar las citaciones en un lugar visible en el sitio de la supuesta infracción o cerca de él.
- Su empleador debe corregir los peligros en el lugar de trabajo dentro del plazo indicado en la citación y debe certificar que dichos peligros se hayan reducido o eliminado.
- Tiene el derecho de recibir copias de su historial médico o de los registros de su exposición a sustancias o condiciones tóxicas y peligrosas.
- Su empleador debe colocar este aviso en un lugar visible de su lugar de trabajo.

La Ley de Seguridad y Salud Ocupacionales de 1970 (la Ley), P.L. 91-596, garantiza condiciones ocupacionales seguras y saludables para los hombres y las mujeres que desempeñen algún trabajo en toda la Nación. La Administración de Seguridad y Salud Ocupacionales (OSHA), dependiente del Departamento del Trabajo de los Estados Unidos, es la responsable principal de supervisar la Ley. Los derechos que se indican en este documento pueden variar según las circunstancias particulares. Para presentar un reclamo, informar sobre una emergencia o pedir consejo, asistencia o productos de la OSHA, llame al 1-800-321-OSHA o a la oficina de la OSHA más cercana a usted: • Atlanta (404) 562-2300 • Boston (617) 565-9860 • Chicago (312) 353-2220 • Dallas (214) 767-4731 • Denver (303) 844-1600 • Ciudad de Kansas (816) 426-5861 • Nueva York (212) 337-2378 • Filadelfia (215) 861-4900 • San Francisco (415) 975-4310 • Seattle (206) 553-5930. El número TTY es 1-877-889-5627. Para presentar un reclamo en línea u obtener más información sobre los programas federales y estatales de la OSHA, visite el sitio Web de la OSHA en www.osha.gov. Si su lugar de trabajo se encuentra en un estado que funciona según un plan aprobado por la OSHA, su empleador debe colocar en un sitio visible el equivalente estatal de este afiche.

1-800-321-OSHA

www.osha.gov

Departmento del Trabajo de los E.E. UU. • Administracíon de Seguridad y Salud Ocupacionales • OSHA 3167

ATTACHMENT 3. MATERIAL SAFETY DATA SHEETS

MSDS Number: **H2381** * * * * * *Effective Date:* ***08/10/04*** * * * * * *Supercedes:* ***11/02/01***

MSDS Material Safety Data Sheet

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. And Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

J.T.Baker®

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

HEXANE

1. Product Identification

Synonyms: Hexanes,Normal Hexane; Hexyl Hydride; Hexane 95%
CAS No.: 110-54-3 (n-hexane)
Molecular Weight: 86.18
Chemical Formula: CH3(CH2)4CH3 n-hexane
Product Codes: 9262, 9304, 9308, N168

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Hexane	110-54-3	85 - 100%	Yes
Methylcyclopentane	96-37-7	1 - 2%	Yes
Trace amount of Benzene (10 ppm)	071-43-2	*	No

3. Hazards Identification

Emergency Overview

DANGER! EXTREMELY FLAMMABLE LIQUID AND VAPOR. VAPOR MAY CAUSE FLASH FIRE. HARMFUL OR FATAL IF SWALLOWED. HARMFUL IF INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS THE CENTRAL AND PERIPHERAL NERVOUS SYSTEMS.

J.T. Baker SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 2 - Moderate
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 0 - None
Contact Rating: 2 - Moderate
Lab Protective Equip: GOGGLES; LAB COAT; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER
Storage Color Code: Red (Flammable)

Potential Health Effects

The health hazards addressed are for the major component: n-hexane.

Inhalation:
Inhalation of vapors irritates the respiratory tract. Overexposure may cause lightheadedness, nausea, headache, and blurred vision. Greater exposure may cause muscle weakness, numbness of the extremities, unconsciousness and death.
Ingestion:
May produce abdominal pain, nausea. Aspiration into lungs can produce severe lung damage and is a medical emergency. Other symptoms expected to parallel inhalation.
Skin Contact:
May cause redness, irritation, with dryness, cracking.
Eye Contact:
Vapors may cause irritation. Splashes may cause redness and pain.
Chronic Exposure:
Repeated or prolonged skin contact may defat the skin and produce irritation and dermatitis. Chronic inhalation may cause peripheral nerve disorders and central nervous system effects.

Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired respiratory function may be more susceptible to the effects of the substance. May affect the developing fetus.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Call a physician.
Ingestion:
Aspiration hazard. If swallowed, DO NOT INDUCE VOMITING. Give large quantities of water. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Remove any contaminated clothing. Wipe off excess from skin. Wash skin with soap and water for at least 15 minutes. Get medical attention if irritation develops or persists.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper eyelids occasionally. Get medical attention immediately.

Note to Physician:
BEI=2,5-hexadione in urine, sample at end of shift at workweeks end, 5 mg/g creatine.

Also, measure n-hexane in expired air. Analgesics may be necessary for pain management, there is no specific antidote. Monitor arterial blood gases in cases of severe aspiration.

---

5. Fire Fighting Measures

Fire:
Flash point: -23C (-9F) CC
Autoignition temperature: 224C (435F)
Flammable limits in air % by volume:
lel: 1.2; uel: 7.7
Extremely Flammable Liquid and Vapor! Vapor may cause flash fire. Dangerous fire hazard when exposed to heat or flame.
Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Contact with oxidizing materials may cause extremely violent combustion.Explodes when mixed @ 28C with dinitrogen tetraoxide. Sensitive to static discharge.
Fire Extinguishing Media:
Dry chemical, foam or carbon dioxide. Water may be ineffective.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Water spray may be used to keep fire exposed containers cool. Vapors can flow along surfaces to distant ignition source and flash back. Vapor explosion hazard exists indoors, outdoors, or in sewers.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! If a leak or spill has not ignited, use water spray to disperse the vapors, to protect personnel attempting to stop leak, and to flush spills away from exposures. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker SOLUSORB® solvent adsorbent is recommended for spills of this product.

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7. Handling and Storage

Protect against physical damage. Store in a cool, dry well-ventilated location, away from direct sunlight and any area where the fire hazard may be acute. Store in tightly closed containers (preferably under nitrogen atmosphere). Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage room or cabinet. Separate from oxidizing materials. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
N-Hexane [110-54-3]:
-OSHA Permissible Exposure Limit (PEL): 500 ppm (TWA)
-ACGIH Threshold Limit Value (TLV): 50 ppm (TWA), Skin
other isomers of hexane
-ACGIH Threshold Limit Value (TLV): 500 ppm (TWA),1000ppm (STEL)
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Breathing air quality must meet the requirements of the OSHA respiratory protection standard (29CFR1910.134).
Skin Protection:
Wear impervious protective clothing, including boots, gloves, lab coat, apron or coveralls, as appropriate, to prevent skin contact.
Eye Protection:
Use chemical safety goggles and/or a full face shield where splashing is possible. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.
Odor:
Light odor.
Solubility:
Insoluble in water.
Specific Gravity:
0.66
pH:
No information found.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
ca. 68C (ca. 154F)
Melting Point:
ca. -95C (ca. -139F)
Vapor Density (Air=1):
3.0

Vapor Pressure (mm Hg):
130 @ 20C (68F)
Evaporation Rate (BuAc=1):
9

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Heat will contribute to instability.
Hazardous Decomposition Products:
May produce acrid smoke and irritating fumes when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Strong oxidizers.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

N-Hexane: Oral rat LD50: 28710 mg/kg. Irritation eye rabbit: 10 mg mild. Investigated as a tumorigen, mutagen and reproductive effector.

--------\Cancer Lists\---

	---NTP Carcinogen---		
Ingredient	Known	Anticipated	IARC Category
Hexane (110-54-3)	No	No	None
Methylcyclopentane (96-37-7)	No	No	None
Trace amount of Benzene (10 ppm) (071-43-2)	Yes	No	1

12. Ecological Information

Environmental Fate:
When released into the soil, this material may biodegrade to a moderate extent. When released into the soil, this material is not expected to leach into groundwater. When released into the soil, this material is expected to quickly evaporate. When released into water, this material may biodegrade to a moderate extent. When released to water, this material is expected to quickly evaporate. When released into the water, this material is expected to have a half-life between 1 and 10 days. This material has an estimated bioconcentration factor (BCF) of less than 100. This material has a log octanol-water partition coefficient of greater than 3.0. This material is not expected to significantly bioaccumulate. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into the air, this material is expected to have a half-life between 1 and 10 days.
Environmental Toxicity:
No information found.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: HEXANES
Hazard Class: 3
UN/NA: UN1208
Packing Group: II
Information reported for product/size: 215L

International (Water, I.M.O.)

Proper Shipping Name: HEXANES
Hazard Class: 3
UN/NA: UN1208
Packing Group: II
Information reported for product/size: 215L

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Hexane (110-54-3)	Yes	Yes	Yes	Yes
Methylcyclopentane (96-37-7)	Yes	Yes	No	Yes
Trace amount of Benzene (10 ppm) (071-43-2)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

		--Canada--		
Ingredient	Korea	DSL	NDSL	Phil.
Hexane (110-54-3)	Yes	Yes	No	Yes
Methylcyclopentane (96-37-7)	Yes	Yes	No	Yes
Trace amount of Benzene (10 ppm) (071-43-2)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

	-SARA 302-		------SARA 313------	
Ingredient	RQ	TPQ	List	Chemical Catg.
Hexane (110-54-3)	No	No	Yes	No
Methylcyclopentane (96-37-7)	No	No	No	No
Trace amount of Benzene (10 ppm) (071-43-2)	No	No	Yes	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Hexane (110-54-3)	5000	No	No
Methylcyclopentane (96-37-7)	No	No	No
Trace amount of Benzene (10 ppm) (071-43-2)	10	U019	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: Yes Fire: Yes Pressure: No
Reactivity: No (Mixture / Liquid)

WARNING:
THIS PRODUCT CONTAINS A CHEMICAL(S) KNOWN TO THE STATE OF CALIFORNIA TO CAUSE CANCER.

Australian Hazchem Code: 3[Y]E
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: **1** Flammability: **3** Reactivity: **0**
Label Hazard Warning:
DANGER! EXTREMELY FLAMMABLE LIQUID AND VAPOR. VAPOR MAY CAUSE FLASH FIRE. HARMFUL OR FATAL IF SWALLOWED. HARMFUL IF INHALED. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS THE CENTRAL AND PERIPHERAL NERVOUS SYSTEMS.
Label Precautions:
Keep away from heat, sparks and flame.
Keep container closed.
Use only with adequate ventilation.
Wash thoroughly after handling.
Avoid breathing vapor or mist.
Avoid contact with eyes, skin and clothing.
Label First Aid:
Aspiration hazard. If swallowed, vomiting may occur spontaneously, but DO NOT INDUCE. If vomiting occurs, keep head below hips to prevent aspiration into lungs. Never give anything by mouth to an unconscious person. Call a physician immediately. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes. In all cases call a physician.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:

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Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is

intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE WITH RESPECT TO THE INFORMATION SET FORTH HEREIN OR THE PRODUCT TO WHICH THE INFORMATION REFERS. ACCORDINGLY, MALLINCKRODT BAKER, INC. WILL NOT BE RESPONSIBLE FOR DAMAGES RESULTING FROM USE OF OR RELIANCE UPON THIS INFORMATION.

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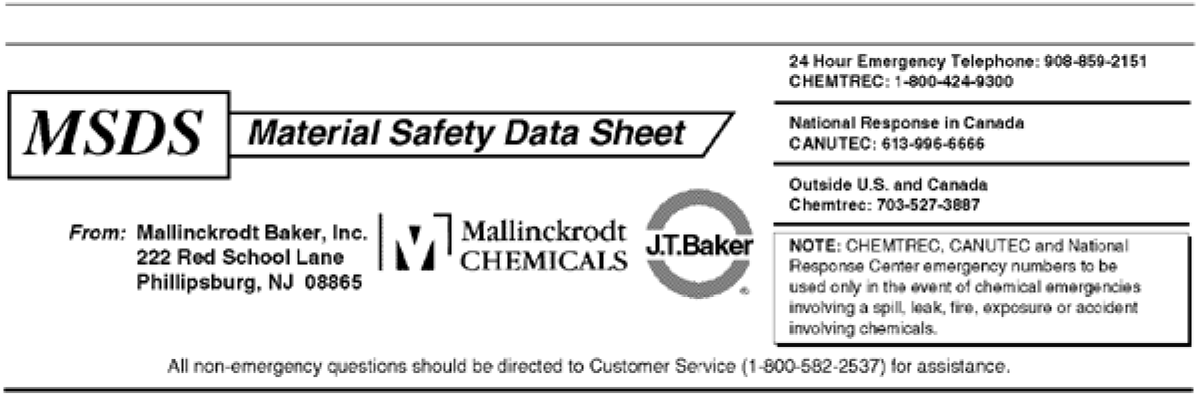
Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **M2015** * * * * * *Effective Date:* ***08/10/04*** * * * * * *Supercedes:* ***11/12/01***



MSDS *Material Safety Data Sheet*

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS

J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

METHYL ALCOHOL

1. Product Identification

Synonyms: Wood alcohol; methanol; carbinol
CAS No.: 67-56-1
Molecular Weight: 32.04
Chemical Formula: CH3OH
Product Codes:
J.T. Baker: 5217, 5370, 5794, 5811, 5842, 5869, 9049, 9063, 9065, 9066, 9067, 9069, 9070, 9071, 9073, 9075, 9076, 9077, 9091, 9093, 9096, 9097, 9098, 9263, 9822, 9830, V654
Mallinckrodt: 3004, 3006, 3016, 3017, 3018, 3024, 3041, 3701, 4295, 5160, 8814, H080, H488, H603, H985, V079, V571

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Methyl Alcohol	67-56-1	100%	Yes

3. Hazards Identification

Emergency Overview

POISON! DANGER! VAPOR HARMFUL. MAY BE FATAL OR CAUSE BLINDNESS IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. CANNOT BE MADE NONPOISONOUS. FLAMMABLE

LIQUID AND VAPOR. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM AND LIVER.

SAF-T-DATA$^{(tm)}$ Ratings (Provided here for your convenience)

Health Rating: 3 - Severe (Poison)
Flammability Rating: 3 - Severe (Flammable)
Reactivity Rating: 1 - Slight
Contact Rating: 3 - Severe (Life)
Lab Protective Equip: GOGGLES & SHIELD; LAB COAT & APRON; VENT HOOD; PROPER GLOVES; CLASS B EXTINGUISHER
Storage Color Code: Red (Flammable)

Potential Health Effects

Inhalation:
A slight irritant to the mucous membranes. Toxic effects exerted upon nervous system, particularly the optic nerve. Once absorbed into the body, it is very slowly eliminated. Symptoms of overexposure may include headache, drowsiness, nausea, vomiting, blurred vision, blindness, coma, and death. A person may get better but then worse again up to 30 hours later.
Ingestion:
Toxic. Symptoms parallel inhalation. Can intoxicate and cause blindness. Usual fatal dose: 100-125 milliliters.
Skin Contact:
Methyl alcohol is a defatting agent and may cause skin to become dry and cracked. Skin absorption can occur; symptoms may parallel inhalation exposure.
Eye Contact:
Irritant. Continued exposure may cause eye lesions.
Chronic Exposure:
Marked impairment of vision has been reported. Repeated or prolonged exposure may cause skin irritation.
Aggravation of Pre-existing Conditions:
Persons with pre-existing skin disorders or eye problems or impaired liver or kidney function may be more susceptible to the effects of the substance.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention immediately.
Skin Contact:
Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper

eyelids occasionally. Get medical attention immediately.

---

5. Fire Fighting Measures

Fire:
Flash point: 12C (54F) CC
Autoignition temperature: 464C (867F)
Flammable limits in air % by volume:
lel: 6.0; uel: 36
Flammable Liquid and Vapor!
Explosion:
Above flash point, vapor-air mixtures are explosive within flammable limits noted above. Moderate explosion hazard and dangerous fire hazard when exposed to heat, sparks or flames. Sensitive to static discharge.
Fire Extinguishing Media:
Use alcohol foam, dry chemical or carbon dioxide. (Water may be ineffective.)
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. Use water spray to blanket fire, cool fire exposed containers, and to flush non-ignited spills or vapors away from fire. Vapors can flow along surfaces to distant ignition source and flash back.

---

6. Accidental Release Measures

Ventilate area of leak or spill. Remove all sources of ignition. Wear appropriate personal protective equipment as specified in Section 8. Isolate hazard area. Keep unnecessary and unprotected personnel from entering. Contain and recover liquid when possible. Use non-sparking tools and equipment. Collect liquid in an appropriate container or absorb with an inert material (e. g., vermiculite, dry sand, earth), and place in a chemical waste container. Do not use combustible materials, such as saw dust. Do not flush to sewer! If a leak or spill has not ignited, use water spray to disperse the vapors, to protect personnel attempting to stop leak, and to flush spills away from exposures. US Regulations (CERCLA) require reporting spills and releases to soil, water and air in excess of reportable quantities. The toll free number for the US Coast Guard National Response Center is (800) 424-8802.

J. T. Baker SOLUSORB® solvent adsorbent is recommended for spills of this product.

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7. Handling and Storage

Protect against physical damage. Store in a cool, dry well-ventilated location, away from any area where the fire hazard may be acute. Outside or detached storage is preferred. Separate from incompatibles. Containers should be bonded and grounded for transfers to avoid static sparks. Storage and use areas should be No Smoking areas. Use non-sparking type tools and equipment, including explosion proof ventilation. Containers of this material may be hazardous when empty since they retain product residues (vapors, liquid); observe all warnings and precautions listed for the product. Do Not attempt to clean empty containers since residue is difficult to remove. Do not pressurize, cut, weld, braze, solder, drill, grind or expose such containers to heat, sparks, flame, static electricity or other sources of ignition: they may explode and cause injury or death.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
For Methyl Alcohol:
- OSHA Permissible Exposure Limit (PEL):
200 ppm (TWA)
- ACGIH Threshold Limit Value (TLV):
200 ppm (TWA), 250 ppm (STEL) skin

Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures below the Airborne Exposure Limits. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details. Use explosion-proof equipment.

Personal Respirators (NIOSH Approved):
If the exposure limit is exceeded and engineering controls are not feasible, wear a supplied air, full-facepiece respirator, airlined hood, or full-facepiece self-contained breathing apparatus. Breathing air quality must meet the requirements of the OSHA respiratory protection standard (29CFR1910.134). This substance has poor warning properties.

Skin Protection:
Rubber or neoprene gloves and additional protection including impervious boots, apron, or coveralls, as needed in areas of unusual exposure.

Eye Protection:
Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

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9. Physical and Chemical Properties

Appearance:
Clear, colorless liquid.
Odor:
Characteristic odor.
Solubility:
Miscible in water.
Specific Gravity:
0.8
pH:
No information found.
% Volatiles by volume @ 21C (70F):
100
Boiling Point:
64.5C (147F)
Melting Point:
-98C (-144F)
Vapor Density (Air=1):
1.1

Vapor Pressure (mm Hg):
97 @ 20C (68F)
Evaporation Rate (BuAc=1):
5.9

10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage.
Hazardous Decomposition Products:
May form carbon dioxide, carbon monoxide, and formaldehyde when heated to decomposition.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Strong oxidizing agents such as nitrates, perchlorates or sulfuric acid. Will attack some forms of plastics, rubber, and coatings. May react with metallic aluminum and generate hydrogen gas.
Conditions to Avoid:
Heat, flames, ignition sources and incompatibles.

11. Toxicological Information

Methyl Alcohol (Methanol) Oral rat LD50: 5628 mg/kg; inhalation rat LC50: 64000 ppm/4H; skin rabbit LD50: 15800 mg/kg; Irritation data-standard Draize test: skin, rabbit: 20mg/24 hr. Moderate; eye, rabbit: 100 mg/24 hr. Moderate. Investigated as a mutagen, reproductive effector.

```
--------\Cancer Lists\------------------------------------------------------
                                        ---NTP Carcinogen---
Ingredient                              Known    Anticipated    IARC Category
------------------------------------    -----    -----------    -------------
Methyl Alcohol (67-56-1)                 No          No             None
```

12. Ecological Information

Environmental Fate:
When released into the soil, this material is expected to readily biodegrade. When released into the soil, this material is expected to leach into groundwater. When released into the soil, this material is expected to quickly evaporate. When released into the water, this material is expected to have a half-life between 1 and 10 days. When released into water, this material is expected to readily biodegrade. When released into the air, this material is expected to exist in the aerosol phase with a short half-life. When released into the air, this material is expected to be readily degraded by reaction with photochemically produced hydroxyl radicals. When released into air, this material is expected to have a half-life between 10 and 30 days. When released into the air, this material is expected to be readily removed from the atmosphere by wet deposition.
Environmental Toxicity:

This material is expected to be slightly toxic to aquatic life.

13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be handled as hazardous waste and sent to a RCRA approved incinerator or disposed in a RCRA approved waste facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

14. Transport Information

Domestic (Land, D.O.T.)

Proper Shipping Name: METHANOL
Hazard Class: 3
UN/NA: UN1230
Packing Group: II
Information reported for product/size: 358LB

International (Water, I.M.O.)

Proper Shipping Name: METHANOL
Hazard Class: 3, 6.1
UN/NA: UN1230
Packing Group: II
Information reported for product/size: 358LB

15. Regulatory Information

```
--------\Chemical Inventory Status - Part 1\---------------------------------
Ingredient                                       TSCA  EC   Japan  Australia
-----------------------------------------------  ----  ---  -----  ---------
Methyl Alcohol (67-56-1)                          Yes  Yes   Yes      Yes

--------\Chemical Inventory Status - Part 2\---------------------------------
                                                        --Canada--
Ingredient                                       Korea  DSL   NDSL  Phil.
-----------------------------------------------  -----  ---   ----  -----
Methyl Alcohol (67-56-1)                          Yes   Yes   No     Yes

--------\Federal, State & International Regulations - Part 1\----------------
                                           -SARA 302-    ------SARA 313------
Ingredient                                 RQ    TPQ     List  Chemical Catg.
-----------------------------------------  ---   -----   ----  --------------
Methyl Alcohol (67-56-1)                   No    No      Yes         No

--------\Federal, State & International Regulations - Part 2\----------------
                                                      -RCRA-    -TSCA-
Ingredient                                 CERCLA     261.33     8(d)
```

```
  -----------------------------------------  ------     ------     ------
  Methyl Alcohol (67-56-1)                   5000       U154       No


Chemical Weapons Convention:  No     TSCA 12(b):  No     CDTA:  No
SARA 311/312:  Acute: Yes      Chronic: Yes  Fire: Yes Pressure: No
Reactivity: No          (Pure / Liquid)
```

Australian Hazchem Code: 2PE
Poison Schedule: S6
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: **1** Flammability: **3** Reactivity: **0**
Label Hazard Warning:
POISON! DANGER! VAPOR HARMFUL. MAY BE FATAL OR CAUSE BLINDNESS IF SWALLOWED. HARMFUL IF INHALED OR ABSORBED THROUGH SKIN. CANNOT BE MADE NONPOISONOUS. FLAMMABLE LIQUID AND VAPOR. CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. AFFECTS CENTRAL NERVOUS SYSTEM AND LIVER.
Label Precautions:
Avoid breathing vapor.
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.
Keep container closed.
Use only with adequate ventilation.
Keep away from heat, sparks and flame.
Label First Aid:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. In case of contact, immediately flush eyes or skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. In all cases get medical attention immediately.
Product Use:
Laboratory Reagent.
Revision Information:
No Changes.
Disclaimer:
****

Mallinckrodt Baker, Inc. provides the information contained herein in good faith but makes no representation as to its comprehensiveness or accuracy. This document is intended only as a guide to the appropriate precautionary handling of the material by a properly trained person using this product. Individuals receiving the information must exercise their independent judgment in determining its appropriateness for a particular purpose. MALLINCKRODT BAKER, INC. MAKES NO REPRESENTATIONS OR WARRANTIES, EITHER EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY WARRANTIES OF

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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

Material Safety Data Sheet

Hydrochloric Acid, 1:1 Aqueous Solution

ACC# 95574

Section 1 - Chemical Product and Company Identification

MSDS Name: Hydrochloric Acid, 1:1 Aqueous Solution
Catalog Numbers: M-043, M043, MCC-030298
Synonyms: Muriatic acid; Chlorohydric acid; Hydrogen chloride; Spirits of salt
Company Identification:
Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410
For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
7647-01-0	Hydrochloric acid	< 20	231-595-7
7732-18-5	Water	Balance	231-791-2

Hazard Symbols: T C
Risk Phrases: 23 35

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: colorless to slight yellow clear liquid. **Danger!** Corrosive. Causes eye and skin burns. May cause severe respiratory tract irritation with possible burns. May cause severe digestive tract irritation with possible burns. May cause fetal effects based upon animal studies. Possible sensitizer.
Target Organs: Respiratory system, teeth, eyes, skin, circulatory system.

Potential Health Effects

Eye: May cause irreversible eye injury. Vapor or mist may cause irritation and severe burns. Contact with liquid is corrosive to the eyes and causes severe burns. May cause painful sensitization to light.
Skin: May be absorbed through the skin in harmful amounts. May cause skin sensitization, an allergic reaction, which becomes evident upon re-exposure to this material. Contact with liquid is corrosive and causes severe burns and ulceration.
Ingestion: May cause circulatory system failure. Causes severe digestive tract burns with abdominal pain, vomiting, and possible death. May cause corrosion and permanent tissue destruction of the esophagus and digestive tract.

Inhalation: May cause severe irritation of the respiratory tract with sore throat, coughing, shortness of breath and delayed lung edema. Causes chemical burns to the respiratory tract. Exposure to the mist and vapor may erode exposed teeth. Causes corrosive action on the mucous membranes.
Chronic: Prolonged or repeated skin contact may cause dermatitis. Repeated exposure may cause erosion of teeth. May cause fetal effects. Laboratory experiments have resulted in mutagenic effects. Prolonged exposure may cause conjunctivitis, photosensitization, and possible blindness.

Section 4 - First Aid Measures

Eyes: Get medical aid immediately. Do NOT allow victim to rub or keep eyes closed. Extensive irrigation with water is required (at least 30 minutes). SPEEDY ACTION IS CRITICAL!
Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Destroy contaminated shoes.
Ingestion: Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately. Give milk of magnesia.
Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If breathing is difficult, give oxygen. Do NOT use mouth-to-mouth resuscitation. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.
Notes to Physician: Do NOT use sodium bicarbonate in an attempt to neutralize the acid.
Antidote: Do NOT use oils or ointments in eye.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Water runoff can cause environmental damage. Dike and collect water used to fight fire. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Not flammable, but reacts with most metals to form flammable hydrogen gas. Use water spray to keep fire-exposed containers cool. Vapors may be heavier than air. They can spread along the ground and collect in low or confined areas. Reaction with water may generate much heat which will increase the concentration of fumes in the air. Containers may explode when heated.
Extinguishing Media: For large fires, use water spray, fog, or alcohol-resistant foam. Substance is nonflammable; use agent most appropriate to extinguish surrounding fire. Do NOT get water inside containers. Do NOT use straight streams of water. Most foams will react with the material and release corrosive/toxic gases. Cool containers with flooding quantities of water until well after fire is out. For small fires, use carbon dioxide (except for cyanides), dry chemical, dry sand, and alcohol-resistant foam.
Flash Point: Not applicable.
Autoignition Temperature: Not applicable.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: 3; Flammability: 0; Instability: 0

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Large spills may be neutralized with dilute alkaline solutions of soda ash (sodium carbonate, $Na2CO3$), or lime (calcium oxide, CaO). Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Remove all sources of ignition. Provide ventilation. Do not get water inside containers. A vapor suppressing foam may be used to reduce vapors. Cover with dry earth, dry sand, or other non-combustible material followed with plastic sheet to minimize spreading and contact with water.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use only in a well-ventilated area. Contents may develop pressure upon prolonged storage. Do not breathe dust, vapor, mist, or gas. Do not get in eyes, on skin, or on clothing. Keep container tightly closed. Do not ingest or inhale. Discard contaminated shoes. Use caution when opening. Keep from contact with moist air and steam.
Storage: Do not store in direct sunlight. Store in a tightly closed container. Store in a cool, dry, well-ventilated area away from incompatible substances. Corrosives area. Do not store in metal containers. Do not store near flammable or oxidizing substances (especially nitric acid or chlorates).

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate general or local exhaust ventilation to keep airborne concentrations below the permissible exposure limits.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Hydrochloric acid	2 ppm Ceiling	50 ppm IDLH	5 ppm Ceiling; 7 mg/m3 Ceiling
Water	none listed	none listed	none listed

OSHA Vacated PELs: Hydrochloric acid: No OSHA Vacated PELs are listed for this chemical. Water: No OSHA Vacated PELs are listed for this chemical.
Personal Protective Equipment
Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear neoprene or polyvinyl chloride gloves to prevent exposure.
Clothing: Wear appropriate protective clothing to prevent skin exposure.
Respirators: A respiratory protection program that meets OSHA's 29 CFR 1910.134 and ANSI Z88.2 requirements or European Standard EN 149 must be followed whenever workplace conditions warrant a respirator's use.

Section 9 - Physical and Chemical Properties

Physical State: Clear liquid

Appearance: colorless to slight yellow
Odor: strong, pungent
pH: 0.01
Vapor Pressure: 5.7 mm Hg @ 0 deg C
Vapor Density: 1.26
Evaporation Rate:> 1.00 (N-butyl acetate)
Viscosity: Not available.
Boiling Point: 81.5-110 deg C @ 760 mmHg
Freezing/Melting Point:-74 deg C
Decomposition Temperature: Not available.
Solubility: Miscible.
Specific Gravity/Density:1.0-1.2
Molecular Formula:HCl.H2O
Molecular Weight:36.46

Section 10 - Stability and Reactivity

Chemical Stability: Stable under normal temperatures and pressures.
Conditions to Avoid: Mechanical shock, incompatible materials, metals, excess heat, exposure to moist air or water, bases.
Incompatibilities with Other Materials: Bases, acetic anhydride, alkali metals, aluminum, amines, copper, copper alloys, fluorine, iron, sodium hydroxide, steel, sulfuric acid, vinyl acetate, zinc, potassium permanganate, cesium acetylene carbide, rubidium acetylene carbide, rubidium carbide, sodium, chlorosulfonic acid, oleum, carbonates, perchloric acid, calcium phosphide, metal oxides, acetates, cesium carbide, beta-propiolactone, ethyleneimine, propylene oxide, lithium silicides, alcohols + hydrogen cyanide, 2-aminoethanol, ammonium hydroxide, calcium carbide, 1,1-difluoroethylene, ethylene diamine, magnesium boride, mercuric sulfate, silver perchlorate + carbon tetrachloride, uranium phosphide.
Hazardous Decomposition Products: Hydrogen chloride, chlorine, carbon monoxide, carbon dioxide, hydrogen gas.
Hazardous Polymerization: Will not occur.

Section 11 - Toxicological Information

RTECS#:
CAS# 7647-01-0: MW4025000; MW4031000
CAS# 7732-18-5: ZC0110000
LD50/LC50:
CAS# 7647-01-0:
Inhalation, mouse: LC50 = 1108 ppm/1H;
Inhalation, mouse: LC50 = 8300 mg/m3/30M;
Inhalation, rat: LC50 = 3124 ppm/1H;
Inhalation, rat: LC50 = 45000 mg/m3/5M;
Inhalation, rat: LC50 = 8300 mg/m3/30M;
Oral, rabbit: LD50 = 900 mg/kg;
CAS# 7732-18-5:
Oral, rat: LD50 = >90 mL/kg;
Carcinogenicity:
CAS# 7647-01-0:
ACGIH: A4 - Not Classifiable as a Human Carcinogen

IARC: IARC Group 3 - not classifiable CAS# 7732-18-5: Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology: Experimental reproductive effects have been reported.
Teratogenicity: Embryo or Fetus: Stunted fetus, Inhalation, rat TCL0=450 mg/m3/1H Specific Developmental Abnormalities: homeostatis, Inhalation, rat TCL0=450 mg/m3/1H (female 1 days pre-mating).
Reproductive Effects: No information available.
Neurotoxicity: No information available.
Mutagenicity: Cytogenetic analysis: Hamster, lung = 30 mmol/L.; Cytogenetic analysis: Hamster, ovary = 8 mmol/L.
Other Studies: No data available.

Section 12 - Ecological Information

Ecotoxicity: Fish: Bluegill/Sunfish: 3.6 mg/L; 48Hr; Lethal (unspecified) Bluegill/Sunfish: LC50; 96 Hr; pH 3.0-3.5 No data available.
Environmental: Rapidly hydrolyzes when exposed to water. Will exhibit extensive evaporation from soil surfaces. Upon transport through the soil, hydrochloric acid will dissolve some of the soil materials (especially those with carbonate bases) and the acid will neutralize to some degree.
Physical: No information available.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

Section 14 - Transport Information

	US DOT	IATA	RID/ADR	IMO	Canada TDG
Shipping Name:	No information available.				No information available.
Hazard Class:					
UN Number:					
Packing Group:					

Section 15 - Regulatory Information

US FEDERAL

TSCA

CAS# 7647-01-0 is listed on the TSCA inventory.
CAS# 7732-18-5 is listed on the TSCA inventory.

Health & Safety Reporting List

None of the chemicals are on the Health & Safety Reporting List.

Chemical Test Rules

None of the chemicals in this product are under a Chemical Test Rule.

Section 12b

None of the chemicals are listed under TSCA Section 12b.

TSCA Significant New Use Rule

None of the chemicals in this material have a SNUR under TSCA.

SARA

CERCLA Hazardous Substances and corresponding RQs

CAS# 7647-01-0: 5000 lb final RQ; 2270 kg final RQ

SARA Section 302 Extremely Hazardous Substances

CAS# 7647-01-0: 500 lb TPQ

SARA Codes

CAS # 7647-01-0: acute.

Section 313

This material contains Hydrochloric acid (CAS# 7647-01-0, 20%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.

Clean Air Act:

CAS# 7647-01-0 is listed as a hazardous air pollutant (HAP). This material does not contain any Class 1 Ozone depletors. This material does not contain any Class 2 Ozone depletors.

Clean Water Act:

CAS# 7647-01-0 is listed as a Hazardous Substance under the CWA. None of the chemicals in this product are listed as Priority Pollutants under the CWA. None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 7647-01-0 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.
CAS# 7732-18-5 is not present on state lists from CA, PA, MN, MA, FL, or NJ.
California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

T C

Risk Phrases:

R 23 Toxic by inhalation.
R 35 Causes severe burns.

Safety Phrases:

S 1/2 Keep locked up and out of reach of children.
S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 36/37/39 Wear suitable protective clothing, gloves and eye/face protection.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S 9 Keep container in a well-ventilated place.

WGK (Water Danger/Protection)
CAS# 7647-01-0: 1
CAS# 7732-18-5: No information available.
Canada - DSL/NDSL
CAS# 7647-01-0 is listed on Canada's DSL List.
CAS# 7732-18-5 is listed on Canada's DSL List.
Canada - WHMIS
This product has a WHMIS classification of D2A, E.
Canadian Ingredient Disclosure List
CAS# 7647-01-0 is listed on the Canadian Ingredient Disclosure List.
Exposure Limits
CAS# 7647-01-0: OEL-AUSTRALIA:TWA 5 ppm (7 mg/m3) OEL-AUSTRIA:TWA 5 ppm (7 mg/m3) OEL-BELGIUM:STEL 5 ppm (7.7 mg/m3) OEL-DENMARK:STEL 5 ppm (7 mg/m3) OEL-FINLAND:STEL 5 ppm (7 mg/m3);Skin OEL-FRANCE:STEL 5 ppm (7.5 mg/m3) OEL-GERMANY:TWA 5 ppm (7 mg/m3) OEL-HUNGARY:STEL 5 mg/m3 OEL-JAPAN:STEL 5 ppm (7.5 mg/m3) OEL-THE NETHERLANDS:TWA 5 ppm (7 mg/m3) OEL-THE PHILIPPINES:TWA 5 ppm (7 mg/m3) OEL-POLAND:TWA 5 mg/m3 OEL-RUSSIA:STEL 5 ppm (5 mg/m3) OEL-SWEDEN:STEL 5 ppm (8 mg/m3) OEL-SWITZERLAND:TWA 5 ppm (7.5 mg/m3);STEL 10 ppm (15 mg/m3) OEL-THAILAND:TWA 5 ppm (7 mg/m3) OEL-TURKEY:TWA 5 ppm (7 mg/m3) OEL-UNITED KINGDOM:TWA 5 ppm (7 mg/m3);STEL 5 ppm (7 mg/m3) OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

Section 16 - Additional Information

MSDS Creation Date: 7/06/1999
Revision #3 Date: 3/18/2003

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

Material Safety Data Sheet

Nitric Acid

ACC# 16550

Section 1 - Chemical Product and Company Identification

MSDS Name: Nitric Acid
Catalog Numbers: S71972, S71972MF, S75623-2, S75623-3, S76523, A198C-212, A198C4X-212, A200-212, A200-500, A200-612GAL, A200C-212, A200C4X-212, A200C4X2001, A200C4X2122, A200C4X212L, A200J500, A200S-212, A200S-500, A200S4X-212, A200S4X212L, A200SI-212, A467-1, A467-2, A467-250, A467-500, A483-212, A509-212, A509-500, A509SK-212, S719721, S719721MF, S71972SC
Synonyms: Azotic Acid; Engravers Nitrate; Hydrogen Nitrate.
Company Identification:

Fisher Scientific
1 Reagent Lane
Fair Lawn, NJ 07410

For information, call: 201-796-7100
Emergency Number: 201-796-7100
For CHEMTREC assistance, call: 800-424-9300
For International CHEMTREC assistance, call: 703-527-3887

Section 2 - Composition, Information on Ingredients

CAS#	Chemical Name	Percent	EINECS/ELINCS
7697-37-2	Nitric acid	69-71	231-714-2
7732-18-5	Water	29-31	231-791-2

Hazard Symbols: O C
Risk Phrases: 35 8

Section 3 - Hazards Identification

EMERGENCY OVERVIEW

Appearance: clear to yellow liquid. **Danger!** Corrosive. Strong oxidizer. Contact with other material may cause a fire. Causes eye and skin burns. Check internal container upon receipt. Bottles should be vented periodically to relieve pressure. Causes digestive and respiratory tract burns.
Target Organs: Eyes, skin, mucous membranes.

Potential Health Effects
Eye: Causes severe eye burns. May cause irreversible eye injury. May cause chemical conjunctivitis and corneal damage.
Skin: Causes skin burns. May cause deep, penetrating ulcers of the skin. May cause skin rash (in milder cases), and cold and clammy skin with cyanosis or pale color.
Ingestion: May cause severe and permanent damage to the digestive tract. Causes

gastrointestinal tract burns. May cause perforation of the digestive tract. May cause systemic effects.
Inhalation: Effects may be delayed. Causes chemical burns to the respiratory tract. Inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis and pulmonary edema. Aspiration may lead to pulmonary edema. May cause systemic effects. May cause acute pulmonary edema, asphyxia, chemical pneumonitis, and upper airway obstruction caused by edema.
Chronic: Repeated inhalation may cause chronic bronchitis. Repeated exposure may cause erosion of teeth. Effects may be delayed.

Section 4 - First Aid Measures

Eyes: Get medical aid immediately. Do NOT allow victim to rub or keep eyes closed. Extensive irrigation with water is required (at least 30 minutes).
Skin: Get medical aid immediately. Immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse. Destroy contaminated shoes.
Ingestion: Do NOT induce vomiting. If victim is conscious and alert, give 2-4 cupfuls of milk or water. Never give anything by mouth to an unconscious person. Get medical aid immediately.
Inhalation: Get medical aid immediately. Remove from exposure and move to fresh air immediately. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Do NOT use mouth-to-mouth resuscitation. If breathing has ceased apply artificial respiration using oxygen and a suitable mechanical device such as a bag and a mask.
Notes to Physician: Treat symptomatically and supportively.

Section 5 - Fire Fighting Measures

General Information: As in any fire, wear a self-contained breathing apparatus in pressure-demand, MSHA/NIOSH (approved or equivalent), and full protective gear. Strong oxidizer. Contact with combustible materials may cause a fire. During a fire, irritating and highly toxic gases may be generated by thermal decomposition or combustion. Use water spray to keep fire-exposed containers cool. Substance is noncombustible. Use water with caution and in flooding amounts.
Extinguishing Media: Substance is noncombustible; use agent most appropriate to extinguish surrounding fire. Contact professional fire-fighters immediately.
Flash Point: Not available.
Autoignition Temperature: Not available.
Explosion Limits, Lower: Not available.
Upper: Not available.
NFPA Rating: (estimated) Health: 4; Flammability: 0; Instability: 0; Special Hazard: OX

Section 6 - Accidental Release Measures

General Information: Use proper personal protective equipment as indicated in Section 8.
Spills/Leaks: Absorb spill with inert material (e.g. vermiculite, sand or earth), then place in suitable container. Avoid runoff into storm sewers and ditches which lead to waterways. Clean up spills immediately, observing precautions in the Protective Equipment section. Neutralize spill with sodium bicarbonate. Provide ventilation. A vapor suppressing foam may be used to reduce vapors.

Section 7 - Handling and Storage

Handling: Wash thoroughly after handling. Remove contaminated clothing and wash before reuse. Use only in a well-ventilated area. Do not breathe dust, vapor, mist, or gas. Keep container tightly closed. Avoid contact with clothing and other combustible materials. Do not get on skin or in eyes. Avoid ingestion and inhalation. Discard contaminated shoes.
Storage: Keep away from heat, sparks, and flame. Do not store near combustible materials. Keep container closed when not in use. Store in a cool, dry, well-ventilated area away from incompatible substances. Bottles should be vented periodically in order to overcome pressure buildup.

Section 8 - Exposure Controls, Personal Protection

Engineering Controls: Facilities storing or utilizing this material should be equipped with an eyewash facility and a safety shower. Use adequate ventilation to keep airborne concentrations low.
Exposure Limits

Chemical Name	ACGIH	NIOSH	OSHA - Final PELs
Nitric acid	2 ppm TWA; 4 ppm STEL	2 ppm TWA; 5 mg/m3 TWA 25 ppm IDLH	2 ppm TWA; 5 mg/m3 TWA
Water	none listed	none listed	none listed

OSHA Vacated PELs: Nitric acid: 2 ppm TWA; 5 mg/m3 TWA Water: No OSHA Vacated PELs are listed for this chemical.
Personal Protective Equipment
Eyes: Wear appropriate protective eyeglasses or chemical safety goggles as described by OSHA's eye and face protection regulations in 29 CFR 1910.133 or European Standard EN166.
Skin: Wear appropriate gloves to prevent skin exposure.
Clothing: Wear a chemical apron. Wear appropriate clothing to prevent skin exposure.
Respirators: Wear a NIOSH/MSHA or European Standard EN 149 approved full-facepiece airline respirator in the positive pressure mode with emergency escape provisions.

Section 9 - Physical and Chemical Properties

Physical State: Liquid
Appearance: clear to yellow
Odor: strong odor - acrid odor
pH: 1.0
Vapor Pressure: 6.8 mm Hg
Vapor Density: Not available.
Evaporation Rate: Not available.
Viscosity: Not available.
Boiling Point: 186.8 deg F
Freezing/Melting Point:-43.6 deg F
Decomposition Temperature: Not available.
Solubility: Soluble in water.
Specific Gravity/Density:1.50
Molecular Formula:HNO_3

Molecular Weight:63.0119

Section 10 - Stability and Reactivity

Chemical Stability: Stable. Decomposes when in contact with air, light, or organic matter.
Conditions to Avoid: High temperatures, incompatible materials, ignition sources, moisture, combustible materials, reducing agents.
Incompatibilities with Other Materials: Reducing agents, combustible materials, strong bases, alcohols, aldehydes, cyanides, metals, Incompatible with many substances..
Hazardous Decomposition Products: Nitrogen oxides.
Hazardous Polymerization: Has not been reported.

Section 11 - Toxicological Information

RTECS#:
CAS# 7697-37-2: QU5775000; QU5900000
CAS# 7732-18-5: ZC0110000
LD50/LC50:
CAS# 7697-37-2:
Inhalation, rat: LC50 = 260 mg/m3/30M;
Inhalation, rat: LC50 = 130 mg/m3/4H;
Inhalation, rat: LC50 = 67 ppm(NO2)/4H;
CAS# 7732-18-5:
Oral, rat: LD50 = >90 mL/kg;
Carcinogenicity:
CAS# 7697-37-2: Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA. CAS# 7732-18-5: Not listed by ACGIH, IARC, NIOSH, NTP, or OSHA.
Epidemiology: No information found.
Teratogenicity: No information found.
Reproductive Effects: No information found.
Neurotoxicity: No information found.
Mutagenicity: No information found.
Other Studies: See actual entry in RTECS for complete information.

Section 12 - Ecological Information

Ecotoxicity: No data available. No information available.
Environmental: Terrestial: During transport through the soil, nitric acid will dissolve some of the soil material, in particular, the carbonate based materials. The acid will be neutralized to some degree with adsorption of the proton also occurring on clay materials. However, significant amounts of acid are expected to remain for transport down toward the ground water table. Upon reaching the ground water table, the acid will continue to move, now in the direction of the ground water flow.
Physical: Not expected to biodegrade or bioconcentrate.
Other: No information available.

Section 13 - Disposal Considerations

Chemical waste generators must determine whether a discarded chemical is classified as a hazardous waste. US EPA guidelines for the classification determination are listed in 40 CFR Parts 261.3. Additionally, waste generators must consult state and local hazardous waste regulations to ensure complete and accurate classification.
RCRA P-Series: None listed.
RCRA U-Series: None listed.

Section 14 - Transport Information

	US DOT	IATA	RID/ADR	IMO	Canada TDG
Shipping Name:	NITRIC ACID				NITRIC ACID
Hazard Class:	8				8(9.2)
UN Number:	UN2031				UN2031
Packing Group:	II				II

Section 15 - Regulatory Information

US FEDERAL

TSCA
CAS# 7697-37-2 is listed on the TSCA inventory.
CAS# 7732-18-5 is listed on the TSCA inventory.
Health & Safety Reporting List
None of the chemicals are on the Health & Safety Reporting List.
Chemical Test Rules
None of the chemicals in this product are under a Chemical Test Rule.
Section 12b
None of the chemicals are listed under TSCA Section 12b.
TSCA Significant New Use Rule
None of the chemicals in this material have a SNUR under TSCA.
SARA

CERCLA Hazardous Substances and corresponding RQs
CAS# 7697-37-2: 1000 lb final RQ; 454 kg final RQ
SARA Section 302 Extremely Hazardous Substances
CAS# 7697-37-2: 1,000 lb TPQ
SARA Codes
CAS # 7697-37-2: acute, chronic, flammable.
Section 313
This material contains Nitric acid (CAS# 7697-37-2, 69 71%),which is subject to the reporting requirements of Section 313 of SARA Title III and 40 CFR Part 373.
Clean Air Act:
This material does not contain any hazardous air pollutants. This material does not contain any Class 1 Ozone depletors. This material does not contain any Class 2 Ozone depletors.
Clean Water Act:
CAS# 7697-37-2 is listed as a Hazardous Substance under the CWA. None of the chemicals in this

product are listed as Priority Pollutants under the CWA. None of the chemicals in this product are listed as Toxic Pollutants under the CWA.

OSHA:

None of the chemicals in this product are considered highly hazardous by OSHA.

STATE

CAS# 7697-37-2 can be found on the following state right to know lists: California, New Jersey, Pennsylvania, Minnesota, Massachusetts.
CAS# 7732-18-5 is not present on state lists from CA, PA, MN, MA, FL, or NJ.
California No Significant Risk Level: None of the chemicals in this product are listed.

European/International Regulations

European Labeling in Accordance with EC Directives

Hazard Symbols:

O C

Risk Phrases:

R 35 Causes severe burns.
R 8 Contact with combustible material may cause fire.

Safety Phrases:

S 26 In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S 36 Wear suitable protective clothing.
S 45 In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).
S23B Do not breathe fumes.

WGK (Water Danger/Protection)

CAS# 7697-37-2: 1
CAS# 7732-18-5: No information available.

Canada - DSL/NDSL

CAS# 7697-37-2 is listed on Canada's DSL List.
CAS# 7732-18-5 is listed on Canada's DSL List.

Canada - WHMIS

This product has a WHMIS classification of C, D1A, E.

Canadian Ingredient Disclosure List

CAS# 7697-37-2 is listed on the Canadian Ingredient Disclosure List.

Exposure Limits

CAS# 7697-37-2: OEL-ARAB Republic of Egypt:TWA 2 ppm (5 mg/m3) OEL-AUSTRALIA:TWA 2 ppm (5 mg/m3);STEL 4 ppm (10 mg/m3) OEL-BELGIUM:TWA 2 ppm (5.2 mg/m3);STEL 4 ppm (10 mg/m3) OEL-CZECHOSLOVAKIA:TWA 2.5 mg/m3;STEL 5 mg/m3 OEL-DENMARK:TWA 2 ppm (5 mg/m3) OEL-FINLAND:TWA 2 ppm (5 mg/m3);STEL 5 ppm (13 mg/m3);Skin OEL-FRANCE:TWA 2 ppm (5 mg/m3);STEL 4 ppm (10 mg/m3) OEL-GERMANY:TWA 10 ppm (25 mg/m3) OEL-HUNGARY:STEL 5 mg/m3 OEL-JAPAN:TWA 2 ppm (5.2 mg/m3) OEL-THE PHILIPPINES:TWA 2 ppm (5 mg/m3) OEL-POLAND:TWA 10 mg/m3 OEL-RUSSIA:TWA 2 ppm;STEL 2 mg/m3;Skin OEL-SWEDEN:TWA 2 ppm (5 mg/m3);STEL 5 ppm (13 mg/m3) OEL-SWITZERLAND:TWA 2 ppm (5 mg/m3);STEL 4 ppm (1 mg/m3) OEL-THAILAND:TWA 2 ppm (5 mg/m3) OEL-TURKEY:TWA 2 ppm (5 mg/m3) OEL-UNITED KINGDOM:TWA 2 ppm (5 mg/m3);STEL 4 ppm (10 mg/m3) OEL IN BULGARIA, COLOMBIA, JORDAN, KOREA check ACGIH TLV OEL IN NEW ZEALAND, SINGAPORE, VIETNAM check ACGI TLV

Section 16 - Additional Information

MSDS Creation Date: 9/30/1998
Revision #10 Date: 4/01/2003

The information above is believed to be accurate and represents the best information currently available to us. However, we make no warranty of merchantability or any other warranty, express or implied, with respect to such information, and we assume no liability resulting from its use. Users should make their own investigations to determine the suitability of the information for their particular purposes. In no event shall Fisher be liable for any claims, losses, or damages of any third party or for lost profits or any special, indirect, incidental, consequential or exemplary damages, howsoever arising, even if Fisher has been advised of the possibility of such damages.

ATTACHMENT 4. HEAT STRESS AND COLD STRESS INFORMATION

HEAT EXHAUSTION

What happens to the body:

Headaches, dizziness, or light-headedness, weakness, mood changes, irritability or confusion, feeling sick to your stomach, vomiting, fainting, decreased and dark-colored urine, and pale, clammy skin.

What should be done:

- Move the person to a cool shaded area. Don't leave the person alone. If the person is dizzy or light-headed, lay him on his back and raise his legs about 6-8 inches. If the person is sick to his stomach, lay him on his side.
- Loosen and remove heavy clothing.
- Have the person drink some cool water (a small cup every 15 minutes) if he is not feeling sick to his stomach.
- Try to cool the person by fanning him. Cool the skin with a cool spray mist of water or wet cloth.
- If the person does not feel better in a few minutes call for emergency help (ambulance or call 911.)

(If heat exhaustion is not treated, the illness may advance to heat stroke.)

How to Protect Workers

- Learn the signs and symptoms of heat-induced illnesses and what to do to help the worker.
- Train workers about heat-induced illnesses.
- Perform the heaviest work during the coolest part of the day.
- Slowly build up tolerance to the heat and the work activity (usually takes up to 2 weeks.)
- Use the buddy system (work in pairs.)
- Drink plenty of cool water (one small cup every 15-20 minutes.)
- Wear light, loose-fitting, breathable (like cotton) clothing.
- Take frequent short breaks in cool, shaded areas (allow your body to cool down.)
- Avoid eating large meals before working in hot environments.
- Avoid caffeine and alcoholic beverages (these beverages make the body lose water and increase the risk of heat illnesses.)

Workers are at increased risk when…

- They take certain medications. Check with your doctor, nurse, or pharmacy to see if medicines you take affect you when working in hot environments.
- They have had a heat-induced illness in the past.
- They wear personal protective equipment.

HEAT STROKE - A Medical Emergency

What happens to the body:

Dry, pale skin (no sweating); hot red skin (looks like a sunburn); mood changes; irritability, confusion, and not making any sense; seizures or fits, and collapse (will not respond).

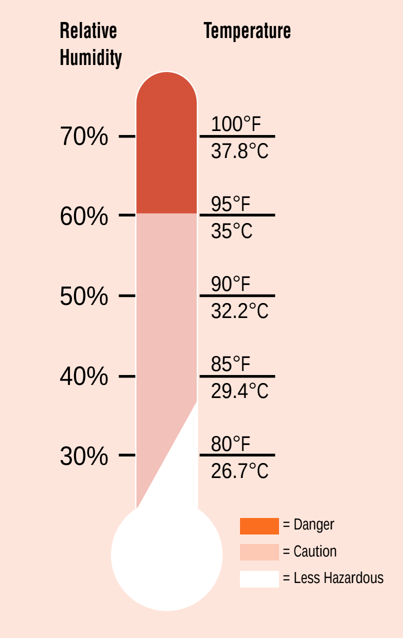
What should be done:

- Call for emergency help (i.e., ambulance or 911.)
- Move the person to a cool, shaded area. Don't leave the person alone. Lay him on his back and if the person is having seizures, remove objects close to him so he won't hit them. If the person is sick to his stomach, lay him on his side.
- Remove heavy and outer clothing.
- Have the person drink some cool water (a small cup every 15 minutes) if he is alert enough to drink anything and not feeling sick to his stomach.
- Try to cool the person by fanning him or her. Cool the skin with a cool spray mist of water, wet cloth, or wet sheet.
- If ice is available, place ice packs in armpits and groin area.

THE HEAT EQUATION

HIGH TEMPERATURE + HIGH HUMIDITY + PHYSICAL WORK = HEAT ILLNESS

When the body is unable to cool itself through sweating, **serious** heat illnesses may occur. The most severe heat-induced illnesses are **heat exhaustion** and **heat stroke**. If actions are not taken to treat heat exhaustion, the illness could progress to heat stroke and **death**.



Oregon Occupational Safety & Health Division
440-3333E-S(9/03)

FROSTBITE

What happens to the body:

Freezing in deep layers of skin and tissue; pale, waxy-white skin color; skin becomes hard and numb; usually affects fingers, hands, toes, feet, ears, and nose.

What to do: (land temperatures)

- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet or tight clothing that may cut off blood flow to the affected area.
- **Do not** rub the affected area because rubbing damaged the skin and tissue.
- Gently place the affected area in a warm water bath (105°) and monitor the water temperature to **slowly** warm the tissue. Don't pour warm water directly on the affected area because it will warm the tissue too fast, causing tissue damage. Warming takes 25-40 minutes.
- After the affected area has been warmed, it may become puffy and blister. The affected area may have a burning feeling or numbness. When normal feeling, movement, and skin color have returned, the affected area should be dried and wrapped to keep it warm. **Note:** If there is a chance the affected area may get cold again, do not warm the skin. If the skin is warmed and then becomes cold again, it will cause severe tissue damage.
- Seek medical attention as soon as possible.

How to Protect Workers

- Recognize the environmental and workplace conditions that lead to potential cold-induced illnesses and injuries.
- Learn the signs and symptoms of cold-induced illnesses/injuries and what to do to help the worker.
- Train workers about cold-induced illnesses and injuries.
- Select proper clothing for cold, wet, and windy conditions. Layer clothing to adjust to changing environmental temperatures. Wear a hat and gloves, in addition to underwear that will keep water away from the skin (polypropylene.)
- Take frequent short breaks in warm, dry shelters to allow the body to warm up.
- Perform work during the warmest part of the day.
- Avoid exhaustion or fatigue because energy is needed to keep muscles warm.
- Use the buddy system (work in pairs.)
- Drink warm, sweet beverages (sugar water, sports-type drinks.) **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol**.
- Eat warm, high-calorie foods like hot pasta dishes.

Workers are at increased risk when…

- They have predisposing health conditions such as cardiovascular disease, diabetes, and hypertension.
- They take certain medications. Check with your doctor, nurse, or pharmacy and ask if medicines you take affect you while working in cold environments.
- They are in poor physical condition, have a poor diet, or are older.

HYPOTHERMIA - (Medical Emergency)

What happens to the body:

Normal body temperature (98.6°F/37°C) drops to or below 95°F/35°C; fatigue or drowsiness; uncontrolled shivering; cool, bluish skin; slurred speech; clumsy movements; irritable, irrational, or confused behavior.

What to do: (land temperatures)

- Call for emergency help (i.e., ambulance or 911).
- Move the person to a warm, dry area. Don't leave the person alone.
- Remove wet clothing and replace with warm, dry clothing or wrap the person in blankets.
- Have the person drink warm, sweet drinks (sugar water or sports-type drinks) if he is alert. **Avoid drinks with caffeine** (coffee, tea, or hot chocolate) **or alcohol**.
- Have the person move his arms and legs to create muscle heat. If he is unable to do this, place warm bottles or hot packs in the armpits, groin, neck, and head areas. **Do not** rub the person's body or place him in a warm water bath. This may stop his heart.

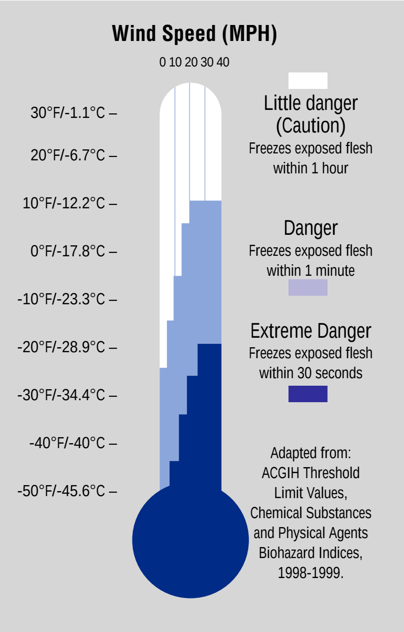
What to do: (water temperatures)

- Call for emergency help (i.e., ambulance or 911). Body heat is lost up to 25 times faster in water.
- **Do not** remove any clothing. Button, buckle, zip, and tighten any collars, cuffs, shoes, and hoods because the layer of trapped water closest to the body provides a layer of insulation that slows the loss of heat. Keep the head out of the water and put on a hat or hood.
- Get out of the water as quickly as possible or climb on anything floating. **Do not** attempt to swim unless a floating object or another person can be reached because swimming or other physical activity uses body heat and reduces survival time by about 50 percent.
- If getting out of the water is not possible, wait quietly and conserve body heat by folding arms across the chest, keeping thighs together, bending knees, and crossing ankles. If another person is in the water, huddle together with chests held closely.

THE COLD STRESS EQUATION

LOW TEMPERATURE + WIND SPEED + WETNESS = INJURIES & ILLNESS

When the body is unable to warm itself, serious cold-related illnesses and injuries may occur, and permanent tissue damage and death may result. **Hypothermia** can occur when *land temperatures* are **above** freezing or *water temperatures* are below 98.6°F/37°C. Cold-related illnesses can slowly overcome a person who has been chilled by low temperatures, brisk winds, or wet clothing.



Adapted from: ACGIH Threshold Limit Values, Chemical Substances and Physical Agents Biohazard Indices, 1998-1999.

Oregon Occupational Safety & Health Division
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