FINAL REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT

March Point (Whitmarsh) Landfill

Skagit County, Washington

Prepared for:

Whitmarsh Landfill PLP Group
Mount Vernon, Washington

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amec

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March Point (Whitmarsh) Landfill
Skagit County, Washington

February 10, 2017
Project 014159000

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2/10/17

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EXECUTIVE SUMMARY

AMEC Environment & Infrastructure, Inc. (AMEC) prepared this Remedial Investigation/Feasibility Study (RI/FS) Report for the former March Point (Whitmarsh) Landfill, located in Anacortes, Washington, with Washington State Department of Ecology (Ecology) Facility Site ID 2662. The RI/FS was completed by AMEC under contract to the Whitmarsh Landfill Potentially Liable Person (PLP) Group, which consists of Skagit County, the Washington State Department of Natural Resources, Shell Oil Company, and Texaco, Inc.

Site History: The site was used as an informal public dump for solid waste from the 1950s until 1961, when Skagit County leased the property from the state to operate the site as a landfill. The County operated the landfill as a burn dump until about 1969 and then as a sanitary landfill until the landfill closed in 1973. At the time of closure, the landfill was covered with a 2–3-foot-thick layer of soil, consistent with the closure regulations at that time. A sawmill operated at the site from the late 1980s until approximately August 2011. At that time, wood waste up to 10 feet thick had accumulated over large portions of the landfill. Figure ES-1 shows a series of historical aerial photographs from 1937 when no landfill was present and from 1966 through 1973 showing the gradual expansion of the landfill.

Field Investigations: AMEC conducted several field investigations at the site and collected samples of soil, groundwater, surface water, sediments, landfill gas (LFG), and seep water for laboratory testing. A geophysical investigation was conducted to evaluate whether buried metallic objects (e.g., drums) were present within the landfill. The limits of the solid waste are generally defined by the landfill footprint. A total of 44 test pits dug in the solid waste did not identify any evidence of hazardous or dangerous wastes or a large number of drums in the landfill. Laboratory results showed concentrations of metals greater than preliminary cleanup levels (PCLs) in soil and water, but this was expected given the large amount of putrescible waste in the landfill. The waste has been degraded by anaerobic decomposition, which results in reducing conditions that, in turn, can cause metals present in soil or metallic objects to mobilize and migrate into surface water or groundwater. The geophysical investigation indicated that the landfill contains a significant volume of metal objects, such as appliances and metallic debris. Surface water samples collected upgradient of the landfill, which are believed to be representative of background conditions, also detected elevated levels of several metals. LFG containing methane at concentrations exceeding lower explosive limits exists at the site. However, this gas does not currently pose a serious concern since there are no occupied structures or utilities presently at the landfill for methane to accumulate in or below. Polychlorinated biphenyls, a few pesticides, hydrocarbon fuel constituents, and five semivolatile organic compounds were detected in soil and/or water at levels above the PCLs. No dioxins or furans were detected in soil or groundwater samples above the PCLs. Sediments in the nearshore area adjacent to the landfill have

not been adversely affected by discharges from the landfill. No archaeological or cultural resources were encountered during any field work.

Shallow groundwater within the solid waste appears to be discharging into Padilla Bay inner lagoon at a limited number of seeps noted along the shoreline. Although not observed, groundwater also may be discharging into the drainage swale on the west side of the landfill. A low-permeability silt/clay layer (the Bay Mud unit) beneath the solid waste limits the infiltration of groundwater from the landfill to the underlying Lower Aquifer. A low-permeability feature resembling a dike extends along the southern half of the landfill, along the shoreline. This feature appears to minimize discharge of groundwater from the landfill because no surface water seeps were observed in this area along the edge of the landfill.

Focused Feasibility Study: AMEC identified and evaluated seven remedial action alternatives to address potential exposure to landfill solid waste and constituents of concern associated with the landfill. The majority of wood waste has been removed.

The Focused Feasibility Study's preferred alternative (Alternative 3) would involve moving solid waste from the edges of the landfill inward, grading the waste to a mound, installing a passive LFG collection system and monitoring, placing an engineered cap over the landfill with standard geosynthetic clay laminated liner (GCLL) and enhanced GCLL extending to the Bay Mud, and constructing a perimeter access road around the landfill. The engineered cap would minimize or eliminate infiltration into the landfill. With infiltration minimized into the waste, it is expected that water levels within the landfill would rapidly decline until a steady-state level near the mean water level in the underlying aquifer. Enhanced GCLL along the shoreline would also minimize discharge of groundwater from the landfill to surface waters. LFG collection system would vent LFG to the atmosphere.

Alternative 2 also presents a reasonable, plausible, and cost-effective approach to closure considering the low levels of short-term risk posed by the site. Alternative 2 involves the enhancement of the existing soil cover, and offers many of the advantages of the other cover alternatives, which are 75 to 250 percent more costly. However, Alternative 2 does not meet the applicable or relevant and appropriate requirements under the Minimum Functional Standards of Washington Administrative Code 173-304 for a low permeability cover and sufficient grading; therefore, this alternative is eliminated from further evaluation.

Groundwater encountered within the solid waste during construction will be removed, pre-treated, and transported to a wastewater treatment facility for treatment and disposal. Construction work along the shoreline may require several state and federal permits, including a Section 10/404 Permit from the U.S. Army Corps of Engineers and a Section 401 Water Quality Certification from Ecology.

Following construction, site conditions will be inspected and groundwater levels will be periodically monitored to assess performance of the remedial measures. Groundwater levels within the solid waste are expected to decline following installation of the low-permeability cap. However, if groundwater levels within the landfill rise, then the excess groundwater would need to be removed and transported for treatment at a wastewater treatment facility, as required.

The total estimated cost to implement Alternative 3 is approximately $12 million, which also includes 30 years of operation and maintenance costs. These cost estimates were prepared in 2015 dollars and have not been adjusted for inflation or discount rate.

For any of the capping alternatives included in the Feasibility Study, there are potential refinements and value engineering opportunities that should be considered during remedial design. Some concepts that merit further review and evaluation could include:

- Reduction in the thickness of cover soil layers,
- Reuse of existing cover soil,
- Consideration of alternative drainage materials,
- Optimization of overall site grading and minimization of earthworks, and
- Minimization of any disturbance and handling of waste material.

Other concepts should be considered during detailed design to create an optimized final closure for the site.

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APPENDICES

ACRONYMS AND ABBREVIATIONS

2,3,7,8-TCDD	2,3,7,8-tetrachlorodibenzo-p-dioxin
µg/L	micrograms per liter
Agreed Order	Agreed Order DE-08TCPHQ-5999
AMEC	AMEC Environment & Infrastructure, Inc.
ARARs	applicable or relevant and appropriate requirements
ARI	Analytical Resources, Inc.
BNSF	BNSF Railway Company
CAP	Cleanup Action Plan
CFR	Code of Federal Regulations
CLARC	Ecology's Cleanup Levels and Risk Calculations
cm/s	centimeters per second
COCs	constituents of concern
CQAPP	construction quality assurance project plan
CSM	conceptual site model
CZM	Coastal Zone Management
DCA	disproportionate cost analysis
DNR	Washington State Department of Natural Resources
Ecology	Washington State Department of Ecology
EM	electromagnetic
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FFS	Focused Feasibility Study
FS	feasibility study
GCL	geosynthetic clay liner
GCLL	geosynthetic clay laminated liner
HDPE	high-density polyethylene
LFG	landfill gas
MFS	minimum functional standards (WAC 173-304)
MHHW	mean higher high water
MLLW	mean lower low water
msl	mean sea level
MTCA	Model Toxics Control Act (WAC 173-340)
NAVD88	North American Vertical Datum of 1988
NGA	Northwest Geophysical Associates, Inc.
ng/kg	nanograms per kilogram
NOAA Fisheries	National Oceanographic and Atmospheric Administration National Marine Fisheries Service
ODEQ	Oregon Department of Environmental Quality
OHWM	ordinary high water mark
PAHs	polycyclic aromatic hydrocarbons
PCBs	polychlorinated biphenyls
PCLs	preliminary cleanup levels
pg/g	picograms/gram
PLP	potentially liable party
pptr	parts per trillion
PQLs	practical quantitation limits

ACRONYMS AND ABBREVIATIONS
(Continued)

PVC	polyvinyl chloride
RAOs	remedial action objectives
RCW	Revised Code of Washington
RI	remedial investigation
SAP	sampling and analysis plan
SCUM	Sediment Cleanup Users Manual
SEPA	State Environmental Policy Act
SHA	site hazard assessment
Shell	Shell Oil Company
site	Former March Point (Whitmarsh) Landfill
SMS	Sediment Management Standards (WAC 173-204)
Snow Mountain	Snow Mountain Land Company, LLC
SQS	Sediment Quality Standard
STP	shovel test probe
SVOCs	semivolatile organic compounds
TEQ	toxic equivalency quotient
Texaco	Texaco, Inc.
USACE	U.S. Army Corps of Engineers
VOCs	volatile organic compounds
TEE	terrestrial ecological evaluation
TPH	total petroleum hydrocarbons
TPH-D	total petroleum hydrocarbons as diesel
TPH-G	total petroleum hydrocarbons as gasoline
TPH-Oil	total petroleum hydrocarbons in the heavy oil range
USACE	United States Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
WAC	Washington Administrative Code

FINAL REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT
March Point (Whitmarsh) Landfill
Skagit County, Washington

1.0 INTRODUCTION

On behalf of the participating March Point (aka Whitmarsh) Landfill Potentially Liable Parties (PLPs; at this time consisting of Shell Oil Company [Shell], Skagit County, Texaco, Inc. [Texaco], and the Washington State Department of Natural Resources [DNR]) and pursuant to Agreed Order DE-08TCPHQ-5999 (the Agreed Order), AMEC Environment & Infrastructure, Inc. (AMEC), has prepared this Remedial Investigation/Feasibility Study (RI/FS) Report for the former March Point (Whitmarsh) Landfill, located on the east side of March Point at 9663 South March Point Road in Anacortes, Washington (the site) (Figure 1). The site is listed on the Washington State Department of Ecology (Ecology) Hazardous Sites List as Facility Site ID 2662.

This RI/FS Report presents results from both the RI and the FS. The RI was conducted in two phases. Results from the Phase I RI were used to focus the Phase II RI. This RI/FS Report details the approach and results of the RI, summarizes the nature and extent of contamination, presents a conceptual site model (CSM) of exposure pathways for constituents of concern (COCs) at the site, presents proposed final cleanup levels and remedial action objectives (RAOs), outlines important project considerations governing and guiding the permanent cleanup action under the Model Toxics Control Act (MTCA) Cleanup Regulation (Washington Administrative Code [WAC] 173-340) and the applicable landfill closure requirements under the applicable or relevant and appropriate requirements (ARARs) (WAC 173-304). This report also identifies, screens, and evaluates the remedial alternatives at the site, and identifies the preferred alternative for corrective measures at the site.

The Feasibility Study presented in Sections 11.0–14.0 is a Focused Feasibility Study (FFS) that identifies and evaluates key remedial components (EPA, 1991) of various practical technologies being used for landfill remedies as part of developing remedial alternatives, taking into consideration the MTCA minimum requirements for cleanup actions specified in WAC 173-340-360(2).

The RI/FS Report was prepared for submittal to Ecology in accordance with Section VII.A of the Agreed Order. The former March Point (Whitmarsh) Landfill is one of 10 sites on Padilla Bay and nearby Fidalgo Bay that are being investigated and cleaned up as part of the Puget Sound Initiative.

1.1 OBJECTIVES AND SCOPE

The goals of the RI/FS report are to:

- Define the extent of solid waste contained in the current landfill;
- Summarize and synthesize data collected for the RI and define the nature and extent of soil, groundwater, surface water, seepage water migrating into the lagoon, and sediment contamination at the site;
- Define the nature and extent of landfill gas (LFG) present within the landfill;
- Define the potential for ongoing leachate/gas production and the need for leachate/gas controls;
- Define the need for a shoreline protection system for Padilla Bay, due to the proximity of site solid waste to the bay and the potential for the solid waste to affect the bay;
- Present a complete CSM for the site;
- Evaluate cleanup standards that apply to potential remedial alternatives developed during the FS;
- Identify and evaluate representative remedial technologies and develop remedial alternatives from these technologies;
- Evaluate the remedial alternatives against the evaluation criteria defined in MTCA and other ARARs;
- Select the preferred remedial alternative; and
- Provide a schedule for the implementation of the preferred alternative.

1.2 ORGANIZATION OF THE REMEDIAL INVESTIGATION/FEASIBILITY STUDY REPORT

This RI/FS Report is divided into the following 15 sections:

- Section 1 – Describes the objectives of the RI/FS and the organization of this report.
- Section 2 – Provides background information about the site, including location, historical and current use, site ownership, regulatory and compliance history, and previous environmental investigations conducted at or near the site.
- Section 3 – Describes the components of the RI, including geophysical investigation, groundwater monitoring well installation, methane monitoring well installation, test pit investigation, archaeological surveys, groundwater/seep/surface water sampling, methane monitoring, and sediment sampling.
- Section 4 – Provides information regarding the development of site-specific preliminary cleanup levels (PCLs).

- Section 5 – Describes the nature and extent of contamination at the site based on the findings from the RI, including a comparison of analytical data to the PCLs.
- Section 6 – Presents and summarizes the results of geotechnical, tidal, and hydrogeological studies performed at the site.
- Section 7 – Presents the conceptual site model, including a terrestrial ecologic evaluation for the site.
- Section 8 – Evaluates the PCLs developed in Section 4 and chooses proposed final cleanup levels for the site.
- Section 9 – Presents the RAOs for the FS.
- Section 10 – Presents various considerations that may affect the selection of the preferred remedial alternative, including the ARARs, other site-specific considerations, and removal of wood waste from the site.
- Section 11 – Identifies, screens, and selects the essential municipal landfill closure components and combines these to form remedial alternatives that will be evaluated further during the FS.
- Section 12 – Presents the remedial alternatives that will be evaluated further during the FS.
- Section 13 – Evaluates the remedial alternatives with respect to the MTCA evaluation criteria of protectiveness, permanence, cost, long-term effectiveness, short-term risks, technical and administrative implementability, public concerns, and cost by using a the disproportionate cost analysis (DCA) to determine whether the cleanup action uses permanent solutions to the maximum extent practicable.
- Section 14 – Selects the preferred remedial alternative and presents a preliminary implementation schedule.
- Section 15 – Provides a list of references for materials cited in this report.

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2.0 SITE DESCRIPTION

This section presents a brief description of the property, site operational history, site regulatory and compliance history, and previous investigations and cleanup actions that have been conducted for the site.

2.1 LOCATION AND ENVIRONMENTAL SETTING

The March Point Landfill (approximately 14 acres of upland) is located north of South March Point Road at the base of a bluff in the tidelands area of Padilla Bay in the city of Anacortes, Washington (Figure 1). The March Point Landfill was a public dump in the 1950s, and was operated by Skagit County as a landfill from 1961 until its closure in 1973. Padilla Bay is a National Marine Estuarine Sanctuary that supports sustenance fishing by the Swinomish Indian Tribal Community. Due to the site's proximity and potential impacts to Padilla Bay and Bay Lagoon, it has been identified by Ecology as a high priority cleanup area under the Puget Sound Initiative. The March Point Landfill is bounded by South March Point Road to the south, the BNSF Railway Company (BNSF) railroad causeway and Padilla Bay to the north and northeast, and the Swinomish Indian Reservation to the east and southeast (Figure 1). State Highway 20 runs generally east-west about 800 feet southeast of the site beyond South March Point Road. The landfill is buttressed with heavy rock riprap along its saltwater edge to the northeast, which includes the BNSF right-of-way. The embankment under the railroad serves as a dike separating the bay lagoon from the Padilla Bay. A short trestle (approximately 110 feet wide) in the railroad embankment allows for salt water exchange between the inner and outer lagoon. The area southeast of the landfill is owned by the Swinomish Indian Tribal Community and has been developed as light industrial/commercial area.

The elevation of the March Point Landfill generally ranges from 6 to 25 feet above mean lower low water (MLLW). The landfill surface is relatively flat across the top with higher elevations on the north end. The March Point Landfill slopes down to tidelands on the northeast and east sides and to drainage channels along the north and south sides. The tidelands on the northeast and east sides consist of the inner lagoon and outer lagoon, with an estuarine stream running along the eastern boundary continuing out toward Padilla Bay (Figure 2).

Padilla Bay is part of an ancient delta of the Skagit River that was abandoned by the river and currently has no substantial freshwater stream input. Water depths in Padilla Bay are shallow, with the bottom generally at an elevation of less than 12 feet below MLLW. Tidal fluctuation within Padilla Bay averages 8 feet and can vary from -3 feet to +12 feet MLLW.

2.2 HISTORICAL AND CURRENT USE

This section presents a brief history of landfill operation and ownership. Figures depicting changes in parcel boundary and landfill extent through time are included in the Draft Uplands RI/FS Work Plan (AMEC, 2008a).

2.2.1 Ownership of Properties at the Site

According to the Skagit County Assessor's Office, the March Point Landfill area currently includes five tax parcel numbers (P19676, P19684, P19707, P19713, and P19761). A map showing parcel numbers and boundaries is provided in Figure 3. Ownership of the five parcels is as follows.

- The Snow Mountain Land Company, LLC (Snow Mountain) owns parcel P19713.
- Parcel P19676 has split ownership. Snow Mountain owns land on this parcel above the 1890 high tide meander line. The State of Washington owns the portion of the parcel below the meander line, and the DNR manages it on behalf of the state. The meander line was resurveyed by a Washington State Licensed surveyor in 2015.
- The Charles Moon Credit Trust owns parcel P19684.
- The State of Washington owns parcel P19707, which is managed by the DNR.
- Ralph Hillestead owns parcel P19761.

2.2.2 Landfill History

Prior to the 1950s, the property consisted of undeveloped tidelands lying between the main Mount Vernon-Anacortes highway and the BNSF rail line.

Landfilling began in the 1950s, when the site was used by the public as a convenient, unregulated dump site. In 1961, Skagit County applied for and received a lease from the state to operate the property as a landfill. The County operated the landfill as a "burn dump" and burned waste regularly until 1969 (Skagit County Health Department, 1990). In 1969 or 1970, the County converted the facility to a "sanitary landfill." From 1969 through 1973, the landfill was the primary solid waste disposal facility in Skagit County (Skagit County Health Department, 1990). Skagit County Public Works records of waste accepted from 1970 onward indicate that waste originated from the cities of Anacortes, Burlington, La Conner, Mount Vernon, and Sedro-Woolley; rural Skagit County; Whidbey Island; and the Shell and Texaco refineries, among many others (GeoEngineers, 2007).

Historical documents from the early 1970s indicate that a dike was to be built along the southeastern margin of the landfill, apparently to better contain waste within the landfill. Aerial photographs from this same time period show a linear feature that resembles a dike extending along the current southeastern margin of the landfill. These documents indicate that a dike may have been constructed along the current southeastern margin of the landfill.

Limited records are available regarding the composition and quantity of any potentially hazardous substances dumped at the landfill. According to the Skagit County Health Department (Ecology, 1986), industrial wastes from Allied Chemical and Northwest Petrochemical were dumped at the landfill. Independently, other industrial wastes, including drummed wastes, are also alleged to have been dumped at the landfill. In 1973, Skagit County opened the Inman Landfill and the Whitmarsh Landfill facility ceased operation. Closure appears to have consisted of grading the solid waste and covering it with 2 to 3 feet of soil.

2.2.3 Recent Property Use and Site Operations until 2015

The northern two-thirds of the March Point Landfill was occupied by a cedar log mill operated by Snow Mountain until approximately 2010. The remaining former mill buildings are shown on Figure 3. The log mill had operated in this location since the late 1980s. The former mill area presently contains building foundation concrete slabs, partially dismantled buildings, and an intact shop building.

In 2014 and 2015, DNR conducted a wood waste removal project to address a 2- to 10-foot-thick layer of wood waste (mainly sawdust) left behind after removal of the log mill and associated equipment. The wood waste generally consisted of cedar bark, wood chips, and sawdust. AMEC Environment & Infrastructure, Inc., oversaw and monitored the removal of the wood waste by a DNR-selected contractor. Approximately 44,000 cubic yards of wood waste debris was hauled off-site and recycled as compost material; an estimated 13,000 cubic yards of wood waste debris mixed with rock remains on site. The rock content of this debris is estimated at approximately 50 percent, and the majority of this material is stockpiled in two piles southeast of the log mill foundations (Amec Foster Wheeler, 2015). The rest of residual wood waste is located near the former mill building foundations as part of the road materials.

At the City of Anacortes' request, two 3- to 4-foot high berms were constructed on the east and west sides of the landfill to limit potential stormwater runoff. These berms were hydroseeded after construction. After construction of the berms, the surface of the landfill was re-surveyed, and the current topography is shown in Figure 4. The southern third of the March Point Landfill is unoccupied and covered with light forest, blackberry brambles, and grass.

2.3 SKAGIT COUNTY HAZARD ASSESSMENT

As stated above, the landfill was operated by Skagit County from 1961 until 1973. It appears that the landfill was closed by covering the solid waste with soil. In 2003, the Skagit County Health Department published the Site Hazard Assessment (SHA) for the March Point Landfill, as required under MTCA, and ranked the site on the state's hazard ranking. On this scale, a ranking of 1 represents the highest relative risk and a ranking of 5 represents the lowest relative risk. The County estimated that the site's hazard ranking, an indication of the potential threat to human health and/or the environment, was 2. In the SHA, surface water environmental toxicity was evaluated based on bioassay data rather than toxicity data, due to a single sample with a toxicity of 100 percent collected from a location adjacent to the BNSF railway. The SHA noted that this sample may have been impacted by spills from the railway. The SHA also stated that no groundwater contamination was documented on the upland side of the landfill and that groundwater was likely to move into the bay by seeps or tidal movement. The assessment concluded that groundwater contamination was unlikely to travel to any mainland well locations.

2.4 PREVIOUS ENVIRONMENTAL CHARACTERIZATION/SAMPLING INVESTIGATIONS

Previous investigations conducted prior to the RI included testing surface water and seeps, sometimes as part of studies that included sampling of sediments and/or biota. No soil or groundwater sampling had been conducted at the site prior to the RI. The approximate locations of samples collected during previous investigations are presented in Figure 2. Results from previous seep and surface water analyses conducted during those investigations are summarized in the RI/FS Work Plan (AMEC, 2008a). Summary pages from selected historical reports are presented in Appendix A.

2.4.1 Preliminary Assessment (Ecology, 1985)

The landfill was identified as a medium priority site based on a Preliminary Assessment conducted by Ecology and the U.S. Environmental Protection Agency (EPA) in November 1984. Several potential hazards, both to human health and the environment, were identified. These potential hazards included potentially contaminated groundwater, tidal incursions into the landfill, and groundwater seeps surfacing on the eastern landfill boundary.

The Preliminary Assessment recommended sampling and analysis of seeps for priority pollutants and, if necessary, installation and sampling of groundwater monitoring wells. Further recommendations included collection of historical data regarding industrial activities and waste disposal practices for industries operating in the vicinity of March Point. It is unclear if such information was ever collected (GeoEngineers, 2007).

2.4.2 Site Inspection (Ecology, 1986)

Following the Preliminary Assessment, Ecology conducted a site inspection at the landfill in December 1985. Three surface water samples and one seep sample were collected, consisting of:

- Background water sample from a borrow pit located 40 feet southwest of the landfill (NCT091);

- Estuarial stream sample on the southeast edge of the landfill (NCT092) (the sample map indicates the sample was obtained on the southeast side of the outer lagoon);
- Marine surface water sample collected at high tide on the northeast side of the landfill (NCT094) in the inner lagoon; and
- Seep sample collected from water displaying iron staining that was seeping through the area where a possible dike was previously located within the inner lagoon on the northeast side of the landfill (NCT095).

As reported by GeoEngineers (2007), the samples were analyzed for dissolved metals, volatile organic compounds (VOCs), and phenolics. Based on the analytical results, Ecology made the following conclusions:

> The sampling data do not show a significant problem at this landfill to warrant further sampling or remedial actions. There is no conclusive indication that hazardous materials are leaching from this landfill into Padilla Bay or its surrounding estuarial area. It is recommended that no further hazardous waste sampling or remedial actions be required at this site. (Ecology, 1986)

2.4.3 Analysis of Groundwater Seeps from Whitmarsh Landfill (Fitzgerald, 1989)

GeoEngineers (2007) reported that on June 1, 1988, Ecology obtained a grab sample of groundwater seeping from the northeast corner of the landfill. The sample was analyzed for priority pollutant metals. GeoEngineers reported that Ecology concluded that the results were "an indication of heavy metals problem at the Whitmarsh Landfill which will require further study." Cadmium, copper, lead, nickel, and zinc were determined to exceed marine water quality criteria.

2.4.4 Seep Sampling by Skagit County (Skagit County, 1996)

To address concerns expressed by the Swinomish Indian Tribal Community regarding potential contaminant releases from the landfill into Padilla Bay, Skagit County collected two groundwater seep samples at the landfill in October 1996. The Skagit County report (1996) reads "sample locations were selected based largely on discolored surface water emanating from the concrete rip-rap wall at points where it discharged to the adjacent mudflats. Two such discharge points were identified."

The samples were obtained from the northeast corner of the landfill within the inner lagoon and were analyzed for priority pollutants. The County concluded, "Based on the sample results from our investigation and Ecology's [1986] investigation, we agree with Ecology's findings and conclude that further investigation using county resources is not warranted at this time."

2.4.5 Ecology Investigation of Chemical Contamination at Whitmarsh Landfill and Padilla Bay Lagoon (Ecology, 1999)

Ecology collected two groundwater seep samples near the northeast corner of the landfill in June 1998. The sample locations appear similar to those sampled by Skagit County in October 1996 (Figure 2). The samples were collected to identify contaminants of potential concern to human health and the environment and to determine if additional sampling in Padilla Bay Lagoon would be necessary. The samples were collected from the two most prominent seeps from the landfill, and they were analyzed for metals, trace elements, cyanide, petroleum hydrocarbons, VOCs, polycyclic aromatic hydrocarbons (PAHs), phenols, chlorinated benzenes, phthalate esters, semivolatile organic compounds (SVOCs), polychlorinated biphenyls (PCBs), organotin compounds, pesticides, and herbicides.

Based on the sample results, Ecology concluded:

- The concentrations in seepage were generally low, in most cases less than thresholds of toxicity. Iron and the higher concentrations of the insecticide carbaryl (Sevin) were potentially toxic until further diluted. PCB Aroclor 1242 approached the chronic water quality criterion of 0.03 micrograms per liter (µg/L) for marine waters.

- Chemicals analyzed but not detected in the seepage were priority pollutant metals, cyanide, organophosphorus pesticides, organochlorine pesticides, and herbicides. Previous investigations by Skagit County and others have also shown that metals, cyanide, and pesticides are not important contaminants in seepage from the March Point Landfill (Ecology, 1999).

The report acknowledged that the analyses for this study included a wider range of compounds and lower detection limits than had been done previously (Ecology, 1999). However, some of the detection limits were still greater than the respective cleanup levels; therefore, the presence of these constituents was not precluded.

The tables in the report summarized the analyses conducted and showed that total petroleum hydrocarbons (TPH) in the diesel range (TPH-D) was detected in seep samples at concentrations ranging from 470 µg/L to 850 µg/L. No priority pollutant metals were detected. However, among the trace elements, manganese was detected at concentrations ranging from 127 µg/L to 234 µg/L, exceeding the Clean Water Act human health marine clean water criterion of 50 µg/L.

Ecology (1999) also reported that the Swinomish Indian Tribal Community collected a surface water sample from the inner lagoon near the landfill in September 1997. Ecology reported that “no organic compounds were detected and metals concentrations were low.”

Ecology (1999) also noted, in reference to the June 1988 Ecology investigation, that "cadmium, copper, lead, nickel and zinc substantially exceeded marine water quality criteria, prompting a recommendation for further study. This finding has not been confirmed by other sampling at Whitmarsh" (Fitzgerald, 1989). The cause of the higher metals concentrations, compared to other sampling events, was not addressed.

In AMEC's opinion, the cause was likely due to the presence of particulates/suspended solids in the samples analyzed by the laboratory. Metals are naturally occurring constituents in soil and sediment, and their presence in a water sample may cause an analytical result to be biased high. Immersing sampling containers that contain acid preservative (required for metals samples) into flowing surface water is likely to entrain sediment. The entrained sediment then dissolves into the acidified water (<2 pH) of the sample. This type of sampling issue can be avoided by collecting samples filtered through a 0.43-micrometer (µm) filter using a sampling pump to accurately reflect the dissolved metals concentrations in surface waters.

2.5 PREVIOUS NEARBY ENVIRONMENTAL INVESTIGATIONS

This section presents information with regard to previous environmental investigations near the site and is presented as a general overview of other environmental investigations in the vicinity of the site. The location and specific information regarding each individual investigation are presented in more detail below.

2.5.1 Burlington Northern Whitmarsh Rail Siding (2004)

The BNSF Whitmarsh Rail Siding facility is located approximately 850 feet northwest of the landfill, along the Padilla Bay shoreline north of South March Point Road (Figure 1). Operations at the siding facility over the last 70 years have included loading hazardous materials for shipment to appropriate facilities for treatment, disposal, and/or storage. The siding has been used by various companies, including Northwest Petrochemical, Tecnal Corporation, General Chemical Corporation, and Allied Chemical (Herrera, 2004).

A chemical spill and fire took place at the BNSF Whitmarsh Rail Siding site (aka Whitmarsh Siding site: Facility ID 2683) on July 31, 1991. Following the spill, approximately twenty three (23) 55-gallon drums of contaminated soil were excavated and removed from the site. No confirmation soil samples were collected during the removal, and the cleanup was limited to the area between the two sets of railroad tracks (Herrera, 2004). Two samples from the drummed soil were analyzed for PAHs. Analytical data from the drum samples indicated high concentrations of several PAHs, phenols, cresols, phenyl mercaptans, and cresyl mercaptans.

Ecology inspected the site in 1992 and found pieces of yellow material between several railroad ties (Ecology, 1992). It remains unclear whether this material has been removed. No samples have been collected in the spill area to confirm that soil concentrations are below MTCA cleanup levels (Herrera, 2004). Most of the site, including the spill area, drains directly into Padilla Bay. Based on information in the Herrera Environmental Consultants report, the site has been assigned a site status of “Awaiting Remedial Action” by the Ecology Toxics Cleanup Program (Herrera, 2004).

2.5.2 KAW Transport Spill (EPA ID # 110008220870)

A spill occurred at the intersection of Highway 20 and South March Point Road on September 7, 1989, when 2,500 pounds of hazardous waste solids were released. A Form 2, Notification of Dangerous Waste Activities, was filed with Ecology on September 21, 1989. The Form 2 indicated that the spill included both D-listed (arsenic, lead, and chromium) and WP-listed (halogenated hydrocarbon) wastes. Further, the Form 2 indicated the spill was completely cleaned up on September 8, 1989. KAW Transport, the responsible party for the release, filed a subsequent Form 2 to cancel the site listing on October 24, 1989.

No historical records have been identified that indicate whether confirmation sampling (soil or surface water) was conducted to evaluate whether all wastes were properly cleaned up. The spill location is upgradient and to the southeast of the landfill.

2.5.3 Swinomish Indian Tribal Community Phase 2 Environmental Site Investigation (2010)

The Swinomish Indian Tribal Community conducted a Phase 2 environmental site assessment for tribal property (Tribal Economic Zone Area 1) located adjacent to the site (EIGov, 2010). The primary focus of this Phase 2 investigation was tidelands adjacent to the former Whitmarsh Landfill and the BNSF rail spur. Potential contaminant sources being addressed in the investigation included the former Whitmarsh Landfill, petroleum coke spills along the BNSF rail spur, and stormwater from the drainage ditch adjacent to Highway 20.

A total of 48 co-located surface water and sediment samples were collected from the intertidal sediments located east and southeast of the former Whitmarsh Landfill (48 surface water samples and 48 sediment samples collected at the same location). The sample locations were restricted to tidelands owned by the Swinomish Indian Tribal Community. The sediment samples were analyzed for metals, dioxins/furans, VOCs, SVOCs, TPH-D, pesticides, PCBs, and Microtox analyses. The surface water samples were analyzed for metals, VOCs, SVOCs, TPH-D, pesticides, and PCBs.

EIGov used Oregon’s sediment screening levels to evaluate the sediment data rather than Washington State’s Sediment Management Standards (SMS). The sediment samples contained metals exceeding the Oregon Department of Environmental Quality (ODEQ) sediment screening levels for nickel, selenium, and vanadium. Only four out of 48 sediment samples exceeded the ODEQ sediment screening levels for phenol, 2,4 dimethylphenol and hexachlorobenzene. Pesticides were noted above the ODEQ sediment screening levels for DDT and its related metabolites in three sediment samples, Lindane in two sediment samples, and Heptachlor in one sediment sample. Notably, the three sediment samples collected immediately east of the Whitmarsh Landfill were judged to be non-toxic, using the Microtox analyses. None of the five sediment samples analyzed for dioxins and furans contained these compounds at concentrations exceeding the MTCA Method B soil cleanup level of 12.8 nanograms per kilogram (ng/kg) toxic equivalency quotient (TEQ) for unrestricted land use, or exceeding the sediment natural background value of 4 ng/kg TEQ (90/90 upper tolerance limit) for Puget Sound per the Draft Sediment Cleanup Users Manual (SCUM) II guidance (Ecology, 2015a).

The surface water samples contained metals exceeding the Washington State criteria for marine water for chronic exposure (WAC 173-201A-240) (marine water quality criteria) for cadmium, chromium, lead, mercury, nickel, and zinc. DDT, Aldrin, and Heptachlor epoxide exceeded the marine water quality criteria in one, two, and three samples, respectively. The EIGov report recommended additional sampling to determine contaminant migration pathways and eliminate additional source areas. The report also recommended performing a groundwater study to determine conclusively that the former Whitmarsh Landfill is the source of contamination (EIGov, 2010).

2.6 ZONING AND FUTURE LAND USE

The Whitmarsh Landfill lies within the City of Anacortes, and is currently zoned as “HM” or Heavy Manufacturing. AMEC contacted the City’s Department of Community & Economic Development, and the department confirmed that there are no plans to change the zoning for the foreseeable future (Measamer, 2014).

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3.0 SUMMARY OF REMEDIAL INVESTIGATION ACTIVITIES

The RI field work was conducted from October 2008 through August 2013. As described in the Draft RI/FS Work Plan, the RI was conducted in two phases: Phase I was completed from October 2008 through July 2009, and Phase II consisted of multiple sampling events conducted from April 2010 through August 2013. Numerous field activities were conducted at the site, including a geologic reconnaissance, geophysical survey, groundwater monitoring well installation, methane monitoring well installation and sampling, a marine sediment investigation, several rounds of water sampling (groundwater, seeps, surface water), test pit excavation, archaeological survey, a tidal study, and surveying.

Phase I field work was performed in accordance with the Phase I Uplands Sampling and Analysis Plan (SAP) that was included as an appendix to the Draft RI/FS Work Plan (AMEC, 2008a) and in accordance with the Sediment Investigation Work Plan (AMEC, 2008b). Phase II activities comprised several separate sampling events conducted based on three separate SAPs:

- Uplands Phase II RI Sampling and Analysis Plan (AMEC 2010a) (Phase II SAP);
- Landfill Gas Monitoring Work Plan (AMEC, 2011a); and
- Additional Soil and Groundwater Sampling Work Plan (AMEC, 2013) for metals and dioxins/furans.

Sediment sampling locations are presented on Figure 2 in Appendix B, and the uplands sample and seep/surface water sample locations are presented on Figure 5. A summary of environmental samples collected and the analyses performed during the Phase I and Phase II RI is presented in Table 1.

This section presents a brief summary of the RI field work. The full scope of the field studies and the methodologies used are described in more detail in Appendix C. Results of the RI activities are discussed in Sections 5, 6, and 7.

3.1 GEOLOGIC RECONNAISSANCE

On October 2 and 3, 2008, AMEC conducted geologic reconnaissance in the vicinity of the site to verify the geologic conditions presented in previous reports, as discussed in the RI/FS Work Plan (AMEC, 2008a). The geologic reconnaissance included:

- Hiking and observing conditions in the wooded areas adjacent to the site where access was allowed;
- Observation and assessment from South March Point Road and from along the perimeter of the property lines;

- Observation and evaluation from a distance of the exposed hillside on the industrial property to the southwest of the site;
- Observations while walking along the shoreline at the north and northwest margin of the site; and
- Observation and assessment of the Highway 20 road cut south of the site.

As discussed in Sections 3.1 and 3.2 in the RI/FS Work Plan (AMEC, 2008a), the local geology was generally found to be dominated by sand and gravel deposits laid down during the retreat of the latest glaciation (recessional outwash) in the region as well as more recent alluvial materials from the Swinomish Slough/Skagit River Delta (Savoca et al., 2009). Much of the site is underlain by soft silt and clay consistent with Padilla Bay tidelands.

The exposed hillside southwest of the site appeared to consist of alternating layers of glacial deposits, such as sands and gravel. Four different units were visible from the road below the observed topsoil layer. It appeared that these layers consisted of two thinner, predominantly gravel units, and two thicker, predominantly sand units. These observations were incorporated into the CSM discussed in Section 7.1.

3.2 GEOPHYSICAL INVESTIGATION

A geophysical investigation was conducted from September 11 through 14, 2008, to characterize the landfill material and to locate subsurface magnetic anomalies (e.g., buried drums) within the landfill. The investigation was conducted in accordance with Section 2.2 of the Phase I Uplands SAP.

The geophysical investigation was performed by Northwest Geophysical Associates, Inc. (NGA). The geophysical investigation included an electromagnetic (EM) survey utilizing the Geonics EM31 terrain conductivity meter and a magnetic survey utilizing the Geometrics G858G magnetometer/gradiometer. Both the EM and magnetic surveys were conducted on a 10-foot interval, which was sufficient to detect metallic objects such as drums, water heaters, and clothes washers. The EM and magnetic surveys could only be performed in areas of the landfill located away from the sawmill structures, concrete slabs with rebar-reinforcement, EM-conductive pipes, and above-grade and sub-grade electrical utilities.

The geophysical site investigation report (NGA, 2008) is presented in Appendix D.

3.3 MONITORING WELL INSTALLATION AND DEVELOPMENT

AMEC and Cascade Drilling installed 10 monitoring wells and three piezometers at and adjacent to the landfill:

- Monitoring wells MW-02 through MW-04 were installed in October 2008; and
- Monitoring wells MW-05 through MW-11 and piezometers PZ-01 through PZ-03 were installed in March and April 2010.

Three monitoring wells (MW-02 through MW-04) were installed upgradient and cross-gradient from the site in accordance with Section 2.5 of the Phase I Uplands SAP (AMEC, 2008a). The RI/FS Work Plan had proposed four monitoring wells to be installed: three wells within the Lower Aquifer and one deeper well. However, MW-01 was drilled to a total depth of 70 feet below grade and deeper water bearing zones were not encountered; therefore, no well was installed at boring location MW-01.

An additional seven monitoring wells (MW-05 through MW-11) and three piezometers (PZ-01 through PZ-03) were installed in March and April 2010 as part of the Phase II RI. These wells were located within the site boundary and were installed in accordance with Section 2.5 of the Phase II SAP (AMEC, 2010a). MW-05 and MW-07 were deeper wells screened below MLLW. The remaining wells were shallow wells screened within the solid waste.

Monitoring well and piezometer locations are presented on Figure 5. Field water quality parameter measurements are included in Table 2, and well construction details are summarized in Table 3. Field notes are included in Appendix E.

Soil samples were collected from monitoring well borings and submitted to the laboratory for chemical analysis according to the decision criteria established in the work plans (AMEC, 2008a, 2010a). Soil samples collected from monitoring well borings MW-02 through MW-04 during the Phase I RI were analyzed for a suite of 21 metals, including some metals (aluminum, barium, molybdenum, strontium, and titanium) not analyzed in samples collected during the Phase II investigation. Soil samples from monitoring well borings MW-05 through MW-11 installed during the Phase II RI were analyzed for a suite of 16 metals. However, all metals (except molybdenum and strontium) that exceeded the PCLs in one or more samples collected during the Phase I investigation were also analyzed for during the Phase II investigation. In addition to metals, soil samples collected from monitoring well borings MW-01, MW-03, and MW-04 were also analyzed for TPH as gasoline (TPH-G), VOCs, PCBs (MW-03 only), and pesticides (MW-03 only). Soil samples collected from monitoring well borings MW-08 and MW-10 were also analyzed for TPH-G, TPH-D, SVOCs, VOCs, PCBs, and pesticides.

3.4 SEDIMENT INVESTIGATIONS

Sediment samples were collected from the inner lagoon, the swale located south of the landfill, and a portion of the outer lagoon during four rounds of sediment sampling conducted from 2008 through 2011. The sediment samples were collected and analyzed in accordance with the methods described in the Sediment Investigation Work Plan (AMEC, 2008b).

The sediment investigations were conducted to achieve the following objectives:

- Determine if sediments within and adjacent to the inner lagoon adjacent to the site meet the biological criteria specified under Washington State SMS (WAC 173-204);
- Determine if sediments in the drainage swale south of the site contain COCs listed under the SMS at concentrations greater than the SMS cleanup criteria;
- Determine if dioxins/furans and PCBs in sediments that otherwise meet SMS biological criteria pose an unacceptable risk to human health; and
- Determine if any of the above impacts, if identified, are attributable to the landfill.

The data from these investigations were used to determine if sediments adjacent to the site pose an adverse risk to human health and the environment.

The sampling/analysis design for this project used a tiered testing approach:

- Tier 1 – Conduct biological testing (i.e., SMS bioassay tests; amphipod, sediment larval, and Microtox®) on sediment samples collected at selected sample locations;
- Tier 2 – Conduct chemical analysis for SMS COCs on sediment samples collected at selected sample locations or conduct chemical analyses for samples from stations that failed Tier 1 biological tests (WAC 173-204-320), and
- Tier 3 – Evaluate sediment samples (or composites of samples) that met the sediment quality standards biological criteria for potential unacceptable human health risk from bioaccumulative chemicals (dioxins/furans and PCBs) using an exposure scenario specified in the SMS.

Results of the biological and chemical testing and human health risk assessment were used to identify areas that may require additional investigation or to identify areas that may be considered for remedial action and to identify the source. The scope and methodology of the sediment sampling investigations is discussed in more detail in Appendix B.

3.5 LANDFILL TEST PITTING INVESTIGATION

A total of 44 test pits were excavated within the landfill footprint during the RI. The test pits were completed using the methods specified in the work plans listed in Section 3.0 (AMEC, 2008a, 2010a, 2013). The purpose of the Phase I test pits was to obtain soil samples and characterize the nature of landfill solid waste at the locations where geophysical anomalies were identified (Section 3.2). The goals of the Phase II test pit investigation were to delineate the extent of landfill solid waste, determine the nature and extent of landfill solid waste near well MW-03, characterize the northern part of the landfill, and collect soil samples adjacent to the solid waste to determine the nature and extent of soil contamination.

Soil samples were collected from soil horizons in the test pits dug in the landfill to characterize magnetic anomalies. In general, the samples were collected from soil adjacent to metallic objects or where other observations (staining, petroleum-like odor, etc.) suggested that soil may have been impacted by wastes, as described in the RI/FS Work Plan (AMEC, 2008a). During the test pit investigation, an archaeologist was present to screen soils for historical artifacts in or below the solid waste. The archaeological summary is provided in Appendix I.

AMEC and Phillips Service Corporation (the excavation subcontractor) initially mobilized to the site on October 29, 2008, to prepare for Phase I test pit excavation within the landfill footprint. A total of 11 test pits (G1 through G11) were excavated on October 30 to November 2, 2008, as presented on Figure 5.

A total of 33 additional test pits (G12 through G43, including G17.5) were excavated during Phase II activities. Four test pits (G12 through G14, and G31) were excavated by Clearcreek Contractors on October 29, 2009, along the northern boundary of the landfill parallel with the BNSF rail line. Test pits G15 through G30, including G17.5 and G31 through G40, were completed from March 29 through April 5, 2010 and test pits G41, G42, and G43 were excavated by Wyser Construction on March 27, 2013. The last three test pits were excavated at the request of Ecology for collection of soil samples to determine if dioxins and furans were present in the burned solid waste. Composite samples were collected from the walls of each of these final three test pits. The composite samples were prepared from six equal volumes of soil collected from each test pit. The sub-samples were collected from three walls in each test pit, with one subsample collected 6 inches above and the other 6 inches below the solid waste on each of the three side walls. The six soil sample volumes were homogenized into a single composite sample for each test pit (AMEC, 2013).

At each test pit located near the perimeter of the landfill, except the northwestern-most test pits (G30, G38, G39, and G40), if solid waste was encountered, the excavation was continued laterally toward the edge of the site boundary until no more solid waste was encountered. These test pits were backfilled with the materials excavated, and the point where no more solid waste was encountered was marked with a survey lath for subsequent surveying. All other test pits were excavated following the protocol outlined in Section 2.2.3 of the Phase II SAP. Test pits were excavated to the maximum depth or until groundwater was entered in the excavation and obscured visibility. At that point, the test pits were backfilled with material excavated, and the pits were abandoned.

Soil samples were collected from selected test pits during Phase I for chemical characterization and during Phase II for both chemical analysis (metals, TPH, SVOCs, VOCs, PCBs, organochlorine pesticides, and dioxins/furans) and geotechnical testing, according to the decision criteria established in the work plans (AMEC, 2008a; 2010a; and 2013). Table 1 lists the soil samples collected from each test pit and the associated laboratory testing program. A sample of material from inside a drum recovered from test pit G30 (sample G30 – DRUM) was also collected to characterize the contents of the drum.

Test pit logs are presented in Appendix F.

3.6 GEOTECHNICAL INVESTIGATION

Samples of Bay Mud outside the perimeter of the landfill, as well as underneath the landfill, were collected in order to determine the hydraulic and physical properties of the Bay Mud in its natural state as well as in its compressed or loaded state buried beneath the solid waste. All geotechnical samples were collected in accordance with the Phase I Uplands SAP and the Phase II SAP (AMEC, 2008a, 2010a). Five Bay Mud samples were collected using Shelby tubes during the Phase II RI at locations G17.5, MW-08, MW-10, ST-01, and ST-02. Additional soil samples for geotechnical analysis were collected by grab sampling or using Shelby tubes at test pit locations G15, G16, G18, G20, and G24.

3.7 GROUNDWATER/SEEP INVESTIGATIONS

Groundwater and seep water samples were collected in 2008, 2009, 2010, and 2013. All water samples were collected and analyzed in accordance with the methods specified in the Phase I Uplands SAP, the Phase II SAP, and the Additional Soil and Groundwater Sampling Work Plan (AMEC, 2008a, 2010a, 2013). Groundwater and seep samples were collected during nine separate sampling events (Table 1):

- Four separate sampling events were conducted during the Phase I RI from October 2008 through July 2009 to provide a baseline assessment of chemical concentrations in groundwater and seep water during both dry season and wet season regimes. Groundwater and seep samples were collected on October 14–15, 2008, December 17–19, 2008, April 28–29, 2009, and July 23–24, 2009, from three monitoring wells (MW-02, MW-03, and MW-04) and three seep locations (SP-01, SP-02, and SP-03). The samples collected in October 2008 were collected during dry conditions before the fall and winter rains and were intended to represent dry season conditions. The samples collected in December 2008 were collected during the winter rainy period and were intended to represent wet season conditions. The seep sample locations were selected based on field observations on October 14, 2008, during a site walk with Skagit County. All three seeps are located along the eastern boundary of the site adjacent to the inner lagoon. No additional seeps were evident along the eastern landfill boundary. Sample locations are shown on Figure 5.

- Three additional sampling events were conducted during the Phase II RI in April, July, and October 2010 to provide baseline groundwater quality data for the monitoring wells installed during the Phase II investigation as well as continued groundwater monitoring of wells and seeps sampled during the Phase I investigation. Three quarters of groundwater monitoring was conducted for the entire well network (MW-02 through MW-11) and for seeps SP-01 through SP-03.
- Two additional sampling events were conducted on March 26 and August 17, 2013, to provide additional data on dissolved and total metals concentrations in groundwater samples from selected monitoring wells, and to determine if dioxins and furans were present in groundwater from wells near the area where solid waste was burned prior to 1972. Ecology requested that these additional groundwater samples be collected during the wet season and the dry season from wells MW-05 through MW-09 for analysis of total and dissolved metals. In addition, groundwater samples from two wells (MW-08 and MW-09) were analyzed for dioxins and furans.

The samples collected and analyses performed are summarized in Table 1. Results of field water quality parameter measurements are presented in Table 2. Copies of field notes are provided in Appendix E.

3.8 SURFACE WATER INVESTIGATIONS

Surface water samples were collected concurrently with groundwater and seep samples during seven sampling events in 2008, 2009, and 2010. All surface water samples were collected in accordance with the methods specified in the Phase I Uplands SAP and the Phase II SAP (AMEC, 2008a, 2010). Results of field water quality parameter measurements are presented in Table 2. Copies of field notes are provided in Appendix E.

Seven surface water sampling locations (SW-01 through SW-07) were designated in the SAPs (Figure 5). Samples were collected from five of these locations (SW-01, SW-03, SW-04, SW-05, and SW-06) during all seven sampling events. Location SW-07 was sampled only during the December 2008 and April 2009 events. No surface water was flowing at SW-07 during the dry season sampling events in October 2008 and July 2009 or during the three 2010 sampling events; consequently, samples were not collected at SW-07 during these sampling events. The proposed sampling location SW-02 was not sampled during any of the sampling events because the location was dry. The location for SW-01 was chosen because it represents stormwater upgradient of the landfill. The locations for SW-02 through SW-04 were chosen to represent stormwater that collects along the western and southern boundaries of the site. The location for SW-05 was chosen because this area collects surface water flowing from the southeast toward the inner lagoon. The location for SW-06 was chosen to represent surface water within the inner lagoon. The location for SW-07 was chosen to represent surface water along the northern boundary of the landfill along the BNSF right-of-way.

3.9 TIDAL STUDY

Transducers were deployed in April 2010 inside all monitoring wells and piezometers except MW-02 and MW-04, which are considered upgradient and hydrologically isolated from the other wells. All wells with installed transducers, except MW-05 and MW-07, were screened within the solid waste and wood waste above the Bay Mud unit. The transducers were installed on April 16, 2010, in accordance with Section 2.7 of the Phase II SAP (AMEC, 2010a), and set to record data every 15 minutes. Two stilling wells were installed on June 24, 2010, one located in the inner lagoon (referred to as MARSH, see Figure 5) and the other at the Twin Bridges Marina on the Swinomish Channel. Stilling wells are used to record water levels while minimizing the influence of waves and to protect the transducers. The MARSH stilling well reflects the tidal variability in the inner lagoon, while the Twin Bridges stilling well represents tidal variations in Padilla Bay. Both of these locations were subsequently surveyed and instrumented with transducers to allow for collection of accurate tidal data. Data were downloaded from the transducers during the groundwater sampling events in July and October 2010 as well as at the end of January 2011. The transducer data are included in Appendix G, and the tidal water level fluctuations are discussed in Section 6.2.

3.10 LANDFILL GAS INVESTIGATION

In 2010, AMEC measured methane concentrations in the headspace of selected groundwater monitoring wells at the site. In June 2010, Ecology informed the Whitmarsh PLP group about Ecology's concerns regarding the presence of methane at the landfill, especially in on-site structures. AMEC performed methane monitoring for one month at five building locations at the sawmill and in the headspace of 13 groundwater monitoring wells following the procedures outlined in the Methane Detection/Monitoring Plan (AMEC, 2010b).

In a follow-up letter dated October 5, 2010, Ecology requested that additional data be collected to determine the nature and extent of LFG within the landfill. Ten LFG probes (LFGP-01 through LFGP-10) were installed around the landfill (Figure 5) to assist in determining LFG occurrence within the solid waste and within the wood waste layers. Monitoring was conducted in October 2011, January 2012, and April 2012 according to the methods described in the Landfill Gas Monitoring Work Plan (AMEC, 2011a). The methane results and technical memoranda are presented in Appendix H, and summarized in Section 5.7.

3.11 ARCHAEOLOGICAL SURVEY

Archaeological monitoring was performed during the test pit program and no archaeological materials were found at the landfill. A separate archaeological survey was performed along South March Point Road in May 2010 (AMEC, 2011b). This survey was completed using a series of shovel test probes according to the methods outlined in the Archaeological Survey in Appendix I. The archaeological survey results are summarized in Section 5.8.

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4.0 IDENTIFICATION OF CONSTITUENTS OF CONCERN AND PRELIMINARY CLEANUP LEVELS

This section describes the approach used to develop PCLs for the site. The PCLs must be established for any potentially affected media and must be appropriate for the land use and relevant exposure pathways identified in the CSM. Affected media identified through previous investigations include soil, groundwater, sediment, and surface water.

4.1 PRELIMINARY SCREENING LEVELS

Preliminary screening levels were developed in the Draft Uplands RI/FS Work Plan (AMEC, 2008a) to provide a mechanism to evaluate analytical results. In order to encompass a full range of potentially applicable standards, the screening levels were developed for a full suite of COCs, using conservative assumptions that may or may not apply to the site. These screening levels were used to evaluate analytical results obtained during each phase of the RI. The screening levels developed earlier have been updated to PCLs for the RI/FS, following the procedures described below. The PCLs were only updated for compounds that were detected at least once in soil, groundwater (including seeps), sediment, and surface water during the RI.

4.2 SELECTION OF PRELIMINARY CLEANUP LEVELS

MTCA regulations require that remedial action alternatives achieve cleanup standards. MTCA regulations establish three primary components for cleanup standards:

- Cleanup levels for COCs;
- The location of the point of compliance where these cleanup levels must be met; and
- Other regulatory requirements that apply to the site.

MTCA regulations define three basic methods of determining cleanup levels for soil and groundwater.

- Method A – applies to “routine” sites or where few hazardous substances are involved. Method A cleanup levels have been established for unrestricted and industrial land uses.
- Method B – the “universal” method that can be applied to all media at all sites (unrestricted and industrial use). Two types of Method B cleanup levels can be used: standard (or default) cleanup levels based on standard assumptions, and modified cleanup levels that incorporate chemical-specific or site-specific information.
- Method C – a conditional cleanup level that can be used where more rigorous cleanup levels cannot be achieved. Similar to Method B, Method C comprises two types: standard and modified. Use of Method C cleanup levels requires institutional controls

to provide future protection of human health and the environment and is generally applicable only to industrial sites.

For carcinogenic COCs, MTCA Method B and Method C cleanup levels are generally defined by the upper bound of the estimated lifetime cancer risk for individual carcinogens, which cannot exceed 1×10^{-6} and 1×10^{-5}, respectively, for each method. Hazard indices for both Methods B and C cannot exceed 1.0, and the total risk for COCs under each method cannot exceed 1×10^{-5}.

Under the Revised Code of Washington (RCW) 70.105D.030 (2)(d), cleanup standards under MTCA Methods A, B, and C are required to be “at least as stringent as all applicable state and federal laws.” These requirements are similar to the ARARs approach of the federal superfund law, and are described in their entirety in WAC 173-340-710.

Preliminary site-specific cleanup levels must be protective of the pathways established in the CSM, including, but not limited to, the following media exposure pathways:

- Soil – industrial direct human exposure pathways (ingestion, inhalation, dermal absorption);
- Soil – groundwater pathway (protective of a groundwater level that accounts for all groundwater-related pathways, including migration to surface water);
- Sediment – protection of aquatic life, direct human contact, and human exposure through bioaccumulation; and
- Groundwater – the groundwater-to-surface water pathway.

4.2.1 Preliminary Cleanup Levels for Soil

The site is a landfill, and public access will be restricted under all of the remedial alternatives considered in the FS. A potential part of the preferred remedy could involve placement of an impermeable cap over the residual contamination; therefore, MTCA Method C soil cleanup levels are appropriate if containment is part of the selected remedy. MTCA Method C industrial soil cleanup levels are based on adult occupational exposures and assume that current and future land use will be restricted to industrial purposes. If all of the solid waste is removed or if the landfill remains in its current state with no containment and no impermeable cover, then MTCA Method B soil cleanup levels may be more appropriate.

PCLs for soil are selected by choosing the minimum of the following MTCA cleanup levels:

- MTCA Method C (carcinogenic and noncarcinogenic) Industrial Cleanup Level based on direct contact/ingestion obtained from Ecology’s Cleanup Levels and Risk Calculation (CLARC) website (Ecology, 2014);

- MTCA Method A Soil Cleanup Levels for Industrial Land Use (MTCA Table 745-1) for those constituents with no available MTCA Method C cleanup level;
- Soil cleanup levels protective of the preliminary groundwater cleanup levels described in Section 4.2.2 (WAC 173-340-747[4]); soil cleanup calculations and input parameters are provided in Appendix J;
- While an exemption is requested, until one is received, values are included for MTCA Terrestrial Ecological Evaluation (TEE) soil cleanup level for industrial or commercial sites from WAC 173-340-900 (Table 479-2 of MTCA cleanup regulations); and
- EPA Regional Screening Levels (Formerly EPA Region 9 Preliminary Remediation Goals), based on the dust/particulate ingestion pathway.

After selecting the minimum value from the levels described above, the PCLs are established below for use in the RI. For some constituents, the preliminary Method C cleanup levels were revised upward when compared to natural background levels and laboratory practical quantitation limits (PQLs) in accordance with the MTCA regulations (WAC 173-340-709 and WAC 173-340-705[6]). The modified Method C PCLs were established as follows (Table 4):

- The risk-based soil cleanup level selected for each constituent was compared to the natural background concentration. If the risk-based cleanup level was less than the natural background concentration, the natural background concentration was selected for comparison to the PQL.
- If natural background concentrations were lower than the risk-based soil cleanup level, the risk-based soil cleanup level was selected for comparison to the PQL.
- If the selected natural background concentration or risk-based soil cleanup level was less than the PQL, the PQL was selected as the PCL.

Natural background levels for metals were defined by Ecology (1994) for the Puget Sound area. Puget Sound natural background values were calculated as the 90th percentile value using Ecology's MTCA*Stat* program on a sample set of n = 45. Screening levels that were below the defined Puget Sound natural background levels were adjusted up to the applicable natural background level in accordance with the limitations set forth in WAC 173-340-706(6).

The value for chromium was set at a calculated value, rather than the value defined by Ecology. Data for the calculation were obtained from the Ecology (1994) report for 10 sample locations closest to Anacortes. Ecology's MTCA*Stat* program was used to calculate the 90th percentile concentration and four times the 50th percentile concentration for total chromium. WAC 173-340-709(3)(c) defines background concentration as the lower of the two values for log-normally distributed data sets. The lower value (four times the 50th percentile concentration) was determined to be the appropriate background concentration for the Anacortes area. The background total chromium concentration calculated using this method is 117 milligrams per kilogram. The MTCA*Stat* output for calculation of background chromium concentrations was provided as Appendix D in the RI/FS Work Plan (AMEC, 2008a).

The target PQLs shown in Table 4 are the lowest soil reference levels for each analyte, when available. For analytes with no soil reference levels, standard laboratory reporting limits are included in Table 4. The PQLs were obtained from the current project laboratory, Analytical Resources, Inc. (ARI) of Tukwila, Washington, an Ecology-accredited laboratory. The preliminary soil cleanup levels chosen in the manner described above are summarized on Table 4.

4.2.2 Preliminary Cleanup Levels for Marine Sediments

PCLs for marine sediments based on protection of human health are shown in Table 5. PCLs were established for PCBs and dioxins and furans, which were the analyses performed on the marine sediment samples collected during the RI. Marine sediment PCLs were identified following the SCUM II guidance (Ecology, 2015a).

Marine sediment cleanup levels are selected by choosing the minimum from the following:

- Natural background –obtained from Table 10-1 of the SCUM guidance;
- Laboratory PQLs – obtained from Table 11-1 and Appendix D of the SCUM guidance; and
- Risk-based standards – as illustrated in Chapter 8 of the SCUM guidance. Risk-based standards are established as the lowest of:
  - Benthic sediment cleanup objective – obtained from Table 8-1 of the SCUM guidance
  - Human health risk of less than $1x10^{-6}$ and Hazard Quotient =1
  - Higher trophic level risk, and
  - Applicable laws.

The marine sediment cleanup levels are set at Natural Background, Risk Based Standards or PQL, whichever is highest. The preliminary marine sediment cleanup levels are summarized in Table 5.

4.2.3 Preliminary Cleanup Levels for Groundwater and Seeps

PCLs for groundwater are based on protection of marine surface water. Analytical results for groundwater presented in Section 5.5 were compared to marine surface water criteria, rather than MTCA Method A or Method B drinking water criteria, because groundwater will not be used as a current or potential future source of drinking water. Groundwater has been found to be discharging to marine surface water, and the marine surface water criteria are more conservative for many COCs.

Candidates for groundwater PCLs based on values available in the CLARC database are presented in Table 6 for all constituents detected in samples collected during previous upland investigations.

PCLs for groundwater are selected by choosing the minimum of the following MTCA cleanup levels:

- Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A) – Acute and Chronic effects, Aquatic Life, Freshwater and Marine Water;
- National Recommended Water Quality Criteria (Clean Water Act §304) – Freshwater and Marine Water, Acute and Chronic effects, Aquatic Life and for the Protection of Human Health, Consumption of Water and Organisms and Consumption of Organisms Only;
- National Toxics Rule (40 Code of Federal Regulations [CFR] 131) – Freshwater and Marine Water, Acute and Chronic effects, Aquatic Life, and Human Health, Consumption of Water and Organisms; and
- MTCA Method B Surface Water levels calculated using Ecology's CLARC tables if a federal or local surface water value is not found in the above references (Ecology, 2014).

For constituents that do not have a surface water value using the references above, the minimum value from the following MTCA cleanup levels was selected as the PCL:

- MTCA Method A levels for constituents that do not have a Method B level available; and
- MTCA standard Method B levels based on drinking water beneficial use, which include Federal Maximum Contaminant Levels (EPA, 2009; Ecology, 2014).

For some constituents, the preliminary Method B cleanup levels were revised upward in accordance with the MTCA regulations ([WAC 173-340-705[6]) so that the screening levels were not lower than the PQLs obtained by the project laboratory. The PCLs established by this process are modified MTCA Method B cleanup levels.

The target reporting limits (PQLs) in Table 6 are the lowest groundwater reference levels for each analyte, when available. For analytes with no groundwater reference levels, standard laboratory reporting limits are included in Table 6. The PQLs were obtained from ARI, the current project laboratory. The preliminary groundwater cleanup levels chosen in the manner described above are summarized on Table 6.

4.2.4 Preliminary Cleanup Levels for Surface Water

PCLs for surface water based on protection of marine surface water are shown in Table 7. Candidates for surface water PCLs based on values available in the CLARC database are presented in Table 7 for all constituents detected during previous upland analyses.

Surface water reference levels were identified using the following sources:

- Water Quality Standards for Surface Waters of the State of Washington (WAC 173-201A) – Acute and Chronic effects, Aquatic Life, Freshwater and Marine Water;
- National Recommended Water Quality Criteria (Clean Water Act §304) – Freshwater and Marine Water, Acute and Chronic effects, Aquatic Life and for the Protection of Human Health, Consumption of Water and Organisms and Consumption of Organisms Only;
- National Toxics Rule (40 CFR 131) – Freshwater and Marine Water, Acute and Chronic effects, Aquatic Life, and Human Health, Consumption of Water and Organisms; and
- MTCA Method B Surface Water levels calculated using Ecology's CLARC tables if a federal or local surface water value is not found in the above references (Ecology, 2015b).

The target reporting limits (PQLs) in Table 7 are the lowest surface water reference levels for each analyte, when available. For analytes with no surface water reference levels, standard laboratory reporting limits are included in Table 7. The PQLs were obtained from the current project laboratory, ARI. The preliminary surface water cleanup levels chosen in the manner described above are summarized on Table 7.

4.3 GROUNDWATER CONDITIONAL POINT OF COMPLIANCE

The majority of remedial alternatives would involve a low-permeability cap to limit infiltration and a reduced permeability earthen berm to reduce lateral flow of groundwater beyond the existing landfill footprint (see Sections 11–15). As such, once remedial measures are implemented, movement of groundwater present within the solid waste will be mainly restricted to downward vertical migration through the Bay Mud underlying the solid waste. The point of greatest concern is the marine shoreline north and east of the landfill, and therefore the conditional point of compliance will be established in a series of wells installed through the Bay Mud near the shoreline of the inner lagoon. A series of monitoring wells will be installed into the solid waste and along the shoreline into the first aquifer underlying the Bay Mud (Lower Aquifer) and monitored for water quality on a periodic basis. Lateral movement of groundwater migrating into the lagoon will be monitored by sampling seeps periodically.

The appropriate sampling periods for both groundwater and seeps will be determined during the development of the Cleanup Action Plan (CAP).

Although we refer to water in the solid waste as “groundwater,” the water is defined as “leachate” under WAC 173-304. However, the solid waste has been covered with a permeable sand cover for several decades, and the landfill has no bottom liner except for that provided by the Bay Mud. So while the water in the solid waste is technically leachate, ongoing infiltration of rainwater over many years has leached material from the solid waste so that the water acts like a perched groundwater body within the unconfined solid waste. In this report, perched groundwater within the solid waste will be referred to as groundwater or landfill groundwater for the purposes of discussion.

4.4 TERRESTRIAL ECOLOGICAL EVALUATION

During completion of the RI, the need to complete a TEE was discussed with Ecology. Most of the remedial options considered in this RI/FS will isolate the solid waste from the environment through use of a wildlife-impenetrable cover liner or by removal of the solid waste from the site entirely. As stated in WAC 173-340-7491(1)(b), an exemption from a TEE is appropriate when “all soil contaminated with hazardous substances is, or will be, covered by buildings, paved roads, pavement or other physical barriers that will prevent plants or wildlife from being exposed to the soil contamination.” Exclusion from a TEE requires an institutional control under WAC 173-340-440.

If the preferred remedial alternative isolates the solid waste and soil from the environment and establishes institutional controls meeting the requirements of WAC 173-340-440, an exclusion from the requirement for a TEE will be requested from Ecology.

If the preferred remedial alternative does not isolate the solid waste from the environment (for instance, if burrowing animals can breach the cover liner) then a TEE will need to be completed in order to show whether or not the preferred remedial alternative poses a risk to the burrowing animals or if additional engineering steps are necessary to isolate the solid waste from the environment. In either case, implementation of institutional controls meeting the requirements of WAC 173-340-440 will still be required.

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5.0 NATURE AND EXTENT OF CONTAMINATION

This section presents the data gathered during Phase I and Phase II of the RI and discusses the nature and extent of detected levels of contamination. The discussion below is organized by the medium or investigation approach.

5.1 GEOPHYSICAL INVESTIGATION RESULTS

Field data from the geophysical surveys were post-processed as described in the Geophysical Investigation Report prepared by NGA (NGA, 2008), which is included as Appendix D. The geophysical survey data indicated 11 anomalies of interest (G1 through G11 on Figure 6). Anomalies of interest G1 through G8 were selected from magnetic survey data (primarily from analytical signal data) and represent targets that exhibited a magnetic signature across two or more transect lines (Figure 6 in Appendix D). Anomalies exhibiting signatures across two or more transect survey lines are more likely to be concentrations of metallic debris in the subsurface than are single source items. Anomalies of interest G9 through G11 were selected from EM data (primarily from the in-phase data) and represent anomalies that exhibited EM signatures consistent with those of metallic conductive bodies.

Test pits were excavated at the location of each of the geophysical anomalies, as described in Section 3.5. Metal debris potentially responsible for the anomalies identified during the geophysical investigation was encountered at all test pit locations (Figure 6 of Appendix D). One partially crushed steel drum was unearthed at test pit location G9. The drum contained fiberglass material and solidified resin. No external markings or labels were present on this drum. Five to six partially crushed steel drums were unearthed at test pit location G10. One of those steel drums contained one plastic drum inside the outer steel drum. Several markings were found on these drums, including “Amoco 543,” “Nalco,” and “UOP Polymerization Catalyst.” Representative photographs of the unearthed drums are included in Appendix K. The other metal debris encountered included old appliances, auto parts, sinks, pressure vessels, and an armored air hose. One clip of old ammunition was unearthed at G5. Excavation at location G1 was terminated prior to reaching the proposed depth and prior to groundwater being encountered due to the presence of suspected asbestos-containing material. This material was sent for asbestos analysis at NVL Laboratories, Inc. in Seattle, Washington. Analytical results confirmed that the material contained 23 percent chrysotile, a common form of asbestos.

A linear magnetic/EM anomaly feature was also detected between locations G1 and G10 (Figure 6). This anomaly is approximately 400 feet long and is not consistent with magnetic or EM data signatures exhibited by buried drums. More likely, this anomaly is due to the presence of deeper steel pipes, a reinforced concrete pipe, or other material with a different magnetic signal than nearby soils. Based on a review of historic aerial photography for the site and observations during excavation of test pits G21 and G23, this anomaly is most likely related to an old roadbed created using imported materials with a different magnetic signal than the native soils underlying the site. This is discussed in more detail in Section 7.1.1.

In summary, large numbers of drums or other sources of hazardous or dangerous waste were not identified within the landfill during the Phase I and Phase II investigation. Most of the test pit anomalies were identified as typical municipal solid waste (e.g., washing machines, miscellaneous metal debris, and burnt solid waste). Empty drums were identified in only three out of a total of eleven test pits.

5.2 SEDIMENT RESULTS

Sediment bioassay and analytical results were used to determine whether marine sediment in the two separate decision units (Unit A and Unit B) adjacent to the site pose an adverse risk to the human health and the environment.

5.2.1 Sediment Decision Unit A

Sediment Decision Unit A comprises the Inner and Outer Lagoon areas, excluding the area near the culvert adjacent to the southeastern portion of the landfill and the associated drainage channel running along the east side of the landfill.

5.2.1.1 Evaluation of Tier I Testing – Bioassay

Two rounds of bioassay testing were conducted on sediments collected within Sediment Decision Unit A. Sediments collected within the inner lagoon adjacent to the site during the initial round of sampling were screened for toxicity using a suite of three bioassays: an acute 10-day amphipod bioassay using *Ampelisca abdita*, a chronic 48- to 96-hour sediment larval test using *Dendraster excentricus*, and a chronic saline pore water Microtox® bioassay (See Appendix B). None of the amphipod or sediment larval tests exceeded the SQS criteria; however, the Microtox® pore water bioassay exceeded the SQS at seven locations within the inner lagoon.

Following discussions with Ecology and the conclusion that there may have been factors other than SMS COC chemistry that contributed to the Microtox® bioassay SQS exceedances, a second round of sediment sampling was conducted at the locations with Microtox® pore water bioassay SQS exceedances (see Figure 3 in Appendix B). The additional sediments were screened for toxicity using the standard chronic 20-day *Neanthes arenaceodentata* (juvenile polychaete) growth and survival test (Table 7 in Appendix B). The endpoints were determined using the standard endpoint and using the ash-free dry weight endpoint. The complete bioassay report is provided in Appendix B. One of the 20-day juvenile polychaete tests exceeded the SQS criteria, but the remaining sediments met the SQS criteria.

All of the sediments tested with the Microtox® pore water bioassay during the second round of bioassay testing that were tested within two to three days of sample collection passed the SQS criteria, but samples held for longer holding times showed an increasing number of failures (Table 8 in Appendix B). Based on the results of the bioassay testing conducted on the Round 2 sediments, the Microtox® bioassay SQS exceedances during the Round 1 testing appear to be the result of increased toxicity associated with longer holding times, and not with chemistry.

5.2.1.2 Evaluation of Tier III Testing – Bioaccumulative COCs

PCBs were not detected in any of the composite samples from the inner lagoon or Padilla Bay north of the BNSF railroad spur; however, one composite sample (MPC-2) did have elevated reporting limits due to matrix interference (Table 9 in Appendix B and Figure 7). PCBs were not detected in the discrete samples collected adjacent to two potential point sources (MP-26 or MP-27) within the inner lagoon (Figure 7).

The composite samples and the discrete samples from the inner lagoon were analyzed for dioxins and furans (Table 10 in Appendix B). A TEQ was calculated for selected congeners using the World Health Organization 2005 toxicity equivalency factors (Van den Berg et al., 2006), and the TEQ is consistent with updated SMS, as shown in Table 6-2 of the SCUM guidance (Ecology, 2015a). TEQs for the samples ranged from 0.36 parts per trillion (pptr[1]) to 4.17 pptr (Table 10 in Appendix B and Figure 7).

5.2.2 Sediment Decision Unit B

Sediment Decision Unit B comprises sediments located near the surface water culvert adjacent to the southeastern portion of the landfill and within the drainage channel along the east side of the landfill.

5.2.2.1 Evaluation of Tier III Testing – Bioaccumulative COCs

PCBs were not detected in the discrete samples collected adjacent to surface water culvert (MP-25, Figure 7); however, dioxin/furan concentrations at MP-25 (47.82 pptr) were substantially higher than any other sample from the inner lagoon. This anomalous result prompted further investigation of the distribution of dioxins and furans in the tidal drainage channel downgradient of sample MP-25 (MP-34 through MP-39; Figure 7). The TEQs for these samples ranged from 0.69 pptr to 13.62 pptr (Table 10 in Appendix B and Figure 7). The TEQ values did not show a consistent trend in decreasing concentration with distance from the suspected upgradient source near MP-25. Sediments collected in the ditch had total organic carbon (TOC) values that ranged from 1.01 to 5.23 percent, and total percent fines (grain size < 63 µm) ranged from 1.5 percent to 61.6 percent. Dioxins and furans are

1 pptr is equivalent to picograms per gram.

associated with the finer organic fractions and samples with a higher percentage of TOC and fines had higher concentrations. The concentration of dioxins and furans in samples within the ditch with TOC values and percent fines similar to the values seen at MP-25 (4.64 percent TOC and 44 percent fines) had substantially lower TEQs (Table 10 in Appendix B).

5.2.2.2 Potential Sources of Dioxin within the Watershed

An evaluation of the potential sources of dioxins and furans was also conducted for the site sediment samples as well as additional data from literature (for potential dioxin sources) and samples collected from Fidalgo Bay, Padilla Bay, and Samish Bay (provided in Appendix B). The evaluation concluded that:

- The signatures of dioxins and furans in all samples collected in this study are clearly distinguished from those associated with dioxins/furans from wood burning, trash burning, and municipal solid waste incineration, as derived from the literature cited dioxin/furan signatures (see Appendix B).
- The signatures of dioxins and furans in collected samples from this study can be accounted for by a mixture of signatures for typical marine sediments near stormwater outfalls and regional background samples from nearby Padilla Bay and Fidalgo Bay, as derived from the cited literature (see Appendix B).
- Samples collected from locations closer to the stormwater culvert adjacent to the southeast portion of the site (SE Culvert on Figure 7) are more similar to the dioxin/furan signature of stormwater runoff (Figure 6 in Appendix B). Samples in the lagoon have a dioxin/furan signature more closely resembling Puget Sound regional background data. This gradient of signature, from stormwater outfall to background, reflects the spatial arrangement of the samples moving away from the SE Culvert (MP-25).
- In general, total dioxin/furan concentrations in the samples collected display a decreasing concentration gradient from the SE Culvert (MP-25) to the receiving tidal drainage channel, to the inner lagoon and, finally, to Padilla Bay, north of the BNSF railroad spur (Figure 7).
- This gradient is also reflected in the proportional contribution of octa-chlorinated dibenzo dioxin, which accounts for the majority of the dioxins and furans in collected samples and Puget Sound regional background samples (Figure 8 in Appendix B).
- A watershed assessment which included an outfall survey conducted as part of the Whitmarsh Landfill RI indicates that the SE Culvert (where MP-25 was located) drains surface water runoff from areas upgradient of the site (Figure 9 of Appendix B).

5.2.3 Conclusions

This section presents the findings of the data evaluation for Decision Units A and B.

5.2.3.1 Sediment Decision Unit A

Evaluation of the data presented in Section 5.2.1 for the 32 sediment sampling points that are included in Sediment Decision Unit A shows that:

- No impacts on sediments in the inner lagoon or Padilla Bay associated with the landfill were identified.

Initial failures of the Microtox® bioassay test are attributable to longer holding times for initial bioassays and not to ecological effects of the landfill on adjacent sediments. This conclusion was based on expanding toxicity testing, which was conducted based on collaborative discussions with Ecology staff.

Based on these findings, no additional sediment investigations in Sediment Decision Unit A are warranted, and the sediments adjacent to the site will not be considered for remedial measures in this RI/FS.

5.2.3.2 Sediment Decision Unit B

Evaluation of the data presented in Section 5.2.2 for the seven sediment sampling points included in Sediment Decision Unit B show that:

- No impacts on sediments in the inner lagoon or Padilla Bay associated with the landfill were identified.
- Watershed studies conducted as part of the Sediment RI (Appendix B) show that a stormwater culvert southeast of the site (near sediment sample MP-25 and surface water sample SW-05) discharges stormwater runoff draining from areas upgradient of the site. These results provide multiple lines of evidence that a source unrelated to the Whitmarsh Landfill is contributing to dioxins and furans in the drainage channel and the remainder of the decision unit, and that the influence of this culvert decreases moving away from sediment sample MP-25 (Figure 7).
- The dioxins and furans detected in the sediment near the SE Culvert do not originate from a source within the landfill. Ecology has concurred that the source(s) of dioxins and furans in the drainage channel adjacent to the site are not associated with the Whitmarsh Landfill.

Based on these findings, no additional sediment investigations in sediment decision unit B are warranted, and the sediments adjacent to the site will not be considered for corrective measures in this RI/FS.

5.3 TEST PIT RESULTS FOR LIMITS OF SOLID WASTE

Test pits were used to delineate the extent of solid waste at the site. Solid waste was found at the northwest end of the landfill, and observations while excavating test pits G29, G30, and G38 through

G40 revealed that the solid waste in this area was not overlain by cover soil. AMEC was also unable to determine the solid waste limits between G18 and G19 due to access limitations. The approximate solid waste limits are shown in Figure 5.

5.4 SOIL SAMPLE RESULTS

A total of 40 soil samples were collected at depths ranging from 1 to 37 feet below ground surface during monitoring well installation and the landfill test pit investigation. These include 38 primary soil samples, one field duplicate soil sample, and one sample of material collected from inside a drum recovered from test pit G30. Soil samples from monitoring well and test pit locations were submitted for laboratory analysis according to the decision criteria established in the work plans. A summary of all upland samples collected and the analysis scheme are presented in Table 1.

Soil analytical results exceeding PCLs are shown on Figure 8 and are summarized in Table 8. The complete soil analytical tables are included in Appendix L. Soil results that exceeded the PCLs are discussed in more detail below.

5.4.1 Monitoring Well Soil Sample Results

Analytical results for monitoring well soil samples that exceed PCLs are presented in Table 8. Borings MW-01 and MW-04 were determined to be hydraulically upgradient from the landfill and most likely representative of background soil conditions. Boring MW-03 was advanced through the landfill solid waste, and the well was screened within the solid waste. Wells MW-08 and MW-10 were also screened in the solid waste material, but the soil samples from these two wells were collected from the underlying, confining Bay Mud unit. Monitoring well boring logs are provided in Appendix F.

All monitoring well soil samples detected at least one metal at a concentration above the applicable PCL. In addition, one sample (from MW-03) exceeded the PCL for PCBs (Aroclor 1254) and benzene. Additional PCBs congeners (at MW-03 only) and VOCs were detected in other monitoring well soil samples, but none was found exceeding PCLs. No TPH or SVOCs were detected in any of the monitoring wells above the respective PCLs.

5.4.2 Test Pit Soil Sample Results

All test pit soil samples contained several metals at concentrations greater than PCLs (See Figure 8; Table 8). In addition, analytical results from test pit soil samples revealed the following additional exceedances of PCLs:

- Samples from three locations (G5, G32, and G35) exceeded the PCL for TPH-G and one sample (at location G29) exceeded the PCL for TPH in the oil range (TPH-Oil). Benzene was also detected at location G32 exceeding the PCL.

- Samples from five locations (G1, G5, G29, G32, and G35) had one to a few SVOCs detected above their respective PCLs.
- With the exception of benzene, no other VOCs exceeded the respective PCLs in any test pit sample.
- Concentrations of the PCBs congener Aroclor 1254 exceeded its PCL in samples from five locations: G3, G4, G5, G6, and G32.
- Pesticides were detected at concentrations above their respective PCLs in one or more test pit soil samples, including aldrin (at location G5), delta-BHC (at locations G3 and G6), dieldrin (at location G3 and location G5), methoxychlor (at location G4), 4-4'-DDD (at location G29), and 4,4'-DDE (at location G35).

TPH, SVOCs, and VOCs were detected in the test pit soil samples, but did not exceed the respective PCL. The toxicity equivalents for dioxins and furans (expressed as the toxicity-equivalent concentration of 2,3,7,8-tetrachlorodibenzo-p-dioxin [2,3,7,8-TCDD]) in the composite samples from G41, G42, and G43 ranged from 0.13 to 2.58 picograms per gram (pg/g), which is less than the MTCA Method B cleanup level of 12.8 pg/g for 2,3,7,8-TCDD per Ecology's CLARC database. Complete analytical results for dioxins and furans in these samples are presented in Table L-2 in Appendix L.

5.5 GROUNDWATER/SEEP SAMPLE RESULTS

Complete analytical data for groundwater and seep samples are presented in Appendix L. Individual results that exceeded PCLs are presented in Table 9 and are shown on Figures 9 and 10.

5.5.1 Groundwater Sample Results

Groundwater samples were collected from monitoring wells during multiple rounds of sampling conducted from October 2009 through March 2013. Groundwater samples were collected from monitoring wells MW-02, MW-03, and MW-04 during the Phase I investigations in October and December 2008 and April and July 2009. Phase II groundwater samples were collected from the wells listed above and from monitoring wells MW-05, MW-06, MW-07, MW-08, MW-09, MW-10, and MW-11 in April, July, and October 2010 (Table 1). One additional set of groundwater samples were collected from MW-08 and MW-09 in March 2013 for analysis of dioxins and furans.

Samples from all monitoring wells contained several total and dissolved metals at concentrations exceeding PCLs (Figure 9), typically including arsenic, iron, and manganese. SVOCs, PAHs, and VOCs were detected during both Phase I and Phase II sampling events. Five SVOCs—bis(2-ethylhexyl) phthalate, chrysene, 1-methylnaphthalene, and 2,4-dimethylphenol exceeded applicable PCLs in one or more groundwater sample. Samples from wells MW-3, MW-10, and MW-11 contained pesticides (4,4'-DDD, 4,4'-DDE, and alpha-BHC) at concentrations exceeding applicable PCLs. One

VOC, benzene, was detected in groundwater samples at concentrations that exceeded the applicable PCL. The benzene exceedances were observed in samples from MW-06, MW-09, MW-10, and MW-11. Three PCB constituents (Aroclor 1232, Aroclor 1242, and Aroclor 1248) were detected in groundwater samples at concentrations that exceeded the applicable PCL: Aroclors 1232 and 1242 in MW-03 and Aroclor 1248 in MW-08. No TPH was detected at concentrations greater than the PCL in any groundwater sample analyzed.

The groundwater samples collected in March 2013 from MW-08 and MW-09 did not have detections of dioxins/furans at or above the laboratory reporting limit (See Table L-4 in Appendix L).

Results analyzed for dioxins and furans by EPA Method 1613B can be reported as follows:

- A reporting limit can be specified for target analytes that meet the method identification criteria and are free of interferences. The reporting limit is generally the lowest calibration standard. Results reported to the reporting limit are typically not flagged by the laboratory.
- An estimated detection limit can also be reported for each analyte not detected. The sample-specific estimated detection limit is an estimate of the concentration of a given analyte that would have to be present to produce a signal with a peak height of at least 2.5 times the background signal level of the analytical instrument. The estimate is specific to a particular analysis of the sample and is affected by factors such as sample size and dilution. The estimated detection limit value can be reported for non-detected analytes, rather than the reporting limit. Any analyte that generates a peak greater than 2.5 times the noise and meets all qualitative requirements but is less than the RL would be reported with a “J” flag. Method B PCL of dioxins/furans for groundwater is 0.673 picograms per liter (expressed as the toxicity-equivalent concentration of 2,3,7,8-TCDD.

5.5.2 Seep Sample Results

Seep samples were collected from locations SP-01, SP-02, and SP-03 during seven sampling events from October 2008 through October 2010. Samples collected during the first four sampling events as part of the Phase I RI were analyzed for the full suite of analyses as indicated in Table 1. Samples collected during the three later sampling events during the Phase II RI were analyzed for a reduced suite of analytes plus TPH-D (Table 1). Analytical results are summarized below.

Analytical results that exceeded the PCLs are presented in Table 9 and shown on Figure 10. The results shown in Figure 8 illustrate the following exceedances of PCLs:

- All of the seep sample locations detected concentrations of total and dissolved metals (aluminum, arsenic, iron, manganese, and one isolated silver hit), greater than the PCL during one or more sampling events.

- Concentrations of one SVOC, 1-methylnaphthalene, exceeded the PCL in samples collected from SP-03 during the first four sampling events. No other SVOC was detected above its respective PCL in any other seep sample. SVOCs were not analyzed during the final three sampling events.
- Benzene was detected at concentrations above its PCL in samples collected from SP-01 during the four Phase I sampling events. No other VOC exceeded its PCL.
- Concentrations of total PCBs exceeded the PCL in the samples collected at SP-03 during four sampling events. Concentrations of Aroclors 1232, 1242, and 1248 also exceeded the respective PCL in samples collected during one or more sampling events at SP-03. PCBs were not detected at concentrations greater than the PCL during the final two sampling events at SP-03 in July and October 2010. Aroclor 1232 exceeded the PCL in one sample collected at SP-02 in April 2009.
- One pesticide, 4,4’-DDE, exceeded its PCL in a single sample collected at SP-01 in July 2010. No other pesticides exceeded applicable PCLs.
- TPH-D and several other SVOCs and VOCs were detected in seep samples collected during Phase I and Phase II, but no additional analytes exceeded the applicable PCL.

5.6 SURFACE WATER RESULTS

Surface water samples were collected during all seven Phase I and Phase II sampling events from locations SW-01, SW-03, SW-04, SW-05, and SW-06. A sample was collected from SW-07 only during the December 2008 and April 2009 sampling events. Proposed location SW-02 was not sampled during any of the sampling events because the location was dry.

Surface water samples were analyzed for the full suite of analyses during the Phase I sampling events and for a reduced suite of analyses during the Phase II sampling events, as shown in Table 1.

Analytical results that exceed the PCL are presented in Table 10. Analytical results that exceed the PCLs are presented on Figure 11 and summarized below:

- Samples from all surface water sampling locations contained concentrations of several total and dissolved metals (including aluminum, arsenic, copper, manganese, nickel, silver, and lead) greater than the PCLs during one or more sampling events, although arsenic was the most commonly detected metal.
- The pesticide 4,4’-DDD was detected in one sample collected at SW-06 in December 2008 exceeding the PCL. However, 4,4’-DDD was not detected during any other sampling events at this location. No other pesticide exceeded its applicable PCL.
- The concentration of two SVOCs, butyl benzyl phthalate and chrysene, exceeded PCLs at one location during one sampling event: butyl benzyl phthalate at SW-05 in October 2008 and chrysene at SW-01 in July 2009.

- The concentration of benzene exceeded its PCL in samples from SW-07 in December 2008 and April 2009. Selected other SVOCs and VOCs were detected during Phase I sampling events, but no other detected concentrations exceeded the associated PCL.

5.7 LFG Monitoring Results

The LFG monitoring data collected in 2011 and 2012 are summarized in Table 11. Methane concentrations measured in April 2010 are plotted on Figure 12. The highest LFG readings coincided with the thickest accumulations of wood waste in the center of the site at LFGP-004, with a maximum methane concentration of approximately 70 percent and a maximum carbon dioxide concentration of approximately 32 percent.

Elevated LFG concentrations may have been correlated to the thickness of wood waste across the site (Section 7.1). This correlation would be consistent with the expected pattern of LFG generation. Wood waste was more likely than landfill solid waste to be responsible for generation of LFG at the site because it was only 4 to 20 years old compared to the older solid waste that had been in place for at least 40 years. In addition, much of the solid waste deposited prior to 1969 was burned and therefore has a lower organic content compared to wood. However, it should be noted that LFG data do not differentiate between sources. LFG data represent the combined gas production of all onsite organic material.

The bulk of the wood waste was removed from the landfill in 2014 (See Section 2.2.3). A portion of the remaining wood waste may be incorporated into the final remedial alternative. It will be necessary to monitor the amount of methane being produced in the solid waste after the final remedial alternative has been selected and implemented. Copies of the methane monitoring memoranda are included in Appendix H.

5.8 Archaeological Survey Findings

Two different archaeological surveys were completed during the RI. The first survey was conducted in conjunction with the test pit investigations. During placement of the test pits, an AMEC archaeologist was present to observe the test pit operations and to identify and inventory cultural resources. No cultural resources were encountered in the test pits; a copy of the archaeologist's field notes are included in Appendix I.

A second archaeological survey was completed along South March Point Road and the landfill. Prior to development as a landfill, the area of the landfill was an active tidal flat, subject to daily tides, with a low potential for archaeological deposits. The southwestern boundary of the landfill abuts the natural slope of the uplands. As a result, this area maintained a higher probability for unknown and significant cultural resources. An archaeological survey was performed along this perimeter where the landfill abuts surface water drainage. This area was considered to have the highest probability of archaeological deposits. A pedestrian survey of this area and a series of 15 shovel test probes (STPs) were completed along the margin of the landfill.

Sediments exposed within the STPs consisted mainly of sawmill debris, garbage, and silts and clays. The sawmill debris was composed of large woody fragments and sawdust, which created a large cap on top of the landfill sediments. Often, this sawmill layer was followed by a mottled layer of mixed fill consisting of garbage and burned sediment with silt.

Sediments become more clayey at the base of several STPs. The sediments encountered appear to be very heterogeneous and hold little potential for intact archaeological deposits. No archaeological materials were observed during the pedestrian survey or excavation of STPs. No intact native sediments were observed; all sediments appear to be fill deposits and of mixed context. No cultural materials, or undisturbed sediments, were observed during the survey. A copy of the second archaeological survey is included in Appendix I. The archeological monitoring performed during the RI/FS resulted in a recommendation to develop an Inadvertent Discovery Plan during the CAP process to account for accidental discovery of archeologically-significant findings during any relocation of the solid waste along the western side of the landfill, or along the shoreline portion of the landfill if any solid waste is “pulled-back” from the current shoreline to establish lower angle slopes.

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6.0 GEOTECHNICAL AND HYDROGEOLOGICAL EVALUATIONS

This section presents results from geotechnical and hydrological evaluations conducted during the Phase II investigation. Samples of Bay Mud outside the perimeter of the landfill, as well as underneath the landfill, were collected to determine the hydraulic and physical properties of the Bay Mud in its natural state as well as in its compressed or loaded state buried beneath the solid waste. Geotechnical testing was conducted on soil samples collected during both the monitoring well installation (samples collected in Shelby tubes) and the test pit investigation (samples collected in jars). Samples were tested to determine shear strength, triaxial permeability, as well as conventional physical parameters. These data were used to evaluate the hydraulic properties of the Bay Mud and to assess if the Bay Mud is acting as a potential aquitard underneath the solid waste. The geotechnical soils properties will also be used during conceptual planning and engineering design of future remedial options.

Hydrogeological data were obtained from transducers deployed within the monitoring well network at the site and at two stilling wells installed outside the landfill footprint (Section 3.9). This evaluation was conducted to assess both seasonal changes in groundwater flow and the influence of the tidal cycles on groundwater flow. This information was utilized to better characterize the hydraulic connection between groundwater and surface waters of Padilla Bay.

6.1 GEOTECHNICAL RESULTS

Soil samples for geotechnical analysis were collected, either by grab sampling or using Shelby tubes, during the Phase II investigation at locations G15, G16, G17.5, G18, G20, G24, MW-08, MW-10, ST-01, and ST-02 (Figure 5). Samples were tested for the following geotechnical parameters:

- Grain size,
- Atterberg limits,
- Moisture content,
- Triaxial strength,
- Hydraulic conductivity,
- One-dimensional consolidation, and
- Organic matter content.

Results of selected geotechnical tests are summarized in Table 12 and the complete laboratory report is included as Appendix M.

Results from the grain size and Atterberg limit tests were used together with field observations from the Phase I and Phase II investigations to refine the geological logs (Appendix F) and construct geologic cross sections across the landfill footprint (Figures 13 and 14). An Atterberg test is used to determine how a fine-grained soil responds to changes in moisture content—how the soil strength changes as the moisture content increases. These results are used to help classify soils.

Five samples were collected using Shelby tubes during the Phase II investigation at locations G17.5, MW-08, MW-10, ST-01, and ST-02. The material collected at G17.5 was representative of the suspected dike-like feature that is believed to have previously existed along portions of the edge of the landfill. The materials collected at MW-08 and MW-10 were representative of the underlying Bay Mud unit, and the materials collected from at locations ST-01 and ST-02 were representative of the inner lagoon surface sediments. In addition to the standard geotechnical parameters (grain size, moisture content, and Atterberg limits), these five samples were also analyzed to assess hydraulic conductivity, triaxial compression, and consolidation (G17.5, MW-10, and ST-02 only) parameters. These tests yielded the following key findings:

- **Dike-Like Area - Sample G17.5**: This sample was classified as organic silt and is representative of material in the suspected dike-like feature. The hydraulic conductivity was determined to be 4.43 x 10^{-6} centimeters per second (cm/s). This material could be derived from the Bay Mud or lagoon deposits, given the similarity of the sedimentology between these three units.
- **Underlying Bed - Samples MW-08 and MW-10**: These samples were classified as sandy clayey silts and are representative of the underlying Bay Mud unit. The hydraulic conductivity for these two samples ranged from 7.91 x 10^{-8} cm/s (MW-08) to 8.91 x 10^{-8} cm/s (MW-10).
- **Surface Sediment - Samples ST-01 and ST-02**: These samples were classified as clayey silt and are representative of the surface sediment in the inner lagoon adjacent to the site. The hydraulic conductivity was similar for both samples, with results of 3.43 x 10^{-6} cm/s for ST-02 and 4.06 x 10^{-6} cm/s for ST-01. Both samples exhibited shear failure in the triaxial compression test, and sample ST-01 displayed two distinct shear planes.

The oldest topographic map from 1886 shows the future footprint of the landfill as a marshy area (Figure 15). Padilla Bay is ringed with extensive tide flats characterized by wide expanses of fine-grained sediments derived from erosion of glacial sediments from shoreline bluff that are mainly silts and clays (Bulthuis, 2013). The sediments in the southern tideflats of Padilla Bay are finer-grained and muddier than the northern sandy tideflats (Bulthuis, 2013). The Bay Mud unit appears to have been deposited upon the glacial recessional outwash of the underlying regional aquifer, as shown in Figures 13 and 14. These types of sediments are characteristically deposited in low-energy environments characteristic of Padilla Bay, which once received discharges of sediment from the

Skagit River as it flowed across a large delta prior to diking of the river channel in the 1880s (Bulthuis, 2013)

The lateral extent of the Padilla Bay tide flats, the historic presence of the tide flats as shown in the oldest topographic maps, and the similarity of the sediments among the five samples submitted for hydraulic conductivity analyses (see Table 12 and Figures 13 and 14) supports the conclusion that the Bay Mud and the current day lagoon deposits are both laterally equivalent and continuous.

6.2 Tidal Study And Groundwater Head Results

The transducer data were downloaded during the groundwater monitoring events in July and October 2010 as well as in January 2011. The transducer data are included in Appendix G. According to Serfes (Serfes, 1991), a series of 71 consecutive hourly water level measurements can be used to calculate the mean hydraulic gradient at a site, while minimizing the influence of tidal variation. The method used by Serfes to calculate the mean hydraulic gradient is widely used at tidally influenced sites because it filters out the various major tidal variations that could affect groundwater flow. This hourly water level information, collected over a period of several months, provided the data needed to evaluate the influence of seasonal water level variations on shallow groundwater flow.

Transducer data were evaluated using the Serfes method for individual 71-hour periods at the end of April 2010, July 2010, October 2010, and January 2011. These four periods represent a good approximation of the intermediate spring, the dry summer, the intermediate fall, and the wet winter seasons. The corresponding potentiometric surface maps are included as Figures 16 through 19.

In general, shallow groundwater in the northern part of the site flows from northwest to southeast following the surface topography. From the central portion of the southern end of the site and from further east, the groundwater either flows east toward the inner lagoon or south/southwest toward the drainage swale. Based on the potentiometric maps in Figures 16 to 19, seasonal groundwater elevations at the site fluctuate approximately 2.3 feet at upgradient locations (MW-03 and MW-11) and approximately 1.2 feet at the location farthest downgradient (PZ-03). The groundwater gradient appears to be similar in the April, July, and October potentiometric maps, but increases in the January 2011 potentiometric map, during what could be considered the wettest part of the year based on precipitation data from nearby Anacortes. The horizontal gradient in the northern part of the site was calculated using the differences in head and the horizontal distance between MW-03 and MW-08, based on Figures 17 and 19. According to these calculations, the horizontal gradient in the northern part of the site during January 2011 was approximately 0.0062 foot/foot compared to the horizontal gradient of 0.0032 foot/foot during July 2010. Only three wells were screened in the Lower Aquifer (MW-02, MW-05, and MW-07). Water levels were measured manually in these three wells in July 2010 and October 2010. Since MW-05 and MW-07 are tidally influenced, manually measured water levels can only be qualitatively compared. The groundwater elevations were measured in MW-02 (19.55 and 19.35 feet above mean sea level [msl]) and MW-04 (17.01 and 16.57 feet above msl), while the groundwater elevations in MW-05 (3.53 and 3.85 feet above msl), and MW-07 (3.69 and 3.05 feet above msl) were 15 feet lower than MW-02. The groundwater elevation differences suggest that groundwater flow in the Lower Aquifer is southeasterly.

Two well pairs, PZ-01/MW-05 and PZ-03/MW-07, were identified as being suitable to calculate the vertical gradient between perched groundwater within the solid waste and the Lower Aquifer beneath the Bay Mud. The four selected dates on which the vertical gradient was calculated coincide with the dates of the four potentiometric maps (Figure 16 through 19). According to these calculations (Table 13), the vertical gradient is downward for all four dates. The highest downward gradients among these dates was observed in April 2011 (-0.161 foot/foot for PZ-01/MW-05) and April 2010 (-0.267 foot/foot for PZ-03/MW-07). These dates coincide with the culmination of the relatively wet part of the year during winter and early spring. The vertical gradients decreased from a high in April 2010 to a low in October 2010 (0.088 foot/foot for PZ-01/MW-05 and 0.0024 foot/foot for PZ-03/MW-07), most likely reflecting the decrease in precipitation and available water for recharge during the late spring and summer months. From October 2010 to January 2011, the vertical gradients increased, reflecting the increase in precipitation and the available water for recharge.

During extreme high tides, the vertical gradient in PZ-03/MW-07 reverses and becomes upward; however, this reversal occurred only during a handful of the most extreme high tide events throughout the monitoring period. A positive, upwards directed gradient (0.017) was seen in PZ-0/MW-07 in one out of seven dates (Table 13). Based on the geophysical investigation, the area around PZ-03 and MW-07 has a much higher apparent conductivity compared to the rest of the site (Figure 6 in Appendix D). During the reversal in the vertical gradient, more saline water from the Lower Aquifer temporarily flows upward into the less saline, shallower aquifer. However, it should be noted that during the 15 months that the marsh stilling well recorded accurate water levels, the water levels in the inner lagoon were higher than the water levels in MW-06 and PZ-3 for less than 0.5 percent of the time (Figure 20).

The summary hydrographs for all wells (Figure 20) indicate that the wells screened in the Lower Aquifer (e.g., MW-05 and MW-07) are strongly influenced by tidal variation, whereas wells screened in solid waste show very limited responses to tidal fluctuations. Piezometer PZ-02 did not recharge after installation and has remained dry for the entire monitoring interval. The transducer/logger installed in the marsh stilling well failed on October 7, 2011, most likely caused by corrosion.

Changes in groundwater elevation during the monitoring period for wells screened in the solid waste were greatest in the northwest part of the site (MW-03 and MW-11) with a variation of approximately

3 feet in groundwater elevation. The remaining wells screened in the solid waste showed a change in groundwater elevation on the order of 2 feet or less. The highest groundwater elevations were observed in mid-December 2010 and late January 2011.

Figure 21 summarizes the tidal data collected from the inner lagoon and Twin Bridges tidal gauges. The data indicate that the inner lagoon completely empties during the low-tide cycle, as was observed during site visits during the Phase I and Phase II investigation. There appears to be no lag between the timing of the high tide observed at the two tidal gauges; however, the amplitude of the tide is greater at the Twin Bridges location. This is to be expected as the Twin Bridges location is located at the mouth of the Swinomish Channel.

As shown in Figure 20, the average water levels in most of the groundwater monitoring wells are several feet higher than the average tide level measured in the marsh stilling well. The differences in water levels are more pronounced in the northernmost groundwater monitoring wells. Moreover, 8 of the 10 wells that experienced changes in water level exhibit limited or no response to tidal fluctuations. MW-05 and MW-07 are screened in the Lower Aquifer. These wells are located closest to the inner lagoon and exhibit clear tidal signatures. The boring for MW-07 did not encounter the Bay Mud layer present elsewhere.

Figures 22 through 25 show the effects of precipitation and tidal fluctuations on water levels. These figures show that the groundwater levels within the solid waste generally respond minimally or not at all to tidal fluctuations. Infiltration of precipitation is also clearly shown in these figures. In summary, the water level monitoring conducted at the site shows that:

- Groundwater levels within the solid waste are generally higher than tidally influenced surface water levels in the inner lagoon.
- Groundwater levels within the solid waste are generally higher than the water levels in the Lower Aquifer monitoring wells MW-05 and MW-07, and the majority of vertical hydraulic gradients measured were negative, indicating downward directed flow from the solid waste to the Lower Aquifer (Table 13).
- Groundwater levels within the solid waste are mainly influenced by seasonal precipitation, with higher elevations seen in the spring and corresponding decreases in water levels through the summer and early fall.
- Groundwater levels within the solid waste display no tidal influence, except where the Bay Mud thins (Figure 14).

6.3 OTHER HYDROLOGIC FACTORS

Surface water elevation is not only influenced by tides, it also can be affected by storms, earthquake-induced tsunamis, and sea level rise. Of these factors, storm-induced water level elevation change is the least likely to affect the inner lagoon next to the landfill. The primary storm wind direction during the winter months is from the south-southwest (Bulthuis, 2013). The inner lagoon is sheltered from southerly winds by the nearby hillside and by Highway 20. Winds from the north-northwest from Georgia Strait are also likely during the winter months; however, though the northerly winds can develop a good fetch to produce waves, the shallow nature of Padilla Bay often limits wave heights (Bulthuis, 2013). In addition, the inner lagoon is only connected to the rest of Padilla Bay by an approximately 110-footwide channel under the BNSF railroad embankment. This embankment also protects the shoreline of the landfill from the effects of the northerly winds and waves.

In 2005, the Washington Division of Geology and Earth Resources modeled a possible earthquake-induced tsunami in the Strait of Juan de Fuca. The tsunami or earthquake induced tidal wave was modeled after a magnitude 9.1 earthquake on the Cascadia subduction zone. Water level increases at the site due solely to the tsunami were predicted to range from 1.5 to 6 feet (0.5 to 2.0 meters) in height (Walsh et al., 2005).

Higher than normal water levels from the tsunami would only last about two hours, and there would be little to no effect if the tide was low at the time of tsunami. As part of the wood waste removal project, AMEC surveyed the ordinary high water mark (OHWM), and it was determined that the OHWM was 9.24 feet MLLW.

If the tsunami occurred during the high tide, the water level in the inner lagoon could rise to a maximum elevation of approximately 16 feet above MLLW based on the OHWM. Given the protection of the BNSF railway embankment, and the restrictions of the 75-foot inlet, the water level rise due to a tsunami may be much less than 6 feet. The rationale behind this conclusion is that highest observed tidal level at the Twin Bridges stilling well was typically about 1 foot higher than that seen in the inner lagoon. High water from the tsunami would be a transient effect and the chances of a Cascadia subduction zone quake are estimated to be 10 percent in the next 50 years, and even this probability is uncertain (CREW, 2013).

Lastly, overall rise in sea level due to climate change for the Puget Sound is estimated to range from 3 inches to 22 inches by 2050, and from 6 inches to 50 inches by 2100, depending on modeling assumptions (Mote et al., 2008). The median estimates of sea level rise for the Puget Sound range from 6 inches by 2050 to 13 inches by 2100 (Mote et al., 2008). The Swinomish Indian Tribal Community compiled a report in 2010 describing the various climate challenges facing the tribal lands, including storm surges, global sea level rise, and tsunamis. The report defined an “inundation risk zone” of 5 feet above mean higher high water (MHHW) to account for the range of potential sea level rise, and an additional 3 feet to account for the range of likely storm or tidal surges, for a total of 8 feet above MHHW. The report concerns all of the tribal lands exposed to inundation, including the southern parts or the reservation adjacent to Skagit, Kiket, and Similk Bays, as well as Padilla Bay (Swinomish ITC, 2010).

The ordinary mean high water mark elevation at the former Whitmarsh Landfill was established by AMEC at an elevation of 9.24 feet above MLLW. Using VDatum 3.5, a software package developed by the National Oceanic and Atmospheric Administration, MHHW elevation relative to MLLW is +8.30 feet for a tidal channel located in the outer lagoon.

In order to account for sea level rise by 2100, the highest elevation potentially exposed to even the highest water level under normal conditions would be elevation 13.0 feet MLLW. Storm-related surface water rises in the inner lagoon and the effects of waves are limited by the shallowness of Padilla Bay and the presence of the BNSF railroad embankment.

Tsunami-related sea-level rises are very uncertain in timing and magnitude and short in duration, and are difficult to predict due to the complexities of modeling a large subduction zone earthquake and the protection provided by the railroad track levee. Any damages related to the effects of a tsunami will be dealt with through contingency measures outlined in the long-term monitoring plan.

To summarize, remedial alternatives considered for the site should consider future sea level rise (whether short-term due to tsunamis or longer-term climate change) and the combined effects of sea level rise with short-term storm surges. To account for tsunamis, remedial alternatives may need to address a short-term sea level rise of 1.5 to 6 feet. To account for climate change by 2100, Mote et al. (2008) set an upper limit of just over 4 feet (50 inches) for Puget Sound. The Swinomish Indian Tribal Community (2010) "inundation risk zone" of 5 feet above MHHW is slightly above Mote's upper limit. As discussed above, the protected area or inner lagoon of Padilla Bay will not likely experience the 3-foot-high storm surges projected by the Swinomish Indian Tribal Community. Therefore, for remedial alternatives at this site that could be materially affected by higher sea level or saline conditions, AMEC has established an elevation of 16 feet (7.6 feet above MHHW) as sufficiently protective in relation to tsunamis, climate-related sea level rise, and storm surge.

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7.0 CONCEPTUAL SITE MODEL AND EXPOSURE PATHWAYS AND RECEPTORS

This section describes the current conceptual site model developed based on the Phase I and Phase II remedial investigations, as well as available historical data and the exposure pathways and receptors at the site.

7.1 CONCEPTUAL SITE MODEL

This section presents the conceptual site model. This model uses available known data from the Phase I and Phase II remedial investigations and summarizes how these data may be expanded upon to produce a reasonable, holistic interpretation of site conditions. The model projects the available data and makes assumptions that best fit the known data.

7.1.1 Geology

The regional geology was discussed in Section 3.1 of the RI/FS Work Plan (AMEC, 2008a). The geology in the vicinity of the site was shaped by a complex history of accretion, mountain orogeny, igneous intrusions, and deposition of terrestrial and marine sediments (Savoca et. al., 2009). The area has been repeatedly overridden by advancing and retreating continental glaciers, including the most recent stage of glaciations (the Vashon Stade of the Frasier glaciation) about 17,000 years ago. During the last glaciation, the Skagit River valley was excavated by submarine meltwater. Upon deglaciation, this area was filled by fluvial, estuarine, and deltaic deposits during the Holocene. These Holocene deposits represent most of the lowland surficial deposits observed in the vicinity of the site.

Based on the RI field investigations, the stratigraphy at the site is interpreted as shown on Figures 13 and 14. Most of the site, excluding the southwestern-most part, was covered by wood waste. The wood waste was generated during operation of the log mill at the site. The maximum observed thickness of wood waste (10 feet) was found in boring MW-10, located in the central part of the sawmill operations. From there, the thickness of wood waste decreased to the northwest and southeast. No wood waste is present above the solid waste in the far northwestern and southeastern parts of the site.

Underlying the wood waste was a 1-foot to 3-foot layer of cover soil, generally consisting of silty sand overlying the solid waste. This silty sandy cover soil was present in many of the test pits and borings, though in some cases the cover material has settled into the solid waste. The solid waste varies from approximately 8 to 16 feet in thickness (see Figures 13 and 14). The approximate volume of solid waste is estimated to be 340,000 cubic yards. The solid waste consists of burnt and unburnt municipal solid wastes. No large numbers of drums or other sources of hazardous or dangerous waste were identified within the landfill during the Phase I and Phase II investigation. Crushed drums were only identified at three test pits, located where anomalies were detected during the geophysical survey.

Along the southeastern portion of the site is a buried “dike-like” feature consisting in some areas of low-permeability organic silt; in other areas the dike appeared to be constructed of poorly- and well-graded sand that was apparently constructed in the 1970s to contain the solid waste. The hydraulic conductivity of organic silt material is low (4.43×10^{-6} cm/s) and appears to restrict discharge of groundwater as seeps along this portion of the landfill (see Figure 13).

Stratigraphy beneath the wood waste, cover soil, and landfill solid waste consists of the following units (from shallowest to deepest):

- **Silt to Peat Unit:** This unit was found only at MW-04 and consists of silt with various amounts of peat. The unit is up to 16 feet thick and is likely an onshore continuation of the Bay Mud observed in test pits below the landfill solid waste. Figure 26 shows the top elevation of the Bay Mud.
- **Poorly Graded Gravel Unit** (potential old roadbed material): This unit was observed in the bottom of test pits G21 and G23, and potentially within the fill in boring PZ-02. This unit consists of poorly graded gravels with fine to coarse sand. Based on the location where this unit is encountered, the linear features observed in historical aerial photographs, and the anomaly identified during the geophysical study, this unit is interpreted as an old roadbed.
- **Padilla Bay Mud Unit:** This unit was found below the landfill solid waste in several test pits, including G3, G7, G11, G18, G19, and G38, and in all borings except PZ-02 and MW-07. This tide flat deposit consists of silt with various amounts of clay or a lean clay and organics (peat-like material). The thickness of this unit, where fully penetrated, ranges from inches (MW-06) to 9.5 feet (MW-05) as shown on the isopach map, Figure 27.
- **Poorly Graded to Well Graded Sand Unit** (Recessional Outwash/Lower Aquifer): This unit is found in borings MW-01, MW-02, MW-04, MW-05, MW-06, MW-07, MW-08, MW-10, PZ-02, and PZ-03; and test pits G-18, G-19, and G-38. This unit consists of poorly- to well-graded sand with little or no fines. This unit is up to 31 feet thick (as evident in MW-01). This unit is mapped as Qago (Alluvial and Recessional Outwash Aquifer), and is dated to the Holocene or Pleistocene Epoch based on Schuster (2000).
- **Lean Clay Unit (till)**: This unit is found in MW-01, MW-02, and MW-04. This unit is very stiff, lean clay with occasional fine sand laminations and is not fully penetrated in any boring where encountered. This unit is mapped as Qgt (Till Confining Unit), and is a glacial till unit dated to the Pleistocene Epoch based on Schuster (2000).

Lithologic data from monitoring wells (presented in cross section in Figures 13 and 14) suggest that the landfill material is underlain by native Bay Mud in thicknesses up to approximately 9.5 feet over most of the site. Based on the local topography and the lithological information from test pits G21 and G23 as well as boring PZ-02, it appears that the solid waste is underlain by an old roadbed and associated fill material along the eastern edge. This potential roadbed material is found stratigraphically higher than the Bay Mud (and Lower Aquifer unit) encountered elsewhere at the site.

It is assumed that the Bay Mud unit is continuous beneath the landfill. The Bay Mud is underlain by a glacial outwash sand unit (Lower Aquifer). The Bay Mud likely acts like an aquitard, separating shallow groundwater in the landfill material from lower water-bearing zones. This is supported by hydrograph data (Figure 20), which indicates that the Lower Aquifer is tidally influenced, while shallow groundwater within the solid waste landfill material above the aquitard is not tidally influenced.

7.1.2 Groundwater Elevations and Flow Directions

The hydrogeological investigations have identified two main groundwater systems at the site (Figures 13 and 14):

- Shallow, perched groundwater within the solid waste inside the footprint of the March Point Landfill; and
- A Lower Aquifer within recessional outwash sands (Qago unit).

The Bay Mud functions as an aquitard between the solid waste and the Lower Aquifer. It appears that the upgradient, shallow groundwater zone between MW-02 and MW-04 is hydraulically disconnected from shallow groundwater within the landfill footprint and is more likely connected to the Lower Aquifer. Groundwater elevations measured in upgradient, off-site monitoring wells MW-02 and MW-04 are significantly higher than wells observed within the landfill footprint (Figure 13). The swale along South March Point Road (shown on cross section A-A' in Figure 13) should act as a discharge zone for upgradient groundwater and the groundwater in the waste if there were hydraulic connectivity between these two water-bearing zones. However, surface flow in the swale appears to be limited to seasonal precipitation, and occasional influx of tidally-influenced surface water from the inner lagoon. At high tide, water in the swale has been observed to extend just south of monitoring well MW-02, suggesting that groundwater at MW-04 and as far north as MW-02 might be disconnected from groundwater within the landfill. Based on these findings, it appears that the upgradient, shallow groundwater zone between MW-02 and MW-04 is hydraulically disconnected from the shallow perched groundwater within the solid waste landfill footprint and is more likely connected to the Lower Aquifer.

It appears, based on the potentiometric maps (Figures 16 through 19) and local topography (Figure 4), that a groundwater ridge is present southeast of the sawmill building and extends to the southeast corner of the site. Monitoring well MW-03 is located within the solid waste footprint. However, based on the potentiometric maps, the well location is on the upgradient end of the landfill (Figures 16 through 19). Groundwater in the solid waste east of the groundwater ridge flows toward the inner lagoon and the seeps seen at SP-01, SP-02, and SP-03. Groundwater in the solid waste west of the groundwater ridge flows toward the swale bordering the southwest side of the landfill. The swale may receive discharge both from upgradient groundwater on the west (outside the landfill) and southwest side of March Point Road and from groundwater beneath and within the landfill, though direct discharge of groundwater from the solid waste was not observed. Surface water is present in the swale during the winter and spring, and dries out during the summer with the exception of high tides reaching up the swale. Surface water within the swale ultimately flows into the inner lagoon south of the landfill boundary.

No seeps were observed along the southern landfill shoreline of the inner lagoon (Figure 28). The southern landfill shoreline is the approximate location of a linear dike-like feature observed along the eastern extent of the landfill area in historical aerial photographs from 1971 (Figure 28). Soils encountered at MW-05, G16, G17.5, and G18 showed properties consistent with material that could potentially have been used for a dike. The hydraulic conductivity of the dike-like material collected from G17.5 was 4.43 x 10^{-6} cm/s, which is three orders of magnitude less than published hydraulic conductivity values (ranging from 1.3 to 8.8 x 10^{-3} cm/s) for solid waste material (Penmethsa, 2007). It should be noted that the actual permeability of solid waste varies depending on component material, age and the amount of compaction (Reddy et al., 2009). It is likely that the solid waste at the landfill has a higher permeability than the dike-like feature. Thus, the dike-like feature could act as a hydraulic barrier at the site, diverting groundwater flow to the southern or southwestern edge of the site, which explains the absence of seeps along this part of the landfill.

Seeps observed at the northern end of the landfill enter the inner lagoon and are encountered in approximately the same location as seeps referred to in historical reports (Figures 2 and 28). In addition, surface water observed at location SW-07 was similar in color and odor to seep water encountered at location SP-01 during the December 2008 sampling event. These observations may suggest that a dike does not extend north to this part of the landfill boundary. Historic aerial photographs also indicate that this northern boundary was created as landfill material was being deposited and later armored with large concrete debris (visible today) when landfill operations ended.

7.1.3 Subsurface Migration of Contaminants

The conceptual site model suggests that limited areas exist along the landfill boundary where groundwater within the solid waste is seeping, or has the potential to seep, into surface water. These areas are predominantly in the eastern part of the swale south of the site and the northeastern landfill boundary within the inner lagoon. Further, the landfill solid waste extends northwesterly at least to the locations of G38, G39, and G40.

Soil samples collected from within the landfill footprint indicate that selected metals (antimony, arsenic, barium, cadmium, copper, lead, mercury, nickel, and zinc) are present throughout the landfill footprint at concentrations exceeding the PCLS. PCBs (Aroclor 1254) and pesticides (dieldrin, Aldrin, methoxyclor, 4,4’-DDD, and 4.4’-DDE) were found at concentrations exceeding the PCLs in soil samples across the site. TPH-G, TPH-Oil, and benzene were only identified exceeding the PCLs at a few locations (Figure 8). Arsenic, barium, copper, and nickel were detected in soil samples outside the landfill footprint at concentrations that exceed the PCL (see Table 14). The concentrations of arsenic in soil samples collected within the solid waste were within the range concentrations in soil samples outside the landfill footprint. Ecology has not established a background value for barium in the Puget Sound Basin (Ecology, 1994).

Figure 9 shows where concentrations of COCs exceed the PCL in groundwater samples collected from monitoring wells at the site. As with soils, several metals are found in groundwater (both total and dissolved) exceeding the PCLs for metals, especially the redox-sensitive metals iron and manganese. Arsenic, copper, and lead, also exceeded the PCLs in most groundwater samples. Among the pesticides, 4,4’-DDD and/or 4,4’-DDE were found in a few groundwater samples at concentrations exceeding the PCL. PCBs and SVOCs were noted above their respective PCLs in only a couple of groundwater samples (Figure 9).

Figure 10 shows where concentrations of COCs exceed the PCL in seep samples collected at the site. As with groundwater, metals are found in seep water samples (both total and dissolved) exceeding the PCLs for several metals, especially the redox-sensitive metals iron and manganese. 4,4’-DDE was noted in a seep sample at SP-01 at an estimated concentration exceeding its PCL (the analytical result is estimated due to variability between the two chromatographic columns used in the analysis). One or more individual PCB Aroclors were noted above the respective PCLs in several seep water samples collected at SP-03, and Aroclor 1232 was detected above its PCL in one seep water sample collected at SP-02 (Figure 10 and Table 14). The PCL for total PCBs was exceeded only in the seep water samples collected at SP-03 during December 2008 and April 2009 at concentrations of 0.115 and 0.091 µg/L, respectively. 4,4’-DDE was found at a concentration greater than the PCL at SP-01.

However, most of the elevated 4,4’-DDE and PCB concentrations were observed during the winter and spring months. These findings potentially indicate that small amounts of groundwater from within the landfill may possibly seep into the inner lagoon during the wet season. Based on the sediment bioassays conducted as part of the Sediment RI, the seep discharges do not have a negative effect on the sediment biota (Appendix B). Also, concentrations of metals in the upstream surface water sample SW-01 are similar to or higher than concentrations in the seep samples, which could suggest that the concentrations of metals in the seep samples represent background concentrations.

Similar concentrations of metals were noted in samples collected at the upgradient sample location SW-01 and in samples collected at downstream sample locations, which may suggest that the downgradient surface water samples represent background concentrations or contributions from an off-site source. Surface water samples contained higher concentrations of total metals than dissolved metals, suggesting that entrained sediment in the water samples may have affected these results (as shown by high concentrations of dissolved aluminum, a very abundant element present in many minerals). Iron and manganese are also common mineral components and since metals samples are preserved at a pH of less than 2, sediment introduced into the bottle can dissolve, causing higher apparent dissolved metals concentrations.

Natural organic compounds are decomposed in the sediment and soil by bacteria through a variety of chemical pathways, depending on the availability of a number of oxidizing agents, such as oxygen. The standard profile of sediment/soil respiration consists of a series of oxidants that are consumed in order of free energy release, that order being: oxygen, nitrate, manganese oxides, iron oxides/hydroxides, sulfate, and carbon dioxide (Appelo and Postma, 2010). Generally, the lower free-energy oxidants will not be utilized until the higher free-energy oxidants have been consumed (Appelo and Postma, 2010).

Site conditions strongly suggest that elevated concentrations of iron and manganese observed in groundwater have resulted from redox conditions caused by the decomposition of organic matter at the site. The low concentrations of dissolved oxygen (<1.0 milligrams per liter) and the negative oxidation reduction potential readings in some of the samples from the monitoring wells indicate anoxic conditions. The anoxic conditions, the high organic content of nearby sediments, and the concentrations of iron and manganese in the groundwater indicate that naturally occurring, bacterially mediated degradation of organic matter and reduction of manganese oxides and iron oxides/hydroxides is producing the high levels of dissolved iron and manganese that are detected in the groundwater samples.

7.1.4 Landfill Gas Migration

LFG at the landfill was monitored from 2010 through 2011. Selected monitoring data are presented in Table 11 and are shown on Figure 12. The sampling and monitoring results show that the highest concentrations of methane generally coincided with the thickest accumulations of wood waste. One of the requirements in WAC-173-304-460 is that no explosive levels of methane are allowed beyond the property line.

The highest concentrations of LFG and methane were detected in LFGP-004, with a maximum methane concentration of approximately 70 percent and a maximum carbon dioxide concentration of approximately 32 percent. This probe was installed in the area with among the thickest accumulation of wood waste. There may have been a correlation between wood waste thickness and LFG percent. The LFG data do not differentiate between sources. It is not known if there is also a correlation between LFG percent and solid waste characteristics such as organic content, or whether wood waste thickness correlates to lower release rates of LFG generated by solid waste. From the 1950s through 1969 or 1970, the landfill operated as a “burn dump” with open incineration of solid waste. Accumulation of unburned solid waste occurred only over a 4-year span ending in 1973. This solid waste has had over 40 years to degrade, so the quantities of methane generated is anticipated to be significantly reduced in the future.

The removal of the wood waste conducted in late 2014 minimizes a potential source of LFG and lessens the likelihood of differential settlement of the consolidated solid waste. Settlement can contribute to slope failures and ponding, which may tear the cover material. As groundwater within the solid waste slowly infiltrates through the Bay Mud, the solid waste will slowly become drier. Because water is required for processes that generate methane and carbon dioxide, the increasingly drier solid waste will produce less and less LFG over time.

7.2 EXPOSURE PATHWAYS AND RECEPTORS

This section details the exposure pathways and receptors for both human health and terrestrial ecological receptors.

7.2.1 Human Health Exposure Pathways and Receptors

Access to the site is restricted by fencing and a locked gate at the northern end of the site. Currently most of the solid waste is covered by the silty sand cover and the wood waste. As shown in Figure 29, potential and complete exposure pathways at the site under the current conditions are:

- Direct human exposure to solid waste through construction activities such as utility work, especially at the north end of the landfill where solid waste was observed outside of the locked gate near March Point Road.

- Seasonal infiltration of surface water into the solid waste causing groundwater mounding and subsequent discharge of groundwater to the inner lagoon through seeps, where it could eventually affect marine biota. Both the groundwater in the solid waste and the seep water have high concentrations of redox-sensitive metals such as iron and manganese (see Section 5.5.1). Groundwater, in the solid waste and wood waste in some areas, is anoxic. Under anoxic conditions, redox sensitive metals (iron and manganese, etc.) are soluble and can be transported along groundwater flow paths. The presence of contaminants in the seep water samples suggest that contaminated groundwater from the site is discharging from the seeps into Padilla Bay.

- Migration of shallow groundwater though the Bay Mud into the underlying Lower Aquifer, especially where it is thin or absent, and subsequent discharge to surface waters or marine sediment where it could affect marine biota.

- Potential exposure of solid waste through erosion and direct release to surface waters/marine sediment of the inner lagoon where it could affect marine biota.

- Volatilization, dust emission, and inhalation of chemicals and methane gas generated from solid waste.

7.2.2 Terrestrial Ecological Exposure Pathways and Receptors

As stated in WAC 173-340-7491(1)(b), an exemption from a TEE is appropriate when "all soil contaminated with hazardous substances is, or will be, covered by buildings, paved roads, pavement or other physical barriers that will prevent plants or wildlife from being exposed to the soil contamination." Exclusion from a TEE requires an institutional control under WAC 173-340-440.

If the preferred remedial alternative isolates the solid waste and soil from the environment and establishes institutional controls meeting the requirements of WAC 173-340-440, an exclusion from the requirement for a TEE will be requested from Ecology.

If the preferred remedial alternative does not isolate the solid waste from the environment (for instance, if burrowing animals can breach the cover liner) then a TEE will need to be completed in order to show whether or not the preferred remedial alternative poses a risk to the burrowing animals or if additional engineering steps are necessary to isolate the solid waste from the environment. In either case, institutional controls meeting the requirements of WAC 173-340-440 must be implemented.

7.3 SUMMARY

Figure 29 illustrates the conceptual site model for the landfill. The conceptual site model discussed in Section 7.1 suggests that the landfill is somewhat isolated from Lower Aquifer by the tide flat deposits. Large numbers of drums or other sources of hazardous or dangerous waste were not identified within the landfill during the RI. While there are exceedances of PCLs for metals in soil and groundwater samples collected from and beneath the solid waste, this is not surprising since these samples were collected adjacent to solid waste that includes large metallic objects, such as appliances and other metallic debris. Shallow groundwater within the solid waste was found to be discharging from seeps located in a limited area along the northeastern boundary of the landfill. Concentrations of metals, 4,4'-DDE and PCBs were detected in some seep locations above the PCLs. However, based on the sediment bioassays conducted as part of the Sediment RI, the seep discharges do not have a negative effect on the sediment biota. Also, metal concentrations in upstream surface water samples detect are similar or higher than concentrations in the seep samples, suggesting the concentrations of metals in the seep samples may represent background/off-site sources.

LFG and methane concentrations at the site exceed the lower explosive limit, but this gas does not pose an immediate concern since there are no occupied structures or utilities presently existing at the landfill for methane to accumulate in or below. No structures will remain on site after the preferred alternative is constructed. A passive LFG collection system to manage/monitor gas released after cleanup construction is complete is included as a component of capping alternatives. With the majority of the wood waste removed from the site LFG concentrations are also expected to decrease. It is expected that combined lower LFG concentrations and the passive LFG collection system will result in off-site LFG concentrations that are below regulatory thresholds. However, LFG monitoring will be conducted following remediation to verify this expectation.

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8.0 FINAL CONSTITUENTS OF CONCERN AND CLEANUP LEVELS

This section identifies the final list of COCs and presents final cleanup levels for the site.

8.1 FINAL CONSTITUENTS OF CONCERN

Analytical results for detected analytes for all samples were compared to the PCLs presented in Section 4.2. Constituents that were detected in at least one sample at a concentration that exceeded the PCL were chosen as COCs for the site. The COCs for soil, groundwater/seeps, and surface water are presented in Tables 15, 16, and 17, respectively.

8.2 FINAL CLEANUP LEVELS

Final cleanup levels are determined only for the final COCs for the site, identified as described in Section 8.1. Final cleanup levels for some hazardous substances have been adjusted downward in accordance with WAC 173-340-705(4) (multiple hazardous substances or pathways). Cleanup levels were adjusted downward if the total combined excess cancer risk potential (calculated in accordance with MTCA methods) for the carcinogenic substances exceeded one in 100,000 (1×10^{-5}), or if the hazard index calculated in accordance with MTCA methods exceeded 1. The hazard index is calculated by summing hazard quotients for individual COCs. The cleanup levels applicable to the COC must be adjusted to meet these two total risk criteria.

Proposed final cleanup levels are presented in Table 18 for soil, groundwater/seeps, and surface water. Documentation of total risk calculations is provided in Appendix J.

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9.0 REMEDIAL ACTION OBJECTIVES

The remedial action objectives (RAOs) for the Whitmarsh Landfill address the exposure pathways identified in Section 4.2. To address these exposure pathways, the following site-specific RAOs are proposed for the site:

- Protect human health and the environment from the COCs present in site soils and groundwater by preventing human health and wildlife contact with the solid waste and soils/sediments adjacent to the site.
- Prevent future transport/shoreline erosion of solid waste materials in surface water runoff.
- Minimize infiltration of precipitation into the solid waste to the degree practicable, in order to reduce the migration of landfill contaminants to Padilla Bay. This can be done by minimizing seeps or by improving the water quality of the seeps so they can meet surface water quality criteria.
- Minimize the seepage of shallow groundwater into surface water in the northern portion of the inner lagoon to the degree practicable.

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10.0 APPLICABLE STATE AND FEDERAL LAWS

This section presents important considerations that must be addressed in development, design, and implementation of remedial measures at the site.

10.1 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

In addition to the cleanup levels presented in Section 8.0, other regulatory requirements must be considered in the selection and implementation of the cleanup action. MTCA requires the cleanup standards to be "at least as stringent as all applicable state and federal laws" (WAC 173-340-700[6][a]). Besides establishing minimum requirements for cleanup standards, applicable state and federal laws may also impose certain technical and procedural requirements for performing cleanup actions. These requirements are described in WAC 173-340-710. Applicable state and federal laws are discussed below.

The cleanup action at the site will be performed pursuant to MTCA under the terms of the current Agreed Order and/or a future Consent Decree between Ecology and the Whitmarsh PLP Group. Accordingly, the anticipated cleanup action meets the permit exemption provisions of MTCA. Ecology will be responsible for issuing the final approval for the cleanup action, following consultation with other state and local regulators.

Although the cleanup action will be exempt from some state and local permits in accordance with the Agreed Order, several permits/approvals/processes will be required from local, state, and federal agencies. A discussion of each of the anticipated permits/approvals/processes is provided below. A Joint Aquatic Resources Permit Application will be used to apply for the Shoreline Substantial Development Permit, the 401 Water Quality Certification/Modification, and the U.S. Army Corps of Engineers (USACE) Section 10/404 Permit.

10.1.1 Minimum Functional Standards for Solid Waste Handling (WAC-173-304)

The MTCA regulations, under Section WAC 173-340-710(7)(c), state that cleanup actions completed under MTCA must meet the landfill closure requirements as specified in WAC 173-304. WAC 173-304, the Minimum Functional Standards for Solid Waste Handling, specifies requirements for construction and operation of solid waste landfills in Washington. In addition, Ecology has determined that the closure requirements in WAC 173-303 (Dangerous Waste Regulations) are legal ARARs; therefore, the more stringent closure requirements under those laws shall also apply to cleanup actions conducted.

As described in WAC 173-304-407(3), the March Point landfill site shall be closed in a manner that:

1. Minimizes the need for further maintenance.

2. Controls, minimizes, or eliminates threats to human health and the environment from post-closure escape of municipal solid waste constituents, leachate, LFG, and contaminated rainfall or waste decomposition products to the ground, groundwater, surface water, and the atmosphere.
3. Prepares the site for the post-closure period. The continued facility maintenance and monitoring of air, land, and water are necessary for the facility to stabilize and protect human health and the environment.

10.1.2 MTCA Requirements

The main law that governs the cleanup of contaminated sites in the state of Washington is MTCA. The MTCA Cleanup Regulation (WAC 173-340) specifies criteria for the evaluation and conduct of a cleanup action, including criteria for developing cleanup standards. MTCA regulations require that cleanup actions must protect human health and the environment, meet environmental standards in other applicable laws, and provide for monitoring to confirm compliance with cleanup levels.

MTCA places certain requirements on cleanup actions involving containment of hazardous substances that must be met for the cleanup action to be considered in compliance with cleanup standards. These requirements include implementing a compliance monitoring program that is designed to assess the long term integrity of the containment system and applying institutional controls to the affected area (WAC 173-340-440). The key MTCA decision-making document for cleanup actions is the RI/FS. In the RI/FS, the nature and extent of contamination and the associated risks at a site are evaluated, and potential cleanup action alternatives for conducting a site cleanup action are identified. The cleanup action alternatives are then evaluated against MTCA remedy selection criteria. After reviewing the RI/FS, the March Point site's PLP Group will develop a CAP that Ecology will review and approve after consideration of public comment. Following public review of the CAP, the site cleanup process typically moves forward into design, permitting, construction, and long-term monitoring.

As described below, remedial alternatives presented in Section 12 to meet the requirements of MTCA and attains the RAOs set forth for this site. There are minimum requirements that must be met in order for a remedial alternative to comply with the requirements of MTCA. In order to meet the requirements of MTCA, the selected remedy must be protective of human health and the environment under the specified exposure conditions. WAC 173-340-360(2)(a) specifies four threshold criteria that all cleanup actions must satisfy.

The threshold criteria are:

1. Protect human health and the environment.
2. Comply with cleanup standards (per WAC 173-340-700 through WAC 173-340-760).

3. Comply with applicable local, state, and federal laws (per WAC 173-340-710).
4. Provide for compliance monitoring (per WAC 173-340-410 and WAC 173-340-720 through WAC 173-340-760).

In addition, WAC 173-340-360(2)(b) specifies three other criteria that alternatives must achieve:

1. Use permanent solutions to the maximum extent practicable.
2. Provide for a reasonable restoration time frame.
3. Consider public concerns (WAC 173-340-600).

Because of the various size and history of landfills, Washington State has determined that it is impracticable to treat or move a closed solid waste landfill and has outlined specific requirements (refer to WAC 173-340-710[7][c]) that allow a solid waste landfill to be closed in place in a manner that meets the MTCA criteria identified above.

Under WAC 173-340-740(6)(f), MTCA defines the expectation for containment sites as follows:

> *"WAC 173-340-740(6)(f) The department recognizes that, for those cleanup actions selected under this chapter that involve containment of hazardous substances, the soil cleanup levels will typically not be met at the points of compliance specified in (b) through (e) of this subsection. In these cases, the cleanup action may be determined to comply with cleanup standards, provided:*
>
> *(i) The selected remedy is permanent to the maximum extent practicable using the procedures in WAC 173-340-360;*
>
> *(ii) The cleanup action is protective of human health. The department may require a site-specific human health risk assessment conforming to the requirements of this chapter to demonstrate that the cleanup action is protective of human health;*
>
> *(iii) The cleanup action is demonstrated to be protective of terrestrial ecological receptors under WAC 173-340-7490 through 173-340-7494;*
>
> *(iv) Institutional controls are put in place under WAC 173-340-440 that prohibit or limit activities that could interfere with the long-term integrity of the containment system;*
>
> *(v) Compliance monitoring under WAC 173-340-410 and periodic reviews under WAC 173-340-430 are designed to ensure the long-term integrity of the containment system; and*

(vi) The types, levels, and amount of hazardous substances remaining on-site and the measures that will be used to prevent migration and contact with those substances are specified in the draft cleanup action plan."

The specific remedy selected for the March Point landfill site should demonstrate that the other elements of containment are met, as defined by sections (ii) through (iv) above.

10.1.3 Endangered Species Act Section 7 Consultation

The Endangered Species Act (ESA) of 1973, as amended (16 United States Code [USC] § 1531), provides "… a means whereby the ecosystems upon which endangered species depend may be conserved." On May 24, 1999, the U.S. National Oceanographic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) formalized the listing of Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*) as threatened under the ESA. NOAA Fisheries has designated the coho salmon (*O. kisutch*) as a candidate for listing. The U.S. Fish & Wildlife Service (USFWS) listed bull trout (*Salvelinus confluentus*) in Puget Sound as threatened, effective December 1, 1999. The potential presence of these species in the project area may require consultation with NOAA Fisheries and USFWS regarding the effects of the preferred Alternative on Chinook and coho salmon, and bull trout and associated habitat under Section 7 of the ESA.

10.1.4 United States Army Corps of Engineers Section 10/404 Permit

The Rivers and Harbors Act of 1899 (33 CFR 321-329) gives the USACE regulatory authority over construction activities in all navigable waters of the United States. Section 10 of the act is intended to protect these waters for purposes of navigation and general public benefit. This regulation is administered through the Section 10 Permit application process.

Section 404 of the Clean Water Act (33 USC 1344) prescribes procedures to be followed before dredged or fill materials can be discharged into national water resources (including wetlands). As such, Section 404 provides regulatory guidelines and permit requirements for dredging and filling activities. Administration of the requirements of Section 404 is vested in the USACE. When both a Section 10 Permit and a Section 404 Permit may be required, they are typically considered and administered together by the USACE under a single permit application.

10.1.5 Ecology Section 401 Water Quality Certification/Modification

The Clean Water Act of 1977 (Public Law 95-217), which amended the Federal Water Pollution Control Act, provides for restoring national water resources and maintaining water quality. This act, which is administered by EPA, is intended to restore and maintain the chemical, physical, and biological integrity of the nation's waters. Specific policies, programs, and regulatory procedures support the stated objective.

Section 401 of the act requires that any federal permit involving construction activities that may result in discharges into navigable waters also provide state certification that the discharges will comply with applicable provisions of Sections 301, 302, 303, 306, and 307 of the Clean Water Act. The intent of this certification is to protect water resources from degradation and to ensure compliance with water quality standards. In Washington, Ecology has been delegated authority by EPA to administer Section 401 requirements and issue certification.

10.1.6 Ecology Coastal Zone Management Act Consistency Determination

Activities and development affecting coastal resources which involve federal activities, federal licenses or permits, and federal assistance programs (funding) require written Coastal Zone Management (CZM) federal consistency determinations by Ecology. Activities and developments performed by or for federal agencies require that a CZM determination be submitted stating that the project is consistent with Washington's CZM Program to the "maximum extent practicable." Projects obtaining federal permits or licenses or projects that receive federal funding require a certification that they are consistent with Washington’s CZM Program. CZM Determinations/Certifications are submitted to Ecology for concurrence, concurrence with conditions, or objection. A CZM application will need to be submitted and approved before the preferred alternative is constructed.

10.1.7 State Environmental Policy Act

The Washington State Environmental Policy Act (SEPA) (RCW 43.21C; WAC 197-11) and the SEPA procedures (WAC 173-802) require state and local government officials to consider environmental values when making decisions. The SEPA process begins when an application for a permit is submitted to an agency, or an agency proposes to take some official action, such as implementing a MTCA CAP.

Prior to taking any action on a proposal, agencies must follow specific procedures so that appropriate consideration has been given to the environment. The severity of potential environmental impacts associated with a project determines whether an environmental impact statement is required. A SEPA checklist would be required prior to initiating remedial construction activities. Because the site cleanup action will be performed under an Agreed Order/Consent Decree, SEPA and MTCA requirements will be coordinated as necessary. It is expected that a Determination of Non-Significance will be issued for the implementation of the final cleanup action.

10.1.8 Shoreline Management Act

The Shoreline Management Act (RCW 90.58) and its implementing regulations establish requirements for substantial developments occurring within water areas of the state or typically within 200 feet of the shoreline. The City of Anacortes has set forth requirements based on local considerations, such as shoreline use, economic development, public access, circulation, recreation, conservation, and historical and cultural features. Local shoreline management plans are adopted under state regulations, creating an enforceable state law. Because the site cleanup action will be performed under an Agreed Order/Consent Decree, compliance with the substantive requirements of the Shoreline Management Act will be necessary, but a shoreline permit may not be required.

10.1.9 Construction Stormwater General Permit

Construction activities that disturb 1 or more acres of land must comply with the provisions of Washington State construction stormwater regulations (RCW 90.48.260 and WAC 173-226). Although the site cleanup action will be performed under an Agreed Order/Consent Decree, Ecology may still require that a construction stormwater general permit be obtained to satisfy substantive and procedural provisions of these regulations. Substantive requirements could be addressed through preparation of a stormwater pollution prevention plan or equivalent MTCA construction quality assurance project plan (CQAPP) prior to activities that would disturb 1 or more acres of soil. The CQAPP would document planned procedures designed to prevent stormwater pollution by controlling erosion of exposed soil and by containing soil stockpiles and other materials that could contribute pollutants to stormwater. It is anticipated that a CQAPP will be prepared as part of the remedial design process, and supplemented as appropriate by the remedial contractor. These requirements will be coordinated with any applicable permits for the local grading and erosion control.

10.1.10 State-Owned Aquatic Lands Management

Management of the state-owned aquatic lands is governed by the Washington State Constitution Articles XV, XVII, XXVII, Washington State statutes RCW 79.105 through 79.140, and the aquatic land management regulations included in WAC 332-30. The management of state-owned aquatic lands is intended to provide a balance between:

- Encouraging direct public use and access,
- Fostering water-dependent uses,
- Ensuring environmental protection, and
- Utilizing renewable resources.

The power to lease state-owned aquatic lands is vested in the DNR, which has the authority to make leases upon terms, conditions, and length of time in conformance. DNR has the responsibility to consider the natural values of land before leasing it and the authority to withhold land from leasing if DNR determines it has significant natural values. Institutional controls such as deed restrictions and environmental covenants must conform to aquatic lands management laws.

10.1.11 Other Potentially Applicable Regulatory Requirements

Other regulations could also potentially apply for the selected cleanup action related to the following issues:

- **Air/Particulate Emissions** – Site grading or excavation work that could generate dust would be required to comply with applicable air quality regulations (RCW 70.94; WAC 173-400-040(8); Puget Sound Clean Air Agency Regulation 1, Section 9.15.). Controls would need to be in place during construction (e.g., wetting or covering exposed soils and stockpiles), as necessary, to meet the substantive restrictions of the Northwest Clean Air Agency for off-site transport of airborne particulates.

- **Archaeological and Historical Preservation** – The Archaeological and Historical Preservation Act (16 USC 469a-1) would be applicable if any significant archaeological or historical materials were discovered during site grading and excavation activities. Given the area's landforms and environment that are sensitive for cultural resources, archaeological resource analysis should be incorporated into the planning and cleanup efforts to assure that archaeological resources are identified as part of developing investigation strategy (DAHP, 2008).

- **Archaeological Resources Protection Act** – This act (16 USC 470aa; CFR 7) and regulations specify the steps that must be taken to protect archaeological resources and sites that are on public and Native Americans land and to preserve data that is uncovered. Although the marine environment consists of sediments that have been disturbed through continual fill, this regulation will be considered during implementation of the cleanup action through the inclusion of a discovery plan. Appropriate measures will be taken during excavation activities and appropriate tribal members will be contacted in the event that an artifact is encountered.

- **Health and Safety** – Site cleanup-related construction activities would need to be performed in accordance with the requirements of the Washington Industrial Safety and Health Act (RCW 49.17) and the Federal Occupational Safety and Health Act (29 CFR 1910, 1926). These applicable regulations include requirements that workers are to be protected from exposure to contaminants and that excavations are to be properly shored. These requirements are not specifically addressed in the detailed analysis of cleanup action alternatives because they could be met by each of the alternatives.

- **Washington Hydraulics Project Approval** – Hydraulic Project Approval and associated requirements (RCW 75.55.061, WAC 220-110) for construction projects in or nearby state waters have been established for the protection of fish and shellfish. Any form of work that uses, diverts, obstructs, or changes the natural flow or bed of any fresh water or saltwater of the state requires a Hydraulic Project Approval from the Washington Department of Fish and Wildlife. These substantive requirements are potentially applicable to the site, which lies below the high water mark and includes restrictions on dates of in-water work (in-water windows) used to protect fish species at critical life history stages.

- **Washington Solid Waste Management Handling Standards Regulations** – The solid waste management requirements (WAC 173-350) are potentially applicable to the off-site disposal of solid wastes and contaminated media that may be generated as part of the cleanup activities. Waste materials will be sent to facilities licensed and permitted to accept the specific waste material and documentation will be obtained of such disposition.

- **Well Construction** – Regulations (WAC 173-160 and WAC 173-162-020, -030) related to well constructions/licensing establishes minimum standards for any type of well construction. This regulation is potentially applicable to wells constructed for groundwater withdrawal and monitoring. This regulation is also potentially applicable to decommissioning of existing or future wells.

- **Local Permits from City of Anacortes** – Anacortes Municipal Code (Appendix Chapter 33; Section 3306) requires a grading permit application be submitted to the city for any earth grading/clearing. Construction activities such as haul truck operations may require that traffic be directed by flaggers and signage. Dewatering activities associated with the cleanup may require a wastewater discharge permit to discharge water to the local publicly owned treatment works. The applicability of these substantive requirements will be determined through consultation with the City of Anacortes during the design phase of the final selected cleanup action.

- **Tribal Shoreline and Sensitive Areas Permits/Tribal 401 Certification** – Certain type of construction works (e.g., blowing particulates and any discharges into Tribal waters/lands, etc.) along the eastern edge of the landfill berm may require a Tribal Shoreline and Sensitive Areas Permit, a TEPA checklist, and a Tribal issued 401 certification. The applicability of these requirements will be determined through consultation with the Swinomish Indian Tribal Community during the design phase of the final selected cleanup action.

10.2 OTHER CONSIDERATIONS

10.2.1 Habitat Improvement Options

The current shoreline environment along the inner lagoon consists of concrete debris or riprap armoring the shoreline, invasive nonnative plants including the Himalayan blackberry, and very little native vegetation. Ecology has requested that the Feasibility Study alternatives consider inclusion of native vegetation as long as that vegetation will not interfere with performance or maintenance of the remedial alternative. Ecology also has requested that native vegetation be used for the cover (native grasses likely applied in a hydroseed mix), and more native backshore or storm berm species on the areas adjacent to the inner lagoon shoreline. As part of habitat restoration or improvements for this project, a brief description of how habitat restoration options are being developed and integrated into the development of remedial alternatives will be included in the Draft CAP and Engineering Design Reports.

10.2.2. BNSF Railway Concerns

During the RI, the Whitmarsh PLP group had to negotiate an agreement with BNSF to work near the railroad right-of-way and to access the right-of-way in order to reach the shoreline areas by foot. A similar access agreement may be required prior to working near the BNSF right-of-way during the CAP and engineering design work. Work near the BNSF rail line can approach no closer than 25 feet from the centerline of the rail line.

10.3 WOOD WASTE REMOVAL

DNR removed 44,000 cubic yards of wood waste as part of property restoration in 2014 and 2015 following termination of the Snow Mountain log mill lease. There are approximately 13,000 cubic yards of mixed rock and residual wood waste remaining at the former landfill. This mixture was not suitable for compost and is contained in two stockpiles (Figure 4). Minimizing the inclusion of wood waste will reduce methane generation and subsequent settlement of the landfill cap. Lower rates of methane generation will minimize the need for subsequent air emission controls.

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11.0 IDENTIFICATION, SCREENING, AND EVALUATION OF SELECTION OF ESSENTIAL REMEDY COMPONENTS/TECHNOLOGIES

This section identifies and evaluates applicable remedial components/technologies for this MTCA cleanup/landfill remediation project. The remedial actions, objectives, and technologies are shown in Table 19. As the evaluation presented in this report is an FFS, this section identifies components/practical technologies using typical remedies specified by EPA (EPA, 1991) for solid waste landfills that will be selected either as the cleanup action or as a portion of a cleanup action alternative. The selected technologies/components are then combined to form the remedial alternatives.

However, the cleanup action that is selected must still meet each of the requirements specified in WAC 173-340-360. The framework in the EPA guidance is used to structure the discussion in this section.

Key components of the remedy for the site are:

- Engineering controls and supplementing institutional controls;
- Landfill cover (vertical/lateral) including demolition and stormwater control;
- Leachate (or groundwater), LFG collection, treatment and/or containment as necessary;
- Removal (excavation) and off-site disposal as necessary; and
- Long-term maintenance and operation of landfill closure: groundwater/seep, stormwater, LFG, and landfill cover integrity monitoring.

The components identified above meet both the MTCA requirements for cleanup and the closure and post-closure requirements of a landfill site. Each component, along with practical technologies, is described in more detail in Sections 11.1 through 11.5. The remedial components/technologies that are identified and retained are evaluated with respect to their effectiveness, implementability, and cost. Different combinations of these technologies will be selected to develop remedial alternatives in Section 12. Table 20 compares how the components discussed in Sections 11.1 through 11.5 are addressed by each alternative presented in Section 12.

11.1 ENGINEERING CONTROLS AND SUPPLEMENTING INSTITUTIONAL CONTROLS

Institutional controls provide limitations on access or use of the property in order to reduce the potential for applicable receptors to be exposed to COCs from the site. Institutional controls applicable to the site include requirements to provide basic information/notification and/or measures to inform the public about potential risks from the site, deed restrictions to preclude uses of the site that may risk exposure to site COCs, and access restrictions to prevent potential receptors from entering the site. The technologies considered for engineering controls include perimeter fencing using galvanized or poly-coated chain link fence, signage on the fence, and deed restriction. Due to the concerns over release of zinc into the environment from galvanized fencing, uncoated chain link fence has been rejected. Poly-coated fencing and all of the other technologies will be retained. Institutional controls will be coordinated with land owners.

Installation of a perimeter fence will offer some measure of security against unrestricted access to the site by the public. Access restrictions are necessary to protect the public against unintentional contact with solid waste. Signage will be placed on the fence at appropriate locations to inform the general public about the site and why it is fenced. Filing deed restrictions on the various parcels that make up the site will inform individuals and companies who might have interest in the site about its conditions and possible restrictions. These components will be included in all the remedial alternatives that include leaving any solid waste on site. Institutional controls will be coordinated with DNR.

In order to ensure that the selected remedy operates efficiently and is operated and maintained properly, an environmental covenant will be used as a legal measure to provide a clear record of the responsibilities and restrictions for the site. The environmental covenant will be developed as part of the Draft CAP process and will be implemented within the landfill boundaries.

11.2 Landfill Cover Including Demolition and Stormwater Control

Per WAC 173-304, the minimum functional standards (MFS) for a landfill cover are intended to perform two functions:

- Minimize infiltration of stormwater into the solid waste, which creates additional leachate, and
- Provide protection to mitigate the direct contact exposure pathway to humans and the environment (including disease vector control).

Specifically, WAC 173-304-460(3)(e) (i to iii) requires that:

- At least two feet of 1×10^{-6} cm/sec or lower permeability soil or equivalent shall be placed upon the solid waste. Artificial liners may replace soil covers provided that a minimum of fifty mils thickness is used.
- The grade of surface slopes shall not be less than two percent, nor the grade of side slopes more than 33 percent.
- Final cover of at least 6 inches of topsoil be placed over the soil cover and seeded with grass, other shallow rooted vegetation, or other native vegetation.

11.2.1 Vertical Containment

The existing Bay Mud underlying the landfill is a natural, low-permeability layer that protects the Lower Aquifer from impacts by precipitation infiltrating through the solid waste. The presence of the Bay Mud causes water infiltrating into the waste to become perched within the landfill; hence, this water is referred to as *perched groundwater*. The purposes of vertical containment technologies are to minimize surface erosion of the solid waste, reduce the rate of stormwater infiltration into the solid waste, and thereby reduce the amount of perched groundwater seeping from certain parts of the landfill.

The cap may be constructed with various materials such as:

- Imported silty sand to augment the original silty sand cover material.
- Low-permeability clay.
- Geosynthetic clay liner (GCL), a manufactured product that consists of low-permeability clay sandwiched between two layers of geotextile. The same material is also available as a geosynthetic clay laminated liner (GCLL), with a laminate of high-density polyethylene (HDPE) bonded to the geotextile.
- A geomembrane made of polyvinyl chloride (PVC) or HDPE.

Based on the boring logs and test pits, the original cover material at the time of landfill closure in 1973 consisted of 2 to 3 feet of silty sands laid over the solid waste, as shown in boring and test pit logs (Appendix F). The solid waste has consolidated since 1974, and there are areas where the cover materials (the northern portion of the landfill) have thinned. One cover option could include bringing in new silty sand cover materials to restore the original grade and improve drainage while providing additional cover in those areas where thinning of the cover is evident. The existing cover and additional cover material will be graded over any wood waste remaining on site. The soil cover would also provide a minimum 2-foot-thick cap across the landfill.

Clay is very moisture-sensitive and requires a relatively narrow range of moisture content and specific compaction requirements during placement to achieve the desired permeability. Therefore, it is a difficult material to place properly in the Pacific Northwest, where a single rain event can delay the placement for several days until the moisture content has been adjusted to the optimum level.

Installation of GCL/GCLL, however, is very simple and quick. The GCL/GCLL is delivered in rolls, wrapped in plastic sheeting to protect it against premature hydration. A roll can be placed on the ground and rolled out where needed. The seams are simply overlapped without any mechanical ties. Ease and speed of installation of GCL/GCLL are advantages to using GCL/GCLL as cover material. GCL/GCLL also have the advantage of “self-sealing” average-sized holes, thus allowing for more flexibility and speed during installation, compared to PVC or HDPE. GCL/GCLL are susceptible to hydration once exposed to rain; however, they can still be installed during a rain event, whereas PVC and HDPE geomembranes require dry and clean surfaces to allow seaming the joints. Therefore, GCL/GCLL is a viable option and will be retained.

Geomembranes offer very low permeability and have very high durability. PVC geomembrane pieces can be either welded or glued together at the seams. Glue-bonding is faster than welding. However, PVC membranes are not as strong as HDPE and can be punctured more easily than HDPE. HDPE geomembrane pieces are welded together, which takes slightly longer than glue-bonding. The main difference between PVC and HDPE is their service life. PVC is susceptible to loss of plasticizers with time, especially when it is exposed to sunlight or to wet and dry cycles. Loss of plasticizers makes the material brittle, susceptible to cracking and leaks, and less puncture-resistant. HDPE is the most durable synthetic material and is widely used as liner or cap for landfills. Both PVC and HDPE will be retained as technologies for vertical containment.

11.2.2 Lateral Containment

Lateral containment aims to create a barrier between the landfill and the shoreline, intended to minimize seeps of perched contaminated groundwater from the landfill. Barriers may be constructed with a slurry wall, clay, GCL/GCLL, geomembrane (PVC or HDPE), or existing soil cover material along the shoreline. An earthen berm would be required for geomembrane installations. A berm would serve as a dam to the tidal fluctuations, thus allowing ample time to place, weld, and test the geosynthetics' joints. A berm is a necessity for installation of PVC and HDPE, but not for GCL/GCLL, or earthen cap. Those can be installed during a normal tide cycle. However, the berm may be eliminated if the quantity of excavation along the bay is minimal and the face of the excavation can be covered within one tide cycle.

Slurry Wall. Construction of a slurry wall would require excavation of a trench along the shoreline edge within the newly placed earthen berm. The excavated material would be blended with clay and water to lower its permeability, then returned to the trench as a slurry backfill. This technology is time-consuming. Blending clay with the excavated material is a wet operation. Moreover, during the blending operations, mud is frequently splashed around and during a rainfall event the volume of the slurry and potential loss of slurry containment can be problematic. The proximity of such an operation to Padilla Bay increases the importance of slurry containment and makes this technology more risky than other alternatives. In addition, the clay lowers permeability by adsorption, whereby positively charged hydrogen ions in water are adsorbed to the negatively charged clay ions. However, in a nearshore, saline environment, the adsorption of hydrogen ions is reduced due to the presence of other positively charged (sodium) ions in sea water. A type of clay referred to as "sodium clay" adsorbs less sodium, thus has lower permeability. However, the permeability still will not be as low as it would be in fresh water. Due to the proximity to the nearshore environment and the higher risk of release of mud or slurry into the bay, this technology will not be considered as an option.

Clay or GCL/GCLL. Clay or GCL/GCLL can be used as a veneer on the inside of the earthen berm (if required for a specific alternative). Clay or GCL/GCLL can also be used on top of the solid waste without the berm, which would reduce the lateral hydraulic conductivity and eliminate the flow of perched groundwater/leachate in the form of seeps. Due to the high salinity of sea water, neither material would be as effective as it would be in fresh water.

To address this salinity concern, AMEC contacted CETCO, a leading manufacturer of GCLs/GCLLs, and discussed various technical options. Subsequent, permeability testing was performed on a representative Polymer bentonite GCLL sample using seawater as the permeating fluid. AMEC provided a 5-gallon sample of Puget Sound seawater to the CETCO lab in Illinois. CETCO conducted two tests; the first test used pure bentonite with Puget Sound seawater as the permeating fluid, and failed to meet the MFS. A second test used a mixture of bentonite and a polymer compound and Puget Sound seawater as the permeating fluid. The polymer in the mixture protects the bentonite from ion-exchange reactions that lower the permeability of regular bentonite. The polymer-enhanced version of the bentonite GCLL is referred to as enhanced GCL (manufacturer name Resistex Plus).

CETCO ran the permeability test of the enhanced GCL for over 600 hours, or 25 days. When the chemistry of the water leaving the test equipment matched that of the influent seawater, nearly 10 pore volumes had passed through the bentonite/polymer. The calculated hydraulic conductivity for enhanced GCL was 9.54×10^{-9} cm/sec. (See May 22, 2015 CETCO memo in Appendix N.) The test continued to run for five more months, and eventually 35 pore volumes with the same calculated hydraulic conductivity passed through the bentonite/polymer. (See July 2015 CETCO calculations summary in Appendix N.)

Subsequently, CETCO calculated the potential leakage rate through the GCL as compared to a 2-foot-thick layer of soil having a hydraulic conductivity of 1.0×10^{-6} cm/sec (the minimum amount of cover required by the MFS, a project-specific ARAR). The MFS cover would have a calculated leakage rate of 1,384 gallons/acre/day versus 392 gallons/acre/day for an enhanced GCL. (See May 22, 2015 CETCO memo in Appendix N.) Therefore, the enhanced GCL performs better than the MFS cover.

While the enhanced GCL is a relatively new type of GCL, studies have suggested that an enhanced GCL would have an expected service life exceeding 120+ years. Additional testing is being performed that will refine the expected service life. (See April 26, 2015 CETCO memo in Appendix N.)

CETCO also offers both the normal sodium bentonite GCL (Bentomat) and enhanced GCL (Resistex Plus) with an optional 5-mil thick HDPE geolaminate that is bonded to the GCL geotextile. CETCO refers to this combination as a GCLL. The laminated HDPE can be installed facing up or down, depending on the application—in this case, CETCO recommends installing the geolaminate facing up to help prevent desiccation. This will help keep the bentonite or enhanced bentonite fully hydrated while providing a backup layer of protection from infiltration. (See Benson and Scalia article in Appendix N.)

Because the geolaminate is bonded to the GCL "sandwich," there are no wrinkles or gaps between these layers. If rainwater does penetrate the laminate through a defect, the underlying bentonite will seal the puncture. Because the GCLL is under the pressure of 3 feet of earthen materials, the bentonite has the ability to self-heal any small punctures and holes due to its gel-like nature. (See Budihardjo et al. article in Appendix N.)

Lastly, to model GCLL and HDPE leakage performance, CETCO calculated how a single cover consisting solely of 60 mil-thick HDPE geomembrane would perform in comparison to a single cover of GCLL, as specified in two of the other alternatives. This calculation assumes that there is some type of installation or manufacturing defect in the HDPE at a rate of two defects per hectare and in the GCLL at 10 errors per hectare due to the thinner geolaminate. These calculations show that the thicker HDPE will actually have a leakage rate approximately 10 times higher than the GCLL, primarily due to the gap between the HDPE and the underlying higher permeability soils caused by the wrinkles in the stiffer HDPE fabric. (See July 2015 CETCO calculations summary and Giroud technical paper in Appendix N.)

Based on this information, the GCLL is believed to be ideal for use as lateral containment due to its ease and speed of installation and the fact that it would achieve the desired permeability in the saline environment, as well as offer a low leakage rate; therefore, this option is retained.

Geomembrane. A geomembrane barrier constructed from PVC or HDPE could be installed along the shoreline to serve as a hydraulic barrier. However, due to the need to weld or join the individual layers of geomembrane, a berm must be constructed to allow for installation of geomembrane under dry conditions. The berm would isolate the cover from the tidal fluctuations during construction and allow for testing of the welds or joins. To provide containment, the geomembrane from the cap can be extended down into the earthen berm and tied into the Bay Mud. The geomembrane would offer better protection against release of perched groundwater from the landfill than PVC. PVC geomembranes would be susceptible to loss of plasticizers due to exposure to daily wet and dry cycles by the tides, which would shorten the service life compared to HDPE geomembrane.

Therefore, the HDPE geomembrane will be retained for use as a lateral containment barrier due to its effectiveness and long service life.

Existing Soil Cover Material. Restoration of the existing landfill soil cover, once re-graded and covered with 6 inches of seeded topsoil, would reduce infiltration through the solid waste and therefore reduce the potential discharge of perched groundwater to the seeps. The reuse of existing soil cover material is efficient. Therefore, the use of the existing landfill soil cover could be considered for use as a lateral containment barrier due to its relative effectiveness.

Summary. Use of GCLL over the solid waste along the bay or as a veneer over the earthen berm could be practical and offers advantages for its ease and speed of installation along the shoreline, where construction operations are limited to a narrow time window due to tides. Although its permeability would be higher in a saline environment compared to fresh water settings, the GCLL would substantially reduce the hydraulic connection between the perched groundwater and Padilla Bay. Use of HDPE geomembrane as a hydraulic barrier is also an effective technique to reduce the hydraulic connection between the perched groundwater and the tide. Restoration and re-use of the existing soil cover, along with regrading and re-vegetation, would reduce infiltration somewhat to the perched groundwater and potential discharge of perched groundwater to the seeps.

Therefore, GCLL, and HDPE or PVC geomembranes, and restoration and re-use of the existing soil cover will be considered in separate alternatives.

11.2.3 Demolition

The existing building within the landfill footprint will need to be demolished and disposed of either off site or on site, or recycled off site. Incorporating the demolition debris into the waste on site is an acceptable approach and will be retained. The remediation contractor may propose off-site recycling of concrete, which will be evaluated at the time of construction. However, off-site recycling is not usually cost effective for the available quantities. The structural steel and metal siding will be recycled off site.

11.2.4 Surface/Stormwater Controls

Managing site runoff at the landfill and preventing off-site surface water from running on to the site is a core component of the containment remedy, as it would minimize infiltration into the landfill and the potential for contaminant leaching to groundwater, and would prevent conveyed stormwater from coming into direct contact with land-filled solid waste. These technologies reduce water infiltration into the solid waste and associated leachate generation, and slow the rate of cap erosion. Surface controls most commonly used at municipal landfill sites are grading and revegetation. Revegetation is necessary to stabilize the surface of a landfill site, promote evapotranspiration, decrease erosion of the cover soil by wind and water, and reduce sedimentation in stormwater runoff.

These surface controls are typically implemented to prevent leachate intrusion into the groundwater system by minimizing the amount of groundwater interacting with the solid waste. This can be done by lining stormwater ditches or tight-lining stormwater conveyance systems and designing site components to direct water flow to areas outside of solid waste.

11.3 LEACHATE (OR GROUNDWATER) AND LANDFILL GAS COLLECTION, TREATMENT AND CONTAINMENT

In WAC 173-304, existing landfills that did not have leachate collection systems were not required to meet the bottom liner and leachate collection and treatment requirements. However, it is expected that any alternative that lessens infiltration will lower groundwater levels within the solid waste. Those alternatives that use a cover layer (GCLL, PVC, and/or HDPE) to minimize infiltration will see the greatest decrease in groundwater levels within the solid waste (short of an alternative that removes all waste). If the selected alternative includes a cover layer, then the CAP will describe the method used to monitor groundwater levels within the solid waste after implementation of the selected alternative, and any contingent plans for addressing groundwater if the groundwater levels do not stabilize near the mean water level measured in the Lower Aquifer monitoring wells.

One key component of the remedy for the site is ensuring that LFG is being addressed properly. This can be accomplished by a passive or active gas collection and treatment system or monitoring to ensure that the LFG levels are safe. The LFG system should be designed to capture the gas within the landfill and ensure that LFG does not migrate outside of the landfill boundary, and that LFG is discharged safely to avoid any potential damage to the buildings (if any), utility corridors, and other surface and subsurface structures on and around the site.

Landfills that have been closed for a long time, such as March Point landfill (which has been closed for over 40 years), or low volume and relatively shallow sites, can usually achieve effective on-site LFG accumulation control with trenches or wells installed immediately below the landfill cover. Additionally, effective perimeter LFG migration control can usually be achieved with simple passive ventilation trenches buried within the edge of solid waste or native soil. Such passive vent systems consist of a slotted or perforated pipe buried within highly permeable backfill materials (e.g., drain rock). Trench depth is dependent on the depth of solid waste, such that the perforated pipe is placed at approximately one-half the solid waste depth unless deeper permeable strata exist that could cause LFG migration. Burial depth can vary, depending on native soil conditions or changes in solid waste edge depth to accommodate landscaping or a landfill cover system.

11.4 REMOVAL (EXCAVATION) AND OFF-SITE DISPOSAL AS NECESSARY

Disposal is a remedial technology that applies to both solid waste (solids) and perched and contaminated groundwater (liquid). The disposal option considered for the solids is disposal off site in a lined permitted landfill. The options for excess perched groundwater include off-site treatment and disposal, or on-site treatment followed by off-site disposal.

Excavation and off-site disposal of all solid waste in the landfill would also require removal of a large volume of perched groundwater to eliminate or minimize release of groundwater from the landfill. Perched groundwater would need to be disposed of at the local wastewater treatment facility. In the event that perched/contaminated groundwater is transferred to the local wastewater treatment facility for treatment and discharge, it is possible that various batches could be rejected by the wastewater treatment facility if they exceed the facility's discharge criteria. Such rejections could result in substantial delays and increased cost during remediation. Treatment of removed groundwater on site would substantially reduce this likelihood, and therefore is considered the only practical option for groundwater disposal.

11.5 LONG-TERM MAINTENANCE AND OPERATION OF LANDFILL CLOSURE: GROUNDWATER/SEEP, STORMWATER, LANDFILL GAS, AND LANDFILL COVER INTEGRITY MONITORING

In order to ensure the final remedy selected is effective and will provide long-term protection of human health and the environment, the long–term monitoring of the groundwater, seeps, and LFG monitoring is required and will be included in all alternatives proposed in Section 12 except the "No Action" alternative. Any seeps observed during low tides would be also monitored for water quality. Stormwater monitoring may not be required as part of the landfill closure because the stormwater that is conveyed off site is blocked from contact with solid waste; however, any future operating facilities located at the landfill may be required to monitor their stormwater consistent with National Pollutant Discharge Elimination System permit requirements. At this time, there are no known future facilities identified for this site.

HDPE, PVC, and GCLL caps are expected to be very effective in limiting infiltration into the solid waste and therefore limiting leachate migration to groundwater and seeps. It is estimated that the amount of time required to achieve final cleanup levels in groundwater and seeps will be in the range of five to ten years after installation of these low permeability caps.

The final groundwater/seep monitoring locations/numbers, sampling frequency, analytes, and LFG monitoring plan, along with the integrity monitoring plan for the landfill cover will be provided either in a Compliance Monitoring Plan in the Draft CAP or an Operations, Maintenance, and Monitoring Plan.

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12.0 REMEDIAL ALTERNATIVES

This section describes the elements of each of the remedial alternatives developed for the site. Each alternative is discussed separately, with a description of the conceptual design and the uncertainties and assumptions that were made, as well as issues associated with it. DNR removed approximately 44,000 cubic yards of wood waste. Approximately 13,000 cubic yards of residual wood waste mixed with rock remains, as well as approximately 48,000 cubic yards of cover soil with an average thickness of 2 feet. We assume half of the cover soil, or 24,000 cubic yards, will be useable in the cover system. Therefore, a total of approximately 37,000 cubic yards of sand, wood waste, and rock will remain as waste to be added to the volume of the solid waste being considered in this FS. Potential reuse of the wood waste after screening out the rocky debris for use as a soil additive, or off-site recycling as compost, will be considered during drafting of the CAP. The amount of wood waste incorporated below the landfill cover would be minimized to the extent possible.

In developing the remedial alternatives and their associated implementation costs, all the survey information was based on the North American Vertical Datum of 1988 (NAVD88), which can be converted to MLLW by adding 0.53 foot to NAVD88. All elevations discussed in the description of alternatives and on the figures are relative to MLLW datum.

Seven remedial alternatives have been developed based on the selected components/technologies and their relative effectiveness as follows:

- **Alternative 1 – No Action:** This alternative is required as a base alternative against which other alternatives are compared. In this alternative only institutional controls would be implemented.

- **Alternative 2 – Restoration of Existing Soil Cover:** This alternative includes institutional controls, screening and re-grading of the existing landfill soil cover, placement of a 6-inch layer of seeded topsoil for vertical containment, and lateral containment.

- **Alternative 3 – GCLL Cap:** This alternative includes institutional controls, installation of an enhanced GCLL veneer for lateral containment, and an engineered cap with GCLL for vertical containment.

- **Alternative 4 – HDPE Cap:** This alternative includes institutional controls, installation of a perimeter earthen berm with an enhanced GCLL veneer for lateral containment, and an engineered cap with HDPE geomembrane for vertical containment.

- **Alternative 5 – HDPE Cap Anchored into Bay Mud:** The elements of this alternative are the same as Alternative 3, except the HDPE would be anchored into the Bay Mud to provide lateral containment instead of using an enhanced GCLL veneer over the berm.

- **Alternative 6 – PVC Cap:** The elements in this alternative are the same as Alternative 5, except the PVC geomembrane would be considered instead of HDPE for vertical containment.

- **Alternative 7 – Landfill Removal:** This alternative includes complete excavation of solid waste from the landfill and disposal off site. This alternative is included since it involves relocating the solid waste to a lined, permitted landfill.

12.1 ALTERNATIVE 1 – NO ACTION

This alternative serves as the baseline against which the other alternatives are compared. In this alternative, a perimeter security fence would be installed and the landfill surface would be regraded to create a small mound in the center. Regrading would contour the site and allow more stormwater to drain horizontally from the site instead of infiltrating vertically into the waste.

A 6-foot-high, poly-coated chain-link fence would be installed around the landfill with new gates. The cuttings from installation of fence posts would be incorporated into the landfill as part of site regrading such that the cuttings would not be left at the surface.

The existing monitoring points would be abandoned in place. The landfill would be regraded to fill the depression left in the middle after removal of the wood waste. An estimated 10,000 cubic yards of material would be regraded to eliminate any depression from the wood waste removal.

No long term monitoring or maintenance would be associated with this alternative.

12.2 ALTERNATIVE 2 – RESTORATION OF EXISTING SOIL COVER

Alternative 2 involves restoration and re-use of the existing landfill cover soil, as well as the following elements:

- Re-grading of the existing soil cover material, along with additional imported soil as needed, to a gently sloping mound covering all exposed solid waste across the landfill footprint.

- Compaction of the re-graded cover material.

- Installation of a passive LFG collection system.

- Installation of a groundwater monitoring well network.

- Construction of a perimeter access road and drainage ditches.

- Placement of an additional 6-inch layer of seeded topsoil over the restored cover material.

The proposed plan view and cross section for this alternative are shown on Figures 30 through 32.

In order to eliminate disturbance of the solid waste, no solid waste excavation will be performed. Instead, the existing 2–3-foot-thick soil cover material will be re-graded and spread across the areas where solid waste is exposed, including the shoreline edges of the landfill along Padilla Bay. The existing soil cover material is anticipated to include silty sand to sand with gravel. Additional clean soil could be imported as needed to restore the thickness of the cover material.

Prior to any earthwork, the contractor would complete site setup, including installation of a sorbent boom along the edge of the landfill to prevent releases that may enter the bay, installation of silt fences and/or straw wattles and other erosion control measures around the perimeter of the landfill, as well as temporary, perimeter security fencing along the landward sides of the landfill to maintain site security. Based on the current dimensions of the landfill, an estimated 1,500 linear feet of sorbent boom, 2,000 linear feet of silt fence, and 2,600 linear feet of temporary fencing would be needed.

The project would be constructed during the dry season (July through October) when the level of perched groundwater is typically the lowest and the low tide generally occurs during daylight hours. The existing perched groundwater within the landfill is typically encountered at Elevation11.5 feet MLLW during the summer months. Groundwater management in the form of extraction and treatment is not anticipated, as no intrusive activities through the solid waste into the perched groundwater will be performed. Regrading of the cover material, especially in the nearshore/shoreline areas, will require sedimentation controls such as silt fences or other measures

The work along the northern edge of the landfill would be within the railroad right-of-way (25 feet from the centerline of the tracks). Therefore, it is expected that all of the requirements typically imposed by BNSF for work within the rail right-of-way would apply. These requirements include worker training, insurance, shoring, and employment of a flagger during applicable construction activities. Typically, a full time flagger is not required once a temporary fence is installed and workers are physically separated from the tracks. Due to the shallow depth of landfill material in this area, intrusion into the rail right-of-way should be minimal. Shoring is not expected to be required for this alternative.

As the earthwork proceeds, the existing cover soil will be re-graded across the site to ensure a minimum 2-foot thickness of cover soil material is present over the landfill solid waste. The cover soil will serve as a passive LFG collection layer. A network of 4-inch-diameter perforated plastic pipe with risers would be installed into this layer to collect and passively vent LFG into the atmosphere. The landfill would be re-graded to a minimum average grade of 2 percent toward the center of the landfill. The final slope of the interior portion would be adjusted as needed to accommodate the placement of re-graded existing cover soil material and achieve positive surface water drainage, but will generally conform to the surface grade as the former soil cover currently exists.

As final grades are achieved, the existing soil cover material will be compacted to increase the in-place density and stability of the material. As the final shape of the existing soil cover is constructed, a 6-inch-thick layer of topsoil (Figure 32) will be placed with sufficient nutrients to promote vegetation growth. A perimeter access road would be constructed around the landfill at approximately Elevation 16 feet MLLW. The road would be approximately 15 feet wide with a 2-foot-wide stormwater ditch on the landfill side. The road would be constructed with crushed rock with a 5 percent slope toward the outside to promote stormwater runoff. Stormwater runoff from the interior of the landfill would flow into the roadside ditch, which would be conveyed across the road via buried 4-inch-diameter plastic pipes, then flow via surface flow to the exterior perimeter swales and the bay. The ditches and discharge points would be adequately protected against erosion by vegetation and/or suitable gravel/crushed rock. A row of silt fences would be installed around the perimeter of the completed landfill, along the perimeter swales, to capture any sediment that may erode from the landfill cap until vegetation over the newly constructed landfill cap is mature and any erosion has stabilized.

The final surface of the landfill and shoreline area would be hydroseeded with native grass and a wildflower mix with appropriate fertilizer and tackifier. The mix for the top of the landfill would likely contain blue wildrye, tufted hairgrass, creeping red fescue, meadow barley, and redtop. For the shoreline area, the mix would likely contain backshore species, such as dunegrass, creeping bentgrass, coastal strawberry, Pacific gumweed, beach pea, saltweed, and silver bursage. This seed mix would be integrated into the amended sand layer within the re-used ballast material. The final, actual species and mix ratios would be determined during the design. A 10- to 20-foot-wide band of shrubs and trees may be planted along the shoreline. Hydroseeding and plantings would be conducted in early fall, prior to the start of cold weather.

Upon completion of the landfill cap, a 6-foot-tall, poly-coated perimeter chain link fence would be installed around the landfill perimeter to maintain site security. The fence would have vehicle and man-gates on both sides to allow entry to the landfill and provide access to the shoreline for maintenance and repair. To monitor the groundwater level and determine post-remediation hydraulic connectivity with the tides, groundwater level monitoring wells will be installed along the shoreline as specified in the Draft CAP. Each pair of monitoring wells would consist of a 2-inch-diameter shallow well completed within the solid waste and a 2-inch-diameter deep well completed within the Lower Aquifer (Figure 30). The exact location and number of wells will be determined during preparation of the CAP and the number and location of wells shown in Figure 30 may vary. These wells would allow water levels to be monitored both in perched groundwater within the solid waste and in the Lower Aquifer. With infiltration minimized into the waste, it is expected that water levels in the perched aquifer would decline until a steady-state level is obtained.

To monitor the groundwater level and determine post-remediation hydraulic connectivity with the tides, several groundwater level monitoring wells will be installed along the shoreline. Each pair would consist of a 6-inch-diameter shallow well completed within the solid waste and a 2-inch-diameter deep well completed within the Lower Aquifer (Figure 30). The exact quantity and location of wells will be determined in the Draft CAP. These wells would allow water levels to be monitored both in perched groundwater within the solid waste and in the Lower Aquifer. With infiltration minimized into the waste, it is expected that water levels in the perched aquifer would decline until a steady-state level is obtained. The purpose of larger-diameter shallow wells would be to allow perched groundwater to be removed by pumping, should the levels continually rise within the solid waste and not reach equilibrium.

The long term monitoring program for this alternative would include monitoring water levels, using transducers in the four proposed well pairs, and sampling the wells shown on Figure 30. The water levels would be logged continuously and downloaded semi-annually for the first five years, then annually thereafter, if conditions have stabilized. The water levels are not expected to exceed the current levels after implementation of the alternative. If the water levels rise above the current water levels, then dewatering may be necessary. The water levels in MW-9 seldom rose above 12 feet MLLW or above 11 feet MLLW at MW-6 (Figure 20). Therefore, those elevations would be considered to be the maximum level to which the perched groundwater may rise at those areas before dewatering is required, or other actions taken to address the rise in water levels within the solid waste. In that case, a work plan would be prepared to remove the water on a periodic basis. Based on the observations from the first five years, an appropriate inspection and dewatering plan would be developed. For the purpose of the FFS, it is assumed that the inspection and dewatering frequency would be reduced to once every five years. For cost estimating purposes only, it is assumed that every five years a total of 2 million gallons of groundwater would be removed from the landfill and transported to the local wastewater treatment facility for treatment.

The sampling and analysis would consist of sampling groundwater from the conditional point of compliance wells semi-annually for a period of five years, then annually thereafter. The samples would be analyzed for the COCs in groundwater and the seeps, which include dissolved/total metals (arsenic, copper, iron, lead, manganese, mercury, selenium, and silver), benzene, 1-methylnaphthalene, 2,4-dimethylnaphthalene, benzo(a)anthracene, bis (2ethylhexyl)phthalate, chrysene, 4,4’-DDD, 4-4’-DDE, chrysene, and Aroclors 1232, 1242, and 1248 for the first five years. After five years, the list of COCs would be limited to dissolved arsenic and iron, benzene, 1-methylnaphthalene, 2,4-dimethylnaphthalene, and 4-4’-DDE.

The final groundwater/seep monitoring locations/numbers, sampling frequency, analytes, and LFG monitoring plan, along with the integrity monitoring plan for the landfill cover, will be provided either in a Compliance Monitoring Plan in the Draft CAP or an Operations, Maintenance, and Monitoring Plan.

12.3 ALTERNATIVE 3 – GCLL CAP

Alternative 3 involves constructing an engineered landfill with a low-permeability cap, in general compliance with ARAR WAC 173-304. Alternative 3 includes the following elements:

- The solid waste at the edges of the landfill would be excavated and returned to the landfill;
- The solid waste would be regraded to a gently sloping mound;
- An engineered cap using GCLL would be constructed over the landfill; and
- An enhanced GCLL would be constructed over the landfill along the shoreline.

The proposed plan view, cross sections, and details for this alternative are shown on Figures 33 through 35.

In order to provide the necessary space to allow for construction of the engineered cap without expanding the current footprint of the landfill, the solid waste along the edges of the landfill would be excavated to the full depth of the cap system, extending outward to a horizontal distance needed for new construction. The bottom of the solid waste is assumed to be at about Elevation 5 feet MLLW, approximately matching the current elevation of the Bay Mud within the inner lagoon, which ranges between Elevations 5 and 8 feet MLLW (Figure 33).

The OHWM was established by AMEC's certified biologist. The shoreline was inspected and the OHWM was identified based on vegetation. The specific elevations at those locations were surveyed and a mean elevation of 9.24 feet MLLW was established. The highest tide at the nearby USACE tidal gauge, located at Swinomish Slough, is approximately Elevation 11.5 feet ±0.5 feet MLLW. Based on the engineer's experience on several other shoreline projects completed along waterways, typical stable slopes below the OHWM range from 4 to 5 horizontal to 1 vertical (4-5H:1V), depending on the tide and wave actions. It is conservatively assumed the slope of the final grade of the landfill below Elevation 10 feet MLLW, facing Padilla Bay, would be 5H:1V.

Solid waste along Padilla Bay would be removed to a horizontal distance of 10 feet into the landfill and sloped up at 5H:1V to about Elevation 15 feet MLLW, with the solid waste placed back onto the landfill. Along the landward sides of the landfill, any excavation would be limited to a depth of 3 feet to accommodate the cap system without changing the perimeter grades. The estimated total quantity of solid waste to be removed and used to create the necessary slopes would be approximately 25,000 cubic yards.

Prior to any earthwork, the contractor would complete site setup, including installation of:

- A sorbent boom along the edge of the landfill to prevent releases that may enter the bay;
- Silt fences and/or straw wattles and other erosion control measures around the perimeter of the landfill; and
- Temporary, perimeter security fencing along the landward sides of the landfill to maintain site security.

Based on the current dimensions of the landfill, an estimated 1,500 linear feet of sorbent boom, 2,000 linear feet of silt fence, and 2,600 linear feet of temporary fencing would be needed.

The project would be constructed during the dry season (July through October) when the level of perched groundwater is typically the lowest, and the low tide generally occurs during daylight hours. The existing perched groundwater within the landfill is typically encountered at Elevation 11.5 feet MLLW during the summer months. Perched groundwater would need to be recovered when excavating portions of the solid waste below the water surface. Standard construction dewatering pumps and hoses would be set up to remove the perched groundwater as excavation proceeds.

Two or more 20,000-gallon-capacity settlement tanks would be set up on site to hold the removed groundwater and allow the majority of the suspended solids to settle out. A groundwater filtration system consisting of sand filters would remove the majority of remaining suspended solids. The filtered water would be stored in two or more post-filtration holding tanks. Based on the approximately 1,500 linear feet of shoreline and assuming a porosity of 45 percent within the solid waste, it is estimated that approximately 1.3 million gallons of groundwater could be generated. The filtered water would be tested in accordance with the testing requirements of the City of Anacortes wastewater treatment plant. If the groundwater test results meet the criteria established by the City of Anacortes wastewater treatment plant, the removed groundwater would be transported to the facility by tanker trucks. Based on tanker and trailer capacity of 6,000 gallons, approximately 220 truck trips would be required to transport the groundwater to the treatment facility. Assuming seven truck trips per work day, or 40,000 gallons daily, the task would take 33 work days or about 7 weeks (~1.5 months) to complete. This effort would be conducted concurrently with other remedial construction activities at the site. Based on the specific conductivity readings, the groundwater does not contain high concentrations of salt (less than 1 percent based on specific conductivity) and should not be a problem for treatment at the City of Anacortes wastewater treatment plant.

Excavation of the solid waste from the shoreline would need to be conducted while the tide is out to minimize adverse impacts to surface water quality. The general direction of excavation would be from the southeast toward the northeast corner of the landfill, where the shoreline meets the railroad embankment. Long-reach excavators would excavate the solid waste in segments. After excavation of a segment was completed, a sand layer followed by a layer of enhanced GCLL would be placed on the exposed surface, and some or all of the cap cover material would be placed over the enhanced GCLL. Separate sections of GCLL would be overlapped approximately 2 feet with a thin layer of dry clay placed between them to seal the seam. The work area would be limited to dimensions that can be completed during one tide cycle, so that no solid waste would come into direct contact with surface water. Along the other sides of the landfill, the solid waste would be removed to the full depth of the cap system (about 3 feet). The cap system installation would proceed as the solid waste is graded to its final contours. The final footprint of the landfill would be approximately 15 acres.

As discussed in Section 6.3, an additional 7.6 feet above MHHW has been allowed for future storm surge or water level rises associated with climate change or tsunamis. Therefore, enhanced GCLL (Resistex Plus CL or the equivalent) would be used along the shoreline up to Elevation 16 feet MLLW. The remainder of the landfill above Elevation 16 feet MLLW will be capped with a standard GCLL (Bentomat CL or the equivalent). See Appendix N for properties and specifications of both the standard and enhanced GCLL materials.

Other concerns with GCL cover systems include burrowing animals, freeze/thawing of the bentonite in the GCL, ion exchange, and desiccation. One foot of crushed rock would be included in the cap system to prevent damage to the membrane by burrowing animals. Increasing the cover thickness above the GCLL to 3 feet will prevent freezing of the hydrated bentonite, since the normal frost depth is 12 to 18 inches deep in western Washington. Ion exchange occurs when calcium ions replace sodium ions in the clay structure and cause shrinkage during subsequent desiccation, ultimately increasing the clay permeability. Ion exchange will be minimized by using cover materials that are not likely to leach calcium and by preventing desiccation. Desiccation will be prevented or minimized by insulation offered by the 3 feet of cover materials. In addition, the GCLL will be installed with the laminate side up, which will seal in the moisture below the cap and further minimize the potential for desiccation.

The work along the northern edge of the landfill would be within the railroad right-of-way (25 feet from the centerline of the tracks). Therefore, it is expected that all of the requirements typically imposed by BNSF for work within the rail right-of-way would apply. These requirements include, but are not limited to, worker training, insurance, shoring, and employment of a flagger during applicable construction activities. Typically, a full time flagger is not required once a temporary fence is installed and workers are physically separated from the tracks. Due to the shallow depth of excavation, it is expected that shoring would not be required.

As the earthwork proceeds, the relocated solid waste would be used to regrade the landfill to an average slope of around 5 percent toward the center of the landfill. This configuration would offer sufficient capacity to accommodate all the solid waste and the remaining wood waste. The final slope of the interior portion would be adjusted, as needed, to accommodate the actual final quantity of solid waste and wood waste.

As the final shape of the solid waste is constructed, an 8-inch layer of sand would be placed over the solid waste to provide a smooth surface, free of debris and deleterious material, and to serve as a passive LFG collection layer. A network of 4-inch-diameter, perforated plastic pipes with risers would be installed into this layer to collect and passively vent LFG into the atmosphere. A layer of GCLL would then be placed over the landfill to serve as the low permeability barrier. The GCLL would be covered with 6 inches of sand, 12 inches of crushed rock, 12 inches of silty soil, then 6 inches of topsoil (Figure 35) with sufficient nutrients to promote vegetation growth. Below Elevation 10 feet MLLW, the cover soil would consist of 24 inches of amended sand and gravel that can withstand the erosive force of water and promote vegetation growth. The specific gradation and composition of the material will be determined during the design.

An access perimeter road would be constructed around the landfill at approximately Elevation 20 feet MLLW. The road would be approximately 15 feet wide with a 2-foot-wide stormwater ditch on the landfill side. The road would be constructed with crushed rock with a 5 percent slope toward the outside to promote stormwater runoff. Stormwater runoff from the interior of the landfill would flow into the roadside ditch, which would be conveyed across the road via buried, 4-inch-diameter plastic pipes, then flow via surface flow to the exterior perimeter swales and the bay. The ditches and discharge points would be adequately protected against erosion by vegetation and/or suitable gravel/crushed rock. A row of silt fences would be installed around the perimeter of the completed landfill, along the perimeter swales, to capture any sediment that may erode form the landfill cap until vegetation over the newly constructed landfill cap is mature and any erosion has stabilized.

The final surface of the landfill and shoreline area would be hydroseeded with native grass and a wildflower mix with appropriate fertilizer and tackifier. The mix for the top of the landfill would likely contain blue wildrye, tufted hairgrass, creeping red fescue, meadow barley, and redtop. For the shoreline area, the mix would likely contain backshore species such as dunegrass, creeping bentgrass, coastal strawberry, Pacific gumweed, beach pea, saltweed, and silver bursage. The final, actual species and mix ratios would be determined during the design. Hydroseeding and plantings would be conducted in early fall, prior to the start of cold weather.

Upon completion of the landfill cap, a 6-foot tall, poly-coated chain link fence would be installed around the landfill perimeter to maintain site security. The fence would have vehicle and man-gates on both sides to allow entry to the landfill and provide access to the shoreline for maintenance and repair. The former Whitmarsh landfill is protected from significant wave action due to its isolation from Padilla Bay by the BNSF embankment and the lack of fetch. The need for shoreline protection measures (if any) will be evaluated during design of the selected remedial alternative.

The long term monitoring and maintenance for this alternative would be the same as described for Alternative 2. The final groundwater/seep monitoring locations/numbers, sampling frequency, analytes, and LFG monitoring plan, along with the integrity monitoring plan for the landfill cover, will be provided either in a Compliance Monitoring Plan in the Draft CAP or an Operations, Maintenance, and Monitoring Plan. In particular, LFG modeling will be conducted during the remedial design to evaluate LFG quality and to determine whether the current design proposed in feasibility study stage (an 8-inch thick gas collection layer system using 4-inch perforated pipe/sand) beneath the GCLL is adequate.

12.4 ALTERNATIVE 4 – HDPE CAP

Alternative 4 would involve constructing an engineered low-permeability cap, in general compliance with ARAR WAC 173-304. Alternative 4 includes the following elements:

- The solid waste at the edges of the landfill would be excavated and returned to the landfill;
- An earthen berm would be constructed along Padilla Bay to allow membrane installation where the cap system would tie in;
- The solid waste would be regraded to a gently sloping mound; and
- An engineered cap would be constructed over the landfill with an HDPE geomembrane and cover soil, as well as a layer of GCLL as lateral containment.

The proposed plan view, cross sections, and details for this alternative are shown on Figures 36 through 39.

An earthen berm is required for installation of the HDPE cap. It will serve as a dam to the tides and allow sufficient time for HDPE welding and testing, while its surface is clean and dry. In order to provide the necessary space to allow construction of the earthen berm along the eastern boundary of the landfill and install the engineered cap without expanding the current footprint of the landfill, the solid waste along the edges of the landfill would be excavated to the full depth of solid waste, extending outward to the horizontal distance needed for new construction. The horizontal extent of solid waste to be removed along the landward and railroad track sides of the landfill would be limited to approximately 20 feet. This distance would provide sufficient space to construct an engineered cap without expanding the footprint of the landfill on those sides.

In order to allow the necessary earthwork to proceed without significant impact by the high tides during construction of the engineered cap, an earthen berm would be constructed along the eastern boundary of the landfill from the Bay Mud beneath the solid waste (Elevation 5 feet MLLW) up to Elevation 10 feet MLLW. The berm would be 5 feet wide across the top, and the back slope toward the landfill would be 2H:1V. Based on these dimensions, the width of the base of the earthen berm would be 40 feet. Therefore, solid waste along the eastern boundary of the landfill would be removed to a horizontal distance of 40 feet and placed back onto the landfill. The total quantity of solid waste to be removed and used for regrading would be approximately 55,000 cubic yards.

Prior to any earthwork, the contractor would complete site setup, similar to Alternative 3. Dewatering trenches or pits would be excavated near and parallel to the eastern boundary of the landfill to remove perched groundwater near the eastern edge of the landfill during removal of the solid waste, to minimize release of the accumulated perched groundwater. The dewatering trenches would be excavated about 70 to 100 feet away from the bay to allow the construction activities to proceed unhindered. Additional permeability and flow rate data would need to be obtained as part of a pre-design investigation to allow determination of specific dimensions and spacing of the trenches. Currently, we assume that a total of approximately 400 linear feet of dewatering trenches would be excavated to the depth of 12 feet below existing grade.

Standard construction dewatering pumps and hoses would be set up to remove the perched groundwater. A treatment system similar to that described for Alternative 3 would be installed. More holding tanks would likely be needed to maintain the earthwork operations. An estimated 3.3 million gallons of groundwater would be generated (approximately 550 truck trips). The task would take 83 work days or about 16 weeks (~4 months) to complete. This effort would be conducted concurrently with other remedial construction activities at the site.

The sequence and method of excavation would be the same as that described for Alternative 3. After excavation of each segment is completed, the earthen berm would be constructed along that excavated segment. The berm would be constructed with sand and gravel, with a final slope facing the bay of 5H:1V (Figure 37). A layer of enhanced GCLL would be placed on the interior side of the berm facing the landfill to lower its hydraulic conductivity and limit or eliminate seeps of groundwater as shown in Figure 39, Detail 4.

Along the other sides of the landfill, the solid waste would be removed to the full depth of solid waste at a slope as steep as possible. Imported sand and gravel backfill would be placed in the void to form a clean perimeter. A small area at the southeast corner of the landfill where solid waste would be removed would remain exposed. This area would be covered with 1 foot of sand. An estimated 20,000 cubic yards of imported backfill would be used to re-construct the perimeter of the landfill. The final footprint of the landfill would be approximately 15 acres.

The work along the northern edge of the landfill would be within the railroad right-of-way (25 feet from the centerline of the tracks). Therefore, it is expected that all of the requirements typically imposed by BNSF for work within the rail right-of-way would apply, including shoring.

As the clean backfill and earthen berm construction around the landfill is completed, the solid waste would be placed against it in compacted layers and graded at a slope of 5H:1V up to Elevation 20 feet MLLW. From this elevation, the landfill slope would be approximately 10H:1V toward the center of the landfill, then flatten to about 20H:1V (5 percent slope) near the peak. This configuration would offer sufficient capacity to accommodate all the solid waste and the remaining wood waste. The final slope of the interior portion would be adjusted up or down, as needed, to accommodate the actual final quantity of solid waste and wood waste.

As the final shape of the solid waste is constructed, the LFG collection and venting system would be constructed similar to that described for Alternative 3. A layer of 8-ounce-per-square-yard nonwoven geotextile would be placed over the landfill to serve as a cushioning layer for the geomembrane. This cushioning layer is used to protect the geomembrane from accidental puncture due to small protrusions from the underlying venting layer. Then a layer of 60-mil HDPE geomembrane would be installed over the geotextile. The geotextile and geomembrane would be anchored into the newly constructed perimeter berm. A drainage layer consisting of geonet with geotextile on both sides would be placed over the geomembrane. The drainage layer would be covered with 18 inches of sandy soil, then 6 inches of topsoil (Figure 38) with sufficient nutrients to promote vegetation growth. It should be noted that sea level rise due to tsunamis, storm surge, and climate change will not affect performance of an HDPE cover system.

An access perimeter road would be constructed at Elevation 20 feet MLLW. The road would be approximately 15 feet wide with a 2-foot-wide stormwater ditch on the landfill side. The road would be constructed of crushed rock with a 10 percent slope toward the outside to promote stormwater runoff. Stormwater runoff from the interior of the landfill would flow into the roadside ditch, and would be conveyed across the road via buried, 4-inch-diameter plastic pipes, then flow via surface flow to the exterior perimeter swales and the bay. The ditches and discharge points would be adequately protected against erosion by vegetation and/or suitable gravel/crushed rock. A row of silt fences would be installed around the perimeter of the completed landfill, along the perimeter swales, to capture any sediment that may erode form the landfill cap, until vegetation over the newly constructed landfill cap matures and any erosion stabilizes.

The final surface of the landfill and earthen berm would be hydroseeded with native grass and a wildflower mix with appropriate fertilizer and tackifier, as described for Alternative 3. Depending on the final design of the landfill and location of the geomembrane anchor trench with respect to the OHWM, other native plants may be included as well, although some plants cannot be placed over the geomembrane due to potential long-term adverse impact to the geomembrane by root growth. Hydroseeding and plantings would be conducted in early fall, prior to the start of cold weather.

Upon completion of the landfill capping, a 6-foot tall, poly-coated perimeter chain link fence would be installed around the landfill to maintain site security. The fence would have vehicle and man-gates on both sides to allow entry to the landfill and provide access to the shoreline for maintenance and repair.

The long term monitoring and maintenance for this alternative would be the same as described for Alternative 2.

12.5 ALTERNATIVE 5 – HDPE CAP ANCHORED INTO BAY MUD

All of the elements and approach to the project for Alternative 5 are the same as Alternative 4, except that the HDPE geomembrane would be anchored into the Bay Mud within the earthen berm instead of using a layer of enhanced GCLL on the landfill side of the berm. The plan view of the completed landfill would be the same as for Alternative 4 (Figures 36 through 39, Detail 5). It should be noted that sea level rise due to tsunamis, storm surge, and climate change will not affect performance of an HDPE cover system.

The earthen berm is included in Alternative 5 because the geosynthetic cap system must be installed "in the dry" (i.e., no surface water is present). Therefore, either the work hours would be limited to low tides, which would more than double the duration and cost of installation, or an earthen berm would have to be constructed along the bay to serve as a dam against tidal action so that construction of the landfill and cap system could continue irrespective of the tides. For cost estimating purpose, we have assumed that an earthen berm would be needed. The geomembrane would be anchored into the Bay Mud within the earthen berm.

The long-term monitoring and maintenance program for Alternative 5 would be the same as for Alternative 2.

12.6 ALTERNATIVE 6 – PVC CAP

Alternative 6 is the same as Alternative 4, except PVC would be used as the geomembrane instead of HDPE. All construction elements, the landfill configuration, and the long-term monitoring program would be the same as described for Alternative 2. The plan view of the completed landfill would be the same as for Alternative 4 (Figure 36 through Figure 39, Detail 4). It should be noted that sea level rise due to tsunamis, storm surge, and climate change will not affect performance of a PVC cover system.

12.7 ALTERNATIVE 7 – LANDFILL REMOVAL

Alternative 7 entails complete removal of all the waste and restoration of the Bay Mud. For this alternative, all existing perched groundwater encountered during excavation would be removed, treated, and disposed of offsite. Remaining mixed wood waste and rock and solid waste would be excavated to the Bay Mud layer beneath the landfill and disposed of in another, permitted landfill, and a 1-foot layer of sand would be placed over the newly exposed Bay Mud to allow its natural restoration.

The excavation would be conducted from east to west, using a long-reach excavator. Dewatering trenches would be installed parallel to the excavation face and about 100 feet away. Based on the size of the landfill, the elevation of perched groundwater within the solid waste, and estimated porosity, an estimated 14–15 million gallons of perched groundwater would be recovered. A system for pre-treatment of the recovered groundwater to remove suspended solids would be used as described for Alternative 3. The estimated volume of 14–15 million gallons would require approximately 2,500 truck trips to transport the water to the water treatment facility. In order to expedite treatment of the perched groundwater and allow the groundwater discharge rate to keep up with the excavation, the system would require two to three times the capacity as that described for Alternative 4. Furthermore, as the landfill is excavated, the available working space would be reduced, and the water pre-treatment and handling system would either have to be relocated to an off-site location or else the water would have to be shipped off site without pre-treatment. For the purpose of cost estimates, it is assumed that the system would be relocated off site to within 1 mile of the project site when about two-thirds of the landfill or about 10 acres (approximately 340,000 cubic yards) of solid waste had been removed. System relocation would double the cost of transportation for about 5 million gallons of the recovered groundwater.

As excavation proceeds to the west, 1 foot of sand would be placed over the newly exposed Bay Mud to allow natural restoration of the site. The excavated waste would be loaded onto dump trucks and transported to another, permitted landfill. Excavation of the entire landfill contents may expose unforeseen conditions that would substantially impact the cost. Therefore, a category of “Unknown Conditions” should be included for this alternative.

Upon completion of waste removal, appropriate consideration would be given to stormwater runoff from March Point Road and points of entry into Padilla Bay, and appropriate erosion protection measures would be installed. Some additional backfill may need to be placed at the toe of the railroad embankment. Potential impacts of permanent waste removal on the structural integrity and stability of the railroad tracks and associated embankment needs to be evaluated and discussed with the railroad company.

Following construction, the site would be monitored for signs of erosion during the wet season, and any modifications or repairs would be made to allow the area to restore naturally.

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13.0 EVALUATION OF REMEDIAL ALTERNATIVES

This section describes the minimum requirements and procedures for the evaluation of remedial alternatives with respect to each other and the RAOs. These requirements are:

- Threshold requirements, and
- Other requirements.

13.1 THRESHOLD REQUIREMENTS

As specified in Section 10.1.2, cleanup actions performed under MTCA must comply with several basic requirements. Cleanup action alternatives that do not comply with these criteria are not considered suitable cleanup actions under MTCA. As provided in WAC 173-340-360(2)(a), the four threshold requirements for cleanup actions are that they must:

- Protect human health and the environment;
- Comply with cleanup standards;
- Comply with applicable state and federal laws (Refer to Section 10); and
- Provide for compliance monitoring.

13.2 OTHER REQUIREMENTS

Under MTCA, when selecting from the alternatives that meet the minimum requirements described above, the alternatives shall be further evaluated against the following additional criteria that they shall:

- Use permanent solutions to the maximum extent practicable using a DCA per WAC 173-340-360(3)(f);
- Provide for a reasonable restoration timeframe per WAC 173-340-360(2)(b)(ii); and
- Consider public concerns per WAC 173-340-380.

13.3 DISPROPORTIONATE COST ANALYSIS

MTCA requires that when selecting from cleanup action alternatives that fulfill the threshold requirements, the selected action shall use permanent solutions to the maximum extent practicable per WAC 173-340-360(2)(b)(i) and (3). “Permanent solution” or “permanent cleanup action” means a cleanup action in which cleanup standards of WAC 173-340-700 through 173-340-760 can be met without further action being required at the site being cleaned up or any other site involved with the cleanup action, other than the approved disposal of any residues from the treatment of hazardous substances as defined in WAC 173-340-200. “Practicable” means capable of being designed, constructed and implemented in a reliable and effective manner, including consideration of cost. When considering cost under this analysis an alternative shall not be considered practicable if the incremental costs of the alternative are disproportionate to the incremental degree of benefits provided by the alternative over other lower-cost alternatives.

MTCA specifies that the permanence of these qualifying alternatives shall be evaluated by balancing the costs and benefits of each of the alternatives with a DCA in accordance with WAC 173-340-360(3)(f), using seven evaluation criteria:

- Protectiveness;
- Per3manence;
- Long term effectiveness;
- Short term risk;
- Technical and administrative implementability;
- Public concerns;
- Cost; and
- Restoration time frame

Table 21 compares the seven alternatives detailed in Section 12 using these evaluation criteria with comparison and numerical rating, and Table 22 shows the cost benefit ratios and DCA for the alternatives. The comparison of benefits relative to costs may be quantitative, but will often be qualitative and require the use of best professional judgment. When possible for this FS, quantitative factors such as mass of contaminant removed or percentage of area of impacts remaining were compared to costs for the alternatives evaluated, but many of the benefits associated with the criteria described below were necessarily evaluated qualitatively. As specified in WAC 173-340-360(3)(e)(ii)(C), Ecology has the discretion to favor or disfavor qualitative benefits and use that information in selecting a cleanup action.

In order to favor the benefits represented by particular criteria associated with the primary goals of the remedial action, this RI/FS report uses a weighting system generally accepted by Ecology (see https://fortress.wa.gov/ecy/gsp/Sitepage.aspx?csid=219). The first three criteria associated with environmentally-based benefits are more highly weighted than the other three criteria, which are associated with non-environmental factors. Costs are disproportionate to benefits if the incremental costs of the more permanent alternative exceed the incremental degree of benefits achieved by the other lower-cost alternative (WAC 173-340-360[e][i]). Where two or more alternatives are equal in benefits, Ecology selects the less costly alternative (WAC 173-340-360[e][ii][C]). Each criterion is discussed separately here. Figure 40 presents the comparative benefit of each alternative to the cost benefit ratio of each alternative. Figure 41 compares the cost of each alternative with the cost benefit ratio for each alternative.

13.3.1 Protectiveness: Weighting Factor = 30%

Alternatives 2 through 7 would be more protective of the environment than Alternative 1. Alternative 2 includes the restoration and re-use of the existing cover soil, and prevents contact with the waste. The re-grading and restoration of the existing cover will increase surface water runoff and evapotranspiration, which will reduce infiltration of surface water into the solid waste and reduce potential discharge of perched groundwater to the seeps. Alternatives 3, 4, and 6 all would offer a similar degree of protectiveness or better than the earlier alternatives due to the presence of enhanced GCLL along the eastern boundary of the landfill. They would meet the objective of reducing or eliminating the seeps in the form of concentrated flow and would substantially reduce hydraulic connectivity between the perched groundwater within the solid waste and the bay. Alternative 5 would potentially offer a highest degree of protection than Alternatives 3, 4, and 6, due to the use of HDPE geomembrane, which is relatively impermeable, as a lateral barrier. However, HDPE liners would have defects during manufacturing and installation that would cause higher leakage rates compared to GCLL, as described in Section 11.2.2.

Alternative 7, with an assigned raw score value of 9, would be the most protective alternative, since all solid waste would be removed from the site. Alternative 5 is next ranked with a raw score value of 8, due to the impermeable quality of HDPE. Other capping alternatives, Alternatives 3 and 4, are assigned with a raw score of 8, while Alternative 6 has a raw score of 7.

13.3.2 Permanence: Weighting Factor = 20%

Alternatives 2 through 7 would be more permanent than Alternative 1. Alternative 1 would be the least permanent alternative. It is likely that some erosion would occur with Alternative 1 during an extreme precipitation event (e.g., 100-year storm event). Alternative 2 would offer more permanence than Alternative 1, but not as much as the other alternatives, since Alternative 2 does not include a geosynthetic layer that would limit erosion. Alternative 6 would provide improved permanence than Alternatives 1 and 2, but would be slightly less permanent than the other capping alternatives due to potential for loss of plasticizers from the PVC geomembrane. Alternatives 3, 4, and 5 would be more permanent. Alternative 7 with a raw score of 9 would be the most permanent, since the solid waste would be completely removed from the site and disposed of in a lined, engineered landfill.

13.3.3 Long-Term Effectiveness: Weighting Factor = 20%

Alternative 1 would not be effective in the long term to meet the RAOs. Alternative 7 would be the most effective alternative, since the solid waste would no longer be located near a body of water. As a result, Alternative 7 is assigned a raw score of 10. Alternative 6 would be the least effective alternative among the other engineered caps alternatives, because of its higher likelihood of damage to the PVC geomembrane due to loss of plasticizers and increased potential for cracking and leaks. Alternatives 3, 4, and 5 would be significantly more effective than Alternative 2, since the hydraulic connectivity with the bay would be virtually eliminated, whereas Alternative 2 would reduce but not effectively eliminate the hydraulic connectivity.

As such, similar raw scores described in “Permanence” are assigned to Alternatives 3 to 7.

13.3.4 Short-Term Risks: Weighting Factor = 10%

Alternative 7 presents the highest short-term (least benefit) risk due to excavation of all of the landfilled solid waste, with the highest possibility for release of pollutants to the bay during the short-term of construction, both from the solid waste as well as the perched groundwater. Potential spillage of solid waste off site during transportation of the waste due to accidents would also present a risk that is likely and unique to this alternative. An additional adverse possible risk would be to the railroad embankment and its stability and safety, depending on the extent of waste removal. Alternatives 2 through 6 have less risk (higher benefit) associated with their implementation than Alternative 7 due to substantially less excavation of solid waste; among these, Alternative 2 has the lowest risk since no solid waste relocation is required and the solid waste is capped in place. Alternative 2 would require the least amount of imported soil and other materials. It essentially relies on the restoration and reuse of existing cover material with a supplemental topsoil layer.

Alternatives 1 and 2 would present the least short-term risk (highest benefit) due to absence of any excavation along the edges of the landfill. Except for Alternatives 1 and 2, Alternative 3 presents the least amount of risk among the alternatives due to requiring less waste relocation and perched groundwater handling than Alternatives 4 through 7. Alternative 2 is assigned a raw score of 8. Alternative 3 is assigned an intermediate raw score of 7, and a raw score of 6 assigned for alternatives 4 thorough 6.

This category received the lowest weighting factor (10 percent) because short term risks can be managed through appropriate design and administrative controls such as implementing a proper site-specific health and safety plan during construction work.

13.3.5 Technical and Administrative Implementability: Weighting Factor = 10%

All alternatives would be implementable from both a technical and administrative standpoint. Alternative 7, with a raw score of 6, would present more of a challenge compared to other alternatives due to loss of operating space as the landfill is removed. Alternative 3 scores higher for technical implementability than Alternatives 4, 5 and 6 because the low permeability GCLL cover does not require welding together of sheets of HDPE or PVC fabric in a dry environment, and due to the use of a berm. Alternative 1, with a raw score of 10, presents the least amount of administrative effort.

13.3.6 Public Concerns: Weighting Factor = 10%

Alternatives 1 and 2 would not address current public concerns, since they would not meet the RAOs described in Section 9. Alternatives 3 through 7 would address current public concerns by meeting the RAOs, but the public may express new concerns due to the risk associated with excavation of solid waste, in particular with Alternative 7. However, given the public's preference for more permanent and for a protective cleanup alternative that entails complete source removal from the site over the capping alternatives, a similar raw score would be assigned to Alternative 7. Partial excavation along a body of water, as is proposed for Alternatives 3 through 6, has been conducted routinely on other projects and the potential for releases into the environment are short term and manageable (e.g., use of earthen berm for containment). Alternative 2 addresses potential public concerns by lowering the risk of a release to the environment due to solid waste excavation.

Further evaluation of the "consideration of public concerns" criterion will be conducted after the public comment period is completed. The results of the disproportionate cost analysis may change based on any future adjustment to this criterion.

13.3.7 Cost

The estimated capital and operation and maintenance costs, where applicable, for Alternatives 1 through 7 are presented in Tables 23 through 29, respectively. The cost estimates presented in this feasibility study are considered within -30 to +50 percent of actual costs of the completed project. The primary use of these estimates is to allow comparison between alternatives during the selection process. Given the similarity of the capping/monitoring components of each alternatives, the actual costs are likely to be proportionally higher or lower for all of the alternatives and relative costs are not anticipated to change significantly. The estimated costs for Alternatives 2 through 6 include the cost for first five years of post-construction monitoring and 30 years of operation and maintenance activities. The estimates have been prepared in 2015 dollars and have not been adjusted based on annual escalation or the long-term discount rate. The contingency rate applied to each alternative is slightly different and is based on the degree of difficulty and uncertainty, level of detail in the conceptual design, and the engineer's confidence in the estimated costs.

Alternative 1 is the lowest cost alternative at a total cost of $231,000, and Alternative 7 is the highest cost alternative at an estimated cost of $83 million. Alternatives 2 through 6 are estimated to cost $6.4 million, $12 million, 15.3 million, $15.3 million, and $15.2 million, respectively. The cost difference of $70,000 between Alternatives 4, 5, and 6 is a negligible percentage of the total project value and thus is not considered a distinguishing factor between these three alternatives. Alternative 3 provides an additional cost savings of approximately $3.2 million compared to Alternatives 4, 5, and 6. The estimated 30-year-long operation and maintenance cost for Alternatives 2 through 6 are similar, in the range of $2.7 million.

Costs are not assigned a weighting factor like other criteria.

13.3.8 Provision for Reasonable Restoration Time Frame

The expected restoration time frame for the different alternatives needs to be based on the factors cited in WAC 173-340-360(4)(b). These factors include:

- Potential risk posed by the site to human health and the environment;
- Practicability of achieving a shorter restoration time frame;
- Current use of the site and surrounding areas that may be affected by releases from the site;
- Potential future use of the site and surrounding areas that may be affected by releases from the site;
- Availability of alternative water supplies;
- Likely effectiveness and reliability of institutional controls;
- Ability to control and monitor migration of hazardous substances from the site;
- Toxicity of hazardous substances left at the site; and
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions.

Alternatives 1 and 2 would both allow precipitation to infiltrate the solid wastes and continue the process of groundwater discharge to the inner lagoon through the seeps. Therefore, neither alternative would have an acceptable restoration time frame.

Alternatives 3 through 6 would allow the landfill to remain intact. The capping and lateral containment should eliminate discharge of groundwater to the inner lagoon. The current use of the site and the future use will remain the same, and access to the site will be restricted through installation of fencing. As currently envisioned for Alternatives 3 through 6, all future uses of the site will need to be restricted to those uses compatible with maintaining the performance of the selected alternative. If these capping alternatives work correctly, groundwater levels within the solid waste should continue to decline either through seepage or removal of groundwater from the solid waste. Monitoring groundwater levels within the solid waste and groundwater quality in the regional aquifer will determine if the capping alternatives are working as planned. The restoration time frame for these alternatives is estimated at five to ten years.

Alternative 7 would remove all refuse from the footprint of the landfill thereby removing all of the risks to human health and the environment. The estimated time for restoration of five years is based on the time necessary for re-establishing the lagoon habitat after removal is complete.

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14.0 SELECTION OF PREFERRED ALTERNATIVE

Alternative 1 is still considered a viable option; however, it would not meet the project RAOs or the ARARs, and is therefore eliminated as a possible alternative. Alternative 7, which has the highest benefit scores, has a very high short-term risk and disproportionately high cost (highest ratio of cost/benefit), and is likewise eliminated as a possible alternative.

Alternative 2 presents a reasonable, plausible, and cost-effective approach to closure considering the low levels of risk posed by the site. Alternative 2 involves the enhancement of the existing soil cover, and offers many of the advantages of the other cover alternatives, which are 75 to 250 percent more costly. The one limitation of Alternative 2 is that the cover layer configuration does not fully meet the technical specifications of the currently applicable solid waste closure rules. Alternative 2 does not meet the ARARs under the MFS of WAC-173-304 for a low permeability cover and sufficient grading; therefore, Alternative 2 is eliminated from further evaluation. Alternative 3 would be as effective as Alternatives 4, 5, and 6 at protecting human health and the environment by minimizing or eliminating the seeps of groundwater emanating from within the landfill and reducing the possibility of erosion of the solid waste. This alternative would be effective in meeting the RAOs over the long term, since no degradation or change in its intended function is expected. The proposed construction requirements and steps involved present minimal and acceptable short-term risk and are considered common practice. Alternative 3 offers a lower potential for leakage of water in and out of the landfill, due to its self-sealing capability.

Consistent with MTCA requirements, Alternative 3 makes the greatest use of high-preference technologies and represents “permanent to maximum extent practicable” alternatives evaluated in this study comparing the ratio of the estimated cleanup cost to the overall weighted benefit scores. As shown in Table 22, Alternative 3 has the lowest cost/benefit ratio of “1,505” among all viable options. When compared to Alternative 3, Alternatives 4, 5, 6 would cost 26 percent more ($3.2 million) without any substantially higher benefit. The incremental cost for Alternatives 4, 5, and 6 is considered disproportionate to the incremental degree of benefit achieved over that of Alternative 3. As a result, Alternatives 4, 5, 6 were determined to be “impracticable” and were discarded from further consideration.

As explained in Appendix N of this report, the standard and enhanced GCLL combination for Alternative 3 would allow for easier, faster, cost effective, and more reliable installation. Table 30 compares GCLL and HDPE as cover materials. Among its advantages, GCLL:

- Can be installed in light rain;
- Does not require perfectly clean surfaces or welding/seaming;

- Is less likely to be installed incorrectly than other typical geomembranes (HDPE or PVC);
- Requires less rigorous quality control/quality assurance during installation than geomembrane;
- Entails less use of natural resources than geomembrane, and eliminates the need to import backfill material and construct a berm;
- Exceeds the permeability requirements both in freshwater and saline environments;
- Is less susceptible than geomembrane to damage from post-construction traffic;
- Is easier than geomembrane to maintain and/or repair in case of damage, and
- Is the lowest cost option that meets or exceeds all the ARARs and their requirements as shown in Table 22, while offering the same level of protection, effectiveness, and durability as other viable alternatives.

Alternative 3 is the MTCA preferred remedy of the site based on the DCA. Alternative 3 meets the threshold requirements and other MTCA/MFS requirements and is the remedy that is permanent to the maximum extent practicable as determined by the DCA. Based on the evaluation in Section 13, the preferred cleanup action alternative is Alternative 3, which includes:

- Moving solid waste (35,000 cy) from the edges of the landfill inward, and grading the waste to a mound to make proper/required grading per the MFS of WAC-173-304.
- Installing a passive LFG collection system, and placing an engineered cap over the landfill with standard GCLL.
- Installing enhanced GCLL extending to the Bay Mud, and constructing a perimeter access road around the landfill. The engineered cap would minimize or eliminate infiltration of groundwater into the landfill, and the GCLL would minimize discharge of groundwater from the landfill to surface waters.
- Treatment of wastewater (1.3 million gallon) generated during the construction work.
- Installation of an LFG collection system, which would vent LFG to the atmosphere, as well as groundwater collection/treatment as needed to prevent off-site migration.
- Installation of stormwater control measures.
- Institutional and engineering controls.
- Long-term monitoring of groundwater (quality and levels for hydraulic control purpose), seepage, LFG, and the landfill closure facility.
- Habitat restoration at the shoreline.

Construction of the preferred Alternative 3 would be practical and implementable from both technical and administrative standpoints. Construction within the intertidal zone would present some challenges, but these challenges are standard in shoreline rehabilitation and/or restoration projects, and can be readily addressed using well-established engineering and construction practices. This alternative would address concerns raised by the public without introducing new public concerns.

For any of the capping alternatives included in the FS, there are potential refinements and value engineering opportunities that should be considered during remedial design. Some concepts that merit further review and evaluation could include:

- Reduction in the thickness of cover soil layers,
- Reuse of existing cover soil,
- Consideration of alternative drainage materials,
- Optimization of overall site grading and minimization of earthworks, and
- Minimization of any disturbance and handling of waste material.

Other concepts should be considered during detailed design to create an optimized final closure for the site.

The schedule for implementation of the preferred alternative requires many steps to be completed beginning with completion and finalization of this RI/FS. Assuming that the RI/FS report is completed in 2016, the CAP could then be completed by December 2016 followed by design and permitting of the preferred alternative in 2017 and/or 2018. Depending upon the length of time required for permitting, the procurement and actual construction activities would then occur in late 2018 or most likely during the spring and summer of 2019.

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TABLES

TABLE 1

SUMMARY OF UPLAND RI SAMPLES AND ANLYSES

March Point (Whitmarsh) Landfill
Skagit County, Washington

Sample ID	Depth (feet bgs)	Date(s) Sampled	Geotechnical Testing Methods[1]	Metals[2, 3]	TPH-G[4]	TPH-D[5]	SVOCs[6]	VOCs[7]	PCBs[8]	Pesticides[9]	Dioxins and Furans[10]	Full Water Suite[11]	Reduced Water Suite[12]	2013 Additional Soil and Groundwater Sampling[13]
PHASE I SAMPLES														
Soil Samples														
MW-01	11.5	10/7/2008	--	X	X	--	--	X	--	--	--	--	--	--
	20.5		--	X	X	--	--	X	--	--	--	--	--	--
	37		--	X	X	--	--	X	--	--	--	--	--	--
MW-03	11.5	10/9/2008	--	X	X	--	--	X	X	X	--	--	--	--
MW-04	8.5	10/8/2009	--	X	X	--	--	X	--	--	--	--	--	--
	19		--	X	X	--	--	X	--	--	--	--	--	--
G1	1	11/1/2008	--	X	X	X	X	X	X	X	--	--	--	--
	5.5		--	X	X	X	X	X	X	X	--	--	--	--
G3	1	10/31/2008	--	X	X	X	X	X	X	X	--	--	--	--
	8		--	X	X	X	X	X	X	X	--	--	--	--
	12		--	X	X	X	X	X	X	X	--	--	--	--
G4	1	10/31/2008	--	X	X	X	X	X	X	X	--	--	--	--
	5		--	X	X	X	X	X	X	X	--	--	--	--
G5	1	11/2/2008	--	X	X	X	X	X	X	X	--	--	--	--
	5		--	X	X	X	X	X	X	X	--	--	--	--
	9		--	X	X	X	X	X	X	X	--	--	--	--
G6	6	11/1/2008	--	X	X	X	X	X	X	X	--	--	--	--
G10	8	11/1/2008	--	X	X	X	X	X	X	X	--	--	--	--
G11	11	10/31/2008	--	X	X	X	X	X	X	X	--	--	--	--
Groundwater Samples														
MW-02	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
MW-03	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
MW-04	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
Seep Samples														
SP-01	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
SP-02	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
SP-03	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
Surface Water Samples														
SW-01	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
SW-03	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
SW-04	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
SW-05	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
SW-06	--	multiple[14]	--	--	--	--	--	--	--	--	--	X	--	--
SW-07	--	multiple[15]	--	--	--	--	--	--	--	--	--	X	--	--

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TABLE 1

SUMMARY OF UPLAND RI SAMPLES AND ANLYSES
March Point (Whitmarsh) Landfill
Skagit County, Washington

Sample ID	Depth (feet bgs)	Date(s) Sampled	Geotechnical Testing Methods[1]	Metals[2, 3]	TPH-G[4]	TPH-D[5]	SVOCs[6]	VOCs[7]	PCBs[8]	Pesticides[9]	Dioxins and Furans[10]	Full Water Suite[11]	Reduced Water Suite[12]	2013 Additional Soil and Groundwater Sampling[13]
PHASE II SAMPLES														
Soil Samples														
G15	15	3/29/2010	X	--	--	--	--	--	--	--	--	--	--	--
G16	7	3/29/2010	X	--	--	--	--	--	--	--	--	--	--	--
	10	3/29/2010	X	--	--	--	--	--	--	--	--	--	--	--
G17.5	7	4/1/2010	X	X	X	X	X	X	X	X	--	--	--	--
G18	8	3/30/2010	X	--	--	--	--	--	--	--	--	--	--	--
G20	12	3/29/2010	X	--	--	--	--	--	--	--	--	--	--	--
G24	16	3/30/2010	X	--	--	--	--	--	--	--	--	--	--	--
G29	9	3/31/2010	X	X	X	X	X	X	X	X	--	--	--	--
G30	7	3/31/2010	--	X	X	X	X	X	X	X	--	--	--	--
	Drum		--	X	X	X	X	--	X	X	--	--	--	--
G32	12	3/31/2010	--	X	X	X	X	X	X	X	--	--	--	--
G35	15	4/1/2010	--	X	X	X	X	X	X	X	--	--	--	--
G37	10	3/31/2010	X	X	X	X	X	X	X	X	--	--	--	--
MW-08	24-26	4/2/2010	X	X	X	X	X	X	X	X	--	--	--	--
MW-10	24-26	4/1/2010	X	X	X	X	X	X	X	X	--	--	--	--
G41	10	3/27/2013	--	--	--	--	--	--	--	--	X	--	--	X
G42	11	3/27/2013	--	--	--	--	--	--	--	--	X	--	--	X
G43	8	3/27/2013	--	--	--	--	--	--	--	--	X	--	--	X
ST-01	0	4/2/2010	X	--	--	--	--	--	--	--	--	--	--	--
ST-02	0	4/2/2010	X	--	--	--	--	--	--	--	--	--	--	--
Groundwater Samples														
MW-02	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--
MW-03	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--
MW-04	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--
MW-05	--	multiple[17]	--	--	--	--	--	--	--	--	--	X[19]	X[20]	X
MW-06	--	multiple[17]	--	--	--	--	--	--	--	--	--	X[19]	X[20]	X
MW-07	--	multiple[18]	--	--	--	--	--	--	--	--	--	X[19]	X[20]	X
MW-08	--	multiple[16]	--	--	--	--	--	--	--	--	X	X	--	X
MW-09	--	multiple[18]	--	--	--	--	--	--	--	--	X	X[19]	X[20]	X
MW-10	--	multiple[16]	--	--	--	--	--	--	--	--	--	X	--	--
MW-11	--	multiple[16]	--	--	--	--	--	--	--	--	--	X	--	--
Seep Samples														
SP-01	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--
SP-02	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--
SP-03	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--

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March Point (Whitmarsh) Landfill
Skagit County, Washington

Sample ID	Depth (feet bgs)	Date(s) Sampled	Geotechnical Testing Methods[1]	Metals[2, 3]	TPH-G[4]	TPH-D[5]	SVOCs[6]	VOCs[7]	PCBs[8]	Pesticides[9]	Dioxins and Furans[10]	Full Water Suite[11]	Reduced Water Suite[12]	2013 Additional Soil and Groundwater Sampling[13]
PHASE II SAMPLES														
Surface Water Samples														
SW-01	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--
SW-03	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--
SW-04	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--
SW-05	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--
SW-06	--	multiple[16]	--	--	--	--	--	--	--	--	--	--	X	--

Notes

1. Geotechnical testing methods were as follows: moisture content by ASTM D2216, particle size distribution by ASTM D422, Atterberg limits by ASTM D4318A, hydraulic conductivity by ASTM D5084, and organic matter/ash content/total solids by ASTM D2974.
2. Phase I soil samples were anlyzed for the metals aluminum, antimony, arsenic, barium, beryllium, cadmium, chromium, copper, iron, lead, manganese, mercury, molybdenum, nickel, selenium, silver, strontium, thallium, titanium, vanadium, and zinc.
   Phase II soil samples were analyzed for the same metals as the Phase I samples, except for aluminum, barium, molybdenum, strontium, and titanium.
3. Metals testing methods were as follows: mercury by EPA 7470A; lead, arsenic, nickel, and thorium by EPA 200.8; and everything else by EPA 6010.
4. The method used for TPH-G was NWTPH-Gx.
5. The method used for TPH-D was NWTPH-Dx. Samples were treated using silica-gel cleanup prior to analysis.
6. The method used for SVOCs was EPA 8270D with low-level PAHs by SIM (select ion monitoring).
7. The method used for VOCs was EPA 8260.
8. The method used for PCBs was EPA 8082.
9. The method used for pesticides was EPA 8081.
10. The method used for dixoins and furans was EPA 1613B.
11. The full water suite included analysis for total and dissolved metals, TPH-G, TPH-D, SVOCs, PAHs, VOCs, PCBs, and pesticides. See Table L-3 in Appendix L.
12. The reduced water suite includes the total and dissolved metals arsenic, lead, mercury, and thallium; PCBs; and pesticides; plus TPH-D for seep samples.
13. The additonal groundwater monitoring included Phase II metals for all samples except MW-08, plus dioxins and furans for MW-08 and MW-09. The additional soil samples were analyzed for dioxins and furans.
14. Sampled during Phase I quarterly monitoring events on October 14-15, 2008, December 17-19, 2008, April 28-29, 2009, and July 23-24, 2009
15. Sampled only during the Phase I December 2008 and April 2009 events.
16. Sampled during Phase II quarterly monitoring events on April 13-15, 2010, July 12-15, 2010, and October 4-8, 2010.
17. Sampled during Phase II quarterly monitoring events and on March 28, 2013.
18. Sampled during Phase II quarterly monitoring events and on March 26, 2013.
19. Full suite analyzed during Phase II quarterly monitoring events.
20. Reduced suite analyzed for during additional sampling in March 2013.

Abbreviations

-- = not applicable
bgs = feet below ground surface
PAHs = polyaromatic hydrocarbons
PCBs = polychlorinated biphenyls
SVOCs = semivolatile organic compounds
TPH-D = total petroleum hydrocarbons as diesel
TPH-G = total petroleum hydrocarbons as gasoline
VOCs = volatile organic compounds

TABLE 2

RESULTS OF FIELD WATER QUALITY PARAMETER MEASUREMENTS
March Point (Whitmarsh) Landfill
Skagit County, Washington

Station	Sampling Date	Sampling Method[1]	Water Quality Parameters: pH (unitless)	Conductivity[2,3] (S/cm)	Temperature (°C)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Depth to Water (ft below MP)	Notes
MW-02	Oct 2008	peri	7.32	0.22	11.8	10	0	5	
	Dec 2008	peri	7.05	0.000589	9.9	213	1.01	7.83	water clear, turbidity reading wrong?
	Apr 2009	peri	6.97	0.000623	10.43	37	0	7.56	
	Jul 2009	peri	6.36	0.0999+	12.2	10.2	0	8.2	conductivity probe failing, recalibration didn't work
	Apr 2010	peri	6.71	0.090	9.7	0	0	NA	
	Jul 2010	peri	6.32	0.0498	11.6	0	6.14	8.15	
	Oct 2010	peri	6.48	0.0519	12.6	3	5.62	8.35	
MW-03	Oct 2008	peri	7.87	0.156	14.6	7.7	0	9.9	
	Dec 2008	peri	10.9	0.000418	7.9	4.7	0.18	8.02	
	Apr 2009	peri	6.94	0.000643	9.4	0.1	0	7.86	
	Jul 2009	peri	7.15	0.00162	15.7	11.6	8.48	9.4	conductivity probe failing, results might not be representative
	Apr 2010	peri	7.34	99.9	9.4	24.6	0	NA	
	Jul 2010	peri	6.99	0.0513	15.3	4.9	6.03	8.86	
	Oct 2010	peri	7.05	0.0555	16.7	0	5.19	9.1	
MW-04	Oct 2008	peri	8.09	0.186	11.1	35	0	3.8	
	Dec 2008	peri	9.89	0.000464	9.2	0	1.01	3.37	
	Apr 2009	peri	7.26	0.000513	10.52	0	0	2.95	
	Jul 2009	peri	7.33	0.00103	12.6	2.8	8.87	3.05	
	Apr 2010	peri	7.58	0.090	10.3	9.7	0	NA	
	Jul 2010	peri	7.05	0.0482	12	0	7	3.29	
	Oct 2010	peri	7.2	0.0509	12.1	16.4	5.34	3.73	
MW-05	Apr 2010	peri	6.93	0.212	13.8	361	0	NA	water clear, turbidity reading wrong?
	Jul 2010	peri	6.42	0.236	14	0	5.61	13.27	
	Oct 2010	peri	6.48	0.232	14.1	8	4.97	13.43	
	Mar 2013	peri	6.78	0.00197	12.18	26.8	0.15	13.17	
	Aug 2013	peri	7.30	0.00168	15.4	2.4	1.09	12.85	clear, slight yellow tint
MW-06	Apr 2010	peri	6.57	0.00161	11.25	15.0	0.89	NA	
	Jul 2010	peri	6.23	0.175	14.3	2.9	6.91	8.68	
	Oct 2010	peri	6.25	0.000177	16.2	1.6	5.23	9.74	
	Mar 2013	peri	6.57	0.00133	9.79	23.9	0.00	8.23	
	Aug 2013	peri	6.68	0.00129	16.6	4.0	1.59	9.19	clear, slight yellowish color with organic type sheen
MW-07	Apr 2010	peri	6.86	0.0041	13.85	32.0	0.92	NA	
	Jul 2010	peri	6.61	0.292	14.8	5.5	7.30	11.5	
	Oct 2010	peri	6.87	0.000213	15.3	5.0	5.24	12.27	
	Mar 2013	peri	7.01	0.00591	12.3	5.6	0.13	11.41	
	Aug 2013	peri	6.92	0.00185	14.8	4.0	0.92	12.05	clear, slight yellowish color
MW-08	Apr 2010	peri	6.73	0.127	12.2	0.0	1.25	NA	
	Jul 2010	peri	6.51	0.128	12.3	19.3	6.24	16.39	
	Oct 2010	peri	6.40	0.000145	12.8	25.0	5.13	16.4	
	Mar 2013	peri	6.56	0.00133	12.87	502.0	0.00	15.44	
MW-09	Apr 2010	peri	6.92	0.09	11.2	106.0	0.00	NA	conductivity probe having issues
	Jul 2010	peri	6.64	0.0871	13.2	9.5	6.76	12.98	
	Oct 2010	peri	6.54	0.0886	12.8	2.8	5.10	12.95	
	Mar 2013	peri	6.77	0.000714	11.98	19.7	0.00	12.3	
	Aug 2013	peri	6.92	0.00079	14	3.3	0.88	12.95	

TABLE 2

RESULTS OF FIELD WATER QUALITY PARAMETER MEASUREMENTS
March Point (Whitmarsh) Landfill
Skagit County, Washington

Station	Sampling Date	Sampling Method[1]	Water Quality Parameters: pH (unitless)	Conductivity[2,3] (S/cm)	Temperature (°C)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Depth to Water (ft below MP)	Notes
MW-10	Apr 2010	peri	7.71	0.000633	11.22	27.0	0.34	NA	
	Jul 2010	peri	7.38	0.064	11.9	4.9	6.57	16.68	
	Oct 2010	peri	7.14	0.0709	11.6	2.6	4.63	16.69	
MW-11	Apr 2010	peri	7.53	0.000548	11.65	23.0	0.49	NA	
	Jul 2010	peri	7.17	0.0612	12.9	4.5	7.04	10.18	
	Oct 2010	peri	7.21	0.0638	13.7	5	4.55	10.41	
SP-01	Oct 2008	peri	8.08	0.0192	10.9	100	3.68	NA	slight yelllowish tint
	Dec 2008	sub	8.66	0.000997	0.5	113	9.42	NA	slight orange tint
	Apr 2009	peri	7.31	0.000749	13.61	13.7	5.45	NA	
	Jul 2009	peri	7.37	0.00308	16	14	12.9	NA	
	Apr 2010	NA	6.96	0.09	12	6.3	7.56	NA	
	Jul 2010	NA	5.98	0.0804	12.5	31.6	8.97	NA	
	Oct 2010	peri	6.42	0.0724	12.1	9.5	10.56	NA	
SP-02	Oct 2008	sub	7.51	0.0344	13.4	43	8.9	NA	
	Dec 2008	peri	10.02	0.0000123	0.1	78	6.92	NA	slightly cloudy
	Apr 2009	peri	6.99	0.132	13.84	9	7.6	NA	
	Jul 2009	peri	7.26	0.00152	18	55	11.63	NA	
	Apr 2010	NA	7.16	0.194	12.8	52	13.06	NA	
	Jul 2010	NA	6.44	0.35	14.5	14.9	9.32	NA	
	Oct 2010	peri	6.84	0.000931	12.8	8.6	10.37	NA	
SP-03	Oct 2008	peri	7.75	0.00193	13.2	395	12.15	NA	orange cloudy water
	Dec 2008	peri	10.15	0.0000043	0.3	363	11.95	NA	slight orange tint
	Apr 2009	peri	6.95	0.129	14.31	145	5.48	NA	
	Jul 2009	peri	6.86	0.00206	19.3	45	11.65	NA	
	Apr 2010	peri	6.93	0.0051	16.67	90	6.45	NA	
	Jul 2010	peri	6.6	0.16	14.9	121	9.72	NA	
	Oct 2010	peri	6.14	0.116	15.2	24.1	7.44	NA	
SW-01	Oct 2008	sub	6.34	0.00234	10.9	12.8	11.85	NA	scattered millfoil
	Dec 2008	sub	7.45	0.000214	0.9	26.7	8.41	NA	scattered millfoil
	Apr 2009	sub	6.97	0.046	10.56	4.1	8.76	NA	scattered algae
	Jul 2009	sub	6.81	0.0025	16	0	7.72	NA	
	Apr 2010	dunk	7.0	0.0979	9.8	333	7.13	NA	
	Jul 2010	NA	6.17	0.0648	17.5	91	3.48	NA	
	Oct 2010	peri	6.26	0.063	11.6	6.9	12.2	NA	plant and wildlife debris in water
SW-03	Oct 2008	sub	9.2	0.0034	6.3	50	11.63	NA	slight yelllowish tint
	Dec 2008	sub	6.83	0.0000135	1.9	125	8.99	NA	slight brown tint
	Apr 2009	sub	7.82	0.00221	16.34	15	14.09	NA	foam on water surface at station
	Jul 2009	sub	6.79	0.0999+	17.4	20	1.52	NA	conductivity probe reading incorrectly
	Apr 2010	peri	7.42	0.486	12.4	621	13.33	NA	
	Jul 2010	NA	6.97	2.53	26.1	149	9.64	NA	
	Oct 2010	peri	7.7	0.999	13.6	24.8	11.99	NA	plant and wildlife debris in water

TABLE 2

RESULTS OF FIELD WATER QUALITY PARAMETER MEASUREMENTS

March Point (Whitmarsh) Landfill
Skagit County, Washington

Station	Sampling Date	Sampling Method[1]	Water Quality Parameters: pH (unitless)	Conductivity[2,3] (S/cm)	Temperature (°C)	Turbidity (NTU)	Dissolved Oxygen (mg/L)	Depth to Water (ft below MP)	Notes
SW-04	Oct 2008	sub	8	0.00417	4.4	220	11.45	NA	slight brown tint
	Dec 2008	sub	6.8	0.00000903	1.8	198	8.99	NA	slight brown tint
	Apr 2009	sub	6.74	0.00755	12.49	17.2	7.52	NA	
	Jul 2009	sub	8.27	0.0999	22.7	45.7	2.59	NA	
	Apr 2010	dunk	NS	NS	NS	NS	NS	NA	
	Jul 2010	NA	7.78	2.14	21.1	3.7	7.33	NA	
	Oct 2010	peri	7.6	0.399	16	11.5	10.2	NA	
SW-05	Oct 2008	sub	8.07	0.0308	5.1	107	9.37	NA	slight yelllowish tint
	Dec 2008	sub	6.78	0.00000791	2.2	133	9.03	NA	slight yelllowish tint
	Apr 2009	sub	7.54	0.00682	16.47	11	10.55	NA	
	Jul 2009	sub	8.66	0.0313	26.4	12.3	4.18	NA	
	Apr 2010	NA	8.06	0.15	10.5	1	9.7	NA	
	Jul 2010	NA	8.74	2.36	26.1	22.7	12.44	NA	
	Oct 2010	peri	8.09	0.000465	16.8	19.6	10.18	NA	
SW-06	Oct 2008	sub	7.93	0.0361	6.7	29	8.68	NA	
	Dec 2008	sub	6.51	0.0215	0.9	43	9.1	NA	
	Apr 2009	sub	7.41	0.0183	16.81	14	13.85	NA	
	Jul 2009	sub	7.62	0.04	23.5	27	3.76	NA	
	Apr 2010	NA	7.94	0.694	13.5	5.5	12.57	NA	
	Jul 2010	NA	8.29	0.0369	26.4	133	16.09	NA	
	Oct 2010	peri	7.84	1.16	16.9	10.1	10.07	NA	
SW-07	Oct 2008	NA	NS	NS	NS	NS	NS	NS	
	Dec 2008	peri	8.2	0.000606	3.8	91.3	10.08	NA	slight orange tint
	Apr 2009	NA	NS	NS	NS	NS	NS	NS	
	Jul 2009	NA	NS	NS	NS	NS	NS	NS	

Notes

1. peri = sample collected using peristaltic pump.
   sub = sample collected by submerging precleaned laboratory-supplied sampling bottle.
2. For monitoring wells, values represent stabilized values following purging and recorded immediatedly prior to sampling.
   For seeps, values are nonstabilized, instantaneous readings recorded prior to sampling.
   For surface water samples, the value was measured immediately prior to sampling.
3. Plus symbol (+) indicates parameter exceeded calibration range of the instrument.

Abbreviations

°C = degrees Celsius	NA = not applicable
ft = feet	NS = not sampled
mg/L = milligrams per liter	NTU = nephelometric turbidity units
MP = measuring point	S/cm = siemens per centimeter

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TABLE 3

WELL CONSTRUCTION SUMMARY
March Point (Whitmarsh) Landfill
Skagit County, Washington

Well ID [1, 2]	Ground Surface Elevation (feet MLLW)	Total Borehole Depth (feet bgs)	Screened Interval (feet bgs)	Screened Interval Elevation (feet MLLW)	Filter Pack Interval (feet bgs)	Screened Interval Geological Unit
MW-02	28.5	20.2	8-18	20.5 - 10.5	2	Lower Aquifer
MW-03	21.87	20.5	5-15	16.87 - 6.87	2	Refuse
MW-04	21.04	38.5	15-25	6.04 - (3.96)	2	Lower Aquifer
MW-05	17.47	33	23-33	(5.53) - (15.53)	2	Lower Aquifer
MW-06	16.07	19.5	4.5-9.5	11.57 - 6.57	2	Refuse
MW-07	15.87	19.5	13-18	2.87 - (2.13)	2	Lower Aquifer
MW-08	26.17	34	10-20	16.17 - 6.17	2	Refuse
MW-09	21.27	18	6.5-16.5	14.77 - 4.77	2	Refuse
MW-10	26.87	34	10-20	16.87 - 6.87	2	Refuse
MW-11	22.17	18	5-15	17.17 - 7.17	2	Refuse
PZ-01	18.27	13.5	6-11	12.27 - 7.27	2	Refuse
PZ-02	17.37	15	4-7	13.37 - 10.37	2	Refuse
PZ-03	13.57	19.5	3-8	10.57 - 5.57	2	Refuse

Notes
1. MW-02, MW-03, and MW-04 were installed during the Phase I investigation. All other wells were installed during the Phase II investigation.
2. Wells installed using Hollow-Stem Auger drilling methods; wells constucted with 2-inch diameter Sch. 40 PVC 10 slot well screen with 2/12 silica pack.

Abbreviations
bgs = below ground surface.
MLLW = mean lower low water
PVC = polyvinyl chloride

TABLE 4

PRELIMINARY CLEANUP LEVELS FOR SOIL
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in milligrams per kilogram (mg/kg)

Analyte	Chemical Abstracts Service No.	Target Reporting Limit (PQL)	MTCA Method A, Industrial Land Use	MTCA Method C, Carcinogen	MTCA Method C, Noncarcinogen	EPA Regional Screening Levels	MTCA Method B Protective of Groundwater as Marine Surface Water[1]	Whitmarsh Site Specific TEE - Wildlife Exposure Model[2]	Puget Sound Soil Natural Background (Ecology, 1994)	PCL[3]
Metals										
Aluminum	7429-90-5	5.0	--	--	3,500,000	990,000	NA	--	32,600	990,000
Antimony	7440-36-0	5.0	--	--	1,400	410	5.06	--	--	5.1
Arsenic	7440-38-2	5.0	20	87.5	1,050	1.6	0.117	7.0 [4]	7.0	7.0
Barium	7440-39-3	0.3	--	--	700,000	190,000	824	102	--	102
Beryllium	7440-41-7	0.1	--	--	7,000	2,000	63.2	--	0.60	63
Cadmium	7440-43-9	0.2	2	--	3,500	800.00	0.035	--	1.0	1.0
Chromium (chromium III)	7440-47-3	0.5	2,000	--	5,250,000	1,500,000	1,480	67	117 [5]	117
Copper	7440-50-8	0.3	--	--	140,000	41,000	1.07	--	36	36
Iron	7439-89-6	5.0	--	--	2,450,000	720,000	NA	--	58,700	720,000
Lead	7439-92-1	2.0	1,000	--	--	800	500	118	24	118
Manganese	7439-96-5	5.0	--	--	490,000	23,000	NA	--	1,200	23,000
Mercury	7439-97-6	0.05	2	--	--	43.00	0.021	0.7 [6]	0.07	0.07
Molybdenum	7439-98-7	0.5	--	--	17,500	5,100	NA	--	--	5,100
Nickel	7440-02-0	1.0	--	--	70,000	20,000	10.7	--	48	48
Strontium	7440-24-6	0.1	--	--	2,100,000	610,000	NA	--	--	610,000
Titanium	7440-32-6	0.5	--	--	--	--	NA	--	--	--
Vanadium	7440-62-2	0.3	--	--	17,500	5,200	1,600	--	--	1,600
Zinc	7440-66-6	1.0	--	--	1,050,000	310,000	101	359	85	101
TPH										
TPH - Diesel range	NA	5	2,000	--	--	--	NA	--	--	2,000
TPH - Heavy oil range	NA	10	2,000	--	--	--	NA	--	--	2,000
TPH - Gasoline range	NA	5	30/100	--	--	--	NA	--	--	30/100
SVOCs										
1-Methylnaphthalene	90-12-0	0.067	--	4,526	245,000	99.00	NA	--	--	99
2,4-Dimethylphenol	105-67-9	0.067	--	--	70,000	12,000	3.11	--	--	3.1
2-Methylnaphthalene	91-57-6	0.067	--	--	14,000	4,100	NA	--	--	4,100
2-Methylphenol	95-48-7	0.067	--	--	175,000	31,000	0.19	--	--	0.19
4-Methylphenol (p-cresol)	106-44-5	0.067	--	--	350,000	3,100	NA	--	--	3,100
Acenaphthene	83-32-9	0.067	--	--	210,000	33,000	66	--	--	66
Acenaphthylene	208-96-8	0.067	--	--	--	--	NA	--	--	--
Anthracene	120-12-7	0.067	--	--	1,050,000	170,000	3,933	--	--	3,933
Benzo(a)anthracene	56-55-3	0.067	--	180	--	2.10	0.072	--	--	0.07
Benzo(a)pyrene	50-32-8	0.067	2	17.98	--	0.21	0.194	--	--	0.19
Benzo(b)fluoranthene	205-99-2	0.067	--	180	--	2.10	0.240	--	--	0.24
Benzo(ghi)perylene	191-24-2	0.067	--	--	--	--	NA	--	--	--
Benzo(k)fluoranthene	207-08-9	0.067	--	1,800	--	21.00	0.252	--	--	0.25
Benzoic acid	65-85-0	0.67	--	--	14,000,000	2,500,000	257	--	--	257
Bis(2-ethylhexyl) phthalate	117-81-7	0.067	--	9,375	70,000	--	2.64	--	--	2.6
Butyl benzyl phthalate	85-68-7	0.067	--	69,100	700,000	910	2.32	--	--	2.3
Chrysene	218-01-9	0.067	--	18,000	--	210.00	0.080	--	--	0.08
Dibenzofuran	132-64-9	0.067	--	--	3,500	1,000	0.086	--	--	0.09
Dimethyl phthalate	131-11-3	0.067	--	--	--	--	NA	--	--	--
Di-n-butyl phthalate	84-74-2	0.067	--	--	350,000	62,000	72.0	--	--	72

TABLE 4

PRELIMINARY CLEANUP LEVELS FOR SOIL
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in milligrams per kilogram (mg/kg)

Analyte	Chemical Abstracts Service No.	Target Reporting Limit (PQL)	MTCA Method A, Industrial Land Use	MTCA Method C, Carcinogen	MTCA Method C, Noncarcinogen	EPA Regional Screening Levels	MTCA Method B Protective of Groundwater as Marine Surface Water[1]	Whitmarsh Site Specific TEE - Wildlife Exposure Model[2]	Puget Sound Soil Natural Background (Ecology, 1994)	PCL[3]
Fluoranthene	206-44-0	0.067	--	--	140,000	22,000	85.2	--	--	85
Fluorene	86-73-7	0.067	--	--	140,000	22,000	174	--	--	174
Naphthalene	91-20-3	0.067	5	--	70,000	18	131.31	--	--	5.0
N-Nitrosodiphenylamine	86-30-6	0.33	--	26,786	--	350.00	0.099	--	--	0.33
Phenanthrene	85-01-8	0.067	--	--	--	--	NA	--	--	--
Phenol	108-95-2	0.067	--	--	1,050,000	180,000	45.8	--	--	46
Pyrene	129-00-0	0.067	--	--	105,000	17,000	1,132	--	--	1,132
VOCs										
1,1,2-Trichloroethane	79-00-5	0.001	--	2,303	14,000	5	0.003	--	--	0.0033
1,2,4-Trimethylbenzene	95-63-6	0.001	--	--	--	260.00	NA	--	--	260
1,2-Dichlorobenzene	95-50-1	0.001	--	--	315,000	9,800	4.92	--	--	4.9
1,3,5-Trimethylbenzene	108-67-8	0.001	--	--	35,000	10,000	NA	--	--	10,000
1,4-Dichlorobenzene	106-46-7	0.001	--	24,306	245,000	12.00	0.35	--	--	0.35
2-Butanone	78-93-3	0.005	--	--	2,100,000	200,000	NA	--	--	200,000
4-Methyl-2-pentanone	108-10-1	0.005	--	--	280,000	53,000	NA	--	--	53,000
Acetone	67-64-1	0.005	--	--	3,150,000	630,000	28.9	--	--	29
Benzene	71-43-2	0.001	0.03	2,386	14,000	5	0.007	--	--	0.0068
Carbon disulfide	75-15-0	0.001	--	--	350,000	3,700	2.83	--	--	2.8
Chlorobenzene	108-90-7	0.001	--	--	70,000	1,400	1.137	--	--	1.1
Dichlorodifluoromethane	75-71-8	0.001	--	--	700,000	400	NA	--	--	400
Ethylbenzene	100-41-4	0.001	6	--	350,000	27	4.58	--	--	4.6
Isopropylbenzene (cumene)	98-82-8	0.001	--	--	350,000	11,000	NA	--	--	11,000
m,p-Xylenes	1330-20-7	0.001	9	--	700,000	2,600	7.19	--	--	7.2
Methylene chloride	75-09-2	0.002	0.02	65,625	21,000	53	0.020	--	--	0.02
n-Butylbenzene	104-51-8	0.001	--	--	175,000	51,000.00	NA	--	--	51,000
n-Propylbenzene	103-65-1	0.001	--	--	350,000	21,000	3.27	--	--	3.3
o-Xylene	95-47-6	0.001	9	--	700,000	3,000	4.04	--	--	4.0
p-Isopropyltoluene	99-87-6	0.001	--	--	--	--	NA	--	--	--
sec-Butylbenzene	135-98-8	0.001	--	--	350,000	--	NA	--	--	--
tert-Butylbenzene	98-06-6	0.001	--	--	350,000	--	NA	--	--	--
Tetrachloroethene	127-18-4	0.001	0.05	62,500	21,000	3	0.007	--	--	0.0074
Toluene	108-88-3	0.001	7	--	280,000	45,000	9.45	--	--	7.0
PCBs										
Aroclor 1248	12672-29-6	0.004	--	--	--	0.74	NA	--	--	0.74
Aroclor 1254	11097-69-1	0.004	--	65.6	70	1	0.00004	--	--	0.004
Aroclor 1260	11096-82-5	0.004	--	65.6	--	0.74	0.164	--	--	0.16
Total PCBs	1336-36-3	0.028	10	65.6	--	0.74	NA	0.65	--	0.65
Dioxins/Furans										
Total dioxins/furans normalized to 2,3,7,8-TCDD		0.000001	--	0.00168	0.0041	0.000022	NA	--	0.000012 [7]	0.000022

TABLE 4

PRELIMINARY CLEANUP LEVELS FOR SOIL
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in milligrams per kilogram (mg/kg)

Analyte	Chemical Abstracts Service No.	Target Reporting Limit (PQL)	MTCA Method A, Industrial Land Use	MTCA Method C, Carcinogen	MTCA Method C, Noncarcinogen	EPA Regional Screening Levels	MTCA Method B Protective of Groundwater as Marine Surface Water[1]	Whitmarsh Site Specific TEE - Wildlife Exposure Model[2]	Puget Sound Soil Natural Background (Ecology, 1994)	PCL[3]
Pesticides (Organochlorine)										--
Chlordane	57-74-9	0.0017	--	375	1,750	6.50	0.0008	--	--	0.0017
alpha-Chlordane	5103-71-9	0.0017	--	--	--	--	NA	--	--	--
gamma-Chlordane	5566-34-7	0.0017	--	--	--	--	NA	--	--	--
Aldrin	309-00-2	0.0017	--	7.72	105	0	0.0006	--	--	0.0017
4,4'-DDD	72-54-8	0.0033	--	547	--	7.20	0.0012	--	--	0.0033
4,4'-DDE	72-55-9	0.0033	--	386	--	5.10	0.0022	--	--	0.0033
4,4'-DDT	50-29-3	0.0033	4	386	1,750	7	0.0170	--	--	0.017
Dieldrin	60-57-1	0.0033	--	8.2	175	0	0.0007	0.07	--	0.0033
Endosulfan I	959-98-8	0.0017	--	--	21,000	3,700	0.0004	--	--	0.0017
Endrin	72-20-8	0.0033	--	--	1,050	180	0.0005	--	--	0.0033
Heptachlor	76-44-8	0.0017	--	29.17	1,750	0	0.0001	--	--	0.0017
Heptachlor epoxide	1024-57-3	0.0017	--	14.42	45.50	0.19	0.0008	--	--	0.0017
Hexachlorobenzene	118-74-1	0.0033	--	82	2,800	1	NA	--	--	1.1
a-Hexachlorocyclohexane	319-84-6	0.0017	--	20.83	28,000	--	0.0001	--	--	0.0017
b-Hexachlorocyclohexane	319-85-7	0.0017	--	72.92	--	0.96	0.0004	--	--	0.0017
c-Hexachlorocyclohexane	319-86-8	0.0017	--	--	--	--	NA	--	--	--
Methoxylchlor	72-43-5	0.017	--	--	17,500	3,100	NA	--	--	3,100
Conventionals										
Ammonia	7664-41-7	0.1	--	--	--	--	NA	--	--	--
Sulfide	7723-14-0	0.4	--	--	--	--	NA	--	--	--

Notes

1. Calculated using fixed-parameter three-phase partitioning model, Washington Administrative Code 173-340-747(4).
   NA signifies that no surface water screening levels were found in Ecology's 2008 CLARC database and no soil screening level was calculated.
2. TEE value is the lowest from the calculations performed for mammalian predator, avian predator, and mammalian herbivore.
3. PCL was chosen as the lower of the MTCA Method A cleanup levels, MTCA Method C cleanup levels, and TEE cleanup level for industrial and commercial sites, unless natural background concentration and/or available laboratory PQL values were higher. In those cases, PCL was set to the natural background concentration or the PQL. The PCL shown is the screening level used in Table 7.
4. TEE values are for speciated arsenic; the lower value for arsenic (III) is used. The arsenic (V) value is 95 mg/kg.
5. Background level for chromium was calculated using Ecology's MTCAStat program based on Ecology's 1994 data for the ten sampling locations closest to Anacortes.
6. TEE value is for organic mercury; inorganic mercury value is 9 mg/kg.
7. Puget Sound background value obtained from Ecology's document titled: Urban Seattle Area Soil Dioxin and PAH Concentrations Initial Summary Report, September 2011, Publication No. 11-09-049.

Abbreviations

-- = No value available
CLARC = Cleanup Levels and Risk Calculations
EPA = U.S. Environmental Protection Agency
MTCA = Model Toxics Control Act
PCBs = polychlorinated biphenyls
PCL = preliminary cleanup level
PQL = practical quantitation limit.
SVOCs = semivolatile organic compounds
TCDD = tetrachlorodibenzo-p-dioxin
TEE = terrestrial ecological evaluation
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds

amec

TABLE 5

PRELIMINARY CLEANUP LEVELS FOR MARINE SEDIMENTS

March Point (Whitmarsh) Landfill
Skagit County, Washington

Parameter	Benthic Risk Based Standards[3]				Human Health		Preliminary Cleanup Level
	SMS Marine Sediment (mg/kg-OC)		Marine Sediment AETs (µg/kg dry weight)				
	SQS/SCO	CSL/SIZ Max	SQS	CSL	Natural Background [1]	PQL [2]	
PCBs						(µg/kg dry weight)	(µg/kg dry weight)
Aroclor 1016	--	--	--	--	--	14	14
Aroclor 1221	--	--	--	--	--	12	12
Aroclor 1232	--	--	--	--	--	12	12
Aroclor 1242	--	--	--	--	--	12	12
Aroclor 1248	--	--	--	--	--	12	12
Aroclor 1254	--	--	--	--	--	12	12
Aroclor 1260	--	--	--	--	--	14	14
Total PCB	12	65	130	1000		--	14
					(ng/kg TEQ)	(ng/kg TEQ)	(ng/kg TEQ)
Dioxins/Furans	--	--	--	--	4	5	5

Notes:

1. Natural background values obtained from Table 10-1 of Washington State Department of Ecology SCUM II guidance. Natural or regional background for PCBs could not be calculated following the statistical methods outlined in the SCUM II guidance because there were fewer than 10 detections of each individual Aroclor in the Oceanographic Survey Vessel (OSV) Bold Summer 2008 Survey Data Report data set.
2. PQL values obtained from Table 11-1 of SCUM guidance, except for Aroclors which were obtained from Table D-1, Appendix D of SCUM II guidance.
3. Benthic values are from Table 8-1 of SCUM II guidance. Section 9.2.1 of SCUM II provides for an option of NOT calculating risk-based sediment concentrations based on the consumption of fish/shellfish. The guidance states that risk-based sediment concentrations based on the consumption of fish/shellfish exposure pathway by human and higher trophic level receptors (e.g., fish-eating mammals and birds) can be assumed to be below background concentrations. Therefore, risk-based concentrations for human and higher trophic level receptors were not calculated.

Abbreviations:

µg/kg = microgram per kilogram
mg/kg-OC = milligram per kilogram organic carbon normalized
ng/kg = nanogram per kilogram
AETs = Apparent effects threshold
CSL = cleanup screening levels
PCBs = polychlorinated biphenyls
PQL = Practical Quantitation Limit
SCO = Sediment cleanup objective
SCUM = Sediment Cleanup Users Manual
SIZ = Sediment impact zone
SMS = Sediment Management Standards
SQS = Sediment Quality Standards
TEQ = Toxicity Equivalents

TABLE 6

PRELIMINARY CLEANUP LEVELS FOR GROUNDWATER AND SEEPS
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Chemical Abstracts Service No.	Target Reporting Limit (PQL)	Groundwater MTCA Method A	Groundwater MTCA Method B, Carcinogen	Groundwater MTCA Method B, Non-Carcinogen	Groundwater Federal MCL[1]	Groundwater State MCL[1]	Surface Water - Aquatic Life - Fresh/Acute - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Marine/Acute - WAC 173-201A	Surface Water - Aquatic Life - Marine/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Chronic - Clean Water Act §304
Metals													
Aluminum	7429-90-5	20	--[2]	--	16,000	--	--	--	--	--	--	750	87
Antimony	7440-36-0	0.2	--	--	6.4	6	6	--	--	--	--	--	--
Arsenic	7440-38-2	0.2	5	0.06	4.8	10	10	360.0	190.0	69.0	36.0	340	150
Barium	7440-39-3	0.5	--	--	3,200	2,000	2,000	--	--	--	--	--	--
Beryllium	7440-41-7	0.2	--	--	32	4	4	--	--	--	--	--	--
Cadmium	7440-43-9	0.1	5	--	8	5	5	18.0 [3]	3.22 [3]	42.0	9.3	2.00	0.25
Chromium	7440-47-3	0.5	50	--	24,000	100	100	1,945 [3]	631 [3]	--	--	570	74
Copper	7440-50-8	0.5	--	--	640	1,300	1,300	1,364 [3]	796 [3]	4.8	3.1	--	--
Iron	7439-89-6	20	--	--	11,200	--	--	--	--	--	--	--	1,000
Lead	7439-92-1	0.1	15	--	--	15	15	330.0 [3]	12.9 [3]	210.0	8.1	65	2.5
Manganese	7439-96-5	0.5	--	--	2,240	--	--	--	--	--	--	--	--
Mercury	7439-97-6	0.02	2	--	--	2.00	2.00	2.10	0.012	1.8	0.025	1.4	0.77
Molybdenum	7439-98-7	0.2	--	--	80	--	--	--	--	--	--	--	--
Nickel	7440-02-0	0.5	--	--	320	--	100	5,231 [3]	591 [3]	74.0	8.2	470	52
Selenium	7782-49-2	0.5	--	--	80	50	50	20.0	5.0	290.0	71	--	5.0
Silver	7440-22-4	0.2	--	--	80	--	--	--	--	1.9	--	3.2	--
Strontium	7440-24-6	1.0	--	--	9,600	--	--	--	--	--	--	--	--
Titanium	7440-32-6	5.0	--	--	--	--	--	--	--	--	--	--	--
Vanadium	7440-62-2	0.2	--	--	80	--	--	--	--	--	--	--	--
Zinc	7440-66-6	4.0	--	--	4,800	--	--	--	--	90.0	81.0	120	120
TPH													
TPH - Diesel range	NA	100	500	--	--	--	--	--	--	--	--	--	--
TPH - Heavy oil range	NA	200	500	--	--	--	--	--	--	--	--	--	--
TPH - Gasoline	NA	250	800/1000	--	--	--	--	--	--	--	--	--	--
SVOCs													
1-Methylnaphthalene	90-12-0	0.01	--	1.51	560	--	--	--	--	--	--	--	--
2,4-Dimethylphenol	105-67-9	3.0	--	--	160	--	--	--	--	--	--	--	--
2-Methylnaphthalene	91-57-6	1.0	--	--	32	--	--	--	--	--	--	--	--
2-Methylphenol	95-48-7	1.0	--	--	400	--	--	--	--	--	--	--	--
2-Nitrophenol	88-75-5	3.0	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	59-50-7	3.0	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol (p-cresol)	106-44-5	2.0	--	--	800	--	--	--	--	--	--	--	--
Acenaphthene	83-32-9	0.01	--	--	960	--	--	--	--	--	--	--	--
Acenaphthylene	208-96-8	0.01	--	--	--	--	--	--	--	--	--	--	--
Anthracene	120-12-7	0.01	--	--	4,800	--	--	--	--	--	--	--	--
Benzo(a)anthracene	56-55-3	0.01	--	0.12	--	--	--	--	--	--	--	--	--
Benzo(a)pyrene	50-32-8	0.01	0.1	0.012	--	0.2	0.2	--	--	--	--	--	--
Benzo(b)fluoranthene	205-99-2	0.01	--	0.12	--	--	--	--	--	--	--	--	--
Benzo(g,h,i)perylene	191-24-2	0.01	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	207-08-9	0.01	--	1.2	--	--	--	--	--	--	--	--	--
Benzoic acid	65-85-0	20.0	--	--	64,000	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl) phthalate	117-81-7	3.0	--	6.25	320	6	6	--	--	--	--	--	--
Butyl benzyl phthalate	85-68-7	1.0	--	46.1	3,200	--	--	--	--	--	--	--	--
Carbaryl	63-25-2	20	--	--	1,600	--	--	--	--	--	--	2.1	2.1
Chrysene	218-01-9	0.01	--	12	--	--	--	--	--	--	--	--	--
Dibenzofuran	132-64-9	0.01	--	--	16	--	--	--	--	--	--	--	--

TABLE 6

PRELIMINARY CLEANUP LEVELS FOR GROUNDWATER AND SEEPS

March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Surface Water - Aquatic Life - Marine/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Marine/Chronic - Clean Water Act §304	Surface Water - Human Health – Fresh Water – Clean Water Act §304	Surface Water - Human Health – Marine – Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Acute - National Toxics Rule - 40 CFR 131	Surface Water - Aquatic Life - Fresh/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Acute - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Fresh Water – National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Marine – National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Non-Carcinogen	Surface Water MTCA Method B, Carcinogen	PCL[2]
Metals													
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	87
Antimony	--	--	5.60	640	--	--	--	--	14.00	4300	1,000	--	5.60
Arsenic	69	36	0.018	0.14	360	190	69	36	0.018	0.14	17.68	0.098	0.2
Barium	--	--	1,000	--	--	--	--	--	--	--	--	--	1,000
Beryllium	--	--	--	--	--	--	--	--	--	--	--	--	4
Cadmium	40.00	8.80	--	--	3.70	1.00	42	9.3	--	--	--	--	0.25
Chromium	--	--	--	--	550	180	--	--	--	--	243,056	--	74
Copper	4.8	3.1	1,300	--	17	11	2.4	2.4	--	--	2,880	--	2.4
Iron	--	--	--	--	--	--	--	--	--	--	--	--	1,000
Lead	210	8.1	--	--	65	2.5	210	8.1	--	--	--	--	2.50
Manganese	--	--	50	100	--	--	--	--	--	--	--	--	50
Mercury	1.8	0.94	--	0.3	2.1	0.012	1.8	0.025	0.14	0.15	--	--	0.02
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--	80
Nickel	74	8.2	610	4,600	1,400	160	74	8.2	610	4,600	1,103	--	8.20
Selenium	290	71.0	170	4,200	20	5	290	71	--	--	2,701	--	5
Silver	1.9	--	--	--	3.4	--	1.9	--	--	--	25,926	--	1.90
Strontium	--	--	--	--	--	--	--	--	--	--	--	--	9,600
Titanium	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--	--	--	80
Zinc	90	81	7,400	26,000	110	100	90	81	--	--	16,548	--	81
TPH													
TPH - Diesel range	--	--	--	--	--	--	--	--	--	--	--	--	500
TPH - Heavy oil range	--	--	--	--	--	--	--	--	--	--	--	--	500
TPH - Gasoline	--	--	--	--	--	--	--	--	--	--	--	--	800/1,000
SVOCs													
1-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	1.51
2,4-Dimethylphenol	--	--	100	1,000	--	--	--	--	--	--	552	--	380
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	32
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	400
2-Nitrophenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Chloro-3-methylphenol	--	--	500	3000	--	--	--	--	--	--	--	--	500.00
4-Methylphenol (p-cresol)	--	--	--	--	--	--	--	--	--	--	--	--	800
Acenaphthene	--	--	200	400	--	--	--	--	--	--	648	--	200.00
Acenaphthylene	--	--	--	--	--	--	--	--	--	--	--	--	--
Anthracene	--	--	200	200	--	--	--	--	9,600	110,000	25,926	--	8,300
Benzo(a)anthracene	--	--	0.0110	0.013	--	--	--	--	0.0028	0.031	--	0.296	0.01
Benzo(a)pyrene	--	--	0.00077	0.00084	--	--	--	--	0.0028	0.031	--	0.030	0.01
Benzo(b)fluoranthene	--	--	0.0038	0.018	--	--	--	--	0.0028	0.031	--	0.296	0.01
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(k)fluoranthene	--	--	0.011	0.012	--	--	--	--	0.0028	0.031	--	2.96	0.01
Benzoic acid	--	--	--	--	--	--	--	--	--	--	--	--	64,000
Bis(2-ethylhexyl) phthalate	--	--	0.028	0.029	--	--	--	--	1.8	5.9	399	3.56	1.2
Butyl benzyl phthalate	--	--	800	3,000	--	--	--	--	--	--	1,250	8.32	8.32
Carbaryl	1.6	--	--	--	--	--	--	--	--	--	--	--	20
Chrysene	--	--	0.022	0.022	--	--	--	--	0.0028	0.031	--	29.6	0.01
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	16

TABLE 6

PRELIMINARY CLEANUP LEVELS FOR GROUNDWATER AND SEEPS
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Chemical Abstracts Service No.	Target Reporting Limit (PQL)	Groundwater MTCA Method A	Groundwater MTCA Method B, Carcinogen	Groundwater MTCA Method B, Non-Carcinogen	Groundwater Federal MCL[1]	Groundwater State MCL[1]	Surface Water - Aquatic Life - Fresh/Acute - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Marine/Acute - WAC 173-201A	Surface Water - Aquatic Life - Marine/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Chronic - Clean Water Act §304
SVOCs (continued)													
Diethyl phthalate	84-66-2	1.0	--	--	12,800	--	--	--	--	--	--	--	--
Di-n-butyl phthalate	84-74-2	1.0	--	--	1,600	--	--	--	--	--	--	--	--
Fluoranthene	206-44-0	0.01	--	--	640	--	--	--	--	--	--	--	--
Fluorene	86-73-7	0.01	--	--	640	--	--	--	--	--	--	--	--
Naphthalene	91-20-3	0.01	160	--	160	--	--	--	--	--	--	--	--
N-Nitrosodiphenylamine	86-30-6	1.0	--	17.86	--	--	--	--	--	--	--	--	--
Phenanthrene	85-01-8	0.01	--	--	--	--	--	--	--	--	--	--	--
Phenol	108-95-2	1.0	--	--	2,400	--	--	--	--	--	--	--	--
Pyrene	129-00-0	0.01	--	--	480	--	--	--	--	--	--	--	--
Pyridine	110-86-1	5.0	--	--	8	--	--	--	--	--	--	--	--
VOCs													
1,2,4-Trimethylbenzene	95-63-6	0.2	--	--	--	70	70	--	--	--	--	--	--
1,2-Dichlorobenzene	95-50-1	0.2	--	--	720	600	600	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	0.2	--	--	80	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	106-46-7	0.2	--	8.10	560	75	75	--	--	--	--	--	--
2-Butanone	78-93-3	5.0	--	--	4,800	--	--	--	--	--	--	--	--
2-Chlorotoluene	95-49-8	0.2	--	--	160	--	--	--	--	--	--	--	--
4-Isopropyltoluene	99-87-6	0.2	--	--	--	--	--	--	--	--	--	--	--
Acetone	67-64-1	5.0	--	--	7,200	--	--	--	--	--	--	--	--
Benzene	71-43-2	0.2	5	0.80	32	5	5	--	--	--	--	--	--
Chlorobenzene	108-90-7	0.2	--	--	160	100	100	--	--	--	--	--	--
Chloroethane	75-00-3	0.2	--	--	--	--	--	--	--	--	--	--	--
Chloroform	67-66-3	0.2	--	1.41	80	80	80	--	--	--	--	--	--
Chloromethane	74-87-3	0.5	--	--	--	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	156-59-2	0.2	--	--	16	70	70	--	--	--	--	--	--
cis-1,3-Dichloropropene	10061-01-5	0.2	--	--	--	--	--	--	--	--	--	--	--
Dichlorodifluoromethane	75-71-8	0.2	--	--	1,600	--	--	--	--	--	--	--	--
Diethyl ether	60-29-7	0.2	--	--	1,600	--	--	--	--	--	--	--	--
Ethylbenzene	100-41-4	0.2	700	--	800	700	700	--	--	--	--	--	--
Isopropylbenzene (cumene)	98-82-8	0.2	--	--	800	--	--	--	--	--	--	--	--
m,p-Xylenes	1330-20-7	0.4	1,000	--	1,600	10,000	10,000	--	--	--	--	--	--
Methylene chloride	75-09-2	1.0	5	21.88	48	5	5	--	--	--	--	--	--
n-Butylbenzene	104-51-8	0.2	--	--	400	--	--	--	--	--	--	--	--
n-Propylbenzene	103-65-1	0.2	--	--	800	--	--	--	--	--	--	--	--
o-Xylene	95-47-6	0.2	1,000	--	1,600	--	--	--	--	--	--	--	--
p-Isopropyltoluene	99-87-6	0.2	--	--	--	--	--	--	--	--	--	--	--
sec-Butylbenzene	135-98-8	0.2	--	--	800.00	--	--	--	--	--	--	--	--
Toluene	108-88-3	0.2	1,000	--	640	1,000	1,000	--	--	--	--	--	--
trans-1,3-Dichloropropene	10061-02-6	0.2	--	--	--	--	--	--	--	--	--	--	--
PCBs													
Aroclor 1232	11141-16-5	0.01	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1242	53469-21-9	0.01	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1248	12672-29-6	0.01	--	--	--	--	--	--	--	--	--	--	--
Total (PCBs)	1336-36-3	0.07	0.1	0.04	--	0.5	0.5	2.0	0.014	10.0	0.030	--	0.014

TABLE 6

PRELIMINARY CLEANUP LEVELS FOR GROUNDWATER AND SEEPS
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Surface Water - Aquatic Life - Marine/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Marine/Chronic - Clean Water Act §304	Surface Water - Human Health – Fresh Water – Clean Water Act §304	Surface Water - Human Health – Marine – Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Acute - National Toxics Rule - 40 CFR 131	Surface Water - Aquatic Life - Fresh/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Acute - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Fresh Water – National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Marine – National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Non-Carcinogen	Surface Water MTCA Method B, Carcinogen	PCL[2]
SVOCs (continued)													
Diethyl phthalate	--	--	4,000	90,000	--	--	--	--	23,000	120,000	28,412	--	17,000
Di-n-butyl phthalate	--	--	200	400	--	--	--	--	2,700	12,000	2,913	--	2,000
Fluoranthene	--	--	40	50	--	--	--	--	300	370	86.42	--	40.00
Fluorene	--	--	30	40	--	--	--	--	1,300	14,000	3,457	--	1,100
Naphthalene	--	--	--	--	--	--	--	--	--	--	4,714	--	4,714
N-Nitrosodiphenylamine	--	--	3.3	6.0	--	--	--	--	5.0	16	--	9.45	3.3
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenol	--	--	2,000	100,000	--	--	--	--	21,000	4,600,000	556,000	--	10,000
Pyrene	--	--	20	20	--	--	--	--	960	11,000	2,593	--	830
Pyridine	--	--	--	--	--	--	--	--	--	--	--	--	8.0
VOCs													
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	70
1,2-Dichlorobenzene	--	--	700	1,000	--	--	--	--	2,700	17,000	4,197	--	600
1,3,5-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	80
1,4-Dichlorobenzene	--	--	200	200	--	--	--	--	400	2,600	3,241	21	21
2-Butanone	--	--	--	--	--	--	--	--	--	--	--	--	4,800
2-Chlorotoluene	--	--	--	--	--	--	--	--	--	--	--	--	160
4-Isopropyltoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
Acetone	--	--	--	--	--	--	--	--	--	--	--	--	7,200
Benzene	--	--	2.2	51	--	--	--	--	1.2	71	1,990	22.7	1.2
Chlorobenzene	--	--	90	600	--	--	--	--	680	21,000	5,185	--	130
Chloroethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Chloroform	--	--	50	1,000	--	--	--	--	5.7	470	6,823	55	5.7
Chloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--
cis-1,2-Dichloroethene	--	--	--	--	--	--	--	--	--	--	--	--	16
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlorodifluoromethane	--	--	--	--	--	--	--	--	--	--	--	--	1,600
Diethyl ether	--	--	--	--	--	--	--	--	--	--	--	--	1,600
Ethylbenzene	--	--	400	1,000	--	--	--	--	3,100	29,000	6,823	--	400
Isopropylbenzene (cumene)	--	--	--	--	--	--	--	--	--	--	--	--	800
m,p-Xylenes	--	--	--	--	--	--	--	--	--	--	--	--	1,000
Methylene chloride	--	--	8.0	510	--	--	--	--	4.7	1,600	17,284	3,601	4.70
n-Butylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	400.00
n-Propylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	800
o-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	1,000
p-Isopropyltoluene	--	--	--	--	--	--	--	--	--	--	--	--	--
sec-Butylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	800.00
Toluene	--	--	300	2,000	--	--	--	--	6,800	200,000	18,855	--	1,300
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs													
Aroclor 1232	--	--	--	--	--	0.014	--	0.03	--	--	--	--	0.014
Aroclor 1242	--	--	--	--	--	0.014	--	0.03	--	--	--	--	0.014
Aroclor 1248	--	--	--	--	--	0.014	--	0.03	--	--	--	--	0.014
Total PCBs	--	0.03	0.000064	0.000064	--	--	--	--	0.00017	0.00017	--	0.0001	0.07

TABLE 6

PRELIMINARY CLEANUP LEVELS FOR GROUNDWATER AND SEEPS
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Chemical Abstracts Service No.	Target Reporting Limit (PQL)	Groundwater MTCA Method A	Groundwater MTCA Method B, Carcinogen	Groundwater MTCA Method B, Non-Carcinogen	Groundwater Federal MCL[1]	Groundwater State MCL[1]	Surface Water - Aquatic Life - Fresh/Acute - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Marine/Acute - WAC 173-201A	Surface Water - Aquatic Life - Marine/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Chronic - Clean Water Act §304
Pesticides (Organochlorine)													
4,4'-DDD	72-54-8	0.00125	--	0.36	--	--	--	1.1	0.001	0.13	0.001	--	--
4,4'-DDE	72-55-9	0.00125	--	0.26	--	--	--	1.1	0.001	0.13	0.001	--	--
4,4'-DDT	50-29-3	0.00125	0.3	0.26	8.00	--	--	1.1	0.001	0.13	0.001	1.10	0.001
Aldrin	309-00-2	0.00063	--	0.0026	0.24	--	--	2.5	0.0019	0.71	0.0019	3.0	--
a-Hexachlorocyclohexane	319-84-6	0.000625	--	0.0139	128	--	--	--	--	--	--	--	--
b-Hexachlorocyclohexane	319-85-7	0.000625	--	0.0486	--	--	--	--	--	--	--	--	--
c-Hexachlorocyclohexane	319-86-8	0.000625	--	--	--	--	--	--	--	--	--	--	--
Dieldrin	60-57-1	0.00125	--	0.0055	0.80	--	--	2.5	0.0019	0.71	0.0019	0.24	0.056
Endosulfan I	959-98-8	0.000625	--	--	96	--	--	0.22	0.056	0.034	0.0087	0.22	0.056
Heptachlor	76-44-8	0.000625	--	0.019	8.0	0.40	0.40	0.52	0.0038	0.053	0.0036	--	--
Heptachlor Epoxide	1024-57-3	0.000625	--	0.0048	0.1040	0.20	0.20	--	--	--	--	--	--
Hexachlorobenzene	118-74-1	0.00125	--	0.055	12.80	1.00	1.00	--	--	--	--	--	--
Lindane	58-89-9	0.000625	0.2	0.08	4.8	0.2	0.2	2.00	0.08	0.16	--	0.95	--

TABLE 6

PRELIMINARY CLEANUP LEVELS FOR GROUNDWATER AND SEEPS
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Surface Water - Aquatic Life - Marine/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Marine/Chronic - Clean Water Act §304	Surface Water - Human Health – Fresh Water – Clean Water Act §304	Surface Water - Human Health – Marine – Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Acute - National Toxics Rule - 40 CFR 131	Surface Water - Aquatic Life - Fresh/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Acute - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Fresh Water – National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Marine – National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Non-Carcinogen	Surface Water MTCA Method B, Carcinogen	PCL[2]
Pesticides (Organochlorine)													
4,4'-DDD	--	--	0.000019	0.000019	--	--	--	--	0.00083	0.00084	--	0.0005	0.00125
4,4'-DDE	--	--	0.0000376	0.0000376	--	--	--	--	0.00059	0.00059	--	0.0004	0.00125
4,4'-DDT	0.13	0.001	0.0000072	0.0000072	1.1	0.001	0.13	0.001	0.00059	0.00059	0.02	0.0004	0.00125
Aldrin	1.3	--	0.000001	0.000001	3	--	1.3	--	0.00013	0.00014	0.02	0.0001	0.000625
a-Hexachlorocyclohexane	--	--	0.00042	0.00047	--	--	--	--	0.0039	0.013	160	0.0079	0.0006
b-Hexachlorocyclohexane	--	--	0.0015	0.002	--	--	--	--	0.014	0.046	--	0.0277	0.0015
c-Hexachlorocyclohexane	--	--	0.0123	0.0414	--	--	--	--	--	--	--	--	0.0123
Dieldrin	0.71	0.0019	0.000001	0.000001	2.5	0.0019	0.71	0.0019	0.00014	0.00014	0.028	0.000087	0.00125
Endosulfan I	0.034	0.0087	8	10	--	--	--	--	--	--	58	--	0.0087
Heptachlor	--	--	0.000023	0.000024	0.52	0.0038	0.053	0.0036	0.00021	0.00021	0.12	0.00013	0.000625
Heptachlor Epoxide	--	--	0.000016	0.000016	0.52	0.0038	0.053	0.0036	0.00010	0.00011	0.003	0.00006	0.000625
Hexachlorobenzene	--	--	0.0000064	0.0000064	--	--	--	--	0.00075	0.00077	0.24	0.00047	0.00125
Lindane	0.16	--	2.50	2.8	2	0.08	0.16	--	0.019	0.063	5.98	0.05	0.019

Notes

1. U.S. Environmental Protection Agency, National Primary Drinking Water Regulations, Maximum Contaminant Levels, EPA 816-F-09-004, May 2009
2. PCL was chosen as the lower of the aquatic marine acute and chronic water quality criteria published in WAC 173-201A, aquatic marine acute and chronic and human health (fish ingestion) water quality criteria published in Section 304 of the Clean Water Act, aquatic marine acute and chronic and human health (fish ingestion) water quality criteria published in the National Toxics Rule (40 CFR 131), and MTCA Method B surface water cleanup levels (carcinogen and noncarcinogen). The lower of the MTCA A and B (carcinogen and noncarcinogen) and MCL was chosen as the PCL for compounds that did not have an associated surface water criteria. Final PCLs that were lower than the associated PQL were adjusted upward to the PQL.
3. Hardness dependent values calculated using an average hardness of 469 mg/L.

Abbreviations

-- = No value available
CFR = Code of Federal Regulations
MCL = maximum contaminant level
MTCA = Model Toxics Control Act
NA = not applicable
PCBs = polychlorinated biphenyls
PCL = preliminary cleanup level
PQL = practical quantitation limit
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds
WAC = Washington Administrative Code

TABLE 7

PRELIMINARY CLEANUP LEVELS FOR SURFACE WATER
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Chemical Abstracts Service No.	Target Reporting Limit (PQL)	Surface Water - Aquatic Life - Fresh/Acute - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Marine/Acute - WAC 173-201A	Surface Water - Aquatic Life - Marine/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Chronic - Clean Water Act §304
Metals								
Aluminum	7429-90-5	20	--	--	--	--	750	87
Arsenic	7440-38-2	0.2	360.0	190.0	69.0	36.0	340	150
Barium	7440-39-3	0.5	--	--	--	--	--	--
Chromium	7440-47-3	0.5	1,945 [3]	631 [3]	--	--	570	74
Copper	7440-50-8	0.5	1,364 [3]	796 [3]	4.8	3.1	--	--
Iron	7439-89-6	20	--	--	--	--	--	1,000
Lead	7439-92-1	0.1	330.0 [3]	12.9 [3]	210.0	8.1	65	2.5
Manganese	7439-96-5	0.5	--	--	--	--	--	--
Mercury	7439-97-6	0.02	2.10	0.012	1.8	0.025	1.4	0.77
Molybdenum	7439-98-7	0.2	--	--	--	--	--	--
Nickel	7440-02-0	0.5	5,231 [3]	591 [3]	74.0	8.2	470	52
Silver	7440-22-4	0.2	--	--	1.9	--	3.2	--
Strontium	7440-24-6	1.0	--	--	--	--	--	--
Titanium	7440-32-6	5.0	--	--	--	--	--	--
Vanadium	7440-62-2	0.2	--	--	--	--	--	--
Zinc	7440-66-6	4.0	--	--	90.0	81.0	120	120
SVOCs								
1-Methylnaphthalene	90-12-0	0.01	--	--	--	--	--	--
2-Methylnaphthalene	91-57-6	1.0	--	--	--	--	--	--
2-Methylphenol	95-48-7	1.0	--	--	--	--	--	--
4-Methylphenol (p-cresol)	106-44-5	2.0	--	--	--	--	--	--
Acenaphthene	83-32-9	0.01	--	--	--	--	--	--
Benzo(g,h,i)perylene	191-24-2	0.01	--	--	--	--	--	--
Benzoic acid	65-85-0	20.0	--	--	--	--	--	--
Benzyl alcohol	100-51-6	5.0	--	--	--	--	--	--
Bis(2-ethylhexyl) phthalate	117-81-7	3.0	--	--	--	--	--	--
Butyl benzyl phthalate	85-68-7	1.0	--	--	--	--	--	--
Carbaryl	63-25-2	20	--	--	--	--	2.1	2.1
Chrysene	218-01-9	0.01	--	--	--	--	--	--
Dibenzofuran	132-64-9	0.01	--	--	--	--	--	--
Diethyl phthalate	84-66-2	1.0	--	--	--	--	--	--
Di-n-butyl phthalate	84-74-2	1.0	--	--	--	--	--	--
Fluoranthene	206-44-0	0.01	--	--	--	--	--	--
Fluorene	86-73-7	0.01	--	--	--	--	--	--
Naphthalene	91-20-3	0.01	--	--	--	--	--	--
Phenanthrene	85-01-8	0.01	--	--	--	--	--	--
Phenol	108-95-2	1.0	--	--	--	--	--	--
Pyrene	129-00-0	0.01	--	--	--	--	--	--

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TABLE 7

PRELIMINARY CLEANUP LEVELS FOR SURFACE WATER
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Surface Water - Aquatic Life - Marine/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Marine/Chronic - Clean Water Act §304	Surface Water - Human Health – Fresh Water – Clean Water Act §304	Surface Water - Human Health – Marine – Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Acute - National Toxics Rule - 40 CFR 131	Surface Water - Aquatic Life - Fresh/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Acute - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Fresh Water – National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Marine – National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Non-Carcinogen	Surface Water MTCA Method B, Carcinogen	PCL[2]
Metals													
Aluminum	--	--	--	--	--	--	--	--	--	--	--	--	87
Arsenic	69	36	0.018	0.14	360	190	69	36	0.018	0.14	17.68	0.098	0.2
Barium	--	--	1,000	--	--	--	--	--	--	--	--	--	1,000
Chromium	--	--	--	--	550	180	--	--	--	--	243,056	--	74
Copper	4.8	3.1	1,300	--	17	11	2.4	2.4	--	--	2,880	--	2.4
Iron	--	--	--	--	--	--	--	--	--	--	--	--	1,000
Lead	210	8.1	--	--	65	2.5	210	8.1	--	--	--	--	2.50
Manganese	--	--	50	100	--	--	--	--	--	--	--	--	50
Mercury	1.8	0.94	--	0.3	2.1	0.012	1.8	0.025	0.14	0.15	--	--	0.02
Molybdenum	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	74	8.2	610	4,600	1,400	160	74	8.2	610	4,600	1,103	--	8.20
Silver	1.9	--	--	--	3.4	--	1.9	--	--	--	25,926	--	1.90
Strontium	--	--	--	--	--	--	--	--	--	--	--	--	--
Titanium	--	--	--	--	--	--	--	--	--	--	--	--	--
Vanadium	--	--	--	--	--	--	--	--	--	--	--	--	--
Zinc	90	81	7,400	26,000	110	100	90	81	--	--	16,548	--	81
SVOCs													
1-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylnaphthalene	--	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	--	--	--	--	--	--	--	--	--	--	--	--	--
4-Methylphenol (p-cresol)	--	--	--	--	--	--	--	--	--	--	--	--	--
Acenaphthene	--	--	670	990	--	--	--	--	--	--	648	--	648.15
Benzo(g,h,i)perylene	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzoic acid	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzyl alcohol	--	--	--	--	--	--	--	--	--	--	--	--	--
Bis(2-ethylhexyl) phthalate	--	--	1.2	2.2	--	--	--	--	1.8	5.9	399	3.56	1.2
Butyl benzyl phthalate	--	--	1,500	1,900	--	--	--	--	--	--	1,250	8.32	8.32
Carbaryl	1.6	--	--	--	--	--	--	--	--	--	--	--	20
Chrysene	--	--	0.0038	0.018	--	--	--	--	0.0028	0.031	--	29.6	0.01
Dibenzofuran	--	--	--	--	--	--	--	--	--	--	--	--	--
Diethyl phthalate	--	--	17,000	44,000	--	--	--	--	23,000	120,000	28,412	--	17,000
Di-n-butyl phthalate	--	--	2,000	4,500	--	--	--	--	2,700	12,000	2,913	--	2,000
Fluoranthene	--	--	130	140	--	--	--	--	300	370	86.42	--	86.42
Fluorene	--	--	1,100	5,300	--	--	--	--	1,300	14,000	3,457	--	1,100
Naphthalene	--	--	--	--	--	--	--	--	--	--	4,714	--	4,714
Phenanthrene	--	--	--	--	--	--	--	--	--	--	--	--	--
Phenol	--	--	10,000	860,000	--	--	--	--	21,000	4,600,000	556,000	--	10,000
Pyrene	--	--	830	4,000	--	--	--	--	960	11,000	2,593	--	830

TABLE 7

PRELIMINARY CLEANUP LEVELS FOR SURFACE WATER
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Chemical Abstracts Service No.	Target Reporting Limit (PQL)	Surface Water - Aquatic Life - Fresh/Acute - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Marine/Acute - WAC 173-201A	Surface Water - Aquatic Life - Marine/Chronic - WAC 173-201A	Surface Water - Aquatic Life - Fresh/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Chronic - Clean Water Act §304
VOCs								
1,2,4-Trimethylbenzene	95-63-6	0.2	--	--	--	--	--	--
1,3,5-Trimethylbenzene	108-67-8	0.2	--	--	--	--	--	--
1,4-Dichlorobenzene	106-46-7	0.2	--	--	--	--	--	--
Acetone	67-64-1	5.0	--	--	--	--	--	--
Benzene	71-43-2	0.2	--	--	--	--	--	--
Bromoform	75-25-2	0.2	--	--	--	--	--	--
Carbon disulfide	75-15-0	0.2	--	--	--	--	--	--
cis-1,3-Dichloropropene	10061-01-5	0.2	--	--	--	--	--	--
Dibromochloromethane	124-48-1	0.2	--	--	--	--	--	--
Dichlorodifluoromethane	75-71-8	0.2	--	--	--	--	--	--
Diethyl ether	60-29-7	0.2	--	--	--	--	--	--
m,p-Xylenes	1330-20-7	0.4	--	--	--	--	--	--
o-Xylene	95-47-6	0.2	--	--	--	--	--	--
Toluene	108-88-3	0.2	--	--	--	--	--	--
trans-1,3-Dichloropropene	10061-02-6	0.2	--	--	--	--	--	--
Pesticides (Organochlorine)								
4,4'-DDD	72-54-8	0.00125	1.1	0.001	0.13	0.001	--	--
Lindane	58-89-9	0.000625	2.00	0.08	0.16	--	0.95	--

TABLE 7

PRELIMINARY CLEANUP LEVELS FOR SURFACE WATER
March Point (Whitmarsh) Landfill
Skagit County, Washington

Concentrations in micrograms per liter (µg/L)

Analyte	Surface Water - Aquatic Life - Marine/Acute - Clean Water Act §304	Surface Water - Aquatic Life - Marine/Chronic - Clean Water Act §304	Surface Water - Human Health – Fresh Water – Clean Water Act §304	Surface Water - Human Health – Marine – Clean Water Act §304	Surface Water - Aquatic Life - Fresh/Acute - National Toxics Rule - 40 CFR 131	Surface Water - Aquatic Life - Fresh/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Acute - National Toxics Rule, 40 CFR 131	Surface Water - Aquatic Life - Marine/Chronic - National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Fresh Water – National Toxics Rule, 40 CFR 131	Surface Water - Human Health – Marine – National Toxics Rule, 40 CFR 131	Surface Water MTCA Method B, Non-Carcinogen	Surface Water MTCA Method B, Carcinogen	PCL[2]
VOCs													
1,2,4-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
1,3,5-Trimethylbenzene	--	--	--	--	--	--	--	--	--	--	--	--	--
1,4-Dichlorobenzene	--	--	63	190	--	--	--	--	400	2,600	3,241	21	21
Acetone	--	--	--	--	--	--	--	--	--	--	--	--	--
Benzene	--	--	2.2	51	--	--	--	--	1.2	71	1,990	22.7	1.2
Bromoform	--	--	--	--	--	--	--	--	--	--	--	--	--
Carbon disulfide	--	--	--	--	--	--	--	--	--	--	--	--	--
cis-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--	--	--
Dibromochloromethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Dichlorodifluoromethane	--	--	--	--	--	--	--	--	--	--	--	--	--
Diethyl ether	--	--	--	--	--	--	--	--	--	--	--	--	--
m,p-Xylenes	--	--	--	--	--	--	--	--	--	--	--	--	--
o-Xylene	--	--	--	--	--	--	--	--	--	--	--	--	--
Toluene	--	--	1,300	15,000	--	--	--	--	6,800	200,000	18,855	--	1,300
trans-1,3-Dichloropropene	--	--	--	--	--	--	--	--	--	--	--	--	--
Pesticides (Organochlorine)													
4,4'-DDD	--	--	0.00031	0.00031	--	--	--	--	0.00083	0.00084	--	0.0005	0.00125
Lindane	0.16	--	0.98	1.8	2	0.08	0.16	--	0.019	0.063	5.98	0.05	0.019

Notes

1. PCL was chosen as the lower of the aquatic marine acute and chronic water quality criteria published in WAC 173-201A, aquatic marine acute and chronic and human health (fish ingestion) water quality criteria published in Section 304 of the Clean Water Act, aquatic marine acute and chronic and human health (fish ingestion) water quality criteria published in the National Toxics Rule (40 CFR 131), and MTCA Method B surface water cleanup levels (carcinogen and noncarcinogen). Final PCLs that were lower than the associated PQL were adjusted upward to the PQL.

Abbreviations

-- = No value available
CFR = Code of Federal Regulations
MTCA = Model Toxics Control Act
PCL = preliminary cleanup level
PQL = practical quantitation limit
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds
WAC = Washington Administrative Code

TABLE 8

SUMMARY OF PCL EXCEEDANCES
FOR MONITORING WELL AND TEST PIT SOIL SAMPLES
OCTOBER/NOVEMBER 2008 AND MARCH/APRIL 2010 [1,2]
March Point (Whitmarsh) Landfill
Skagit County, Washington

Sample ID	PCL	MW-01			MW-03	MW-04		MW-08	MW-10	G1		G3			G4		G5		
Depth (ft bgs)		11.5	20.5	37	11.5	8.5	19	26-27.5	24.5-26	1	5.5	1	8	12	1	5	1	5	9
Analyte [3] / Sample Date		10/7/2008			10/9/2008	10/8/2008		4/2/2010	4/1/2010	11/1/2008		10/31/2008			10/31/2008		11/2/2008		
Metals (mg/kg)																			
Antimony	5.1	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Arsenic	7	--	--	--	--	14 J	--	--	11	--	--	--	--	8.8	--	--	--	--	--
Barium	102	--	--	239	117	--	--	NA	NA	--	115	--	--	--	--	259	--	--	--
Cadmium	1.0	--	--	--	--	--	--	1.3	--	--	2.6	--	--	--	--	2.7	--	--	--
Copper	36	--	--	61	373	44.6	--	60.2	--	--	76	--	76.0	--	--	49.3	--	--	36.4
Lead	118	--	--	--	171	--	--	--	--	--	--	--	--	--	--	238	--	--	--
Mercury	0.07	--	--	--	--	--	--	--	--	--	6.9	--	0.10	0.08	--	0.08	--	--	0.26
Nickel	48	99	81	56	80	83	60	55 J	--	76	90	63	60	--	76	75	62	65	62
Zinc	101	--	--	--	282	--	--	245	--	--	381	--	174	--	--	311	187	225	187
TPH (mg/kg)																			
Gasoline-Range Organics (TPH-G)	30/100	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	310 J
Lube Oil (TPH-Oil)	2,000	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
VOCs (µg/kg)																			
Benzene	6.8	--	--	--	--	--	--	--	--	--	--	--	--	11	--	--	--	--	--
SVOCs (µg/kg)																			
2,4-Dimethylphenol	3,100	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
2-Methylphenol	190	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
Benzo(a)anthracene	70	NA	NA	NA	NA	NA	NA	--	--	--	270	--	--	--	--	--	--	--	130
Benzo(a)pyrene	190	NA	NA	NA	NA	NA	NA	--	--	--	240	--	--	--	--	--	--	--	120
bis(2-Ethylhexyl) phthalate	2,600	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	6,000
Chrysene	80	NA	NA	NA	NA	NA	NA	--	--	--	320	--	--	--	--	--	--	--	180
Dibenzofuran	90	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
Phenol	46,000	NA	NA	NA	NA	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
PCBs (µg/kg)																			
Aroclor 1254	4	NA	NA	NA	27	NA	NA	--	--	--	--	--	22	--	--	240	--	--	110 J
Pesticides (µg/kg)																			
4,4'-DDD	3.3	NA	NA	NA	--	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDE	3.3	NA	NA	NA	--	NA	NA	--	--	--	--	--	--	--	--	--	--	--	--
Aldrin	1.7	NA	NA	NA	--	NA	NA	--	--	--	--	--	--	--	--	--	--	--	390
Dieldrin	3.3	NA	NA	NA	--	NA	NA	--	--	--	--	--	24	--	--	--	--	--	210

TABLE 8

SUMMARY OF PCL EXCEEDANCES
FOR MONITORING WELL AND TEST PIT SOIL SAMPLES
OCTOBER/NOVEMBER 2008 AND MARCH/APRIL 2010 [1,2]
March Point (Whitmarsh) Landfill
Skagit County, Washington

Sample ID	PCL	G6		G10	G11	G17.5	G29	G30		G32	G35	G37
Depth (ft bgs)		6	field dup.	8	11	7	9	7	DRUM [4]	12	15	10
Analyte [3] / Sample Date		11/1/2008		11/1/2008	10/31/2008	4/1/2010	3/31/2010	3/31/2010	3/31/2010	3/31/2010	4/1/2010	3/31/2010
Metals (mg/kg)												
Antimony	5.1	--	11 J	--	--	--	--	--	--	--	--	--
Arsenic	7	--	--	--	13	8	--	--	--	--	70	--
Barium	102	--	--	--	--	NA	NA	NA	NA	NA	NA	NA
Cadmium	1.0	--	--	--	--	--	--	--	--	--	--	--
Copper	36	50.0	70.8	--	--	--	--	--	--	261	57.5	--
Lead	118	--	--	--	--	--	--	--	--	--	184	--
Mercury	0.07	--	--	--	--	--	--	--	--	0.13	0.34	--
Nickel	48	69	69	67	--	55 J	78 J	211 J	190 J	179 J	495 J	361 J
Zinc	101	175	345	--	--	--	--	--	133	413	149	--
TPH (mg/kg)												
Gasoline-Range Organics (TPH-G)	30/100	--	--	--	--	--	--	--	--	350	90	--
Lube Oil (TPH-Oil)	2,000	--	--	--	--	--	3,400	--	--	--	--	--
VOCs (µg/kg)												
Benzene	6.8	--	--	--	--	--	--	--	NA	11	--	--
SVOCs (µg/kg)												
2,4-Dimethylphenol	3,100	--	--	--	--	--	--	--	--	--	130,000	--
2-Methylphenol	190	--	--	--	--	--	--	--	--	--	130,000	--
Benzo(a)anthracene	70	--	--	--	--	--	--	--	--	100 J	--	--
Benzo(a)pyrene	190	--	--	--	--	--	--	--	--	--	--	--
bis(2-Ethylhexyl) phthalate	2,600	--	--	--	--	--	--	--	--	--	--	--
Chrysene	80	--	--	--	--	--	1,100 J	--	--	190	--	--
Dibenzofuran	90	--	--	--	--	--	--	--	--	240	--	--
Phenol	46,000	--	--	--	--	--	--	--	--	73,000	--	--
PCBs (µg/kg)												
Aroclor 1254	4	76	31	--	--	--	--	--	--	42	--	--
Pesticides (µg/kg)												
4,4'-DDD	3.3	--	--	--	--	--	4.4	--	--	--	--	--
4,4'-DDE	3.3	--	--	--	--	--	--	--	--	--	620	--
Aldrin	1.7	--	--	--	--	--	--	--	--	--	--	--
Dieldrin	3.3	--	--	--	--	--	--	--	--	--	--	--

Notes

1. Data qualifiers are as follows:
   J = Reported value is an estimate.
2. Sample IDs beginning with "G" are test pits; sample IDs beginning with "MW" are monitoring wells.
3. Analyte not shown if detected concentration did not exceed PCL in any soil sample.
4. Material sample found in a drum in the test pit.

Abbreviations

-- = Analyte does not exceed the applicable PCL
µg/kg = micrograms per kilogram
bgs = below ground surface
dup = field duplicate
ft = feet
mg/kg = milligrams per kilogram
NA = not analyzed
PCBs = polychlorinated biphenyls
PCL = preliminary cleanup level
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons

TABLE 9

SUMMARY OF PCL EXCEEDANCES IN GROUNDWATER AND SEEP SAMPLES[1]

March Point (Whitmarsh) Landfill
Skagit County, Washington

Analyte / Sample ID / Sample Date	PCL	MW-02							MW-03						
		10/14/2008	12/18/2008	4/29/2009	7/24/2009	4/13/2010	7/13/2010	10/5/2010	10/14/2008	12/18/2008	4/28/2009	7/23/2009	4/13/2010	7/13/2010	10/5/2010
Dissolved Metals (µg/L)															
Arsenic	0.2	1.9	2.2	2.3 J-	2.5	2.3	2.9	2.7	4.1	0.5	0.5 J-	4.1	2.5	3.5	4.3
Copper	2.4	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Iron	1,000	--	--	--	--	NA	NA	NA	11,800	--	--	13,400	NA	NA	NA
Lead	2.5	--	--	--	--	3	--	--	--	--	--	--	--	--	--
Manganese	50	--	--	--	--	NA	NA	NA	332	227	276 J-	319	NA	NA	NA
Selenium	5	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Silver	1.9	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Total Metals (µg/L)															
Aluminum	87	--	--	--	--	NA	NA	NA	460 J	--	--	--	NA	NA	NA
Arsenic	0.2	2	2.2	2.3	2.8	4.8	2.9	2.5	4.9	2.7	2.8	4.1	2.5	3.5	4.1
Copper	2.4	--	--	--	--	NA	NA	NA	3	--	--	--	NA	NA	NA
Iron	1,000	--	--	--	--	NA	NA	NA	13,400	12,200	14,600	12,500	NA	NA	NA
Lead	2.5	--	--	--	--	--	--	--	16 J	--	--	--	--	--	--
Manganese	50	--	--	--	64	NA	NA	NA	350	254	301	307	NA	NA	NA
Mercury	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	1.9	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
PCBs (µg/L)															
Aroclor 1232	0.014	--	--	--	--	--	--	--	--	0.029 J	0.019	--	--	--	--
Aroclor 1242	0.014	--	--	--	--	--	--	--	0.03	--	--	--	--	--	--
Aroclor 1248	0.014	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total PCBs	0.07	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pesticides (µg/L)															
4,4'-DDD	0.00125	--	--	--	--	--	--	--	--	0.0056 J	0.0058	0.0075	0.0072	0.0074	--
4,4'-DDE	0.00125	--	--	--	--	--	--	--	--	--	--	--	--	--	--
alpha-BHC	0.0006	--	--	--	--	--	--	--	0.015	0.031 J	0.041	0.016	0.026	0.034	0.027
SVOCs (µg/L)															
1-Methylnaphthalene	1.51	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
2,4-Dimethylphenol	380	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Benzo(a)anthracene	0.01	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
bis(2-ethylhexyl)phthtlate	1.2	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Chrysene	0.01	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
VOCs (µg/L)		--	--	--	--										
Benzene	1.2	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA

TABLE 9

SUMMARY OF PCL EXCEEDANCES IN GROUNDWATER AND SEEP SAMPLES[1]
March Point (Whitmarsh) Landfill
Skagit County, Washington

Sample ID		MW-03 Field Duplicate				MW-04							MW-05				
Analyte Sample Date	**PCL**	**10/14/2008**	**12/18/2008**	**4/28/2009**	**7/23/2009**	**10/14/2008**	**12/19/2008**	**4/29/2009**	**7/24/2009**	**4/13/2010**	**7/13/2010**	**10/5/2010**	**4/14/2010**	**7/14/2010**	**10/7/2010**	**3/28/2013**	**8/17/2013**
Dissolved Metals (µg/L)																	
Arsenic	0.2	4	0.4	0.5 J-	4.1	4.6	4.4	5.5 J-	5.9	5.6	6.1	6.4	2.5	2.2	2.3	1.4	1.6
Copper	2.4	--	--	--	--	--	--	--	--	NA	NA	NA	3	4	--	--	--
Iron	1,000	12,000	--	1,360 J-	13,600	--	--	--	--	NA	NA	NA	4,510	6,980	8,450	20,000	15,500
Lead	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	50	336	226	284 J-	327	127	121	124 J-	125	NA	NA	NA	294	573	487	664	511
Selenium	5	--	--	--	--	--	--	--	--	NA	NA	NA	--	--	50	--	--
Silver	1.9	--	--	--	--	--	--	--	--	NA	NA	NA	--	--	--	--	--
Total Metals (µg/L)																	
Aluminum	87	--	--	--	--	160	--	--	--	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	0.2	4.4	2.8	2.7	4	4.1	4.8	5.6	5.6	5.8	6.1	6.3	1.7	3	2.2	1.4	1.8
Copper	2.4	--	--	--	--	--	--	--	--	NA	NA	NA	5	5	--	--	--
Iron	1,000	12,400	12,300	13,300	12,900	--	--	--	--	NA	NA	NA	4,820	6,020	8,440	20,100	9,590
Lead	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	50	349	258	282	316	136	129	124	127	NA	NA	NA	309	570	484	665	341
Mercury	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--	28.6	--	--
Silver	1.9	--	--	--	--	--	--	--	--	NA	NA	NA	7	--	--	--	--
PCBs (µg/L)																	
Aroclor 1232	0.014	--	0.031 J	0.022	--	--	--	--	--	--	--	--	--	--	--	NA	NA
Aroclor 1242	0.014	0.031	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA
Aroclor 1248	0.014	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA
Total PCBs	0.07	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA
Pesticides (µg/L)																	
4,4'-DDD	0.00125	--	0.0061 J	0.0061	0.0082	--	--	--	--	--	--	--	--	--	--	NA	NA
4,4'-DDE	0.00125	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA
alpha-BHC	0.0006	0.015	0.036 J	0.039	0.018	--	--	--	--	--	--	--	--	--	--	NA	NA
SVOCs (µg/L)																	
1-Methylnaphthalene	1.51	--	--	--	--	--	--	--	--	NA	NA	NA	--	--	--	NA	NA
2,4-Dimethylphenol	380	--	--	--	--	--	--	--	--	NA	NA	NA	--	--	--	NA	NA
Benzo(a)anthracene	0.01	--	--	--	--	--	--	--	--	NA	NA	NA	--	--	--	NA	NA
bis(2-ethylhexyl)phthtlate	1.2	--	--	--	--	--	--	--	--	NA	NA	NA	--	--	--	NA	NA
Chrysene	0.01	--	--	--	--	--	--	--	--	NA	NA	NA	--	--	--	NA	NA
VOCs (µg/L)																	
Benzene	1.2	--	--	--	--	--	--	--	--	NA	NA	NA	--	--	--	NA	NA

TABLE 9

SUMMARY OF PCL EXCEEDANCES IN GROUNDWATER AND SEEP SAMPLES[1]
March Point (Whitmarsh) Landfill
Skagit County, Washington

Sample ID		MW-06					MW-07					MW-08			MW-09				
Analyte / Sample Date	**PCL**	**4/15/2010**	**7/14/2010**	**10/7/2010**	**3/28/2013**	**8/17/2013**	**4/15/2010**	**7/14/2010**	**10/6/2010**	**3/26/2013**	**8/17/2013**	**4/14/2010**	**7/13/2010**	**10/7/2010**	**4/14/2010**	**7/13/2010**	**10/7/2010**	**3/26/2013**	**8/17/2013**
Dissolved Metals (µg/L)																			
Arsenic	0.2	0.7	0.7	0.8	1.2	0.9	--	--	--	--	0.9	2.2	1.8	1.6	1.2	1.4	1.4	1.7	1.5
Copper	2.4	--	--	--	--	--	5	6	--	--	--	--	--	--	--	--	--	--	--
Iron	1,000	98,400	102,000	97,700	77,900	92,200	4,520	3,940	2,370	5,820	1,540	34,300	36,600	46,600	19,000	22,400	21,300	22,700	24,500
Lead	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	50	2,730	2,670	2,220	2,310	2,300	579	372	217	673	183	1,680	1,660	2,390	449	543	447	529	565
Selenium	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	1.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total Metals (µg/L)																			
Aluminum	87	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Arsenic	0.2	1	1.2	0.7	1.2	1.0	--	0.9	--	--	1	2.2	1.7	1.8	1.4	1.3	1.4	1.8	1.4
Copper	2.4	--	--	--	--	--	9	5	--	--	4	3	--	--	3	3	--	--	--
Iron	1,000	101,000	102,000	95,700	74,600	91,400	4,590	3,650	2,710	5,720	1,590	38,800	37,300	42,900	19,600	22,800	19,400	23,100	24,000
Lead	2.5	--	--	--	--	--	--	--	--	--	--	3	--	--	3	--	--	--	--
Manganese	50	2,720	2,690	2,270	2,240	2,340	581	356	234	672	185	1,990	1,790	2,140	464	548	411	555	551
Mercury	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	1.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
PCBs (µg/L)																			
Aroclor 1232	0.014	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA
Aroclor 1242	0.014	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA
Aroclor 1248	0.014	0.017	--	--	NA	NA	--	--	--	NA	NA	0.015	--	--	--	--	--	NA	NA
Total PCBs	0.07	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA
Pesticides (µg/L)																			
4,4'-DDD	0.00125	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA
4,4'-DDE	0.00125	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA
alpha-BHC	0.0006	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA
SVOCs (µg/L)																			
1-Methylnaphthalene	1.51	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA
2,4-Dimethylphenol	380	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA
Benzo(a)anthracene	0.01	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA
bis(2-ethylhexyl)phthtlate	1.2	--	--	1.3	NA	NA	--	--	--	NA	NA	--	--	--	--	--	2.4	NA	NA
Chrysene	0.01	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	0.014	0.015	0.011	NA	NA
VOCs (µg/L)																			
Benzene	1.2	--	--	--	NA	NA	--	--	--	NA	NA	--	--	--	--	--	--	NA	NA

TABLE 9

SUMMARY OF PCL EXCEEDANCES IN GROUNDWATER AND SEEP SAMPLES[1]
March Point (Whitmarsh) Landfill
Skagit County, Washington

Sample ID		MW-09 FD	MW-10			MW-11			MW-11 Field Duplicate			SP-01						
Analyte / Sample Date	**PCL**	**3/26/2013**	**4/15/2010**	**7/13/2010**	**10/7/2010**	**4/15/2010**	**7/14/2010**	**10/8/2010**	**4/15/2010**	**7/14/2010**	**10/8/2010**	**10/15/2008**	**12/17/2008**	**4/28/2009**	**7/24/2009**	**4/14/2010**	**7/15/2010**	**10/7/2010**
Dissolved Metals (µg/L)																		
Arsenic	0.2	1.7	2.8	2.8	3	1.8	1.4	1.9	1.8	1.4	2	0.4	--	0.4 J-	1.2	0.4	1.2	1.2
Copper	2.4	--	--	3	--	--	--	--	--	3	--	--	--	--	--	NA	NA	NA
Iron	1,000	22,900	11,300	13,800	13,900	10,600	11,100	13,000	10,800	11,100	12,200	--	--	--	12,300	NA	NA	NA
Lead	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	50	531	210	200	200	320	271	294	326	272	279	154	233	225 J-	173	NA	NA	NA
Selenium	5	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA	NA
Silver	1.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA	NA
Total Metals (µg/L)																		
Aluminum	87	--	NA	NA	NA	NA	NA	NA	NA	NA	NA	--	150	--	--	NA	NA	NA
Arsenic	0.2	1.7	2.7	2.7	3	1.8	1.4	1.9	1.9	1.4	1.9	1.4	1.4	1.3	1.3	1.4	1.3	1.3
Copper	2.4	--	3	--	--	--	3	--	--	3	--	--	--	--	--	NA	NA	NA
Iron	1,000	22,800	11,300	13,100	14,100	10,800	9,930	12,500	10,800	10,800	12,100	15,900	22,100	15,500	12,100	NA	NA	NA
Lead	2.5	--	3	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	50	546	210	190	202	323	240	287	324	264	284	173	251	238	163	NA	NA	NA
Mercury	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	1.9	--	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA	NA
PCBs (µg/L)																		
Aroclor 1232	0.014	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1242	0.014	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Aroclor 1248	0.014	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Total PCBs	0.07	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Pesticides (µg/L)																		
4,4'-DDD	0.00125	NA	--	0.0058 J	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDE	0.00125	NA	0.16	0.058 J	--	--	0.34 J	--	--	0.32 J	--	--	--	--	--	--	0.082 J	--
alpha-BHC	0.0006	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs (µg/L)																		
1-Methylnaphthalene	1.51	NA	--	--	--	2.8	2.8	3.1	2.7	2.8	2.6	--	--	--	--	NA	NA	NA
2,4-Dimethylphenol	380	NA	--	--	--	640	--	--	650	--	--	--	--	--	--	NA	NA	NA
Benzo(a)anthracene	0.01	NA	--	--	--	--	--	--	--	0.012 J	--	--	--	--	--	NA	NA	NA
bis(2-ethylhexyl)phthtlate	1.2	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA	NA
Chrysene	0.01	NA	--	--	--	--	--	--	--	--	--	--	--	--	--	NA	NA	NA
VOCs (µg/L)																		
Benzene	1.2	NA	--	--	2.7	8.3	3.7	6.4	8.6	3.9	5.9	2.6	2.4	1.9	2.2	NA	NA	NA

TABLE 9

SUMMARY OF PCL EXCEEDANCES IN GROUNDWATER AND SEEP SAMPLES[1]

March Point (Whitmarsh) Landfill
Skagit County, Washington

Analyte / Sample ID / Sample Date	PCL	SP-02 10/15/2008	SP-02 12/18/2008	SP-02 4/28/2009	SP-02 7/24/2009	SP-02 4/15/2010	SP-02 7/15/2010	SP-02 10/7/2010	SP-03 10/15/2008	SP-03 12/18/2008	SP-03 4/28/2009	SP-03 7/24/2009	SP-03 4/15/2010	SP-03 7/15/2010	SP-03 10/7/2010
Dissolved Metals (µg/L)															
Arsenic	0.2	--	--	0.7 J-	1.1	--	1.3	12	0.8	--	0.6 J-	0.8	--	--	0.8
Copper	2.4	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Iron	1,000	--	--	--	18,200	NA	NA	NA	--	--	3,940 J-	25,800	NA	NA	NA
Lead	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	50	126	364	332 J-	321	NA	NA	NA	434	477	545 J-	444	NA	NA	NA
Selenium	5	--	--	--	--	NA	NA	NA	--	--	--	50	NA	NA	NA
Silver	1.9	11	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Total Metals (µg/L)															
Aluminum	87	270	2,230	680	900	NA	NA	NA	580	--	--	--	NA	NA	NA
Arsenic	0.2	--	1.4	1.7	2.4	0.6	0.5	0.9	1.3	--	1.1	0.8	0.9	1.5	2.2
Copper	2.4	--	5	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Iron	1,000	5,890	21,400	25,100	26,400	NA	NA	NA	55,300	19,800	41,100	25,400	NA	NA	NA
Lead	2.5	--	--	--	--	--	--	--	--	--	--	--	NA	NA	--
Manganese	50	85	409	373	314	NA	NA	NA	557	495	570	395	NA	NA	NA
Mercury	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Silver	1.9	8	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
PCBs (µg/L)															
Aroclor 1232	0.014	--	--	0.028	--	--	--	--	--	0.086 J	0.091	--	--	--	--
Aroclor 1242	0.014	--	--	--	--	--	--	--	0.035 J	0.029 J	--	--	--	--	--
Aroclor 1248	0.014	--	--	--	--	--	--	--	--	--	--	--	0.017 J	--	--
Total PCBs	0.07	--	--	--	--	--	--	--	0.035 J	0.115	0.091	--	0.017 J	--	--
Pesticides (µg/L)															
4,4'-DDD	0.00125	--	--	--	--	--	--	--	--	--	--	--	--	--	--
4,4'-DDE	0.00125	--	--	--	--	--	--	--	--	--	--	--	--	--	--
alpha-BHC	0.0006	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs (µg/L)															
1-Methylnaphthalene	1.51	--	--	--	--	NA	NA	NA	4	5.2	5.3	3.6	NA	NA	NA
2,4-Dimethylphenol	380	--	--	--	--	--	--	--	--	--	--	--	NA	NA	NA
Benzo(a)anthracene	0.01	--	--	--	--	--	--	--	--	--	--	--	NA	NA	NA
bis(2-ethylhexyl)phthtlate	1.2	--	--	--	--	--	--	--	--	--	--	--	NA	NA	NA
Chrysene	0.01	--	--	--	--	--	--	--	--	--	--	--	NA	NA	NA
VOCs (µg/L)															
Benzene	1.2	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA

Notes
1. Data qualifiers are as follows:
J = analyte was positively identified; result is an estimated concentration.
J- = value is esitmated with a possible low bias

Abbreviations
-- = does not exceed the PCL
µg/L = micrograms per liter
NA = Not analyzed
PCBs = polychlorinated biphenyls
PCL = preliminary cleanup level
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds

TABLE 10

SUMMARY OF PCL EXCEEDANCES IN SURFACE WATER SAMPLES[1]

March Point (Whitmarsh) Landfill

Skagit County, Washington

Analyte / Sample ID / Sample Date	PCL	SW-01							SW-03						
		10/14/2008	12/14/2008	4/28/2009	7/23/2009	4/13/2010	7/12/2010	10/7/2010	10/15/2008	12/17/2008	4/29/2009	7/23/2009	4/13/2010	7/12/2010	10/5/2010
Dissolved Metals (µg/L)															
Arsenic	0.2	3.2	2.4	2.9 J-	5.1	2.4	3.8	4.1	1.1	--	1.8 J-	1.8	1.3	3.8	1.1
Copper	2.4	--	--	--	--	NA	NA	NA	--	3	--	--	NA	NA	NA
Manganese	50	--	--	391 J-	150	NA	NA	NA	203	335	159 J-	180	NA	NA	NA
Nickel	8.2	--	--	--	--	NA	NA	NA	--	9	--	--	NA	NA	NA
Silver	1.9	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Total Metals (µg/L)															
Aluminum	87	170	650	440	13,200	NA	NA	NA	290	100	3,080	140	NA	NA	NA
Arsenic	0.2	4.8	5.8	5	21.3 J	6.6	20.1	6.5	2.2	--	3	2.5 J	2	11	1.7
Copper	2.4	--	5	--	38	NA	NA	NA	--	4	10	3	NA	NA	NA
Iron	1,000	--	1,610	--	16,500	NA	NA	NA	1,790	--	7,920	1,360	NA	NA	NA
Lead	2.5	--	--	--	24	--	9	--	--	--	3	--	--	13	--
Manganese	50	--	660	414	313	NA	NA	NA	230	353	276	195	NA	NA	NA
Mercury	0.02	--	0.0284	--	0.0649	--	--	0.0215	--	--	--	--	--	0.071	--
Nickel	8.2	--	--	--	72.2 J	NA	NA	NA	--	9	12.6	--	NA	NA	NA
Silver	1.9	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Zinc	81	--	--	--	150	NA	NA	NA	--	--	--	--	NA	NA	NA
Pesticides (µg/L)															
4,4'-DDD	0.00125	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs (µg/L)															
Butylbenzylphthalate	8.32	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Bis(2-ethylhexyl) phthalate	1.2	--	1.6	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Chrysene	0.01	--	--	--	0.014	NA	NA	NA	--	--	--	--	NA	NA	NA
VOCs (µg/L)															
Benzene	1.2	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA

TABLE 10

SUMMARY OF PCL EXCEEDANCES IN SURFACE WATER SAMPLES[1]
March Point (Whitmarsh) Landfill
Skagit County, Washington

Analyte — Sample ID / Sample Date	PCL	SW-04 10/15/2008	SW-04 12/18/2008	SW-04 4/29/2009	SW-04 7/23/2009	SW-04 4/13/2010	SW-04 7/14/2010	SW-04 10/6/2010	SW-05 10/15/2008	SW-05 12/17/2008	SW-05 4/29/2009	SW-05 7/23/2009	SW-05 4/13/2010	SW-05 7/14/2010	SW-05 10/6/2010
Dissolved Metals (µg/L)															
Arsenic	0.2	2	--	2 J-	3	1.4	4.6	1.6	--	--	1.7 J-	3	0.6	2.5	1.3
Copper	2.4	--	5	3 J-	3	NA	NA	NA	--	3	--	4	NA	NA	NA
Manganese	50	68	246	164 J-	55	NA	NA	NA	345	227	795 J-	75	NA	NA	NA
Nickel	8.2	--	11	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Silver	1.9	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Total Metals (µg/L)															
Aluminum	87	1,570	4,240	440	1,090	NA	NA	NA	120	400	190	90	NA	NA	NA
Arsenic	0.2	2.8	8	2	4 J	1.4	5.2	1.6	1.5	0.8	1.6	4 J	1.2	3.2	1.9
Copper	2.4	4	12	4	6	NA	NA	NA	--	4	3	4	NA	NA	NA
Iron	1,000	3,490	7,580	1,020	2,440	NA	NA	NA	1,700	1,080	2,010	720	NA	NA	NA
Lead	2.5	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Manganese	50	125	382	176	107	NA	NA	NA	366	243	782	89	NA	NA	NA
Mercury	0.02	--	--	--	--	--	--	--	--	--	--	--	--	--	--
Nickel	8.2	--	17	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Silver	1.9	--	--	--	--	NA	NA	NA	3	--	--	--	NA	NA	NA
Zinc	81	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Pesticides (µg/L)															
4,4'-DDD	0.00125	--	--	--	--	--	--	--	--	--	--	--	--	--	--
SVOCs (µg/L)															
Butylbenzylphthalate	8.32	--	--	--	--	NA	NA	NA	23	--	--	--	NA	NA	NA
Bis(2-ethylhexyl) phthalate	1.2	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
Chrysene	0.01	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA
VOCs (µg/L)															
Benzene	1.2	--	--	--	--	NA	NA	NA	--	--	--	--	NA	NA	NA

TABLE 10

SUMMARY OF PCL EXCEEDANCES IN SURFACE WATER SAMPLES[1]
March Point (Whitmarsh) Landfill
Skagit County, Washington

Analyte — Sample ID / Sample Date	PCL	SW-06							SW-07	
		10/15/2008	12/17/2008	4/29/2009	7/23/2009	4/13/2010	7/14/2010	10/6/2010	12/17/2008	4/28/2009
Dissolved Metals (µg/L)										
Arsenic	0.2	3	--	4 J-	5	1	3	2	0.5	0.6 J-
Copper	2.4	--	3	3 J-	6	NA	NA	NA	--	--
Manganese	50	80	132	289 J-	--	NA	NA	NA	229	169 J-
Nickel	8.2	--	--	--	--	NA	NA	NA	--	--
Silver	1.9	8	--	--	--	NA	NA	NA	--	--
Total Metals (µg/L)										
Aluminum	87	--	2,250	370	--	NA	NA	NA	110	--
Arsenic	0.2	3	3	3	5 J	1.4	4	0.8	1.7	1.4
Copper	2.4	--	8	4	7	NA	NA	NA	3	--
Iron	1,000	--	4,620	1,370	--	NA	NA	NA	18,000	12,800
Lead	2.5	--	--	--	--	--	--	--	--	--
Manganese	50	90	239	300	--	NA	NA	NA	262	197
Mercury	0.02	--	--	--	--	--	--	--	--	--
Nickel	8.2	--	11	--	10 J	NA	NA	NA	--	--
Silver	1.9	7	--	--	--	NA	NA	NA	--	--
Zinc	81	--	--	--	--	NA	NA	NA	--	--
Pesticides (µg/L)										
4,4'-DDD	0.00125	--	0.0019 J	--	--	--	--	--	--	--
SVOCs (µg/L)										
Butylbenzylphthalate	8.32	--	--	--	--	NA	NA	NA	--	--
Bis(2-ethylhexyl) phthalate	1.2	--	--	--	--	NA	NA	NA	--	--
Chrysene	0.01	--	--	--	--	NA	NA	NA	--	--
VOCs (µg/L)										
Benzene	1.2	--	--	--	--	NA	NA	NA	2.2	3.6

Notes
1. Data qualifiers are as follows:
   J = analyte was positively identified;
   result is an estimated concentration.
   J- = value is esitmated with a possible low bias

Abbreviations
-- = does not exceed the PCL
µg/L = micrograms per liter
NA = Not analyzed
PCL = preliminary cleanup level
SVOCs = semivolatile organic compounds
VOCs = volatile organic compounds

TABLE 11

LANDFILL GAS MONITORING DATA
March Point (Whitmarsh) Landfill
Skagit, Washington

Date	Sampling Location	Methane (% by volume)	Carbon Dioxide (% by volume)	Oxygen (% by volume)	Nitrogen [1] (% by volume)	Relative Pressure (inches of water)	Barometric Pressure (inches of mercury)	Depth (feet bgs)	Top of Screen (feet bgs)	Bottom of Screen (feet bgs)	Woodwaste Intervals (feet bgs)	Refuse Interval (feet bgs)
10/5/2011		32.0	12.2	0.0	55.3	-0.29	29.53					
1/24/2012	LFGP-001	29.1	10.2	0.5	60.2	0.49	29.59	10.5	5	10	0-2	4-9
4/3/2012		30.8	9.1	0.1	60.0	-0.05	29.70					
10/5/2011		39.4	2.1	0.0	58.4	-0.29	29.52					
1/24/2012	LFGP-002	38.7	2.4	0.0	58.9	-0.51	29.44	11	6	11	0-1	6-10.5
4/3/2012		40.2	4.3	0.7	54.8	-0.33	29.67					
10/5/2011		16.9	11.2	0.0	71.9	-0.51	29.60					
1/24/2012	LFGP-003	17.8	9.8	0.0	72.4	-0.78	29.48	9	4	9	0-1.5	3-9
4/3/2012		11.0	9.7	0.0	79.3	-0.66	29.67					
10/5/2011		70.6	29.3	0.0	0.1	-0.43	29.58					
1/24/2012	LFGP-004	67.3	32.6	0.0	11.0	-0.51	29.44	15	5	15	0-7.5	7.5-15
4/3/2012		68.2	31.7	0.0	0.1	-0.48	29.66					
10/5/2011		1.0	2.9	19.6	76.2	1.34	29.60					
1/24/2012	PZ-01	0.1	0.0	21.2	78.7	-0.51	29.48	13.5	6	11	0-1	5-11
4/3/2012		0.1	0.1	21.1	78.7	-0.09	29.67					
10/5/2011		10.8	22.7	0.0	66.3	-0.39	29.61					
1/24/2012	LFGP-006	5.3	16.0	0.0	78.7	-0.78	29.48	9	4	9	0-1.5, 4.5-5.5	1.5-5.5
4/3/2012		5.5	11.1	0.3	83.1	-0.52	29.70					
10/5/2011		0.1	9.2	12.9	77.8	-0.41	29.61					
1/24/2012	LFGP-007	0.2	8.7	14.2	76.8	-38.6	29.59	10	5	10	NA	0-6
4/3/2012		0.0	8.2	14.3	77.5	-0.82	29.70					
10/5/2011		29.4	16.9	0.0	53.6	-0.38	29.61					
1/24/2012	LFGP-005	33.2	13.2	0.0	53.5	-38.6	29.59	9	4	9	0-4.5	4.5-9
4/3/2012		29.5	12.0	0.0	58.5	-0.61	29.70					
10/5/2011		18.1	22.2	0.0	59.7	-0.38	29.61					
1/24/2012	LFGP-008	66.8	24.0	0.0	9.0	-38.6	29.59	9	4	9	0-4.5	1-9
4/3/2012		31.6	18.5	0.0	49.9	-0.82	29.70					
10/5/2011		22.3	14.0	0.0	63.6	-0.43	29.62					
1/24/2012	LFGP-010	69.7	9.4	0.0	20.6	0.49	29.59	8	3	8	0-2.5	4.5-8
4/3/2012		58.3	13.3	0.1	28.3	0.05	29.70					
10/5/2011		40.4	32.5	0.0	27.0	-0.52	29.62					
1/24/2012	LFGP-009	44.3	27.6	0.0	28.1	0.49	29.59	10.5	5	10	0-9	6-10.5
4/3/2012		39.8	25.8	0.2	34.2	0.10	29.70					
10/5/2011		0.5	0.5	21.1	77.9	-0.39	29.62					
1/24/2012	MW-08	3.9	1.6	20.0	75.1	-0.78	29.48	34	10	20	0-7	12-23
4/3/2012		1.0	0.6	20.9	77.5	-0.20	29.67					
10/5/2011		0.1	0.1	21.5	78.3	-0.42	29.62					
1/24/2012	MW-10	32.0	18.8	0.0	49.1	-0.78	29.48	34	10	20	1.5-10	11.5-23.5
4/3/2012		0.1	0.1	21.1	78.7	-0.21	29.67					

Note
1. GEM-2000 reports nitrogen % as “balance,” the majority of which is assumed to represent atmospheric nitrogen.

Abbreviation(s)
bgs = below ground surface
LFGP = landfill gas probe
MW = monitoring well
PZ = piezometer

TABLE 12

GEOTECHNICAL DATA: APRIL 2010

March Point (Whitmarsh) Landfill
Skagit County, Washington

Sample ID	Depth (feet bgs)	Sample Type[1]	Moisture Content ASTM D2216 (%)	Particle Size Distribution, dry				Atterberg Limits (ASTM D4318A)				Hydraulic Conductivity ASTM D5084 (cm/s)	Method ASTM D2974		
				Gravel	Sand	Silt	Clay	Plasticity Index (%)	Liquid Limit (%)	Plastic Limit (%)	USCS Classification		Organic Matter (%)	Total Solids (%)	Ash Content (%)
G15-15	15	grab	39.29	0.3	15.9	61.8	22.1	4.5	31.5	27	ML	NA	NA	NA	NA
G16-7	7	grab	29.53	40.2	18.3	30.6	11	6.3	33.9	27.6	ML	NA	NA	NA	NA
G16-10	10	grab	57.95	0	0.3	59.7	39.9	30	73	43	MH	NA	NA	NA	NA
G17.5-7	7	Shelby	65.28	0	18.1	35.6	46.3	29.2	63.9	34.7	MH	4.43E-06	5.23	60.5	94.77
G18-8	8	grab	77.11	0	5.9	49.4	44.6	34.9	72.7	37.8	MH	NA	NA	NA	NA
G20-12	12	grab	63.51	0	4.1	36.5	59.4	28.4	63.8	35.4	MH	NA	NA	NA	NA
G24-16	16	grab	73.77	14.7	16.8	55.1	13.5	14.6	56.5	41.9	MH	NA	NA	NA	NA
MW-08-24	24	Shelby	48.01	9.3	20.7	43.7	26.3	20.6	47.4	26.8	CL	7.91E-08	NA	NA	NA
MW-10-24	24	Shelby	37	2.6	22.4	55.8	19	NA	NA	NA	ML	8.91E-08	NA	NA	NA
ST-01	0	Shelby	76.82	0.3	1.8	52.1	45.9	52.9	91.3	38.4	CH	4.06E-06	NA	NA	NA
ST-02	0	Shelby	139.6	0.3	4.1	58.5	37.3	32	74	42	MH	3.43E-06	NA	NA	NA

Note

1. Grab samples were collected from the excavator bucket, Shelby samples were collected by pushing a Shelby tube with the drill rig.

Abbreviations

ASTM = American Society for Testing and Materials
bgs = below ground surface
CH = inorganic clay of high plasticity
CL = inorganic clay of low plasticity
cm/s = centimeters per second
MH - inorganic silt of high plasticity
ML = inorganic silt of low plasticity
NA = not analyzed
USCS = Unified Soil Classification System

TABLE 13

SUMMARY OF VERTICAL GRADIENTS

March Point (Whitmarsh) Landfill
Skagit County, Washington

Date	Well Pair PZ-01 (shallow)/MW-05 (deep)[1]				Well Pair PZ-03 (shallow)/MW-07 (deep)[2]			
	Groudwater Elevations (feet NAVD88)		Difference in Groundwater Elevation	Vertical Gradient (feet per foot)[3]	Groudwater Elevations (feet NAVD88)		Difference in Groundwater Elevation	Vertical Gradient (feet per foot)[3]
	MW-05[1]	PZ-01[1]			MW-07[1]	PZ-03[1]		
4/26/10	6.870	9.858	2.988	-0.147	6.080	8.139	2.059	-0.267
7/26/10	6.834	9.603	2.770	-0.136	6.028	7.714	1.686	-0.219
10/26/10	7.544	9.341	1.797	-0.088	7.592	7.610	0.019	-0.002
1/26/11	7.770	10.764	2.994	-0.147	7.695	8.773	1.077	-0.140
4/26/11	6.847	10.125	3.277	-0.161	6.478	8.185	1.707	-0.222
7/26/11	6.559	9.629	3.070	-0.151	5.763	7.596	1.834	-0.238
10/2/11	7.371	9.334	1.963	-0.097	7.437	7.308	-0.129	0.017

Notes

1. Distance between mid-points of screened interval for well pair PZ-01/MW-05 is 20.3 feet.
2. Distance between mid-points of screened interval for well par PZ-03/MW-07 is 7.7 feet.
3. Negative number indicates downward vertical gradient.

Abbreviations

NAVD88 = North American Vertical Datum of 1988

TABLE 14

SUMMARY OF PCL EXCEEDANCES FOR SAMPLES OUTSIDE LANDFILL FOOTPRINT[1]

March Point (Whitmarsh) Landfill

Skagit County, Washington

SOIL

Sample ID		MW-01			MW-04	
Depth (ft bgs)		11.5	20.5	37	8.5	19
Sample Date	PCL	10/7/2008			10/8/2009	
Metals (mg/kg)						
Arsenic	7	--	--	--	**14 J**	--
Barium	102	--	--	**239**	--	--
Copper	36	--	--	**61**	**44.6**	--
Nickel	48	**99**	**81**	**56**	**83**	**60**

SEEPS

	Sample ID	SP-01						
	Sample Date	10/15/2008	12/17/2008	4/28/2009	7/24/2009	4/14/2010	7/15/2010	10/7/2010
	PCL							
Dissolved Metals (µg/L)								
Arsenic	0.2	**0.4**	--	**0.4 J-**	**1.2**	**0.4**	**1.2**	**1.2**
Iron	1,000	--	--	--	**12,300**	NA	NA	NA
Manganese	50	**154**	**233**	**225 J-**	**173**	NA	NA	NA
Total Metals (µg/L)								
Aluminum	87	--	**150**	--	--	NA	NA	NA
Arsenic	0.2	**1.4**	**1.4**	**1.3**	**1.3**	**1.4**	**1.3**	**1.3**
Iron	1,000	**15,900**	**22,100**	**15,500**	**12,100**	NA	NA	NA
Manganese	50	**173**	**251**	**238**	**163**	NA	NA	NA
Pesticides (µg/L)								
4,4'-DDE	0.00125	--	--	--	--	--	**0.082 J**	--
VOCs (µg/L)								
Benzene	1.2	**2.6**	**2.4**	**1.9**	**2.2**	NA	NA	NA

	Sample ID	SP-02						
	Sample Date	10/15/2008	12/18/2008	4/28/2009	7/24/2009	4/15/2010	7/15/2010	10/7/2010
	PCL							
Dissolved Metals (µg/L)								
Arsenic	0.2	--	--	**0.7 J-**	**1.1**	--	**1.3**	**12**
Iron	1,000	--	--	--	**18,200**	NA	NA	NA
Manganese	50	**126**	**364**	**332 J-**	**321**	NA	NA	NA
Silver	1.9	**11**	--	--	--	NA	NA	NA
Total Metals (µg/L)								
Aluminum	87	**270**	**2,230**	**680**	**900**	NA	NA	NA
Arsenic	0.2	--	**1.4**	**1.7**	**2.4**	**0.6**	**0.5**	**0.9**
Copper	2.4	--	**5**	--	--	NA	NA	NA
Iron	1,000	**5,890**	**21,400**	**25,100**	**26,400**	NA	NA	NA
Manganese	50	**85**	**409**	**373**	**314**	NA	NA	NA
Silver	1.9	**8**	--	--	--	NA	NA	NA
PCBs (µg/L)								
Aroclor 1232	0.014	--	--	**0.028**	--	--	--	--

TABLE 14

SUMMARY OF PCL EXCEEDANCES FOR SAMPLES OUTSIDE LANDFILL FOOTPRINT[1]

March Point (Whitmarsh) Landfill
Skagit County, Washington

SEEPS (Continued)

	Sample ID	SP-03						
	Sample Date	10/15/2008	12/18/2008	4/28/2009	7/24/2009	4/15/2010	7/15/2010	10/7/2010
	PCL							
Dissolved Metals (µg/L)								
Arsenic	0.2	**0.8**	--	**0.6 J-**	**0.8**	--	--	**0.8**
Iron	1,000	--	--	**3,940 J-**	**25,800**	NA	NA	NA
Manganese	50	**434**	**477**	**545 J-**	**444**	NA	NA	NA
Selenium	5	--	--	--	**50**	NA	NA	NA
Total Metals (µg/L)								
Aluminum	87	**580**	--	--	--	NA	NA	NA
Arsenic	0.2	**1.3**	--	**1.1**	**0.8**	**0.9**	**1.5**	**2.2**
Iron	1,000	**55,300**	**19,800**	**41,100**	**25,400**	NA	NA	NA
Manganese	50	**557**	**495**	**570**	**395**	NA	NA	NA
PCBs (µg/L)								
Aroclor 1232	0.014	--	**0.086 J**	**0.091**	--	--	--	--
Aroclor 1242	0.014	**0.035 J**	**0.029 J**	--	--	--	--	--
Aroclor 1248	0.014	--	--	--	--	**0.017 J**	--	--
Total PCBs	0.07	--	**0.115**	**0.091**	--	--	--	--
SVOCs (µg/L)								
1-Methylnaphthalene	1.51	**4**	**5.2**	**5.3**	**3.6**	NA	NA	NA

SURFACE WATER

	Sample ID	SW-01						
	Sample Date	10/14/2008	12/14/2008	4/28/2009	7/23/2009	4/13/2010	7/12/2010	10/7/2010
	PCL							
Dissolved Metals (µg/L)								
Arsenic	0.2	**3.2**	**2.4**	**2.9 J-**	**5.1**	**2.4**	**3.8**	**4.1**
Manganese	50	--	--	**391 J-**	**150**	NA	NA	NA
Total Metals (µg/L)								
Aluminum	87	**170**	**650**	**440**	**13,200**	NA	NA	NA
Arsenic	0.2	**4.8**	**5.8**	**5**	**21.3 J**	**6.6**	**20.1**	**6.5**
Copper	2.4	--	**5**	--	**38**	NA	NA	NA
Iron	1,000	--	**1,610**	--	**16,500**	NA	NA	NA
Lead	2.50	--	--	--	**24**	--	**9**	--
Manganese	50	--	**660**	**414**	**313**	NA	NA	NA
Mercury	0.02	--	**0.0284**	--	**0.0649**	--	--	**0.0215**
Nickel	8.2	--	--	--	**72.2 J**	NA	NA	NA
Zinc	81	--	--	--	**150**	NA	NA	NA
SVOCs (µg/L)								
Chrysene	0.01	--	--	--	**0.014**	NA	NA	NA

TABLE 14

SUMMARY OF PCL EXCEEDANCES FOR SAMPLES OUTSIDE LANDFILL FOOTPRINT [1]

March Point (Whitmarsh) Landfill
Skagit County, Washington

SURFACE WATER (Continued)

	Sample ID	SW-03						
	Sample Date	10/15/2008	12/17/2008	4/29/2009	7/23/2009	4/13/2010	7/12/2010	10/5/2010
	PCL							
Dissolved Metals (µg/L)								
Arsenic	0.2	**1.1**	--	**1.8 J-**	**1.8**	**1.3**	**3.8**	**1.1**
Copper	2.4	--	**3**	--	--	NA	NA	NA
Manganese	50	**203**	**335**	**159 J-**	**180**	NA	NA	NA
Nickel	8.2	--	**9**	--	--	NA	NA	NA
Total Metals (µg/L)								
Aluminum	87	**290**	**100**	**3,080**	**140**	NA	NA	NA
Arsenic	0.2	**2.2**	--	**3**	**2.5 J**	**2**	**11**	**1.7**
Copper	2.4	--	**4**	**10**	**3**	NA	NA	NA
Iron	1,000	**1,790**	--	**7,920**	**1,360**	NA	NA	NA
Lead	2.50	--	--	**3**	--	--	**13**	--
Manganese	50	**230**	**353**	**276**	**195**	NA	NA	NA
Mercury	0.02	--	--	--	--	--	**0.071**	--
Nickel	8.2	--	**9**	**12.6**	--	NA	NA	NA

	Sample ID	SW-04						
	Sample Date	10/15/2008	12/18/2008	4/29/2009	7/23/2009	4/13/2010	7/14/2010	10/6/2010
	PCL							
Dissolved Metals (µg/L)								
Arsenic	0.2	**2**	--	**2 J-**	**3**	**1.4**	**4.6**	**1.6**
Copper	2.4	--	**5**	**3 J-**	**3**	NA	NA	NA
Manganese	50	**68**	**246**	**164 J-**	**55**	NA	NA	NA
Nickel	8.2	--	**11**	--	--	NA	NA	NA
Total Metals (µg/L)								
Aluminum	87	**1,570**	**4,240**	**440**	**1,090**	NA	NA	NA
Arsenic	0.2	**2.8**	**8**	**2**	**4 J**	**1.4**	**5.2**	**1.6**
Copper	2.4	**4**	**12**	**4**	**6**	NA	NA	NA
Iron	1,000	**3,490**	**7,580**	**1,020**	**2,440**	NA	NA	NA
Manganese	50.0	**125**	**382**	**176**	**107**	NA	NA	NA
Nickel	8.2	--	**17**	--	--	NA	NA	NA

TABLE 14

SUMMARY OF PCL EXCEEDANCES FOR SAMPLES OUTSIDE LANDFILL FOOTPRINT [1]
March Point (Whitmarsh) Landfill
Skagit County, Washington

SURFACE WATER (Continued)

	Sample ID	SW-05						
	Sample Date	10/15/2008	12/17/2008	4/29/2009	7/23/2009	4/13/2010	7/14/2010	10/6/2010
	PCL							
Dissolved Metals (µg/L)								
Arsenic	0.2	--	--	1.7 J-	3	0.6	2.5	1.3
Copper	2.4	--	3	--	4	NA	NA	NA
Manganese	50	345	227	795 J-	75	NA	NA	NA
Total Metals (µg/L)								
Aluminum	87	120	400	190	90	NA	NA	NA
Arsenic	0.2	1.5	0.8	1.6	4 J	1.2	3.2	1.9
Copper	2.4	--	4	3	4	NA	NA	NA
Iron	1,000	1,700	1,080	2,010	720	NA	NA	NA
Manganese	50	366	243	782	89	NA	NA	NA
Silver	1.9	3	--	--	--	NA	NA	NA
SVOCs (µg/L)								
Butylbenzylphthalate	8.32	23	--	--	--	NA	NA	NA

	Sample ID	SW-06						
	Sample Date	10/15/2008	12/17/2008	4/29/2009	7/23/2009	4/13/2010	7/14/2010	10/6/2010
	PCL							
Dissolved Metals (µg/L)								
Arsenic	0.2	3	--	4 J-	5	1	3	2
Copper	2.4	--	3	3 J-	6	NA	NA	NA
Manganese	50	80	132	289 J-	--	NA	NA	NA
Silver	1.9	8	--	--	--	NA	NA	NA
Total Metals (µg/L)								
Aluminum	87	--	2,250	370	--	NA	NA	NA
Arsenic	0.2	3	3	3	5 J	1.4	4	0.8
Copper	2.4	--	8	4	7	NA	NA	NA
Iron	1,000	--	4,620	1,370	--	NA	NA	NA
Manganese	50	90	239	300	--	NA	NA	NA
Nickel	8.2	--	11	--	10 J	NA	NA	NA
Silver	1.9	7	--	--	--	NA	NA	NA
Pesticides (µg/L)								
4,4'-DDD	0.00125	--	0.0019 J	--	--	--	--	--

TABLE 14

SUMMARY OF PCL EXCEEDANCES FOR SAMPLES OUTSIDE LANDFILL FOOTPRINT [1]
March Point (Whitmarsh) Landfill
Skagit County, Washington

SURFACE WATER (Continued)

	Sample ID	SW-07	
	Sample Date	12/17/2008	4/28/2009
	PCL		
Dissolved Metals (µg/L)			
Arsenic	0.2	**0.5**	**0.6 J-**
Manganese	50	**229**	**169 J-**
Total Metals (µg/L)			
Aluminum	87	**110**	**--**
Arsenic	0.2	**1.7**	**1.4**
Copper	2.4	**3**	**--**
Iron	1,000	**18,000**	**12,800**
Manganese	50	**262**	**197**
VOCs (µg/L)			
Benzene	1.2	**2.2**	**3.6**

Notes

1. Data qualifiers are as follows:
   J = Reported value is an estimate.
   J- = Value is estimated with a possible low bias.

Abbreviations

-- = Analyte does not exceed the PCL.
µg/L = micrograms per liter
bgs = below ground surface
ft = feet
NA = not analyzed
PCBs = polychlorinated biphenyls
PCL = preliminary cleanup levels
SVOC = semivolatile organic compound
VOC = volatile organic compound

TABLE 15

CONSTITUENTS OF CONCERN IN SOIL[1]
March Point (Whitmarsh) Landfill
Skagit County, Washington

Metals		PCBs/Pesticides	
Antimony	Lead	4,4'-DDD	Dieldrin
Arsenic	Mercury	4,4'-DDE	Aroclor 1254
Barium	Nickel	Aldrin	
Cadmium	Zinc		
Copper			
SVOCs		**VOCs**	**TPH**
2,4-Dimethylphenol	Chrysene	Benzene	Gasoline
2-Methylphenol	Dibenzofuran		Lube oil range hydrocarbons
Benzo(a)anthracene	Phenol		
Benzo(a)pyrene			
bis(2-Ethylhexyl) phthalate			

Note
1. Constituents were evaluated as constituents of concern based on criteria described in text.

Abbreviations
PCBs = polychorlinated biphenyls
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds

TABLE 16

CONSTITUENTS OF CONCERN IN GROUNDWATER AND SEEPS[1]

Marsh Point (Whitmarsh) Landfill

Skagit County, Washington

Inorganics	SVOCs	Pesticides/PCBs	VOCs
Arsenic	1-Methylnaphthalene	4,4'-DDD	Benzene
Copper	2,4-Dimethylphenol	4,4'-DDE	
Iron	Benzo(a)anthracene	alpha-BHC	
Lead	bis(2-Ethylhexyl)phthalate	Aroclor 1232	
Manganese	Chrysene	Aroclor 1242	
Mercury		Aroclor 1248	
Selenium		Total PCBs	
Silver			

Note

1. Constituents were evaluated as constituents of concern based on criteria described in text.

Abbreviations

PCBs = polychlorinated biphenyls
SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds

TABLE 17

CONSTITUENTS OF CONCERN IN SURFACE WATER[1]

Marsh Point (Whitmarsh) Landfill
Skagit County, Washington

Inorganics	SVOCs
Arsenic	Butylbenzylphthalate
Copper	Chrysense
Lead	bis(2-ethylhexyl)phthalate
Manganese	**VOCs**
Mercury	Benzene
Nickel	**Pesticides/PCBs**
Silver	4,4'-DDD
Zinc	

Note

1. Constituents were evaluated as constituents of concern based on criteria described in text.

Abbreviations

SVOCs = semivolatile organic compounds
TPH = total petroleum hydrocarbons
VOCs = volatile organic compounds

TABLE 18

SUMMARY OF FINAL CLEANUP LEVELS
March Point (Whitmarsh) Landfill
Skagit County, Washington

Analyte	Chemical Abstracts Service No.	Final Cleanup Level	Method Group	Units
FINAL SOIL CLEANUP LEVELS				
Antimony	7440-36-0	5.1	Metals	mg/kg
Arsenic	7440-38-2	7.0		
Barium	7440-39-3	102		
Cadmium	7440-43-9	1.0		
Copper	7440-50-8	36		
Lead	7439-92-1	108		
Mercury	7439-97-6	0.07		
Nickel	7440-02-0	48		
Zinc	7440-66-6	101		
TPH - Heavy oil range	NA	2000	TPH	mg/kg
TPH - Gasoline range	NA	30/100		
2,4-Dimethylphenol	105-67-9	3.1	SVOCs	mg/kg
2-Methylphenol	95-48-7	2.3		
Benzo(a)anthracene	56-55-3	0.10		
Benzo(a)pyrene	50-32-8	0.12		
Bis(2-ethylhexyl) phthalate	117-81-7	2.6		
Chrysene	218-01-9	0.08		
Dibenzofuran	132-64-9	0.09		
Phenol	108-95-2	46		
Benzene	71-43-2	0.0068	VOCs	mg/kg
Aldrin	309-00-2	0.0017	Pesticides	mg/kg
4,4'-DDD	72-54-8	0.0033		
4,4'-DDE	72-55-9	0.0033		
Dieldrin	60-57-1	0.0033		
Methoxylchlor	72-43-5	1.0		
FINAL GROUNDWATER/SEEP CLEANUP LEVELS				
Arsenic	7440-38-2	0.2	Metals	µg/L
Copper	7440-50-8	2.4		
Iron	7439-89-6	1000		
Lead	7439-92-1	0.54		
Manganese	7439-96-5	20		
Mercury	7439-97-6	0.02		
Silver	7440-22-4	1.9		
1-Methylnaphthalene	90-12-0	1.51	SVOCs	µg/L
2,4-Dimethylphenol	105-67-9	50.0		
4-Methylphenol	106-44-5	20		
Benzo(a)anthracene	56-55-3	0.01		
Chrysene	218-01-9	0.01		
Benzene	71-43-2	1.2	VOCs	µg/L
Aroclor 1232	11141-16-5	0.014	PCBs	µg/L
Aroclor 1242	53469-21-9	0.014		
Aroclor 1248	12672-29-6	0.014		
Total polychlorinated biphenyls	1336-36-3	0.07		
4,4'-DDD	72-54-8	0.00125	Pesticides	µg/L
4,4'-DDE	72-55-9	0.00125		
a-Hexachlorocyclohexane	319-84-6	0.0006		
FINAL SURFACE WATER CLEANUP LEVELS				
Arsenic	7440-38-2	0.2	Metals	µg/L
Copper	7440-50-8	2.4		
Lead	7439-92-1	2.5		
Manganese	7439-96-5	50.0		
Mercury	7439-97-6	0.02		
Nickel	7440-02-0	8.2		
Silver	7440-22-4	1.9		
Zinc	7440-66-6	81		
Butyl benzyl phthalate	85-68-7	8.2	SVOCs	µg/L
bis(2-ethylhexyl)phthalate	117-81-7	1.2		
Chrysene	218-01-9	0.01		
Benzene	71-43-2	1.2	VOCs	µg/L
4,4'-DDD	72-54-8	0.00125	Pesticides	µg/L

Abbreviations
µg/L = microgram per liter
mg/kg = milligram per kilogram
PCBs = polychlorinated biphenyls

TABLE 19

IDENTIFICATION OF REMEDIAL TECHNOLOGIES
March Point (Whitmarsh) Landfill
Skagit County, Washington

Remedial Action	Objective	Technology	Technology Options
Institutional Controls	Present administrative protective measures	Perimeter security fencing	Galvanized fencing Polycoated fencing
		Public notification	File a deed restriction for future subsurface access Post signs
Containment	Contain the landfill securely to minimize contact with the refuse and groundwater	Vertical barrier	Earthen material Geosynthetic clay liner Polyvinyl chloride geomembrane High density polyethylene geomembrane
		Lateral barrier	Slurry wall Sand with natural siltation Earthen barrier Geosynthetic clay liner Geosynthetic barrier
Disposal	Remove the refuse to minimize or eliminate contact	Excavation and disposal	Excavate the refuse and dispose off site
	Dispose excess perched groundwater in the landfill to minimize release	Dewatering	Dewatering wells Dewatering trenches
		Treatment	On-site treatment and discharge Off-site treatment and discharge On-site treatment and off-site discharge

TABLE 20

POTENTIAL REMEDIAL ACTIONS[1]
March Point (Whitmarsh) Landfill
Anacortes, Washington

Potential Remedial Actions					Alternatives						
Environmental Media	**Response Actions**	**Remedial Technologies**	**Options**	**Descriptions**	**1 - No Action**	**2 - Restoration of Existing Cover**	**3 - GCLL Cap**	**4 - HDPE Cap**	**5 - HDPE Cap Anchored into Bay Mud**	**6 - PVC Cap**	**7 - Landfill Removal**
Soils/Landfill Contents	No Response			No Action	X						
	Engineering Controls and Supplementing Institutional Controls	Deed Restrictions		All property deeds within the site would include restrictions on property use	X	X	X	X	X	X	
		Fencing		Security fencing installed around the perimeter of the landfill to restrict access	X	X	X	X	X	X	
	Containment (Landfill Cover)	Surface Controls	Grading and Stormwater Control	Reshaping the topography to manage infiltration and runoff to control erosion		X	X	X	X	X	
			Revegetation	Seeding, fertilizing and watering until vegetation has been established		X	X	X	X	X	
		Cap	Native Soil	Uncontaminated soil placed over landfill		X[2]	X	X	X	X	
			Single Barrier	Flexible membrane liner, usually protected with additional fill and topsoil			X	X	X	X	
	Long Term Operations/Maintenance	Varied		Includes biannual mowing and inspection of landfill for settlement		X	X	X	X	X	
Hot Spot	Soil/Hot Spot Removal	Removal	Excavation/off-site disposal	Transport and disposal at suitable landfill			X[3]	X[3]	X[3]	X[3]	X
			Excavation/ Consolidation	Consolidation of material under landfill cap			X[4]	X[4]	X[4]	X[4]	
	Drums, Batteries, etc	Removal	Excavation and segregation	As the solid waste is being excavated to restore grades, any drums, batteries, and affected soil encountered will be segregated and tested and disposed of off site appropriately			X	X	X	X	
	Air/Dust	Containment	Dust Controls	Moisture control during construction		X	X	X	X	X	X
				Restoration of vegetation		X	X	X	X	X	
Groundwater and Leachate	No Action				X						
	Containment (Landfill Cover)	Vertical Barriers	Flexible Membrane Liner	Installation of cover over the landfill			X	X	X		
		Lateral Barriers	Existing Bay Mud	Installation of liner keyed into Bay Mud to minimize lateral movement of groundwater/leachate			X	X	X	X	
	Collection	Extraction (Temporary)	Wells	Removal of groundwater leachate during construction			X	X	X	X	X
		Extraction	Wells	Removal of groundwater/ leachate after construction			X[5]	X[5]	X[5]	X[5]	

TABLE 20

POTENTIAL REMEDIAL ACTIONS[1]
March Point (Whitmarsh) Landfill
Anacortes, Washington

Potential Remedial Actions					Alternatives						
Environmental Media	**Response Actions**	**Remedial Technologies**	**Options**	**Descriptions**	**1 - No Action**	**2 - Restoration of Existing Cover**	**3 - GCLL Cap**	**4 - HDPE Cap**	**5 - HDPE Cap Anchored into Bay Mud**	**6 - PVC Cap**	**7 - Landfill Removal**
Groundwater and Leachate (con't)	Treatment	Off-site Treatment	POTW	Disposal of groundwater/ leachate using sewer or truck			X[5]	X[5]	X[5]	X[5]	
	Monitoring		New Wells	Inside the refuse for water levels only; lower aquifer wells for water levels and water quality		X	X	X	X	X	
Seeps	Monitoring		Water Samples	From any seeps, especially northeast margin			X	X	X	X	
Landfill Gas	Collection	Passive Vents	Pipe Vents	Pipe vents installed in gas collection area below membrane cap			X	X	X	X	

Notes:
1. This table adapted from Table 2-3 of U.S. EPA Office of Solid Waste and Emergency Response Directive 9355.3-11, Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites, February 1991
2. Alternative 2 would bring additional clean cover soil on-site as needed to restore the 2 percent minimum grade required for drainage.
3 While there are no known quantities of waste on-site that would require off-site disposal, Alternatives 3 through 6 have assumed that off-site disposal may be necessary in the case that such wastes are uncovered. during grading for drainage and slope restoration.
4. Due to the need to establish the correct slopes for stormwater drainage, Alternatives 3 through 6 would require solid wastes to be pulled back from the edges of the landfill and buried under the membrane cover material.
5. Due to ongoing infiltration through the current soil cover, groundwater/leachate levels within the solid waste are 5 to 12 feet higher than mean water levels in the inner lagoon or the Swinomish Channel. It is expected that groundwater levels with the solid wastes will equibrate with the underlying Lower Aquifer and the inner lagoon, thereby eliminating the need for any further pumping.

Abbreviations:
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
EPA = Environmental Protection Agency
GCLL = geosynthetic clay laminated liner
HDPE = high desity polyethylene
POTW = publicly-owned treatment works
PVC = polyvinyl chloride

TABLE 21

COMPARISON OF REMEDIAL ALTERNATIVES
March Point (Whitmarsh) Landfill
Skagit County, Washington

Standards/Criteria		1 - No Action	2 - Renovate Existing Cap	3 - GCLL Cap	4 - HDPE Cap	5 - HDPE Anchored into Bay Mud	6 - PVC Cap	7 - Landfill Removal
Protectiveness	Pros	Informs the public	Generally protective of the public and the environment.	Protective of the public and the environment	Protective of the public and the environment	Protective of the public and the environment; virtually no hydraulic connectivity with the Bay Mud	Protective of the public and the environment	Removes all environmental concerns from the site
	Cons	Not protective of the environment	Allows some hydraulic connectivity with Padilla Bay and allows more infiltration than the engineered caps in Alternatives 3 through 6.	May allow some hydraulic connectivity with Padilla Bay.	May allow some hydraulic connectivity with Padilla Bay.	Leaves refuse in place.	Allows some hydraulic connectivity with Padilla Bay due to potential weathering due to wet/dry cycling along shoreline.	Transfers refuse to waste disposal facility.
	Rating	**Low (3)**	**Low-Moderate (4)**	**High (8)**	**High (8)**	**High (8)**	**Moderate to High (7)**	**Very High (9)**
Permanence	Pros	Institutional controls would remain in place permanently.	The renovated cover would drain better than the current cover.	GCLL is a natural and durable product as cap. It's flexibility would allow it to conform to small surface irregularities.	HDPE is a durable product as cap.	HDPE is a durable product as cap.	Long-lasting material.	All possibility of contamination is removed.
	Cons	Existing exposure pathways would remain.	Renovated cover would use sandy materials that would be more susceptible to erosion than the engineered caps.	Would require some maintenance.	Would require some maintenance.	Would require some maintenance.	PVC not as durable as HDPE.	There may be some liability associated with disposal elsewhere.
	Rating	**Low to Moderate (4)**	**Moderate (5)**	**High (8)**	**High (8)**	**High (8)**	**Medium High (7)**	**Very High (9)**
Long-Term Effectiveness	Pros	Informs the public.	Addresses most of the RAOs.	Addresses the RAOs.	Addresses the RAOs.	Addresses the RAOs.	Addresses the RAOs.	Most effective by eliminating the source.
	Cons	Not protective of the environment.	Some hydraulic connection with Padilla Bay will remain.	Would require some maintenance.	Would require some maintenance.	Would require some maintenance.	Maintains some hydraulic connectivity with Padilla Bay and will require some maintenance.	May cause concerns off site.
	Rating	**Low (3)**	**Low to Moderate (4)**	**High (8)**	**High (8)**	**High (8)**	**Medium High (7)**	**Highest (10)**
Short-Term Risk	Pros	No risks associated with implementation.	Low risk since refuse is only minimally disturbed during regrading.	Low risk to relocate some waste on site.	Low risk to relocate some waste on site.	Low risk to relocate some waste on site.	Low risk to relocate some waste on site.	Removes risk after completion.
	Cons	Does not address environmental risks.	Some releases to Padilla Bay may occur during construction, but less than other alternatives.	Some releases to Padilla Bay may occur during construction, but less than other alternatives.	Some releases to Padilla Bay may occur during construction.	Some releases to Padilla Bay may occur during construction.	Some releases to Padilla Bay may occur during construction.	Highest risk of releases to the environment and off site during implementation - construction.
	Rating	**High (8)**	**High (8)**	**Medium High (7)**	**Moderate to High (6)**	**Moderate to High (6)**	**Moderate to High (6)**	**Low (3)**
Technical and Administrative Implementability	Pros	No challenges in implementation.	This type of construction has routinely been performed for waterfront remediation.	This type of construction has routinely been performed for waterfront remediation. Can be installed during tidal cycle.	This type of construction has routinely been performed for waterfront remediation.	This type of construction has routinely been performed for waterfront remediation.	This type of construction has routinely been performed for waterfront remediation.	This type of construction has been performed for waterfront remediation.
	Cons	Not protective of the environment.	Few challenges presented since existing shoreline remains intact.	Excavation and backfill within tidal zone present some challenges.	Excavation and backfill within tidal zone present some challenges. In addition a berm must be constructed to install cover during tidal cycle.	Excavation and backfill within tidal zone present some challenges. In addition a berm must be constructed to install cover during tidal cycle.	Excavation and backfill within tidal zone present some challenges. In addition a berm must be constructed to install cover during tidal cycle.	Excavation and backfill within tidal zone present some challenges, particularly due to a decrease in available space on site as construction proceeds.
	Rating	**High (8)**	**High (8)**	**Very High (9)**	**High (8)**	**High (8)**	**High (8)**	**Moderate to High (6)**
Public Concerns	Pros	Informs the public.	Addresses most public concerns.	Addresses public concerns.	Addresses public concerns.	Addresses public concerns.	Addresses public concerns.	Addresses public concerns.
	Cons	Does not address the public's environmental concerns.	Concerns with respect to hydraulic connection with Padilla Bay may remain.	Refuse left in-place may cause some concerns.	Refuse left in-place may cause some concerns.	Refuse left in-place may cause some concerns.	Some concerns with respect to hydraulic connection with Padilla Bay may remain.	May initiate new public concerns over off-site transport.
	Rating	**Low (3)**	**Moderate (5)**	**High (8)**	**High (8)**	**High (8)**	**Moderate to High (6)**	**High (8)**
Cost	Pros	Cost very low.	Restores original surface cover and improves surface water drainage and lessens infiltration at lower cost than majority of alternatives.	Closes the landfill and achieves RAOs in accordance with minimum functional standards (WAC 173-304).	Closes the landfill and achieves RAOs in accordance with minimum functional standards (WAC 173-304).	Closes the landfill and achieves RAOs in accordance with minimum functional standards (WAC 173-304).	Closes the landfill and achieves RAOs in accordance with minimum functional standards (WAC 173-304).	All waste is removed.
	Cons	Does not meet the RAOs.	Infiltration of surface water would be slightly higher than Alternatives 4 to 6, with lower permeability capping materials.	May increase long-term maintenance cost.	May increase long-term maintenance cost.	May increase long-term maintenance cost.	May increase long-term monitoring cost due to remaining hydraulic connectivity with Padilla Bay.	Unrealistically high cost without any appreciable/significant benefit.
	Notes	**Low**	**Low to Moderate**	**Moderate**	**High**	**High**	**High**	**Highest**

Abbreviations
GCLL = geosynthetic clay laminated liner
HDPE = high density polyethylene
PVC = polyvinyl chloride
RAO = remedial action objective
WAC = Washington Administrative Code

Rating	Numerical Scale
Low	3
Low to moderate	4
Moderate	5
Moderate to high	6
Medium high	7
High	8
Very high	9
Highest	10

TABLE 22

COST BENEFIT RATIOS AND DISPROPORTIONATE COST ANALYSIS

March Point (Whitmarsh) Landfill
Anacortes, Washington

	Components	1- No Action	2- Restoration of Existing Soil Cover	3- GCLL Cap	4- HDPE Cap	5- HDPE Cap Anchored into Bay Mud	6 - PVC Cap	7 - Landfill Removal
		Alternatives						
	Brief Description of Alternative	A base line against other alternatives, institutional/engineering controls only implemented	Regrading of the existing landfill soil cover, seeded topsoil for vertical/lateral containment	GCLL veneer for lateral/vertical cap. Bentonite GCLL above 16 feet in elevation, bentonite/polymer GCLL below that elevation along shoreline	HDPE veneer for lateral/vertical containment, bentonite/polymer GCLL along shoreline below 16 feet in elevation	HDPE veneer for lateral/vertical containment and anchoring	PVC veneer for lateral/vertical containment, bentonitte/polymer GCLL along shoreline below 16 feet in elevation	Complete removal and off-site disposal of 400,000 cubic yards of solid waste
Cost	*Capital + Periodic (for 30 years); $ Unit is $1,000*	$231	$6,397	$12,040	$15,272	$15,292	$15,225	$82,837

A. Evaluation of Components/ARARs

		1- No Action	2- Restoration of Existing Soil Cover	3- GCLL Cap	4- HDPE Cap	5- HDPE Cap Anchored into Bay Mud	6 - PVC Cap	7 - Landfill Removal
Components (WAC 173-340, 304, 351)	Institutional/engineering controls	YES	YES	YES	YES	YES	YES	YES
	Landfill cover materials	NA	Existing soil cover	GCLL	HDPE	HDPE	PVC	NA
	Lateral containment apron along shoreline	NA	NA	Enhanced GCLL	Enhanced GCLL	HDPE	Enhanced GCLL	NA
	Amount of solid waste excavation to make the embankment and smooth joining the capping materials (CY)	NA	NA	35,000	55,000	55,000	55,000	340,000
	Off-site disposal of excavated solid waste (CY)	NA	NA	NA	NA	NA	NA	340,000
	Stormwater control measures	NO	YES	YES	YES	YES	YES	YES
	Wastewater generated during the construction for the treatment (MG)	NA	NA	1.3	3.3	3.3	3.3	14.5
	Installation of landfill gas collection/treatment system	NO	NO	YES	YES	YES	YES	NA
	Groundwater collection/treatment as needed to prevent off-site migration	NA	NO	YES	YES	YES	YES	NA
	Long-term monitoring/operation of landfill closure facility	NA	YES	YES	YES	YES	YES	NA
	Long-term groundwater monitoring and groundwater elevation for hydraulic control	NO	YES	YES	YES	YES	YES	NA
	Long-term monitoring of seepage & landfill gas	NO	YES	YES	YES	YES	YES	NA
	Habitat restoration at the shoreline	NA	YES	YES	YES	YES	YES	YES
ARARs	Meet WAC 173-304 for all elements for "municipal landfill closure"	NO	NO	YES	YES	YES	YES	YES
	Estimated restoration time frame (WAC 173-340-360[2][b][i]) estimated	unknown	unknown	5 to 10 years	5 to 10 years	5 to 10 years	5 to 10 years	5 years
	Meets MTCA (173-340) criteria for "human health and environmental risk"	NO	NO	YES	YES	YES	YES	YES
	Meets MTCA (173-340) criteria for "long-term monitoring of off-site contaminant migration per WAC 1730340-360(2)(a)(iv)"	NO	NO	YES	YES	YES	YES	NA

B. Disproportionate Cost Analysis

	Criteria	Weight (%)[1]	1 Raw Score[3]	1 Weighted Score	2 Raw Score[3]	2 Weighted Score	3 Raw Score[3]	3 Weighted Score	4 Raw Score[3]	4 Weighted Score	5 Raw Score[3]	5 Weighted Score	6 Raw Score[3]	6 Weighted Score	7 Raw Score[3]	7 Weighted Score
DCA and Relative Benefits Ranking Calculation (WAC 173-340-360[3][f])	Protectiveness	30%	3	0.9	4	1.2	8	2.4	8	2.4	8	2.4	7	2.1	9	2.7
	Permanence	20%	4	0.8	5	1	8	1.6	8	1.6	8	1.6	7	1.4	9	1.8
	Long-term effectiveness	20%	3	0.6	4	0.8	8	1.6	8	1.6	8	1.6	7	1.4	10	2.0
	Short-term risks	10%	8	0.8	8	0.8	7	0.7	6	0.6	6	0.6	6	0.6	3	0.3
	Technical and administrative implementability	10%	8	0.8	8	0.8	9	0.9	8	0.8	8	0.8	8	0.8	6	0.6
	Public concerns[2]	10%	3	0.3	5	0.5	8	0.8	8	0.8	8	0.8	6	0.6	8	0.8
	Composite Totals	100%	4.2		5.1		8		7.8		7.8		6.9		8.2	
	Overall Alternative Benefit Ranking		7		6		3		4		2		5		1	
	Ratio of Cost/Benefit		55		1,254		1,505		1,958		1,961		2,207		10,102	

C. Decision Criteria

	1- No Action	2- Restoration of Existing Soil Cover	3- GCLL Cap	4- HDPE Cap	5- HDPE Cap Anchored into Bay Mud	6 - PVC Cap	7 - Landfill Removal
Does this alternative "meet both MTCA and ARARs?"	NO	NO	YES	YES	YES	YES	YES
Is the alternative "permanent to maximum extent practicable?"	NA[4]	NA[4]	YES	YES	YES	NO	YES

Notes:
1. Refer to Section 13.3 for the rationale for assigning these weight fraction to each criteria.
2. The consideration of public concerns criterion will be re-evaluated after the public comment period as necessary.
3. Raw score for each alternative is based on the qualitative rating provided by the PLPs and consultants' similar type of projects experiences and references. Refer to Table 21 and Section 13 for details.
4. Alternatives 1 and 2 do not fully comply with MTCA threshold criteria and ARARs including WAC 173-304.

Rating	Numerical Scale
Low	3
Low to moderate	4
Moderate	5
Moderate to high	6
Medium high	7
High	8
Very high	9
Highest	10

Abbreviations:
ARAR = applicable or relevant and appropriate requirement
CY = cubic yard
DCA = disproportionate cost analysis
GCLL = geosynthetic clay laminated liner
HDPE = high density polyethylene
MG = million gallons
MTCA = Model Toxics Control Act
NA = not applicable
PVC = polyvinyl chloride
WAC = Washington Administrative Code

TABLE 23

COST ESTIMATE FOR ALTERNATIVE 1
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 1 No Action Quantity	Alternative 1 No Action Cost	Backup Information
CONTRACTOR					
Mob/Demob	$6,000	LS	1	$6,000	Used @ about 5% of the total contractor cost
Railroad Requirements	$20,000	LS	1	$20,000	Estimated
Grading	$6	CY	10,000	$60,000	Estimated
Security Fencing	$21	LF	2,600	$54,600	From vendor
Gates	$5,500	LS	1	$5,500	From vendor
Subtotal				**$146,100**	
Prevailing Wage Allowance	8.0	%		$11,688	
SUBTOTAL				**$157,788**	
Sales Tax	8.50	%		$13,412	
CONTRACTOR COST				**$171,200**	
CONSULTANT					
Well Abandonment	$1,000	Ea	10	$10,000	
Surveying	$2,200	Day	2	$4,400	
Consultant Coordination and Inspection	$10,000	LS	1	$10,000	
Reporting	$5,500	LS	1	$5,500	
CONSULTANT COST				**$29,900**	
CAPITAL COST SUBTOTAL				**$201,000**	
Contingency	15	%		$30,150	
TOTAL CAPITAL COST				**$231,000**	

Abbreviations
CY = cubic yard
Ea = each
LF = linear foot
LS = lump sum

TABLE 24

COST ESTIMATE FOR ALTERNATIVE 2

March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 2 Restoration of Soil Cover Quantity	Alternative 2 Restoration of Soil Cover Cost	Backup Information
CONTRACTOR					
Mob/Demob	$180,000	LS	1	$180,000	Estimated @ about 6% of the contractor cost
Site Setup	$200,000	LS	1	$200,000	
Railroad Requirements	$100,000	LS	1	$100,000	Insurance, flagger
Site Clearing (Trees)	$6,000	Acre	7	$42,000	Past experience
Stormwater Treatment System	$55,000	LS	1	$55,000	Estimated
Stormwater Management	$40,000	MO	2	$80,000	Estimated
Ditch Construction	$20	LF	2,600	$52,000	Past experience
Gas Venting System	$16	LF	5,000	$80,000	Pricing from past project
Topsoil Import and Placement	$48	CY	12,000	$576,000	Past experience
General Backfill Import and Placement	$26	CY	36,000	$936,000	Vendor pricing on material
Hydroseeding	$3,000	Acre	15	$45,000	Pricing based on recent experience
Plants	$50,000	Acre	0.5	$25,000	Pricing based on recent experience
Perimeter road	$75	LF	3,800	$285,000	Estimated-Vendor pricing on material
Security Fence	$22	LF	4,100	$90,200	Vendor pricing
Gates	$5,500	LS	2	$11,000	Vendor pricing
Subtotal				**$2,757,200**	
Prevailing Wage Allowance	8.0	%		$220,576	
SUBTOTAL				**$2,977,776**	
Sales Tax	8.50	%		$253,111	
CONTRACTOR COST				**$3,230,887**	

TABLE 24

COST ESTIMATE FOR ALTERNATIVE 2
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 2 Restoration of Soil Cover		Backup Information
			Quantity	Cost	
CONSULTANT					
Field Investigation	$100,000	LS	1	$100,000	Estimated
Well Abandonment	$1,000	LS	10	$10,000	Past experience
Surveying	$2,200	Day	10	$22,000	Past experience
Design	$150,000	LS	1	$150,000	Estimated
Permitting	$130,000	LS	1	$130,000	Recent experience
Well Installation	$4,200	Sets	4	$16,800	Past experience
Project Management	$2,200	MO	30	$66,000	Estimated
Sampling and Analysis	$52,000	LS	1	$52,000	
Construction Management	$20,000	WK	10	$200,000	2 full time staff; part-time senior oversight
Construction Report	$75,000	LS	1	$75,000	Estimated
CONSULTANT COST				**$821,800**	
CAPITAL COST SUBTOTAL				**$4,053,000**	
CONTINGENCY	25	%		$1,013,250	
TOTAL CAPITAL COST				**$5,066,000**	

TABLE 24

COST ESTIMATE FOR ALTERNATIVE 2

March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 2 Restoration of Soil Cover Quantity	Alternative 2 Restoration of Soil Cover Cost	Backup Information
OPERATION AND MAINTENANCE					
Years 1 through 5					
Inspections - Year 1	$16,000	Annual	1	$16,000	
Inspections - Years 2 through 5	$12,000	Annual	4	$48,000	
Groundwater Monitoring	$30,000	Annual	5	$150,000	
Cap Repair	$30,000	Annual	3	$90,000	
Mowing	$6,000	Annual	5	$30,000	
Project Management	$24,000	Annual	5	$120,000	
Years 6 through 30					
Inspections	$3,000	Annual	5	$15,000	
Groundwater Monitoring	$11,000	Annual	5	$55,000	
Cap Repair	$100,000	LS	2	$200,000	
Mowing	$6,000	Annual	25	$150,000	
Project Management	$6,000	Annual	25	$150,000	
O&M COST SUBTOTAL				**$1,024,000**	
Contingency	30	%		$307,200	
Groundwater Removal	$300,000	Round	0	$0	
TOTAL O&M COST				**$1,331,000**	
TOTAL PROJECT COST				**$6,397,000**	

Abbreviations

CY = cubic yard
GCL = geosynthetic clay liner
HDPE = high density polyethylene
LF = linear foot
LS = lump sum
MO = month
O&M = operation and maintenance
SF = square foot
WK = week

TABLE 25

COST ESTIMATE FOR ALTERNATIVE 3
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 3 GCL/GCLL Cap Quantity	Alternative 3 GCL/GCLL Cap Cost	Backup Information
CONTRACTOR					
Mob/Demob	$300,000	LS	1	$300,000	Estimated @ about 6% of the contractor cost
Site Setup	$200,000	LS	1	$200,000	
Railroad Requirements	$100,000	LS	1	$100,000	Insurance, flagger
Site Clearing (Trees)	$6,000	Acre	7	$42,000	Past experience
Refuse Excavation and Grading	$18	CY	35,000	$630,000	Unit price from recent experience
Groundwater Removal and Treatment System	$100,000	LS	1	$100,000	Estimated
Groundwater Management	$100,000	MO	2	$200,000	Estimated
Ditch Construction	$20	LF	2,600	$52,000	Past experience
Berm Construction	$35	CY	0	$0	Vendor pricing on material
GCL	$0.65	SF	900,000	$585,000	Vendor pricing
Enhanced GCLL	$1.20	SF	100,000	$120,000	Vendor pricing
Gas Venting System	$16	LF	5,000	$80,000	Pricing from past project
Placement and Grading Cover Soil	$20	Tons	40,000	$800,000	Vendor pricing on material
Placement and Grading Crushed Rock	$25	Tons	44,000	$1,100,000	
Topsoil Import and Placement	$48	CY	12,000	$576,000	Past experience
Sand and Gravel Import and Placement	$15	Ton	5,000	$75,000	Vendor pricing on material
Hydroseeding	$3,000	Acre	15	$45,000	Pricing based on recent experience
Plants	$50,000	Acre	0.5	$25,000	Pricing based on recent experience
Perimeter road	$75	LF	3,800	$285,000	Estimated-Vendor pricing on material
Security Fence	$22	LF	4,100	$90,200	Vendor pricing
Gates	$5,500	LS	2	$11,000	Vendor pricing
Subtotal				**$5,416,200**	
Prevailing Wage Allowance	8.0	%		$433,296	
SUBTOTAL				**$5,849,496**	
Sales Tax	8.50	%		$497,207	
CONTRACTOR COST				**$6,346,703**	

TABLE 25

COST ESTIMATE FOR ALTERNATIVE 3
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 3 GCL/GCLL Cap Quantity	Alternative 3 GCL/GCLL Cap Cost	Backup Information
CONSULTANT					
Field Investigation	$100,000	LS	1	$100,000	Estimated
Well Abandonment	$1,000	LS	10	$10,000	Past experience
Surveying	$2,200	Day	10	$22,000	Past experience
Design	$150,000	LS	1	$150,000	Estimated
Permitting	$130,000	LS	1	$130,000	Recent experience
Well Installation	$4,200	Sets	4	$16,800	Past experience
Project Management	$2,200	MO	30	$66,000	Estimated
Sampling and Analysis	$50,000	LS	1	$50,000	
Construction Management	$20,000	WK	20	$400,000	2 full time staff; part-time senior oversight
Construction Report	$75,000	LS	1	$75,000	Estimated
CONSULTANT COST				**$1,019,800**	
CAPITAL COST SUBTOTAL				**$7,367,000**	
CONTINGENCY	25	%		$1,841,750	
TOTAL CAPITAL COST				**$9,209,000**	

TABLE 25

COST ESTIMATE FOR ALTERNATIVE 3

March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 3 GCL/GCLL Cap Quantity	Alternative 3 GCL/GCLL Cap Cost	Backup Information
OPERATION AND MAINTENANCE					
Years 1 through 5					
Inspections - Year 1	$16,000	Annual	1	$16,000	
Inspections - Years 2 through 5	$12,000	Annual	4	$48,000	
Groundwater Monitoring	$30,000	Annual	5	$150,000	
Cap Repair	$30,000	Annual	3	$90,000	
Mowing	$6,000	Annual	5	$30,000	
Project Management	$24,000	Annual	5	$120,000	
Years 6 through 30					
Inspections	$3,000	Annual	5	$15,000	
Groundwater Monitoring	$11,000	Annual	5	$55,000	
Cap Repair	$100,000	LS	2	$200,000	
Mowing	$6,000	Annual	25	$150,000	
Project Management	$6,000	Annual	25	$150,000	
O&M COST SUBTOTAL				**$1,024,000**	
Contingency	30	%		$307,200	
Groundwater Removal	$300,000	Round	5	$1,500,000	
TOTAL O&M COST				**$2,831,000**	
TOTAL PROJECT COST				**$12,040,000**	

Abbreviations

CY = cubic yard
GCL = geosynthetic clay liner
HDPE = high density polyethylene
LF = linear foot
LS = lump sum
MO = month
O&M = operation and maintenance
SF = square foot
WK = week

TABLE 26

COST ESTIMATE FOR ALTERNATIVE 4

March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 4 HDPE Cap Quantity	Alternative 4 HDPE Cap Cost	Backup Information
CONTRACTOR					
Mob/Demob	$450,000	LS	1	$450,000	Estimated @ about 5% of the contractor cost
Site Setup	$200,000	LS	1	$200,000	
Railroad Requirements	$300,000	LS	1	$300,000	Insurance, flagger, shoring
Site Clearing (Trees)	$6,000	Acre	7	$42,000	Past experience
Refuse Excavation and Grading	$18	CY	55,000	$990,000	Unit price from recent experience
Groundwater Extraction Trench	$50	LF	400	$20,000	Pricing estimated
Groundwater Removal and Treatment System	$100,000	LS	1	$100,000	Estimated
Groundwater Management	$100,000	MO	5	$500,000	Estimated
Ditch Construction	$20	LF	2,600	$52,000	Past experience
Berm Construction	$35	CY	6,500	$227,500	Vendor pricing on material
Enhanced GCLL	$1.20	SF	22,000	$26,400	Vendor pricing
Gas Venting System	$16	LF	5,000	$80,000	Pricing from past project
HDPE-60 Mil	$0.70	SF	1,000,000	$700,000	Vendor pricing. Includes 10% waste and overlap
Geosynthetics (fabric/composite)	$1.00	SF	1,000,000	$1,000,000	Vendor pricing. Includes 10% waste and overlap
Geomembrane Anchor Trench	$10	LF	4,000	$40,000	Estimated
Placement and Grading Cover Soil	$20	Tons	62,000	$1,240,000	Vendor pricing on material
Topsoil Import and Placement	$48	CY	12,000	$576,000	Past experience
Sand and Gravel Import and Placement	$15	Ton	30,000	$450,000	Vendor pricing on material
General Backfill Import and Placement	$25	CY	5,000	$125,000	Vendor pricing on material
Hydroseeding	$3,000	Acre	15	$45,000	Pricing based on recent experience
Perimeter road	$75	LF	3,800	$285,000	Estimated-Vendor pricing on material
Security Fence	$22	LF	4,100	$90,200	Vendor pricing
Gates	$5,500	LS	2	$11,000	Vendor pricing
Subtotal				**$7,550,100**	
Prevailing Wage Allowance	8.0	%		$604,008	
SUBTOTAL				**$8,154,108**	
Sales Tax	8.50	%		$693,099	
CONTRACTOR COST				**$8,847,207**	

TABLE 26

COST ESTIMATE FOR ALTERNATIVE 4

March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 4 HDPE Cap Quantity	Alternative 4 HDPE Cap Cost	Backup Information
CONSULTANT					
Field Investigation	$100,000	LS	2	$200,000	Estimated
Well Abandonment	$1,000	LS	10	$10,000	Past experience
Surveying	$2,200	Day	10	$22,000	Past experience
Design	$150,000	LS	1	$150,000	Estimated
Permitting	$130,000	LS	1	$130,000	Recent experience
Well Installation	$4,200	Sets	4	$16,800	Past experience
Project Management	$2,200	MO	30	$66,000	Estimated
Sampling and Analysis	$50,000	LS	2	$100,000	
Construction Management	$20,000	WK	22	$440,000	2 full time staff; part-time senior oversight
Construction Report	$75,000	LS	1	$75,000	Estimated
CONSULTANT COST				**$1,209,800**	
CAPITAL COST SUBTOTAL				**$10,057,000**	
CONTINGENCY	25	%		$2,514,250	
TOTAL CAPITAL COST				**$12,571,000**	

TABLE 26

COST ESTIMATE FOR ALTERNATIVE 4
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 4 HDPE Cap Quantity	Alternative 4 HDPE Cap Cost	Backup Information
OPERATION AND MAINTENANCE					
Years 1 through 5					
Inspections - Year 1	$16,000	Annual	1	$16,000	
Inspections - Years 2 through 5	$12,000	Annual	4	$48,000	
Groundwater Monitoring	$30,000	Annual	5	$150,000	
Cap Repair	$30,000	Annual	3	$90,000	
Mowing	$6,000	Annual	5	$30,000	
Project Management	$24,000	Annual	5	$120,000	
Years 6 through 30					
Inspections	$3,000	Annual	5	$15,000	
Groundwater Monitoring	$11,000	Annual	5	$55,000	
Cap Repair	$50,000	LS	2	$100,000	
Mowing	$6,000	Annual	25	$150,000	
Project Management	$6,000	Annual	25	$150,000	
O&M COST SUBTOTAL				**$924,000**	
Contingency	30	%		$277,200	
Groundwater Removal	$300,000	Round	5	$1,500,000	
TOTAL O&M COST				**$2,701,000**	
TOTAL PROJECT COST				**$15,272,000**	

Abbreviations

CY = cubic yard
GCL = geosynthetic clay liner
HDPE = high density polyethylene
LF = linear foot
LS = lump sum
MO = month
O&M = operation and maintenance
SF = square foot
WK = week

TABLE 27

COST ESTIMATE FOR ALTERNATIVE 5
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 5 HDPE Cap Anchored into Bay Mud Quantity	Cost	Backup Information
CONTRACTOR					
Mob/Demob	$450,000	LS	1	$450,000	Estimated @ about 5% of the contractor cost
Site Setup	$200,000	LS	1	$200,000	
Railroad Requirements	$300,000	LS	1	$300,000	Insurance, flagger, shoring
Site Clearing (Trees)	$6,000	Acre	7	$42,000	Past experience
Refuse Excavation and Grading	$18	CY	55,000	$990,000	Unit price from recent experience
Groundwater Extraction Trench	$50	LF	400	$20,000	Pricing estimated
Groundwater Removal and Treatment System	$100,000	LS	1	$100,000	Estimated
Groundwater Management	$100,000	MO	5	$500,000	Estimated
Ditch Construction	$20	LF	2,600	$52,000	Past experience
Berm Construction	$35	CY	6,500	$227,500	Vendor pricing on material
HDPE-60 Mil	$0.70	SF	22,000	$15,400	Vendor pricing
Gas Venting System	$15	LF	5,000	$75,000	Pricing from past project
HDPE-60 Mil	$0.70	SF	1,000,000	$700,000	Vendor pricing. Includes 10% waste and overlap
Geosynthetics (fabric/composite)	$1.00	SF	1,000,000	$1,000,000	Vendor pricing. Includes 10% waste and overlap
Geomembrane Anchor Trench	$10	LF	4,000	$40,000	Estimated
Placement and Grading Cover Soil	$20	Tons	62,000	$1,240,000	Vendor pricing on material
Topsoil Import and Placement	$48	CY	12,000	$576,000	Past experience
Sand and Gravel Import and Placement	$16	Ton	30,000	$480,000	Vendor pricing on material
General Backfill Import and Placement	$25	CY	5,000	$125,000	Vendor pricing on material
Hydroseeding	$3,000	Acre	15	$45,000	Pricing based on recent experience
Perimeter road	$75	LF	3,800	$285,000	Estimated - Vendor pricing on material
Security Fence	$22	LF	4,100	$90,200	Vendor pricing
Gates	$5,500	LS	2	$11,000	Vendor pricing
Subtotal				**$7,564,100**	
Prevailing Wage Allowance	8.0	%		$605,128	
SUBTOTAL				**$8,169,228**	
Sales Tax	8.50	%		$694,384	
CONTRACTOR COST				**$8,863,612**	

TABLE 27

COST ESTIMATE FOR ALTERNATIVE 5
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 5 HDPE Cap Anchored into Bay Mud Quantity	Alternative 5 HDPE Cap Anchored into Bay Mud Cost	Backup Information
CONSULTANT					
Field Investigation	$100,000	LS	2	$200,000	Estimated
Well Abandonment	$1,000	LS	10	$10,000	Past experience
Surveying	$2,200	Day	10	$22,000	Past experience
Design	$150,000	LS	1	$150,000	Estimated
Permitting	$130,000	LS	1	$130,000	Recent experience
Well Installation	$4,200	Sets	4	$16,800	Past experience
Project Management	$2,200	MO	30	$66,000	Estimated
Sampling and Analysis	$50,000	LS	2	$100,000	
Construction Management	$20,000	WK	22	$440,000	2 full time staff; part-time senior oversight
Construction Report	$75,000	LS	1	$75,000	Estimated
CONSULTANT COST				**$1,209,800**	
CAPITAL COST SUBTOTAL				**$10,073,000**	
CONTINGENCY	25	%		$2,518,250	
TOTAL CAPITAL COST				**$12,591,000**	

TABLE 27

COST ESTIMATE FOR ALTERNATIVE 5
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 5 HDPE Cap Anchored into Bay Mud		Backup Information
			Quantity	Cost	
OPERATION AND MAINTENANCE					
Years 1 through 5					
Inspections - Year 1	$16,000	Annual	1	$16,000	
Inspections - Years 2 through 5	$12,000	Annual	4	$48,000	
Groundwater Monitoring	$30,000	Annual	5	$150,000	
Cap Repair	$30,000	Annual	3	$90,000	
Mowing	$6,000	Annual	5	$30,000	
Project Management	$24,000	Annual	5	$120,000	
Years 6 through 30					
Inspections	$3,000	Annual	5	$15,000	
Groundwater Monitoring	$11,000	Annual	5	$55,000	
Cap Repair	$50,000	LS	2	$100,000	
Mowing	$6,000	Annual	25	$150,000	
Project Management	$6,000	Annual	25	$150,000	
O&M COST SUBTOTAL				**$924,000**	
Contingency	30	%		$277,200	
Groundwater Removal	$300,000	Round	5	$1,500,000	
TOTAL O&M COST				**$2,701,000**	
TOTAL PROJECT COST				**$15,292,000**	

Abbreviations
CY = cubic yard
HDPE = high density polyethylene
LF = linear foot
LS = lump sum
MO = month
O&M = operation and maintenance
SF = square foot
WK = week

TABLE 28

COST ESTIMATE FOR ALTERNATIVE 6

March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 6 PVC Cap Quantity	Alternative 6 PVC Cap Cost	Backup Information
CONTRACTOR					
Mob/Demob	$450,000	LS	1	$450,000	Estimated @ about 5% of the contractor cost
Site Setup	$200,000	LS	1	$200,000	
Railroad Requirements	$300,000	LS	1	$300,000	Insurance, flagger, shoring
Site Clearing (Trees)	$6,000	Acre	7	$42,000	Past experience
Refuse Excavation and Grading	$18	CY	55,000	$990,000	Unit price from recent experience
Groundwater Extraction Trench	$50	LF	400	$20,000	Pricing estimated
Groundwater Removal and Treatment System	$100,000	LS	1	$100,000	Estimated
Groundwater Management	$100,000	MO	5	$500,000	Estimated
Ditch Construction	$20	LF	2,600	$52,000	Past experience
Berm Construction	$35	CY	6,500	$227,500	Vendor pricing on material
GCL	$0.65	SF	22,000	$14,300	Vendor pricing
Gas Venting System	$16	LF	5,000	$80,000	Pricing from past project
PVC-40 Mil	$0.65	SF	1,000,000	$650,000	Vendor pricing. Includes 10% waste and overlap
Geosynthetics (fabric/composite)	$1.00	SF	1,000,000	$1,000,000	Vendor pricing. Includes 10% waste and overlap
Geomembrane Anchor Trench	$10	LF	4,000	$40,000	Estimated
Placement and Grading Cover Soil	$20	Tons	62,000	$1,240,000	Vendor pricing on material
Topsoil Import and Placement	$48	CY	12,000	$576,000	Past experience
Sand and Gravel Import and Placement	$16	Ton	30,000	$480,000	Vendor pricing on material
General Backfill Import and Placement	$25	CY	5,000	$125,000	Vendor pricing on material
Hydroseeding	$3,000	Acre	15	$45,000	Pricing based on recent experience
Perimeter road	$75	LF	3,800	$285,000	Estimated-Vendor pricing on material
Security Fence	$22	LF	4,100	$90,200	Vendor pricing
Gates	$5,500	LS	2	$11,000	Vendor pricing
Subtotal				**$7,518,000**	
Prevailing Wage Allowance	8.0	%		$601,440	
SUBTOTAL				**$8,119,440**	
Sales Tax	8.50	%		$690,152	
CONTRACTOR COST				**$8,809,592**	

TABLE 28

COST ESTIMATE FOR ALTERNATIVE 6
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 6 PVC Cap Quantity	Alternative 6 PVC Cap Cost	Backup Information
CONSULTANT					
Field Investigation	$100,000	LS	2	$200,000	Estimated
Well Abandonment	$1,000	LS	10	$10,000	Past experience
Surveying	$2,200	Day	10	$22,000	Past experience
Design	$150,000	LS	1	$150,000	Estimated
Permitting	$130,000	LS	1	$130,000	Recent experience
Well Installation	$4,200	Sets	4	$16,800	Past experience
Project Management	$2,200	MO	30	$66,000	Estimated
Sampling and Analysis	$50,000	LS	2	$100,000	
Construction Management	$20,000	WK	22	$440,000	2 full time staff; part-time senior oversight
Construction Report	$75,000	LS	1	$75,000	Estimated
CONSULTANT COST				**$1,209,800**	
CAPITAL COST SUBTOTAL				**$10,019,000**	
CONTINGENCY	25	%		$2,504,750	
TOTAL CAPITAL COST				**$12,524,000**	
OPERATION AND MAINTENANCE					
Years 1 through 5					
Inspections - Year 1	$16,000	Annual	1	$16,000	
Inspections - Years 2 through 5	$12,000	Annual	4	$48,000	
Groundwater Monitoring	$30,000	Annual	5	$150,000	
Cap Repair	$30,000	Annual	3	$90,000	
Mowing	$6,000	Annual	5	$30,000	
Project Management	$24,000	Annual	5	$120,000	
Years 6 through 30					
Inspections	$3,000	Annual	5	$15,000	
Groundwater Monitoring	$11,000	Annual	5	$55,000	
Cap Repair	$50,000	LS	2	$100,000	

TABLE 28

COST ESTIMATE FOR ALTERNATIVE 6
March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 6 PVC Cap Quantity	Alternative 6 PVC Cap Cost	Backup Information
Mowing	$6,000	Annual	25	$150,000	
Project Management	$6,000	Annual	25	$150,000	
O&M COST SUBTOTAL				**$924,000**	
Contingency	30	%		$277,200	
Groundwater Removal	$300,000	Round	5	$1,500,000	
TOTAL O&M COST				**$2,701,000**	
TOTAL PROJECT COST				**$15,225,000**	

Abbreviations

CY = cubic yard
GCL = geosynthetic clay liner
LF = linear foot
LS = lump sum
MO = month
O&M = operation and maintenance
PVC = polyvinyl chloride
SF = square foot
WK = week

TABLE 29

COST ESTIMATE FOR ALTERNATIVE 7

March Point (Whitmarsh) Landfill
Skagit County, Washington

Description	Rate	Units	Alternative 7 Landfill Removal Quantity	Alternative 7 Landfill Removal Cost	Backup Information
CONTRACTOR					
Mob/Demob	$2,000,000	LS	1	$2,000,000	Estimated @ about 3% of the contractor cost
Site Setup	$200,000	LS	3	$600,000	
Railroad Requirements	$500,000	LS	1	$500,000	Estimated for excavation and completion
Site Clearing (Trees)	$5,000	Acre	7	$35,000	
Refuse Excavation	$15	CY	340,000	$5,100,000	
Groundwater Extraction Trench	$50	LF	2,000	$100,000	Several rows of trenching will be needed
Groundwater Removal System	$250,000	LS	1	$250,000	
Groundwater Management	$300,000	MO	5	$1,500,000	
Non-Hazardous Transportation and Disposal	$70	Ton	560,000	$39,200,000	80% of total - Disposal pricing from the County
Unknown Conditions	$10,000,000	LS	1	$10,000,000	20% of the total - Assumed 1.65 tons/CY
Sand Backfill	$15	Ton	43,000	$645,000	Material pricing from vendor
Stormwater Erosion Control Features	$100,000	LS	1	$100,000	
Subtotal				**$60,030,000**	
Prevailing Wage Allowance	4.0	%		$2,401,200	
SUBTOTAL				**$62,431,200**	
Sales Tax	8.50	%		$5,306,652	
CONTRACTOR COST				**$67,737,852**	
CONSULTANT					
Field Investigation	$100,000	LS	2	$200,000	
Well Abandonment	$1,000	LS	10	$10,000	
Surveying	$2,200	Day	10	$22,000	
Design	$150,000	LS	1	$150,000	
Permitting	$130,000	LS	1	$130,000	
Project Management	$2,200	MO	30	$66,000	
Sampling and Analysis	$200,000	LS	1	$200,000	
Construction Management	$20,000	WK	22	$440,000	
Construction Report	$75,000	LS	1	$75,000	
CONSULTANT COST				**$1,293,000**	
CAPITAL COST SUBTOTAL				**$69,031,000**	
Contingency	20	%		$13,806,200	
TOTAL CAPITAL COST				**$82,837,000**	

Note

1. Waste that may not comply with solid waste standards.

Abbreviations

CY = cubic yard
LF = linear foot
LS = lump sum
MO = month
WK = week

TABLE 30

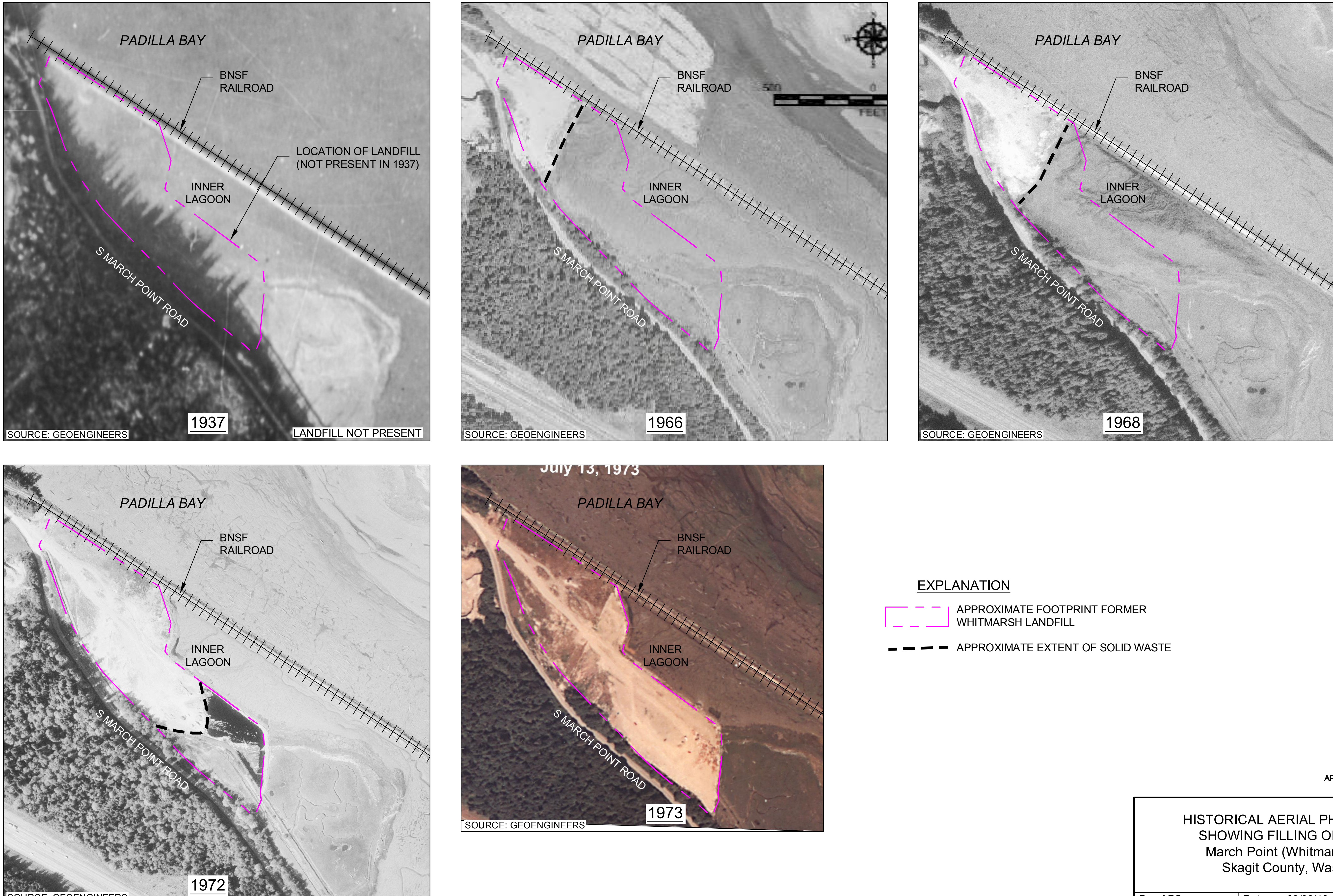
COMPARISON OF GCLL AND HDPE COVERS

March Point (Whitmarsh) Landfill
Anacortes, Washington

	GCLL	HDPE
General Description	0.25 inch of high quality bentonite powder contained between two geotextile layers with a 5-millimeter HDPE-film bonded onto a geotextile layer.	60-millimeter (0.06-inch) thick HDPE.
As Delivered	15-foot-wide rolls, 150 feet in length.	22.5-foot-wide rolls, 560 feet in length.
Installation Requirements		
Weather	GCLL must be kept dry during transport and storage. GCLL can be installed during a light rain. Bentonite will self-hydrate and swell.	HDPE must be dry and clean before welding panels with thermal welder.
Sealing Between Panels	1 to 2 feet of overlap between panels with powdered bentonite between panels. Relatively quick and no testing required.	Panels are heat-welded requiring experienced operators; once welded, bonds are strong. Seals require additional time for testing.
Ease of Installation	GCLL can be installed during typical daily low tides.	HDPE is more time-consuming to install, and a berm to dewater the intertidal area is necessary to allow welding to proceed.
Flexibility	GCLL can cover minor surface irregularities without gaps.	60-millimeter HDPE is stiff and not pliable, and is liable to gape over irregularities.
Solar Heating	Solar heating will not affect GCLL during installation.	Solar heating will cause expansion of HDPE, inducing ripples and mounding while installation proceeds.
Puncture	If both the geolaminate and hydrated bentonite is punctured, the bentonite is self-healing and will plug the leak.	While more resistant to punctures, HDPE does not self-heal and will leak at the puncture.
Ease of Repair	GCLL panels are easily repaired by maintenance staff with patches and bentonite powder.	Specialized equipment and trained staff are needed to repair and weld patches.
Manufacturing Defects	While the geolaminate may have defects, the hydrated bentonite will self-heal and minimize leaks.	Any manufacturing defects or holes in seam welds will allow water to infiltrate the solid waste.
Salinity	GCLL with polymer additive resists degradation in saline conditions and maintains low permeability.	HDPE is resistant to saline conditions.
Comments	Bentonite is a natural product and does not degrade, and bi-layer construction offers additional advantages such as ease of installation and double layers of protection to reduce leakage.	HDPE is a tough petroleum-based product that may be degraded by exposure to certain chemicals. HDPE is more suitable if cover will be exposed to heavy loads. HDPE is a single layer, not bi-layer or composite, and leakage rate is orders of magnitude worse than GCLL if punctured.

Abbreviations:
GCLL = geosynthetic clay laminated liner
HDPE = high density polyethylene

FIGURES



EXPLANATION

APPROXIMATE FOOTPRINT FORMER WHITMARSH LANDFILL

APPROXIMATE EXTENT OF SOLID WASTE

0 250 500
APPROXIMATE SCALE IN FEET

HISTORICAL AERIAL PHOTOGRAPHS
SHOWING FILLING OF LANDFILL
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure ES-1

Plot Date: 03/03/16 - 5:49pm, Plotted by: adam.stenberg
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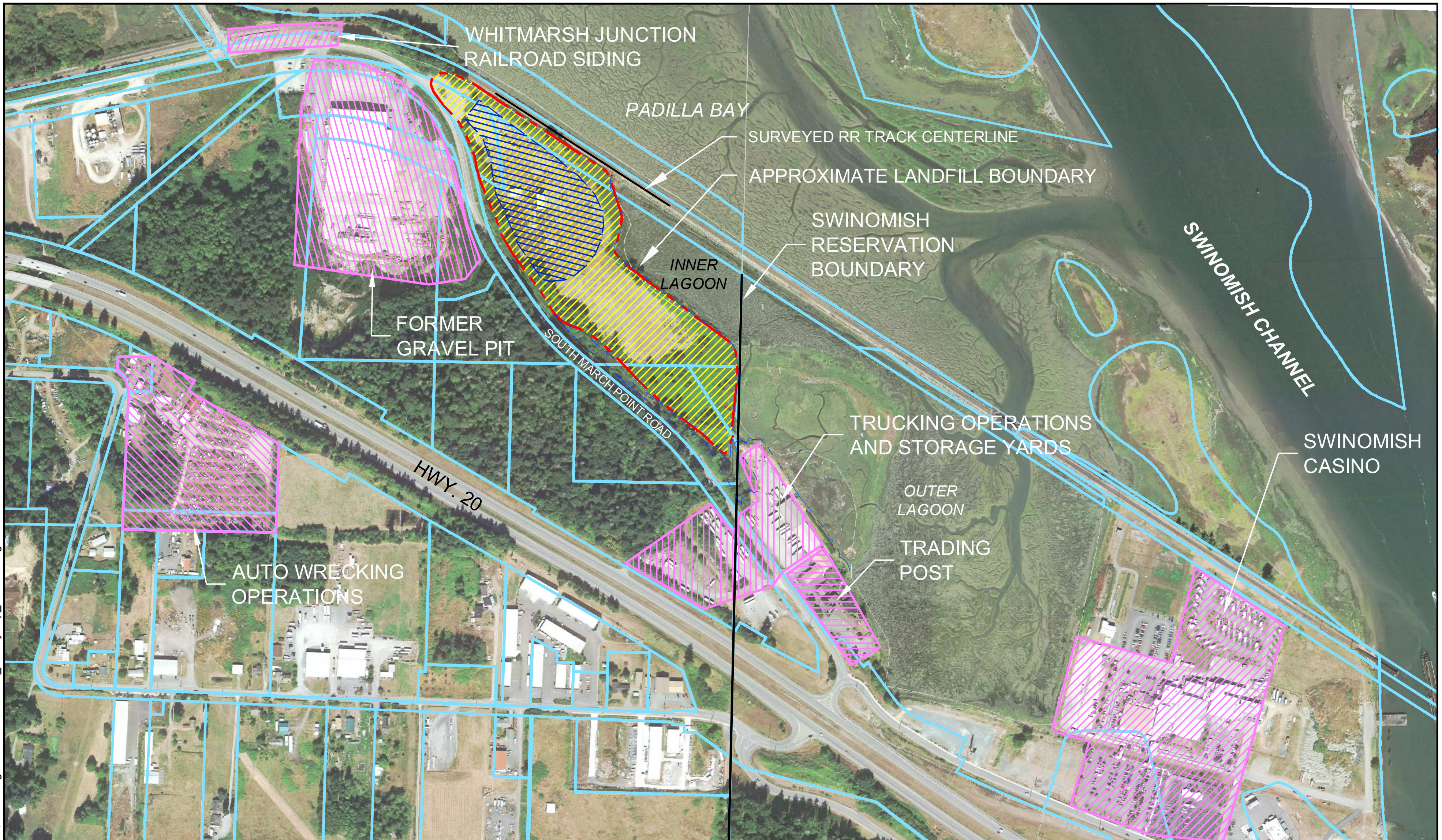


Aerial Photo Courtesy of Google Earth (August 21, 2011)

EXPLANATION

- FORMER SNOW MOUNTAIN LOG MILL
- NEARBY PROPERTIES AND ASSOCIATED USES
- FORMER WHITMARSH LANDFILL APPROXIMATE FOOTPRINT
- PARCEL LINES FROM SKAGIT COUNTY (SEE FIGURE 3 FOR MORE ACCURATE ON-SITE DETAIL)

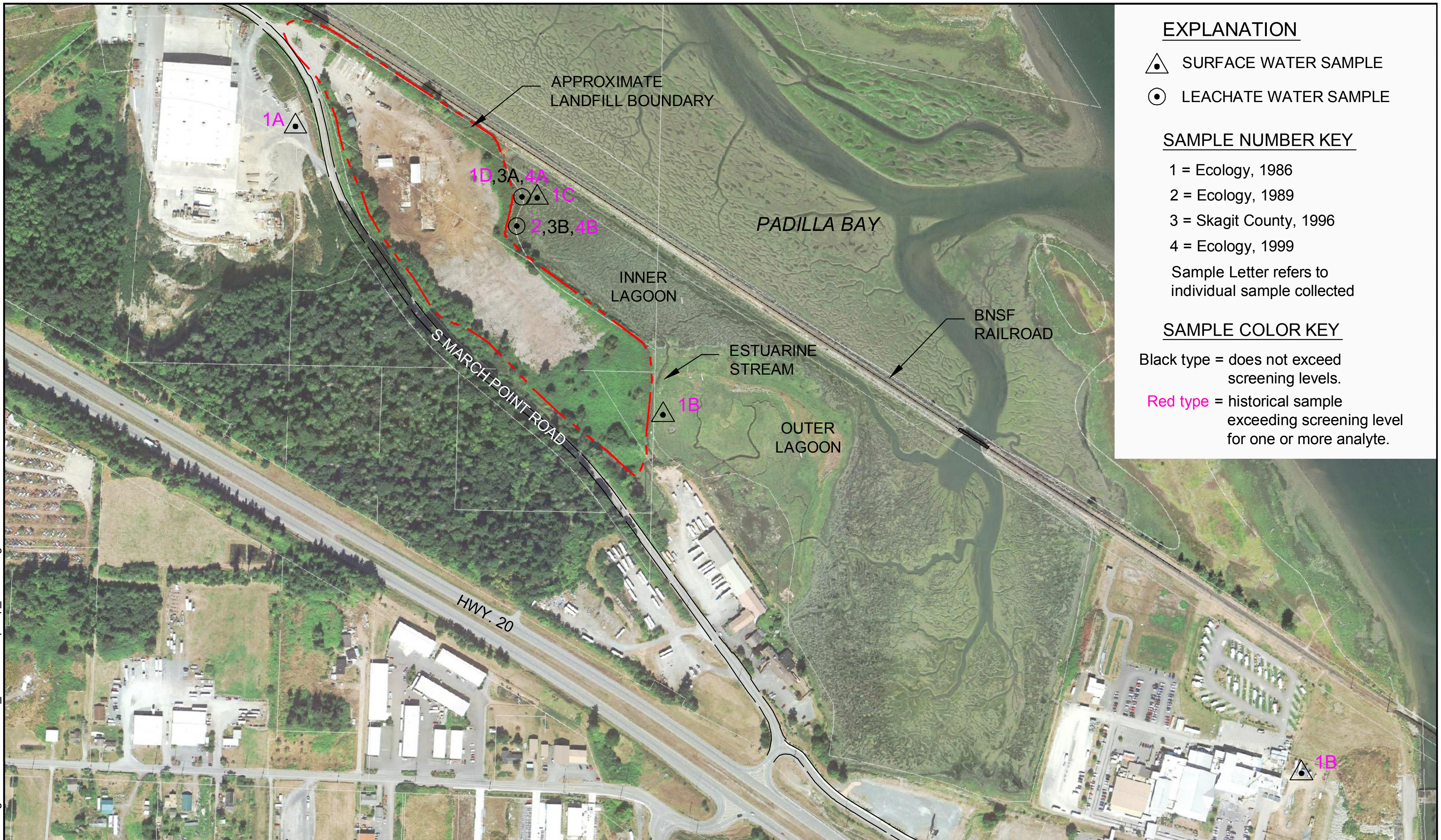
N

0 300 600
APPROXIMATE SCALE IN FEET

SITE VICINITY
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 10/30/15	Project No. 14159
amec		Figure 1

Plot Date: 10/30/15 - 12:58pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh_VicinityMap_100115.dwg



Aerial Photo Courtesy of Google Earth (August 21, 2011)

NOTES:

1. Figure adapted from a 2007 Geoengineers report.
2. Location of Sample 1B unclear from previous reports. Both potential locations are plotted.
3. For details on screening levels for previous studies see the Geoengineers report (2007).

0 250 500
APPROXIMATE SCALE IN FEET

HISTORICAL SAMPLE LOCATIONS
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 05/03/14	Project No. 14159
amec		Figure 2

Plot Date: 05/03/14 - 11:37am, Plotted by: adam.stenberg
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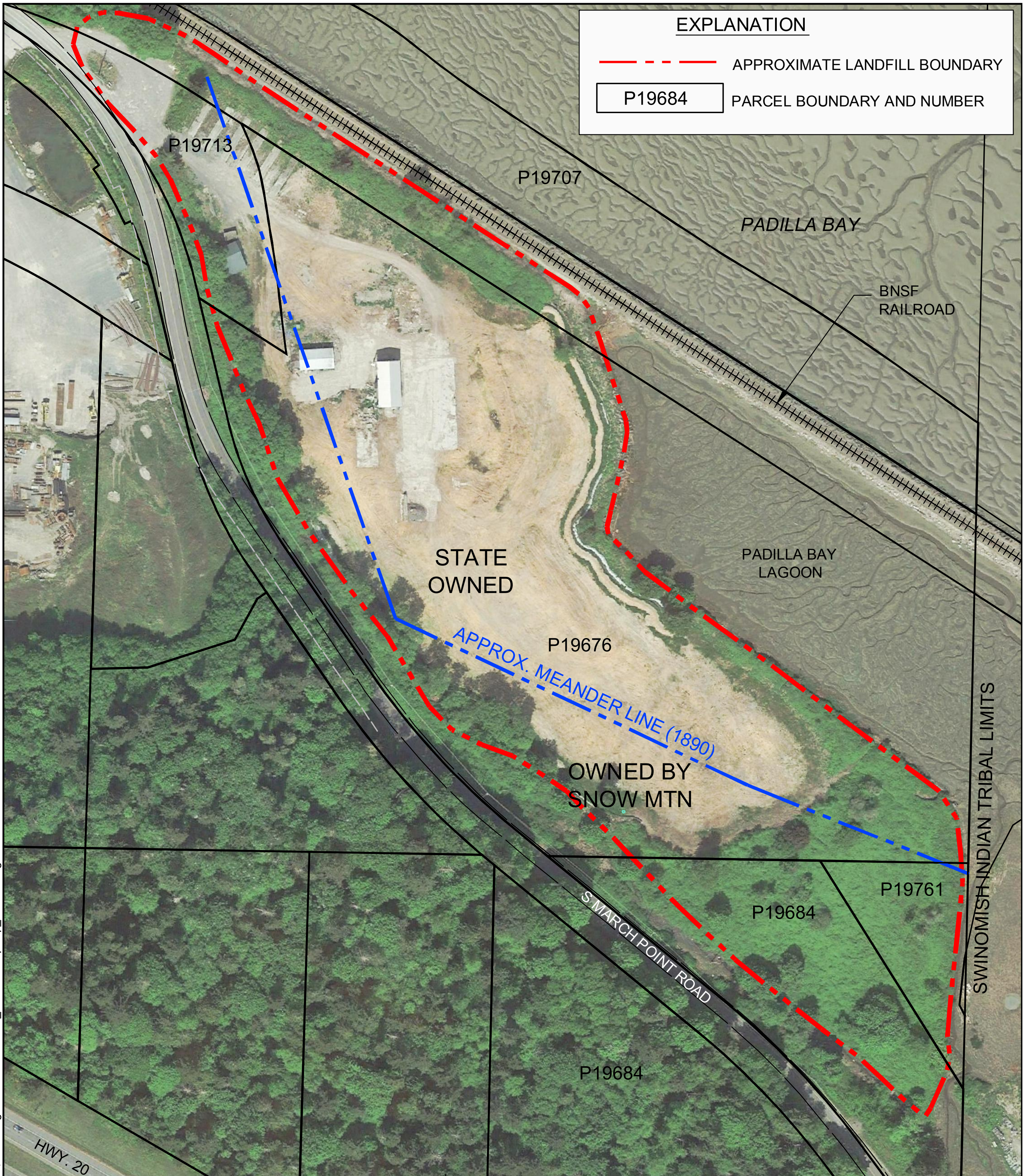


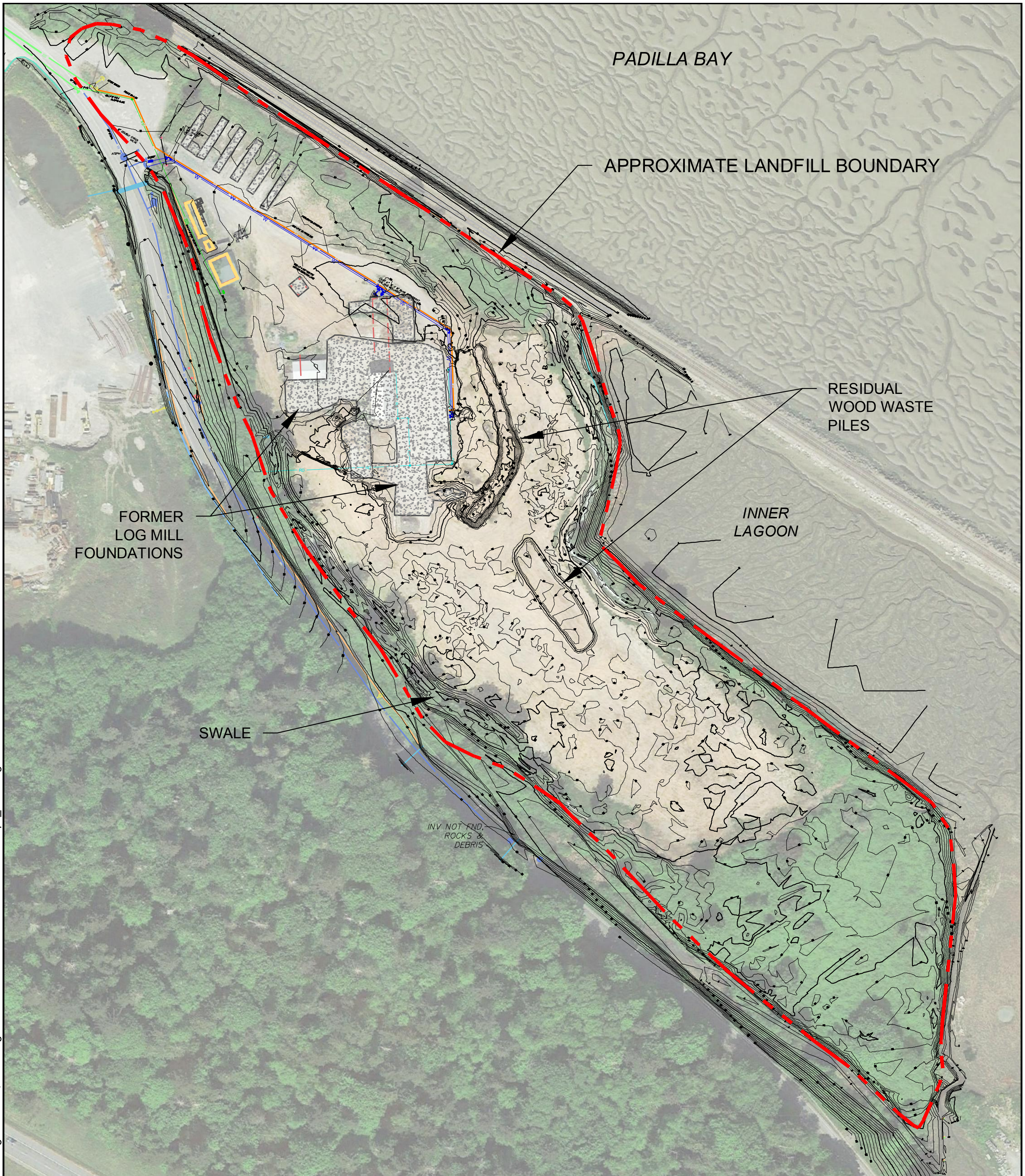
Aerial Photo Courtesy of Google Earth (May, 2015)

0 100 200
APPROXIMATE SCALE IN FEET

SITE PLAN AND PARCEL BOUNDARIES
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 10/04/15	Project No. 14159
amec		Figure 3

Plot Date: 10/04/15 - 10:16pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh_HistoricSampMap_093015.dwg



Aerial Photo Courtesy of Google Earth (May, 2015)
Topography provided by Northwest Datum & Design, Inc
(Contours in 1-ft intervals)

EXPLANATION

FORMER WHITMARSH LANDFILL APPROXIMATE FOOTPRINT

0 0 0
APPROXIMATE SCALE IN FEET

N

CURRENT TOPOGRAPHY AND SURFACE FEATURES

March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 10/30/15	Project No. 14159
amec		Figure 4

Plot Date: 10/30/15 - 1:30pm, Plotted by: adam.stenberg
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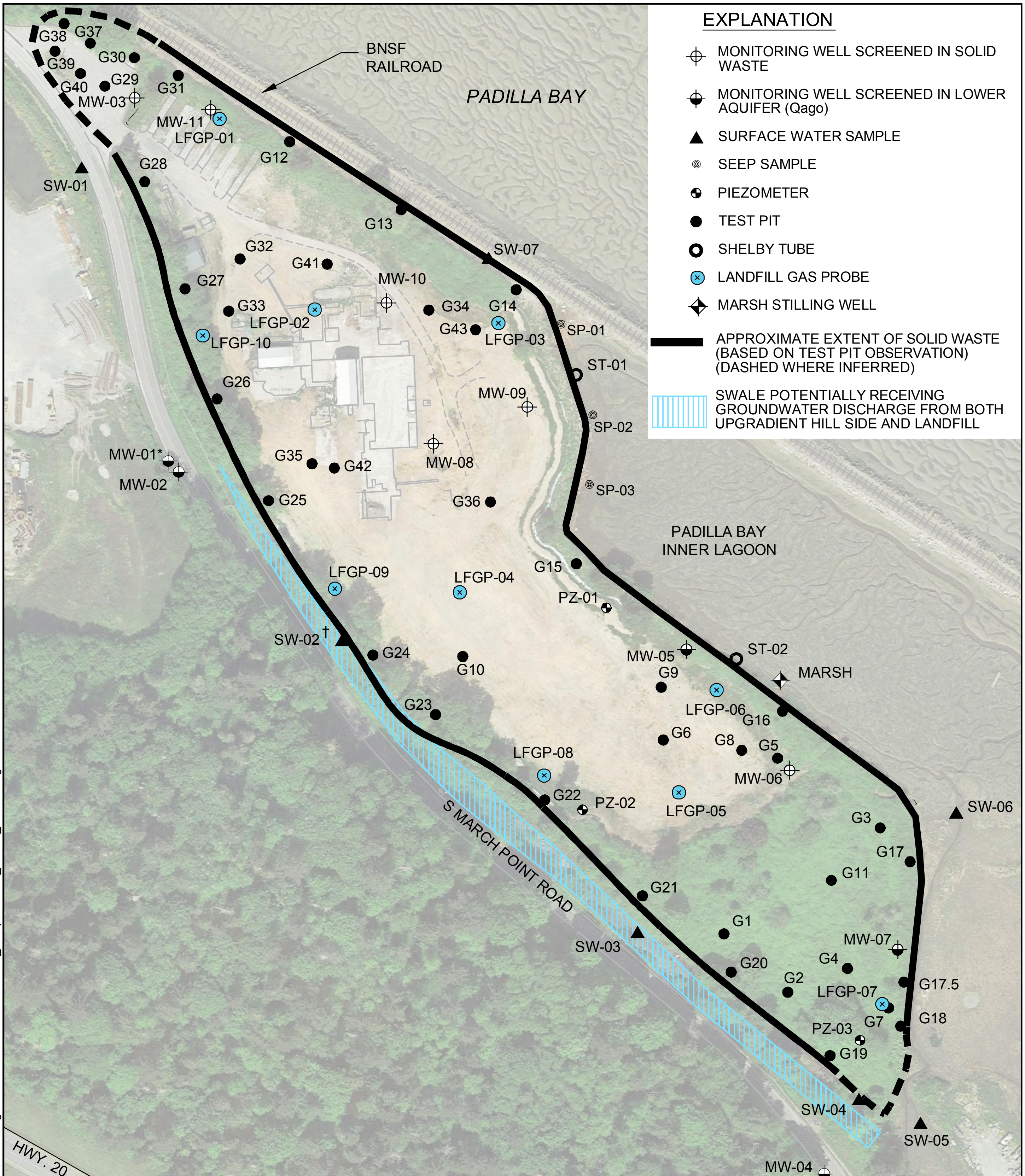


Aerial Photo Courtesy of Google Earth (May, 2015)

NOTES:

* No well was installed at MW-01 because no deeper aquifer was encountered at the time of drilling.

† SW-02 was dry during all sampling events and was therefore not sampled.

N

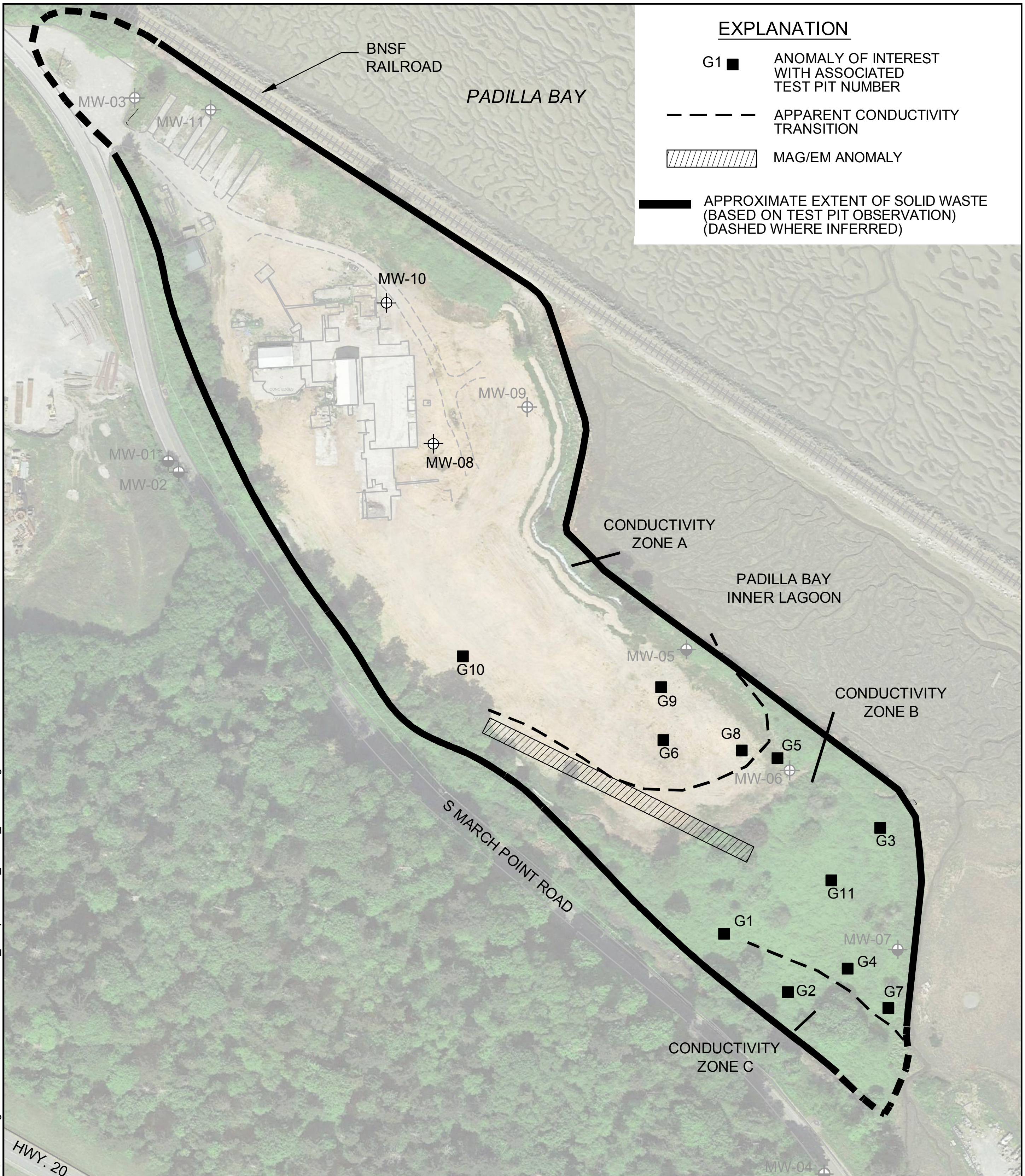
0 100 200

APPROXIMATE SCALE IN FEET

SURVEYED PHASE I AND PHASE II
UPLAND SAMPLE LOCATIONS
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 10/02/15	Project No. 14159
amec		Figure 5

Plot Date: 10/02/15 - 12:40pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_SampLocations_100115_recover.dwg



Aerial Photo Courtesy of Google Earth (May, 2015)

N

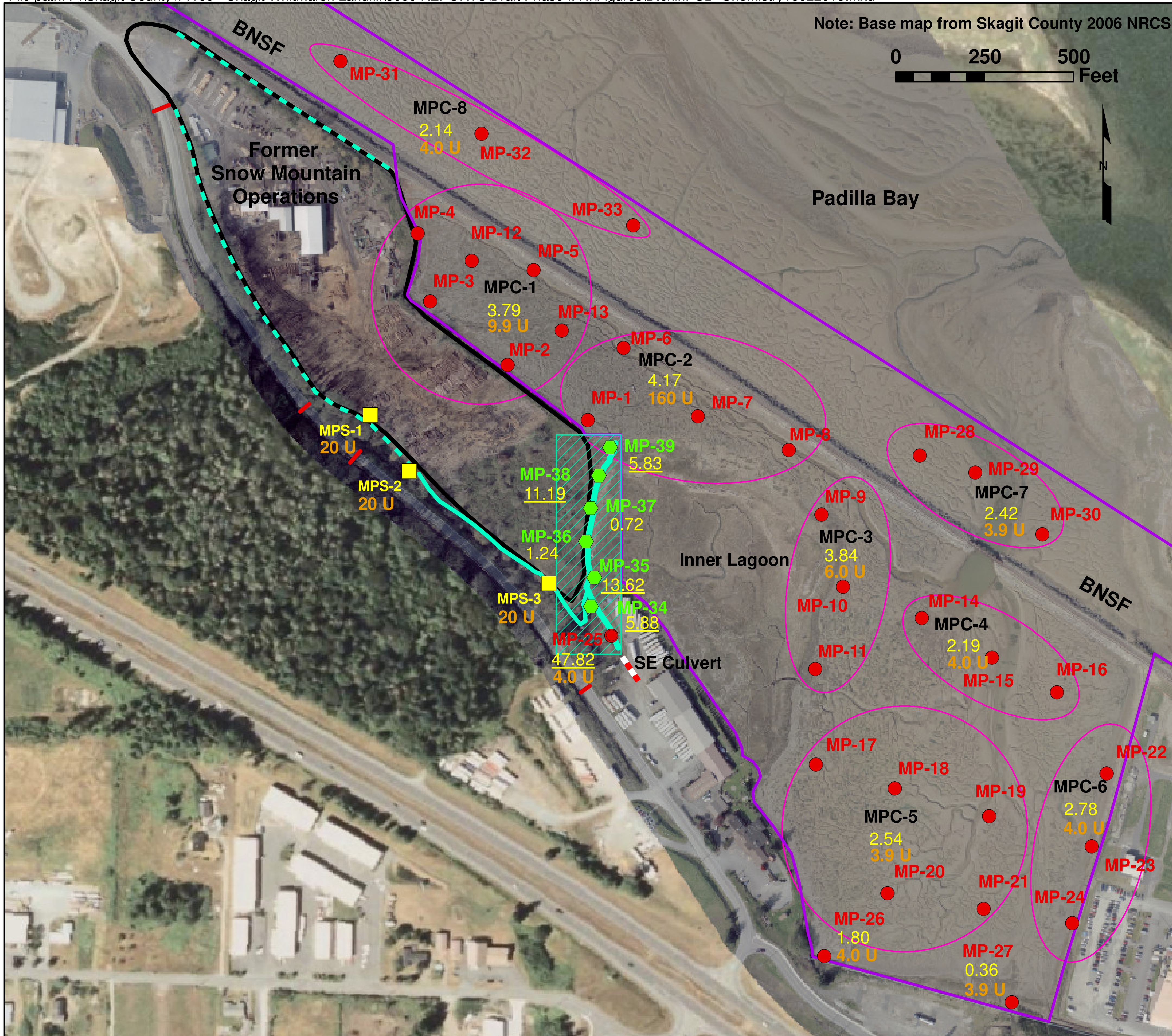
0 100 200
APPROXIMATE SCALE IN FEET

GEOPHYSICAL INVESTIGATION RESULTS
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 11/09/15	Project No. 14159
amec		Figure 6

Plot Date: 11/09/15 - 9:40am, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_SampLocations_100115_recover.dwg

File path: P:\Skagit County\14159 - Skagit Whitmarsh Landfill\3000 REPORTS\Draft Phase II RI\Figures\DIoxinPCB_Chemistry10022015.mxd



Sediment Sampling

- MPS-1 20U — Samples associated with drainage swale along SW Boundary. Total PCBs expressed in ppb dry weight
- MP-39 5.83 — Samples associated with drainage from culvert upgradient of MP-25. Dioxin/furans expressed in pptr TEQ. Underlined values above Preliminary Cleanup Level
- MP-27 — Sediment sampling locations
- MPC-3 2.36 4.0 U — Composite samples. Dioxin/furans expressed in pptr TEQ. Total PCBs expressed in ppb dry weight
- Whitmarsh Landfill Site Boundary
- Tidal Drainage Channel
- Drainage Swale
- 18 Inch Culvert
- 36 Inch Culvert

Decision Units

- Decision Unit A
- Decision Unit B

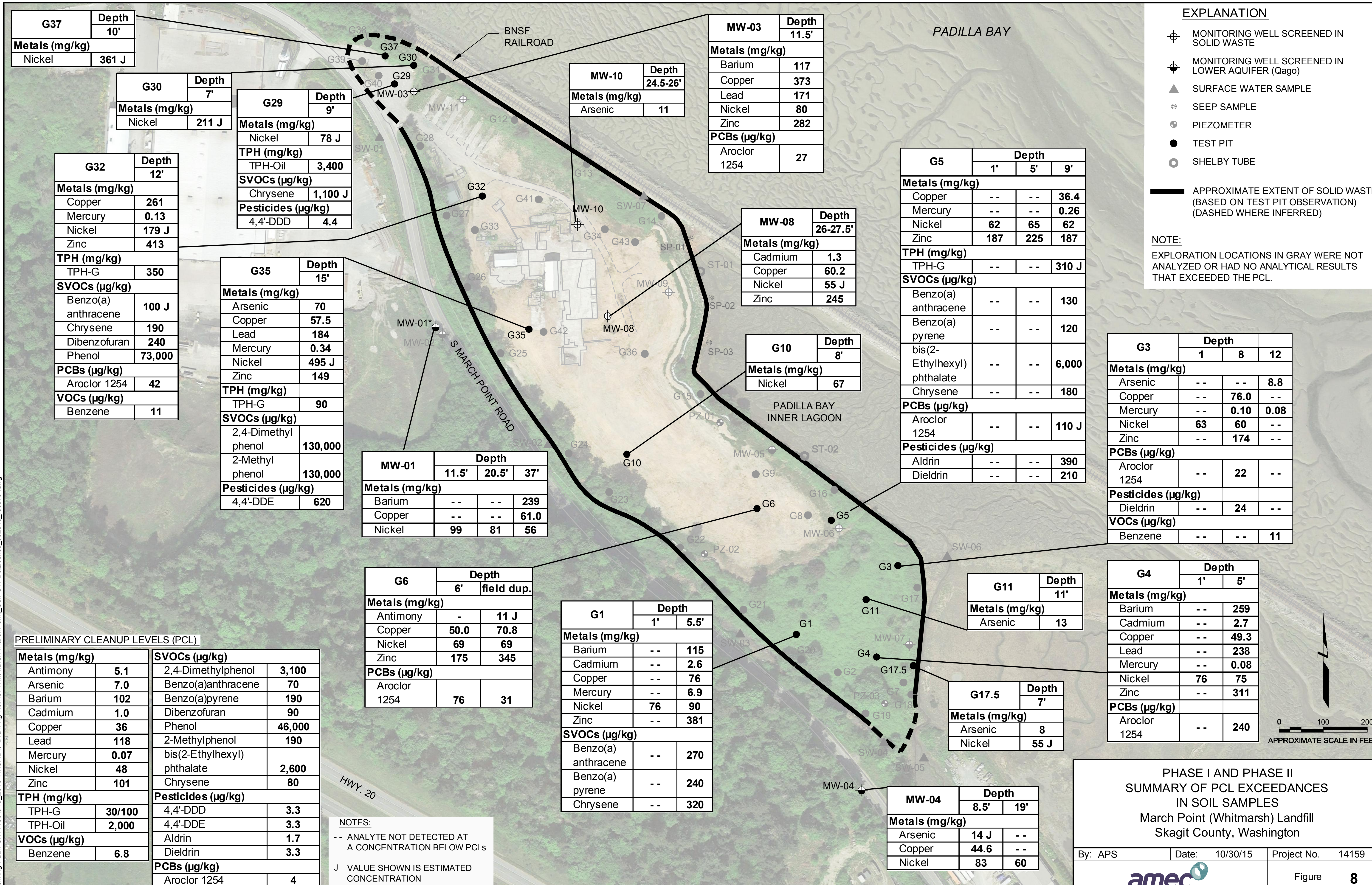
Notes:
Dioxin/furan concentrations expressed in parts per trillion Toxicity Equivalency Quotient using WHO 2005 TEFs. Underlined values exceed Preliminary Cleanup Levels.
Total PCB concentrations expressed in parts per billion-dry weight
Some locations in tidal drainage channel along east margin of the landfill were moved to match the aerial photograph. Locations were moved within ± 1m which is the accuracy of the GPS.
U - Undetected at the reporting limit/

SEDIMENT SAMPLING LOCATIONS AND DECISION UNITS
Remedial Investigation/Feasibility Study Report
March Point (Whitmarsh) Landfill Site
Skagit County, Washington

By: RHG	Date:10/02/2015	Project No. 014159.000.0

amec

Figure 7



G37	Depth
	10'
Metals (mg/kg)	
Nickel	361 J

G30	Depth
	7'
Metals (mg/kg)	
Nickel	211 J

G29	Depth
	9'
Metals (mg/kg)	
Nickel	78 J
TPH (mg/kg)	
TPH-Oil	3,400
SVOCs (µg/kg)	
Chrysene	1,100 J
Pesticides (µg/kg)	
4,4'-DDD	4.4

G32	Depth
	12'
Metals (mg/kg)	
Copper	261
Mercury	0.13
Nickel	179 J
Zinc	413
TPH (mg/kg)	
TPH-G	350
SVOCs (µg/kg)	
Benzo(a) anthracene	100 J
Chrysene	190
Dibenzofuran	240
Phenol	73,000
PCBs (µg/kg)	
Aroclor 1254	42
VOCs (µg/kg)	
Benzene	11

G35	Depth
	15'
Metals (mg/kg)	
Arsenic	70
Copper	57.5
Lead	184
Mercury	0.34
Nickel	495 J
Zinc	149
TPH (mg/kg)	
TPH-G	90
SVOCs (µg/kg)	
2,4-Dimethyl phenol	130,000
2-Methyl phenol	130,000
Pesticides (µg/kg)	
4,4'-DDE	620

MW-03	Depth
	11.5'
Metals (mg/kg)	
Barium	117
Copper	373
Lead	171
Nickel	80
Zinc	282
PCBs (µg/kg)	
Aroclor 1254	27

MW-10	Depth
	24.5-26'
Metals (mg/kg)	
Arsenic	11

MW-08	Depth
	26-27.5'
Metals (mg/kg)	
Cadmium	1.3
Copper	60.2
Nickel	55 J
Zinc	245

G10	Depth
	8'
Metals (mg/kg)	
Nickel	67

G5	Depth		
	1'	5'	9'
Metals (mg/kg)			
Copper	- -	- -	36.4
Mercury	- -	- -	0.26
Nickel	62	65	62
Zinc	187	225	187
TPH (mg/kg)			
TPH-G	- -	- -	310 J
SVOCs (µg/kg)			
Benzo(a) anthracene	- -	- -	130
Benzo(a) pyrene	- -	- -	120
bis(2-Ethylhexyl) phthalate	- -	- -	6,000
Chrysene	- -	- -	180
PCBs (µg/kg)			
Aroclor 1254	- -	- -	110 J
Pesticides (µg/kg)			
Aldrin	- -	- -	390
Dieldrin	- -	- -	210

G3	Depth		
	1	8	12
Metals (mg/kg)			
Arsenic	- -	- -	8.8
Copper	- -	76.0	- -
Mercury	- -	0.10	0.08
Nickel	63	60	- -
Zinc	- -	174	- -
PCBs (µg/kg)			
Aroclor 1254	- -	22	- -
Pesticides (µg/kg)			
Dieldrin	- -	24	- -
VOCs (µg/kg)			
Benzene	- -	- -	11

MW-01	Depth		
	11.5'	20.5'	37'
Metals (mg/kg)			
Barium	- -	- -	239
Copper	- -	- -	61.0
Nickel	99	81	56

G6	Depth	
	6'	field dup.
Metals (mg/kg)		
Antimony	-	11 J
Copper	50.0	70.8
Nickel	69	69
Zinc	175	345
PCBs (µg/kg)		
Aroclor 1254	76	31

G1	Depth	
	1'	5.5'
Metals (mg/kg)		
Barium	- -	115
Cadmium	- -	2.6
Copper	- -	76
Mercury	- -	6.9
Nickel	76	90
Zinc	- -	381
SVOCs (µg/kg)		
Benzo(a) anthracene	- -	270
Benzo(a) pyrene	- -	240
Chrysene	- -	320

G11	Depth
	11'
Metals (mg/kg)	
Arsenic	13

G4	Depth	
	1'	5'
Metals (mg/kg)		
Barium	- -	259
Cadmium	- -	2.7
Copper	- -	49.3
Lead	- -	238
Mercury	- -	0.08
Nickel	76	75
Zinc	- -	311
PCBs (µg/kg)		
Aroclor 1254	- -	240

G17.5	Depth
	7'
Metals (mg/kg)	
Arsenic	8
Nickel	55 J

MW-04	Depth	
	8.5'	19'
Metals (mg/kg)		
Arsenic	14 J	- -
Copper	44.6	- -
Nickel	83	60

PRELIMINARY CLEANUP LEVELS (PCL)

Metals (mg/kg)	
Antimony	5.1
Arsenic	7.0
Barium	102
Cadmium	1.0
Copper	36
Lead	118
Mercury	0.07
Nickel	48
Zinc	101
TPH (mg/kg)	
TPH-G	30/100
TPH-Oil	2,000
VOCs (µg/kg)	
Benzene	6.8

SVOCs (µg/kg)	
2,4-Dimethylphenol	3,100
Benzo(a)anthracene	70
Benzo(a)pyrene	190
Dibenzofuran	90
Phenol	46,000
2-Methylphenol	190
bis(2-Ethylhexyl) phthalate	2,600
Chrysene	80
Pesticides (µg/kg)	
4,4'-DDD	3.3
4,4'-DDE	3.3
Aldrin	1.7
Dieldrin	3.3
PCBs (µg/kg)	
Aroclor 1254	4

NOTES:

- - ANALYTE NOT DETECTED AT A CONCENTRATION BELOW PCLs

J VALUE SHOWN IS ESTIMATED CONCENTRATION

EXPLANATION

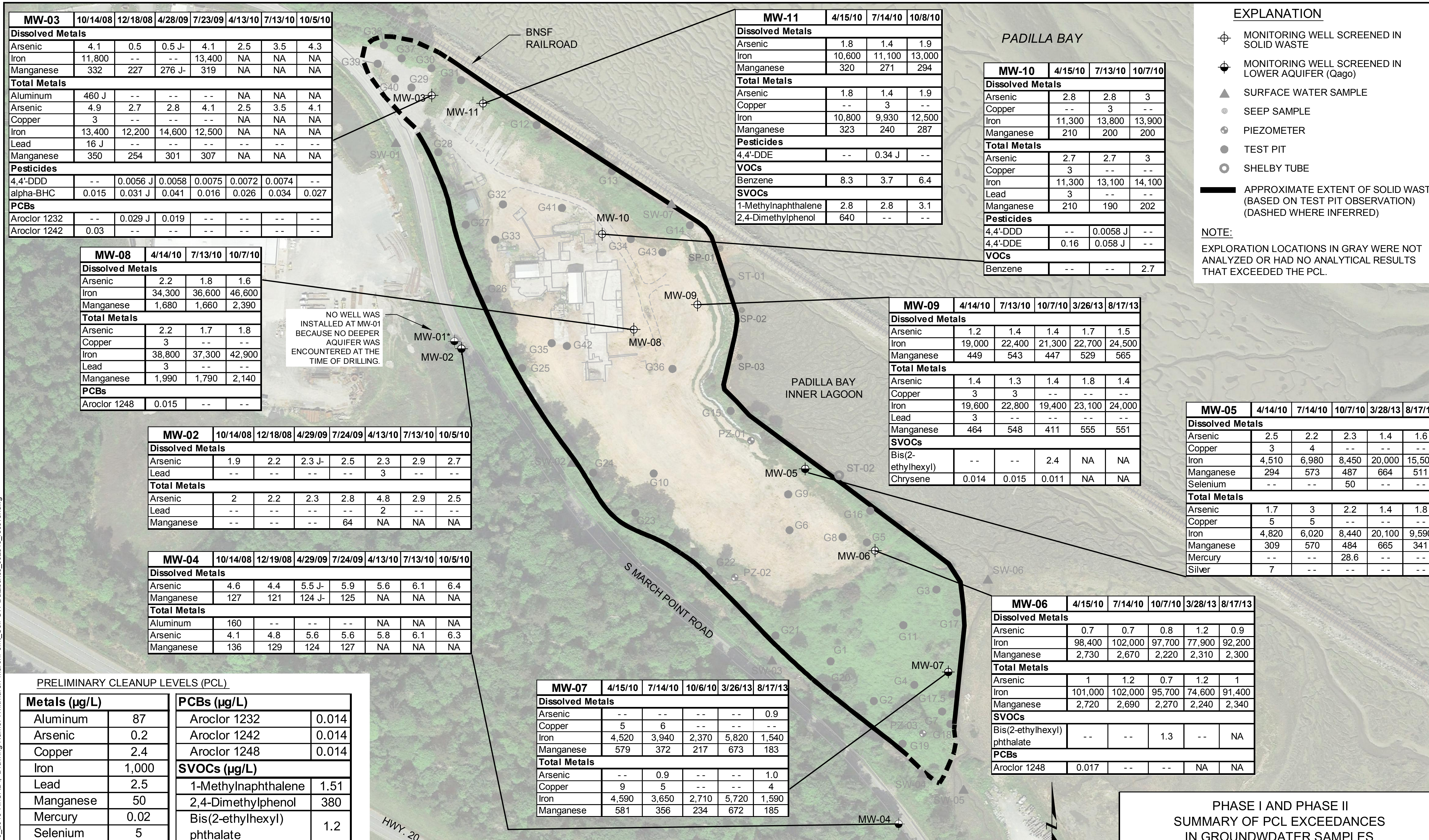
- MONITORING WELL SCREENED IN SOLID WASTE
- MONITORING WELL SCREENED IN LOWER AQUIFER (Qago)
- SURFACE WATER SAMPLE
- SEEP SAMPLE
- PIEZOMETER
- TEST PIT
- SHELBY TUBE
- APPROXIMATE EXTENT OF SOLID WASTE (BASED ON TEST PIT OBSERVATION) (DASHED WHERE INFERRED)

NOTE:
EXPLORATION LOCATIONS IN GRAY WERE NOT ANALYZED OR HAD NO ANALYTICAL RESULTS THAT EXCEEDED THE PCL.

PHASE I AND PHASE II
SUMMARY OF PCL EXCEEDANCES
IN SOIL SAMPLES
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 10/30/15	Project No. 14159
amec		Figure 8

Plot Date: 10/30/15 - 1:26pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_Soil-GW-Databoxes_092815_recover.dwg



MW-03	10/14/08	12/18/08	4/28/09	7/23/09	4/13/10	7/13/10	10/5/10
Dissolved Metals							
Arsenic	4.1	0.5	0.5 J-	4.1	2.5	3.5	4.3
Iron	11,800	- -	- -	13,400	NA	NA	NA
Manganese	332	227	276 J-	319	NA	NA	NA
Total Metals							
Aluminum	460 J	- -	- -	- -	NA	NA	NA
Arsenic	4.9	2.7	2.8	4.1	2.5	3.5	4.1
Copper	3	- -	- -	- -	NA	NA	NA
Iron	13,400	12,200	14,600	12,500	NA	NA	NA
Lead	16 J	- -	- -	- -	- -	- -	- -
Manganese	350	254	301	307	NA	NA	NA
Pesticides							
4,4'-DDD	- -	0.0056 J	0.0058	0.0075	0.0072	0.0074	- -
alpha-BHC	0.015	0.031 J	0.041	0.016	0.026	0.034	0.027
PCBs							
Aroclor 1232	- -	0.029 J	0.019	- -	- -	- -	- -
Aroclor 1242	0.03	- -	- -	- -	- -	- -	- -

MW-11	4/15/10	7/14/10	10/8/10
Dissolved Metals			
Arsenic	1.8	1.4	1.9
Iron	10,600	11,100	13,000
Manganese	320	271	294
Total Metals			
Arsenic	1.8	1.4	1.9
Copper	- -	3	- -
Iron	10,800	9,930	12,500
Manganese	323	240	287
Pesticides			
4,4'-DDE	- -	0.34 J	- -
VOCs			
Benzene	8.3	3.7	6.4
SVOCs			
1-Methylnaphthalene	2.8	2.8	3.1
2,4-Dimethylphenol	640	- -	- -

MW-10	4/15/10	7/13/10	10/7/10
Dissolved Metals			
Arsenic	2.8	2.8	3
Copper	- -	3	- -
Iron	11,300	13,800	13,900
Manganese	210	200	200
Total Metals			
Arsenic	2.7	2.7	3
Copper	3	- -	- -
Iron	11,300	13,100	14,100
Lead	3	- -	- -
Manganese	210	190	202
Pesticides			
4,4'-DDD	- -	0.0058 J	- -
4,4'-DDE	0.16	0.058 J	- -
VOCs			
Benzene	- -	- -	2.7

EXPLANATION

- MONITORING WELL SCREENED IN SOLID WASTE
- MONITORING WELL SCREENED IN LOWER AQUIFER (Qago)
- SURFACE WATER SAMPLE
- SEEP SAMPLE
- PIEZOMETER
- TEST PIT
- SHELBY TUBE
- APPROXIMATE EXTENT OF SOLID WASTE (BASED ON TEST PIT OBSERVATION) (DASHED WHERE INFERRED)

NOTE:

EXPLORATION LOCATIONS IN GRAY WERE NOT ANALYZED OR HAD NO ANALYTICAL RESULTS THAT EXCEEDED THE PCL.

MW-08	4/14/10	7/13/10	10/7/10
Dissolved Metals			
Arsenic	2.2	1.8	1.6
Iron	34,300	36,600	46,600
Manganese	1,680	1,660	2,390
Total Metals			
Arsenic	2.2	1.7	1.8
Copper	3	- -	- -
Iron	38,800	37,300	42,900
Lead	3	- -	- -
Manganese	1,990	1,790	2,140
PCBs			
Aroclor 1248	0.015	- -	- -

MW-09	4/14/10	7/13/10	10/7/10	3/26/13	8/17/13
Dissolved Metals					
Arsenic	1.2	1.4	1.4	1.7	1.5
Iron	19,000	22,400	21,300	22,700	24,500
Manganese	449	543	447	529	565
Total Metals					
Arsenic	1.4	1.3	1.4	1.8	1.4
Copper	3	3	- -	- -	- -
Iron	19,600	22,800	19,400	23,100	24,000
Lead	3	- -	- -	- -	- -
Manganese	464	548	411	555	551
SVOCs					
Bis(2-ethylhexyl)	- -	- -	2.4	NA	NA
Chrysene	0.014	0.015	0.011	NA	NA

MW-05	4/14/10	7/14/10	10/7/10	3/28/13	8/17/13
Dissolved Metals					
Arsenic	2.5	2.2	2.3	1.4	1.6
Copper	3	4	- -	- -	- -
Iron	4,510	6,980	8,450	20,000	15,500
Manganese	294	573	487	664	511
Selenium	- -	- -	50	- -	- -
Total Metals					
Arsenic	1.7	3	2.2	1.4	1.8
Copper	5	5	- -	- -	- -
Iron	4,820	6,020	8,440	20,100	9,590
Manganese	309	570	484	665	341
Mercury	- -	- -	28.6	- -	- -
Silver	7	- -	- -	- -	- -

MW-02	10/14/08	12/18/08	4/29/09	7/24/09	4/13/10	7/13/10	10/5/10
Dissolved Metals							
Arsenic	1.9	2.2	2.3 J-	2.5	2.3	2.9	2.7
Lead	- -	- -	- -	- -	3	- -	- -
Total Metals							
Arsenic	2	2.2	2.3	2.8	4.8	2.9	2.5
Lead	- -	- -	- -	- -	2	- -	- -
Manganese	- -	- -	- -	64	NA	NA	NA

MW-04	10/14/08	12/19/08	4/29/09	7/24/09	4/13/10	7/13/10	10/5/10
Dissolved Metals							
Arsenic	4.6	4.4	5.5 J-	5.9	5.6	6.1	6.4
Manganese	127	121	124 J-	125	NA	NA	NA
Total Metals							
Aluminum	160	- -	- -	- -	NA	NA	NA
Arsenic	4.1	4.8	5.6	5.6	5.8	6.1	6.3
Manganese	136	129	124	127	NA	NA	NA

MW-06	4/15/10	7/14/10	10/7/10	3/28/13	8/17/13
Dissolved Metals					
Arsenic	0.7	0.7	0.8	1.2	0.9
Iron	98,400	102,000	97,700	77,900	92,200
Manganese	2,730	2,670	2,220	2,310	2,300
Total Metals					
Arsenic	1	1.2	0.7	1.2	1
Iron	101,000	102,000	95,700	74,600	91,400
Manganese	2,720	2,690	2,270	2,240	2,340
SVOCs					
Bis(2-ethylhexyl) phthalate	- -	- -	1.3	- -	NA
PCBs					
Aroclor 1248	0.017	- -	- -	NA	NA

MW-07	4/15/10	7/14/10	10/6/10	3/26/13	8/17/13
Dissolved Metals					
Arsenic	- -	- -	- -	- -	0.9
Copper	5	6	- -	- -	- -
Iron	4,520	3,940	2,370	5,820	1,540
Manganese	579	372	217	673	183
Total Metals					
Arsenic	- -	0.9	- -	- -	1.0
Copper	9	5	- -	- -	4
Iron	4,590	3,650	2,710	5,720	1,590
Manganese	581	356	234	672	185

PRELIMINARY CLEANUP LEVELS (PCL)

Metals (µg/L)	
Aluminum	87
Arsenic	0.2
Copper	2.4
Iron	1,000
Lead	2.5
Manganese	50
Mercury	0.02
Selenium	5
Silver	1.9
Pesticides (µg/L)	
4,4'-DDD	0.00125
4,4'-DDE	0.00125
alpha-BHC	0.0006

PCBs (µg/L)	
Aroclor 1232	0.014
Aroclor 1242	0.014
Aroclor 1248	0.014
SVOCs (µg/L)	
1-Methylnaphthalene	1.51
2,4-Dimethylphenol	380
Bis(2-ethylhexyl) phthalate	1.2
Chrysene	0.01
VOCs (µg/L)	
Benzene	1.2

NOTE: ALUMINUM HAD A PCL BUT IS NOT A CONSTITUENT OF CONCERN.

NOTES:

NA NOT ANALYZED

- - ANALYTE NOT DETECTED AT A CONCENTRATION GREATER THAN PCLs

J VALUE SHOWN IS ESTIMATED CONCENTRATION

J- VALUE SHOWN IS ESTIMATED CONCENTRATION WITH A POSSIBLE LOW BIAS

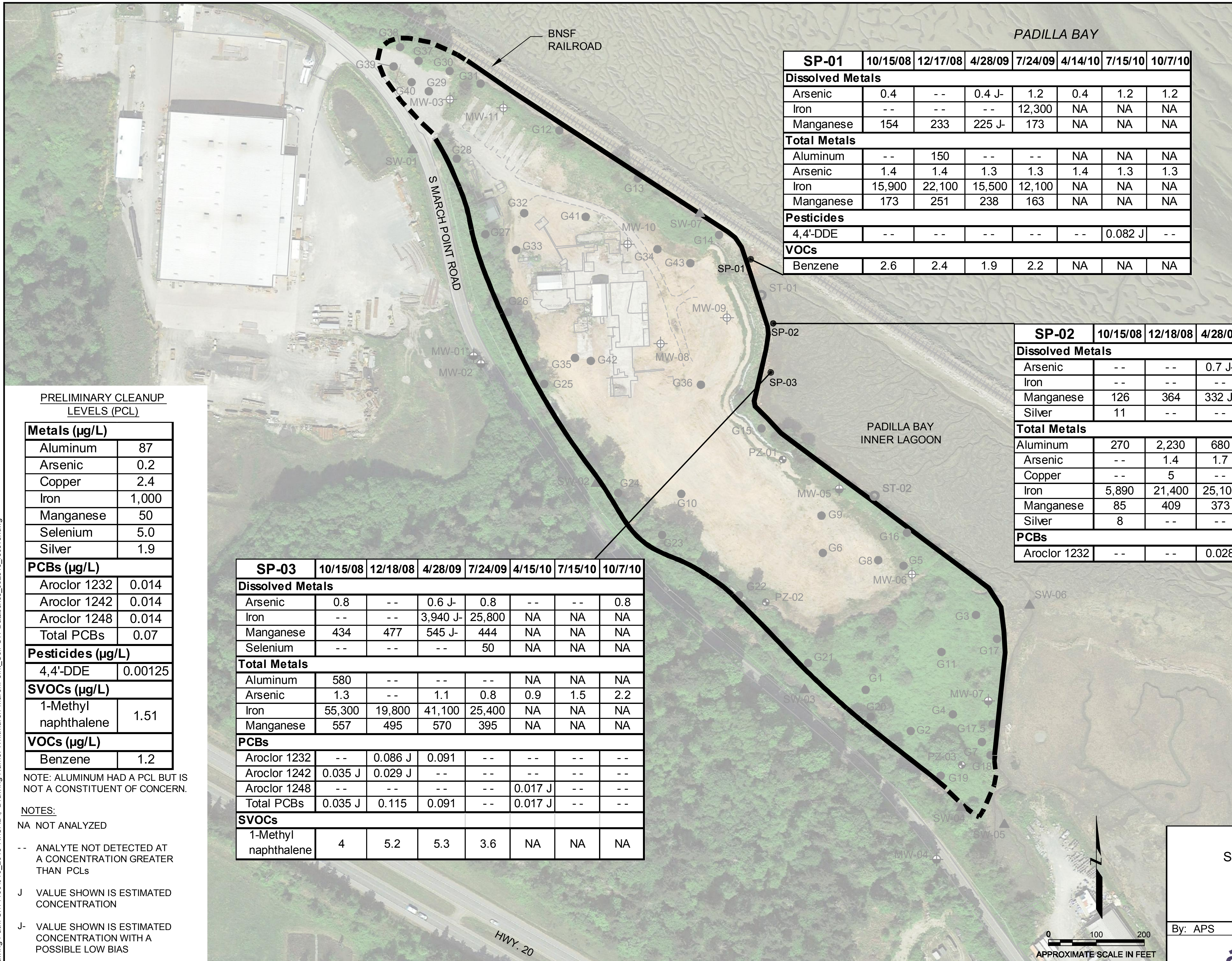
0 100 200

APPROXIMATE SCALE IN FEET

PHASE I AND PHASE II
SUMMARY OF PCL EXCEEDANCES
IN GROUNDWDATER SAMPLES
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 10/30/15	Project No. 14159
amec		Figure 9

Plot Date: 10/30/15 - 1:34pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_Soil-GW-Databoxes_092815_recover.dwg



SP-01	10/15/08	12/17/08	4/28/09	7/24/09	4/14/10	7/15/10	10/7/10
Dissolved Metals							
Arsenic	0.4	- -	0.4 J-	1.2	0.4	1.2	1.2
Iron	- -	- -	- -	12,300	NA	NA	NA
Manganese	154	233	225 J-	173	NA	NA	NA
Total Metals							
Aluminum	- -	150	- -	- -	NA	NA	NA
Arsenic	1.4	1.4	1.3	1.3	1.4	1.3	1.3
Iron	15,900	22,100	15,500	12,100	NA	NA	NA
Manganese	173	251	238	163	NA	NA	NA
Pesticides							
4,4'-DDE	- -	- -	- -	- -	- -	0.082 J	- -
VOCs							
Benzene	2.6	2.4	1.9	2.2	NA	NA	NA

SP-02	10/15/08	12/18/08	4/28/09	7/24/09	4/15/10	7/15/10	10/7/10
Dissolved Metals							
Arsenic	- -	- -	0.7 J-	1.1	- -	1.3	12
Iron	- -	- -	- -	18,200	NA	NA	NA
Manganese	126	364	332 J-	321	NA	NA	NA
Silver	11	- -	- -	- -	NA	NA	NA
Total Metals							
Aluminum	270	2,230	680	900	NA	NA	NA
Arsenic	- -	1.4	1.7	2.4	0.6	0.5	0.9
Copper	- -	5	- -	- -	NA	NA	NA
Iron	5,890	21,400	25,100	26,400	NA	NA	NA
Manganese	85	409	373	314	NA	NA	NA
Silver	8	- -	- -	- -	NA	NA	NA
PCBs							
Aroclor 1232	- -	- -	0.028	- -	- -	- -	- -

SP-03	10/15/08	12/18/08	4/28/09	7/24/09	4/15/10	7/15/10	10/7/10
Dissolved Metals							
Arsenic	0.8	- -	0.6 J-	0.8	- -	- -	0.8
Iron	- -	- -	3,940 J-	25,800	NA	NA	NA
Manganese	434	477	545 J-	444	NA	NA	NA
Selenium	- -	- -	- -	50	NA	NA	NA
Total Metals							
Aluminum	580	- -	- -	- -	NA	NA	NA
Arsenic	1.3	- -	1.1	0.8	0.9	1.5	2.2
Iron	55,300	19,800	41,100	25,400	NA	NA	NA
Manganese	557	495	570	395	NA	NA	NA
PCBs							
Aroclor 1232	- -	0.086 J	0.091	- -	- -	- -	- -
Aroclor 1242	0.035 J	0.029 J	- -	- -	- -	- -	- -
Aroclor 1248	- -	- -	- -	- -	0.017 J	- -	- -
Total PCBs	0.035 J	0.115	0.091	- -	0.017 J	- -	- -
SVOCs							
1-Methyl naphthalene	4	5.2	5.3	3.6	NA	NA	NA

PRELIMINARY CLEANUP LEVELS (PCL)

Metals (µg/L)	
Aluminum	87
Arsenic	0.2
Copper	2.4
Iron	1,000
Manganese	50
Selenium	5.0
Silver	1.9
PCBs (µg/L)	
Aroclor 1232	0.014
Aroclor 1242	0.014
Aroclor 1248	0.014
Total PCBs	0.07
Pesticides (µg/L)	
4,4'-DDE	0.00125
SVOCs (µg/L)	
1-Methyl naphthalene	1.51
VOCs (µg/L)	
Benzene	1.2

NOTE: ALUMINUM HAD A PCL BUT IS NOT A CONSTITUENT OF CONCERN.

NOTES:

NA NOT ANALYZED

- - ANALYTE NOT DETECTED AT A CONCENTRATION GREATER THAN PCLs

J VALUE SHOWN IS ESTIMATED CONCENTRATION

J- VALUE SHOWN IS ESTIMATED CONCENTRATION WITH A POSSIBLE LOW BIAS

EXPLANATION

- MONITORING WELL SCREENED IN SOLID WASTE
- MONITORING WELL SCREENED IN LOWER AQUIFER (Qago)
- SURFACE WATER SAMPLE
- SEEP SAMPLE
- PIEZOMETER
- TEST PIT
- SHELBY TUBE
- APPROXIMATE EXTENT OF SOLID WASTE (BASED ON TEST PIT OBSERVATION) (DASHED WHERE INFERRED)

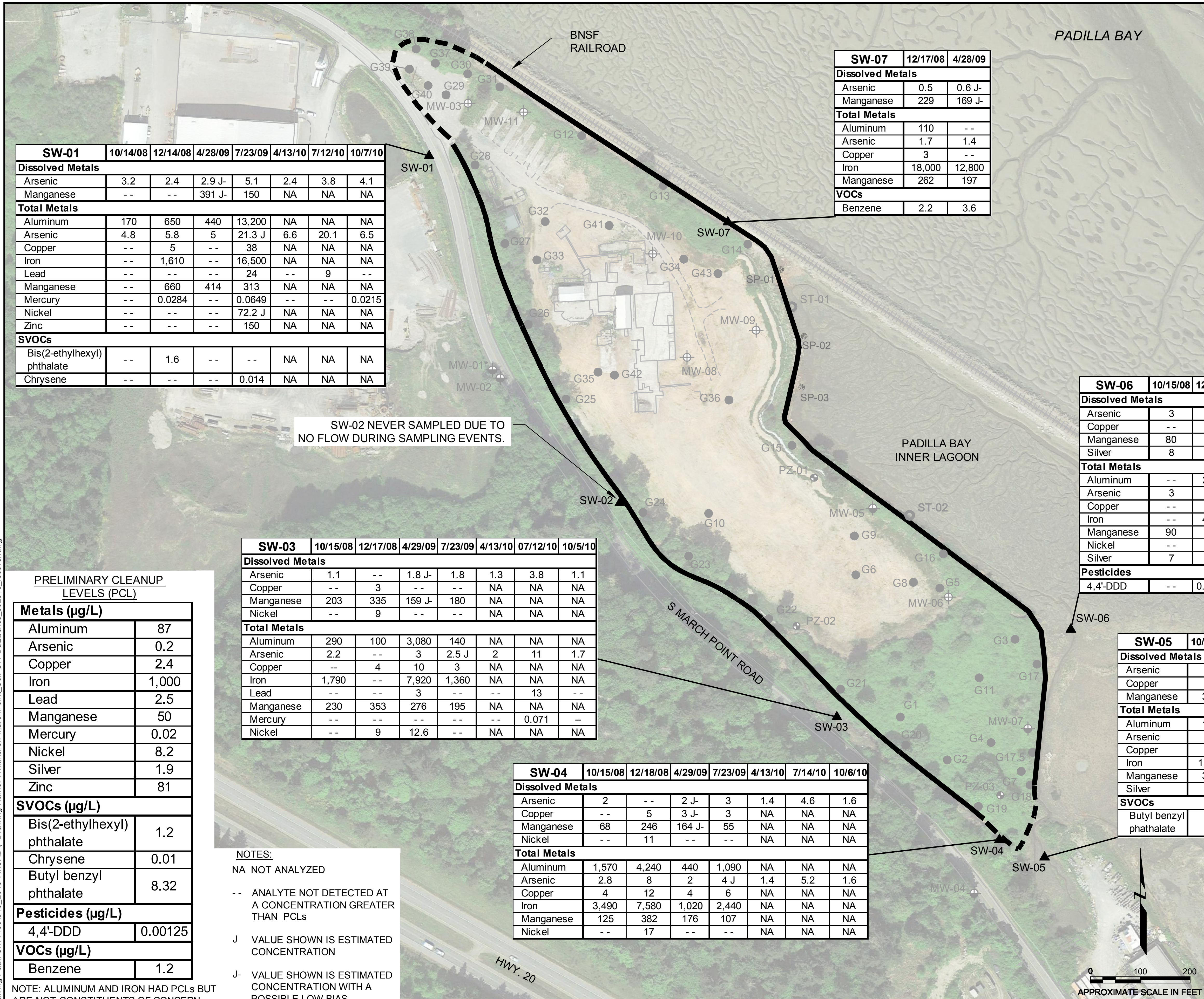
NOTE:

EXPLORATION LOCATIONS IN GRAY WERE NOT ANALYZED OR HAD NO ANALYTICAL RESULTS THAT EXCEEDED THE PCL.

PHASE I AND PHASE II
SUMMARY OF PCL EXCEEDANCES
IN SEEP SAMPLES
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 10/30/15	Project No. 14159
amec		Figure 10

Plot Date: 10/30/15 - 1:38pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_Soil-GW-Databoxes_092815_recover.dwg



SW-01	10/14/08	12/14/08	4/28/09	7/23/09	4/13/10	7/12/10	10/7/10
Dissolved Metals							
Arsenic	3.2	2.4	2.9 J-	5.1	2.4	3.8	4.1
Manganese	- -	- -	391 J-	150	NA	NA	NA
Total Metals							
Aluminum	170	650	440	13,200	NA	NA	NA
Arsenic	4.8	5.8	5	21.3 J	6.6	20.1	6.5
Copper	- -	5	- -	38	NA	NA	NA
Iron	- -	1,610	- -	16,500	NA	NA	NA
Lead	- -	- -	- -	24	- -	9	- -
Manganese	- -	660	414	313	NA	NA	NA
Mercury	- -	0.0284	- -	0.0649	- -	- -	0.0215
Nickel	- -	- -	- -	72.2 J	NA	NA	NA
Zinc	- -	- -	- -	150	NA	NA	NA
SVOCs							
Bis(2-ethylhexyl) phthalate	- -	1.6	- -	- -	NA	NA	NA
Chrysene	- -	- -	- -	0.014	NA	NA	NA

SW-07	12/17/08	4/28/09
Dissolved Metals		
Arsenic	0.5	0.6 J-
Manganese	229	169 J-
Total Metals		
Aluminum	110	- -
Arsenic	1.7	1.4
Copper	3	- -
Iron	18,000	12,800
Manganese	262	197
VOCs		
Benzene	2.2	3.6

SW-06	10/15/08	12/17/08	4/29/09	7/23/09	4/13/10	7/14/10	10/6/10
Dissolved Metals							
Arsenic	3	- -	4 J-	5	1	3	2
Copper	- -	3	3 J-	6	NA	NA	NA
Manganese	80	132	289 J-	- -	NA	NA	NA
Silver	8	- -	- -	- -	NA	NA	NA
Total Metals							
Aluminum	- -	2,250	370	--	NA	NA	NA
Arsenic	3	3	3	5 J	1.4	4	0.8
Copper	- -	8	4	7	NA	NA	NA
Iron	- -	4,620	1,370	- -	NA	NA	NA
Manganese	90	239	300	- -	NA	NA	NA
Nickel	- -	11	- -	10 J	NA	NA	NA
Silver	7	- -	- -	- -	NA	NA	NA
Pesticides							
4,4'-DDD	- -	0.0019 J	- -	- -	- -	- -	- -

SW-05	10/15/08	12/17/08	4/29/09	7/23/09	4/13/10	7/14/10	10/6/10
Dissolved Metals							
Arsenic	- -	- -	1.7 J-	3	0.6	2.5	1.3
Copper	- -	3	- -	4	NA	NA	NA
Manganese	345	227	795 J-	75	NA	NA	NA
Total Metals							
Aluminum	120	400	190	90	NA	NA	NA
Arsenic	1.5	0.8	1.6	4 J	1.2	3.2	1.9
Copper	- -	4	3	4	NA	NA	NA
Iron	1,700	1,080	2,010	720	NA	NA	NA
Manganese	366	243	782	89	NA	NA	NA
Silver	3	- -	- -	- -	NA	NA	NA
SVOCs							
Butyl benzyl phthalate	23	- -	- -	- -	NA	NA	NA

SW-03	10/15/08	12/17/08	4/29/09	7/23/09	4/13/10	07/12/10	10/5/10
Dissolved Metals							
Arsenic	1.1	- -	1.8 J-	1.8	1.3	3.8	1.1
Copper	- -	3	- -	- -	NA	NA	NA
Manganese	203	335	159 J-	180	NA	NA	NA
Nickel	- -	9	- -	- -	NA	NA	NA
Total Metals							
Aluminum	290	100	3,080	140	NA	NA	NA
Arsenic	2.2	- -	3	2.5 J	2	11	1.7
Copper	--	4	10	3	NA	NA	NA
Iron	1,790	- -	7,920	1,360	NA	NA	NA
Lead	- -	- -	3	- -	- -	13	- -
Manganese	230	353	276	195	NA	NA	NA
Mercury	- -	- -	- -	- -	- -	0.071	--
Nickel	- -	9	12.6	- -	NA	NA	NA

SW-04	10/15/08	12/18/08	4/29/09	7/23/09	4/13/10	7/14/10	10/6/10
Dissolved Metals							
Arsenic	2	- -	2 J-	3	1.4	4.6	1.6
Copper	- -	5	3 J-	3	NA	NA	NA
Manganese	68	246	164 J-	55	NA	NA	NA
Nickel	- -	11	- -	- -	NA	NA	NA
Total Metals							
Aluminum	1,570	4,240	440	1,090	NA	NA	NA
Arsenic	2.8	8	2	4 J	1.4	5.2	1.6
Copper	4	12	4	6	NA	NA	NA
Iron	3,490	7,580	1,020	2,440	NA	NA	NA
Manganese	125	382	176	107	NA	NA	NA
Nickel	- -	17	- -	- -	NA	NA	NA

PRELIMINARY CLEANUP LEVELS (PCL)

Metals (µg/L)	
Aluminum	87
Arsenic	0.2
Copper	2.4
Iron	1,000
Lead	2.5
Manganese	50
Mercury	0.02
Nickel	8.2
Silver	1.9
Zinc	81
SVOCs (µg/L)	
Bis(2-ethylhexyl) phthalate	1.2
Chrysene	0.01
Butyl benzyl phthalate	8.32
Pesticides (µg/L)	
4,4'-DDD	0.00125
VOCs (µg/L)	
Benzene	1.2

NOTE: ALUMINUM AND IRON HAD PCLs BUT ARE NOT CONSTITUENTS OF CONCERN.

NOTES:

- NA NOT ANALYZED
- - - ANALYTE NOT DETECTED AT A CONCENTRATION GREATER THAN PCLs
- J VALUE SHOWN IS ESTIMATED CONCENTRATION
- J- VALUE SHOWN IS ESTIMATED CONCENTRATION WITH A POSSIBLE LOW BIAS

EXPLANATION

- MONITORING WELL SCREENED IN SOLID WASTE
- MONITORING WELL SCREENED IN LOWER AQUIFER (Qago)
- SURFACE WATER SAMPLE
- SEEP SAMPLE
- PIEZOMETER
- TEST PIT
- SHELBY TUBE
- APPROXIMATE EXTENT OF SOLID WASTE (BASED ON TEST PIT OBSERVATION) (DASHED WHERE INFERRED)

NOTE:

EXPLORATION LOCATIONS IN GRAY WERE NOT ANALYZED OR HAD NO ANALYTICAL RESULTS THAT EXCEEDED THE PCL.

PHASE I AND PHASE II SUMMARY OF PCL EXCEEDANCES IN SURFACE WATER SAMPLES

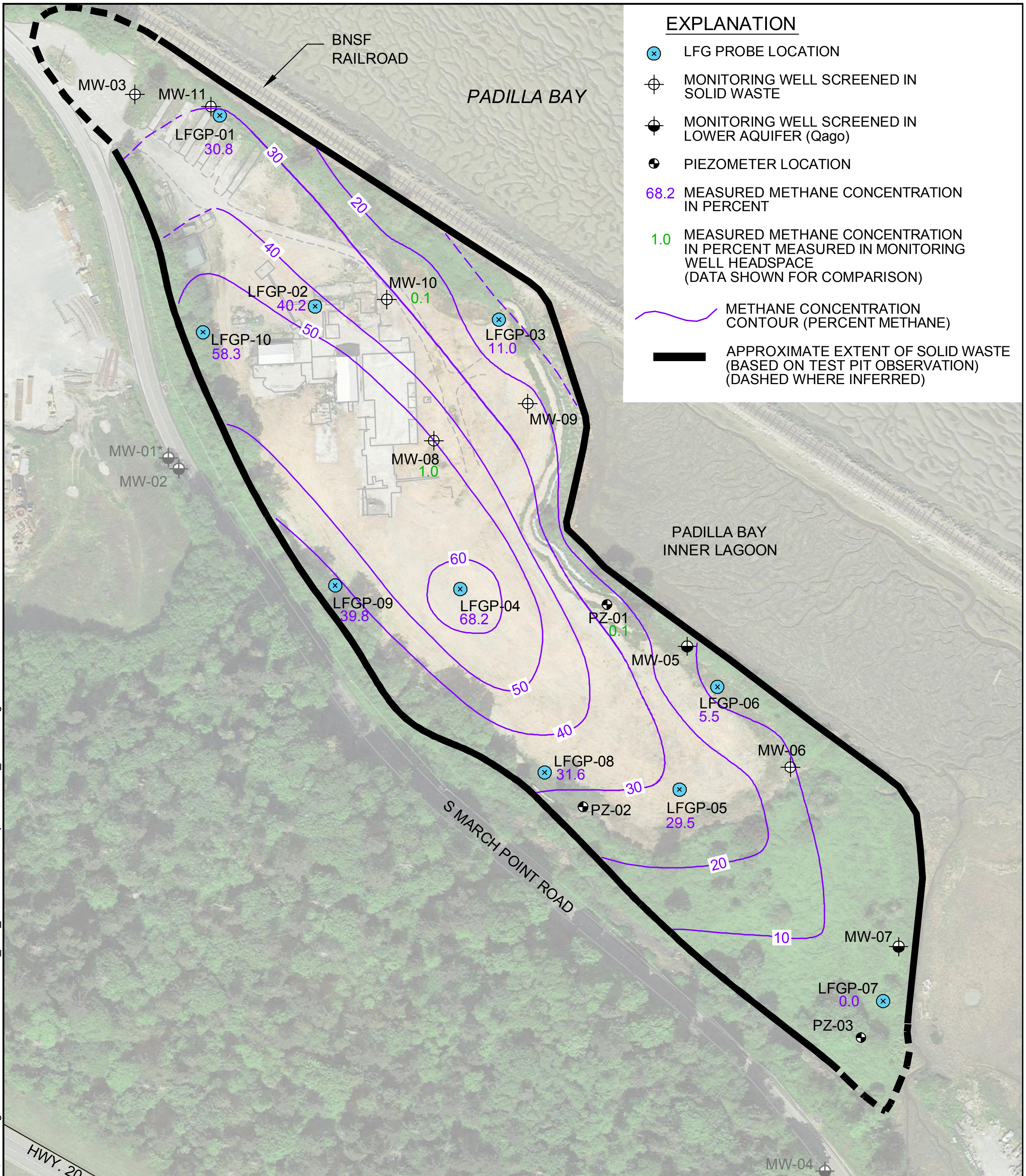
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS | Date: 10/30/15 | Project No. 14159

amec

Figure 11

Plot Date: 10/30/15 - 1:43pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_Soil-GW-Databoxes_092815_recover.dwg



Aerial Photo Courtesy of Google Earth (May, 2015)

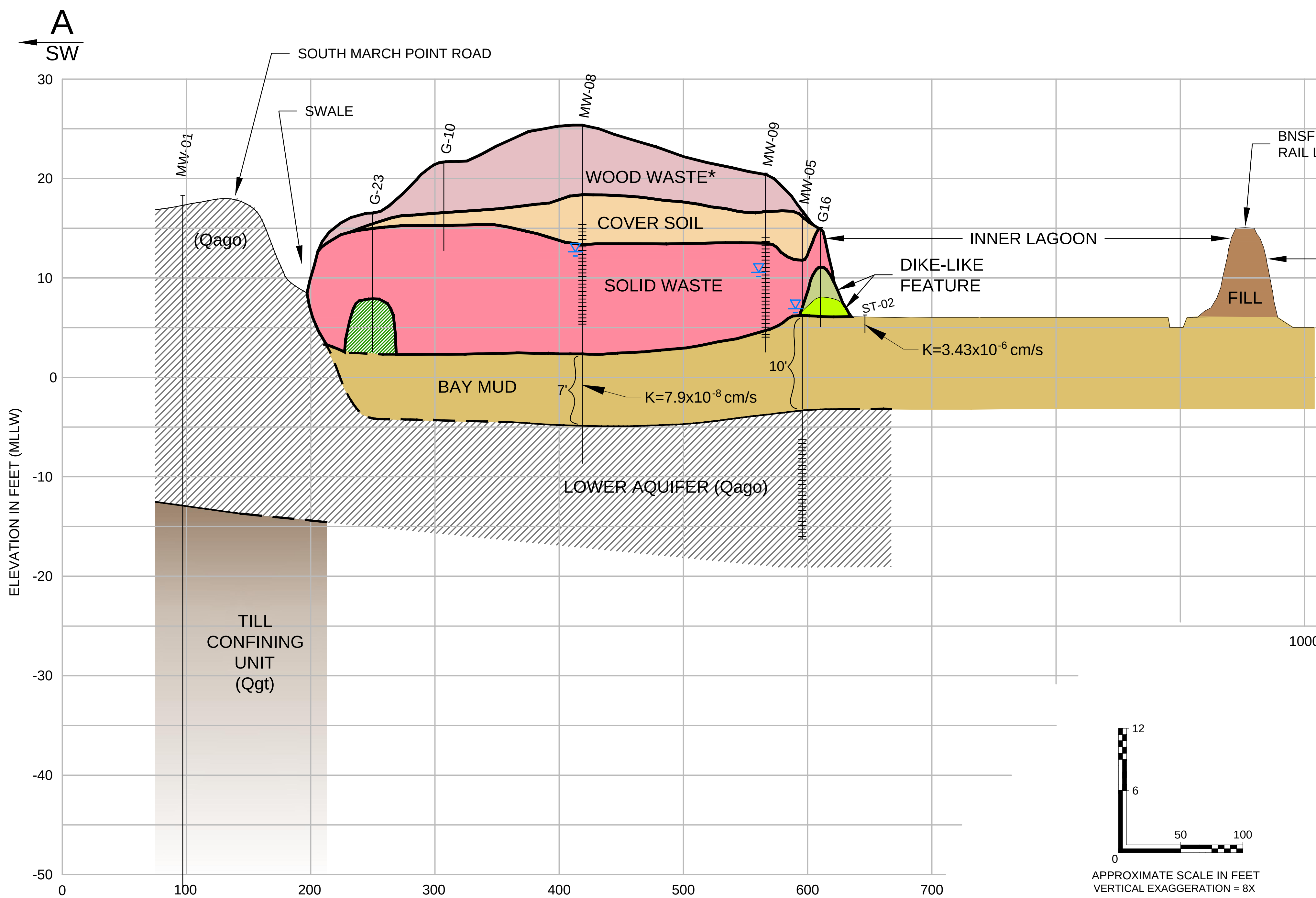
0 100 200
APPROXIMATE SCALE IN FEET

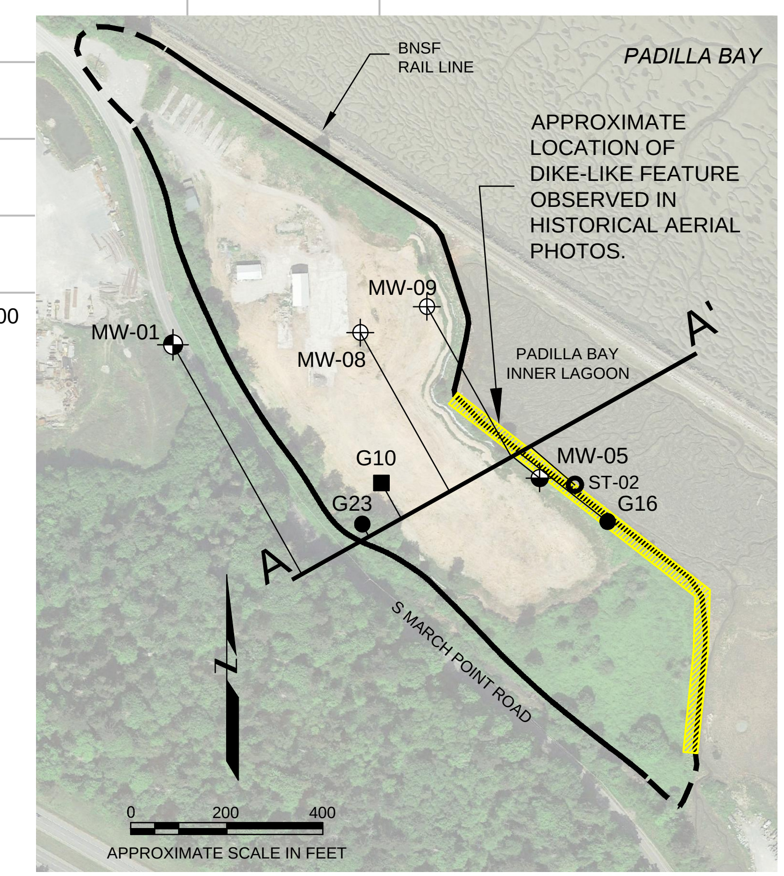
NOTE:
Methane concentrations from groundwater monitoring wells not used to generate contours.

METHANE CONCENTRATIONS, APRIL 2012
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 10/02/15	Project No. 14159
amec		Figure 12

Plot Date: 10/02/15 - 1:42pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_LFG_MethaneConcentApril2012-GW_100215.dwg





KEY:

- WELL SCREEN INTERVAL
- WATER LEVEL (MAY 2010)
- K= HYDRAULIC CONDUCTIVITY CALCULATED USING ASTM METHOD D-5084.
- 7' THICKNESS OF BAY MUD IN FEET
- INFERRED BOUNDARY
- WOOD WASTE*
- COVER SOIL
- SOLID WASTE
- LEAN CLAY TO ELASTIC SILT (CL-ML) (BAY MUD)
- POORLY GRADED SAND TO WELL-GRADED SAND WITH GRAVEL (SP-SW) (Qago, RECESSIONAL OUTWASH AQUIFER)
- POORLY GRADED GRAVEL WITH SAND (GP) [POTENTIALLY OLD ROAD BED CONSISTING OF COBBLE ROAD BASE MATERIAL OBSERVED IN 1968 AERIAL PHOTOGRAPH AND GEOPHYSICAL ANOMALY (APPENDIX B, FIGURE 3)]
- POORLY GRADED SAND (SP) (POTENTIAL DIKE-LIKE FEATURE)
- SILT WITH SAND (ML) (POTENTIAL DIKE-LIKE FEATURE)
- LEAN CLAY (CL) (Qgt, TILL CONFINING UNIT)

* MAJORITY OF THE WOOD WASTE WAS REMOVED IN FALL 2014 BY DNR.

NOTES:

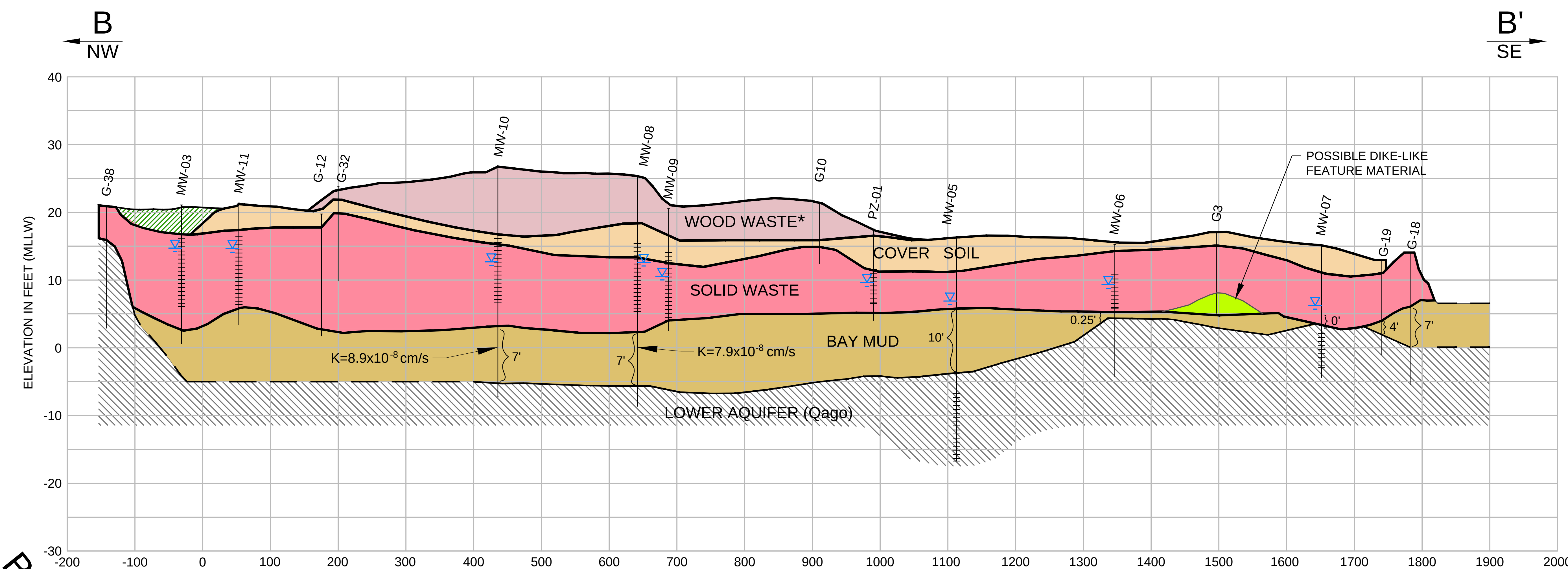
1. Vertical Datum: MLLW (ft)
2. No well installed in MW-01 because no aquifer encountered deeper than the lower aquifer.
3. Simplified geologic unit (Qago, Qgt) designations based on Schuster (2000).

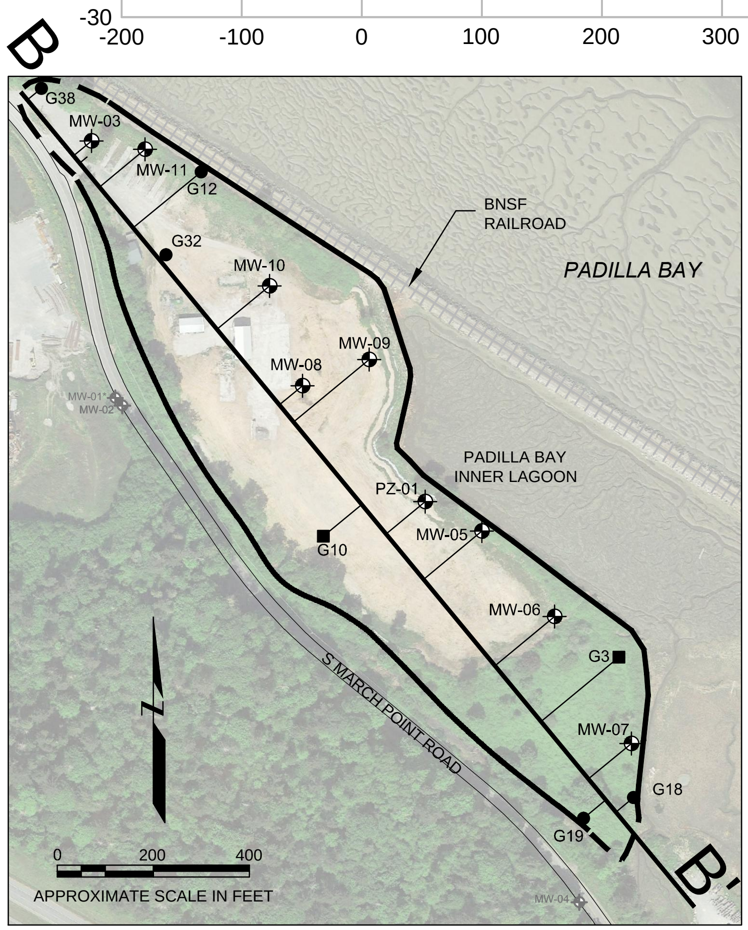
GEOLOGIC CROSS SECTION A-A'

March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/01/16	Project No. 14159
amec		Figure 13

Plot Date: 03/01/16 - 11:02am, Plotted by: adam.stenberg
Drawing Path: X:\Autodesk\DWG-TEMP-Location\AcPublish_5760\, Drawing Name: Whitmarsh_Cross-Sect-A_100115.dwg





KEY:

- WELL SCREEN INTERVAL
- WATER LEVEL (MAY 2010)
- K= HYDRAULIC CONDUCTIVITY CALCULATED USING ASTM METHOD D-5084.
- 7' THICKNESS OF BAY MUD IN FEET
- INFERRED BOUNDARY
- WOOD WASTE*
- COVER SOIL
- SOLID WASTE
- LEAN CLAY TO ELASTIC SILT (CL-ML) (BAY MUD)
- COBBLE/ROAD BASE MATERIAL
- POORLY GRADED SAND TO WELL GRADED SAND WITH GRAVEL (SP-SW) (Qago, RECESSIONAL OUTWASH AQUIFER)
- WELL-GRADED SAND (SW) (POSSIBLE DIKE-LIKE FEATURE)

16
8
0
80
160

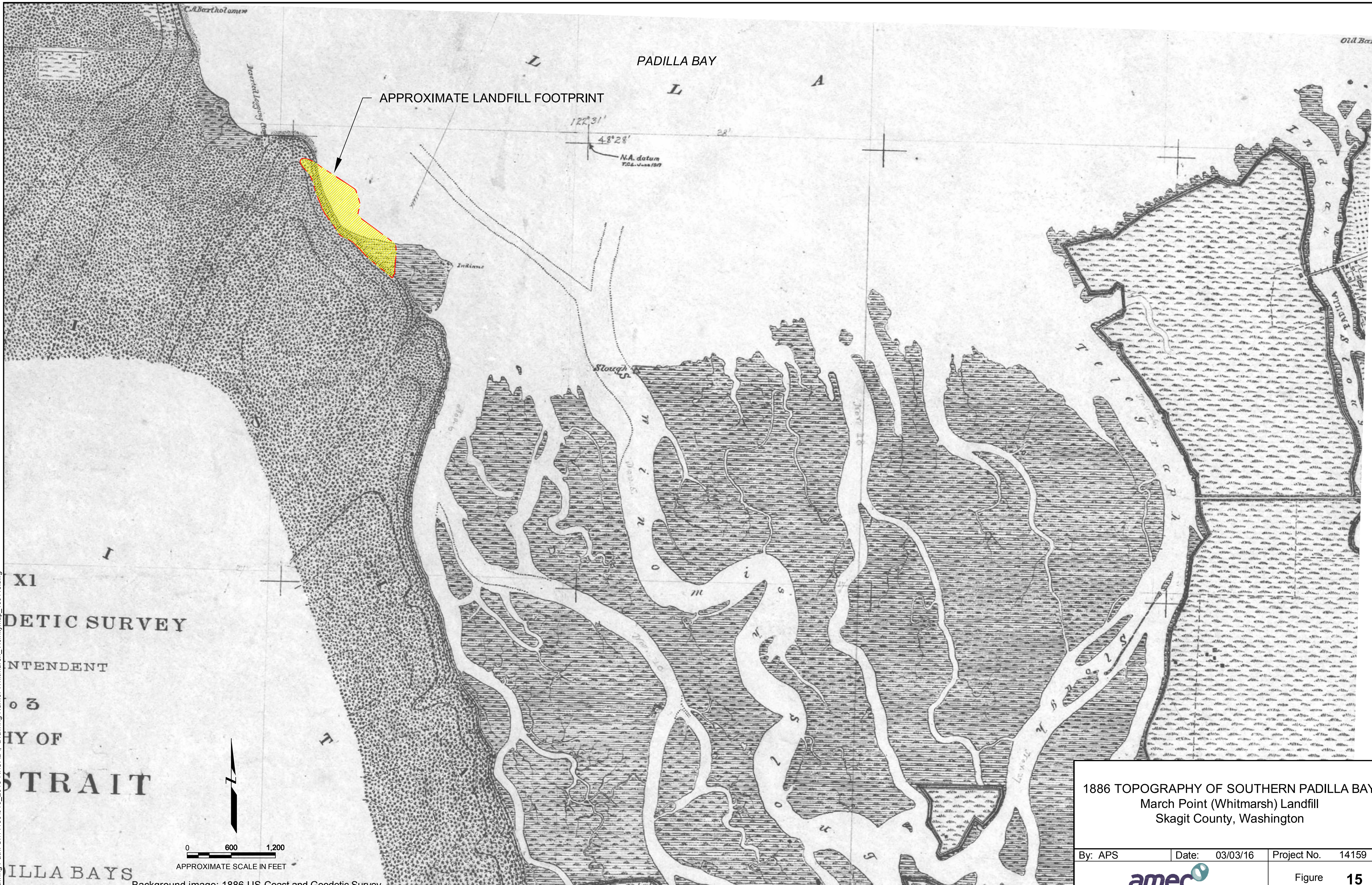
APPROXIMATE SCALE IN FEET
VERTICAL EXAGGERATION = 10X

NOTES:
1. Vertical Datum: MLLW (ft)
2. Simplified geologic unit (Qago, Qgt) designations based on Schuster (2000).

GEOLOGIC CROSS SECTION B-B'
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/01/16	Project No. 14159
amec		Figure 14

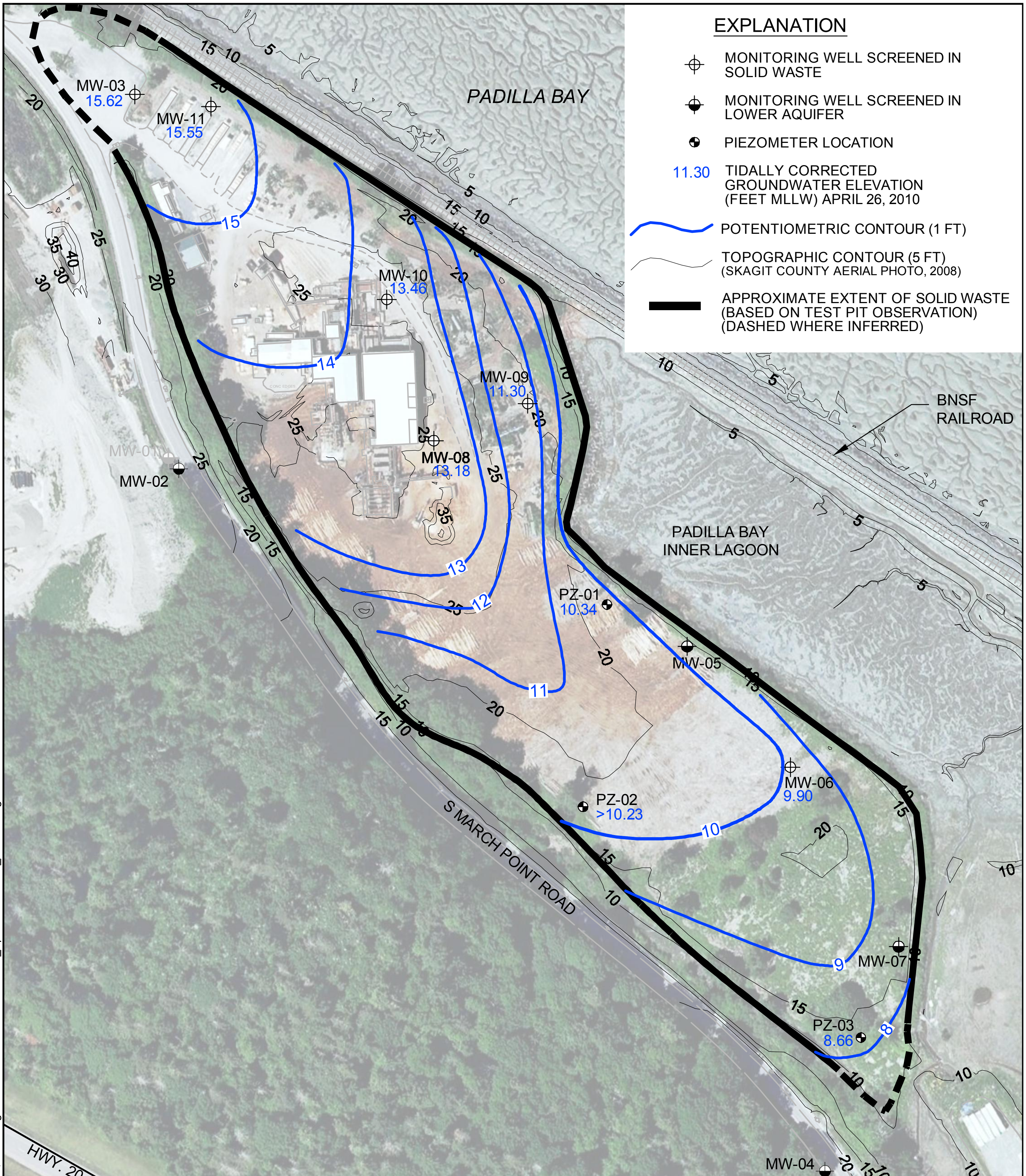
Plot Date: 03/01/16 - 11:04am, Plotted by: adam.stenberg
Drawing Path: X:\Autodesk\DWG-TEMP-Location\AcPublish_5760\, Drawing Name: Whitmarsh_Cross-Sect-B_100115.dwg



1886 TOPOGRAPHY OF SOUTHERN PADILLA BAY
March Point (Whitmarsh) Landfill
Skagit County, Washington

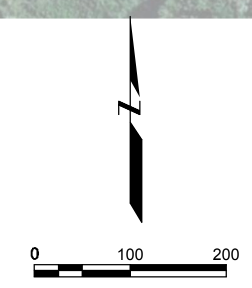
By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 15

Plot Date: 03/03/16 - 5:02pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-R\CAD\, Drawing Name: Whitmarsh_VicinityMap_100115.dwg



Aerial Photo Courtesy of Google Earth (USGS, May 30, 2009)

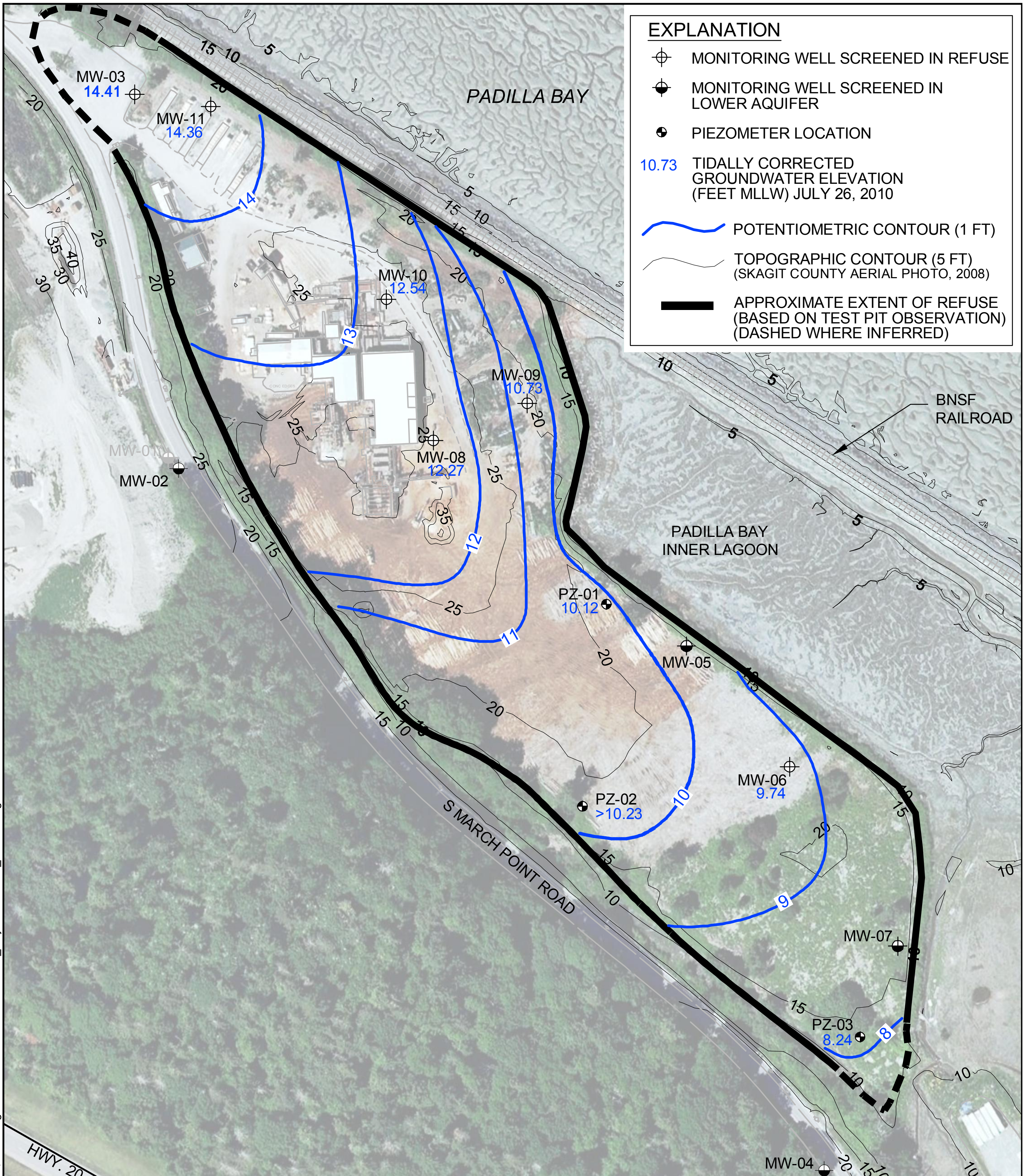
NOTE:
Tidally corrected groundwater elevation on April 26, 2010, calculated based on 71 consecutive one-hour groundwater level measurements using method developed by Serfes (1991).



POTENTIOMETRIC SURFACE MAP
APRIL 26, 2010
March Point (Whitmarsh) Landfill
Skagit County, Washington

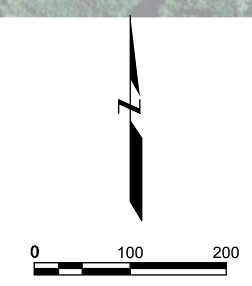
By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 16

Plot Date: 03/03/16 - 4:39pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_April26-2010-GW_100215.dwg



Aerial Photo Courtesy of Google Earth (USGS, May 30, 2009)

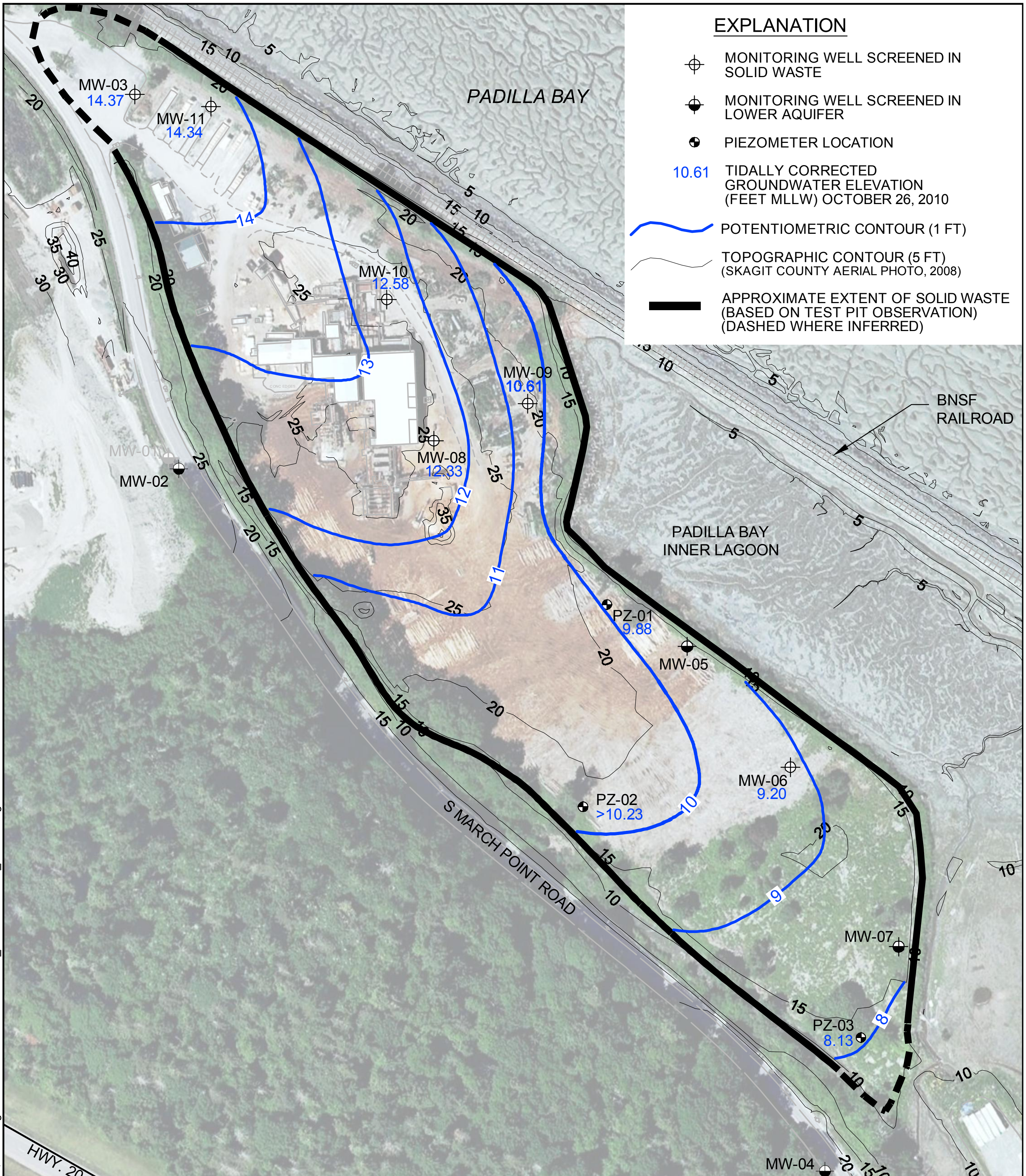
NOTE:
Tidally corrected groundwater elevation on April 26, 2010, calculated based on 71 consecutive one-hour groundwater level measurements using method developed by Serfes (1991).



POTENTIOMETRIC SURFACE MAP
JULY 26, 2010
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 17

Plot Date: 03/03/16 - 6:02pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_July26-2010-GW_100215.dwg



Aerial Photo Courtesy of Google Earth (USGS, May 30, 2009)

NOTE:
Tidally corrected groundwater elevation on April 26, 2010, calculated based on 71 consecutive one-hour groundwater level measurements using method developed by Serfes (1991).

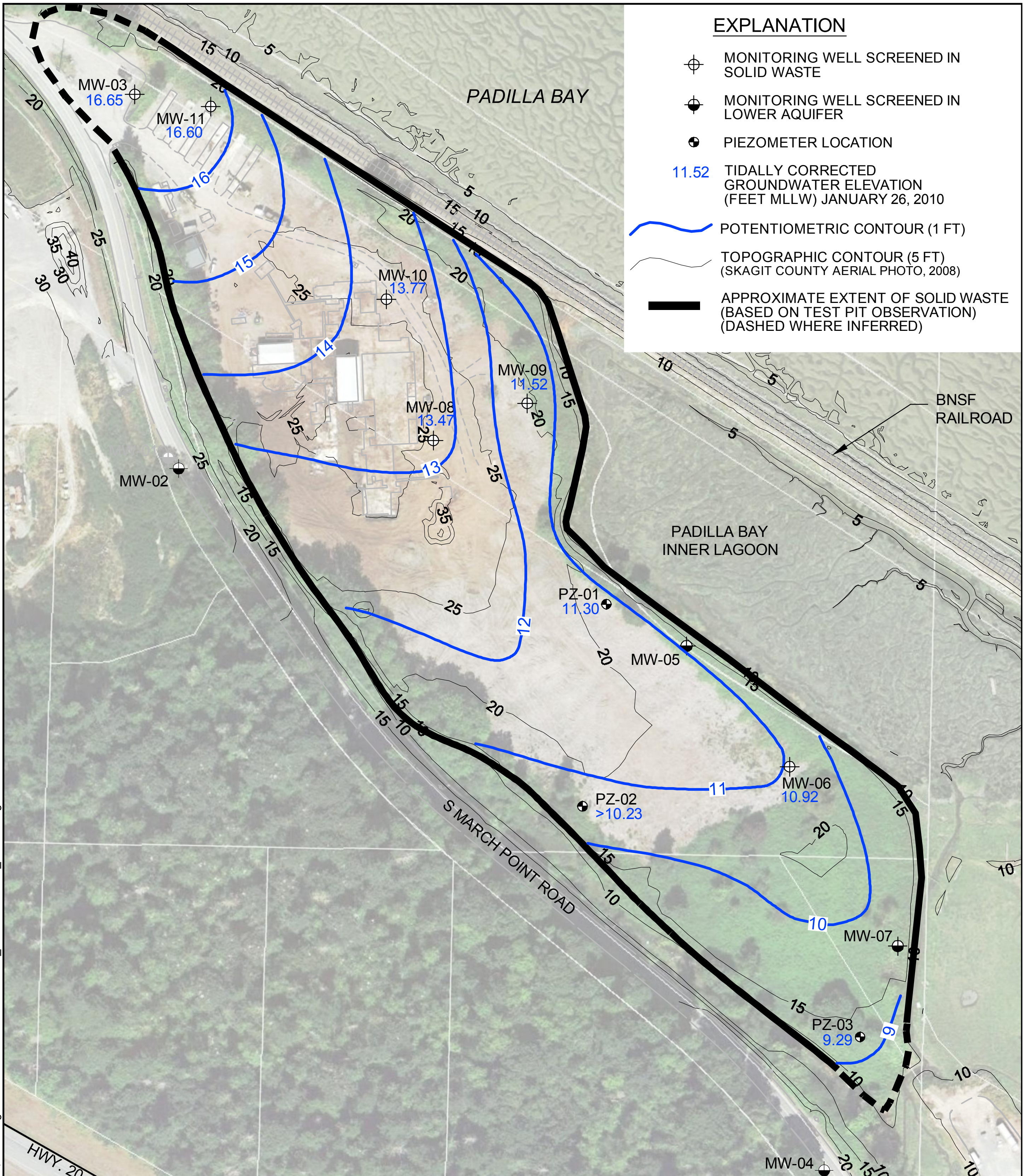
N

0 100 200
APPROXIMATE SCALE IN FEET

POTENTIOMETRIC SURFACE MAP
OCTOBER 26, 2010
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 18

Plot Date: 03/03/16 - 6:12pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_Oct26-2010-GW_100215.dwg



Aerial Photo Courtesy of Google Earth (August 25, 2011)

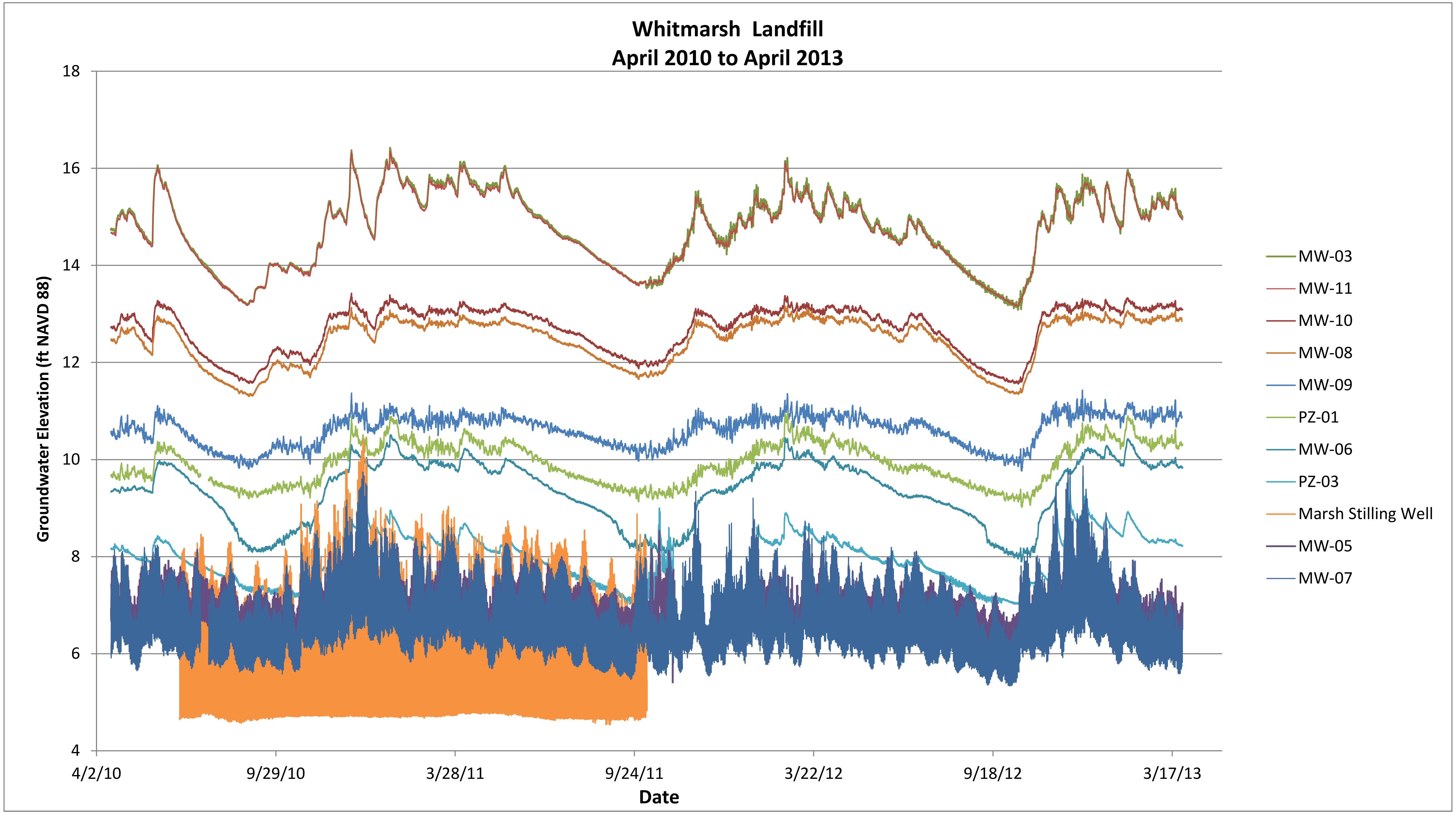
NOTE:
Tidally corrected groundwater elevation on April 26, 2010, calculated based on 71 consecutive one-hour groundwater level measurements using method developed by Serfes (1991).

0 100 200
APPROXIMATE SCALE IN FEET

POTENTIOMETRIC SURFACE MAP
JANUARY 26, 2011
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 19

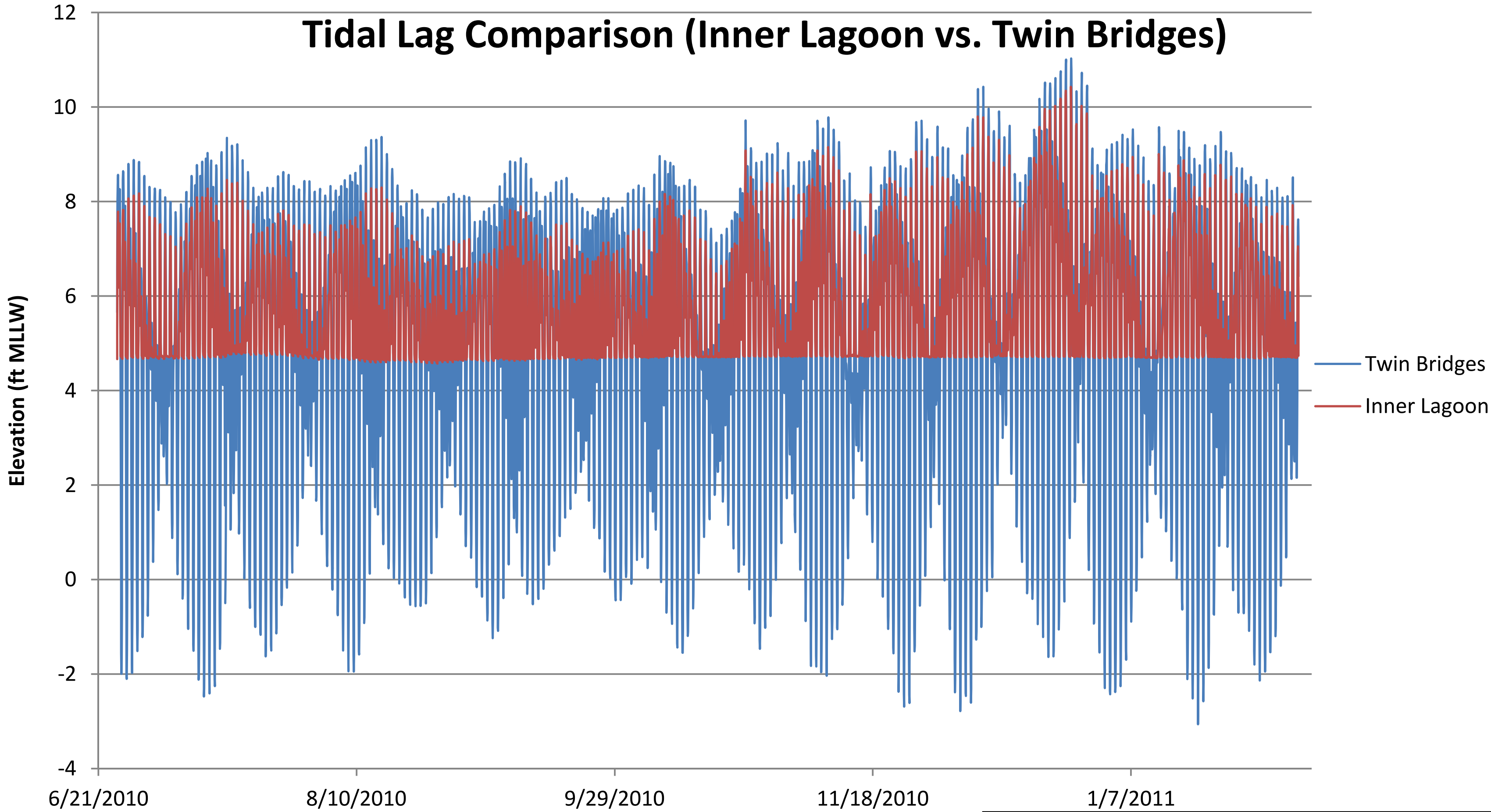
Plot Date: 03/03/16 - 6:19pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_Jan26-2011-GW_100215.dwg



Notes:
1. Piezometer 2 (PZ-02) is dry, and not shown
2. Marsh Stilling Well transducer malfunctioned starting on Oct. 7, 2011

SUMMARY HYDROGRAPH
April 2010 to March 2013
March Point (Whitmarsh) Landfill
Skagit County, Washington

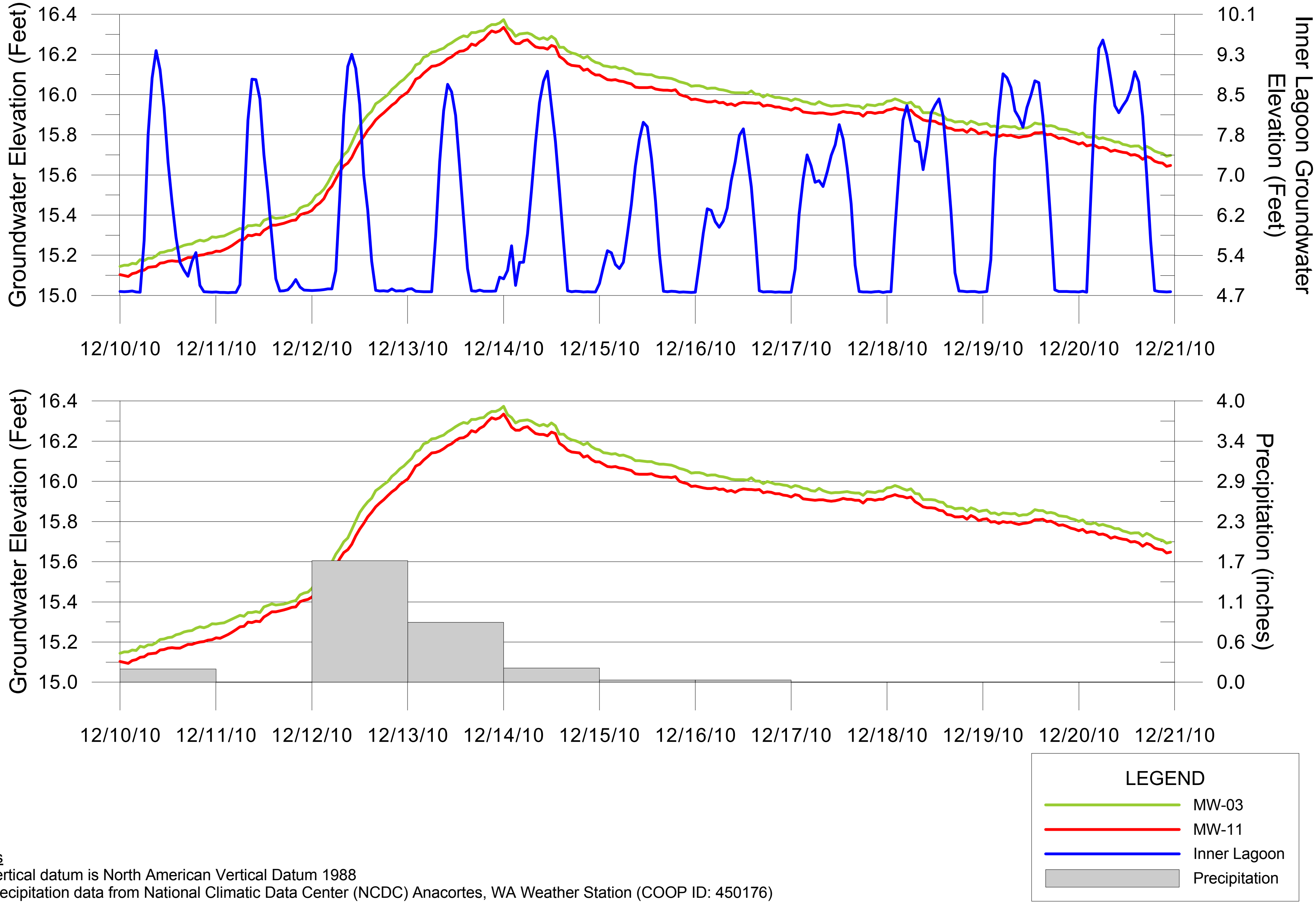
By: NBM	Date: 03/10/14	Project No.: 14159
amec		Figure 20



TIDAL LAG COMPARISON
APRIL 2010 TO JANUARY 2011
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: NPB	Date: 02/23/11	Project No.: 14159
amec		Figure 21

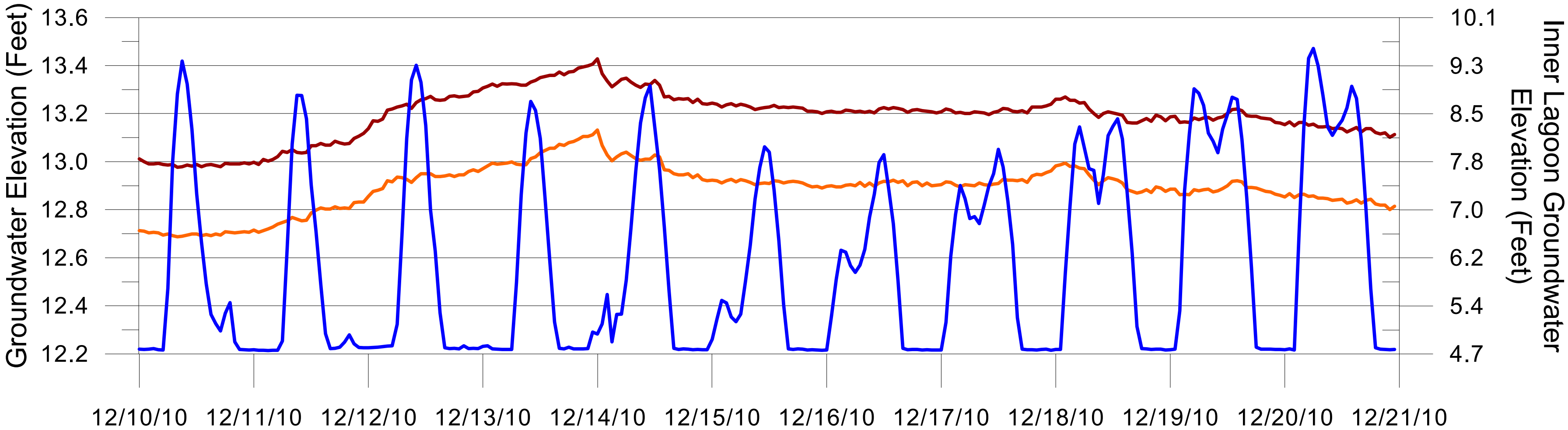
P:\14159 - Skagit Whitmarsh Landfill\5000 Investigation Field Data\Transducer Data\Transducer_Water_Fluctuations.grf

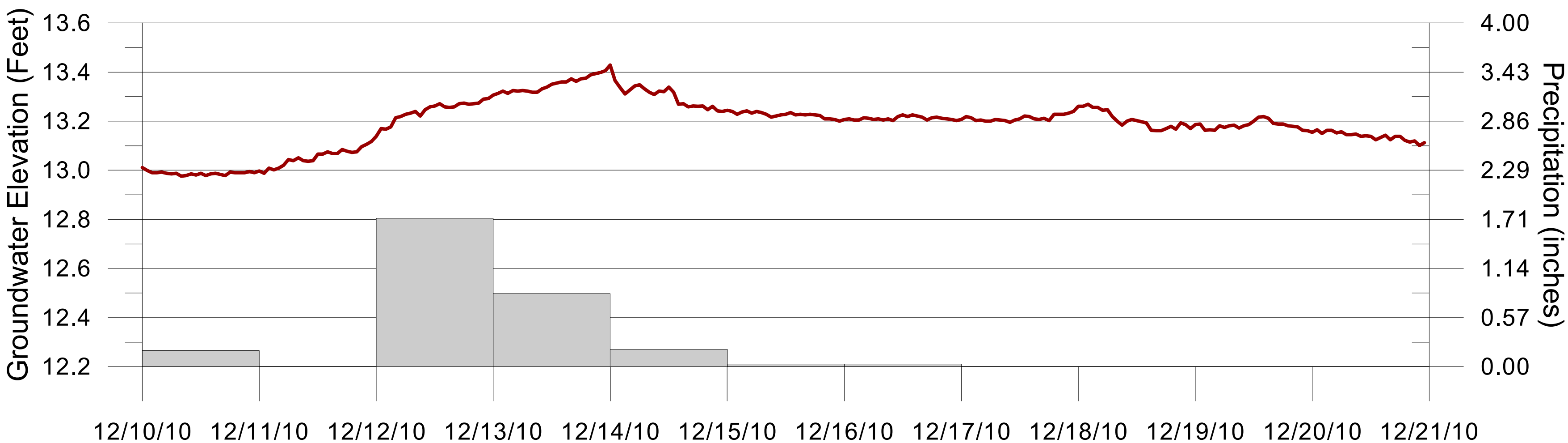


Notes
1. Vertical datum is North American Vertical Datum 1988
2. Precipitation data from National Climatic Data Center (NCDC) Anacortes, WA Weather Station (COOP ID: 450176)

amec	TIDAL FLUCTUATION EVALUATION: WELLS MW-03 and MW-11 March Point (Whitmarsh) Landfill Skagit County, Washington	Prepared By: RLW	Project No. 14159
		3/14/12	Figure No. 22

P:\14159 - Skagit Whitmarsh Landfill\5000 Investigation Field Data\Transducer Data\Transducer_Water_Fluctuations.grf





LEGEND
- MW-08
- MW-10
- Inner Lagoon
- Precipitation

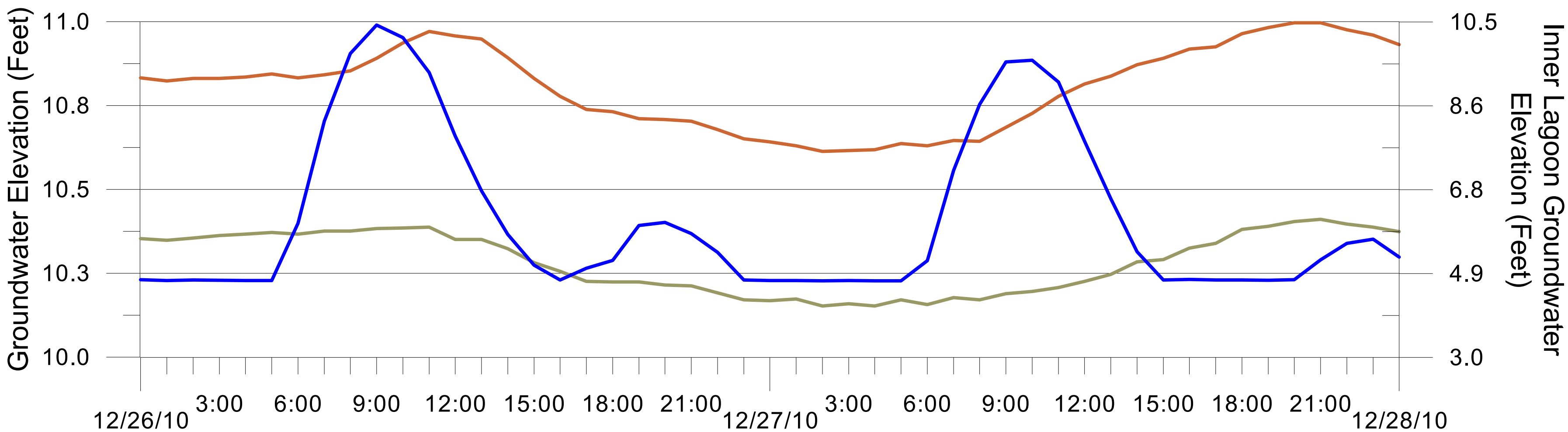
Notes
1. Vertical datum is North American Vertical Datum 1988
2. Precipitation data from National Climatic Data Center (NCDC) Anacortes, WA Weather Station (COOP ID: 450176)

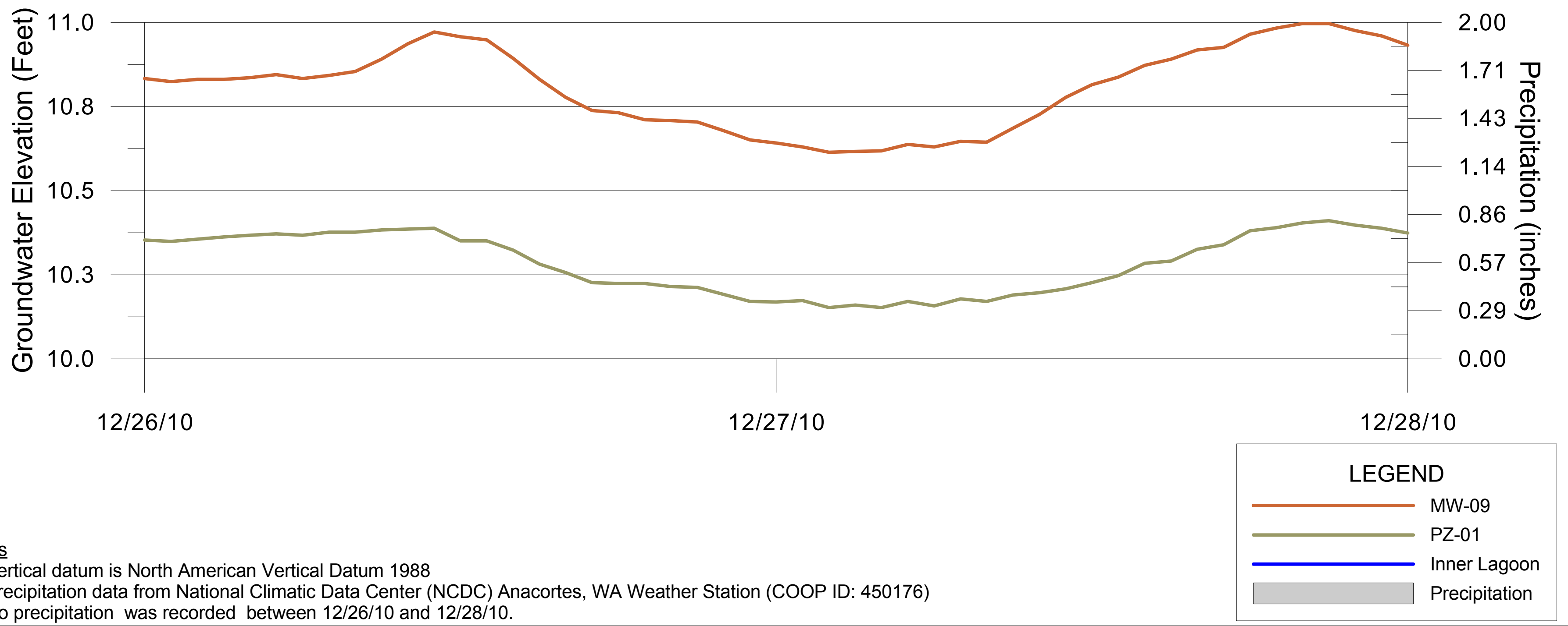
amec

TIDAL FLUCTUATION EVALUATION: WELLS MW-08 and MW-10
March Point (Whitmarsh) Landfill
Skagit County, Washington

Prepared By: RLW	Project No. 14159
3/14/12	Figure No. 23

P:\14159 - Skagit Whitmarsh Landfill\5000 Investigation Field Data\Transducer Data\Transducer_Water_Fluctuations.grf

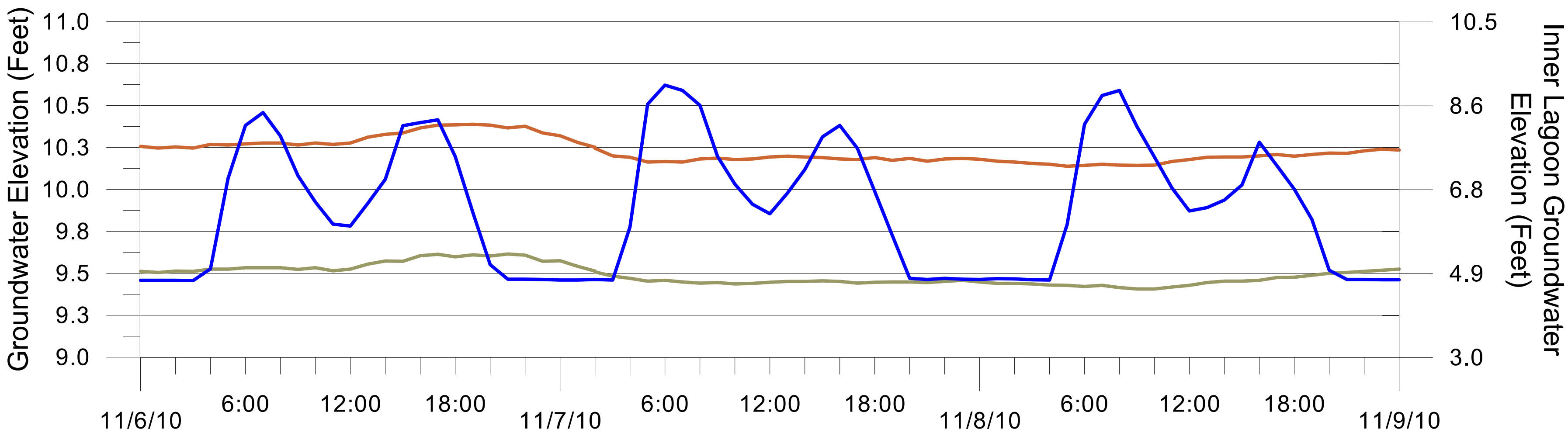


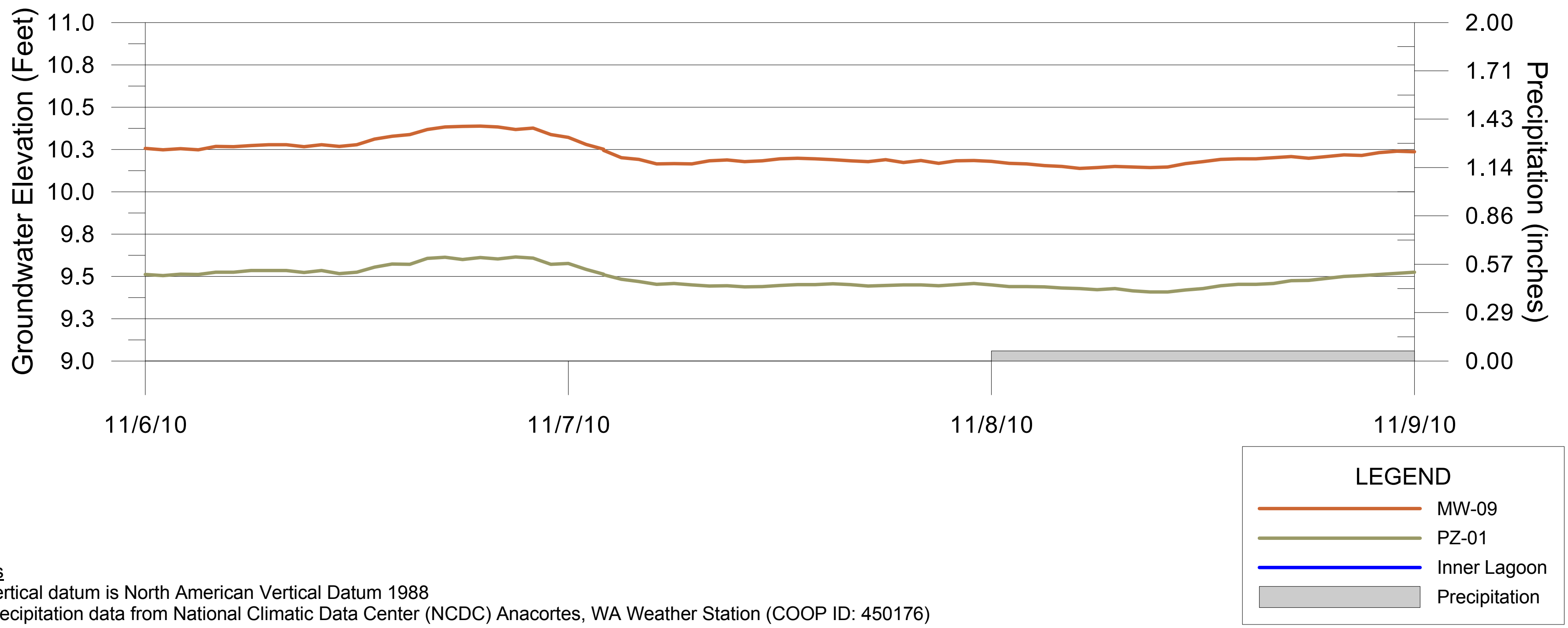


Notes
1. Vertical datum is North American Vertical Datum 1988
2. Precipitation data from National Climatic Data Center (NCDC) Anacortes, WA Weather Station (COOP ID: 450176)
3. No precipitation was recorded between 12/26/10 and 12/28/10.

amec	TIDAL FLUCTUATION EVALUATION: WELLS MW-09 and PZ-01 March Point (Whitmarsh) Landfill Skagit County, Washington	Prepared By: RLW 3/14/12	Project No. 14159 Figure No. 24

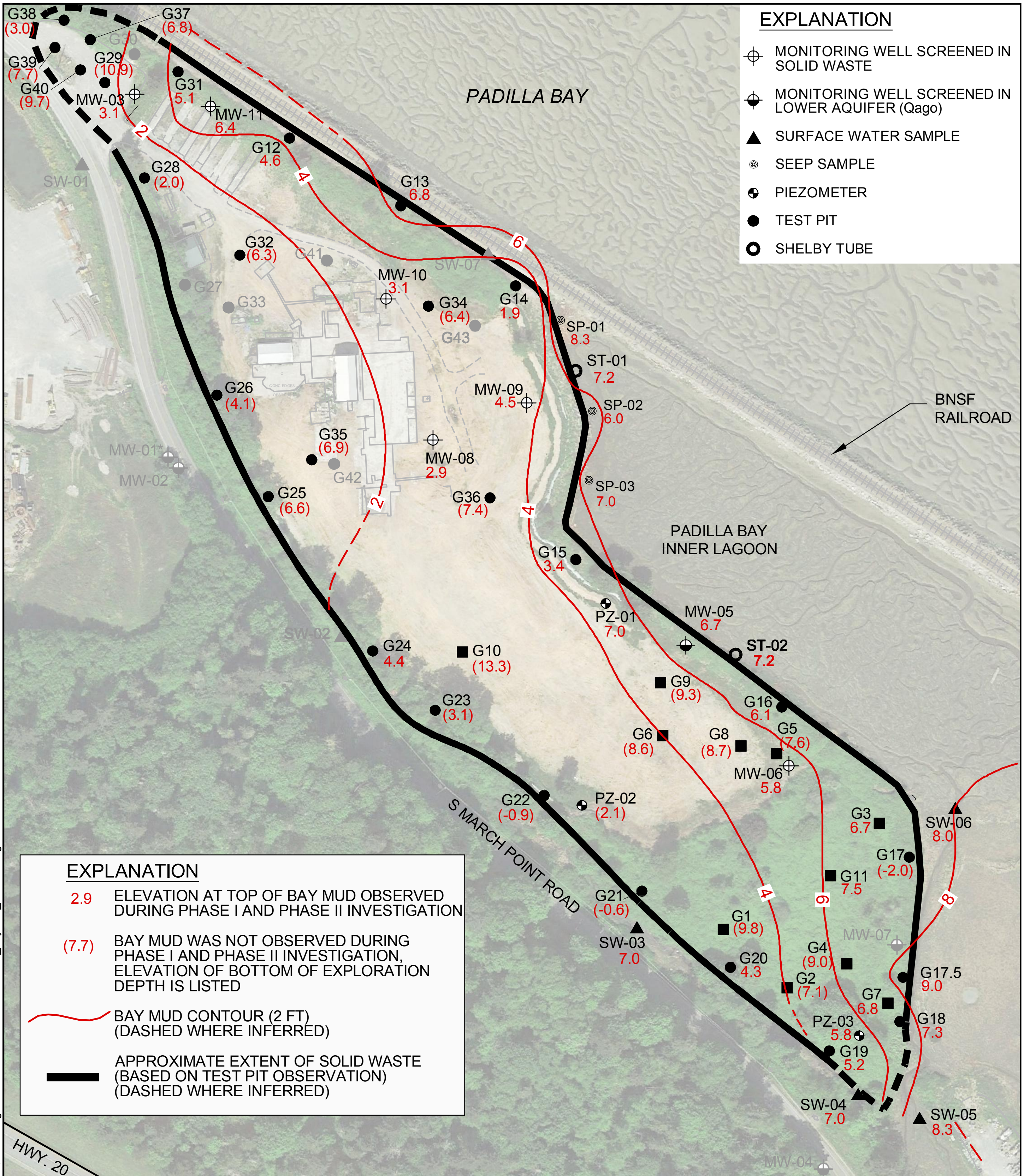
P:\14159 - Skagit Whitmarsh Landfill\5000 Investigation Field Data\Transducer Data\Transducer_Water_Fluctuations.grf





<u>Notes</u>
1. Vertical datum is North American Vertical Datum 1988
2. Precipitation data from National Climatic Data Center (NCDC) Anacortes, WA Weather Station (COOP ID: 450176)

amec	ADDITIONAL TIDAL FLUCTUATION EVALUATION: WELLS MW-09 and PZ-01 March Point (Whitmarsh) Landfill Skagit County, Washington	Prepared By: RLW	Project No. 14159
		3/14/12	Figure No. 25

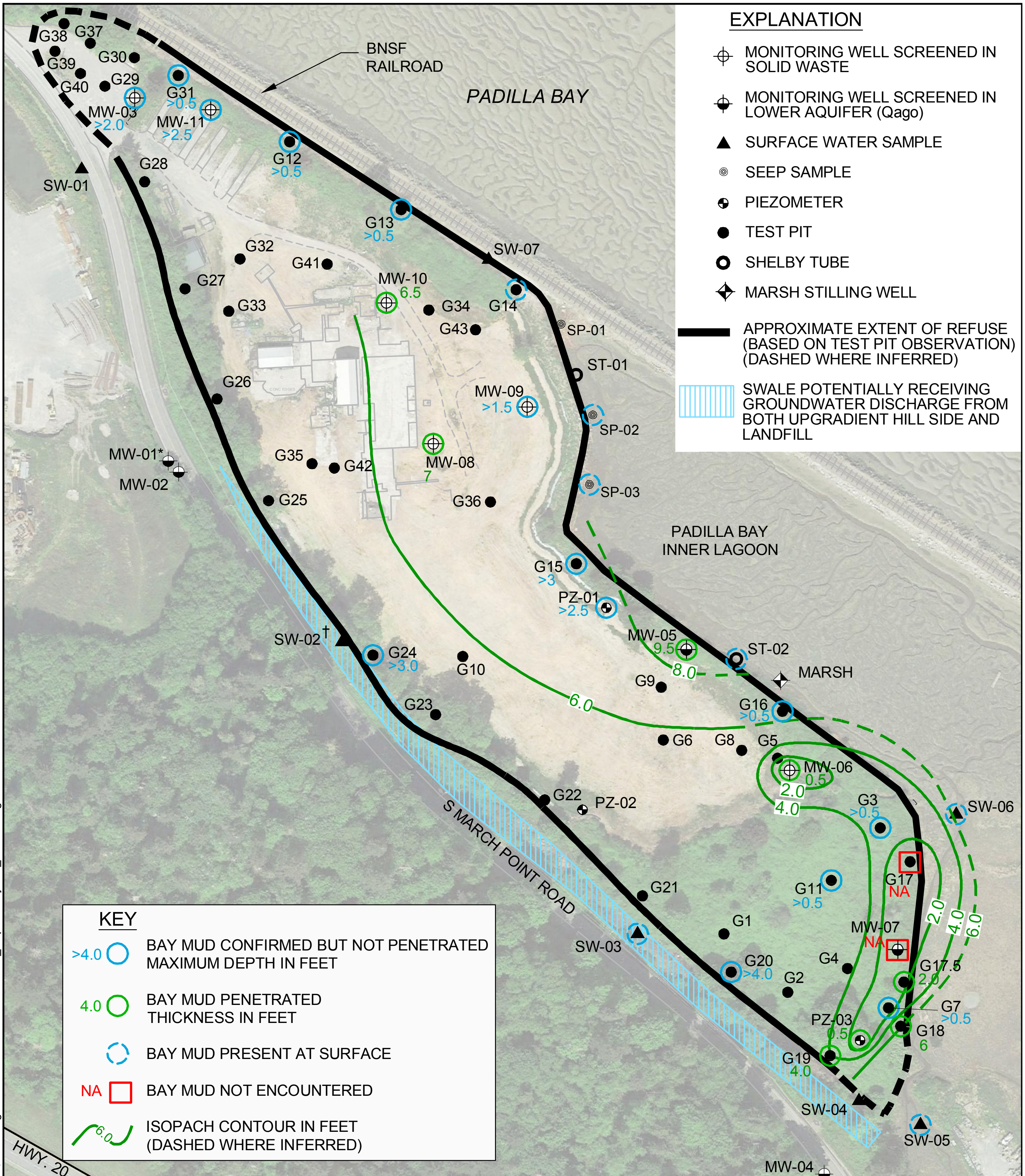


Aerial Photo Courtesy of Google Earth (May 2015)
Vertical Datum: MLLW

TOP ELEVATION OF BAY MUD
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 26

Plot Date: 03/03/16 - 6:30pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_BayMud_100215.dwg



Aerial Photo Courtesy of Google Earth (May 2015)

NOTES:

* No well was installed at MW-01 because no deeper aquifer was encountered at the time of drilling.

† SW-02 was dry during all sampling events and was therefore not sampled.

ISOPACH MAP OF BAY MUD

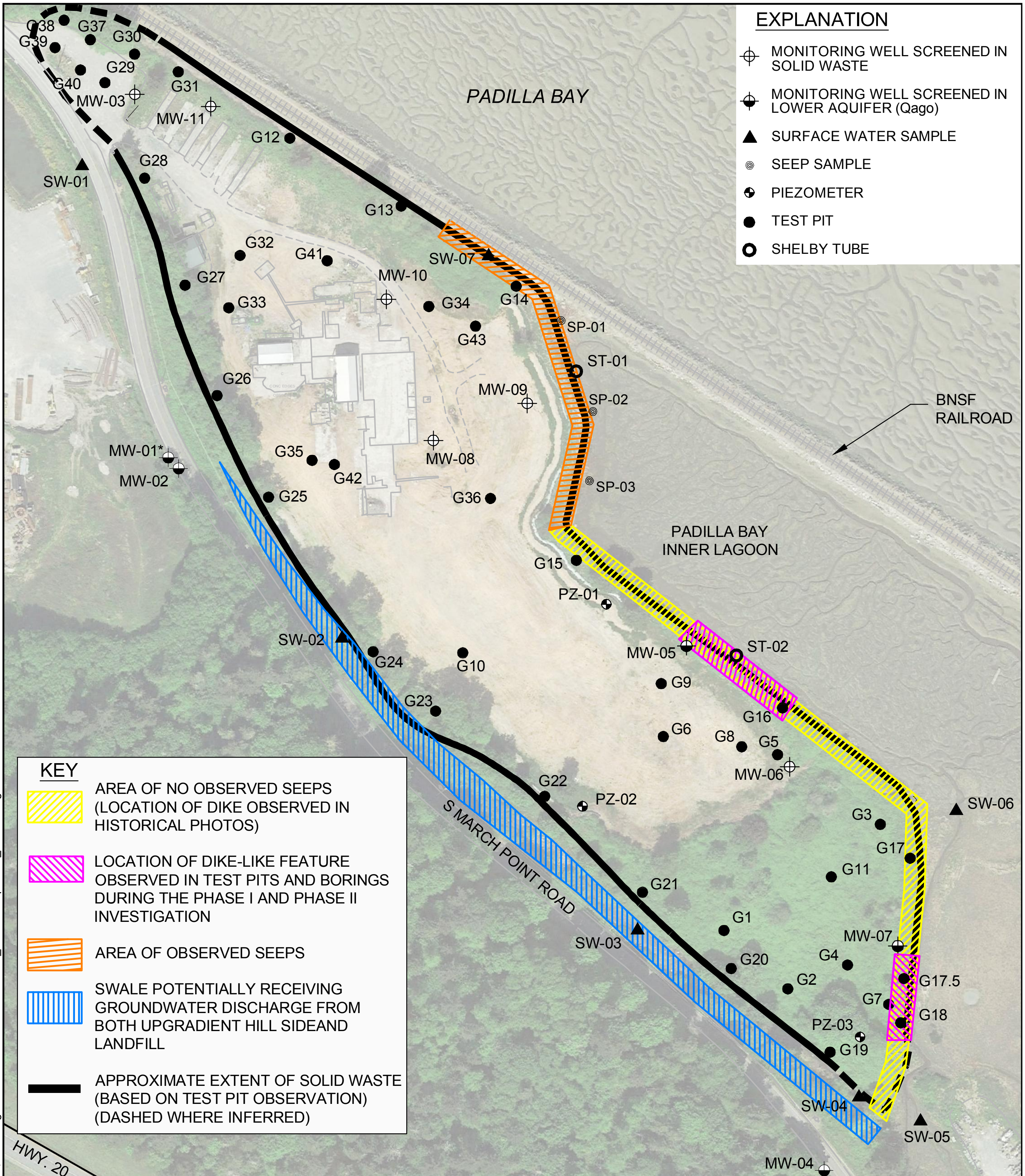
March Point (Whitmarsh) Landfill

Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 27

Plot Date: 03/03/16 - 6:35pm, Plotted by: adam.stenberg

Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_Isopach-BayMud_100215.dwg



Aerial Photo Courtesy of Google Earth
(May 2015)

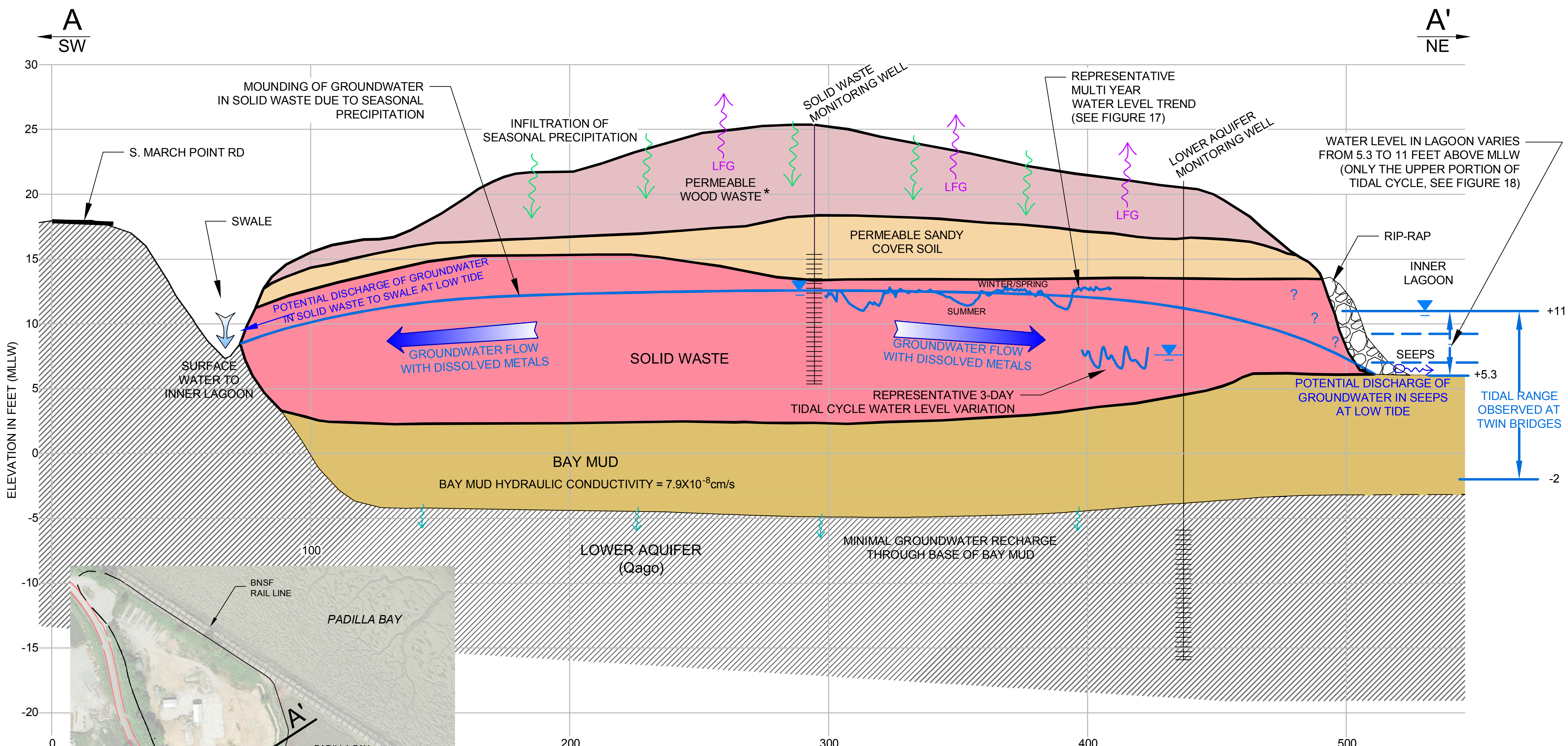
N

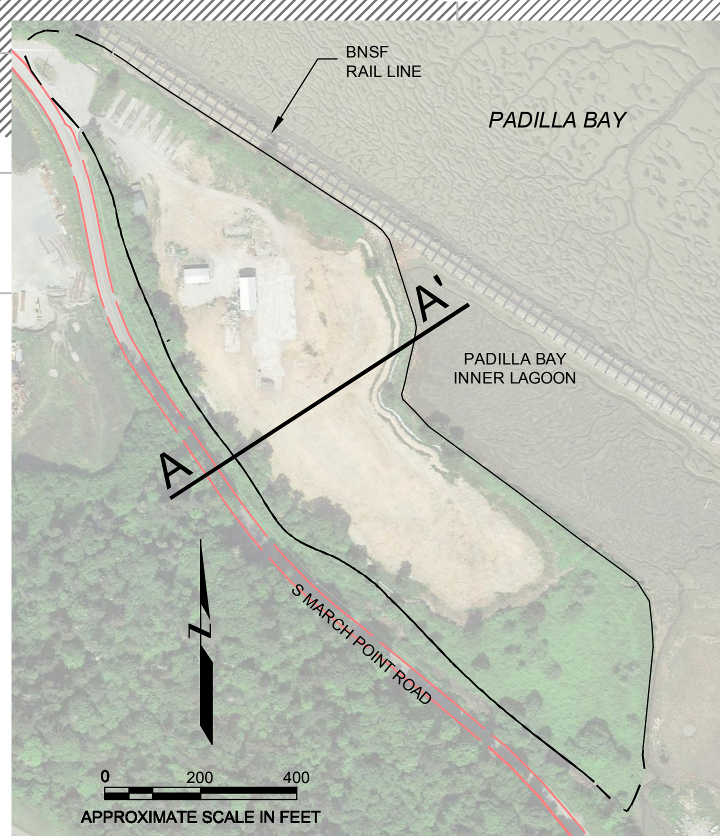
0 100 200
APPROXIMATE SCALE IN FEET

AREAS OF SEEPS
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 28

Plot Date: 03/03/16 - 6:39pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_AreaOfSeeps-Dike_100215.dwg





KEY:

WELL SCREEN INTERVAL

WATER LEVEL (MAY 2010)

* MAJORITY OF THE WOOD WASTE WAS REMOVED IN FALL 2014 BY DNR.

NOTES:

1. Vertical Datum: MLLW (ft)
2. Simplified geologic unit (Qago, Qgt) designations based on Schuster (2000).
3. Hydraulic conductivity calculated using ASTM method D-5084.

APPROXIMATE SCALE IN FEET
VERTICAL EXAGGERATION = 5X

CONCEPTUAL SITE MODEL ILLUSTRATION
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 29

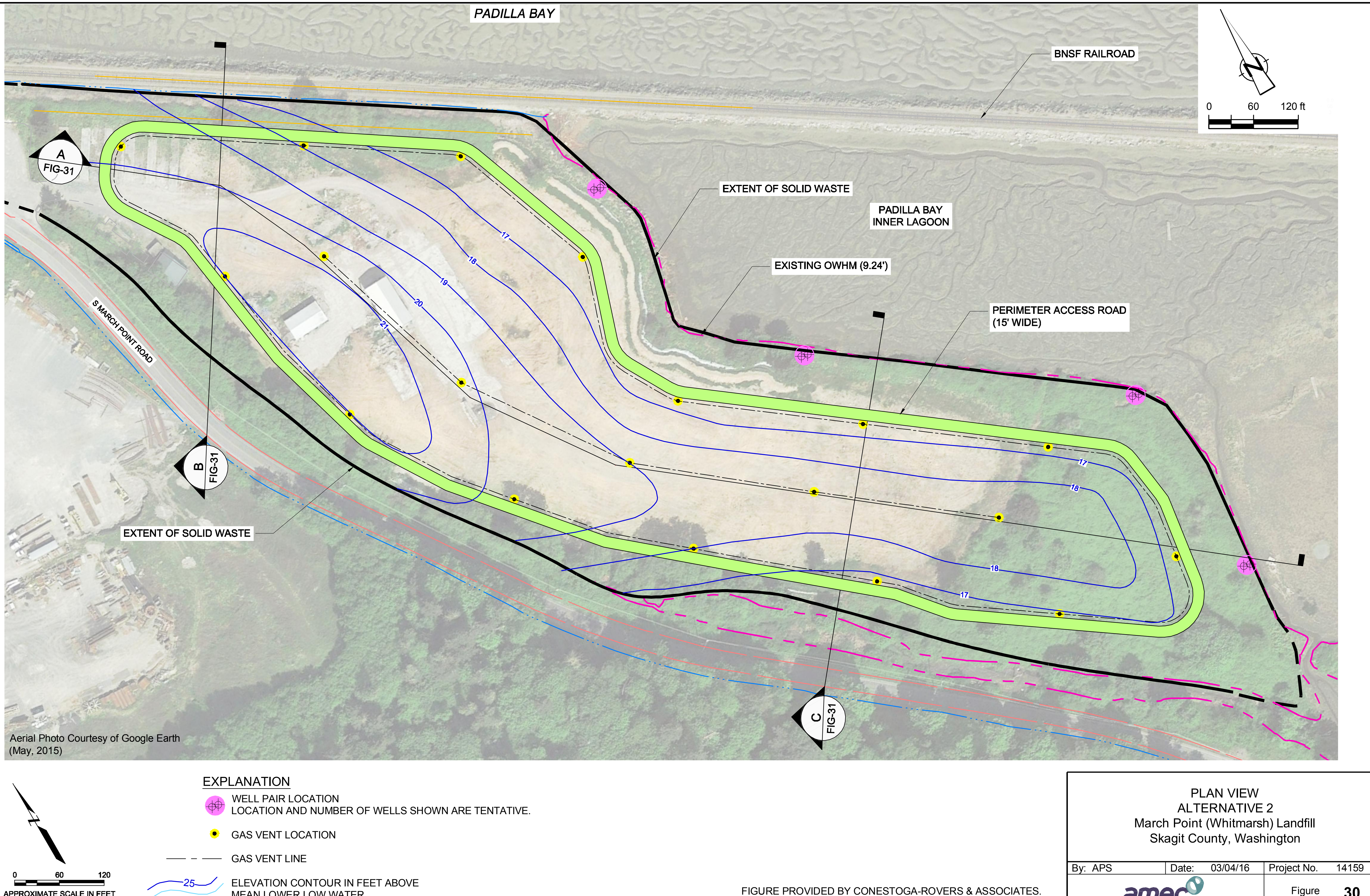
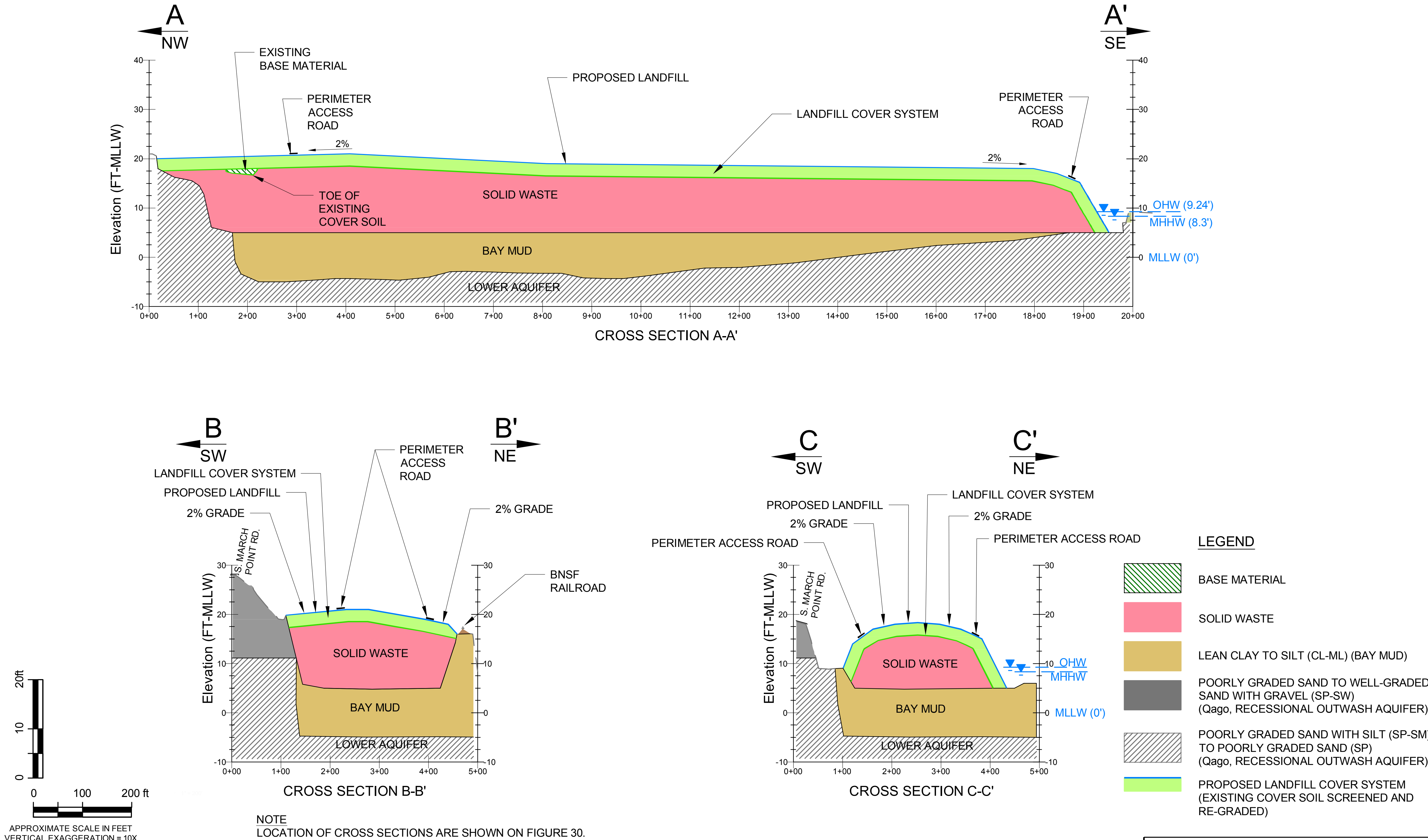


FIGURE PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES.

PLAN VIEW
ALTERNATIVE 2
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/04/16	Project No. 14159
amec		Figure 30

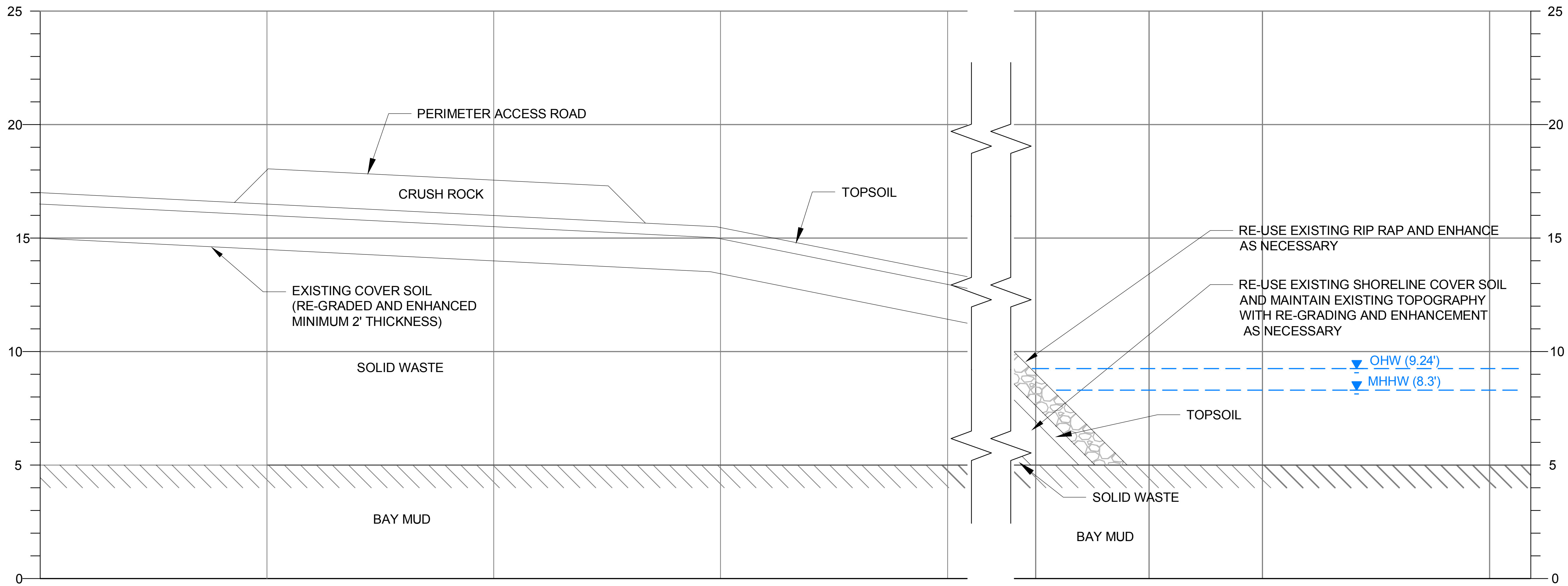
Plot Date: 03/04/16 - 12:17pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-62217-2014(MEMO001)GN-WA001_APS_100215.dwg



CROSS SECTIONS
ALTERNATIVE 2
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/04/16	Project No. 14159
amec		Figure 31

FIGURE PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES.



DETAIL ALONG INNER LAGOON

0 2.5 5 ft

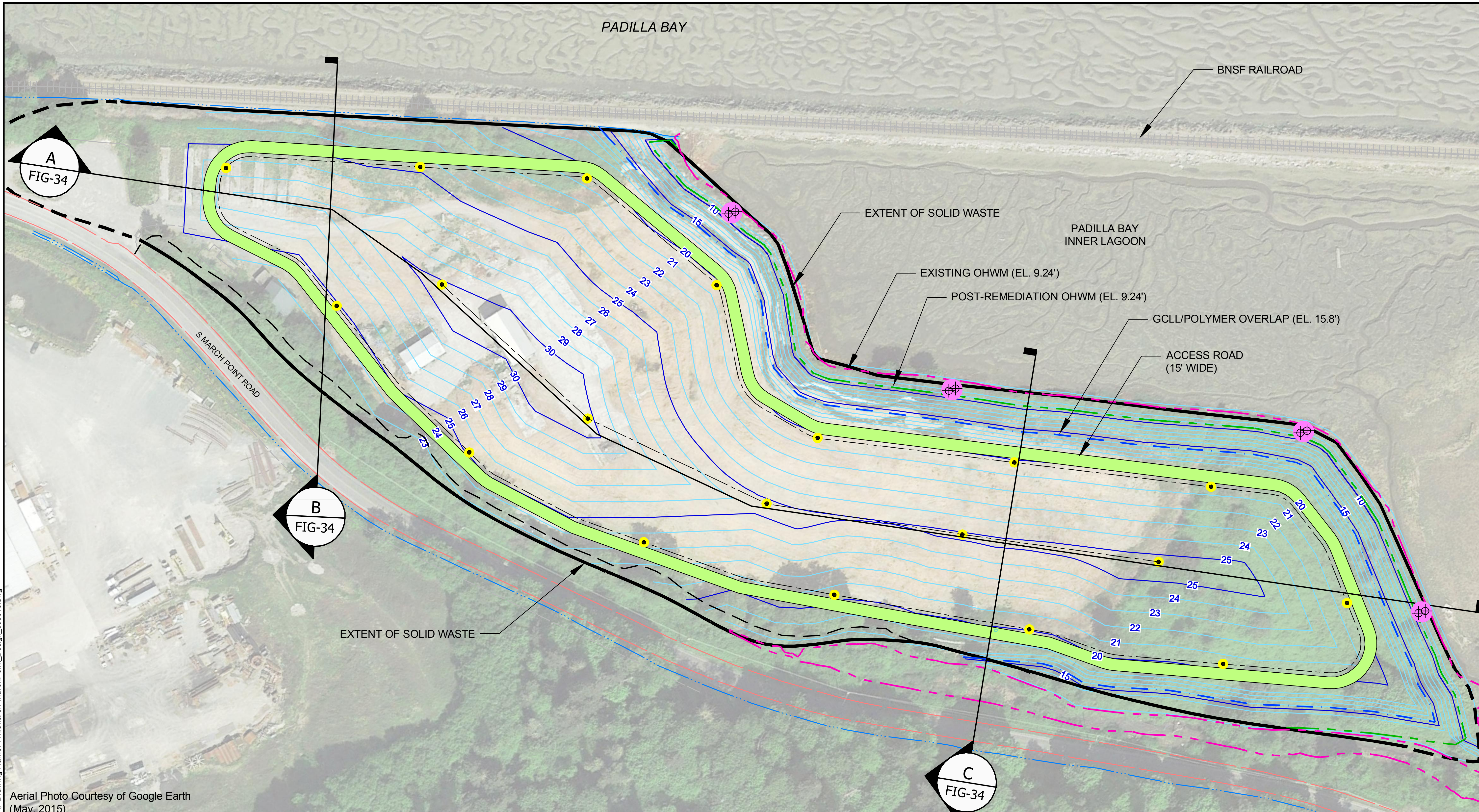
APPROXIMATE SCALE IN FEET

FIGURE PROVIDED BY CONESTOGA-ROVERS & ASSOCIATES.

INNER LAGOON DETAILS
ALTERNATIVE 2
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 32

Plot Date: 03/03/16 - 7:17pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-62217-2014(MEMO001)GN-WA001_APS_100215.dwg



EXPLANATION

WELL PAIR LOCATION
LOCATION AND NUMBER OF WELLS SHOWN ARE TENTATIVE.

GAS VENT LOCATION

GAS VENT LINE

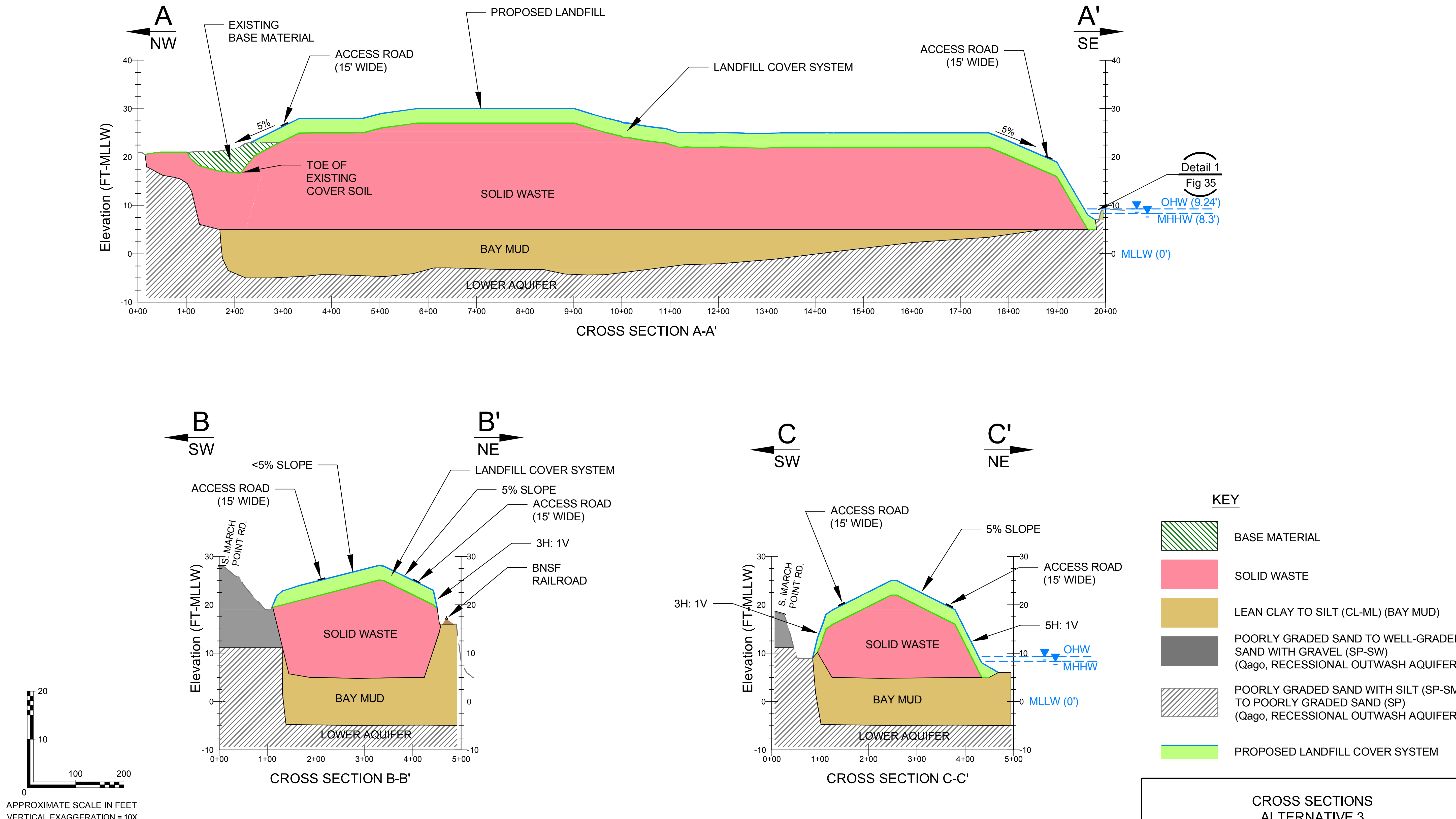
ELEVATION CONTOUR IN FEET ABOVE MEAN LOW LOW WATER

0 60 120
APPROXIMATE SCALE IN FEET

PLAN VIEW
ALTERNATIVE 3
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/04/16	Project No. 14159
amec		Figure 33

Plot Date: 03/04/16 - 11:23am, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_Design_093015.dwg

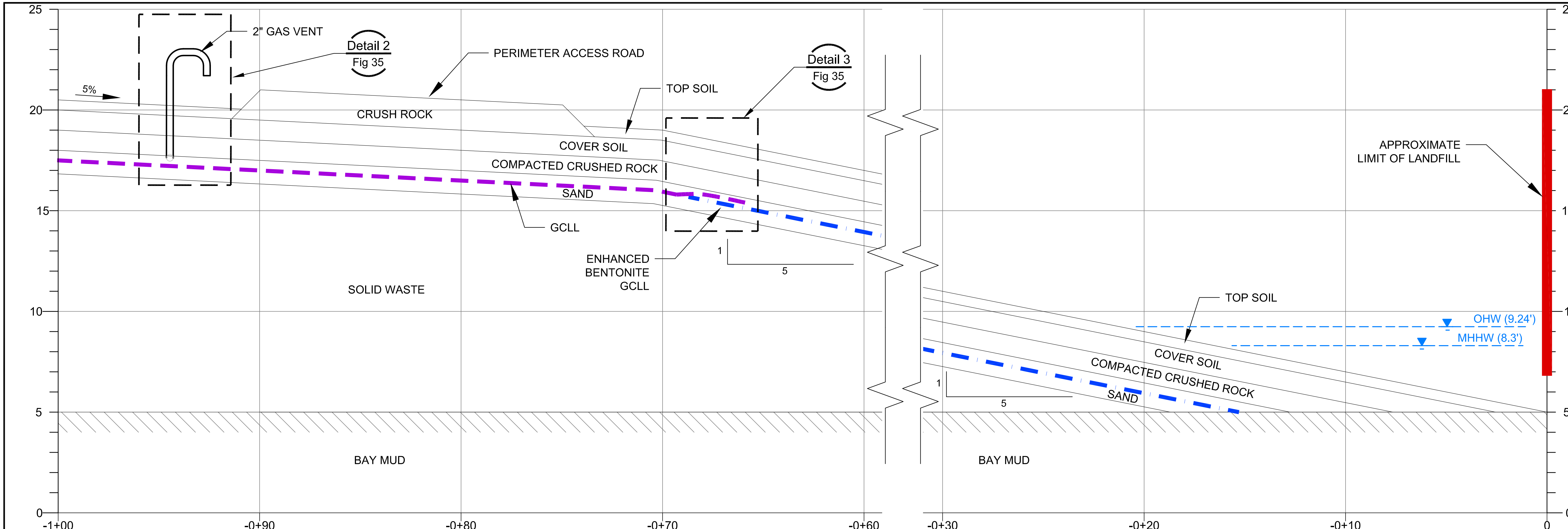


NOTE: LOCATION OF CROSS SECTIONS ARE SHOWN ON FIGURE 33.

CROSS SECTIONS
ALTERNATIVE 3
March Point (Whitmarsh) Landfill
Skagit County, Washington

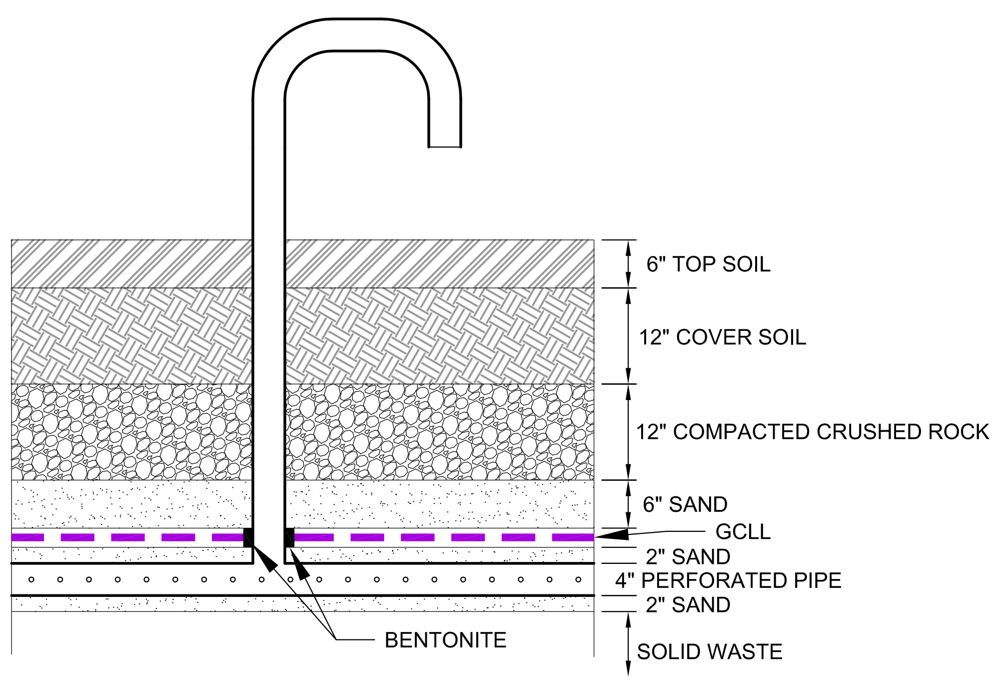
By: APS	Date: 03/04/16	Project No. 14159
amec		Figure 34

Plot Date: 03/04/16 - 2:14pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI(CAD)\, Drawing Name: Whitmarsh-MarchPoint_Design_093015.dwg



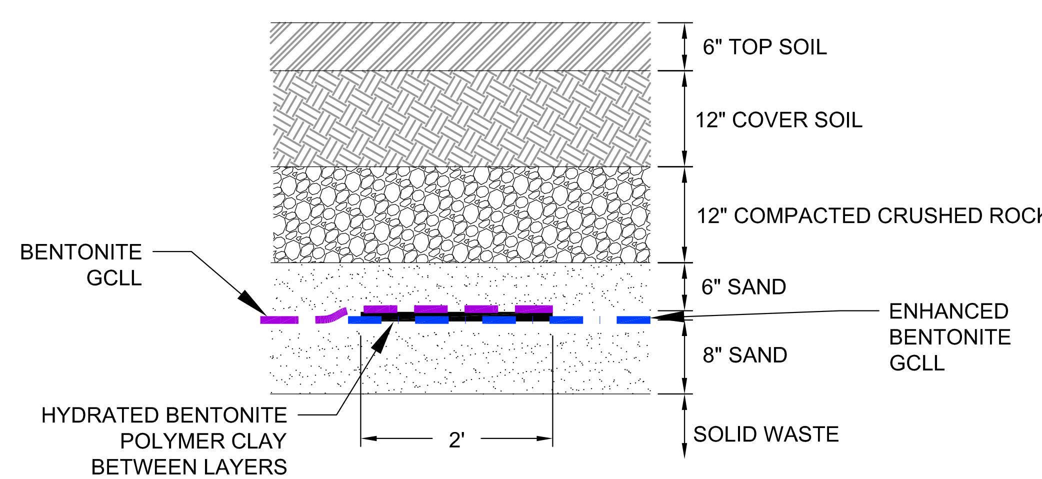
1 DETAIL ALONG INNER LAGOON

0 2.5 5
APPROXIMATE SCALE IN FEET



2 PASSIVE LANDFILL GAS VENT DETAIL

0 1 2
APPROXIMATE SCALE IN FEET



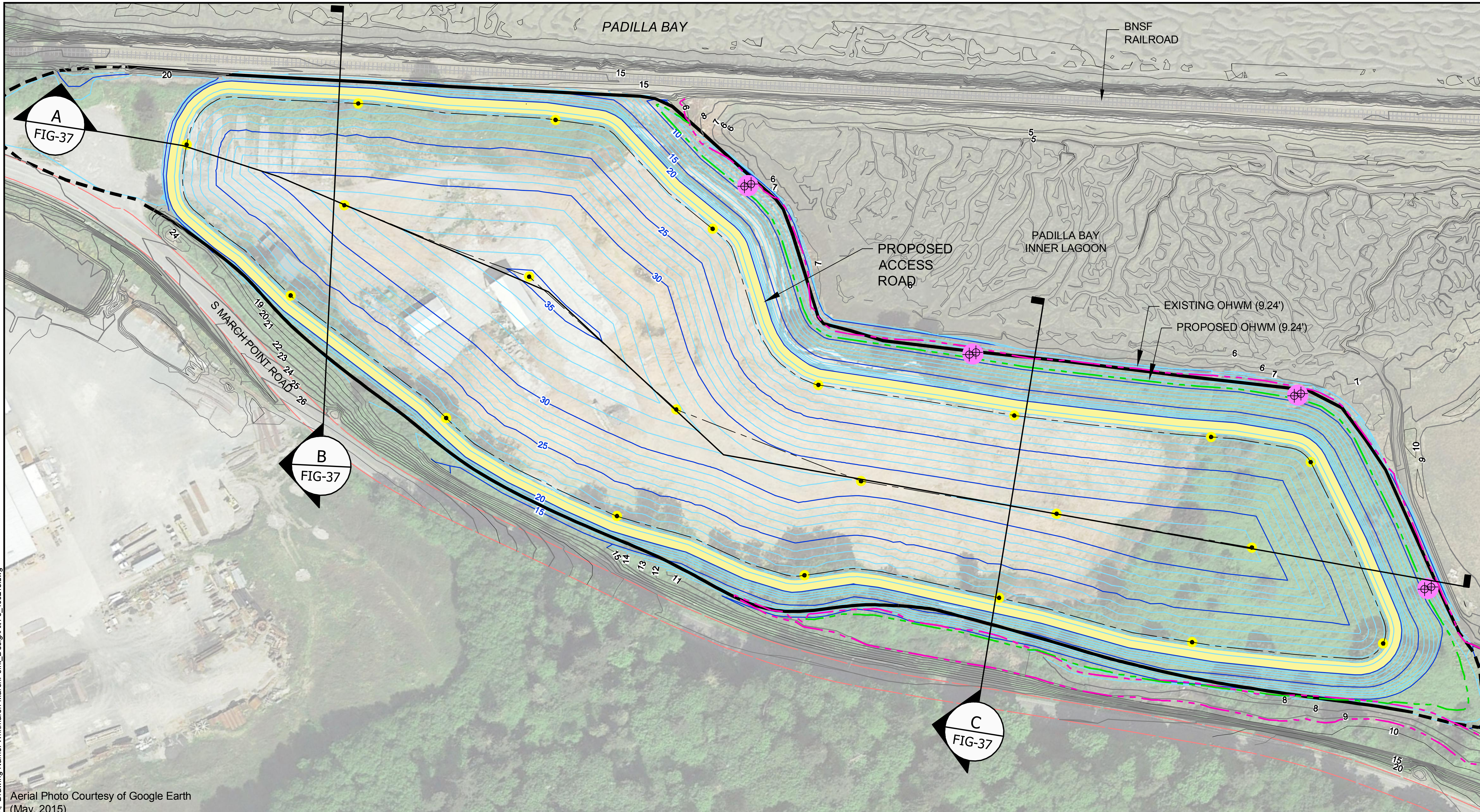
3 GCLL OVERLAP DETAIL

0 1 2
APPROXIMATE SCALE IN FEET

INNER LAGOON DETAILS
ALTERNATIVE 3
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 05/10/16	Project No. 14159
amec		Figure 35

Plot Date: 05/10/16 - 2:43pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-R\CAD\, Drawing Name: Whitmarsh-MarchPoint_Design_041216_recover.dwg



EXPLANATION

WELL PAIR LOCATION
LOCATION AND NUMBER OF WELLS SHOWN ARE TENTATIVE.

GAS VENT LOCATION

GAS VENT LINE

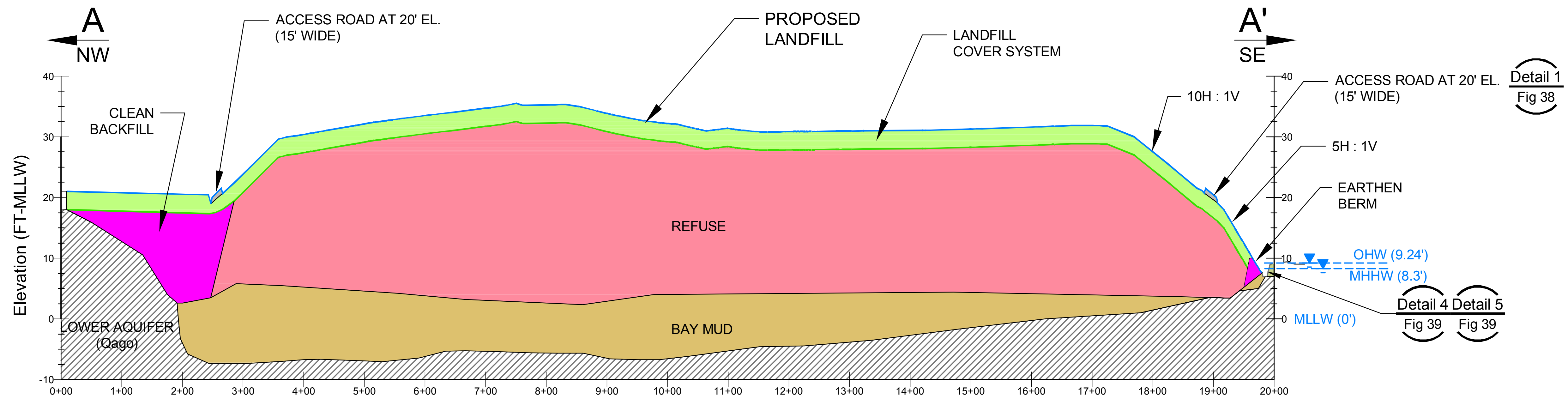
ELEVATION CONTOUR IN FEET ABOVE MEAN LOWER LOW WATER

0 60 120
APPROXIMATE SCALE IN FEET

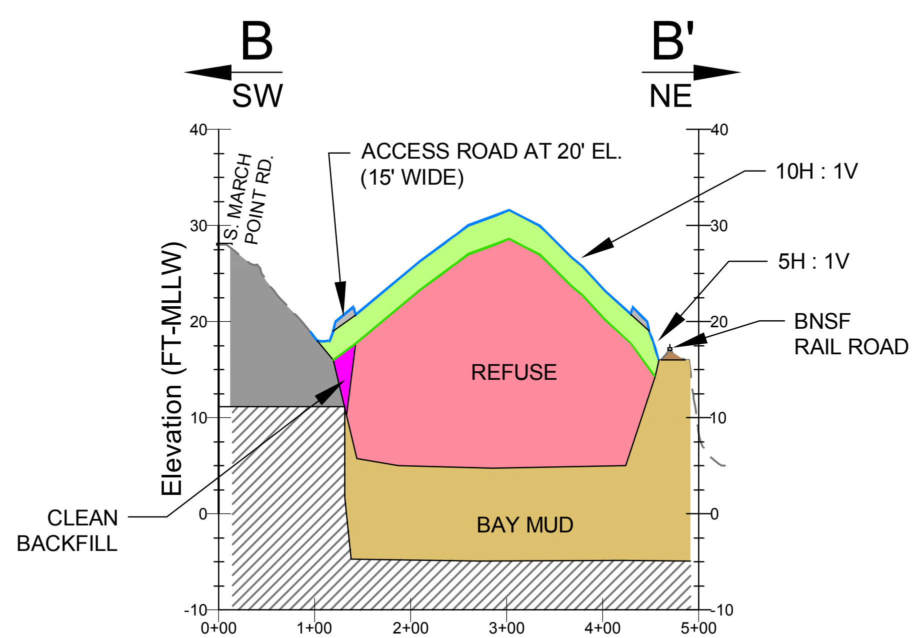
PLAN VIEW
ALTERNATIVES 4, 5, AND 6
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/04/16	Project No. 14159
amec		Figure 36

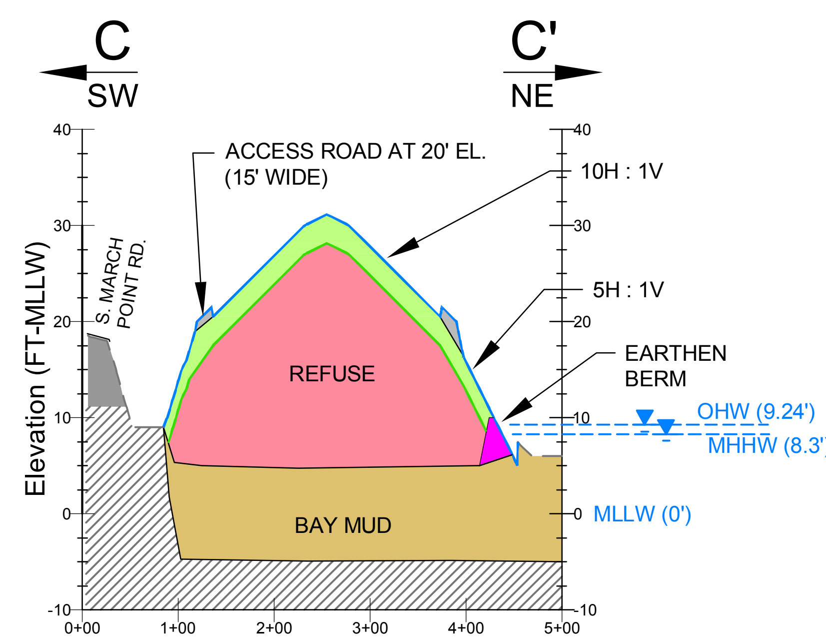
Plot Date: 03/04/16 - 11:08am, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_DesignAlt4-6_100215.dwg



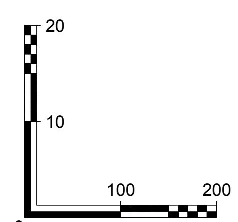
CROSS SECTION A-A'



CROSS SECTION B-B'



CROSS SECTION C-C'



APPROXIMATE SCALE IN FEET
VERTICAL EXAGGERATION = 10X

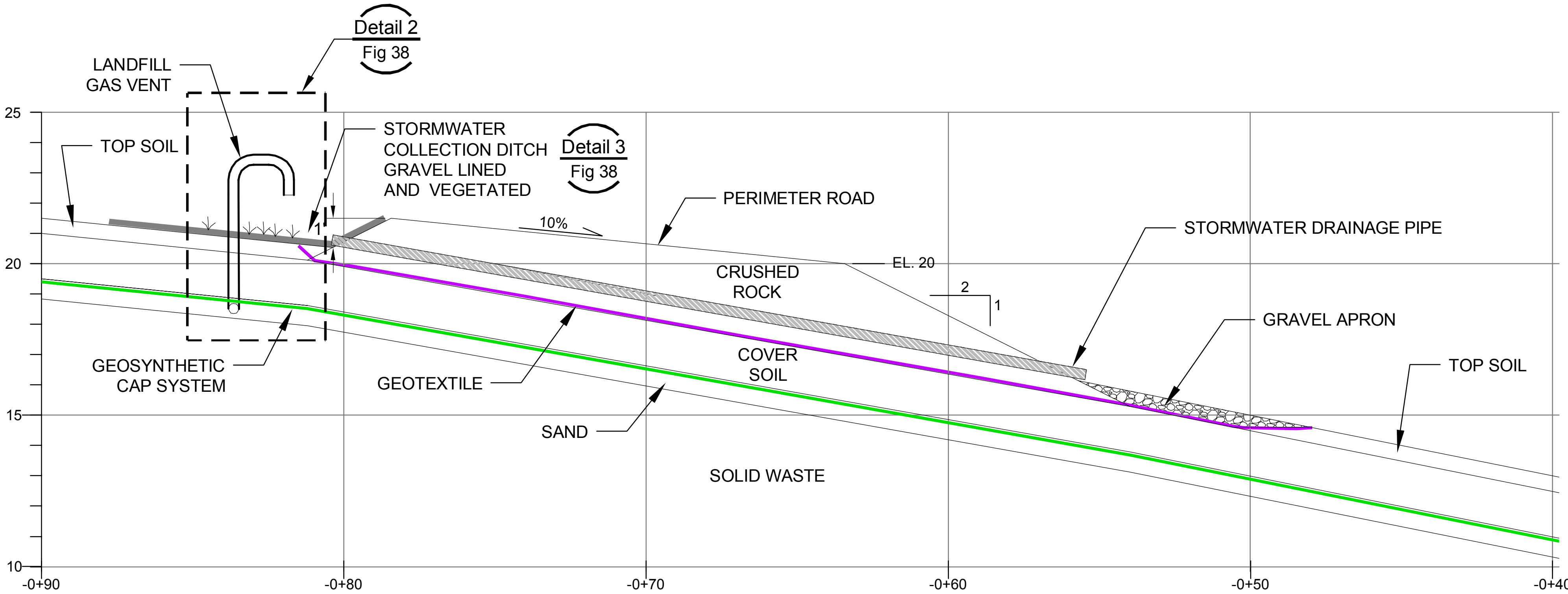
KEY

- REFUSE
- LEAN CLAY TO SILT (CL-ML) (BAY MUD)
- POORLY GRADED SAND TO WELL-GRADED SAND WITH GRAVEL (SP-SW) (Qago, RECESSIONAL OUTWASH AQUIFER)
- POORLY GRADED SAND WITH SILT (SP-SM) TO POORLY GRADED SAND (SP) (Qago, RECESSIONAL OUTWASH AQUIFER)
- CLEAN BACKFILL

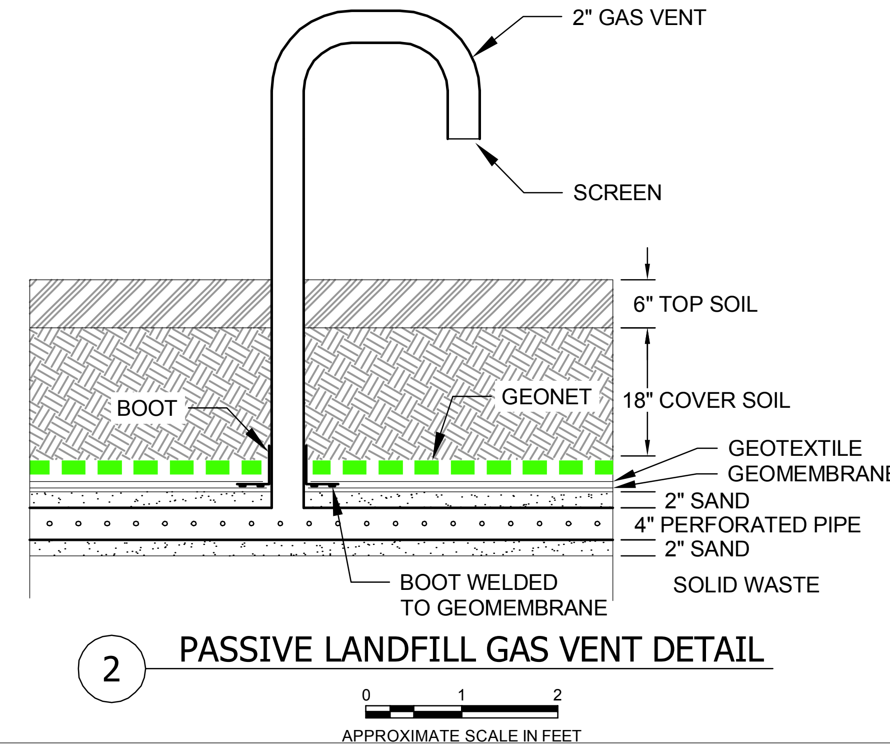
NOTE: LOCATION OF CROSS SECTIONS ARE SHOWN ON FIGURE 36.

CROSS SECTIONS
ALTERNATIVES 4, 5, AND 6
March Point (Whitmarsh) Landfill
Skagit County, Washington

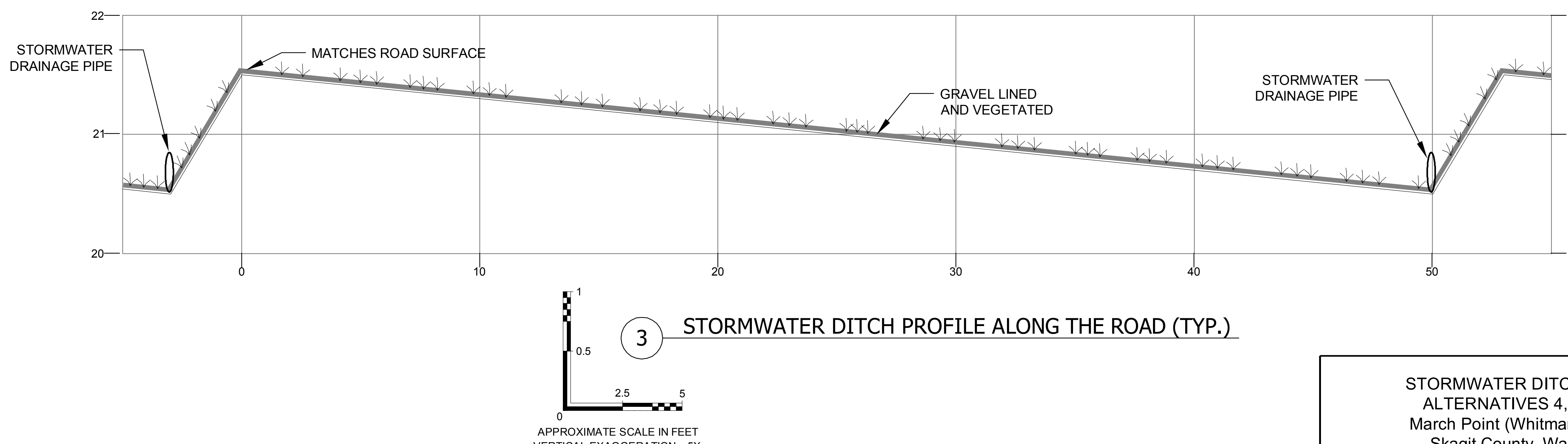
By: APS	Date: 03/04/16	Project No. 14159
amec		Figure 37



1 STORMWATER COLLECTION DITCH AND ROAD DETAIL



2 PASSIVE LANDFILL GAS VENT DETAIL

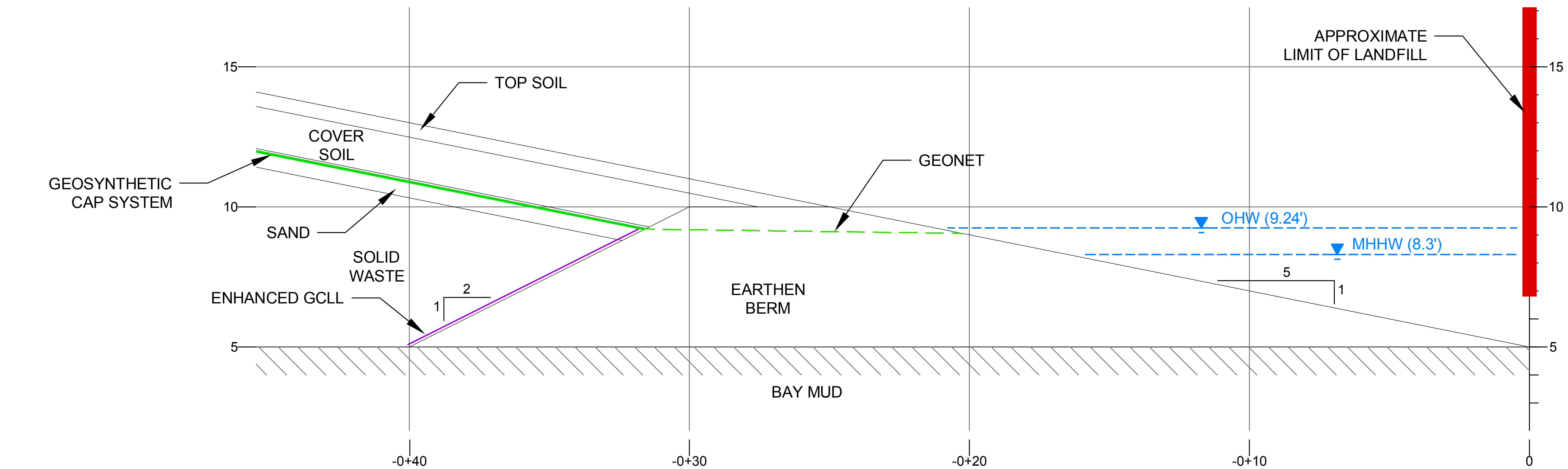


3 STORMWATER DITCH PROFILE ALONG THE ROAD (TYP.)

STORMWATER DITCH DETAILS
ALTERNATIVES 4, 5, AND 6
March Point (Whitmarsh) Landfill
Skagit County, Washington

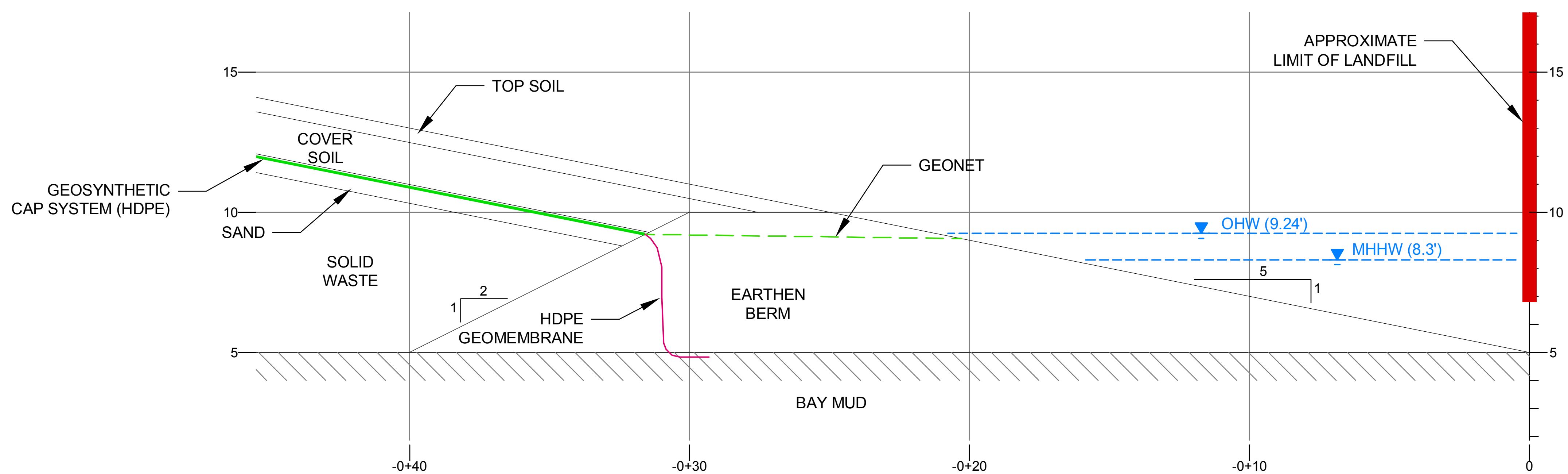
By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 38

Plot Date: 03/03/16 - 8:08pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI(CAD), Drawing Name: Whitmarsh-MarchPoint_DesignAlt4-6_100215.dwg



4 DETAIL ALONG INNER LAGOON
ALTERNATIVE 4 - HDPE GEOMEMBRANE
ALTERNATIVE 6 - PVC GEOMEMBRANE

0 2.5 5
APPROXIMATE SCALE IN FEET



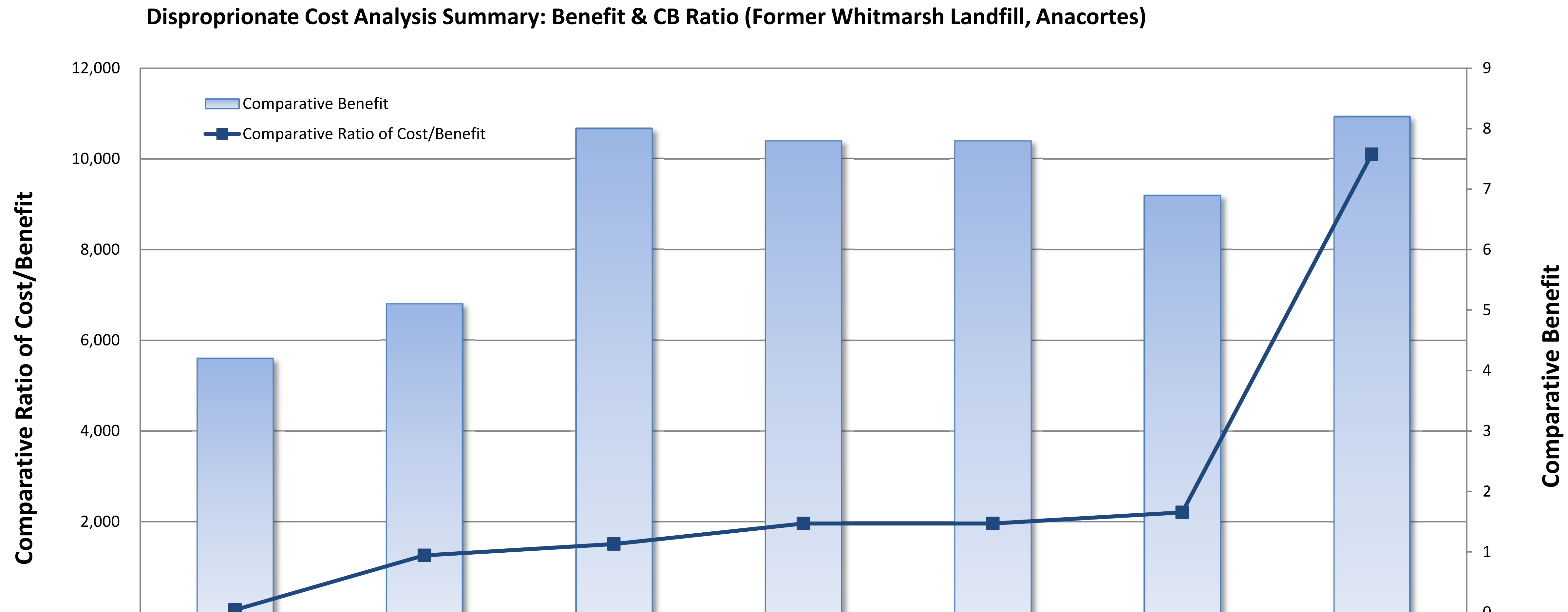
5 DETAIL ALONG INNER LAGOON
ALTERNATIVE 5 - HDPE GEOMEMBRANE

0 2.5 5
APPROXIMATE SCALE IN FEET

INNER LAGOON DETAILS
ALTERNATIVES 4, 5, AND 6
March Point (Whitmarsh) Landfill
Skagit County, Washington

By: APS	Date: 03/03/16	Project No. 14159
amec		Figure 39

Plot Date: 03/03/16 - 8:16pm, Plotted by: adam.stenberg
Drawing Path: S:\14159\016_2015-RI\CAD\, Drawing Name: Whitmarsh-MarchPoint_DesignAlt4-6_100215.dwg



	1- No Action	2- Restoration (Reuse) of Existing Soil Cover for Cap	3 - GCLL Cap	4- HDPE Cap	5- HDPE Cap Anchored into Bay Mud	6 - PVC Cap	7 - Landfill Removal/Off-site Disposal of all Solid Waste
Comparative Benefit	4.2	5.1	8	7.8	7.8	6.9	8.2
Comparative Ratio of Cost/Benefit	55	1,254	1,505	1,958	1,961	2,207	10,102

Alternatives

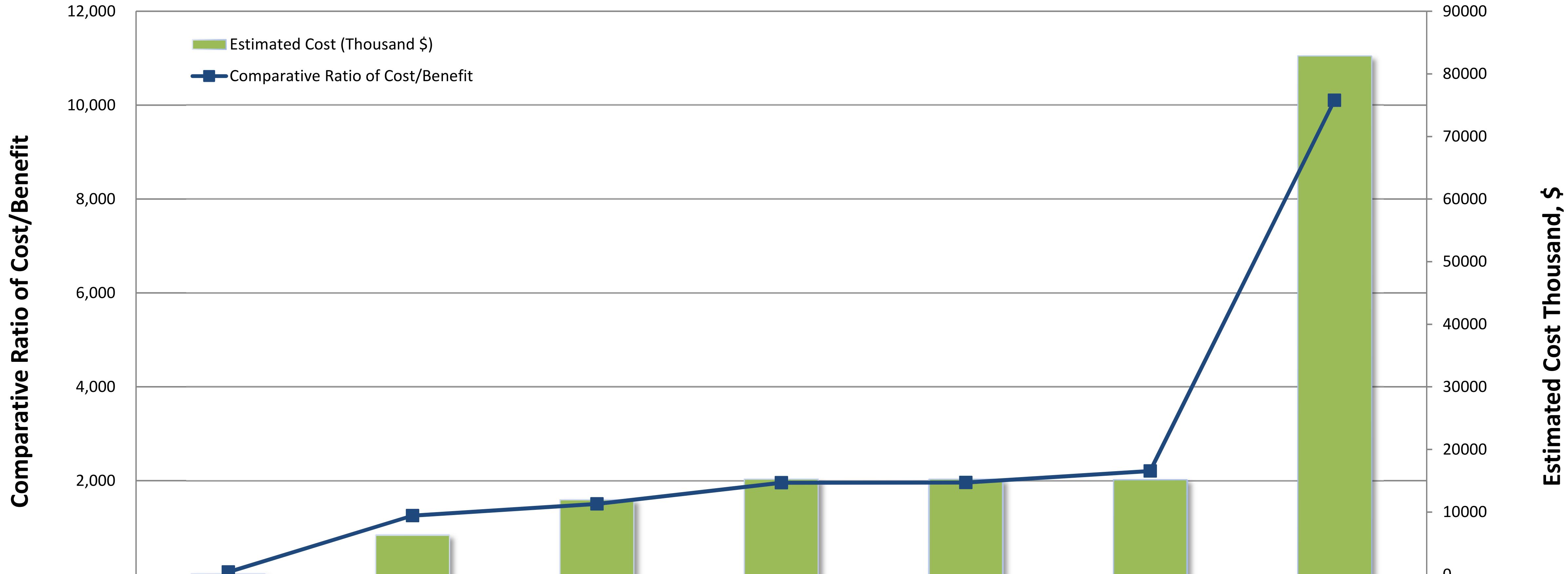
amec

DISPROPORTIONATE COST ANALYSIS SUMMARY: BENEFIT & COST BENEFIT RATIO
Former Whitmarsh Landfill
Anacortes, Washington

By: LPM
Project No.: 14159
Date: 10/01/15

Figure 40

Disproprionate Cost Analysis Summary: Cost & CB Ratio (Former Whitmarsh Landfill, Anacortes)



	1- No Action	2- Restoration (Reuse) of Existing Soil Cover for Cap	3 - GCLL Cap	4- HDPE Cap	5- HDPE Cap Anchored into Bay Mud	6 - PVC Cap	7 - Landfill Removal/Off-site Disposal of all Solid Waste
Estimated Cost (Thousand $)	231	6397	12040	15272	15292	15225	82837
Comparative Ratio of Cost/Benefit	55	1,254	1,505	1,958	1,961	2,207	10,102

Alternatives

amec

DISPROPORTIONATE COST ANALYSIS SUMMARY: COST & COST BENEFIT RATIO
Former Whitmarsh Landfill
Anacortes, Washington

By: LPM
Project No.: 14159
Date: 10/01/15

Figure 41