Bainbridge Island Landfill

Feasibility Study Report

Final Report

Prepared by
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Kitsap County Department of Public Works
Solid Waste Division

November 1, 2000

MEMORANDUM **CH2MHILL**

Bainbridge Island Landfill RI/FS—Final Reports

TO: All holders of Bainbridge Island Landfill Remedial Investigation/ Feasibility Study Reports

FROM: Judi Radloff/CH2M HILL
Michelle Miller/Kitsap County
Brian Sato/Ecology

DATE: November 1, 2000

Ecology has completed the public comment period for the Bainbridge Island Landfill Remedial Investigation/Feasibility Study. During the public comment period, Ecology received comments on the RI/FS reports. Ecology addressed these comments in their Responsiveness Summary issued in October 2000.

Ecology considers the Public Comment Drafts of the RI/FS Reports to be final. Following are the RI/FS documents created for the Bainbridge Island Landfill:

1. Remedial Investigation Report (June 4, 1999 and Addendum October 12, 1999)
2. Remedial Investigation Report Supplement No. 1 (November 11, 1999)
3. Remedial Investigation Report Supplement No. 2 (February 8, 2000)
4. Feasibility Study Report (August 4, 2000)
5. RI/FS Executive Summary (August 4, 2000)

No changes were made to these documents based on the public comments received. These reports will not be revised, and this memorandum finalizes all five documents. Attached are new covers, spines, and cover sheets for all reports except the Executive Summary. This memo is intended to be included with each of the reports, and should be inserted directly behind the new cover sheet, in front of the table of contents.

The documents will retain headers, footers, and other elements that refer to the Public Comment Drafts and draft document dates. Electronic versions of these documents, issued on CD in August 2000, are also considered final, and new CD covers will not be issued.

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Acronym and Abbreviation List

ARAR	applicable or relevant and appropriate requirement
ASIL	acceptable source impact level
bgs	below ground surface
C	degrees Celsius
CAA	Clean Air Act
CAS	Chemical Abstract Service
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	cubic feet per minute
CFR	Code of Federal Regulations
CFU/100 mL	colony forming units per 100 milliliters
cm/sec	centimeters per second
COC	contaminant of concern
COD	chemical oxygen demand
COPC	contaminant of potential concern
CUL	cleanup level
CWA	Clean Water Act
cy	cubic yards
DNS	declaration of nonsignificance
DW	dangerous waste
E&E	Ecology and Environment, Inc.
Ecology	Washington State Department of Ecology
EIS	environmental impact statement
EPA	United States Environmental Protection Agency
ESA	Endangered Species Act
FS	feasibility study
FWPCA	Federal Water Pollution Control Act
gal	gallons
GBWD	Gamble Bay Water District
GCL	geosynthetic clay liner
GP	gas probe
gpm	gallons per minute
GW	groundwater
HDPE	high-density polyethylene
HH	halogenated hydrocarbons
L	liter
lb/cy	pounds per cubic yard
LEL	lower explosive limit
lf	linear feet
LLDPE	linear low density polyethylene
LS	leachate seep
MCC	maximum concentration of contaminants
MCL	maximum contaminant level
MDL	method detection limit

mg	milligram
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg-N/kg	milligrams nitrogen per kilogram
mg-N/L	milligrams nitrogen per liter
mil	one thousandth of an inch
mL	milliliter
MFS	Minimal Functional Standards for Landfills
MLF	main landfill
MNA	monitored natural attenuation
MS	matrix spike
MSA	most stringent ARAR
MSWLF	municipal solid waste landfills
MTCA	Model Toxics Control Act
MUA	multiattribute utility analysis
MW	monitoring well
NAVD	North American vertical datum
NCP	National Contingency Plan
ND	not detected
NEPA	National Environmental Policy Act
NM	no measurement
NMOC	nonmethane organic compound
NPDES	National Pollutant Discharge Elimination System
NSPS	New Stationary Source Performance Standards
NTU	nephelometric turbidity units
OAHP	Washington State Office of Archeology and Historic Preservation
OSHA	Occupational Safety and Health Act
OW	designates offsite well
PAH	polyaromatic hydrocarbon compound
PCB	polychlorinated biphenol compound
pH	hydrogen ion concentration
ppm	parts per million
PSCAA	Puget Sound Clean Air Agency
PUD	Public Utility District
PVC	polyvinyl chloride
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RCW	Revised Code of Washington
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
SDWA	Safe Drinking Water Act
SED	sediment sample prefix
SEPA	State Environmental Policy Act
SVE	soil vapor extraction
SVOC	semivolatile organic compound
SW	surface water
sy	square yards
TAC	toxic air contaminant

TCLP	toxicity characteristic leaching procedure
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
USGS	U.S. Geological Survey
µg	microgram
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
µmho/cm	micromhos per centimeter
VAC	volts alternating current
VOC	volatile organic compound
WAC	Washington Administrative Code
w.c.	water column
WEA	west end area

CHAPTER 1

Introduction

The Bainbridge Island Landfill is a closed municipal solid waste landfill located in the City of Bainbridge Island, Kitsap County, Washington. Kitsap County acquired the property in 1942, and began operating the site as a landfill in about 1946 to reduce indiscriminate dumping on Bainbridge Island. The landfill accepted municipal solid waste, septic tank waste, and tank bottoms from a wood treatment facility. The site stopped accepting waste in 1975 and was closed between 1974 and 1977.

The Washington State Department of Ecology (Ecology) issued an Enforcement Order in 1994 that requires Kitsap County to complete a Remedial Investigation/Feasibility Study (RI/FS) for the site, to follow a scope of work for the RI/FS included in the order, and to conduct interim actions at the site, if necessary, to reduce threats to human health or the environment. This Feasibility Study Report (FS Report) has been prepared by CH2M HILL in accordance with the Washington State Model Toxics Control Act (MTCA, WAC 173-340) and pursuant to Exhibit A, Task IV of the Enforcement Order for an RI/FS at the Bainbridge Island Landfill (No. 94TC-N399).

1.1 Purpose

The purpose of the RI/FS is to collect, develop, and evaluate sufficient information to enable a cleanup action to be selected. The RI phase of the process determines the nature and extent of site-derived contaminants. The FS phase of the process determines what actions are feasible to clean up the site to an acceptable level and selects a preferred remedial alternative.

In accordance with the Enforcement Order scope of work, CH2M HILL prepared the *Bainbridge Island Landfill Remedial Investigation Report* (RI Report; CH2M HILL, 1999a) for Kitsap County. It was submitted to Ecology on June 4, 1999, and revised by addendum on October 12, 1999. The RI Report covers the period March 1996 through May 1997. Two supplemental reports, Supplement 1 and Supplement 2, were also completed for the RI. The *Remedial Investigation Report Supplement 1*, covering May-December 1997, was submitted on November 11, 1999 (CH2M HILL, 1999b). The *Remedial Investigation Report Supplement 2*, documenting work done between March 1998 and August 1999, was finalized on February 8, 2000 (CH2M HILL, 2000).

The RI obtained and analyzed data to fully characterize the nature and extent of contaminants that pose potential risks to human health and the environment, and to support selection of appropriate cleanup actions. The RI Report and Supplements present information obtained during the investigation, and analyze site conditions and environmental media. This FS Report identifies contaminants of concern in site media, identifies and evaluates feasible actions for site cleanup, and selects a preferred remedial alternative.

1.2 Regulatory Actions

Several regulatory activities led to the completion of an RI/FS at the Bainbridge Island Landfill. These actions included sampling and testing by Ecology between 1975 and 1978; U.S. EPA Site Inspection in 1986 and 1987; sampling and testing by the Bremerton-Kitsap County Health District in 1988, 1992, and 1994; and an Ecology Site Hazard Assessment in 1992.

These regulatory actions, described in more detail in Chapter 2, resulted in several interim independent remedial actions and the RI/FS. In 1992 Ecology ranked the entire landfill as a level one hazardous waste site under MTCA (with 1 posing the highest relative health and environmental risk, and 5 the lowest risk). This ranking eventually resulted in an Enforcement Order to Kitsap County in November 1994. Work on the RI began shortly thereafter: preparation of the RI Work Plan began in 1995 and continued into 1996; field investigations began in the summer of 1996 and continued into summer 1999. Work on the FS began in May 1999.

1.3 Approach and Organization

The Enforcement Order specifies the process that Kitsap County is to follow in conducting the RI/FS. In Task IV of the Scope of Work, the Enforcement Order specifies the following requirements for the FS:

- The FS will be conducted in accordance with WAC 173-340-350.
- The FS will include all of the elements of an outline attached to the Enforcement Order. If sections of the outline are not applicable to the site, the excluded sections will be noted in the FS Report with the supporting rationale.
- Cleanup action alternatives will be evaluated in accordance with the requirements of WAC 173-340-360. This evaluation may also include laboratory testing, pilot testing, modeling, and data analysis.

This FS Report follows an outline approved by Ecology in July 1999. The overall approach taken in preparing the report was to summarize relevant information presented in the RI Report and both Supplements; to identify applicable or relevant and appropriate requirements (ARARs) for cleanup; to identify contaminants of concern (COCs) and cleanup levels for site media; to use information on the site waste sources and media to limit the scope of the FS; and to present and evaluate remedial action alternatives. In addition to Chapter 1, Introduction, the following chapters are included in this FS Report:

- **Chapter 2, Site Background.** Summarizes the site's history and environmental setting, and summarizes the RI activities and results.
- **Chapter 3, Development of MTCA Cleanup Levels.** Identifies location-, action-, and chemical-specific ARARs for the site; identifies contaminants of concern and cleanup levels for site media.
- **Chapter 4, Screening of Technologies.** Addresses general scope issues for cleanup alternatives including no action, waste reclamation, waste consolidation and

containment, and groundwater remediation. This chapter also identifies cleanup needs and appropriate technologies for media of concern.

- **Chapter 5, Evaluation of Technologies.** Identifies appropriate technologies for site cleanup; evaluates and screens technologies according to their effectiveness, cost, and how easily they can be implemented; combines technologies into cleanup alternatives and describes each alternative.
- **Chapter 6, Evaluation of Remedial Action Alternatives.** Evaluates cleanup action alternatives that address waste sources and site media of concern in accordance with MTCA requirements.
- **Chapter 7, Comparative Evaluation of Remedial Action Alternatives.** Presents a general discussion of the advantages and disadvantages of each alternative and a table comparing alternatives according to MTCA criteria; identifies the preferred alternative for site cleanup.
- **Chapter 8, Compliance with the State Environmental Policy Act.** Discusses Ecology policies regarding coordination of the State Environmental Policy Act (SEPA) and MTCA; summarizes elements that would be included in an expanded SEPA checklist for the preferred cleanup action alternative; identifies other SEPA activities that will be addressed.
- **Chapter 9, References.** A comprehensive list of references used in the FS Report.

Items listed in the FS outline attached to the Enforcement Order but not included in the FS Report are listed below with a rationale for each. Other items in the Enforcement Order outline are addressed in various sections of this FS Report.

III. INITIAL SCREENING OF ALTERNATIVES, D. Potential Permits Required. RCW 70.105D.090, Remedial Actions Exemptions, and Ecology Policy 130B exempts remedial actions from the procedural requirements of specified state, environmental, and local government permits. Remedial actions are still required to meet substantive permit requirements. However, rather than address specific permit requirements under initial technology and alternative screening (Chapter 5), the requirements are addressed in Chapter 6 under implementability for each alternative as part of the detailed evaluation of alternatives.

V. TREATABILITY STUDIES. Treatability studies are not included in the FS Report because they were not needed to complete the alternatives analysis.

VI. ADDITIONAL INFORMATION NECESSARY TO COMPLY WITH SEPA. Only information needed for the SEPA checklist is included in the FS Report because Ecology Policy 130A establishes Ecology as the lead agency for remedial actions and gives Ecology the responsibility for making threshold determinations and issuing declarations of nonsignificance (DNS). If Ecology makes a threshold determination and issues a DNS before the FS Report is distributed for public review, the additional documents can be appended to the FS Report and incorporated into the public review process. If Ecology issues a declaration of significance and an EIS is required, the EIS will be prepared as a separate document and issued concurrently with the draft Cleanup Action Plan.

CHAPTER 2

Site Background

2.1 Site History and Environmental Setting

2.1.1 Site Description

The Bainbridge Island Landfill is located west of Eagle Harbor on Bainbridge Island, near Seattle, Washington (Figures 2-1 and 2-2[1]). The site covers 40 acres, approximately 7 of which were used for disposing various types of waste from 1948 to 1974. The main landfill is located on an east-facing slope at an elevation of approximately 200 to 260 feet North American Vertical Datum (NAVD-88), as shown in Figures 2-2 and 2-3. The site was originally a steep, narrow, east-sloping ravine, which has been reshaped and largely filled in by landfill activities. The only structures onsite are refuse transfer and recycling stations. Access is restricted by a gated northern entrance off Vincent Road.

The Bainbridge Island Landfill site consists of the following waste disposal areas:

- Main landfill
- West end area (subdivided into northern and southern)
- Five septage pits (south, central, and west pits)
- Trench 3

The locations of these disposal areas are shown in Figure 2-3. The main landfill and west end area accepted and burned primarily domestic refuse and a small amount of commercial waste. The five septage pits received liquid-solid sludge from domestic septic system haulers. The largest pit is the south septage pit, located southwest of the main landfill. Trench 3, located just north of the south septage pit, was an excavation in native soil where liquid wood-preserving waste from the Wyckoff Company was disposed.

2.1.2 Site History

Kitsap County acquired the property that was later to become the Bainbridge Island Landfill as part of a tax foreclosure process in 1942. It was operated as a landfill by several parties over 29 years, during which time it accepted typical domestic waste, tank bottoms from the nearby Wyckoff wood treatment facility (in Trench 3), and petroleum products such as oil. Until 1968, refuse was burned at the site.

The landfill ceased accepting waste in 1975, when a lawsuit brought against the County by a neighboring resident expedited closure of the landfill. Closure activities were completed in 1977. Also in 1977, the Bainbridge Disposal Company opened a refuse transfer station at the site, a facility that is still operating.

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[1] Figures and tables are included at the end of the chapter.

In 1975 the first of several government agencies became involved with the site's investigation and cleanup. The Washington State Department of Ecology sampled surface water and leachate between 1975 and 1978. In 1986 the U.S. Environmental Protection Agency (EPA) conducted a Site Investigation, sampling several waste sources and environmental media, including domestic water wells, surface water, surface and subsurface soil, and sediment. The investigation identified organic contaminants in surface water and leachate, and organic and inorganic contaminants in the septage pits, Trench 3, and the main landfill. Domestic water samples showed no evidence of contamination (E&E, 1987).

Between 1988 and 1994, the Bremerton-Kitsap County Health District collected samples from domestic wells near the landfill, and sampled surface water, leachate, and septage pit sludge from the site (Bremerton-Kitsap County Health District, 1988 and 1992). The samples from the drinking water wells, surface water, and leachate were in compliance with state primary drinking water standards. The metal content of the sludge was similar to typical septage, and viral assays were negative.

In 1990 Ecology became the lead regulatory agency for site management, and in 1992 ranked the site as a level one (highest) waste site under MTCA. Also in 1992, Kitsap County performed an independent remedial action on Trench 3—approximately 475 tons of contaminated sludge from Trench 3 were stabilized and disposed at a hazardous waste landfill, and an additional 930 tons of contaminated soil were removed and disposed (Golder Associates, 1993). Kitsap County began the remedial investigation/feasibility study (RI/FS) for cleanup of the landfill in 1996 under an enforcement order from Ecology. The remedial investigation (RI) was completed in August 1999. The data and interpretations of the RI are recorded in three documents: the RI Report (CH2M HILL, 1999a) and the RI Report Supplements 1 and 2 (CH2M HILL, 1999b, 2000).

2.1.3 Environmental Setting

The region surrounding the landfill site is of moderate topography, and slopes generally to the northeast from a 400-foot-high hill southwest of the site (Figure 2-2). The site occupies an east-trending ravine, a natural depression into which refuse was dumped, surrounded by rolling uplands. Above the banks of the ravine, septage disposal pits were dug in the gentler upland slopes. The north, southeast and southwest portions of the site remain relatively undisturbed and are covered with second-growth forest.

Stormwater drainage from the site flows east to a large lowland about ½ mile east of the site (Figure 2-2). Stormwater drainage originates as two intermittent drainages that converge into a diversion pipe, which passes through the main landfill to two small settling ponds at the eastern toe of the landfill (Figure 2-3). Below the settling ponds, flow crosses under Lynwood Center Road and enters the lowland area east of the site. Rainfall data and monitoring of surface water indicate that surface water only flows following major storms and that it drains quickly. Sediment in the stormwater drainage consists dominantly of fine to coarse sand and fine gravel derived from local soils.

Bainbridge Island has a marine climate dominated by cool, moist winds that move east to northeast off the Pacific Ocean. This pattern results in typically warm, dry summers and cool, wet winters. The average total annual precipitation is 50 inches, of which 80 percent falls between October and March. A year of rainfall monitoring at the leachate monitoring well LW9 (see Figure 2-3) from November 1998 through November 1999 recorded 52 inches of rain at the site (CH2M HILL, 2000).

Land use in the vicinity consists primarily of single-family residential homes, with a small number of commercial and industrial operations within a 3-mile radius. The site is surrounded by low-density residential property, an undeveloped park, undeveloped and recently logged private property, rural residential land, and a tree farm.

2.1.4 Geology and Hydrogeology

The majority of Bainbridge Island is covered by up to 1,600 feet of glacial drift and interglacial sediments deposited beginning approximately 13,000 to 15,000 years ago (USGS, 1988). The unconsolidated glacial deposits consist of recessional outwash of the Vashon glaciation, glacial till, and advance outwash underlain by older Quaternary glacial and interglacial sediments (see RI Figure 4-1). Groundwater occurs in aquifers in the unconsolidated glacial deposits; the water-bearing units consist of permeable, granular materials deposited by glaciofluvial processes, separated by aquitards of low-permeability interglacial lacustrine silt and clay (USGS, 1988; Kitsap County, 1989).

Groundwater conditions and aquifer characteristics at the site and surrounding vicinity were investigated by constructing, monitoring, and slug testing 18 monitoring wells, and by monitoring two nearby pre-existing wells, the Public Utilities District (PUD) well and the Gamble Bay Water District (GBWD) well. Additional information was obtained by reviewing logs of water supply wells in the area. Three aquifers were delineated beneath the site and surrounding vicinity: the upper, lower, and perched aquifers. These aquifers occur in three geologic units, separated by two geologic units that act as aquitards.

Upper Aquifer

The upper aquifer is the primary aquifer beneath the site and is the first aquifer encountered directly beneath the main landfill and all of the other waste sources on the site (Figure 2-4). The upper aquifer occurs in Unit 1, an advance outwash sand, which consists of a uniform brownish gray fine sand with minor silt, extending from the surface to a maximum depth of about 185 feet. All of the monitoring wells installed during the RI and the GBWD well are completed in this aquifer. Groundwater in the upper aquifer is unconfined, and the water table is between 120 and 155 feet below the ground surface of the site. The depth to groundwater is at least 60 feet below the base of the main landfill and over 119 feet below the base of Trench 3.

Groundwater elevations range from about 128 to 138 feet above sea level. Groundwater generally flows from south to north across the site, as shown in Figure 2-5, a recent groundwater elevation contour map (March 1999). The groundwater flow velocity in the upper aquifer is about 0.50 foot per day.

Lower Aquifer

The lower aquifer is confined and occurs in a thin pre-Vashon sand unit, Unit 3. The potentiometric surface of the lower aquifer is about 60 feet above sea level. The direction and velocity of groundwater flow are unknown. The lower aquifer is separated from the upper aquifer by the aquitard Unit 2, upper gray silt, which is a stiff bluish to dark gray silt with variable amounts of sand and clay. This unit is an interglacial lacustrine deposit about 145 feet thick with vertical hydraulic conductivities ranging from 2×10^{-6} to 2×10^{-8} cm/s. Another interglacial lacustrine silt/clay aquitard, Unit 4, underlies the lower aquifer.

The vertical gradient between the upper and lower aquifers was calculated to be 0.47, down. Although groundwater from the upper aquifer may be a minor source of recharge for the lower aquifer because the vertical gradient between the two is down, it would take the water over 875 years to travel the 150 feet between the two aquifers.

Perched Aquifer

The perched aquifer, extending west and north from the northwest corner of the site, consists of highly permeable sand and gravel of Unit 1a, a 10- to 50-foot-thick layer of dense silty sand with gravel that overlies the outwash sand of Unit 1. Water in this aquifer is retarded from flowing downward into the relatively less permeable Unit 1, and therefore remains perched above and hydraulically isolated from the upper aquifer (Figure 2-4). For this reason, the perched aquifer was not monitored. The extent of this aquifer is unknown, and it may actually consist of two or more discrete, permeable lenses within a lower permeability surrounding matrix. Several domestic wells located northwest of the landfill are interpreted to be installed in the perched aquifer.

2.2 Remedial Investigation Summary

The remedial investigation at the Bainbridge Island Landfill was conducted between March 1996 and August 1999, and focused on gathering data that would support a conceptual model for the site and the feasibility study of remedial options. The nature and extent of the chemical contamination and the physical properties of the contaminated media were determined for the landfill waste sources, including landfill gas and leachate, and all environmental media: soil, sediment, air, surface water, and groundwater. A summary of sampling events and number of samples taken for the full RI period is presented in Table 2-1. Contaminant screening levels were developed for soil, sediment, surface water, and groundwater for comparison to concentrations detected in RI samples. Screening levels included the most stringent ARARs developed in the Work Plan, and were updated for revised regulations and additional requirements from Ecology. A domestic well inventory was performed, and water from nearby domestic water-supply wells was sampled.

The actions and findings of the RI are summarized below. Table 2-2 compiles the parameters that exceeded RI screening levels. Information for this summary and Table 2-2 was compiled from the RI Report and Supplements 1 and 2, where full details can be found. Information was also used from the EPA Site Investigation (E&E, 1987) and Kitsap County's independent remedial action on Trench 3 (Golder, 1993); data from these sources are referred to as "historical," because they preceded the remedial investigation.

2.2.1 Waste Sources

Three principal waste sources were investigated: 1) the main landfill and west end area (divided into northern and southern west end areas), 2) the septage pits and Trench 1-2, and 3) Trench 3. These have been evaluated by test pits and soil borings, by surveying their boundaries, and by sampling and analysis. Secondary waste sources investigated include landfill gas and leachate. The results of each waste source investigation are summarized briefly below.

Main Landfill and West End Area

The main landfill and west end area cover roughly 4 acres in the center of the landfill property (Figure 2-3) and received most of the waste disposed at the landfill. The extent of the main landfill and west end area is well defined by test pits, as shown in Figure 2-3. Beneath the main landfill, the native soil is outwash sand and silt of Unit 1, and native soil under the west end area is sand and gravel till of Unit 1a. Landfill cover soil is discussed in Section 2.2.2, Soil, below.

Waste in the main landfill and west end area was characterized physically and chemically in the EPA Site Investigation, the RI Report, and Supplement 2 (see Table 2-1). Landfill waste generally consists of domestic and construction waste mixed with soil and ash. The waste fills an east-trending ravine in a deposit up to approximately 45 feet deep that comprises an estimated total volume of approximately 102,000 cy, including about 3,900 cy in the northern west end area and about 3,100 cy in the southern west end area. The estimated bulk density of waste ranges from 658 to 2,223 lb/cy, with a geometric mean of 1,110 lb/cy. No clear spatial trend has been noted in the composition of the main landfill waste, indicating that there are no distinct cells or waste disposal areas.

Contamination in the refuse includes low levels of SVOCs, pesticides, PCBs, and metals. Table 2-2 shows the preliminary list of contaminants of potential concern (COPCs) that was developed during the RI by comparing detected levels of contaminants to contaminant screening levels.

During the August 1999 sampling, landfill waste was screened to evaluate the proportions and physical and chemical characteristics of three waste fractions: the inert fraction (less than 1½ inches), the garbage fraction (1½ to 3 inches), and the bulky fraction (greater than 3 inches). The inert fraction comprises an average of 67 percent by weight of the waste, and consists mainly of soil, gravel, and ash, with small pieces of glass and plastic. SVOCs, pesticides, PCBs, and metals all exceeded the soil screening levels in the inert fraction. The garbage fraction comprises an average of 7 percent by weight, consisting of various debris mixed with soil, including paper, glass, plastic, wood, styrofoam, metal, and unidentifiable materials. Analyses showed that total SVOCs, pesticides, PCBs, and total metals exceeded the soil screening levels. TCLP metals and TCLP SVOCs analyses showed no exceedances of dangerous waste maximum contaminant concentrations. The bulky waste fraction is an average of 26 percent of the waste, comprising concrete, lumber, wood, appliances, scrap metal, construction debris, and other large waste. This waste fraction was not chemically analyzed.

Septage Pits and Trench 1-2

Five septage pits were disposal sites for septic tank waste consisting of liquid-solid sludge (Figure 2-3). Trench 1-2 is an indistinct feature just northeast of the south septage pit that did not receive waste (R. Hanson, 1995). Two previous investigations, by Ecology between 1975 and 1978, and the 1986 EPA Site Investigation, sampled the south septage pit. Remedial investigation work investigated four other septage pits and Trench 1-2, which had not been sampled previously. The septage pit and Trench 1-2 sampling events are shown in Table 2-1.

The waste material in the septage pits consisted of homogeneous dark brown, soft, moist organic silt with fine sand and small amounts of plastic and glass. The estimated volume of the five septage pits is about 1,500 cy. No physical or chemical evidence of contamination was found in Trench 1-2, so no waste volume was calculated.

Chemical analyses of septage pit samples taken in April 1996 showed that VOCs (one compound), SVOCs, pesticides, total PCBs, TPH, and metals exceeded soil screening levels. Additional samples were taken in April 1998 for state dangerous waste designation including TCLP metals analyses and fish toxicity analysis. No metals exceeded TCLP maximum concentration of contaminants (MCC) values, and the samples did not exhibit fish toxicity; therefore, the sludge would not be designated hazardous or state dangerous waste.

Trench 3

Trench 3 was located between the south septage pit and the main landfill (Figure 2-3) and was the disposal site for liquid wood-preserving waste from the Wyckoff Company. It was located and sampled during the 1986 EPA Site Investigation and was remediated by Kitsap County in 1992. All of the waste and contaminated soil to a depth of 15 feet bgs was removed in 1992 and disposed at a hazardous waste landfill in Arlington, Oregon.

2.2.2 Soil

Soils investigated during the RI included landfill cover soil, and the base soil beneath the landfill and below Trench 3 (Table 2-1). One sample of background soil was taken during the EPA Site Investigation.

Landfill Cover Soil

The waste in the main landfill and west end area is overlain by a layer of apparently site-derived sandy cover soil. It ranges from less than 1 to about 15 feet thick, and is generally thicker over the east end of the main landfill. Its total volume over all landfill areas is estimated to be 16,410 cy. Landfill cover soil at the site generally has little or no contamination: RI and historical samples revealed that only SVOCs and metals exceeded the soil screening levels, and no PCBs were detected. One pesticide, Aldrin, was detected in samples from the 1992 Trench 3 investigation, but no pesticides were detected in the RI samples. One area of cover soil at the east end of the main landfill has a discrete layer of creosote-like contamination and is referred to as the cover soil "hotspot" area. The hotspot area soil has relatively high concentrations of petroleum hydrocarbons, PAHs, pentachlorophenol, and metals. Results of TCLP testing showed that the soil is not a federal hazardous waste. The soil is a state-only dangerous waste (based on persistence criteria, designation WP02). However, state-only dangerous waste may be disposed at a RCRA subtitle D compliant facility. The hotspot area comprises about 1,125 cubic yards of the total landfill cover volume.

Base Soil

Soil below the main landfill, west end area, and Trench 3 was investigated. Historical and RI data show that low concentrations of VOCs, SVOCs, and metals exceeded soil screening levels in base soil below the main landfill and west end area. Soil at 15 feet bgs in the Trench 3 area exceeded screening levels for PAHs and metals, but deeper samples (down to 90 feet bgs) showed metals exceeding screening levels. As discussed in the RI Report (Section 8.1.1), this indicates that natural site background soil concentrations for some metals exceed screening levels.

2.2.3 Sediment

The sediment in the surface water drainage system was sampled during both the RI and the EPA Site Investigation (Table 2-1). SVOCs, heavy-oil-range hydrocarbons, and the metals arsenic, beryllium, and zinc were detected above sediment screening levels. Note that sediment screening levels are the same as soil screening levels.

2.2.4 Landfill Gas and Air Quality

Landfill gas was monitored at 16 gas probes installed in the waste and surrounding soil (Table 2-1). Monitoring consisted of measuring pressure and the relative amounts of methane, carbon dioxide, oxygen, hydrogen sulfide, and balance gas, mostly nitrogen. Gas samples were obtained from probes GP5, 6, and 9 and analyzed for VOCs. Sixteen VOCs were detected in GP9, typical for landfill gas. Low levels of VOCs were detected in GP5 and GP6. Methane was consistently high in GP9 (the one gas probe installed in the waste), up to 80 percent by volume, which is well above the typical landfill value of 55 percent. Methane and other gases measured in probes outside the landfill indicated the presence of air at atmospheric conditions with very little or no impact from landfill gas. Methane was never detected at probes located on the property boundaries.

Air quality was evaluated by computer modeling to determine whether non-methane organic compound (NMOC) emissions from landfill gas would exceed federal air quality standards. The model incorporated the results of a Tier 1 decay analysis to estimate potential emissions, and used measured concentrations of onsite landfill gas. Modeling results showed that the maximum total NMOC emissions would be about 20 tons per year, occurring in 1976, well below the threshold of 162 tons/yr requiring a NMOC investigation. The potential for specific toxic air contaminants (TACs) to migrate offsite was also modeled, using measured VOC concentrations in landfill gas as input. According to the modeling results, no TACs were expected to exceed their respective acceptable source impact levels (ASILs) or MTCA Method B cleanup standards at the property boundaries.

2.2.5 Leachate

Landfill leachate, produced by rainwater percolating through refuse, emanates from a surface seep at the toe of the main landfill (Figure 2-3) and joins the surface water drainage. Leachate was observed to flow intermittently during the RI period, and flow was linked to rainfall events. Six leachate samples were taken during the RI, and one sample was obtained from the leachate well installed in the main landfill (Table 2-1). Sample results indicated that VOCs, TPH, and metals exceeded the surface water screening levels in leachate. In the 1996 and January 1997 samples, SVOCs exceeded screening levels, but had dropped far below screening levels in the 1998 and 1999 samples. The conventional parameters alkalinity, fecal coliform, turbidity, dissolved oxygen, and pH either exceeded surface water screening levels or were outside the range specified by Washington State Class A surface water criteria.

2.2.6 Surface Water

Surface water was monitored each quarter during the RI and sampled at stations upstream and downstream of the main landfill (Figure 2-3, Table 2-1). Two surface water sample stations were downstream of the leachate seep. Apart from one SVOC (bis(2-ethylhexyl) phthalate) detected in one sample, the only parameters that exceeded surface water screening levels were metals, including arsenic, iron, manganese, copper, zinc, and lead. The conventional parameters alkalinity, pH, dissolved oxygen, total coliform, and turbidity either exceeded or were outside the range specified by the surface water screening levels.

2.2.7 Groundwater

Groundwater Monitoring

Fifteen monitoring wells were installed in the upper aquifer in 1996 and 1997, and another three were installed in 1998 (Figures 2-3 and 2-6). These 18 wells were monitored for groundwater elevations and were sampled during 16 quarterly monitoring events between 1996 and 1999 (Table 2-1). Initially, offsite wells were sampled for the same comprehensive list of analytes as onsite groundwater monitoring wells. In response to analytical results, the list of analytes evolved over time to include only VOCs and landfill indicator parameters. One existing well completed in the lower aquifer was also monitored, the Public Utilities District (PUD) well.

Groundwater elevation measurements showed a consistent gradient and flow direction throughout the 3-year monitoring period, flowing generally north and with a slightly radial pattern away from the main landfill. In groundwater beneath the site, contaminants that were above the groundwater screening levels included VOCs, SVOCs, and metals. Conventional parameters above or outside the screening levels were alkalinity, conductivity, dissolved oxygen, nitrate, pH, total coliform, TDS, and turbidity.

Domestic Well Inventory and Sampling

A domestic well inventory was performed in order to identify water-supply wells within a one-mile radius of the site that may have been affected by the landfill. Well records on file with Ecology and the Bremerton-Kitsap County Health District were examined, and a door-to-door survey was conducted in April and July 1996. To characterize the quality of drinking water from these domestic wells, between 17 and 23 wells were sampled between April 1996 and June 1999 (see Figure 2-6 and Table 2-1; see monitoring and analytical schedules in the RI Report and Supplements 1 and 2 for further details.) Vinyl chloride and bis(2-ethylhexyl)phthalate were consistently above screening levels in one or more domestic wells. The metals arsenic, iron, lead, manganese, copper, and zinc were above screening levels in domestic wells, as were the conventional parameters alkalinity, conductivity, dissolved oxygen, total coliform, and turbidity.

Extent of Groundwater Contamination

A set of indicator parameters was found to define an area of landfill-affected groundwater that extends downgradient from the main landfill. These parameters included VOCs, alkalinity, pH, chloride, total dissolved solids, dissolved oxygen, conductivity, nitrate, sulfate, and temperature. A series of maps presented in Supplements 1 and 2 clearly shows the affected area, although the exact shape of the area varies with time and/or parameter. Domestic wells inside the affected area show some evidence of groundwater contamination, including one well, BOW37, that has vinyl chloride concentrations consistently exceeding the MTCA Method B cleanup level of 0.023 µg/L, but below the state drinking water standard of 2 µg/L.

2.3 Nature and Extent of Contamination

Table 2-2 summarizes the contaminants of potential concern that were presented in the three RI reports. These COPCs were identified by comparing site data with RI screening levels. In general, they define the nature and extent of contamination at the site, along with the other factors discussed below.

The Bainbridge Island Landfill site accepted waste from local domestic and commercial sources for 30 years. Waste was placed, unlined, over permeable but dense sandy soil, 60 to 120 feet above the regional groundwater table. The only waste source on site that was found to contain hazardous waste, Trench 3, was completely removed from the site in 1992. The RI data show Trench 3 did not affect soil greater than 15 feet below the ground surface.

Other waste sources have been shown to contain low levels of contaminants typical of domestic waste. Landfill gas and leachate generated by the landfill contain very low levels of contaminants such as VOCs and metals), less than is typical for domestic waste landfills. Surface water, sediment, and soil beneath waste sources show minor or low-level contamination.

The primary medium of concern at the site is groundwater, which is used as an offsite domestic drinking water source. Low levels of VOCs present in the groundwater appear to originate from the landfill as shown by distribution of the indicator parameters. A specific VOC source has not been identified in the main landfill or west end area. Therefore, the feasibility study will focus on control of the waste sources to enable remediation of the groundwater.

Table 2-1
BAINBRIDGE ISLAND LANDFILL FS
RI Sampling Schedule for All Waste Sources and Environmental Media
Numbers of Samples Taken, March 1996 to August 1999

	1996										1997												1998												1999							
	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A
Waste Sources																																										
MLF/WEA waste		6																																								
MLF cover soil																														1												11
MLF/WEA inert fraction[a]																																										10
MLF/WEA refuse fraction[b]																																										8
Septage Pits, Trench 1-2		19																												16[c]												
Soil																																										
MLF base soil																																										10
Trench 3 base soil	8	8																																								
Sediment																																										
		8																																								
Landfill Gas																																										
Monitoring				10	10	22[d]		11	11	11	11	11	11	14	14	14			14			20			20			20			20			20			20					
VOC sampling					2	1																																				
Gas Probe Installation Dates																																										
GP01-07, 09-11	✓																																									
GP08					✓																																					
GP13-15													✓																													
GP12, 16[e]																						✓																				
Leachate																																										
Seep		1								1												1			1									1			1					
Well											1																															
Surface Water																																										
		4									5		4									5			3									5								
Groundwater																																										
Monitoring Wells				8	1	3	11		1	12			12	4		16			16			16			16			16			19			18			9			9		
Domestic Wells		6					15	4	1	1			1	17		18			17			19		6	21			22			13			12			13			13		
Monitoring Well Installation Dates																																										
MW01-07	✓																																									
MW08, 10-12					✓																																					
MW13-16													✓																													
MW17-19																															✓											
Report Periods																																										
RI Report	■	■	■	■	■	■	■	■	■	■	■	■	■	■																												
Supplement 1															■	■	■	■	■	■	■	■	■	■																		
Supplement 2																									■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■

Notes:
MLF/WEA = main landfill and west end area
✓ = installation date of gas probe or monitoring well
[a] Inert fraction also referred to in Supplement 2 as "inert soil"
[b] Refuse fraction referred to in Supplement 2 as "garbage fraction" and "garbage soil"
[c] TCLP and fish bioassay analyses
[d] Gas probes monitored on August 3 and 29, 1996
[e] GP12 and 16 are multi-level probes with shallow, intermediate, and deep monitoring levels

Table 2-2
BAINBRIDGE ISLAND LANDFILL FS
Contaminants of Potential Concern: Parameters that Exceed RI Screening Levels

Contaminant	Waste Sources: MLF	Waste Sources: WEA	Waste Sources: Cover Soil Hotspot	Waste Sources: Cover Soil Outside Hotspot	Waste Sources: Garbage Fraction	Waste Sources: Inert Fraction	Waste Sources: Septage Pits	Waste Sources: Leachate	Media: Soil: Trench 3 Base Soil	Media: Soil: MLF Base Soil	Media: Sediment	Media: Surface Water	Media: Groundwater
VOCs													
vinyl chloride													●
1,1-dichloroethene													●
1,2,3-trichloropropane										●			
1,2-dibromo-3-chloropropane										●			
ethylene dibromide										●			
benzene								●					
1-4 dichlorobenzene							●						
SVOCs/PAHs													
acenaphthene			●										
benzo(a)anthracene	●	●	●		●	●	●	●	●		●		
benzo(a)pyrene	●	●	●		●	●	●	●	●		●		
benzo(b)fluoranthene	●	●	●		●	●	●	●	●		●		
benzo(k)fluoranthene	●	●	●		●	●	●		●				
carbazole			●		●	●							
chrysene	●	●	●	●	●	●	●	●	●		●		
dibenzo(a,h)anthracene		●				●		●	●		●		
fluoranthene			●										
fluorene			●										
indeno(1,2,3-cd)pyrene		●				●			●		●		
naphthalene			●		●								
pyrene			●			●							
bis(2-ethylhexyl)phthalate	●		●		●	●		●		●		●	
pentachlorophenol		●	●	●	●	●							
4-chloroanaline							●						
Pesticides													
4,4'-DDD					●	●	●						
4,4'-DDE	●	●				●	●						
4,4'-DDT	●	●			●	●							
aldrin	●				●	●							
alpha-BHC						●							
beta-BHC					●	●							
gamma-BHC	●												
chlordane	●												
gamma chlordane		●			●	●	●						
dieldrin		●			●	●	●						
heptachlor epoxide						●							
PCBs													
Arochlor 1254	●	●			●	●	●						
Arochlor 1260							●						
Total PCBs	●	●			●	●	●						
TPH													
gasoline range							●						
diesel range			●				●						
heavy oil range		●	●				●				●		
Metals													
arsenic	●	●	●	●	●	●	●	●		●	●	●	●
barium	●	●	●	●	●	●	●			●			
beryllium	●	●	●	●	●	●	●			●			
cadmium	●	●			●	●	●						
chromium	●	●						●			●		
copper	●	●			●	●	●					●	●
iron			●					●				●	●
lead	●	●	●	●	●	●	●			●	●	●[a]	●
manganese	●	●	●	●	●	●	●	●		●		●	●
mercury	●		●		●		●	●					●
nickel	●	●	●	●	●	●	●	●		●	●		
silver							●						
thallium		●	●		●	●	●			●			
vanadium	●		●	●	●	●				●			
zinc	●	●			●	●	●					●	
Conventionals													
alkalinity												●	●
pH (indicator)													●
TDS (indicator)													●
conductivity (indicator)													●
dissolved oxygen												●	●
nitrate													●
nitrite + nitrate													●
turbidity												●	●

Notes:
MLF/WEA = main landfill, west end area
[a] total lead

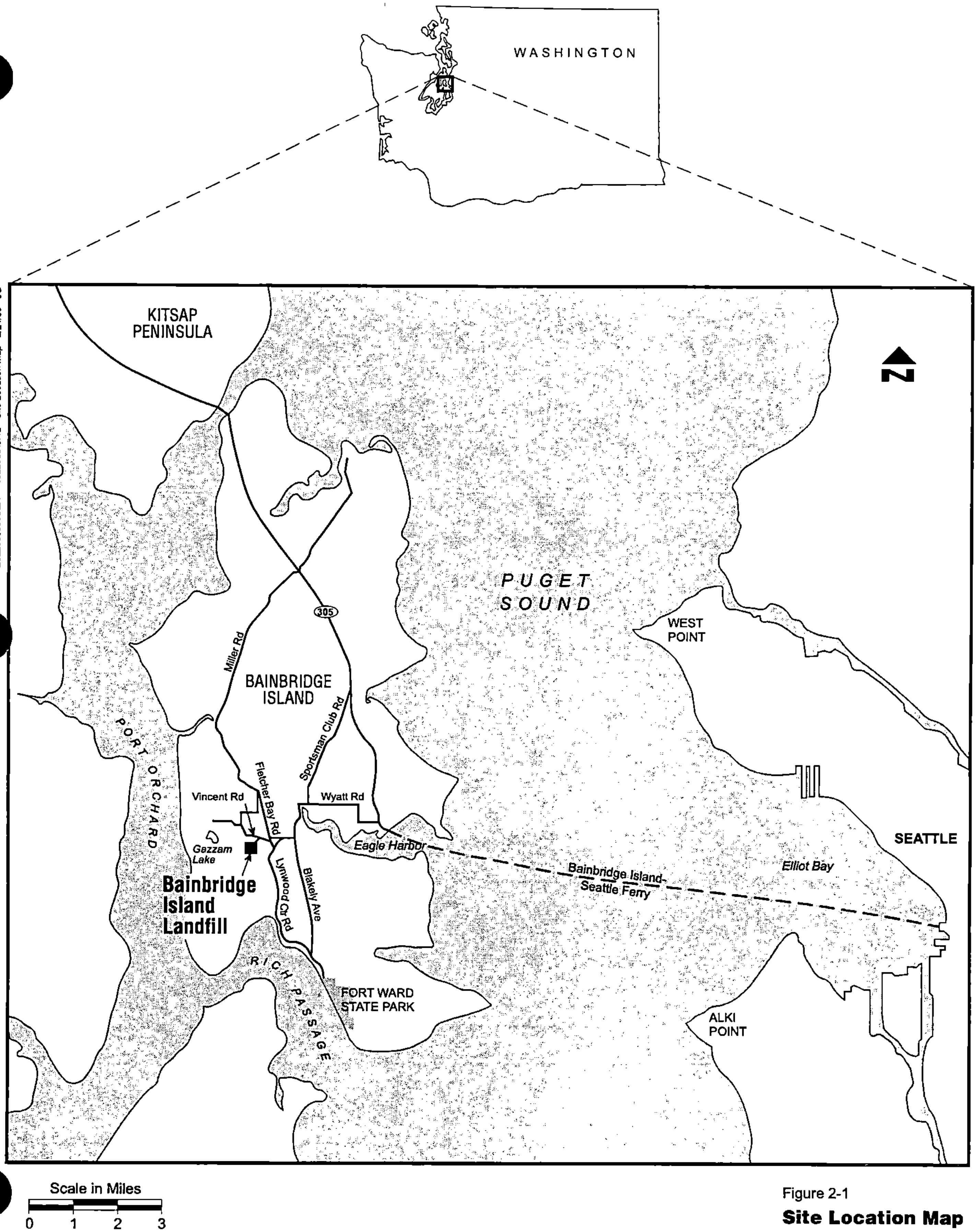
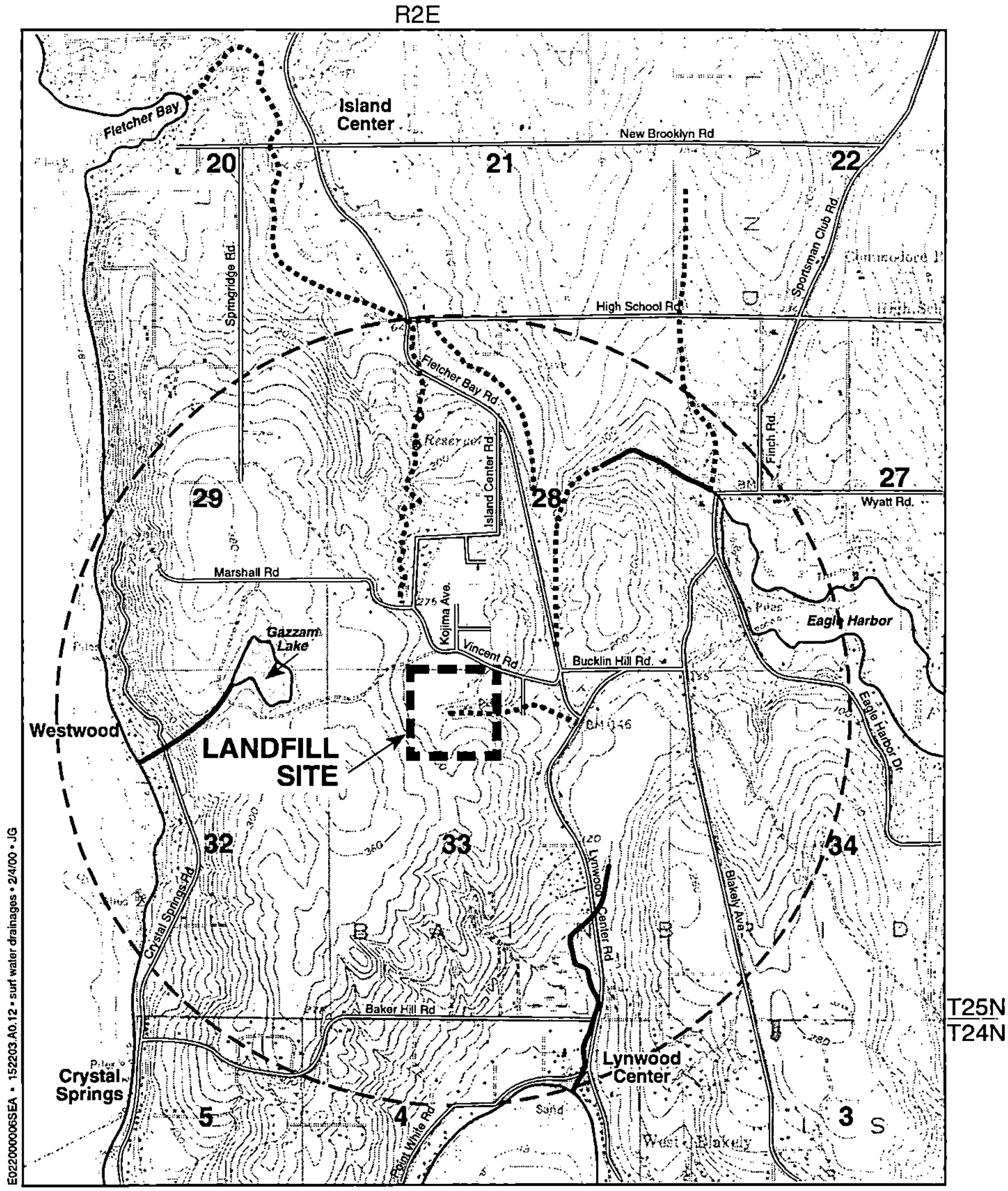


Figure 2-1

Site Location Map

Bainbridge Island Landfill FS

E02200006SEA • 152203.A0.12 • Site Location Map • 2/24/00 • JG



Bainbridge Island Landfill Property Boundary

One Mile Radius from Property

Drainage Course

Stream

NORTH

0 1500

Scale in Feet

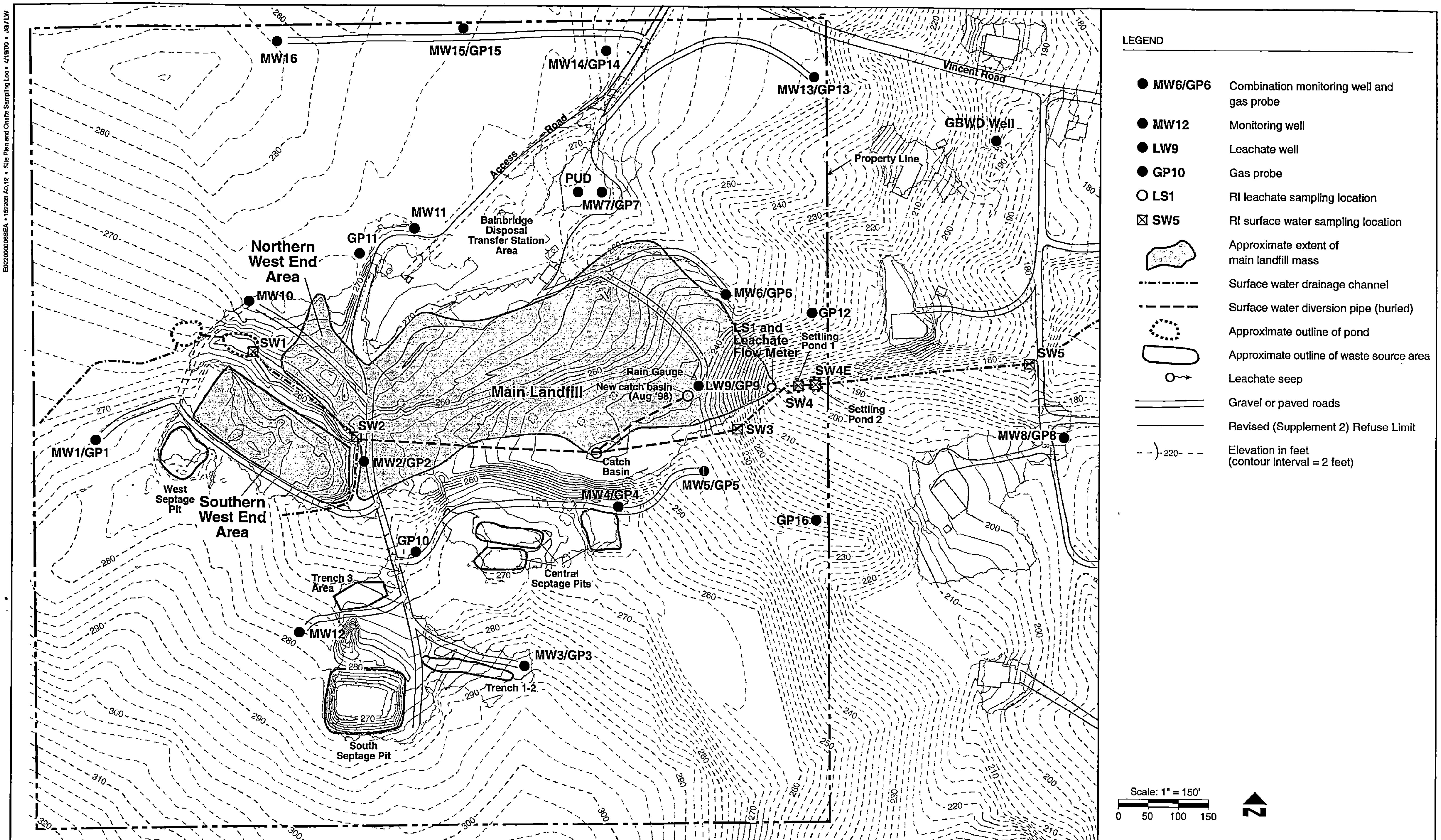
Elevations in feet

Contour interval is 20 feet

Figure 2-2

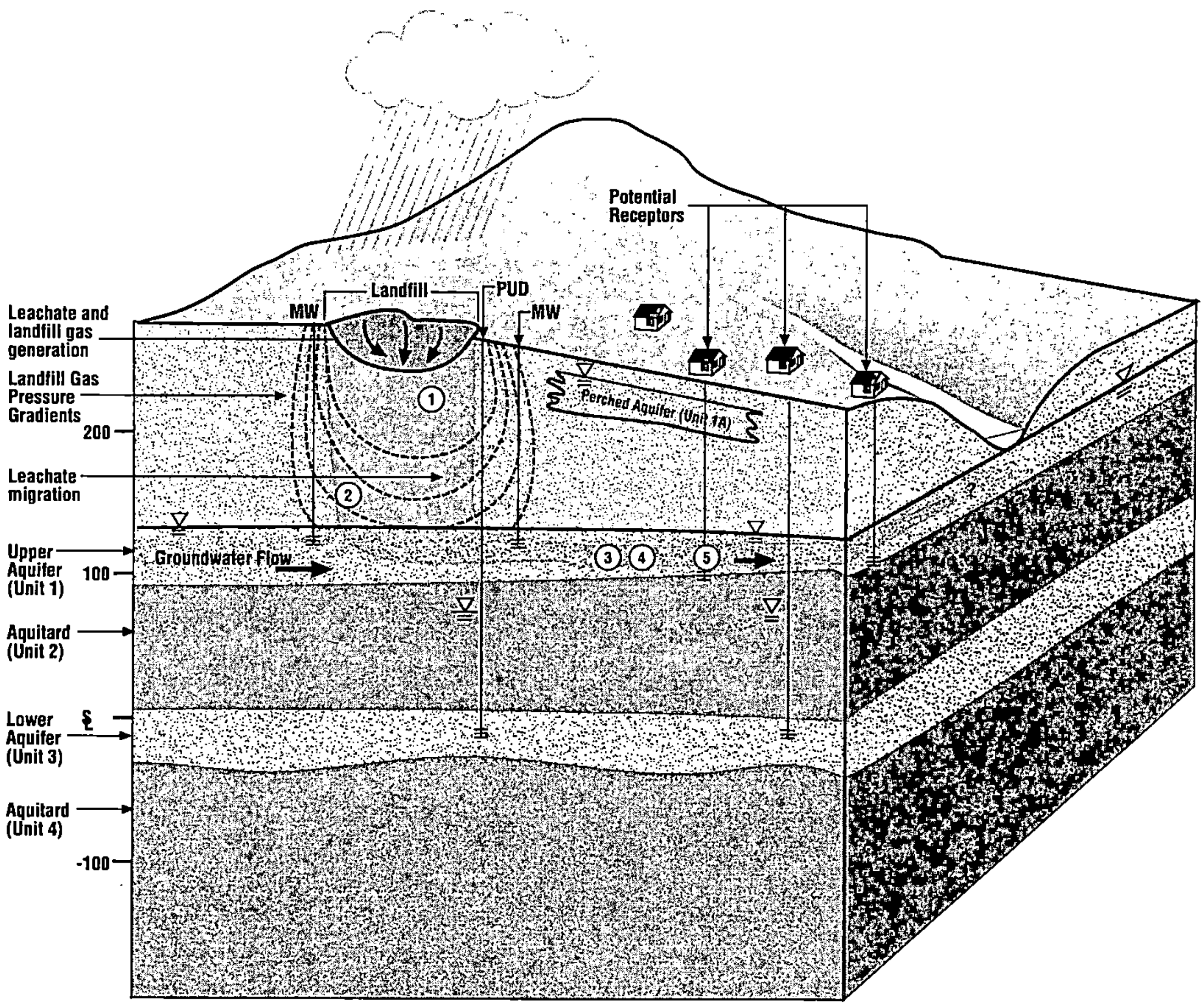
Regional Topography and Surface Water Drainages

Bainbridge Island Landfill FS



Note: Outlines of waste areas and transfer station are approximate.

Figure 2-3
Site Plan
Bainbridge Island Landfill FS



Mechanisms of Groundwater Contaminant Transport

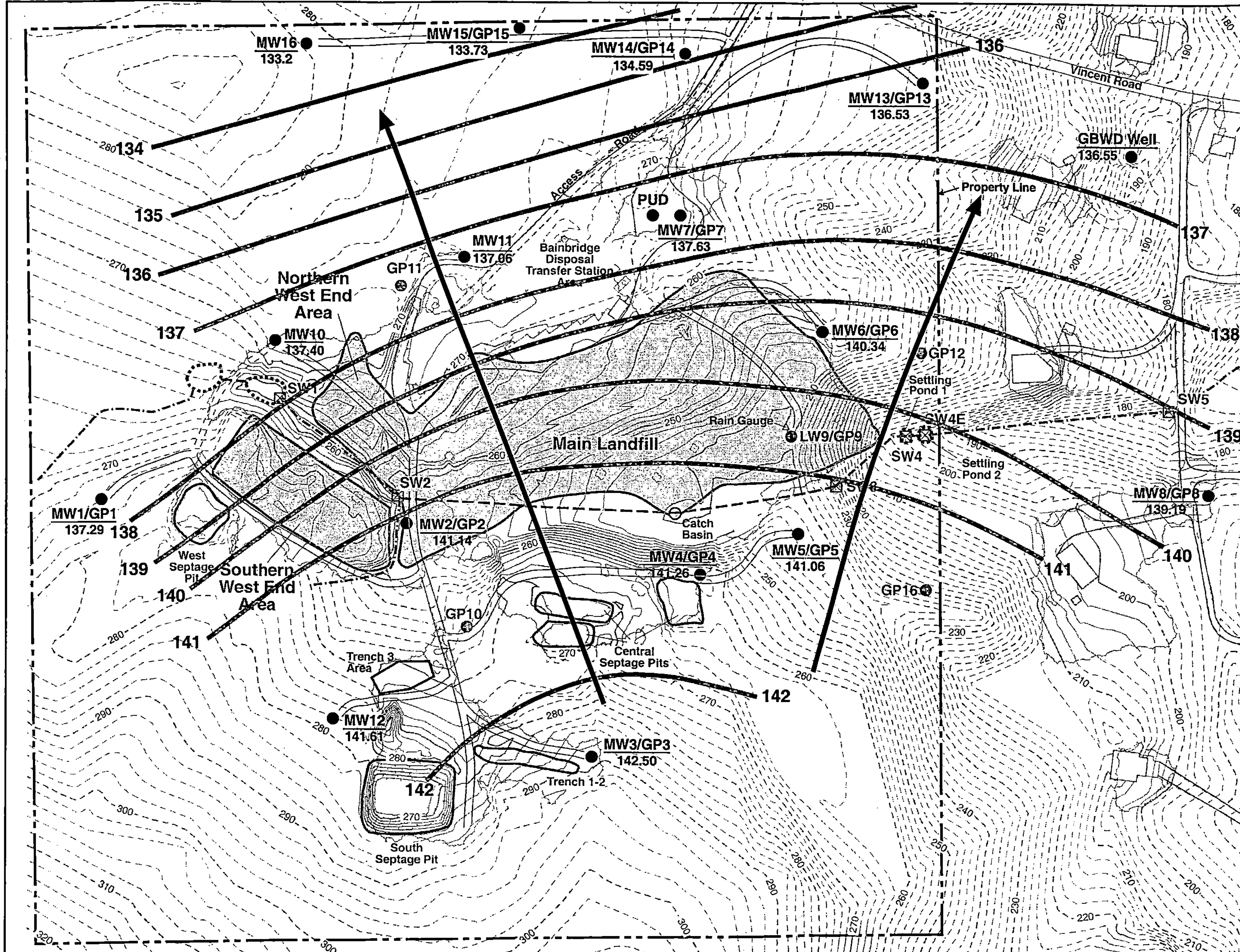
1. Leachate generation from percolation of precipitation and surface water during rainy season through landfill. Leachate migrates down to water table.
2. Landfill gas migration in vadose zone. VOCs from landfill gas enter groundwater and/or percolating leachate.
3. Leachate-enriched groundwater flows north to northeast @ 0.5 ft. per day.
4. Contaminant concentrations reduced by dispersion, sorption, degradation, and dilution.
5. Potential receptors use groundwater (upper aquifer domestic water supply).

Note: For cross-sections and descriptions of geologic units, refer to the RI Report.

Figure 2-4

Conceptual Site Model: Groundwater Contamination

E022000008SEA • 152203.A0.12 • GW elevations March 1999 • 2/4/00 • JG



LEGEND

- ● MW6/GP6 132.36 — Combination monitoring well and gas probe / Groundwater elevation (feet NGVD)
- ● MW12 — Monitoring well
- Approximate extent of main landfill mass
- 134 — Groundwater elevation contour
- Groundwater flow direction

Scale: 1" = 150'

0 50 100 150

N

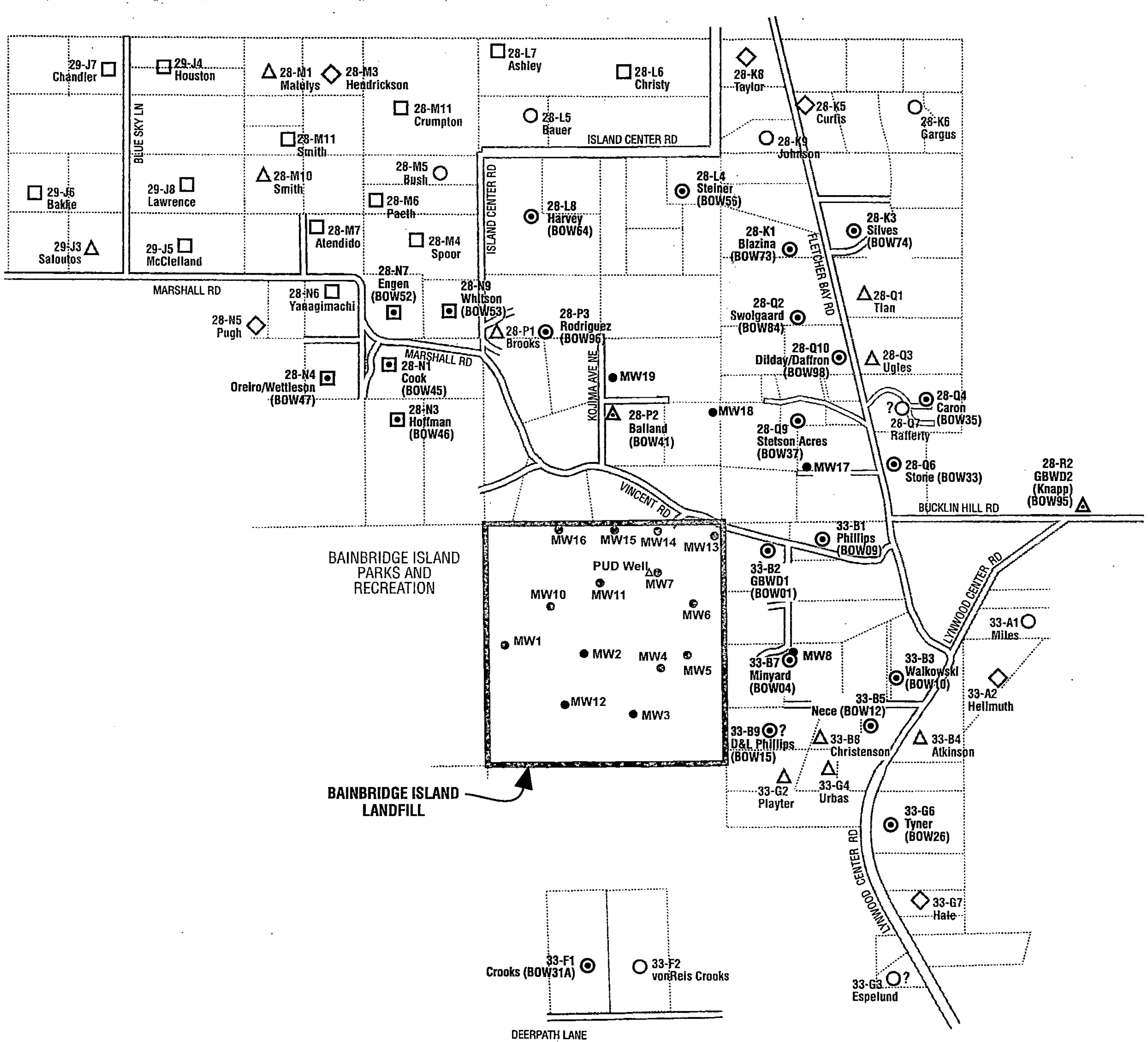
Note: Outlines of waste areas and transfer station are approximate.

Figure 2-5

Groundwater Elevations, March 1999

Bainbridge Island Landfill FS

E022000006SEA • 152203.A0.12 • Area Map • 2/7/00 • jg



Property line

Road

MW8 ● Monitoring Well

○ Upper aquifer domestic well

△ Lower aquifer domestic well

□ Perched aquifer domestic well

◇ Unknown aquifer domestic well

○? Unconfirmed shallow aquifer domestic well

⊙ △ ⊡ ◈ Domestic well sampled since April 1996

33-A1 Map ID number

Hoffman (BOW46) Well owner and sample ID number

NOTE: Well locations are approximate

NORTH

0 400 Scale in Feet

Reference Maps:
Kitsap County Tax Assessor Lot Maps, October 28, 1992.
(Sec. 33-25-2E North Half, Sec. 33-25-2E South Half, Sec. 25-25-2E South Half)

Figure 2-6
Offsite Wells Sampled During RI
Bainbridge Island Landfill FS

CHAPTER 3

Development of MTCA Cleanup Levels

The purpose of this chapter is to establish cleanup standards for the Bainbridge Island Landfill in accordance with MTCA requirements. This involves identifying which contaminants must be remediated, their cleanup levels, and their points of compliance (onsite locations where cleanup levels must be met).

In order to do this, the chapter first presents an analysis of applicable, appropriate, and relevant requirements (ARARs) for the site (Section 3.1). An initial review of regulatory criteria and an analysis of ARARs was presented in the *Bainbridge Island Landfill RI/FS Work Plan* (CH2M HILL, 1996) following procedures outlined in WAC 173-340-700 through 760 (MTCA Cleanup Standards). The discussion below incorporates regulatory revisions that have taken place since the Work Plan was prepared. This analysis identifies the most stringent ARAR (MSA) for each parameter in each medium, including soil, sediment, air, surface water, and groundwater. A general overview of federal, state, and local regulations that may apply to the landfill site is presented in Appendix A.

The MSAs are compared to the level of each detected parameter (Section 3.2). Parameters that exceed their MSAs are considered contaminants of potential concern (COPCs), and a COPC list is produced. (Preliminary lists of COPCs were developed in the RI Report and RI Supplements 1 and 2 using the most stringent ARARs (at the time) as screening levels to evaluate the concentrations of contaminants in the waste sources and environmental media.) This revised COPC list for each medium is then re-evaluated, taking into account the physical characteristics of the site and environmental media, to appraise the fate and transport of contaminants from sources to potential receptors. Supporting data for development of the COPC list is presented in Appendix B.

The re-evaluation produces a final list of contaminants of concern (COCs). Because a site-specific risk assessment has not been completed for this site, cleanup levels for these COCs generally will be the most stringent ARAR for each. The final sections of this chapter identify the points of compliance for each medium where site data will be required to conform to cleanup levels, and evaluate the potential time frame of the site cleanup.

3.1 ARARs

This section summarizes the assessment of the applicable or relevant and appropriate requirements for the Bainbridge Island Landfill. A more detailed analysis can be found in Appendix A. "Applicable" requirements include those requirements that specifically address a hazardous substance, cleanup action, location, or other circumstance at a cleanup site. "Relevant and appropriate" requirements include those that are not legally applicable, but that address problems or situations sufficiently similar to those encountered at the site that their use may be well-suited for the site.

There are three types of ARARs: chemical-specific, location-specific, and action-specific. Chemical-specific ARARs identify health- or risk-based cleanup limits for specific hazardous substances. Location-specific ARARs apply to the concentration of hazardous substances or the conduct of activities solely because they occur in a particular location. Action-specific ARARs define acceptable controls or restrictions on particular kinds of activities. In general, chemical- and location-specific ARARs help to determine the objectives and goals of remedial action, and action-specific ARARs help determine how the remedial action will be performed.

3.1.1 Chemical-Specific ARARs

Chemical-specific ARARs for all media are listed in Table 3-1[1], and are discussed below.

Soil

Applicable soil cleanup levels include MTCA Method A and B cleanup levels for soil and the Puget Sound natural background metals concentrations. In order to protect groundwater from contaminated soils, MTCA specifies that soil cleanup levels be 100 times the MTCA Method B cleanup standard for groundwater (WAC 173-340-740(3)(a)(ii)(A)). This is more stringent than the MTCA Method B cleanup levels for soil, but it is only appropriate at the landfill for volatile organic compounds. MTCA Method B soil cleanup standards are appropriate for other parameters. Based on site RI data, it is unlikely that any contaminants other than VOCs have migrated down through soil to affect (or potentially affect) groundwater. For a complete discussion of the soil-to-groundwater pathway, see Appendix A, Section 2.1.

Sediment

Because the sediment in the storm drainage at the site is deposited by intermittent discharge that cannot support fish and aquatic life, fresh water sediment cleanup standards (not yet promulgated) are not applicable. For this reason, sediment at the site will be treated as soil. MTCA Method B standards for protection of surface water are applicable because remobilization of sediment by storm runoff and discharge to downstream surface water is possible after the remedial action is complete.

Air

The ARARs for air are MTCA Method B cleanup levels for air, Puget Sound Clean Air Agency, and Washington State Minimal Functional Standards for Landfills (Table 3-1).

Surface Water

Both federal and state acute and chronic fresh water quality standards would apply to surface water at the site. However, Ecology has classified the site surface water as stormwater because it runs only intermittently after large rainfalls and cannot support aquatic life nor serve as a drinking water supply. Therefore, federal fresh water and MTCA Method B cleanup levels based on human health criteria for surface water are not applicable. Federal and state criteria based on acute and chronic effects on aquatic life are applicable because surface water runoff from the site may discharge to surface water bodies that are capable of supporting aquatic life.

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[1] Tables and figures are included at the end of the chapter.

Groundwater

Because groundwater is a drinking water supply in the area around the landfill, drinking water standards apply. ARARs for groundwater are federal and Washington State primary and secondary drinking water standards, and MTCA Method B cleanup levels for groundwater (Table 3-1).

3.1.2 Location-Specific ARARs

The laws containing the location-specific requirements identified as part of the ARARs analysis for the FS are summarized in Appendix A. Potential location-specific ARARs are listed in Table 3-2. There are no floodplains, wetlands, shorelines, sensitive habitat, or potentially significant historic features on or sufficiently near the Landfill. The City of Bainbridge Island critical area ordinance would be an ARAR if a critical area is located within the Landfill. Critical areas are defined as aquifer recharge areas, fish and wildlife habitats, frequently flooded areas, geologically hazardous areas, and wetlands and streams and their protective buffer lands. There is no known critical area within the Landfill. Therefore, while this ordinance is applicable, it is not likely to be triggered.

3.1.3 Action-Specific ARARs

Potential action-specific ARARs for the site are listed in Table 3-3.

Institutional Controls

WAC 173-340-440 of MTCA is an applicable ARAR for institutional controls because there may be residual concentrations of hazardous substances exceeding cleanup levels, and because the cleanup action likely will include containment. In addition, WAC 173-160-171(a)(iii), which prohibits construction of water supply wells within 1,000 feet of solid waste landfills, is applicable because the site is a solid waste landfill.

Compliance Monitoring

Four monitoring regulations are applicable to the site, as listed in Table 3-3. These require the preparation of compliance monitoring and groundwater monitoring plans, compliance with occupational health and safety standards, and, if monitoring wells are installed, compliance with the groundwater monitoring well construction regulation.

Collection and Containment

Construction of collection or containment facilities as part of site cleanup needs to meet the City of Bainbridge Island Building Permit requirements, Washington State Waste Discharge General Permit Program, Washington State Minimal Functional Standards for Landfills, Puget Sound Clean Air Agency regulations, and Bremerton-Kitsap County Board of Health Ordinance Number 1996-11.

Treatment and Disposal

For cleanup actions that include treating and disposing contaminated groundwater, five regulations are applicable to the landfill (Table 3-3). First, WAC 173-240 requires submittal of plans and reports for approval. Second, WAC 173-220 requires NPDES permit requirements for point-source disposal of effluent into surface water. Third, if hazardous or dangerous wastes are generated by a cleanup action, they would need to be managed in accordance with the applicable storage, transport, and treatment or disposal requirements of the Washington State Dangerous Waste Regulations (WAC 173-303). Fourth, the City of Bainbridge Island Building Permit Requirements would be applicable if a treatment or disposal facility requires new structures to be built. Fifth, if new structures are sources of air contaminants, then Puget Sound Clean Air Agency regulations would also be applicable

Local Construction Codes

If construction activities disturb more than 5 acres, Washington State's Waste Discharge General Permit Program (WAC 173-226) would apply. If any new structures or modifications to existing structures are needed, it might be necessary to meet local county or city building permit requirements.

3.2 Contaminants of Concern and Remediation Levels

Preliminary lists of media-specific COPCs were presented in the RI Report and Supplements 1 and 2. These COPCs were identified by comparing contaminant concentrations in site samples to RI screening levels (See Chapter 8 of the RI Report, and Chapter 5 of Supplements 1 and 2). The COPCs from the three RI reports are compiled in Table 2-2. In the text below, this preliminary list of COPCs is updated by comparing site analytical data (and modeled data for air quality) to the most stringent ARARs. This updated list of COPCs for site waste sources and all media is shown in Table 3-4. To produce a final list of contaminants of concern (COCs) and develop cleanup or remediation levels, this COPC list is refined using other site data including site history, physical characteristics, frequency of detection, and site background, as discussed below. Supporting data for identification of COCs in all media are included in Appendix B. Table 3-5 is the list of COCs for each medium and their proposed remediation levels.

3.2.1 Soil

Soil at the site has been affected by three waste sources: the main landfill/west end area, the septage pits, and Trench 3. Soil beneath the main landfill and west end area was investigated during the landfill reclamation feasibility evaluation in August 1999. Although soil beneath the septage pits has not been sampled, chemical characterization of the septage pit waste material shows it to be relatively homogeneous and consistent, both within and between individual pits. Waste source COPCs for septage pits become the default COCs for soil beneath the septage pits. Soil beneath the Trench 3 area was investigated both during the RI and during the 1986 EPA Site Investigation.

The COCs and proposed cleanup levels for soil are listed in Table 3-5. Soil cleanup levels for the main landfill and west end area will be applied to the inert waste fraction, which would be graded over a portion of the site and covered with a 2-foot-thick soil cap under a reclamation remediation scenario. Soil amendments will be added to the upper portion of the cover to enhance the growth of planted vegetation to complete the site restoration.

It is likely that residual COCs in the inert fraction will exceed cleanup levels. The August 1999 chemical testing of the inert fraction indicated that up to 6 of 10 samples had PAHs at concentrations that exceed MSAs (see Appendix B). One sample exceeded the PCBs MSA, and five metals MSAs were exceeded in 1 to 4 (out of 10) samples. In order for reclamation with a soil cover on the untreated inert fraction to meet MTCA threshold requirements and project remedial action objectives, concerns about risks to human health and the environment will need to be addressed. The following discussion addresses these concerns, and supports the statement of the effectiveness and ability to meet overall cleanup goals as well as cleanup levels for this remedial alternative in Chapters 5 and 6.

Cleanup Goals to Protect Human Health

The MSAs for soil are the MTCA Method B values for protection of human health. These values are intended to protect children, the most sensitive receptors, under conditions of maximum exposure. Maximum exposure occurs in a residential setting, where children are assumed to inadvertently ingest 200 mg of soil every day of the year for 6 years. These assumptions produce quite restrictive cleanup levels that are undoubtedly protective. However, in recognition of alternative exposure scenarios and land uses, MTCA allows modification of the scenarios under certain circumstances. While this FS does not propose modifying the MTCA Method B values as soil MSAs for the site, some discussion of their application to the site is appropriate.

Under MTCA, cleaning up a site to MTCA Method B values allows for "no further action" and unrestricted land use. The Department of Ecology will recognize such a site as "clean," as long as other MTCA requirements are met. However, cleanups that leave some residual contamination greater than MTCA Method B values do not necessarily present a threat to public health. In cases where the land use is not residential, and institutional controls are applied to the property, the site may be considered clean for non-residential purposes.

The two remedies under consideration at the site will institute both engineering and institutional controls. In the containment option, an impermeable cap would be constructed over the refuse which, combined with access and activity restrictions, would eliminate the potential for exposure to contaminated materials beneath the cap. In this remedy, such controls would be required regardless of contaminant levels beneath the cap. In the reclamation option, most contaminated materials would be removed from the site. The inert fraction used to regrade the site would contain low levels of residual contamination; however, these materials would be placed beneath a soil cap. Controls would be maintained to assure that individuals would not breach the soil cap and incur exposure.

MTCA Method B values are maintained as MSAs for the site, despite their conservatism, because future monitoring may demonstrate that the MSAs are met. This may lift requirements for institutional controls under the reclamation option.

Cleanup Goals to Protect Ecological Receptors

In a letter dated July 20, 1998 (Ecology, 1998), Ecology presented two options to Kitsap County to evaluate potential effects of contaminants on wildlife at the site: 1) compare site contaminant concentrations to screening values provided in the letter, or 2) conduct an ecological risk assessment. Kitsap County elected to use the screening values. This was stated in the RI, and Ecology and the County agreed that the appropriateness of using the screening values would be evaluated during the ARARs analysis in the FS. The ARARs analysis presented in Appendix A concludes that the ecological screening values are not ARARs because the values are not promulgated and are subject to change. However, in order to meet the intent of the July 1998 letter to protect wildlife, Kitsap County will evaluate cleanup options relative to goals to protect wildlife. Kitsap County will do so by trying to meet several provisions contained in the Proposed Amendments to the Model Toxics Control Act (November 1999). These are 1) establishing that the biologically active zone (BAZ) at the site is shallower than a 6-foot depth, and 2) showing that each of the proposed remedial alternatives will include a physical barrier between the BAZ and waste left onsite, which prevents ecological exposure to contaminants. The discussion of the site-specific BAZ is presented below. The effectiveness of each remedial alternative in meeting ecological cleanup goals is discussed in Chapter 5.

The depth to which organisms penetrate soil defines the BAZ. More specifically, factors used to define the biologically active zone include:

- The depth to which soil macro-invertebrates (e.g., earthworms) may penetrate
- The depth to which animals are expected to burrow
- The depth to which plant roots may extend

The BAZ is defined by the characteristics of the soil horizon at any given site. A field reconnaissance was completed to determine the BAZ at the landfill site. The landfill itself is an open area covered with grass, gravel, and a few shrubs and trees. Aside from the active transfer station, the rest of the landfill is surrounded by forest. Between the forest and the open space is a border of shrubs. Both the forest and the open space were studied by a field biologist. The organic soil layer, or A horizon, is shallow in all areas that were observed. There was no evidence of macro-invertebrate activity below the A horizon. Because of the very low organic content of the sand beneath the A horizon (0.3 to 1 percent), macro-invertebrates and their predators are limited to the surface soil.

Several wildlife species were identified by signs of activity, from black bear to meadow voles. It appeared that wildlife occupation of the open area, or landfill, did not represent total wildlife occurrence in the forest surrounding the site. The open area is used primarily as a travel corridor for various species.

Exposure to COCs may be considered possible in ground dwelling, burrowing species. Moles, voles, and coyotes currently use the site, and these species routinely burrow and dig. The mountain beaver occurs in the vicinity, but only in the forested buffers and uplands surrounding the landfill. Evidence of black bear was also observed, but use of the area by this species is speculated as irregular. These wildlife species comprise the burrowing and digging animals at the site.

The depth to which these species may dig helps define the BAZ. Black bear and coyote only dig and grub in the soil duff and leaf litter, and rarely penetrate the A soil horizon. These species may dig through the A soil horizon on rare occasions when they are motivated by a highly preferred food source. However, these mammals rarely expend significant effort pursuing small food sources such as mice or voles.

Vole species in the Pacific Northwest use surface raceways, and moles typically inhabit surface soils at depths varying between 5 to 8 inches (Campbell, 1994; Whitaker, 1997.) Therefore, for small mammals, burrows used for cover and reproduction will occur within the top foot of soil.

Mountain beavers are prolific diggers that may burrow several feet into organic soils (up to 6 feet; Campbell, 1994; Whitaker, 1997). However, the depth of their penetration into the subsurface depends on the substrate. Mountain beavers prefer organic soils and do not burrow in sand because sand is unstable and unsuitable for denning (Campbell, 1994; Whitaker, 1997). Soil samples from the site indicate a high sand content in soils below the A horizon, and the surface soil did not adhere under hand compression, even following a previous night's rain. The low organic content, sandy soil probably limits mountain beavers to shallow burrows in the forested areas around the landfill.

Mountain beavers do not occur in the open area of the site. They typically inhabit stands of Douglas fir (*Psuedotsuga menziesii*) and western hemlock (*Tsuga heterophylla*) (Campbell, 1994). They favor dens under decaying stumps in moist soil regimes with high organic content. Primary foods are sword ferns (*Polystichum munitum*), bracken ferns (*Pteridium aquilinum*), and Douglas fir and hemlock saplings (Campbell, 1994). These preferred habitat and food resources only occur in the adjacent forests surrounding the landfill site. The open area of the landfill site has none of the characteristics required for mountain beaver habitat as described by Campbell (1994). While this species may be present in the surrounding forest, they are unlikely to inhabit the proposed capped areas of the landfill site. In addition, mountain beavers do not forage beyond a radius of approximately 15 meters from any burrow entrance (Campbell, 1994).

Plant roots extend deep into the soil in the forest around the landfill site. However, on the site itself, most of the vegetation is grass. The root zone for grasses and weeds is about one foot deep. Bushes and trees on the perimeter of the landfill penetrate deeper. The root zone on the proposed cap areas can be controlled by planting and maintaining grasses.

The BAZ at the site varies from the forested areas to the open space with regard to the depth of the root zone. However, animal activity is constrained by the low organic content sand layer beneath the shallow surface soil. There are no organisms using the site that are expected to penetrate more than a foot beneath the surface. Mountain beavers may penetrate deeper in the soils of the forested areas around the site, depending on the depth of the organic layer, however, mountain beavers will not inhabit open space in the main landfill area.

Reclamation of the site is proposed to retain the inert fraction of the landfill beneath a 2-foot thick soil cap. Site-derived, low organic content sandy soil will be used to create the cap. The BAZ is expected to form in a layer that consists of approximately the upper three inches of the soil cover and organic debris that accumulate on top of the cover over time. Thus, the biologically active zone will be reestablished from the top of the soil cover upward.

Constituents that exceeded ecological screening levels are copper, lead, zinc, and Arochlor 1254 (see RI Supplement 2). Out of 10 samples, copper exceeded the screening level in 2 samples, lead in 4 samples, zinc in 3 samples, and Arochlor 1254 in 1 sample. While the data are not statistically robust (i.e., the number of samples is relatively small), they indicate that much of the inert material is below the ecological screening level. Furthermore, none of these constituents would be mobile under the proposed site conditions following remediation; they would remain where placed with the inert material.

In summary, the biologically active zone is inhabited by voles, mice, and mountain beaver, which are the only potential receptors in and around the site. The mice and voles are not capable of burrowing to a depth that would expose them to COCs. These organisms will not burrow deeper than one foot. The mountain beaver could potentially burrow to a depth of up to 6 feet; however, they will not burrow in sand. Moreover, mountain beavers inhabit heavily forested areas and very highly organic soils.

3.2.2 Sediment

Section 3.1.1 and Appendix A established that the MSAs for sediment are essentially the same as those for soil. Sediment will be treated as soil during remediation, with the exception of sediment in the catch basin (Figure 2-3). This is the only sediment that contains organic compounds (detected in one sample, SED-5) so it is appropriate to include catch basin sediment with the remedial action for the main landfill waste rather than with other sediment.

Because organic compounds were detected in only one sediment sample, they are not included as COCs for sediment. Similarly, because dibenzofuran was detected only once (in a historic sample) out of 10 samples, and was not detected in subsequent RI samples, it is not included as a COC (Table 3-5).

3.2.3 Landfill Gas/Air

None of the chemical constituents detected in landfill gas exceeds the MSA. Therefore, there are no COPCs, COCs, or proposed cleanup levels for landfill gas/air. The remedial action will address landfill gas to ensure that levels either decrease or do not increase above regulatory levels.

3.2.4 Surface Water

The site-specific surface water COPCs are presented in Table 3-4. Dissolved lead was detected only once (December 1997) at station SW2, which is upstream of the main landfill. The detection was B-qualified, indicating that the value was between the method detection limit and the reporting limit. Therefore, dissolved lead is not included as a COC for surface water. The proposed surface water cleanup level for each remaining COC is the MSA (Table 3-5).

3.2.5 Groundwater

The process for developing groundwater COCs and cleanup levels uses MTCA criteria as guidance. A three-step approach is used to refine the list of COPCs to arrive at a final list of COCs for groundwater :

1. **Identify COPCs:** Identify parameters that have MSAs and compare each parameter in each well to the MSA. Parameters that exceed the MSAs at least once in any single well are carried to Step 2.

2. **Calculate Statistics by Well:** Calculate the frequency and magnitude of the exceedances for each COPC parameter in each well. If a COPC either exceeds the MSA in more than 10 percent of the samples from one well (*exceedance frequency*), or if any sample exceeds more than two times the MSA (*exceedance ratio*), it is carried to Step 3.

3. **Evaluate:** Evaluate the spatial distribution, temporal trends, potential outliers, and background well concentrations of the data from each well. In this step, COPCs either are eliminated or become COCs.

Figure 3-1 is a flow chart illustrating the process for determining the COCs for groundwater. Procedures for completing each step are described in more detail below, followed by a discussion of the results for each of the COPCs and development of the groundwater COCs and cleanup levels.

As explained in Section 2.1.4, the upper aquifer is the first aquifer encountered directly beneath, and has received contamination from, the waste sources on the site. In contrast, the perched and lower aquifers are hydraulically isolated from the upper aquifer, and are therefore isolated from the effects of the landfill. For this reason, the analysis of MSAs and determination of COCs presented below considers only data from wells completed in the upper aquifer.

Step 1: Identify COPCs

Parameters that have MSAs are identified and the data for those parameters are compared to the MSA on a well-specific basis. If any sample in any well exceeds the MSA, the parameter is a COPC and the process continues. Parameters with no exceedances are eliminated as COCs. The list of COPCs for groundwater (parameters that exceed MSAs) is shown in Table 3-4.

Step 2: Calculate Statistics by Well

Two statistics, exceedance frequency and exceedance ratio, are used to screen COPCs in Step 2: if more than 10 percent of the samples from any well exceed the MSA for a parameter, or if any single sample is greater than two times the MSA, then that parameter is further evaluated in Step 3. If neither of these conditions is met, the parameter is eliminated as a COC. The exceedance frequencies and exceedance ratios for the monitor wells are included in Appendix B. They were calculated from the well-specific summary statistics for groundwater in Table 4-21 of Supplement 2. Appendix B also includes the exceedance frequencies and exceedance ratios for the domestic wells, and a summary of the parameters that did not meet Step 2 criteria. These parameters are further evaluated in Step 3 below.

Step 3: Evaluate Temporal Variability, Spatial Distributions, Outliers, and Background

Step 3 integrates the results of Steps 1 and 2 with information on the temporal and spatial distribution of exceedances, an analysis of background concentrations, and an evaluation of whether isolated exceedances may be statistical outliers due to the sampling and/or analysis procedures. Evaluation tools include data tables, time series plots, and boxplots. Time series plots (Appendix C) show how the concentration of a parameter in a well has changed over time. They were produced for parameters with at least four sampling events and two detects, and include data for wells with at least one detect.

Boxplots (Appendix D) are visual tools for examining the statistical distribution of the data, including spatial distribution and outliers. They are useful for comparing relative parameter values between different wells. The horizontal axis shows the concentration of a parameter, and the vertical axis shows individual wells. Monitoring, domestic, and background wells are grouped together on the vertical axis; background wells are identified with a "B" preceding their ID number (see below). The range of parameter values for each well is represented as a "box" that shows the median and spread of the data. The MSA or cleanup level is shown as a vertical line for reference. Boxplots were produced for all wells, and show all the parameters with at least four detected values.

Four monitoring wells and six domestic wells were used as background wells to help evaluate water quality. As part of Step 3, parameters remaining after Steps 1 and 2 are compared to background water quality levels. In this context, "background" is defined as groundwater that has not been affected by the landfill.

Background Wells

Wells that are completed in the shallow aquifer and that are upgradient or cross-gradient are proposed as background wells. Metals and other non-volatile contaminants cannot migrate to cross- or upgradient wells completed in the upper aquifer east and south of the main landfill, given the following: 1) the relatively steep groundwater gradient to the north; 2) the lack of seasonal groundwater flow direction changes; 3) the lack of significant cross- or upgradient pumping centers; and 3) the lack of any observed cross- or upgradient pumping effects at the landfill, as evidenced by undistorted groundwater flow lines. (See RI Report, Figures 4-12 through 4-15; RI Report, Appendix D well records; and RI Supplement 1, Figure 4-3.) Plume maps presented in the RI Supplements 1 and 2 also clearly show the landfill-affected groundwater moving from the landfill to the northeast away from these wells. (See RI Supplement 1, Figures 4-6, 4-11, 4-13, 4-15, 4-16, 4-17, and 4-19, and Supplement 2, Figures 4-16 through 4-26.)

Onsite wells MW1 and MW3 and offsite monitoring well MW8 are considered as background wells because they are not downgradient of any potential onsite contaminant sources (Figure 2-6). Onsite monitoring well MW12 is also considered a background well. Although it is downgradient of the south septage pit, chemical analytical results have shown that groundwater is not affected by septage pit contaminants. Refer to Section 2.1 in Appendix A for a discussion of the possible migration of inorganic contaminants from site sources to the groundwater. (See RI Supplement 1, Figures 4-11 through 4-19.) The offsite background wells are BOW4, BOW10, BOW12, BOW15, BOW26, and BOW31A (Figure 2-6). These wells have been accepted as upgradient and cross-gradient by Ecology (see RI Report, Appendix D, and Supplement 1, Chapter 5).

Discussion of Results

Presented below are the results of the groundwater COC development. Each of the 17 COPCs for groundwater shown in Table 3-4 is discussed, and is either eliminated or determined to be a COC. The discussion for each parameter generally follows the three-step process outlined above: compare the detected values to the MSA; calculate the exceedance percentages and exceedance ratios; and evaluate the spatial distribution, temporal trends, potential outliers, and background well concentrations. For reference, well locations are shown in Figures 2-3 and 2-6. The final list of groundwater COCs is shown in Table 3-5.

Vinyl Chloride (COC)

Vinyl chloride concentrations exceeded the MSA in approximately 25 percent of the 173 monitoring well samples and approximately 10 percent of the 148 domestic well samples. The exceedances occurred in five monitoring wells and three domestic wells.

The five monitoring wells with exceedances all have exceedance ratios greater than 2 and exceedance frequencies greater than 10 percent. One of the three domestic wells with vinyl chloride exceedances has an exceedance ratio greater than 2, and two of the wells have exceedance frequencies greater than 10 percent.

Vinyl chloride was consistently detected, and exceeded the MSA, in monitoring wells MW06, MW07, MW13, and MW14. The highest concentrations were present in well MW14. The distribution of vinyl chloride in the monitoring wells is similar to that of 1,1-DCE and cis-1,2-DCE. Vinyl chloride is a product of anaerobic degradation of these two chemicals. Time series indicate that vinyl chloride concentrations in well MW14 initially increased and are now decreasing, and that concentrations in well MW06 may be increasing (although an earlier sample from this well had a higher concentration than the most recent sample). Vinyl chloride was detected at low concentrations twice in well MW15, which is adjacent to well MW14, and in well MW18 (below the MSA), which is downgradient of MW14.

In the domestic wells, vinyl chloride was consistently detected in well BOW37, at concentrations similar to those in wells MW07 and MW13. The concentrations in well BOW37 appear to be gradually decreasing over time. Vinyl chloride was detected once in eight other domestic wells. Two of the detections were in background wells BOW04 and BOW15. Six of the eight detections were below the MSA, and the remaining two detections were just above the MSA (0.04 μg/L in BOW64 and 0.03 μg/L in BOW96, compared with an MSA of 0.023 μg/L). All subsequent samples in the eight wells were nondetects.

Vinyl chloride was consistently detected in some monitoring and domestic wells at concentrations up to two orders of magnitude higher than the MSA (the MTCA Method B cleanup level). Vinyl chloride is a COC.

1,1-Dichloroethene (COC)

Concentrations of 1,1-dichloroethene (1,1-DCE) in 11 monitoring well samples, approximately 6 percent, exceeded the MSA. All of the exceedances occurred in two wells, MW07 and MW14. In the domestic well samples, 1,1-DCE was detected in one sample at a concentration below the MSA. The exceedance ratio for 1,1-DCE in monitoring well MW14 is 3.8 and the exceedance frequency is 100 percent. The exceedance frequency in MW7 is less than 10 percent and the exceedance ratio is less than 2.

The monitoring well time series shows that concentrations of 1,1-DCE in well MW14 were consistently above the MSA (by less than an order of magnitude), and they are not consistently increasing or decreasing with time. 1,1-DCE was also consistently detected in monitoring wells MW06, MW07, and MW13 at concentrations below the MSA (one sample in well MW07 was above the MSA in June 1997). 1,1-DCE was detected once out of 11 samples at domestic well BOW09, at a concentration below the MSA. BOW09 is downgradient of the landfill; however, 1,1-DCE has not been detected at well BOW01, which lies between the landfill and well BOW09.

Because 1,1-DCE was consistently detected at the landfill property line at concentrations exceeding the MSA, 1,1-DCE is a COC.

Cis-1,2-dichloroethene (not a COC)

Cis-1,2-dichloroethene (cis-1,2-DCE) was detected at a concentration exceeding the MSA in one sample from monitoring well MW14. It did not exceed the MSA in any domestic well samples. The single detection of cis-1,2-DCE in monitoring well MW14 was just barely above the MSA, with an exceedance ratio of 1.1 and an exceedance frequency of 10 percent.

The distribution of cis-1,2-DCE is similar to that of 1,1-DCE and vinyl chloride, and the three chemicals are potential daughter products of TCE. Although the presence of cis-1,2-DCE in monitoring wells is attributable to the landfill, the resulting concentrations in groundwater are consistently below the MSA in all wells. Therefore, cis-1,2-DCE is not a COC.

Pentachlorophenol (not a COC)

Pentachlorophenol (PCP) has been detected three times in monitoring wells, exceeding the MSA in one sample. PCP has never been detected in domestic wells. The single exceedance of the PCP MSA occurred in well MW06, giving an exceedance ratio less than 2, and an exceedance frequency of 17 percent. PCP was detected in one other sample from this well, at a concentration below the reporting limit. Because PCP has only exceeded the MSA in a single groundwater sample, it is not a COC.

Bis(2-ethylhexyl)phthalate (not a COC)

Bis(2-ethylhexyl)phthalate concentrations exceeded the MSA in approximately 8 percent of the 90 monitoring well samples, occurring in six wells. In the domestic wells, there were no exceedances of the MSA.

Exceedance ratios in three monitoring wells are greater than 2, with a maximum factor of 21 in MW07. The exceedance frequencies in these wells range from 17 percent to 33 percent. Four out of the seven exceedances occurred in four monitoring wells during the first round of sampling, in June and August 1996. In three of these four wells (MW2, MW4, and MW11) the five samples that were subsequently collected all had nondetectable concentrations. In well MW7, the five samples taken after the first round of sampling had one detected concentration below the MSA, one concentration exceeding the MSA, and three nondetects. The remaining two exceedances occurred in the second round of sampling in wells MW15 and MW18. Bis(2-ethylhexyl)phthalate was not detected in the three other samples collected from these wells.

Bis(2-ethylhexyl)phthalate is a common ingredient in PVC, the material from which the well casings are constructed. The sporadic detections and exceedances of bis(2-ethylhexyl)-phthalate in the monitoring wells, occurring in the first or second round of monitoring, are most likely from the new PVC casings, and not from the landfill. In well MW6, there was one second exceedance of the MSA, followed by two more nondetects. For this well, changes in chemistry caused by landfill leachate may be increasing the amount of bis(2-ethylhexyl)-phthalate that is leaching from the casings; however, the source of the chemical is most likely the PVC casings.

Bis(2-ethylhexyl)phthalate was detected only once in the domestic wells, in the first round of sampling at well BOW96, at a concentration below the MSA. Drinking water plumbing was constructed to this well in the last 2 years. Although domestic well casings typically are steel, well plumbing, including the pump discharge pipe, is commonly PVC.

Because monitoring well casings and domestic well plumbing, and not the landfill, appear to be the source of bis(2-ethylhexyl)phthalate in groundwater samples, because the infrequent exceedances have generally occurred only when the well casings were new, and because there have been no exceedances of bis(2-ethylhexyl)phthalate in domestic wells, this chemical is not a COC.

General Metals

A change in monitoring well sampling technique may have affected the groundwater data for general metal parameters. During the first sampling rounds (June, July, and August 1996 samples), wells MW01 through MW12 were sampled using stainless steel bailers. In subsequent sampling rounds, these wells were sampled using dedicated, variable-flow submersible pumps. Bailers are known to result in greater recovery of colloidal particles, including total metals, and are suspected to result in low recovery of VOCs because of greater sample disturbance.

Arsenic (not a COC)

It is important to note that the MSA for arsenic in groundwater is below the arsenic detection limit. Because of this, all detectable concentrations exceed the MSA, and the arsenic exceedance frequency is equal to the detection frequency. Similarly, all arsenic exceedance ratios for both the monitoring and domestic wells are greater than 2 because the detection limit is more than twice the MSA.

Arsenic was detected and the MSA was exceeded in approximately 17 percent of the 174 monitoring well samples. The monitoring well exceedances occurred in 12 wells, including 3 of the 4 background monitoring wells. Arsenic exceeded the MSA in 41 percent of the 27 domestic well samples, with exceedances in 9 of the 18 domestic wells, including 5 of the 6 background wells.

The exceedance frequency was greater than 10 percent in six monitoring wells, including background well MW03. Only one or two samples were collected from each domestic well in which arsenic was detected; therefore, the exceedance frequencies in domestic wells in which arsenic was detected were 50 or 100 percent. The maximum arsenic concentrations detected in any wells was at the background domestic well BOW31A, in which arsenic was detected at 11 and 26 µg/L. All downgradient domestic wells had arsenic concentrations that were less than or equal to arsenic concentrations in the domestic background wells.

One monitoring well, MW06, had arsenic concentrations detected at concentrations consistently above the background monitoring wells, which could be attributable to the landfill. However, the source of the arsenic is probably the aquifer matrix. The arsenic concentrations in MW06 (1.6 to 3.5 µg/L) were lower than concentrations in three of the five background domestic wells in which arsenic was measured; concentrations in these background domestic wells ranged from 4 µg/L (BOW10) to 26 µg/L (BOW31A). Other than well MW06, the downgradient monitoring wells appear to have detectable concentrations of arsenic at approximately the same frequency and concentration as the background monitoring wells.

Arsenic concentrations in all upper aquifer domestic and monitoring wells were below the MTCA Method A cleanup level, which is based on background concentrations of arsenic in groundwater for the State of Washington. Therefore, arsenic is not a COC.

Chromium (not a COC)

Chromium concentrations exceeded the MSA in one of 174 samples collected from the monitoring wells. There were no exceedances of the MSA in domestic wells. The single exceedance of the chromium standard occurred in monitoring well MW07 in June 1996. It was the first sample collected from this well; the subsequent 10 samples had nondetectable concentrations of chromium. The exceedance frequency for this well is 9 percent, and the exceedance ratio is 1.4. Therefore, chromium is not a COC.

Iron (not a COC)

Iron was detected at concentrations exceeding the MSA in approximately 17 percent of the 174 monitoring well samples. The exceedances occurred in 13 of the 18 wells sampled. Approximately 19 percent of the 27 samples from domestic wells had iron concentrations exceeding the MSA. The exceedances occurred in five of the domestic wells.

Exceedance ratios for the monitoring wells range from 1.2 to 13, and ten wells have exceedance ratios greater than 2. The exceedance frequencies are greater than 10 percent in two of the monitoring wells. For the domestic wells, the exceedance ratios for three wells are greater than 2, with a maximum of 6.1. With only one or two samples analyzed for iron (with the exception of well BOW01, from which four samples were collected), the exceedance frequencies are all 100 percent for the domestic wells.

In the monitoring wells, which were sampled more times than the domestic wells (9 to 14 rounds for most wells; 4 for MW17, MW18, and MW19), iron concentrations consistently exceeded the MSA in well MW06. The concentrations were typically approximately five times the MSA, and they do not appear to be increasing or decreasing over time. Although these concentrations were higher than iron concentrations in the upgradient monitoring wells, they are comparable with concentrations detected in background domestic wells BOW12, BOW26, and BOW31A.

Other exceedances of the iron MSA in monitoring wells occurred during the first sampling round (1996), when bailers were used to collect groundwater samples. Concentrations since the first round have been below the MSA, with two exceptions: one of 10 samples collected from well MW13 had an iron concentration of 350 μg/L, compared with the MSA of 300 μg/L; and one of 9 samples collected from well MW16 had an iron concentration of 430 μg/L.

All of the exceedances of the iron MSA in domestic wells occurred in background wells (BOW10, 12, 26, and 31A). None of these exceedances is expected to be attributed to the landfill. The condition of higher iron concentrations in domestic background wells than in most other upper aquifer wells, including background monitoring wells, was similar to that observed for arsenic. Because background domestic wells were sampled only in 1996, more recent data are not available for comparison at these wells. Differences in metals concentrations could possibly be attributed to higher than normal rainfall in 1997, 1998, and 1999, resulting in higher diluted metals concentrations.

Iron was detected in only one upper aquifer well, MW06, at concentrations that consistently exceeded the MSA. The exceedances were by less than an order of magnitude, and concentrations were within the range of iron concentrations detected in background domestic wells. Iron concentrations do not appear to be increasing over time. Finally, the MSA for iron is a secondary drinking water standard and not based on health effects. Therefore, iron is not a COC.

Lead (not a COC)

None of the lead concentrations detected in the monitoring wells exceeded the MSA. Two samples out of 27 domestic well samples, approximately 7 percent, exceeded the lead MSA. The two exceedances were in two wells, one of which has an exceedance ratio greater than 2. With only two samples per well, the exceedance frequencies in these wells are 50 percent.

The two domestic well exceedances for lead occurred in background well BOW31A and downgradient well BOW64. The background well is not influenced by the landfill. A subsequent sample from BOW64 had a lead concentration below the MSA. Since lead concentrations in the upper aquifer monitoring wells did not exceed the MSA, the exceedance in well BOW64 is not attributable to the landfill. Therefore, lead is not a COC.

(Note: the single lead value of 20 μg/L that shows up on time series and boxplots for monitoring well MW07 was a nondetect; the reporting limit was 20 μg/L. The other 10 samples collected at this well were below the MSA.)

Manganese (COC)

Approximately 17 percent of the 174 monitoring well samples exceeded the MSA for manganese. These exceedances occurred in ten wells. Manganese concentrations in approximately 19 percent of the domestic well samples exceeded the MSA. All the drinking water exceedances were from four wells. Three monitoring wells and four domestic wells have exceedance ratios above 2. Exceedance frequencies in three monitoring wells and four domestic wells are greater than 10 percent.

The boxplots for monitoring wells indicate that two wells consistently had manganese concentrations exceeding the MSA: MW06 and MW13. Concentrations of manganese in well MW06 were the highest observed, approximately 130 times the MSA. The time series plots indicate that concentrations are not increasing or decreasing over time.

Monitoring well MW13 also had manganese concentrations that were consistently greater than background. Concentrations in this well were approximately an order of magnitude less than concentrations in well MW06 (exceedance ratios are about 12 in MW13, compared with 130 in MW6). MW13 is located approximately 400 feet downgradient of well MW06, at the landfill property line (Figure 2-3). Manganese concentrations in the closest domestic well that is downgradient of well MW13, BOW37 (Figure 2-6), were at least an order of magnitude below those in well MW13, and were all below the manganese standard and background well concentrations. Also, monitoring well MW17, which is between MW13 and BOW37, had manganese concentrations below the MSA and 1 to 2 orders of magnitude below the MW13 concentrations.

The distribution of manganese concentrations in the domestic wells is consistent with the distributions of other metals, in that concentrations are highest in most of the background wells. However, all of the domestic and background wells have manganese concentrations that are lower than those detected in monitoring well MW06.

The MSA for manganese (50 μg/L) is a secondary drinking water standard, based on aesthetics. However, the MTCA Method B cleanup standard of 2,240 μg/L is based on human health effects. Manganese concentrations in well MW06 consistently exceeded this MTCA standard, were significantly above background, and were more than two orders of magnitude above the secondary standard. Therefore, manganese is a COC.

Thallium (not a COC)

Thallium concentrations in approximately 1 percent (2 samples) of the 174 monitoring well samples exceed the MSA. The detection frequency for thallium is only 2 percent. Because the detection frequency was so low, the detection limit was evaluated to determine whether it was low enough to assess MSA exceedances. This low detection frequency is not an indication that the detection limit is too high to assess whether concentrations exceed the MSA; only one sample had a reporting limit that was above the MSA. Therefore, the detection limit is sufficiently low to detect potential thallium exceedances, and the lack of exceedances truly reflects that thallium concentrations do not exceed the MSA. Two monitoring wells, MW03 and MW07, had one sample each that exceeded the thallium MSA; the remaining 10 samples were all below the MSA. The exceedance ratios are both below 2, and the exceedance frequencies are below 10 percent. Therefore, thallium is not a COC.

Conductivity (indicator COC)

Conductivity exceeded the MSA in 45 monitoring well samples, approximately 26 percent of the measurements. The exceedances occurred in six monitoring wells. Conductivity exceeded in the MSA in only one domestic well, BOW74, in a single sample out of a total of 147 samples. Only one of the six monitoring wells with exceedances has an exceedance ratio greater than 2, but the exceedance frequencies in all six wells are greater than 10 percent. The single exceedance of the conductivity MSA in domestic well BOW74 comprised 17 percent of the six samples collected at that well.

Conductivity in one sample from well MW15 was measured at 10 times the MSA in June 1999. However, boxplots and time series plots indicate that this sample is an outlier. All other exceedances of the MSA were by less than a factor of 2. The single exceedance in domestic well BOW74, in March 1999, also appears to be an outlier based on the time series plots and boxplots. The other conductivities measured at this well were below 200 µmho/cm. Conductivity was measured just below the MSA in BOW37, but it appears to be decreasing over time. There are no apparent increasing or decreasing trends of conductivity over time in any other wells.

The MSA is a secondary drinking water standard; it is based on aesthetics, not on adverse health effects. Conductivity is an indicator COC, although not based on concern for human health effects.

Nitrate (not a COC)

Four out of 174 samples, all from monitoring well BMW08, exceeded the nitrate MSA. There were no exceedances of the MSA in domestic wells. Approximately 31 percent of the samples collected in well MW08 exceeded the MSA, by less than a factor of 2. Time series plots show that the exceedances of the nitrate MSA in well MW08 occurred prior to 1998; nitrate in well MW08 has been decreasing since 1997. There were no exceedances in any other well. Therefore, nitrate is not a COC.

Nitrate + Nitrite (not a COC)

Nitrite concentrations in groundwater are much lower than nitrate concentrations, so that the sum of nitrate plus nitrite is close to the concentration of nitrate alone. The statistics for exceedances for the two groups are identical. Therefore, nitrate + nitrite also is not a COC.

pH (indicator COC)

Approximately 22 percent of the 171 monitoring well pH measurements were outside of the MSA pH range of 6.5 to 8.5, all on the low side. The pH was low in 11 wells. For the domestic wells, approximately 13 percent of the pH measurements were outside of the pH range. In seven wells, the pH was below 6.5, and in four wells, the pH was above 8.5. In 8 of the 11 monitoring wells with low pH, greater than 10 percent of the samples are below the lower MSA (including background well MW08). In 7 of the 11 domestic wells with pH outside the MSA range, the exceedance frequency is greater than 10 percent (including background wells BOW04, BOW12, and BOW15).

Examination of the boxplots for the monitoring wells shows that the pH in most of the downgradient wells was lower than the pH in three background monitoring wells, but similar to the pH in background well MW08. The exceptions are well MW02, for which most of the pH measurements were below the lower limit of the MSA, and wells MW04, MW05, and MW19, which had pH values comparable to the pH of the background wells.

For the domestic wells, only the pH at well BOW74 was significantly lower than the background pH ranges. The low pH at BOW74 appears to be due to non-landfill influences, since the pH ranges at wells between BOW74 and the landfill (BOW37, BOW73, and BOW84) are similar to the background pH ranges. Groundwater at BOW74 is only 24 feet below ground surface, which is significantly shallower than groundwater upgradient of this location. Because of this, the well may be subject to surface effects from infiltrating stormwater runoff. According to the boxplots, the pH measurements in the domestic wells that exceeded the upper limit of the MSA appear to be single measurement outliers.

The MSA for pH, a secondary drinking water standard, is not based on adverse human health effects. However, pH is an indicator COC because it is a leachate indicator parameter.

Total Coliform (not a COC)

Approximately 12 percent of the monitoring well samples analyzed for total coliform had detectable coliform counts, with all but one sample exceeding the MSA. (All detections of total coliform greater than one count are MSA exceedances.) The detections occurred in 11 wells. Total coliform was detected, and exceeded the MSA, in 2 percent of the domestic well samples.

In nine monitoring wells, the exceedance ratios are greater than 2; the frequency of exceedance is greater than 10 percent in seven wells. Because only one or two samples from each domestic well were analyzed for total coliform (four samples from BOW01), detections resulted in an exceedance frequency of 50 or 100 percent.

Only one to three samples per well had detectable total coliform. Based on the infrequent and sporadic detections of total coliform in groundwater samples, this parameter was dropped from the analyte list beginning in 1999, with Ecology's approval. Total coliform is not a COC.

Total Dissolved Solids (not a COC)

Approximately 26 percent of the monitoring well samples, from seven wells, exceeded the MSA for TDS. None of the exceedance ratios are greater than 2, but five of the seven wells have an exceedance frequency greater than 10 percent. There were no exceedances of the TDS MSA in domestic wells.

The boxplots and time series plots for the monitoring wells show that TDS was elevated above background in six wells; in four of these wells (MW06, MW07, MW14, and MW15), the MSA for TDS was consistently exceeded. However, the exceedances ratios are less than 2, there were no exceedances in domestic wells, and the MSA is a secondary drinking water standard that is based on non-human health concerns. Therefore, TDS is not a COC.

Summary of Groundwater COCs

The parameters that are COCs for groundwater beneath the landfill are:

- vinyl chloride
- 1,1-dichloroethene
- manganese

Two additional indicator COC parameters are:

- conductivity
- pH

3.3 Points of Compliance

3.3.1 Soil

The remedial action objective for soil is to protect the health of human and ecological receptors. RI data showed that VOCs are the only chemical group mobile enough to potentially contaminate groundwater (see Section 3.1.1, and Appendix A, Section 2.1). Therefore, the points of compliance for soil are:

- From 0 to 15 feet below the ground surface for protection of human health (WAC 173-340-740(6)(c))

- Everywhere on the site for volatile organic constituents for protection of groundwater (WAC 173-340-740-(6)(b))

Remediation objectives based on COCs for specific sources of soil contaminants may result in different points of compliance for different areas of site soil.

3.3.2 Sediment

The point of compliance for sediment is the same as for soil, and is set to protect the health of human and ecological receptors at the site. Remediation of the sediment accumulated in the settling ponds at the east site boundary will aim to meet site soil cleanup levels in any soil/sediment remaining from the ground surface to a depth of 15 feet.

3.3.3 Surface water

The point of compliance for surface water is the point at which hazardous substances are released to waters of the state. Remedial investigation surface water monitoring showed some exceedances of cleanup standards in samples from upstream sample stations SW1 and SW2. It is possible that runoff from the west end area affected surface water and samples at these stations. Contaminants of concern that exceeded surface water cleanup levels also were detected in samples from the leachate seep and surface water directly downstream of the leachate seep.

Because the remedial action is expected to stop the flow of the leachate seep, a point at which hazardous substances from the site enter waters of the state may not be identifiable. Therefore, the point of compliance for surface water will be monitored at the east end of the site, east of the main landfill mass but west of the property boundary (in the vicinity of SW4). If an engineered surface water collection system is constructed for the remedial action, then surface water will be monitored at the point where the discharge enters the natural stormwater flow. Monitoring of an upstream surface water site may be needed to establish background water quality. This station will be upstream of any areas disturbed by original landfilling or remediation actions. It will be west of station SW1.

3.3.4 Groundwater

The point of compliance for groundwater will be specifically identified in the compliance monitoring plan. It will consist of upper aquifer monitoring wells located at the property boundary downgradient of the sources. Monitoring wells MW13, MW14, and MW15 are located on the northern property boundary, downgradient of the sources, and have shown impacts from sources during the RI. These wells would be a logical choice for groundwater compliance monitoring and would be good indicators of the effectiveness of the remedial action on upper aquifer groundwater.

3.4 Restoration Time Frame

The restoration time frame for all media will be influenced by the remedial action selected. Compliance monitoring will be required to establish the restoration time frame for surface water and groundwater. Surface water is expected to have a short restoration time frame. Remediation of other landfill sites has shown that groundwater restoration takes longer than theoretically predicted by models and is expected to take a number of years, even if an active groundwater remediation technology is used. It is also possible that compliance monitoring may be required for soil under a reclamation remedial action. If inert soil with low levels of contaminants that exceed cleanup levels are left onsite, treated to enhance natural attenuation, and covered with a porous soil cap and planted, complete restoration and attainment of site cleanup levels may be demonstrated by sampling after a restoration period.

TABLE 3-1
BAINBRIDGE ISLAND LANDFILL FS
Chemical-Specific ARARs by Environmental Media

ARARs	Source
Soil	
Washington MTCA Method A and B Cleanup Levels for Soil	WAC 173-340
Washington MTCA Method B Cleanup Levels for Protection of Groundwater (Volatile organic compounds only)	WAC 173-340
Natural Background Soil Metals in the Puget Sound	Ecology Pub. #94-115
Sediment	
Washington MTCA Method B Cleanup Levels for Soil	WAC 173-340
Washington MTCA Method B Cleanup Levels for Protection of Groundwater (Volatile organic compounds only)	WAC 173-340
Natural Background Soil Metals in the Puget Sound	Ecology Pub. #94-115
Washington MTCA Method B Cleanup Levels for Protection of Surface Water	WAC 173-340
Air	
Washington MTCA Method B Cleanup Levels for Air	WAC 173-340
Washington State Minimal Functional Standards for Landfills	WAC 173-304-460
Puget Sound Clean Air Agency Regulations	Regulations I and III
Surface Water	
Washington Water Quality Standards for Fresh Water, Chronic (FWC ST)	WAC 173-201A
Washington Water Quality Standards for Fresh Water, Acute (FWA ST)	WAC 173-201A
Federal Water Quality Criteria for Surface Water, Fresh Water Chronic (FWC FED)	40 CFR 131
Federal Water Quality Criteria for Surface Water, Fresh Water Acute (FWA FED)	40 CFR 131
Groundwater	
Federal Maximum Contaminant Level (MCL)	40 CFR 141 and 142
Federal Secondary MCL	40 CFR 141 and 142
Washington State Primary MCL	WAC 246-290
Washington State Secondary MCL	WAC 246-290
Washington MTCA Method B Cleanup Levels for Groundwater	WAC 173-340

TABLE 3-2
BAINBRIDGE ISLAND LANDFILL FS
Potential Location-Specific ARARs

Source/Citation	Requirement	Prerequisite(s)	Designation
Floodplain			
Federal Executive Order 11988 Protection of Floodplains (40 CFR 6, Appendix A)	Take action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values of the floodplain	Action that will occur in a floodplain (i.e., lowlands, and relatively flat areas adjoining inland and coastal waters and other flood-prone areas)	Not an ARAR
Federal and state, Criteria for MSWLFs 40 CFR 258.11 WAC 173-351-130(3)	Demonstrate that the unit will not restrict the flow of the 100-year flood, reduce the temporary water storage capacity of the floodplain, or result in washout of solid waste so as to pose a hazard to human life, wildlife, land or water resources OR close by 10/9/96.	MSWLFs located in 100-year floodplain	Not an ARAR
Wetlands			
Federal Executive Order 11990 Protection of Wetlands (40 CFR 6, Appendix A)	Take action to minimize the destruction, loss, or degradation of wetlands	Wetland as defined by Executive Order 11990, Section 7	Not an ARAR
Federal, Clean Water Act (33 U.S.C. Section 404)	Take action to avoid or minimize the destruction, loss, or degradation of wetlands and surface water bodies	Disposal of dredge and fill material into waters of the United States	Not an ARAR
Shoreline Management Act of 1971 WAC 173-16	Compliance with City of Bainbridge Shoreline Master Program	Action within 200 feet of a shoreline or affecting an associated wetland	Not an ARAR
Sensitive Habitat			
Migratory Bird Treaty Act of 1973 16 USC Section 1531 et.seq.	Take action to protect habitat for migratory birds against pollution, detrimental alteration, or other environmental degradation.	Determination of the presence of migratory birds	Not an ARAR unless U.S. Fist and Wildlife Service determines that the Landfill is a habitat for migratory birds.
Endangered Species Act of 1973 16 USC Section 1536 et.seq 50 CFR 200 60 CFR 402	Take action to conserve endangered species, including consultation with DOI.	Determination of effect upon endangered or threatened species or its habitat.	Not an ARAR unless U.S. Fish and Wildlife Service determines that land is critical habitat for endangered species.

TABLE 3-2
BAINBRIDGE ISLAND LANDFILL FS
Potential Location-Specific ARARs

Source/Citation	Requirement	Prerequisite(s)	Designation
Washington State Department of Fish and Wildlife Priority Habitats and Species List	Priority habitats and species are priorities for conservation and management.	Listed as priority habitat and species.	To be considered.
Shorelines			
Fish and Wildlife Coordination Act (16 USC 661 et seq.) 40 CFR 6.302 (g)	Take action to protect fish or wildlife	Diversion, channeling, or other activity that modifies a stream or river and affects fish or wildlife	Applicable, but not likely to be triggered
Hydraulic Code WAC 220-110	Demonstrate to the Department of Fisheries that the proposed action will not damage fish resources. Required information includes an overall project plan, complete plans and specifications for the proposed work within the ordinary high waterline and complete plans and specifications for protection of fish life.	Work within the ordinary high water limit of state waters that will use, direct, obstruct, or change the natural flow or bed of state waters	Not an ARAR
Shoreline Management Act of 1971 WAC 173-22	Compliance with City of Bainbridge Island Master Program	Action within 200 feet of a shoreline or affecting an associated wetland within the City of Bainbridge	Not an ARAR
Miscellaneous			
WAC 173-303	State Dangerous Waste Regulations	Minimize contamination	Applicable
WAC 173-304	Minimal Functional Standards for Landfills	Minimize contamination	Applicable
Bainbridge Island Municipal Code Ordinance 98-20	City of Bainbridge Island Critical Areas Ordinance	Identified as critical areas	Applicable, but not likely to be triggered.

TABLE 3-3
BAINBRIDGE ISLAND LANDFILL FS
Potential Action-Specific ARARs

Citation	Requirement	Prerequisite	Designation	Comments
General Requirements for Cleanup Actions				
WAC 197-11 SEPA	Determine whether there is a significant adverse environmental impact.	Coordination of SEPA and MTCA.	Applicable	Ecology Policy 130A addresses coordination of MTCA and SEPA.
Institutional Controls				
WAC 173-340-440 MTCA	Institutional controls and financial assurances.	Residual concentrations of hazardous substances exceed MTCA Method A or B cleanup levels; containment as part of the cleanup actions.	Applicable	Will require institutional controls described in restrictive deed covenants and some form of financial assurance.
WAC 173-160-171(a)(iii)	Water-supply wells shall not be located within 1,000 feet of solid waste landfills.	Application for permit to install a water supply well within 1,000 feet of landfill.	Applicable	Will require enforcement by Ecology.
Monitoring				
WAC 296-62 29 CFR 1910.120	Occupational health standards for workers on hazardous waste sites.	Personnel working (e.g., sampling or conducting remedial actions) at the site.	Applicable	Washington's training requirements are more stringent than federal requirements.
WAC 173-160	Must comply with well construction standards	New wells are installed at the site.	Applicable	
WAC 173-340-410	Compliance monitoring plan must be prepared to meet MTCA requirements	Required for cleanup actions under MTCA	Applicable	Will require development of a compliance monitoring plan and approval by Ecology.
WAC 173-304-460(3)(g)(ii)	Groundwater monitoring plan must be prepared per WAC 173-304-490.	Required for landfill design and operation	Applicable	
Collection and Containment				
Federal Executive Order 11988, Protection of Floodplains (40 CFR 6, Appendix A)	Must take action to avoid adverse effects, minimize potential harm, restore and preserve natural and beneficial values of the floodplain.	Construction of collection or containment facilities in the floodplain.	Not applicable	Not within 100-year flood plain.

TABLE 3-3
BAINBRIDGE ISLAND LANDFILL FS
Potential Action-Specific ARARs

Citation	Requirement	Prerequisite	Designation	Comments
Federal Executive Order 11990, Protection of Wetlands (40 CFR 6, Appendix A)	Take action to minimize the destruction, loss, or degradation of wetlands.	Construction of collection or containment facilities impacts adjacent wetlands.	Not applicable	Not within 200 feet of a designated wetland
Federal Clean Water Act Section 404	Take action to avoid or minimize the destruction, loss, or degradation of wetlands and surface water bodies.	Disposal of fill material excavated during construction of collection or containment facilities into adjacent wetlands.	Not applicable	Not within 200 feet of a designated wetland
Shoreline Management Act of 1971	Compliance with City of Bainbridge Island Shoreline Master Program.	Construction of collection or containment facilities occurs within 200 feet of a shoreline or affects an associated wetland.	Not Applicable	Not within 200 feet of a shoreline or affect on associated wetland.
State Waste Discharge General Permit Program WAC 173-226	Construction activities must have an erosion and sediment control plan, procedures for control of other pollutants, and compliance with other local requirements.	Construction activities disturb more than 5 acres.	Applicable	Remedial actions conducted under an agreed order or consent decree are exempt from procedural requirements (RCW 70.105D.90).
State Minimal Functional Standards for Landfill WAC 173-304-460	Functional standards for design of cover systems, leachate collection systems, liners, closure, and gas control.	Construction of collection or containment facilities	Applicable	
Bainbridge-Kitsap County Health District Ordinance 1996-11			Applicable	
Puget Sound Clean Air Agency Regulations	Submit a Notice of Construction prior to constructing or modifying an air contaminant source.	Construction or modification of and air contaminant source.	Applicable	
	Does not cause injury to human health, plant or animal life, property, or does not interfere with enjoyment of life and property.	Emissions or odor and fugitive dust.		

TABLE 3-3
BAINBRIDGE ISLAND LANDFILL FS
Potential Action-Specific ARARs

Citation	Requirement	Prerequisite	Designation	Comments
Treatment and Disposal				
WAC 173-240	Submittal of plans and reports for construction of wastewater treatment facilities.	Preparation of plans and specifications and engineering report for agency approval.	Applicable	Remedial actions conducted under an agreed order or consent decree are exempt from procedural requirements (RCW 70.105D.90).
WAC 173-220 (90.48 RCW; Section 402 FWPCA 40 CFR 122)	NPDES Permit.	Application for and compliance with NPDES program.	Applicable	Remedial actions conducted under and agreed order or consent decree are exempt from procedural requirements (RCW 70.105D.90).
State Dangerous Waste Regulations WAC 173-303	Compliance required for the storage, transport, treatment, or disposal of federal hazardous or state dangerous wastes.	Treatment of contaminated groundwater generates residual solids that designate as federal hazardous or state dangerous wastes.	Applicable	May occur if treatment of groundwater concentrates contaminants.
City of Bainbridge Island Building Permit Requirements	Permits are required for construction of new structures or modifications to existing structures.	Treatment or disposal facilities require construction of new structures.	Applicable	Likely to be required for construction of treatment plant.
Bainbridge-Kitsap County Health District Ordinance 1996-11	All structures within 1,000 feet of a landfill must be protected from landfill gas migration	Located within 1,000 feet of property line	Applicable	Engineer's report certifying that gas generated is below lower explosive limit
Puget Sound Clean Air Agency Regulations	Submit a Notice of Construction prior to constructing or modifying an air contaminant source.	Construction or modification of and air contaminant source.	Applicable	
	Does not cause injury to human health, plant or animal life, property, or does not interfere with enjoyment of life and property.	Emissions or odor and fugitive dust.		

Table 3-4
BAINBRIDGE ISLAND LANDFILL FS
Contaminants of Potential Concern: Parameters that Exceed MSAs

Chemical Group	Chemical	Units	Most Stringent ARAR (MSA)	Source of MSA	Number of Detects Exceeding MSA	Number of Samples
Waste Sources						
WEA (Bulk Waste)						
Metals	Arsenic	ug/kg	7,300	Puget Sound Natural Background	1	6
	Chromium	ug/kg	100,000	MTCA B	1	6
	Iron	ug/kg	5.87E+07	Puget Sound Natural Background	1	6
	Lead	ug/kg	250,000	MTCA B	1	6
MLF Cover Soil Hotspot						
SVOCs	Benzo(a)anthracene	ug/kg	137	MTCA B	3	3
	Benzo(a)pyrene	ug/kg	137	MTCA B	3	3
	Benzo(b)fluoranthene	ug/kg	137	MTCA B	3	3
	Benzo(k)fluoranthene	ug/kg	137	MTCA B	3	3
	Carbazole	ug/kg	50,000	MTCA B	3	3
	Chrysene	ug/kg	137	MTCA B	3	3
	Naphthalene	ug/kg	32,000	MTCA B	3	3
	Pentachlorophenol	ug/kg	8,333	MTCA B	3	3
	Arsenic	ug/kg	7,300	Puget Sound Natural Background	3	3
MLF Cover Soil Outside Hotspot						
No MSA exceedances					0	8
MLF/WEA Garbage Fraction						
SVOCs	Benzo(a)anthracene	ug/kg	137	MTCA B	2	6
	Benzo(a)pyrene	ug/kg	137	MTCA B	1	5
	Benzo(b)fluoranthene	ug/kg	137	MTCA B	1	5
	Benzo(k)fluoranthene	ug/kg	137	MTCA B	1	5
	Chrysene	ug/kg	137	MTCA B	3	6
	Naphthalene	ug/kg	32000	MTCA B Protection GW	1	8
PCBs	Arochlor 1254	ug/kg	1,600	MTCA B	1	8
	Total PCBs	ug/kg	130	MTCA B	3	8
Metals	Arsenic	ug/kg	7,300	Puget Sound Natural Background	3	8
	Iron	ug/kg	5.87E+07	Puget Sound Natural Background	2	8
	Lead	ug/kg	250,000	MTCA B	1	8
MLF/WEA Inert Fraction						
SVOCs	Benzo(a)anthracene	ug/kg	137	MTCA B	6	10
	Benzo(a)pyrene	ug/kg	137	MTCA B	4	10
	Benzo(b)fluoranthene	ug/kg	137	MTCA B	5	10
	Benzo(k)fluoranthene	ug/kg	137	MTCA B	5	10
	Chrysene	ug/kg	137	MTCA B	6	10
	Dibenzo(a,h)anthracene	ug/kg	137	MTCA B	1	10
	Indeno(1,2,3-cd)pyrene	ug/kg	137	MTCA B	1	10
PCBs	Total PCBs	ug/kg	130	MTCA B	3	10
Metals	Arsenic	ug/kg	7,300	Puget Sound Natural Background	2	10
	Iron	ug/kg	5.87E+07	Puget Sound Natural Background	1	10
	Lead	ug/kg	250,000	MTCA B	2	10
Septage Pits						
VOCs	1,4-Dichlorobenzene	ug/kg	182	MTCA B Protection GW	4	18
SVOCs	Benzo(a)anthracene	ug/kg	137	MTCA B	11	18
	Benzo(a)pyrene	ug/kg	137	MTCA B	6	18
	Benzo(b)fluoranthene	ug/kg	137	MTCA B	1	18
	Benzo(k)fluoranthene	ug/kg	137	MTCA B	4	18
	Chrysene	ug/kg	137	MTCA B	11	18
PCBs	Arochlor 1254	ug/kg	1,600	MTCA B	8	18
	Total PCBs	ug/kg	130	MTCA B	16	16
Pesticides	Dieldrin	ug/kg	63	MTCA B	16	18
TPH	Diesel range	ug/kg	200,000	MTCA A	14	18
	Heavy oil range	ug/kg	200,000	MTCA A	16	18
Metals	Arsenic	ug/kg	7,300	Puget Sound Natural Background	16	18
	Lead	ug/kg	250,000	MTCA B	14	18
Soil						
MLF/WEA Base Soil						
No MSA exceedances					0	10
Trench 3 Base Soil						
	Benzo(a)pyrene	ug/kg	137	MTCA B	1	16
SVOCs	Benzo(b)fluoranthene	ug/kg	137	MTCA B	1	16
	Indeno(1,2,3-CD)pyrene	ug/kg	137	MTCA B	1	16
Sediment						
SVOCs	Benzo(a)anthracene	ug/kg	137	MTCA B	2	7
	Benzo(a)pyrene	ug/kg	137	MTCA B	6	7
	Benzo(b)fluoranthene	ug/kg	137	MTCA B	1	7
	Chrysene	ug/kg	137	MTCA B	1	7
	Dibenzo(a,h)anthracene	ug/kg	137	MTCA B	1	7
	Indeno(1,2,3-CD)pyrene	ug/kg	137	MTCA B	1	7
TPH	Heavy oil-range	ug/kg	200,000	MTCA A	1	8
Metals	Arsenic	ug/kg	7,300	Puget Sound Natural Background	3	8
	Beryllium	ug/kg	610	Puget Sound Natural Background	1	8
	Iron	ug/kg	5.87E+07	Puget Sound Natural Background	1	8

Table 3-4
BAINBRIDGE ISLAND LANDFILL FS
Contaminants of Potential Concern: Parameters that Exceed MSAs

Chemical Group	Chemical	Units	Most Stringent ARAR (MSA)	Source of MSA	Number of Detects Exceeding MSA	Number of Samples
Surface Water						
Metals, dissolved	Copper	ug/L	1.8	FWCFED	20	26
	Iron	ug/L	1,000	FWCFED	5	26
	Lead	ug/L	0.30	FWCFED and FWCSTATE	1	26
	Zinc	ug/L	21	FWCSTATE	3	26
Metals, total	Iron	ug/L	1,000	FWCFED	21	26
Conventionals	Alkalinity	mg/L CaCO3	20	FWCFED	6	26
	Dissolved oxygen	mg/L	>9.5	FWASTATE and FWCSTATE	7	23
	Fecal coliform	CFU/100 mL	50	FWASTATE and FWCSTATE	3	26
	pH	Std	6.5 - 8.5	FWASTATE and FWCSTATE	18	23
	Total coliform	CFU/100 mL	50	FWASTATE and FWCSTATE	16	26
	Turbidity	NTU	5.0	FWASTATE and FWCSTATE	16	18
Groundwater						
Monitoring Wells						
VOCs	Vinyl chloride	ug/L	0.023	MTCA B	44	173
	1,1-dichlorethene	ug/L	0.073	MTCA B	11	174
	Cis-1,2-dichloroethene	ug/L	70	MCL	1	174
SVOCs	Pentachlorophenol	ug/L	0.73	MCL	1	90
	Bis(2-ethylhexyl)phthalate	ug/L	6.3	MTCA B	7	90
Metals	Arsenic	ug/L	5.83E-02	MTCA B	29	174
	Chromium	ug/L	100	MCL	1	174
	Iron	ug/L	300	MCL	23	174
	Manganese	ug/L	50	MCL	29	174
	Thallium	ug/L	1.1	MTCA B	2	174
Conventionals	Conductivity	umhos/cm	700	MCL	45	172
	Nitrate	mg-N/L	10	MCL	4	174
	Nitrate+nitrite	mg-N/L	10	MCL	4	174
	pH	Std	6.5 - 8.5	MCL	38[a]	171
	Total coliform	CFU/100 mL	1	MCL	18	160
	Total dissolved solids	mg/L	500	MCL	45	174
Domestic Wells						
VOCs	Vinyl chloride	ug/L	0.023	MTCA B	14	148
Metals	Arsenic	ug/L	5.83E-02	MTCA B	11	27
	Iron	ug/L	300	MCL	5	27
	Lead	ug/L	5	MTCA B	2	27
	Manganese	ug/L	50	MCL	5	27
Conventionals	Conductivity	umhos/cm	700	MCL	1	147
	pH	Std	6.5 - 8.5	MCL	19[b]	146
	Total coliform	CFU/100 mL	1	MCL	2	27
Historical						
Historical MLF- bulk waste						
SVOCs	Benzo(a)anthracene	ug/kg	137	MTCA B	5	29
	Benzo(b)fluoranthene	ug/kg	137	MTCA B	8	29
	Benzo(k)fluoranthene	ug/kg	137	MTCA B	4	29
	Benzo(a)pyrene	ug/kg	137	MTCA B	3	29
	Chrysene	ug/kg	137	MTCA B	9	29
	Bis(2-ethylhexyl)phthalate	ug/kg	71,429	MTCA B	3	29
PCBs	Arochlor 1254	ug/kg	1,600	MTCA B	1	29
	Total PCBs	ug/kg	130	MTCA B	1	29
Pesticides	Aldrin	ug/kg	59	MTCA B	2	29
Metals	Arsenic	ug/kg	7,300	Puget Sound Natural Background	8	29
	Chromium	ug/kg	100,000	MTCA B	4	29
	Iron	ug/kg	5.87E+07	Puget Sound Natural Background	7	29
	Lead	ug/kg	250,000	MTCA B	15	29
Historical MLF Base Soil						
SVOCs	Benzo(a)anthracene	ug/kg	137	MTCA B	1	3
Historical MLF Cover Soil						
SVOCs	Benzo(a)anthracene	ug/kg	137	MTCA B	1	4
	Benzo(a)pyrene	ug/kg	137	MTCA B	1	4
	Benzo(b)fluoranthene	ug/kg	137	MTCA B	1	4
	Benzo(k)fluoranthene	ug/kg	137	MTCA B	1	4
	Chrysene	ug/kg	137	MTCA B	1	4

Notes:
MLF/WEA = main landfill, west end area
[a] pH exceedances are below the lower MSA limit of 6.5
[b] 15 samples had pH below the lower MSA limit of 6.5; 4 samples had pH above the upper MSA limit of 8.5

Table 3-5
BAINBRIDGE ISLAND LANDFILL FS
Contaminants of Concern and Proposed Cleanup Levels

Parameter Group	Contaminant	Soil: Trench 3 Base Soil	Soil: MLF & WEA (Inert & Cover soil)	Soil: Septage Pits	Sediment	Surface Water	Groundwater
VOCs							
	1,4-dichlorobenzene			182 ug/kg			
	1,1-dichloroethene						0.073 ug/L
	vinyl chloride						0.023 ug/L
SVOCs							
	benzo(a)anthracene		137 ug/kg	137 ug/kg	137 ug/kg		
	benzo(a)pyrene	137 ug/kg	137 ug/kg	137 ug/kg	137 ug/kg		
	benzo(b)fluoranthene	137 ug/kg	137 ug/kg	137 ug/kg	137 ug/kg		
	benzo(k)fluoranthene		137 ug/kg	137 ug/kg			
	carbazole		50,000 ug/kg				
	chrysene		137 ug/kg	137 ug/kg	137 ug/kg		
	dibenzo(a,h)anthracene		137 ug/kg		137 ug/kg		
	indeno(1,2,3-cd)pyrene	137 ug/kg	137 ug/kg		137 ug/kg		
	naphthalene		32,000 ug/kg				
	pentachlorophenol		8,333 ug/kg				
TPH							
	diesel-range			200,000 ug/kg			
	heavy oil-range			200,000 ug/kg	200,000 ug/kg		
Metals							
	arsenic		7,300 ug/kg	7,300 ug/kg	7,300 ug/kg		
	beryllium				610 ug/kg		
	cadmium			40,000 ug/kg			
	chromium		100,000 ug/kg				
	copper		2.96E+6 ug/kg	2.96E+6 ug/kg		1.8 ug/L dissolved	
	iron		5.87E+7 ug/kg		5.87E+7 ug/kg	1.0 mg/L total 1.0 ug/L dissolved	
	lead		250,000 ug/kg	250,000 ug/kg		0.3 ug/L dissolved	
	manganese						50 ug/L
	mercury		24,000 ug/kg	24,000 ug/kg			
	selenium		400,000 ug/kg	400,000 ug/kg			
	zinc		2.40E+7 ug/kg	2.40E+7 ug/kg		21 ug/L dissolved	
Pesticides/PCBs							
	4,4'-DDD			4,167 ug/kg			
	Aldrin		59 ug/kg				
	Dieldrin			63 ug/kg			
	Aroclor 1254		1,600 ug/kg	1,600 ug/kg			
	Total PCBs		130 ug/kg	130 ug/kg			
Conventionals							
	alkalinity					20 mg/L	
	conductivity (indicator)						indicator[a]
	dissolved oxygen					> 9.5 mg/L	
	fecal coliform					< 50 CFU/100 mL	
	nitrate (and nitrite + nitrate)						
	pH (indicator)						indicator[a]
	total coliform					< 50 CFU/100 mL	
	turbidity					5.0 NTU	

a Secondary drinking water standard for conductivity is 700 umhos/cm; for pH, 6.5-8.5
MLF = main landfill
WEA = west end area

For source of cleanup level, see associated ARARs tables in Appendix B.

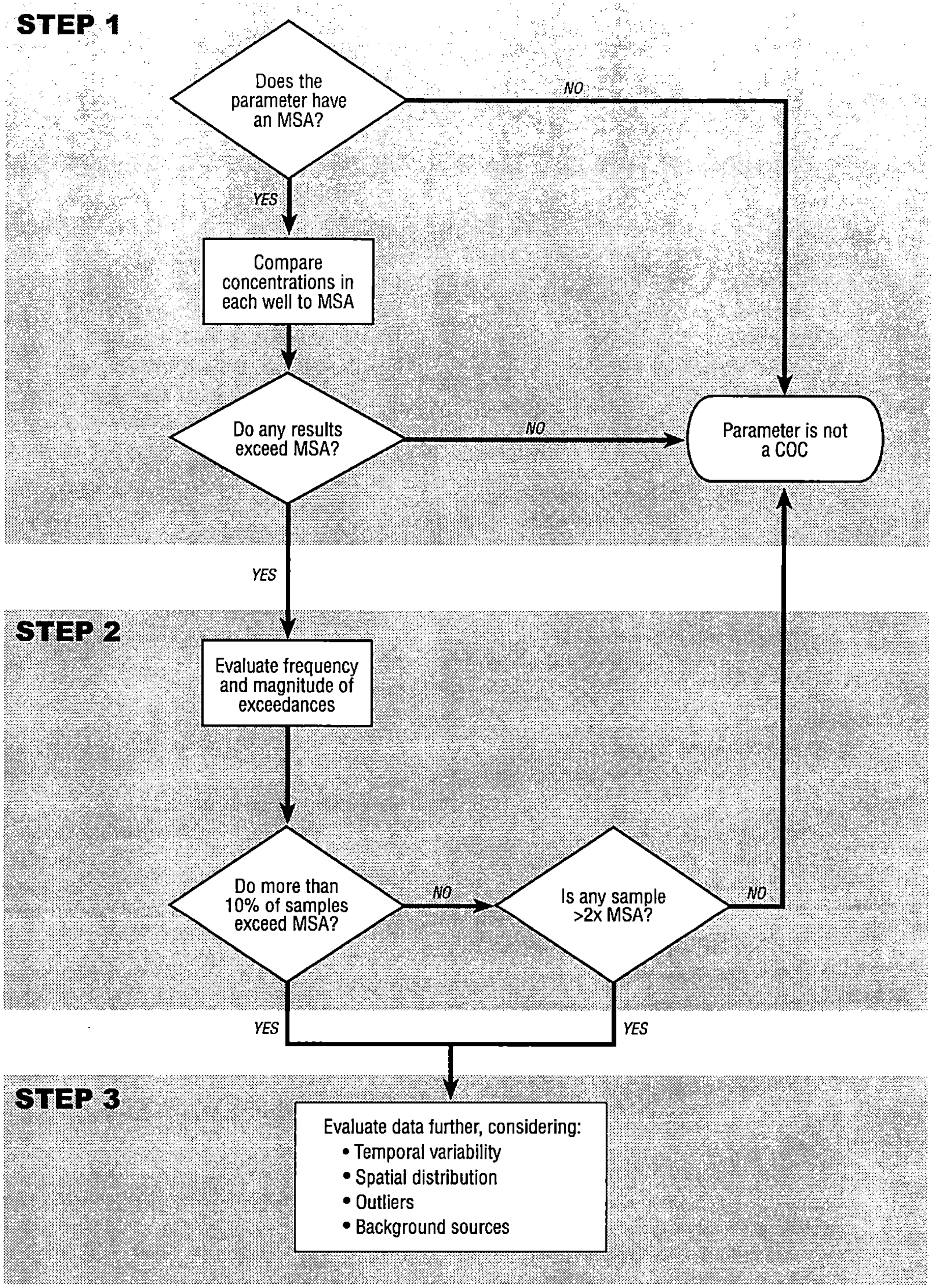


Figure 3-1
Evaluation of COCs for Groundwater
Bainbridge Island Landfill FS

CHAPTER 4

Screening of Technologies

The purpose of this chapter is to focus the feasibility study by identifying general remedial approaches and technologies that are appropriate for the site. The first section of this chapter discusses general remedial approaches for the entire site, and the second section discusses specific remedial approaches and technologies by site media.

4.1 Overview of Remedial Approaches

4.1.1 No Action

In some analyses of alternative actions, such as environmental impact statements, analysis of a "no action" alternative is required to provide a baseline for comparison of possible actions. For this site, a no action alternative would mean that no remedial actions would be taken and that site controls and monitoring would be the same as they were before work began on the RI. However, some remedial action must be taken at the site because contaminants of concern (COCs) have been identified. No action would not meet MTCA threshold requirements and is not acceptable for the site: MTCA threshold requirements for cleanup actions [WAC 173-340-360 (2)] require protection of human health and the environment, compliance with cleanup standards, compliance with applicable state and federal laws, and provisions for compliance monitoring. In addition, analysis of a no action alternative is not needed, because existing baseline conditions have been established by the RI. The no action alternative will not be considered further in this FS.

4.1.2 Waste Consolidation and Containment

This option involves consolidating and containing all waste and media that exceed cleanup levels beneath a constructed impermeable cap. It is referred to in this report as either consolidation and containment, or simply capping. MTCA recognizes the need to use engineering controls such as containment for sites that consist of large volumes of relatively low levels of hazardous substances where treatment is impracticable [WAC 173-340-360(9)]. Containment technologies are consistent with EPA expectations for cleanup actions at municipal landfills, as specified in the EPA guidance document *Conducting Remedial Investigations/Feasibility Studies for CERCLA Municipal Landfill Sites* (EPA, 1991). In addition, EPA has issued a fact sheet, *Presumptive Remedy for CERCLA Municipal Landfill Sites* (EPA, 1993b), that establishes containment as the presumptive remedy on the basis of the framework presented in the RI/FS guidance manual for CERCLA municipal landfill sites (EPA, 1981). Waste containment technologies are recognized by MTCA and CERCLA as feasible remedies for municipal landfill sites, and will be analyzed for remediation of site waste sources.

Consolidation and containment of the waste materials at the site is desirable because this approach would:

- Minimize releases and exposure from waste materials and septage pits

- Remove wastes from much of the site area, resulting in more land with fewer restrictions on final uses
- Establish steeper slopes on the main landfill for management of settlement and surface water runoff
- Reduce cleanup costs by minimizing the area of waste containment

MTCA and CERCLA allow waste consolidation within an area of contamination. Ecology's *Interprogram Policy, Area of Contamination* (August, 1991) and the EPA's RI/FS guidance document (EPA, 1991) state that moving hazardous or dangerous wastes within an area of contamination is not considered waste generation as defined by federal or state hazardous or dangerous waste regulations. At the Bainbridge site, the area of contamination would generally include wastes that are adjacent to or near the main landfill or media that might be contaminated by releases from the main landfill. Under this definition, the northern and southern west end areas and sediment downstream from the main landfill could be consolidated and contained within the main landfill.

Because the septage pits are not directly connected with the main landfill and did not receive municipal solid waste, analytical results from the pits must be evaluated to determine whether or not septage pit waste can be consolidated within the main landfill. Each of the septage pits was initially sampled and screened for toxic organic and inorganic substances, and then sampled and tested for metals by the toxicity characteristic leaching procedure (TCLP) and for toxicity by bioassay. None of the septage pits were found to be hazardous or dangerous wastes, and the septage pits could be consolidated and contained within the main landfill.

The waste containment and consolidation approach would include technologies that are acceptable for the site under MTCA, CERCLA, and federal and state hazardous and dangerous waste regulations and will be analyzed as one technology in this FS.

4.1.3 Waste Reclamation

Site reclamation includes excavating waste from the landfill and separating it into size fractions, which can be treated onsite or disposed offsite. Waste from the septage pits also will be excavated but will be transported directly offsite for disposal without separation or treatment. Landfill site reclamation has been practiced since 1953 and has proven effective at other municipal landfill sites across the U.S. and abroad. At least 17 landfill sites in the U.S. and Canada have been partially or completely excavated for reclamation. Several studies have been published on the feasibility of municipal landfill reclamation, including studies by the EPA (1993a), the California Integrated Waste Management Board (CalRecovery, 1993), and the New York State Energy Research and Development Authority (Schillinger, Salerni, and Boyd, 1992).

Three distinct size fractions were identified in the field study conducted at the site in August 1999 and reported in the RI Report Supplement 2:

- *Bulky* material included large items such as furniture that were disposed in the landfill.

- *Refuse* material (also referred to as the "garbage" fraction) included material similar to household garbage and rubbish that still contained significant amounts of decomposable organic material.

- *Inert* material comprised approximately two-thirds of the volume of material in the landfill. "Inert" refers to the fact the material is not readily decomposable compared to the organic refuse material in the landfill.

After the three fractions have been separated, each will be handled separately to complete the remedial action. The bulky fraction will be taken offsite for disposal. Technologies to be considered for the garbage fraction include offsite disposal and composting.

In any reclamation scenario, the inert material would be replaced and used to regrade the site, and the surface water drainage would be reestablished. The inert materials tested in the August 1999 field study contained contaminants in excess of the cleanup levels (Table 3-5). Therefore, technologies that would protect human health and the environment from contaminants in the inert fraction are evaluated as part of the reclamation alternative. Final contaminant levels in the inert fraction will be determined by chemical testing of the actual material replaced during the remedial action. This material may include soil from the inert fraction, landfill cover soil from outside the hotspot area, sediment from the settling ponds, and small amounts of over-excavated landfill base soil. Technology screening will address the following treatment options for the inert fraction:

- Soil washing
- Steam injection
- Bioremediation
- Replacement and capping with an impermeable cap
- Replacement and capping with a permeable soil cap

If reclamation is selected, the final site restoration and grading plan for the inert fraction will be determined during remedial design. Factors that will contribute to the final grading plan and restoration design include: final contaminant concentrations in the soil, thickness and type of cap (if any), final volume of material (which includes determination of bulk dry density), and site land use planning. For the purposes of comparison and cost estimating, the site restoration assumed for this feasibility study is regrading of the inert fraction to approximate the pre-landfill topography, restoration of an open-channel storm drainage through the center of the site, and hydroseeding with grass.

The primary benefits of the reclamation option are:

- Waste volume reduction and cessation of landfill gas generation.

- Permanent removal of the source of groundwater contamination (garbage waste fraction, leachate, and landfill gas)

- The site can be regraded and the drainage pattern reestablished so that catch basins and special drainage piping that may be needed for the consolidation and containment option could be eliminated.

- Removal of decomposable materials and recompacting the inert materials would minimize the potential for further landfill settling and landfill gas production.

- Removal of these materials would also reduce to some degree the potential for contaminant mobilization, by eliminating the acid-forming biochemical reactions that occur as the organic materials in the bulky and garbage fractions decompose.
- Removal of the bulky and garbage fractions would allow regrading of the landfill area with soil, allowing more potential land use options than consolidation and containment.

Reclamation is an acceptable technology for the site under MTCA and will be analyzed as one technology in this FS. Multiple treatment technologies for the individual waste fractions will be analyzed in detail.

4.1.4 Groundwater Remediation

The results of the RI indicate that there are landfill-derived COCs in both onsite and offsite groundwater. Treatment technologies for onsite groundwater are discussed in Section 4.2.9. Although the concentrations of the COCs in offsite groundwater are quite low (no concentrations exceed drinking water standards), the concentrations do exceed MTCA Method B cleanup levels for groundwater. However, because the concentrations of COCs in offsite groundwater and the MTCA Method B cleanup levels for these COCs are so low, collecting and treating offsite groundwater would most likely not be cost- or time-effective. Permitting and disposing of the large volume of treated water (including monitoring and significant maintenance of recharge facilities) would be difficult and time consuming. Moreover, although offsite groundwater collection is technically feasible, the logistics of property/easement acquisition for well construction, maintenance, and long-term monitoring and access for pipeline, instrumentation and controls, and electric power in and across multiple private residential properties also limits the feasibility of offsite groundwater collection and treatment. Furthermore, the required groundwater pumping may adversely impact the limited groundwater resource relied on by local residents. Therefore, once the source of groundwater contamination is eliminated or greatly reduced, the practical and potentially feasible means of remediating offsite groundwater would be through monitored natural attenuation.

This FS will not evaluate engineered offsite groundwater remediation technologies, but will evaluate other technologies or alternatives for offsite groundwater to protect human health and the environment, such as natural attenuation or providing alternative water supplies, if they are technically feasible and if they can be implemented. This FS will evaluate various engineered groundwater remediation technologies and natural attenuation for onsite groundwater near the waste sources.

4.2 Identification of Technologies

4.2.1 Institutional Controls

Institutional controls can be used to restrict site access, control future site uses through zoning and/or deed restrictions, control development on and near the site, restrict groundwater and surface water use on and near the site, and provide alternative water supplies. The FS will analyze institutional controls.

4.2.2 Monitoring

WAC 173-340-410 requires a compliance and performance monitoring plan to be prepared for all cleanup actions. Because some residual contaminants will remain at the site and in groundwater with either waste containment or reclamation, groundwater and surface water monitoring would need to continue with either of these remedial technologies. This FS will include monitoring of surface water and groundwater with the analysis of any cleanup alternative for the site.

Although subsurface migration of landfill gas has not been identified as a significant current problem at the site, waste containment may enhance gas migration. Landfill gas would not be a concern following waste reclamation because the wastes that generate landfill gas would be removed from the site. In this FS, monitoring of subsurface landfill gas will be analyzed for the waste containment option but not for waste reclamation.

4.2.3 Waste Source Control

The two general technologies for remediation of waste sources are consolidation and containment, and reclamation. Waste consolidation and waste reclamation are described above in Sections 4.1.2 and 4.1.3.

Consolidation and Containment

Following consolidation, waste containment at the site would include the following elements:

- Grading of the waste to create a slope to provide stability for a final cover system, minimize long-term maintenance resulting from waste settlement, enhance surface water runoff, and minimize erosion
- Construction of an enhanced landfill gas venting system beneath the final cover system to prevent increased landfill gas pressures within the waste and to reduce the potential for increased subsurface migration of landfill gas
- Capping of the waste materials with a final cover system to eliminate or minimize infiltration of precipitation into the waste, minimize erosion, and prevent contact with the waste
- Diversion and separation of surface water around the consolidated waste pile to prevent erosion of the final cover system and to eliminate or minimize the flow of surface water into the waste
- Installation of surface water runoff controls such as sedimentation and detention ponds to minimize the impacts of increased surface water runoff from the final cover system

Consolidation and Containment Final Cover System

Of the elements listed above, the final cover system tends to have the widest range of design alternatives. Although WAC 173-351 (which superceded WAC 173-304) is not an ARAR, Ecology has requested that the final cover system design conform to specifications outlined in WAC 173-351-500(1)(a)(i). This landfill regulation requires a final cover system to include a composite barrier layer with an upper component that consists of a minimum of 30 mil (0.76 mm) thickness of geomembrane (60 mils or 1.5 mm thickness for high density polyethylene geomembranes). The composite cover system must include a lower component that consists of at least 2 feet of compacted soil with a permeability of no more than $1x10^{-5}$ cm/s. The geomembrane must be installed in direct and uniform contact with the compacted soil component. The final cover system must also include an anti-erosion layer that contains a minimum of 1 foot of soil with the uppermost 6 inches of soil capable of sustaining native plant growth.

There are no known naturally occurring soils available near the site that would meet permeability requirements for the lower component of the composite barrier layer. To achieve the lower permeability that is needed, available naturally occurring soils would need to be supplemented with an additive such as sodium bentonite to reduce permeability. There would be some challenges in using natural soils with additives for construction of the lower component of the barrier layer, including:

- Preprocessing of natural soils might be required to remove oversized material, wood, and debris
- Fluctuations in the quality of natural soils would require ongoing soil testing and adjustments to the natural soil-additive mixture
- Soil moisture and compaction would need to be monitored closely to achieve the desired permeability
- An extended construction season could be required to mix, place, and compact a soil mixture
- Mixing and placing a soil mixture could be delayed an extended period of time because of inclement weather
- Significant mobilization requirements, soil preprocessing and mixing, monitoring during construction, and an extended construction season could result in high costs relative to other final cover system alternatives

In addition to the difficulties of construction, a soil mixture would have little tensile strength. If differential waste settlement occurred following construction and a soil mixture is subjected to tension, cracks in the soil mixture can develop. Such cracks would reduce the effectiveness of the soil mixture layer in providing a supplemental barrier to infiltration.

In contrast with barrier layers composed of geomembranes in combination with soil mixtures, barrier layers constructed with only manufactured materials such as geomembranes in combination with geosynthetic clay liners (GCLs) have more consistent physical properties and a lower permeability, are easier to construct, are usually lower in cost, and are less subject to tearing or cracking when subjected to tension. WAC 173-351-500(1)(a)(ii) allows for the approval of alternative final cover systems, and composite final cover systems using geomembranes in combination with GCLs have been approved by jurisdictional agencies for capping municipal solid waste landfills in western Washington. Because of the advantages of using manufactured materials for barrier layers in final cover systems and their acceptance by regulatory agencies, this FS will analyze only manufactured materials as alternative technologies for barrier layers.

Reclamation

The reclamation option involves excavating all of the material from the main landfill, both west end areas, and the septage pits. The septage pit material would be disposed offsite without further processing. The landfill material would be separated into bulky, garbage, and inert fractions for further treatment and/or disposal. After waste excavation, processing, and treatment are complete, the site will be restored. Restoration will include regrading the site with a large quantity of material derived from landfill cover soil, clean onsite soil fill from outside the main landfill area, and the inert waste fraction (see Figure 5-3). The disturbed areas will be planted or restored to control erosion and exposure to contaminants, and a surface water drainage channel will be restored.

This FS will analyze the following technologies for reclamation of the three size fractions:

- Bulky fraction—offsite disposal
- Garbage fraction—offsite disposal, onsite composting
- Inert soil—soil washing, bioremediation, steam injection, and capping (impermeable and permeable cap options)

4.2.4 Soil

Soil contamination at the site is limited to areas where contaminants have leached directly into soil underlying waste sources. Contaminant concentrations in soil are low and volumes of soil with concentrations of contaminants that exceed cleanup levels have not been estimated. Because soil contamination is closely tied to the waste sources, soil treatment will depend on which source control option is selected. Soil below the Trench 3 area currently meets cleanup levels at the point of compliance, from 0 to 15 feet below ground surface.

Under the capping option, soil with contaminant concentrations that exceed cleanup levels will be overexcavated along with waste sources until cleanup levels are achieved at the point of compliance. This includes the septage pits, west end area, and peripheral areas of the landfill that are proposed to be excavated for consolidation under the cap (see Figure 5-1). The overexcavated soil also will be consolidated under the cap for containment without treatment. The volume of soil is unknown but is expected to be low.

Under the reclamation option, soil with contaminant concentrations that exceed cleanup levels will be overexcavated in the area of the septage pits only. Chemical testing during the RI indicated that soil below the main landfill and west end area did not exceed cleanup levels, and only one of three historical samples exceeded cleanup levels for only three parameters. The inert fraction of the reclaimed material will be placed on top of the main landfill and west end areas and capped with clean soil. Depending on contaminant concentrations, soil from beneath the septage pits will be combined with the inert fraction or taken offsite for disposal. The south septage pit also may be filled with inert materials.

No other treatment options are considered for soil because contaminant concentrations are low and treatment options are very costly (see discussion of treatment options for inert fraction, Section 5.3.3). Because excavation volumes are considered to be low, soil excavation and treatment are discussed along with source control technologies in the following chapter.

4.2.5 Sediment

Sediment will be treated the same as soil. Sediment that exceeds cleanup levels will be overexcavated until cleanup levels are met at the point of compliance. Excavated sediment will be consolidated beneath the cap under the capping option. Under the reclamation option, sediment will either be combined with the inert fraction or disposed offsite. Sediment excavation and treatment are discussed along with source control technologies in Chapter 5.

4.2.6 Landfill Gas

The RI data showed no exceedances of air quality standards resulting from surface landfill gas emissions or exceedances of standards for combustible gas in soil resulting from subsurface landfill gas migration. Remediation of waste sources by reclamation would eliminate or minimize wastes that produce landfill gas, therefore landfill gas monitoring and remedial measures would not be needed.

Remediation of waste sources by waste consolidation and containment would require a final cover system to be placed over the consolidated waste pile. The final cover system would restrict surface emissions of landfill gas, but could enhance subsurface gas migration by increasing the pressure of the landfill gas beneath the cover. If waste sources are remediated by containment, a landfill gas venting or extraction system would be installed beneath the final cover system to prevent increased gas pressures and potential increased subsurface gas migration. Subsurface landfill gas monitoring would be continued to verify the landfill gas control system's effectiveness, and emissions from the system would be treated or monitored to verify compliance with air quality standards.

The FS will analyze landfill gas collection, treatment, and monitoring for alternatives that include waste consolidation and containment but not for alternatives that include waste reclamation.

4.2.7 Leachate

Leachate is defined as water that has become contaminated by contact with waste. Landfill leachate at the site is generated by infiltration of precipitation and flow of surface water into the waste. If waste reclamation is implemented, leachate generation will be eliminated or minimized by removing significant leachable wastes from the site. If waste consolidation and containment are used, leachate generation will be eliminated or minimized by preventing infiltration through a final cover system and by diverting and separating surface water flows from the waste pile. Because use of either technology will eliminate or minimize leachate generation at the site, alternatives for leachate containment, collection, and treatment will not be considered in this FS.

4.2.8 Surface Water

Under the consolidation and containment option, the existing surface water flow at the site would be diverted around the waste pile. The final cover system and surface water system would be constructed to prevent surface water contact with waste, contaminated soils, or contaminated sediments. The final cover system would generate increased runoff that would need to be managed onsite; remediation of surface water with this option would include diverting surface water around the waste pile, separating surface water from potential sources of contamination, providing some ongoing sedimentation controls, providing detention facilities to control runoff, and monitoring. These surface water remedial actions will be analyzed in this FS in combination with analysis of waste consolidation and reclamation.

Under the reclamation option, the existing surface water flow at the site would be directed into the pre-landfill natural surface water drainage. Surface water would not come into contact with wastes, contaminated soils, or contaminated sediments because these materials would be removed from the natural flow path. With waste reclamation, remediation of surface water would include restoring surface water to a natural drainage, providing sedimentation controls immediately following construction, and monitoring. The drainage pathway will include design elements necessary to prevent erosion of the clean soil cover and to prevent surface water from contacting the inert waste fraction. These surface water remedial actions will be analyzed in this FS in combination with analysis of waste reclamation.

4.2.9 Groundwater

General technology categories for groundwater remediation include groundwater collection and containment with ex situ biological, chemical, and/or physical treatment (typically called pump and treat) and in situ groundwater biological, chemical, and/or physical treatment (including natural attenuation). As discussed in Section 4.1.4, this FS will consider only natural attenuation for offsite groundwater because the concentrations of offsite contaminants are so low that engineered groundwater remediation technologies are impractical.

Technologies for onsite groundwater collection and containment can be divided into those that use trenches and those that use wells. Groundwater remediation using trenches for either groundwater collection or in situ treatment involves excavating trenches downgradient from contaminant sources through the permeable unsaturated and saturated zones of an aquifer into an aquitard. Trenches are backfilled with impermeable material such as a bentonite slurry for groundwater containment, with gravel and perforated pipe for groundwater collection, or with a reactive medium to provide flow-through groundwater treatment. Because the aquitard surface below the site is located approximately 140 to 170 feet below the ground surface, installing a trench would be impractical, and therefore groundwater remediation technologies dependent on trenches will not be considered in this FS. Onsite well pump and treat and in situ treatment are feasible technologies for use at the site and will be evaluated in this FS.

4.3 Summary

This chapter of the FS has identified general remedial approaches and specific technologies that are potentially feasible for remediation of the Bainbridge Island Landfill site. The following general approaches have been determined as potentially feasible and will be analyzed as alternative technologies in this FS:

- Waste consolidation and containment

- Waste reclamation
- Onsite groundwater remediation, including natural attenuation

Analysis of a no action alternative and offsite groundwater remediation (other than natural attenuation) will not be evaluated in this FS.

The following specific technologies and their associated elements have been determined to be potentially feasible and will be analyzed as alternative technologies in this FS:

- **Institutional controls**: restrictions for site access, land use and development through zoning and deed restrictions, and groundwater and surface water uses; alternative water supplies
- **Waste consolidation and containment**: excavation and consolidation of septage, contaminated soils and sediments, and other wastes into the main landfill; grading the consolidated waste pile; construction of an enhanced landfill gas venting system; placement of a final cover system that uses only manufactured materials for a barrier layer; diversion and separation of surface water flows from the consolidated waste pile; construction of surface water sedimentation and runoff controls; monitoring of surface water, groundwater, and landfill gas
- **Waste reclamation**: waste excavation, processing, treatment, and disposal; restoration of site grades, vegetation, and surface water drainage; monitoring of surface water and groundwater
- **Groundwater treatment**: onsite pump and treat using wells, various in situ treatment technologies, and natural attenuation

This feasibility study will not analyze technologies for leachate containment, collection, and treatment, technologies that use natural soils for final cover system barrier layers (capping alternative), or trenches for groundwater remediation.

CHAPTER 5

Evaluation of Technologies

The previous chapter presented general remedial approaches and technologies that could be used in one or more of the remedial approaches. The purpose of this chapter is to present enough information about each of the technologies so that they can be compared and evaluated sufficiently to select a remedial action. Each of the technologies is described and the effectiveness at achieving cleanup levels, implementability, and relative cost of each is presented. Technologies that are retained after this evaluation will be included in one or more remedial alternatives described, evaluated, and compared in Chapters 6 and 7.

5.1 Institutional Controls

Institutional controls could include site access and land use restrictions. Access restrictions would be provided by installing fencing around portions of the site, or the entire site, if needed. Fencing would reduce unauthorized access and potential damage to the cover systems from trespassers. Access restrictions would be applied as necessary for both the reclamation and consolidation and containment options.

If consolidation and containment is pursued, future site uses would need to be restricted to prevent damage to the final cover and surface water control systems. Site use may also need to be restricted for the reclamation option if contaminants onsite are above cleanup levels at depths less than 15 feet bgs. Site uses would be constrained by restrictive deed covenants that are required by MTCA (WAC 173-340-440(4)(a)). If, in the future, there is interest in developing the site for private or public uses, Kitsap County, with public input and Ecology approval, could develop a site use plan that conforms with the restrictive deed covenants. Under reclamation, covenants also could include provisions for resampling the inert fraction fill area at some time in the future to evaluate whether natural attenuation processes have reduced COC concentrations below cleanup levels.

5.2 Monitoring

Compliance monitoring required under MTCA would include monitoring of surface water, groundwater, landfill gas, and any engineered systems installed as part of the remedial action, such as caps. Monitoring would be required to continue at the site for an extended period of time following completion of the cleanup action, probably 30 years. MTCA (WAC 173-340-410) requires the preparation of a compliance monitoring plan that includes monitoring to confirm that human health and the environment are adequately protected, cleanup actions are meeting cleanup or other performance standards, and the long-term effectiveness of cleanup actions are maintained once standards have been attained. The compliance monitoring plan would include a sampling and analysis plan, the data analysis and evaluation procedures to be used, and a description of statistical methods to be employed to evaluate compliance.

Monitoring requirements will vary depending on which remedial alternative is selected. General monitoring provisions are discussed below, followed by a brief description of the different requirements for the remedial alternatives.

5.2.1 Landfill Gas Monitoring

Landfill gas monitoring would include sampling and testing of subsurface landfill gas monitoring probes and of landfill gas emissions from passive vents. The compliance monitoring plan will specify landfill gas monitoring locations, parameters and frequency, data analysis and reporting, and benchmarks for evaluating performance of the landfill gas system. The compliance monitoring plan will include a contingency for upgrading to an active landfill gas extraction system if performance standards are not met. Landfill gas monitoring would probably continue for 30 years and is required only for the capping option.

5.2.2 Surface Water Monitoring

Surface water monitoring would include sampling and chemical testing of upstream and downstream stations for surface water COC parameters. Results will be compared to site cleanup levels and used to evaluate the performance and effectiveness of the remedial action on surface water COC levels. The surface water monitoring portion of the compliance monitoring plan will specify monitoring station locations, parameters and frequency, data analysis and reporting. The monitoring plan also will specify benchmarks for evaluating performance and changes to monitoring protocols.

For an initial period after remedial action construction, surface water monitoring would be the same or similar for any alternative built. Once cleanup levels are achieved under the reclamation alternative, surface water monitoring may no longer be required. This will depend on actual residual soil COC concentrations measured in the inert fraction and an analysis of the possibility of those COCs remobilizing and entering surface water.

5.2.3 Groundwater Monitoring

Groundwater monitoring would include sampling and chemical testing of upgradient and downgradient monitoring wells for groundwater COC parameters. Results will be compared to site cleanup levels and used to evaluate the performance and effectiveness of the remedial action on groundwater COC levels. The groundwater monitoring portion of the compliance monitoring plan will specify which wells will be monitored and tested, parameters and frequency, well maintenance, data analysis and reporting. The monitoring plan also will specify benchmarks for evaluating performance that may include re-evaluation of remedial alternatives for groundwater if cleanup levels are not achieved.

Groundwater monitoring would likely be the same for an initial period after the remedial action construction for all alternatives. It is expected that the groundwater monitoring frequency for the reclamation alternative may decrease more rapidly after the initial monitoring period than for the capping alternative, because the primary source of groundwater COCs would be removed by reclamation. A groundwater monitoring period of 30 years following the remedial action is used for estimating purposes. The actual groundwater monitoring schedule will be described in the compliance monitoring plan, including criteria for longer or shorter monitoring periods.

5.2.4 Engineered Systems Monitoring

Engineered systems monitoring would include inspecting and maintaining any engineered systems installed by the remedial action. Monitoring parameters and frequencies would be included in the compliance monitoring plan.

For the capping option, monitoring would include periodic surveying to measure settlement on the main landfill final cover area, periodic surface reconnaissance of the main landfill final cover area to identify areas of erosion that need repair and revegetation, and inspection and maintenance of the surface water diversion and retention systems to maintain performance. This monitoring would probably continue for 30 years and will be described in the compliance monitoring plan, including criteria for shorter or longer monitoring periods.

For the reclamation alternative, monitoring may include inspection of the inert fraction cover area, including a survey of replanted vegetation to identify areas of erosion that need repair and revegetation, and inspection of the surface water drainage system for performance. Because this reclamation alternative assumes that the site will be restored close to its pre-landfill condition, it is expected that systems monitoring will be needed for less than the standard 30-year period. The compliance monitoring plan will include criteria to determine the actual monitoring period.

5.3 Waste Source Control

Two remedial approaches were identified for waste source control in Chapter 4: 1) consolidation and containment (capping), and 2) reclamation. Each approach consists of several individual technologies bundled together that are needed to complete the remedial action. Some of the technologies are similar or shared by both remedial options, such as excavation and grading. These are described and evaluated first. Each approach also employs some action-specific technologies with several options; these are then described together and evaluated comparatively.

Each technology is described in detail with site-specific information explaining how it would be applied to achieve site cleanup goals. The general effectiveness, implementability, and estimated cost of each technology are then presented. Some of the technologies have several options, such as the type of cap or soil treatment, while others have no alternative within the overall action, such as the need for excavation and grading. For the technologies with two or more alternatives, effectiveness, implementability, and costs are presented with some discussion that compares alternatives.

5.3.1 Excavation, Grading, and Processing

Both of the remedial options require excavation of waste sources and regrading of portions of the site. Waste excavation also includes a nominal amount of overexcavation of native soil that has been impacted by the waste. The capping option would require filling and regrading of areas outside the main cap area. The reclamation option would include processing the excavated waste and separating it into three size fractions. The smallest size fraction, the inert material, would become fill that would be replaced and could be regraded to restore the site close to pre-landfilling grades and contours. Estimates of truck counts and weights for material hauled into or out of the site will be made in the Remedial Design Report. Final grading involved in both options includes construction of surface water systems. The surface water systems are described below in Section 5.5, but the costs for their construction are included in this section.

Capping Option

Excavation and grading for the capping option is planned to decrease the area of the site that requires a final cover system and to increase the area of the site that may be used for other purposes. The approximate areas of waste excavation are shown in Figure 5-1[1] and estimated quantities are provided in Table 5-1. Waste would be excavated from the west end areas and septage pits. Waste would be excavated from the transfer station access area to allow continued access to the transfer station without requiring heavy vehicles to travel over the final cover system (Figure 5-1). Waste would also be excavated from the southwest corner area to allow a surface water diversion system to be constructed outside of the final cover system area and in an area of compacted earth that would not be subject to settlement. Contaminated sediments would be excavated from the settlement ponds near the toe of the landfill. Since the area of contaminated sediments is not very well defined, a 30-foot-wide, 3-foot-deep excavation corridor has been assumed from the toe of the landfill to the property boundary. Approximately 18,900 cubic yards (cy) of waste and sediment would be excavated.

Excavated waste would be placed on the main landfill and graded to provide a gentle slope from northwest to southeast. The steeply sloped portion on the eastern edge of the main landfill would not be regraded. While this area is somewhat steeper than other portions of the main landfill, the slope appears to be shallow enough (less than approximately 3 horizontal to 1 vertical) to allow installation of a final cover system (described in Section 5.3.2). Approximately 12,000 cy of onsite soils would be used to provide a 2-foot armor layer over the consolidated waste. The 2-foot thick armor layer would be necessary to provide an adequate separation between the waste and the barrier layer components. The upper 6 inches of the armor layer would be prepared subgrade for the final cover system (see below).

Most of the areas of waste excavation would need to be filled with earth to maintain even grades over the site. Onsite soils from the general area of the central septage pits would be excavated and used for this purpose and for the armor layer. Additional grading, drainage, and topsoil materials may be brought in from offsite. Excavating soils from the central septage pit area would allow the pits to be regraded, and would allow this area to be widened to accommodate a surface water detention pond adjacent to the south edge of the main landfill (Figure 5-6). It would also allow regrading of the steep slope south of the main landfill.

Approximately 6,450 cy of compacted earth fill would be placed in the southwest corner area and the transfer station access area (Table 5-2). This would provide additional support for heavy truck traffic from the transfer station and a stable ground surface for a surface water diversion system. Approximately 14,450 cy of general earth fill would be placed in the

[1] Figures and tables are included at the end of the chapter.

other areas of waste excavation (Table 5-2). Earth fill would not be placed in the Trench 3 or Trench 1-2 areas because the existing topography does not indicate that there are depressions that need to be filled. A much larger quantity of earth fill than excavated waste would be required to fill the south septage pit to surrounding grades; some of this fill would be obtained from a stockpile immediately northwest of the pit. Somewhat less earth fill than excavated waste would be placed in the northern west end area because the waste in this area is currently above surrounding grades.

Effectiveness. Excavation of the wastes and consolidation beneath one cap would reduce potential contact exposures. Minimizing the containment area and cap "footprint" would maximize the amount of land at the site that may be put to other use, including current use of a portion of the site as a transfer and recycling station.

Implementability. Excavation, consolidation, and regrading are readily implemented using standard construction equipment.

Cost. The estimated cost for excavating and consolidating waste, filling, grading, surface water control, and reseeding is approximately $744,440 (see Appendix E).

Reclamation Option

For reclamation, the main landfill and west end area waste would be excavated and screened into three size fractions: the *bulky* fraction (materials greater than 3 inches), the *garbage* fraction (materials between 1 inch and 3 inches), and the *inert* fraction consisting largely of soil and gravel. The cover soil would be scraped off the landfill and stockpiled prior to excavating the landfill waste. The septage pits also would be excavated but not screened.

The types and amounts of materials in the three size fractions were determined by a field study conducted at the site in August 1999 in which samples of waste were screened, weighed, and analyzed (see Supplement 2). Data from this investigation was used to produce Table 5-3, which summarizes the material amounts that would be involved in the reclamation option. The field study showed that approximately two-thirds of the material by weight in the landfill is soil that is considered inert material.

Figure 5-2 shows the process that would be followed and technology options at different points in the reclamation process. The bulky materials, comprising 21,100 tons or 26 percent by weight of the waste material, would be disposed offsite under any scenario. The garbage fraction, comprising 5,680 tons or 7 percent by weight, may be disposed offsite or composted onsite. Composted garbage material would be stabilized by mixing with the inert fraction and retained onsite. The composting technology is considered below. The inert materials, which comprise just over 79,000 tons (54,400 tons of inerts comprising 67 percent by weight of the waste material and 24,600 tons of cover soil; see Table 5-3), would remain onsite in all scenarios except one (disposal of inerts in an offsite Subtitle D disposal facility) and would be used to regrade the site after excavation. Analysis of samples of the inert fraction and existing cover soils showed that neither would be considered a dangerous waste (by book designation), but contaminants in both fractions would probably exceed the site cleanup levels. Treatment options for the inert fraction, including offsite disposal, are considered below.

One concept for restoring the site includes regrading the site close to the pre-landfill topography and drainage. Figure 5-3 shows approximately how the site would be regraded to move the drainage pathway to an axis near the centerline of the existing disposal site.

Effectiveness. Chemical analytical data show that COC concentrations are higher and exceed cleanup levels in a greater number of samples in the garbage fraction than the inert fraction. Mechanical separation of the garbage fraction from the inert fraction should effectively reduce the volume and concentration of COCs on the site. Removing the garbage fraction from the site also would eliminate the generation of landfill gas and acid-producing leachate, both of which contribute to groundwater contamination.

Implementability. Excavation, processing, and regrading can be readily implemented using standard construction equipment.

Cost. The estimated cost for excavating, screening, and replacing the residual inert materials to regrade the site is $2.2 million (Appendix E). The estimate of costs for landfill excavation is based on an assumption that the production rate for excavation and processing of landfill material would be about 100 tons per hour. This rate is based on CH2M HILL's experience with locally available excavation and processing equipment. At this rate, the excavation and processing of the landfill material would take about 820 hours, or 4 to 5 months. It is assumed that a shaker screen would be used as the primary separation equipment. Landfill excavation and processing rates as high as 600 tons per hour have been reported in the literature at demonstration project sites, but the referenced 600-tons-per-hour rate was achieved with two very large trommel screens (EPA, 1993a). Achieving this production rate at the Bainbridge Island Landfill would probably increase the cost over the assumed conditions.

5.3.2 Waste Treatment—Capping Option

As discussed in Chapter 4, the capping option would include a final cover system for the main landfill that would use only manufactured materials for a barrier layer. Final cover systems using these types of barrier layers have been developed for landfills in western Washington, and a similar type of cover system is proposed for the main landfill (Figure 5-4). The cover system would consist of the four layers described below.

Cover System Layers

Armor Layer

A 2-foot-thick armor layer would be placed over refuse in the main landfill. The top 6 inches of this layer would be prepared by grading and compacting the soil to a smooth, even surface and by removing sticks, rocks, and other materials that might puncture the barrier layer during installation. The total thickness of the armor layer would be 2 feet, including the minimum 6-inch-thick prepared subgrade.

Barrier Layer

Three composite barrier layer types are considered: geosynthetic clay liner (GCL) below 60-mil high-density polyethylene (HDPE), GCL below 40-mil linear low-density polyethylene (LLDPE), and GCL below 50-mil polyvinyl chloride (PVC). Although WAC 173-351-500 only requires for geomembranes (except for HDPE) to have a minimum thickness of 30 mils, a minimum of 40 mils is the assumed thickness for LLDPE and PVC because it is easier to maintain quality control during field seaming of the material. The GCL for the lower component of the barrier layer would consist of a layer of bentonite between two layers of geotextile that are stitched or sewn together. The barrier layers with alternative geomembrane technologies are compared in Table 5-6.

An additional consideration for the barrier layer is the steep slope on the east side of the main landfill. This slope is sufficiently shallow (3 horizontal:1 vertical) to support a final cover system. If capping of the main landfill is selected as part of the preferred alternative for site cleanup, this area of the main landfill would be evaluated in more detail during the preliminary and final design stages to determine if additional support is needed for the final cover system. Typical methods of support on steeply sloped areas include geosynthetic grids or top- and mid-slope anchor trenches.

Sand Drainage Layer

The sand drainage layer would be a minimum of 18 inches thick and would allow infiltrated precipitation to collect and drain from the top of the geomembrane. Sand would be washed to remove fines and increase permeability, and sorted to remove oversized rocks or other material that could puncture the geomembrane. Depending on the steepness and length of final slopes on the main landfill, strip drains might need to be added to the sand drainage layer to increase the flow of infiltration from the drainage layer. Strip drains consist of a free-draining plastic core surrounded by geotextile. The drains are approximately 18 inches wide and would be placed at even spacings on top of the geomembrane and parallel to the slope. If capping of the main landfill is selected as part of the preferred alternative for site cleanup, the need for and spacing of strip drains would be addressed in more detail during preliminary and final design.

Topsoil Layer

The topsoil layer would be a minimum of 12 inches thick and would be sufficient to support vegetation. It would minimize erosion of the final cover system and would provide additional protection for the barrier layer. Depending on the difference in particle size between the topsoil and sand drainage layer, a geotextile layer might need to be added between these layers to prevent the flow of fines from the topsoil into the drainage sand. If capping of the main landfill is selected as part of the preferred alternative for site cleanup, the need for the geotextile layer would be addressed during preliminary and final design.

Estimated quantities of the various final cover system materials are provided in Table 5-4. The quantities of the various layers of material were estimated on the basis of a projected surface area of the main landfill of 18,000 square yards (measured area plus 10 percent). Strip drains were estimated on the basis of an average length of 250 feet and an average spacing of 40 feet (approximately 15 strip drains).

Barrier Types

The GCL for the lower component of the barrier layer would be installed as overlapping sheets on the landfill surface. Heat welding of seams between overlapping sheets would not be required.

The upper component of the composite barrier layer would consist of a plastic geomembrane. Of the plastic geomembranes, the HDPE and LLDPE material is highly resistant to weathering and can be textured for increased stability on steep slopes such as those present on the east side of the main landfill. However, the HDPE is somewhat stiff and more difficult to install than PVC or LLDPE. PVC is somewhat lower in cost than HDPE or LLDPE and is more flexible, elastic, and easier to install than HDPE. However, the PVC material is less resistant to weathering than HDPE or LLDPE and might not function well on steeply sloped areas. LLDPE is a new material that combines some of the properties of HDPE (the resistance to weathering and the ability to be textured for stability on steep slopes) with those of PVC (more flexible and elastic).

Effectiveness. GCLs have been used effectively as the lower component of composite barrier layers for closure of municipal solid waste landfills in western Washington. The GCL will be retained for consideration as the lower component of the composite barrier layer. The PVC geomembrane is eliminated from further consideration because it might not be acceptable for steep slopes. The LLDPE geomembrane is preferred for use as the upper component of the composite barrier layer because it has the same long-term resistance to weathering and reliability on steep slopes as HDPE and has the increased flexibility and elasticity as PVC. The 40-mil LLDPE geomembrane is selected as the preferred technology for the barrier layer and would be included as part of the waste consolidation and containment option.

The composite cover system will comprise a physical barrier that will prevent penetration of the waste by burrowing wildlife or plant roots. This system will be highly effective at eliminating exposure to wildlife and preventing the establishment of forest habitat that would be utilized by wildlife.

Institutional controls will be maintained to preserve the integrity of the impermeable layer. These controls will be maintained to prevent human, animal, or plant activity from breaching the impermeable barrier. Controls will include preventing deep-rooted plants from growing. The cap will be covered with topsoil and planted with grass, establishing an organic layer on top of the cap. Macro-invertebrates and smaller burrowing animals (e.g., voles, moles) may inhabit the organic layer, but will be deterred from penetrating the inorganic, uninhabitable cap to the consolidated waste below. Therefore, neither human nor ecological receptors will be exposed to landfill contaminants under the consolidation and containment alternative.

Implementability. Construction of a five-layer cover system using GCL and geomembrane composite barrier layers is a proven technology and common waste management practice.

Cost. Costs for the three composite barrier types (GCL with PVC, HDPE, and LLDPE) range from about $7.80 to $9.50 per square yard. Installation costs are highest for HDPE/GCL barriers with LLDPE/GCL and PVC/GCL installation costs about the same. Cost for construction of a cover using an LLDPE/GCL barrier layer is estimated to be $698,560 (Appendix E).

5.3.3 Waste Treatment—Reclamation Option

Treatment technologies of the three segregated waste fractions are considered in this section. The bulky fraction (14,700 tons) would be disposed offsite under any scenario. A portion of the bulky fraction consists of ferrous iron, which may be separated out magnetically and recycled if metals markets are favorable. Ferrous iron materials were documented in the bulky fraction but quantities were not estimated, and separation techniques were not tested. The garbage fraction (3,960 tons) may be disposed offsite or composted onsite. The treatment options for inert soil (62,500 tons, which includes inert and cover soil) include soil washing, bioremediation, steam injection, and capping.

Offsite Disposal (Bulky and Garbage Fractions)

A refuse hauling company would be contracted to pick up and haul the excavated waste to a public or commercial disposal site. Because the materials are solid wastes, it is planned that they will be disposed at a RCRA Subtitle D compliant facility. The waste would be placed by the excavation contractor into the refuse company's trucks, which would be equipped for highway travel. The trucks would be covered similar to vehicles hauling solid wastes from transfer stations to disposal sites.

Effectiveness. Disposal in a secure facility offsite would permanently remove these materials from the site and prevent them from releasing contaminants at the site. Disposal in a lined, Subtitle D compliant landfill would still carry a low risk of the materials contributing to contamination at the new disposal site.

Implementability. This is a proven technology and standard commercial practice.

Cost. Cost is moderate. Cost per ton was estimated by querying commercial haulers on rates to remove, haul, and transport the types of materials expected to be encountered. Cost per ton is $26.24 (gate rate) for disposal at the Columbia Ridge landfill in Oregon. Transport cost is estimated at $0.10 per ton per mile, and the estimated trip length is 200 miles.

- Total estimated cost for bulky fraction: $955,000
- Total estimated cost for refuse fraction: $257,000

Composting (Garbage Fraction)

The proposed composting process would promote rapid aerobic decomposition of the decomposable organic materials in the garbage by forcing air through piles of the material. Composting produces a stabilized organic material that is not subject to further bio-degradation and is often used as mulch or as a soil amendment. The proposed system would draw air through the piles of material by suction and would treat the discharged air to remove odors. The composting process relies on a negative aerated static pile with exhaust biofiltration to help minimize space requirements for processing and agitation of the feedstock during composting. It appears the volume of feedstock would be approximately 7,000 cy total. If the process includes a short-term storage area to receive the garbage fraction from screening, and to allow it to be metered into the composting process, composting can be accomplished in one-half acre. With the residence time mentioned above the estimated volume could be processed in an arrangement of four adjacent pads, each having a capacity of 1,600 cy. The system would be built directly on disturbed soil subgrade and would use above-ground aeration piping. The system would require a front end loader to construct, transfer, and deconstruct each batch. It would also require a water source to adjust the pile moisture as piles are constructed.

Leachate management for the composting process would include controlling run-on and engineering the composting process to use any leachate generated by rain falling on the piles. If composting took place during periods of excessive rain, additional provisions for collecting and treating leachate would be used—for example, placing piles on an impervious surface with a sump installed to route leachate to a collection pond or tank.

The recommended aeration rate is 1.2 to 1.5 cfm/cy, which requires 10,000 cfm at a static pressure of approximately 30 inches WC This would require approximately 65 hp of power (150–200 amps @ 480 VAC, three phase). One to two fans would be powered with a diesel or diesel-hydraulic power source because there is no electrical power on site and the project duration is short. Alternatively, the pads could be set up as four independent systems, each with its own fan; the connected horsepower would be about the same (200 amps @ 480 VAC, three phase). The final arrangement can be selected depending on site-specific issues.

After the composting process is complete, the product would have to be screened at approximately 1.5 inches screen size. The oversized materials are expected to be almost entirely film plastic. Small amounts of wood and rock may be present as well. The residual oversized material would be disposed. It is estimated this fraction may be about 5 to 10 percent of the initial weight, or approximately 200 tons.

Effectiveness. Composting is estimated to be 95 percent effective in removing decomposable materials. This would result in a product that would be effectively inert and (although of a different texture) could be mixed with the inert fraction and used in regrading the site. However, the garbage fraction is the smallest fraction of the landfill mass, constituting only 7 percent by weight, and is not composed only of decomposable material. The August 1999 field study showed that inorganic material, including cans and plastics, make up a portion of the garbage fraction, although the amount was not quantified. Composting's effectiveness at contaminant destruction is unknown; significant VOC and SVOC destruction is possible, but there would be no effect on metals. Chemical analytical testing of the compost product would be necessary.***Implementability.*** This is a proven technology, however, there is some uncertainty in the time required.

Cost: Cost is moderate. Cost of constructing, operating, and maintaining an onsite compost facility for approximately 2 months was estimated by an experienced compost system designer to be $440,000 for composting approximately 7,000 cy of garbage (see Appendix E).

Soil Washing (Inert Material)

Soil washing or flushing is a physical separation process used to segregate soil into particles of gravel, sand, or clay. Because of its higher surface area and binding properties, most contaminants adhere to the clay fraction. Soil washing separates the fines, including clay, from the larger particles, thereby generating clean sand and gravel which can be eliminated from cleanup considerations if they are below desired treatment levels. Soil washing can also transfer contaminants from the surface of the larger particles to the smaller fines to achieve cleanup of the larger soil fractions. Soil washing projects reviewed for this study (Department of Defense sites contaminated with heavy metals) processed from 3 to 10 tons per hour.

Effectiveness. The effectiveness of this process depends on many variables, including but not limited to:

- The potential for contamination to adsorb to soil
- The mobility of the contamination
- The presence of clay and silt in the soil

Site soils have low clay and silt contents (generally less than 10 percent), but the organic and ash content of the inert fraction would be another variable on the effectiveness of soil washing. This technology simply transfers the contaminants to a large volume of solid and liquid residuals, which must then be managed. This transfer has little benefit other than removing the contaminants from the site.

Implementability. Soil washing would have an uncertain technical outcome. Extensive pre-testing (including time and expense) without assurance of successful implementation would be required. Substantial administrative work could be required, including permits (or substantive equivalence) and testing to properly manage the treated residuals. The relative amounts of residuals is uncertain; a significant amount of the residuals would be contaminated wash water, which may be more difficult to treat than the solids.

Cost. Cost is high. An estimate obtained from Brice Environmental Services Corp., a leading provider of soil washing, indicates the cost to treat ranges from $50 to $100 per ton, which includes all treatability and pilot testing as well as residuals management. An EPA site in New Jersey used soil washing in 1993 to treat 19,200 tons of soil contaminated by heavy metals for $7.7 million, including offsite disposal of residuals. The total estimated cost for the Bainbridge Island Landfill is $5 to $10 million.

Bioremediation (Inert Material)

Bioremediation includes a number of related technologies in which air and nutrients are supplied to the soil (or waste) materials in order to encourage growth of microorganisms that metabolize organic contaminants to harmless substances.

Effectiveness. According to a 1994 EPA Specification Document, a heterogeneous mixture of many different contaminants at low levels does not lend itself to bioremediation. Therefore this technology would not be expected to have high effectiveness for the inert fraction.

Implementability. Given the low levels of contaminants, operation of a bioremediation system would be erratic.

Cost. Cost is high. Cost would be at least $100 per ton of material treated. Total cost would exceed $10 million.

Capping (Inert Material)

The inert material may be placed in the excavated area, graded without any treatment, and then capped. Two types of caps are possible: a 2-foot-thick soil-only cap or an impermeable cap consisting of a soil layer and a 60-mil HDPE geomembrane. . A thicker cap may also be constructed that would provide more protection to human health and the environment. However, the base case for this technology assumes a 2-foot-thick soil cap. The impermeable cap would prevent contact exposure and inhibit surface water infiltration. Neither cap would require the special drainage diversion facilities or gas venting system needed for the waste consolidation and capping option.

The soil cap would prevent contact exposure but would allow surface water to infiltrate. This would allow flushing of the inert fraction material and would provide oxygen and other trace nutrients that may enhance natural biodegradation processes operative in the native soil to further reduce organic contaminants.

Effectiveness. The effectiveness of an impermeable cap over the inert materials would be at least equal to that of the waste consolidation and capping option, because settlement and certain drainage problems that could damage the cap would be eliminated. The permeable soil cap would be effective at reducing potential contact exposure to the inert materials. The risk of potential human or wildlife contact exposure with a soil cap would be greater than with an impermeable cap but would be an improvement over the existing condition. Institutional and engineering controls would be required because material kept onsite might exceed cleanup levels. The reduction of organic contaminants by natural biodegradation under a soil cap is not known for the site-specific COCs.

An impermeable cap would be effective at protecting groundwater in the same way as the impermeable cover described above for the consolidation and containment option. A permeable cover would be protective of immobile COCs in the inert fraction. Residual contaminants documented in the inert fraction include SVOCs, metals, and PCBs (see Tables 3-4 and 3-5). These contaminants have low mobility and low solubility, indicating that they will not be transported very far from their source areas (see Fate and Transport, Section 8-2, RI Report, CH2M HILL, 1999). Most metals are released into the environment when acidic fluids leach them from source areas. The inert fraction is expected to produce little or no leachate compared to the current leachate being produced by the landfill, resulting in a net decrease in metals dissolution and mobility. Site-specific data from the Trench 3 area shows that high concentrations of SVOCs did not migrate very far into the subsurface, remaining well above the groundwater table (see Appendix A, Section 2.1, Soil). VOCs, the only COCs in groundwater that could have migrated directly from the landfill waste, were not documented in the inert fraction. The low residual concentrations of low-mobility constituents present in the inert fraction would be expected to remain there rather than migrate downward toward groundwater, even with flushing from rainwater infiltration through the permeable cap. The organic compounds would remain preferentially partitioned in the inert waste material which has a much higher organic carbon content (not measured, but contains visible organic matter) than underlying native soils (TOC ranging from 0.3 to 1 percent; Table 7-18, RI Report). That these residual contaminants have persistent low mobility is supported by the fact that they have been subjected to several decades of heavy rainfall but are not present in the groundwater.

Erosion control design elements of the site restoration would prevent surface water from contacting the residual contaminants in the inert fraction, as described below in Section 5.5.2.

Exposure of human and ecological receptors will be controlled for either cap type. The impermeable cap will function as a physical barrier as discussed under the consolidation and containment option, above. The permeable cap in combination with institutional controls will eliminate exposure pathways: humans will not be allowed to dig at the site, and ecological receptors will be controlled by habitat management. Native (sandy) soils will be used to build the cap, which will be planted with grass species. Shrubs and trees should not be planted on the cover to prevent the establishment of the habitat amenable to potentially burrowing wildlife observed at the site. A grass habitat is the same as the existing habitat at the site, which has a very shallow BAZ (see Chapter 3). There is little likelihood of use or habitation of the capped inert fraction by any animals that would dig through the cap. The mountain beaver is the only species in the vicinity of the site that might dig deeper than a foot into the soil. However, it will not inhabit the site unless the site is allowed to revert back to a forest habitat with suitable habitat characteristics as described by Hygnstrom (1994). Even then, the sandy soil and low organic content would not be suitable for denning due to the likelihood of collapse, and would limit the depth to which the mountain beaver might burrow. Therefore, the permeable soil cap in this alternative is protective for both humans and ecological receptors.

Implementability. Capping is a commonly-used technology, and is easily implementable.

Cost. Cost for an impermeable cap is moderate. Costs are estimated conservatively based on recent costs incurred for geomembrane-based caps used to close RCRA Subtitle D compliant landfills. Compacting and grading the inert material and constructing an impermeable geomembrane cap is expected to cost approximately $1.5 million.

Cost for a soil cap is low. It is assumed that material for the soil cap would be site-derived clean soil. The cost for placing and compacting a soil cap is estimated to be $102,000.

5.4 Landfill Gas

A landfill gas control system would be needed under the capping option, but not for the waste reclamation option. Construction of a landfill gas collection system would be completed prior to excavation and consolidation of waste on top of the main landfill area, in order to allow collection trenches to be placed deeper within the waste pile to facilitate landfill gas venting. The collection system would consist of a series of gas collection trenches containing perforated corrugated polyethylene pipe and gravel, oriented parallel to the slope of the main landfill. A typical cross section of a landfill gas collection trench is shown in Figure 5-5 and the approximate locations of the trenches are shown in Figures 5-1 and 5-6. Assuming six gas collection trenches spaced 100 feet apart, a total of approximately 1,600 linear feet of trench would be installed within the waste of the main landfill.

The two alternative technologies for extracting landfill gas from the collection system are passive venting and active extraction. For passive venting, vents would be provided at both ends of each trench. The vents would extend through the landfill cap and allow landfill gas to be released through the final cover system. For active extraction, the lower ends of the perforated pipe in the trenches would be plugged and the upper ends would be connected to a solid header pipe. The header pipe would be collected to a blower that would place a negative pressure on the trenches to enhance removal of landfill gas. The extracted gas would be exhausted through a single large vent or, if necessary, through a landfill gas treatment system such as a flare or an absorption medium like activated carbon.

Because significant subsurface migration of landfill gas has not been observed at the site, the majority of landfill gas generated has apparently been venting through the landfill surface. The passive venting system would allow the existing venting to continue following installation of the final cover system, and would prevent subsurface migration that could result from increased landfill gas pressures beneath the cap. While an active gas extraction system would increase gas removal from the landfill, this does not appear to be necessary to prevent subsurface gas migration. Both types of gas control systems could be readily constructed, however, the operation and maintenance of the active extraction system would be much more complicated: regular adjustments to flow rates would be required to maintain negative pressures within the landfill while at the same time preventing the inflow of air (oxygen) into the waste. Preventing air inflow would be a serious concern for system operation, since too much air inflow could result in a fire within the waste. Therefore, the passive landfill gas venting system is preferred over an active system for landfill gas control.

Effectiveness. The passive venting system would be as effective as the active extraction system and would be much less difficult and less costly to operate. There is some risk of subsurface migration if the passive venting system failed to reduce landfill gas pressures beneath the final cover system. However, the passive venting system would be designed to allow future conversion into an active extraction system if significant subsurface landfill gas migration is observed during compliance monitoring.

Implementability. Both active and passive landfill gas control systems are proven technologies commonly used at closed landfills.

Cost. Construction costs for the active extraction system would be somewhat higher than for the passive venting system, but operation and maintenance costs would be much higher. The cost for constructing the passive landfill gas system, including components to allow future conversion to an active system, is approximately $ 37,000 (Appendix E).

5.5 Surface Water

Surface water management and control are necessary under either remedial option. A natural surface water drainage channel runs from west to east through the center of the site and through the center of the main landfill. The drainage channels stormwater from the site but does not contain a perennial surface water body. Surface water management under a capping option must include permanent diversion and control of surface water to maintain integrity of the landfill cover system. The reclamation option allows for restoration as close as possible to the pre-landfill surface water drainage system. Only one surface water drainage scenario is evaluated for each option.

5.5.1 Surface Water Control Facilities—Capping Option

If waste consolidation and containment is implemented at the site, surface water control facilities would need to be constructed to divert surface water around the main landfill and to manage increased runoff from the impermeable final cover area. Figure 5-6 shows the proposed surface water control facilities for the capping option, and Table 5-5 lists elements of the facilities and provides estimated quantities. The existing ditch in the west end area would be maintained, and additional roadside and general purpose ditches would be provided to direct flows to the southwest corner of the main landfill area. A 24-inch culvert would be constructed beneath the access road near the southwest corner of the main landfill. Surface water flows from the west side of the site and the main landfill would be directed into a lined ditch along the south side of the main landfill, which would convey flows into a detention pond on the southeast side of the main landfill. If necessary, the existing ditch in the west end area and this proposed lined ditch could be converted to pipes to allow better use of the site area or to provide better access to the south side of the main landfill and the proposed detention pond location.

The detention pond would be lined with a geomembrane and would have an approximate top length of 160 feet, an approximate top width of 68 feet, and an approximate depth of 4 feet plus 1 foot of freeboard (total depth of 5 feet). These dimensions would provide a pond with a volume of approximately 23,000 cubic feet and a surface area of approximately 5,100 square feet. The pond would be divided into two sections: the inflow section would include riprap and a sediment trap, and the outflow section would be provided with a controlled outlet structure. A gravel filter would be installed between the two sections. The pond would collect the majority of runoff from the final cover area of the main landfill and runoff from the western portion of the site. The southeast edge of the main landfill would be provided with a runoff control berm to direct as much runoff as possible from the final cover area into the pond. Only the steeply-sloped portion on the east side of the main landfill would not be directed into the pond.

The controlled outlet structure in the detention pond would release water at a reduced rate of flow to prevent downstream increases in peak flows. The portion of the main landfill runoff that is not directed into the detention pond would be considered when sizing the outlet structure. Water from the outlet structure would be released into a 16-inch polyethylene pipe that would convey flows down into the ravine near the east toe of the main landfill. Riprap and an energy dissipater would be provided at the end of the pipe to control erosion.

Effectiveness. Calculations of the ditch, pond, and pipe sizing were completed by a licensed civil engineer following current Kitsap County stormwater management guidance. The system as designed should be highly effective at preventing COCs from entering surface water after construction.

Implementability. The surface water control system utilizes proven technologies.

Cost. The cost for constructing the surface water diversion and control structures is included in the excavation, grading, and filling costs presented in Section 5.3.1.

5.5.2 Surface Water Control Facilities—Reclamation Option

The inert materials would be graded to form a drainage channel along the east-west axis of the landfill area, as shown in Figure 5-3. The location of this channel would approximate the location of the original drainage path through the area prior to landfill construction. This would avoid the need to construct stormwater diversion channels around the capped area. Stormwater would flow in the drainage channel over the cap. A grading and drainage concept is presented in Figure 5-3 that includes placing inert materials and their cover in the base of the surface water drainage in order to maintain slopes that approximate the pre-landfill topography. A grading plan that does not place inert materials in the base of the drainage channel without oversteepening the side slopes may be possible by placing a larger portion of the inert material on upper flat bench areas of the site and by filling other excavated areas such as the south septage pit. If the reclamation option is selected, a detailed grading plan will be prepared in the remedial engineering design report, and will be based on the final land use.

To prevent damage to the cap, erosion of the underlying inert waste materials, and contact of surface water with inert waste materials, erosion protection materials would be placed in the drainage channel on the cap. These may include erosion control mats and large gravel in the center of the channel. Although the drainage channel would be in approximately the same location as before landfill development, it would be at a higher elevation over much of its length because of the inert materials placed beneath it. Therefore, the water velocity at peak flow conditions at the east end of the channel may be greater than in pre-landfill conditions. This may require enhancing the existing settling ponds at the east end of the site, but the improvements would not be more extensive than those required for the capping option.

Effectiveness. The system as designed should be effective at preventing COCs from entering surface water.

Implementability. Restoring the surface water drainage system as close as possible to natural, pre-landfill conditions utilizes proven technologies.

Cost. The cost for the surface water drainage system construction is included in the excavation, grading, and filling costs presented in Section 5.3.1.

5.6 Groundwater

The two primary categories of technology for groundwater remediation that are applicable to the Bainbridge Island Landfill are extraction with ex situ treatment (pump and treat), and in situ treatment. This section describes the various specific technologies for each category, focusing on their effectiveness in remediating VOCs, especially vinyl chloride. The following technologies are discussed in this section:

Pump and Treat

- Pump
  - Extraction wells
- Ex situ treatment technologies
  - Air stripping with discharge to atmosphere
  - Air stripping with thermal oxidation
  - Air stripping with catalytic oxidation
  - Air stripping with ultraviolet oxidation
  - Air stripping with carbon adsorption
  - Biological wastewater treatment
  - Ultraviolet oxidation
  - Carbon adsorption

In Situ Treatment

- Natural aerobic biological stimulation
  - Oxygen enhancement through addition of air or chemicals such as peroxides
  - Cometabolic enhancement through addition of a carbon-based food source
- Air sparging
- In-well air stripping
- Monitored natural attenuation (MNA)

The groundwater remedial options are described below and their general effectiveness is discussed. The comparative effectiveness, implementability, and cost of the groundwater treatment technologies are presented in Table 5-6.

5.6.1 Pump and Treat Systems

A pump and treat system at the Bainbridge Island Landfill site would consist of three to six wells, each ranging from about 175 to 200 feet deep, installed along the northern property boundary between monitoring wells MW-13 and MW-15. This well placement would center the extraction on the area of VOC-contaminated groundwater that flows offsite to the northeast. Each well would be either 4 or 6 inches in diameter and capable of pumping between 15 and 40 gpm. The water would be piped to an onsite treatment plant. After treatment, the water would be discharged to surface water or recharged back to the groundwater either through recharge wells, closed infiltration trenches, or open infiltration ponds.

Ex Situ Air Stripping Treatment Options

Ex situ treatment options would include various air stripping schemes in which the VOCs would be transferred from the groundwater to the air. The VOCs in the air would then either be discharged to the open atmosphere through a tall discharge stack; destroyed by a thermal oxidation, catalytic oxidation, or an ultraviolet oxidation process; or transferred to activated carbon via adsorption. Because of the very low concentration of VOCs in the groundwater (current maximum of about 1 μg/L in MW-14 and an estimated 0.1 μg/L average concentration in the total groundwater extraction), air stripping would not be efficient at removing the VOCs from the groundwater to the very low site cleanup level of 0.023 μg/L for vinyl chloride at the property boundary. Moreover, at the even lower concentrations that would be in the air phase, thermal, catalytic, and ultraviolet oxidation and carbon adsorption are extremely inefficient. Activated carbon is also very inefficient at removing vinyl chloride because of the molecule's small size and low sorption potential. The effectiveness of air stripping and active treatment of VOCs (excluding discharge to the atmosphere) is potentially limited because of the low concentrations and the inherent stripping and treatment inefficiencies.

Effectiveness. Few data from full-scale operations are available to demonstrate the effectiveness of achieving the cleanup level of 0.023 μg/L of vinyl chloride. It is highly unlikely that pumping and treating groundwater would be able to achieve this cleanup level.

Implementability. Construction and operation of air stripping has been demonstrated at many sites. It would require a groundwater right/beneficial use permit, an air discharge permit, and a groundwater or surface water discharge permit. Discharge water must meet groundwater or surface water standards.

Cost. Cost for air stripping would be high. Capital costs would be approximately $1,150,000, and annual O&M costs of about $150,000 per year. This assumes vinyl chloride reduction from 5 ppb to 0.02 ppb with no off gas treatment and no metals pretreatment. Treated water is assumed to be recharged in an onsite trench or pit. O&M includes a sinking fund for well rehabilitation/ replacement, pump replacement, recharge trench rehabilitation/replacement, weekly effluent monitoring, and blower motor and tower packing replacement. Permitting and regulatory reporting costs are not included.

Other Ex Situ Water Treatment Options

Ex situ treatment options also include directly treating the VOCs in the groundwater. These methods include wastewater biological treatment, ultraviolet oxidation as the water passes through a series of clear tubes, and sorption onto activated carbon as the water passes through a series of vessels containing carbon.

Effectiveness. Because of the extremely low VOC concentrations and the inherent treatment inefficiencies, all of these methods are potentially ineffective.

Implementability. Biological treatment would require the addition of substantial quantities of organic matter for the bacteria to survive, and the forced aerated environment of the biological treatment would create a substantial uncontrolled, but diffuse, direct release of VOCs to the atmosphere.

Cost. Cost for this option was not estimated because of the low expected effectiveness.

5.6.2 In Situ Treatment Systems

Aerobic Biological Stimulation

An aerobic biological stimulation treatment system at the Bainbridge Island Landfill would consist of about 20 wells, each ranging from about 160 to 190 feet deep, installed along the northern property boundary between MW-13 and MW-15. Like the placement of extraction wells, in situ treatment wells would be centered on the area of VOC-contaminated groundwater that flows offsite to the northeast. Air, oxygen-releasing chemicals, and/or a carbon-based substrate that constitute nutrients for bacteria would be pumped or placed into the groundwater flow system. These substances would enhance the naturally occurring aerobic bacterial community already present in the aquifer. These bacteria would then aerobically transform the VOCs to carbon dioxide and water. Because of the extremely low concentration of VOCs in the groundwater, biological stimulation may be inefficient, and thus potentially ineffective, at reducing VOC concentrations to the site cleanup standard of 0.023 μg/L for vinyl chloride.

Effectiveness. Aerobic biological stimulation has very little full-scale operations data to support its effectiveness to achieve the cleanup level of 0.023 μg/L of vinyl chloride.

Implementability. Construction and operation have been demonstrated at many sites. This method would add chemicals to the groundwater, requiring additional permitting and monitoring.

Cost. Cost would be moderate, including: capital cost of approximately $870,000 (assuming no off gas treatment) and annual O&M cost of about $90,000 per year (including replacement of equipment).

Air Sparging

Air sparging is a physical phase transfer technology that may be achieved in two ways: 1) with vapor extraction and ex situ vapor treatment, or 2) without vapor extraction and in situ vapor treatment. An air sparging treatment system at the Bainbridge Island Landfill would consist of about 20 wells, each ranging from about 160 to 190 feet deep, installed along the northern property boundary between MW-13 and MW-15. Air would be injected, as for the aerobic biological stimulation system. The VOCs stripped from the groundwater would enter the thick unsaturated zone and would either be extracted or left to be biologically degraded to carbon dioxide and water by the native aerobic soil bacteria. Vapor extraction would be from about 20 soil vapor extraction (SVE) wells installed between the sparging wells. The stripped VOCs would either be discharged to the open atmosphere through a tall stack or treated as described above for ex situ air stripping. If SVE were used, only discharge to the atmosphere will be considered for treatment of the stripped VOCs because of the low concentrations and the inherent stripping and treatment inefficiencies. The effectiveness of air sparging is potentially limited, as discussed above for aerobic biological stimulation.

Effectiveness. There are very little full-scale operations data to support the effectiveness to achieve the cleanup level of 0.023 μg/L of vinyl chloride.

Implementability. Construction and operation has been demonstrated at many sites. Air sparging would require an air discharge permit if SVE were used.

Cost. Cost would be moderate; air sparging would require capital costs of approximately $870,000 and annual O&M costs of about $90,000 per year.

In-Well Stripping

An in-well stripping treatment system at the Bainbridge Island Landfill would consist of about five wells, each ranging from about 170 to 200 feet deep, installed on the northern property boundary between MW-13 and MW-15. Using air blowers, air would be injected into the groundwater through a small diameter drop pipe in each of the wells. The air bubbles would rise through the water column, creating an air-lift pumping action. This pumped water would be discharged back into the aquifer through a second, higher elevation well screen. Depending upon the well design chosen, the VOCs stripped from the groundwater would be extracted and discharged to the atmosphere through a tall stack, or would enter the thick unsaturated zone and be left to be biologically degraded by the native aerobic soil bacteria. If stripped VOCs are extracted, only discharge to the atmosphere will be considered for treating the stripped VOCs based on the same reasons as discussed above for ex situ air stripping. The effectiveness of in-well stripping is potentially limited, as discussed above for aerobic bacterial stimulation.

Effectiveness. Very little full-scale operations data exist to support the effectiveness of in-well stripping to achieve the cleanup level of 0.023 μg/L of vinyl chloride.

Implementability. Construction and operation has been demonstrated at many sites; would require air discharge permit if vapor discharged to atmosphere.

Cost. Cost would be moderate: capital costs of approximately $725,000 and annual O&M costs of about $90,000 per year.

Monitored Natural Attenuation

Natural attenuation is described by the EPA Office of Research and Development and Office of Solid Waste and Emergency Response as "...a variety of physical, chemical, or biological processes that, under favorable conditions, act without human intervention to reduce the mass, toxicity, mobility, volume or concentration of contaminants in soil or groundwater. These in situ processes include biodegradation; dispersion; dilution; sorption; volatilization; radioactive decay; and chemical or biological stabilization, transformation, or destruction of contaminants." (EPA, 1999). Groundwater monitoring for natural attenuation would be described in the compliance monitoring plan.

Natural attenuation is occurring at Bainbridge Island Landfill. Data collected since 1996 show that the area of groundwater containing VOCs is stable—the plume is not growing in length and/or width—and that the VOC concentrations show a decreasing trend. Almost complete natural attenuation of the site VOCs (especially vinyl chloride) is clearly indicated by the general lack of precursor breakdown compounds, including PCE, TCE, and DCE in the landfill waste mass or in groundwater (see RI Report, Figure 8-3). Vinyl chloride breakdown products, including ethene and, more commonly, carbon dioxide and chloride, are either theoretically too low to measure (ethene) because of the extremely low vinyl chloride concentrations, or are totally masked by the general organic decomposition processes occurring within the landfill that generate large volumes of carbon dioxide and a large mass of chloride.

Source control by either capping or reclamation should greatly reduce and/or eliminate the VOC loading to groundwater, thus further lowering the concentration of VOCs leaving the site property to the northeast and thereby increasing the effectiveness of the ongoing natural attenuation.

Effectiveness. Data collected to date on the project indicate that natural attenuation is effective in stabilizing the VOC plume; coupled with source control, monitored natural attenuation will achieve cleanup levels.

Implementability. Implementability is very high, because no additional action is required.

Cost. Cost would be very low; no capital costs would be required, and monitoring costs are included elsewhere in the FS for other remediation components.

5.7 Summary of Technologies

This chapter has presented a number of technology alternatives for source control and groundwater remediation. Based on the evaluation of effectiveness, implementability, and cost, each of the technologies either is retained or eliminated from further consideration. Table 5-6 summarizes all of the technologies that were evaluated and indicates whether or not it was retained for inclusion in one or more of the remedial alternatives. The following chapter puts together all the technologies that are retained into remedial alternatives that are then compared and evaluated against site cleanup goals.

TABLE 5-1
BAINBRIDGE ISLAND LANDFILL FS
Consolidation and Containment
Estimated Waste Excavation Volumes

Area Locations	Average Depth (feet)[a]	Area (square feet)	Volume (cubic yards)
Southern west end area	1.7	38,870	2,447
Northern west end area	10.5	18,490	7,191
Transfer station access area	15	3,480	1,933
Southwest corner area	17.5	6,970	4,518
South septage pit	2.8	13,650	1,416
South central septage pit	2.1	3,045	237
North central septage pit	2.9	3,210	345
East central septage pit	1.6	3,740	222
West septage pit	1.6	5,250	311
Sediment excavation areas	3[b]	2,700	300
Total estimated waste excavation volume			**18,920**

Notes:

a Average depth for the southern west end area was estimated on the basis of assumptions in Section 5.2 of the RI Report. Average depths for the transfer station access, northern west end area, and southwest corner areas were estimated from nearby soil boring or test pit logs, and depths reported in Table 4-2 of Supplement 2. Average depths for the septage pits were calculated by adding one foot to the average depths presented in Table 5-2 of the RI Report.

b Average depth of sediment excavation is assumed to be 3 feet near the eastern toe of the main landfill.

TABLE 5-2
BAINBRIDGE ISLAND LANDFILL FS
Consolidation and Containment
Estimated Earth Fill Volumes

Area Locations	Volume (cubic yards)	
General Earth Fill Volumes		
Southern west end area	2,447	
Northern west end area[a]	5,393	
South septage pit[b]	5,616	
West septage pit[c]	700	
Sediment excavation areas	300	
Total estimated general earth fill volumes		14,456
Compacted Earth Fill Volumes		
Transfer station access area	1,933	
Southwest corner area	4,518	
Total estimated compacted earth fill volume		6,451
Total estimated earth fill volume		**20,907**

Notes:

a Assumes only 75 percent of the excavation would need to be refilled since the area is above surrounding grade.
b Includes 4,200 cy of additional fill needed to fill the pit to surrounding grades.
c Assumes an average depth of fill of 3.6 feet (versus the 1.6 feet of excavated waste) to fill the pit to surrounding grades.

TABLE 5-3
BAINBRIDGE ISLAND LANDFILL FS
Reclamation
Estimated Fill Material Volumes

	Cover Estimate	Waste Estimate	Average % Inert	Average % Garbage	Average % Bulky	Inert Estimate	Garbage Estimate	Bulky Estimate
Cubic Yards (in place)								
Main landfill area	14,810	98,550	67	7	26	66,029	6,899	25,623
West end area	1,600	3,400	67	7	26	2,278	238	884
Total yards	16,410	101,950				68,307	7,137	26,507
Tons								
Estimated bulk density (tons/cy)	1.5	0.555						
Total estimated tons	24,615	56,582				37,910	3,961	14,711
Total estimated tons, cover + waste	81,197							

TABLE 5-4
BAINBRIDGE ISLAND LANDFILL FS
Consolidation and Containment
Estimated Final Cover System Material Quantities

Material Description	Estimated Quantity
Armor layer	
6-inch prepared subgrade	3,000 cy
18-inch subgrade	9,000 cy
Geosynthetic clay liner	18,000 sy
Geomembrane (40 mil LLDPE)	18,000 sy
18-inch sand drainage layer (washed and graded sand)	9,000 cy
Strip drains (optional)	3,750 lf
Geotextile (optional)	18,000 sy
12-inch vegetated topsoil	6,000 cy

Notes:

cy = cubic yards
sy = square yards
lf = linear feet

TABLE 5-5
BAINBRIDGE ISLAND LANDFILL FS
Consolidation and Containment
Estimated Surface Water Control Facilities Quantities

Material Description	Estimated Quantity
Lined detention pond (volume = 23,000 cf; area = 5,100 sf)	1 (lump sum item)
Roadside/general purpose ditches	1,200 lf
Asphalt lined ditch	450 lf
24-inch diameter culvert	30 lf
12-inch diameter culvert	30 lf
16-inch diameter PE pipe	250 lf
Energy dissipater	1 (lump sum item)

Notes:

cf = cubic feet
sf = square feet
lf = linear feet

TABLE 5-6
BAINBRIDGE ISLAND LANDFILL FS
Outcome of Remedial Technology Screening

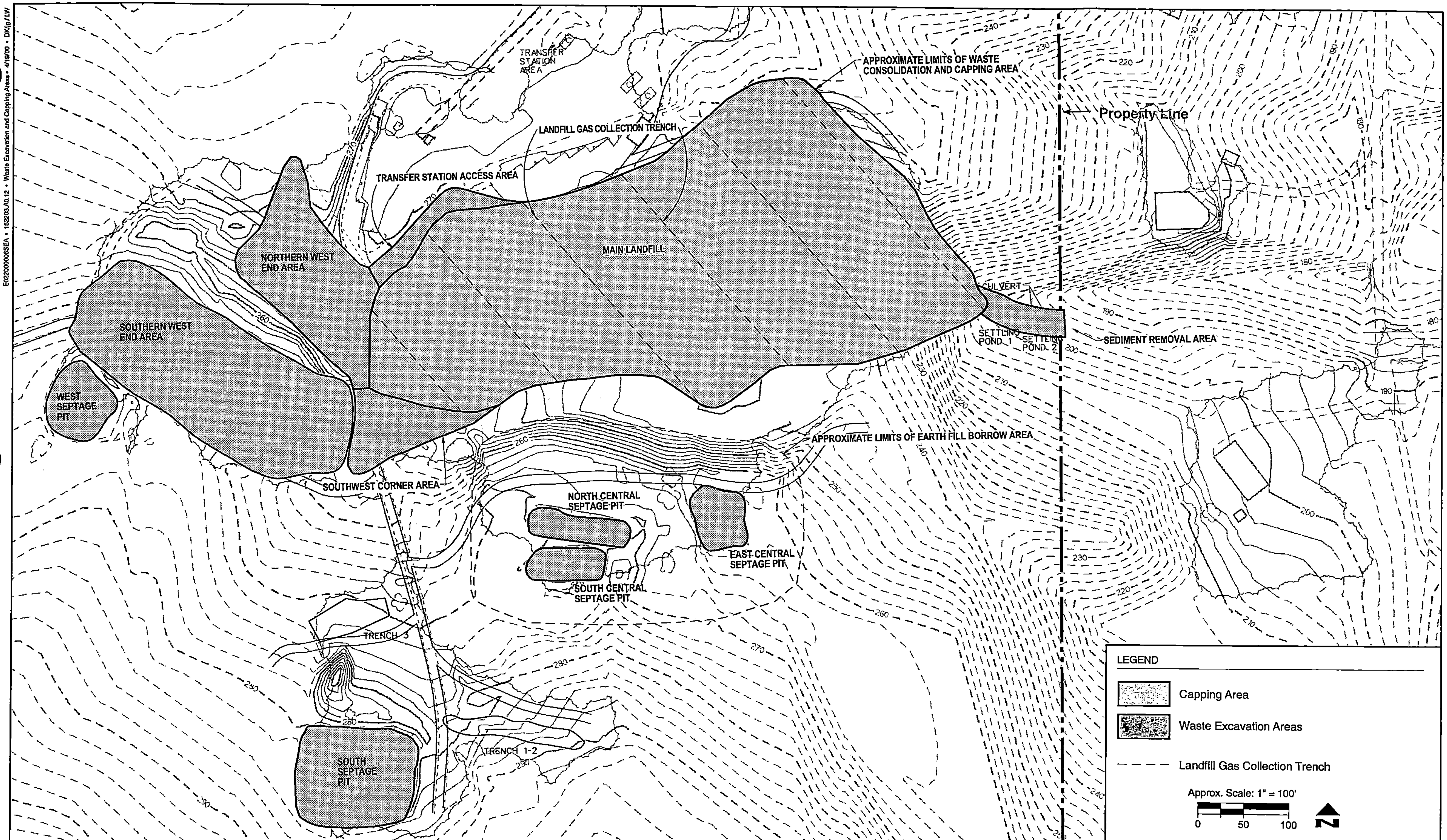
Technology	Effectiveness	Implementability	Cost	Screening Outcome
Waste Consolidation and Containment				
Barrier Layers				
60 mil HDPE	Would provide an essentially impermeable cap over the refuse; HDPE is highly resistant to weathering	Construction has been demonstrated on numerous landfills; field seaming of material requires a high level of QA/QC; stable on steeper slopes	Installed costs are somewhat higher (about $5.00/sy) than for LLDPE and PVC	Not Retained
40 mil LLDPE	Would provide an essentially impermeable cap over the refuse; material is highly resistant to weathering	Construction has been demonstrated on some landfills; field seaming of material requires a high level of QA/QC; stable on steeper slopes	Installed costs are somewhat lower (about $3.30/sy) than for HDPE	Retained as the upper component of a composite barrier layer
40 mil PVC	Would provide an essentially impermeable cap over the refuse; material is somewhat resistant to weathering if plasticizers are stable	Construction has been demonstrated on numerous landfills; field seaming of material requires a high level of QA/QC; might not be stable on steeper slopes	Installed costs are somewhat lower (about $3.70/sy) than for HDPE	Not Retained
GCL	Would provide an impervious (not impermeable) lower component as backup for a composite barrier layer	Construction and use as the lower component of a composite barrier layer has been demonstrated on landfills in western Washington; field seaming is not required and only a moderate level of QA/QC is required	Installed costs add about $4.50/sy to the total cost for barrier layer construction	Retained as the lower component of a composite barrier layer
Landfill Gas Control				
Passive Venting System	Would allow existing gas venting to continue	Easy to construct, operate, and maintain	Low construction and O&M costs	Retained
Active Extraction System	Would enhance removal of landfill gas from the landfill	Easy to construct; difficult to operate and maintain	Moderate construction costs; high O&M costs	Not Retained

TABLE 5-6
BAINBRIDGE ISLAND LANDFILL FS
Outcome of Remedial Technology Screening

Technology	Effectiveness	Implementability	Cost	Screening Outcome
Waste Reclamation				
Offsite Disposal (Bulky and Garbage Fractions)	Would permanently remove these materials from the site and prevent them from releasing contaminants	Proven technology and standard commercial practice	Moderate	Retained
Composting (Garbage Fraction)	Estimated to be 95 percent effective in removing decomposable materials; unknown effectiveness at destroying contaminants; not effective on organic contaminants	Proven technology, but some uncertainty in time required	Moderate, but small volume treated yields negligible benefit	Not Retained
Soil Washing (Inert Material)	Variable, depending on soil's ability to adsorb contaminants, contaminant mobility, amount of clay and silt	Extensive pre-testing, and substantial administrative work required; contaminated residuals must be treated or disposed	High	Not Retained
Bioremediation (Inert Material)	Low effectiveness, due to heterogeneous mixture of many different contaminants	Expected to be low, due to low levels of contaminants	High	Not Retained
Capping (Inert Material)	At least as effective as waste consolidation and capping option; reduces cap settlement risk	Commonly-used technology, easily implementable	Impermeable cap: moderate Permeable soil cap: low	Retained
Groundwater				
Pump and Air Strip with Discharge to Atmosphere	Very little full-scale operations data to support the effectiveness to achieve the cleanup level of 0.023 µg/L of vinyl chloride	Construction and operation has been demonstrated at many sites; would require groundwater right/beneficial use permit, air discharge permit and groundwater or surface water discharge permit; discharge water must meet groundwater or surface water standards	Very high capital cost. High operating and maintenance costs	Not retained
Aerobic Biological Stimulation	Very little full-scale operations data to support the effectiveness to achieve the cleanup level of 0.023 µg/L of vinyl chloride	Construction and operation has been demonstrated at many sites; adds chemicals to the groundwater, thus additional permitting and monitoring would be required	Moderate capital costs. Moderate to high operating and maintenance costs	Not retained

TABLE 5-6
BAINBRIDGE ISLAND LANDFILL FS
Outcome of Remedial Technology Screening

Technology	Effectiveness	Implementability	Cost	Screening Outcome
Air Sparging	Very little full-scale operations data to support the effectiveness to achieve the cleanup level of 0.023 µg/L of vinyl chloride	Construction and operation has been demonstrated at many sites; would require air discharge permit if SVE were used	Moderate capital, operating, and maintenance costs	Not retained
In-Well Stripping	Very little full-scale operations data to support the effectiveness to achieve the cleanup level of 0.023 µg/L of vinyl chloride	Construction and operation has been demonstrated at many sites; would require air discharge permit if vapor discharged to atmosphere	Moderate capital, operating, and maintenance costs	Not retained
Monitored Natural Attenuation	Data collected to date indicate natural attenuation is effective in stabilizing the VOC plume; coupled with source control, MNA will most likely achieve cleanup levels	Easily implemented because no additional action is required	Low cost; monitoring costs are included in other remediation components	Retained



Note: Outlines of waste excavation areas, waste areas, and transfer station are approximate.

Figure 5-1
Waste Excavation and Capping Areas, Consolidation Containment Option
Bainbridge Island Landfill FS

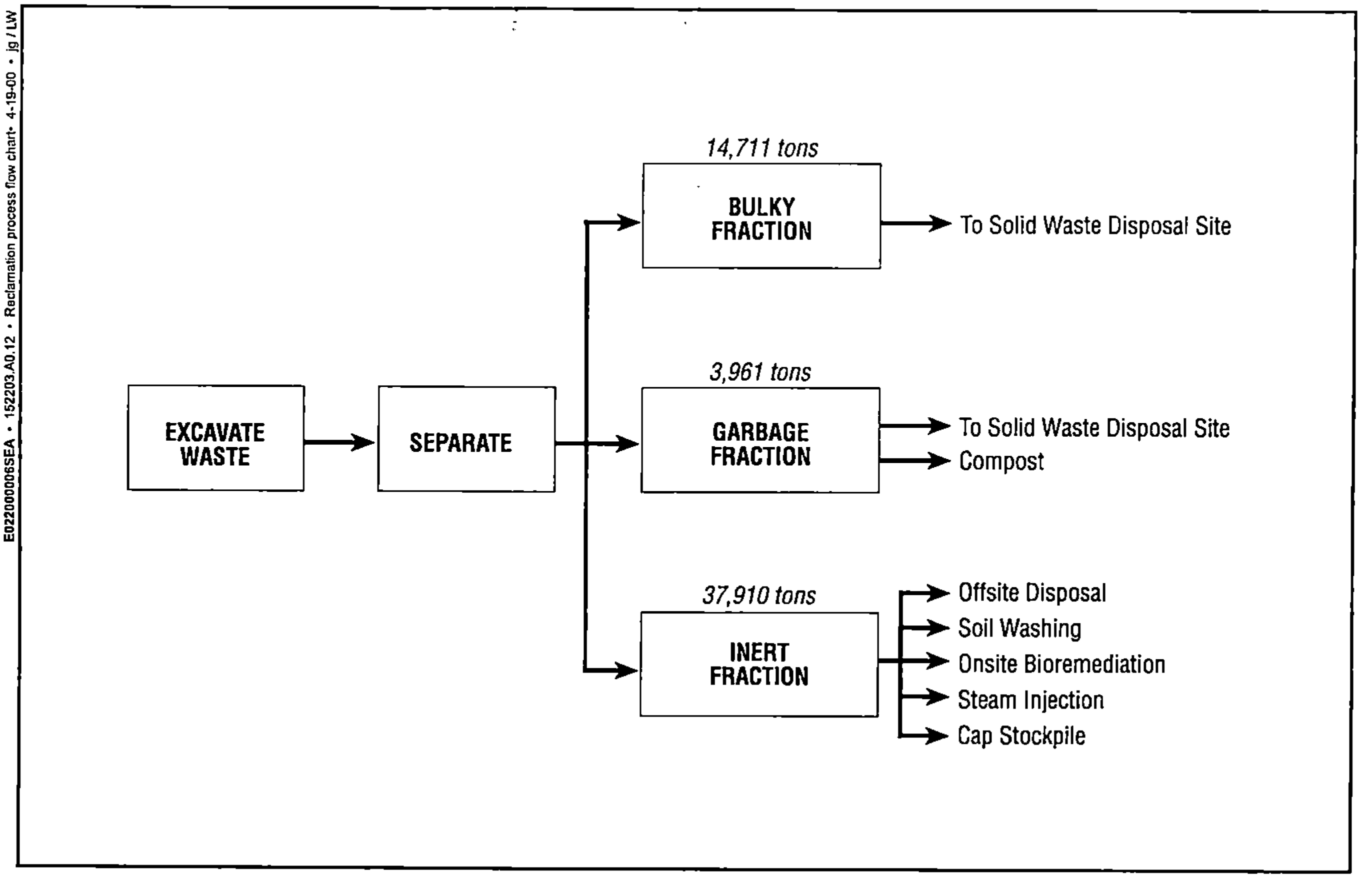
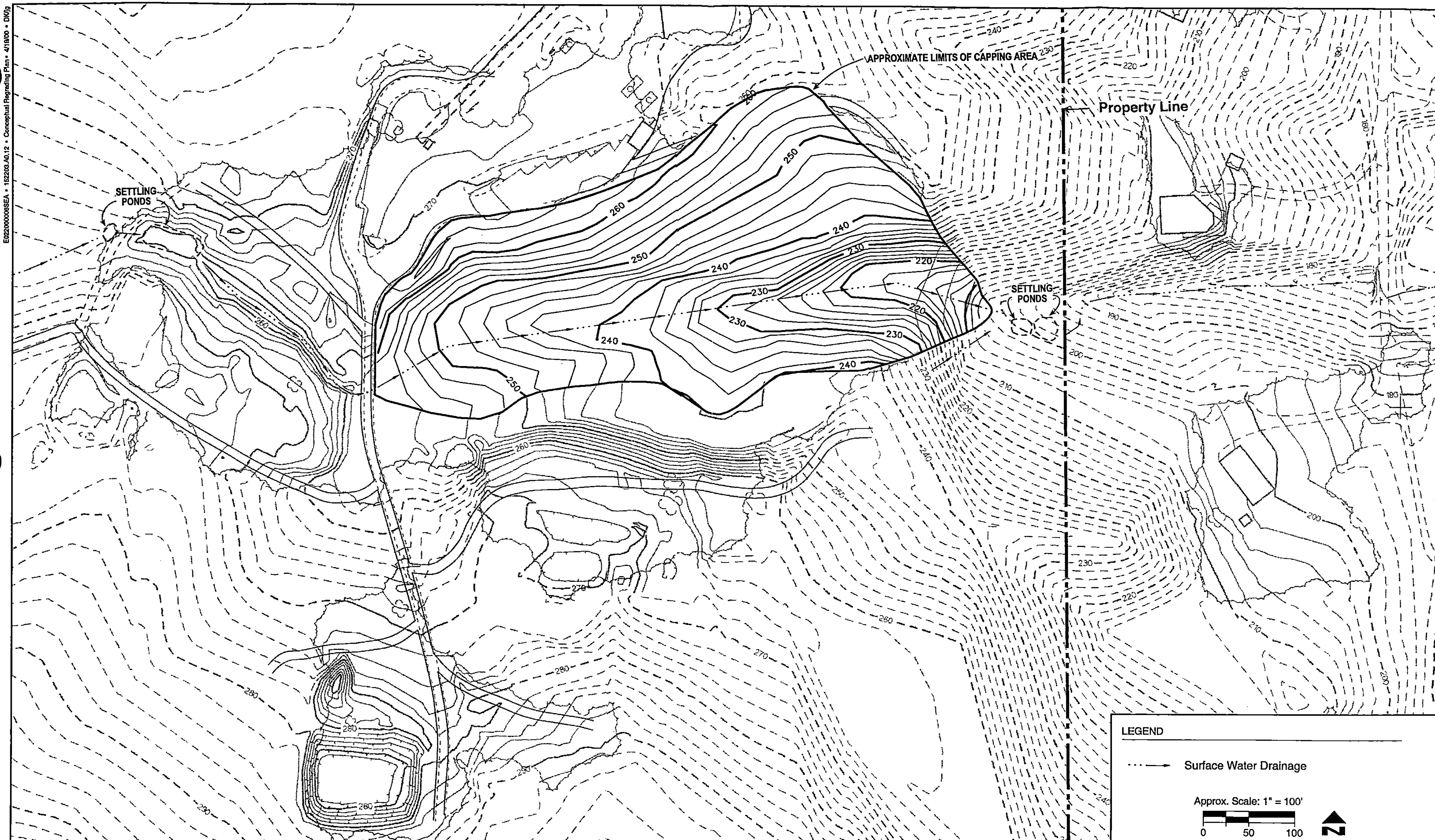


Figure 5-2

Reclamation Process Flow Chart

Bainbridge Island Landfill FS

E02000006SEA • 152203.A0.12 • Conceptual Regrading Plan • 4/18/00 • DK/jg



Note: Outlines of waste areas and transfer station are approximate.

Figure 5-3

Conceptual Regrading Plan, Reclamation Option

Bainbridge Island Landfill FS

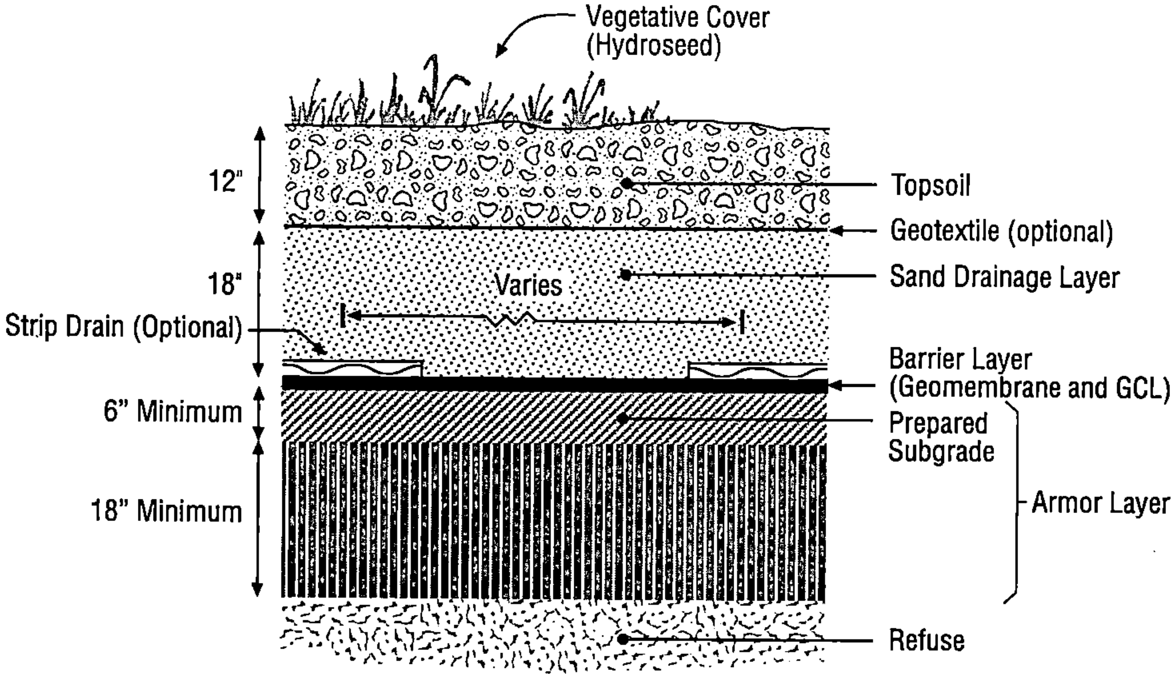


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Figure 5-4

Impermeable Final Cover System Section

Bainbridge Island Landfill FS

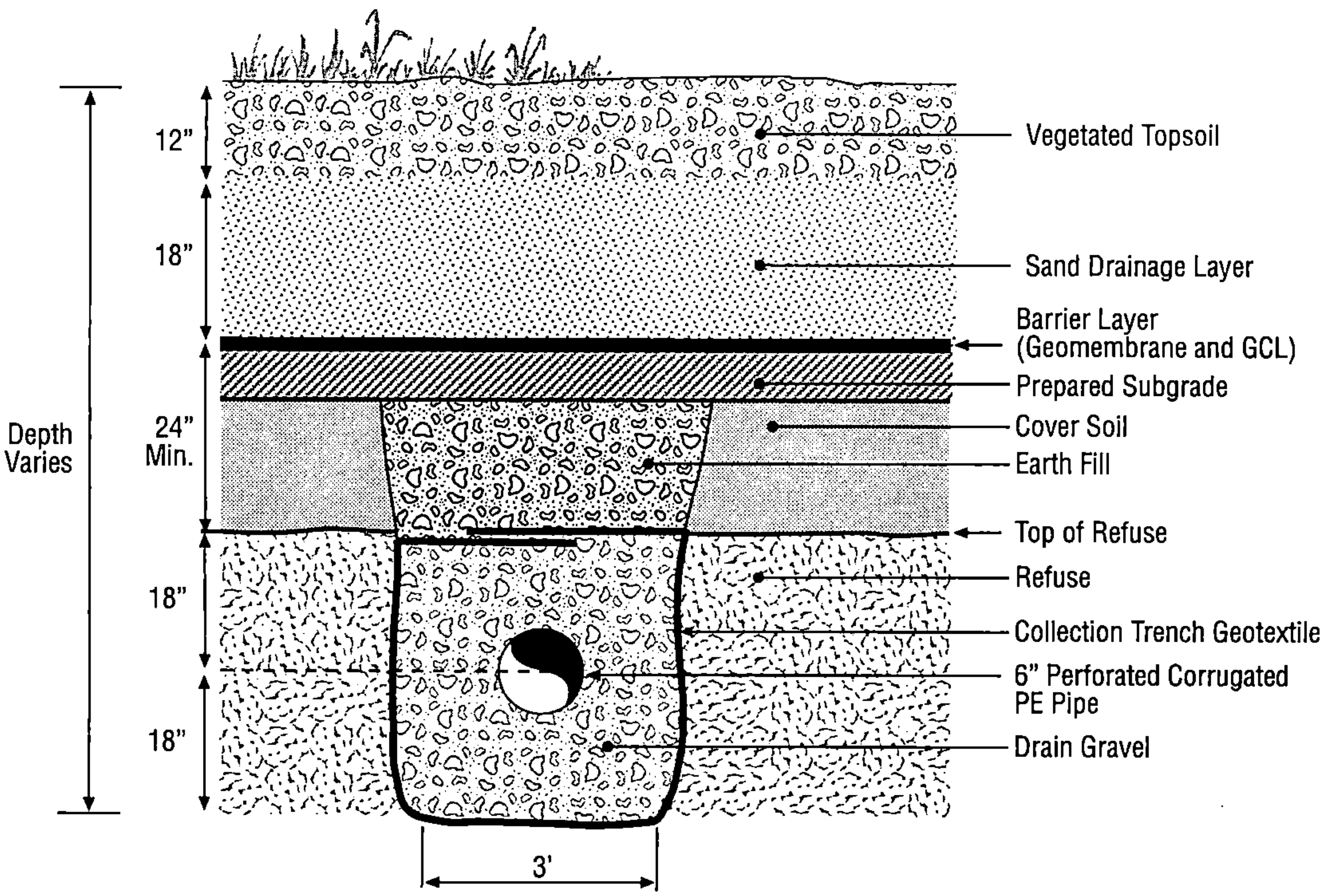

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Figure 5-5

Landfill Gas Collection Trench Section

Bainbridge Island Landfill FS

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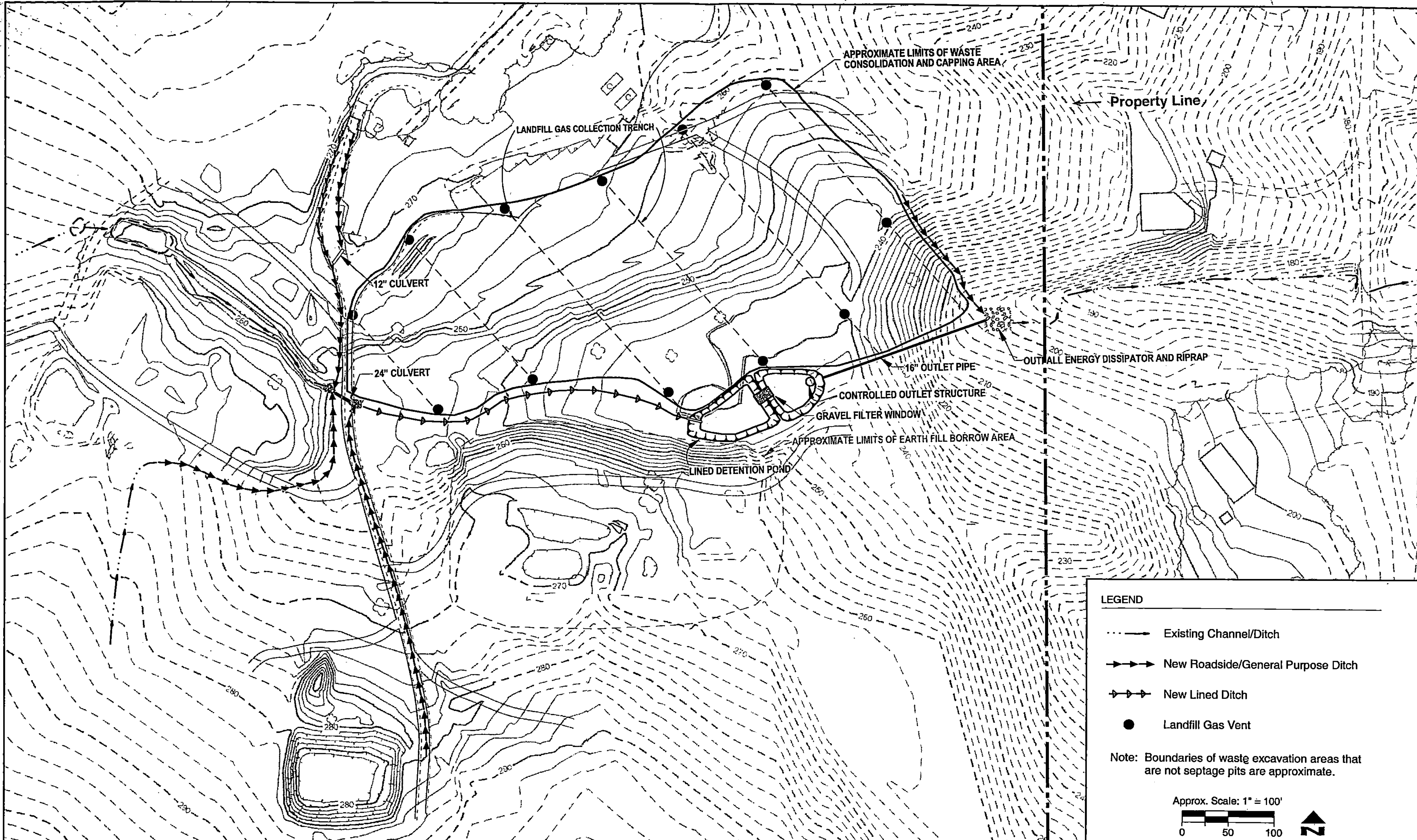

Note: Outlines of waste areas and transfer station are approximate.

Figure 5-6

Surface Water and Landfill Gas Control Facilities, Consolidation and Containment Option

Bainbridge Island Landfill FS

CHAPTER 6

Evaluation of Remedial Action Alternatives

The goal of this feasibility study is to identify a preferred remedial action alternative that meets MTCA requirements and site-specific remedial action objectives. This chapter combines the technologies that were evaluated and retained in Chapter 5 into remedial alternatives that could be implemented at the Bainbridge Island Landfill site. The alternatives are then evaluated against a set of evaluation criteria based on MTCA requirements and site-specific remedial action objectives. Remedial action objectives are specific goals for protecting human health and the environment that also define a framework for developing and evaluating remedial actions. Evaluating each alternative against an objective set of criteria is an effective way to compare alternatives. The comparative evaluation is the last step toward identifying a preferred remedial action alternative.

6.1 Development of Remedial Action Alternatives

The technologies that were retained for further consideration are combined into cleanup action alternatives and carried forward to a more detailed evaluation. Three cleanup action alternatives were selected for more detailed evaluation using MTCA criteria and are briefly summarized below. Details of the individual technologies are provided in Chapter 5.

Alternative 1—Waste Consolidation and Containment with Monitoring, Institutional Controls, and Monitored Natural Attenuation of Groundwater.

This alternative includes the following technologies:

- Excavating waste, sediment, septage pit residue, and soil, and consolidating them on the main landfill
- Filling excavated areas, regrading, and reseeding the site
- Installing a five-layer cap with a 40-mil LLDPE barrier layer
- Installing a passive landfill gas venting system
- Installing a surface water diversion and detention system
- Monitoring natural attenuation in groundwater
- Monitoring surface water and landfill gas for compliance with cleanup levels
- Establishing institutional controls including installation of fencing to control access to the site, and deed restrictions to protect the final cover system

Surface water control facilities would include: general ditches upstream from the landfill and around the final cover area; a lined ditch along the south side of the main landfill; a detention pond on the southeast side of the main landfill; a controlled outlet and discharge pipe from the detention pond; and a riprap/energy dissipater at the outlet of the discharge pipe. Monitoring of groundwater, surface water, subsurface landfill gas, and landfill gas vent emissions would include contingencies for conversion to active landfill gas extraction and active groundwater remediation if cleanup levels are not met.

Alternative 2—Waste Reclamation with a Soil Cap, Monitoring, Institutional Controls, and Monitored Natural Attenuation of Groundwater.

This alternative includes the following technologies:

- Excavating all waste, screening main landfill and west end area waste, and regrading the site with the inert waste fraction (including landfill cover soil outside hotspot area)
- Offsite disposal of bulky fraction
- Offsite disposal of garbage fraction
- Offsite disposal of septage pit waste, sediment, and main landfill cover soil hotspot
- Constructing a 2-foot-thick, site-derived soil cap on the inert fraction
- Restoring the site drainage and re-establishing site vegetation
- Monitoring natural attenuation in groundwater
- Monitoring surface water for compliance with cleanup levels
- Establishing institutional controls, including installation of fencing to control access, zoning, and deed restrictions

Included in the compliance monitoring plan would be a contingency to install active groundwater remediation if cleanup levels are not met with monitored natural attenuation.

Alternative 3—Waste Reclamation with an Impermeable Cap, Monitoring, Institutional Controls, and Monitored Natural Attenuation of Groundwater.

This alternative would be the same as Alternative 2 except that the cap over the inert materials would consist of a combination soil and impermeable geomembrane layer. Because the regrading would restore the drainage alignment to the east-west axis of the landfill area, the stormwater diversion requirements of Alternative 1 would not be necessary. Institutional controls including installation of fencing to control access and execution of deed restrictions to protect the final cover system would also be included with this alternative.

6.2 Evaluation Criteria

Evaluation criteria are used to objectively evaluate how effective each of the three remedial action alternatives is in cleaning up the site. Remedial action objectives also are useful in determining how to measure each of the alternatives against the criteria.

6.2.1 Remedial Action Objectives

Remedial action objectives (RAOs) are site-specific goals for protecting human health and the environment that also define a framework for developing and evaluating remedial action alternatives. In Chapter 3, a set of cleanup levels was developed through an ARARs analysis and by comparing the most stringent ARAR to analytical results obtained from the various waste sources and environmental media at the site. The comparison resulted in a list of COCs and a cleanup level for each COC in each environmental medium that is affected (Table 3-5).

The primary remedial objective is to meet the MTCA cleanup requirements, which are partly defined by the cleanup levels and points of compliance. The following RAOs have been identified based on the nature and extent of contamination defined by the remedial investigation:

- Protect the use of the upper aquifer as a drinking water source
- Prevent or minimize future releases of COCs from the waste sources to surface water and direct contact with humans or wildlife
- Reduce concentrations of COCs in soil, surface water, sediment, and groundwater to acceptable and appropriate cleanup levels
- Maximize permanence of the remedial action

6.2.2 MTCA Threshold Requirements

In WAC 173-340-360, MTCA establishes threshold criteria that any selected remedial action must meet. These threshold requirements include the following:

- Protectiveness of human health and the environment
- Compliance with cleanup standards
- Compliance with ARARs applicable to all remedial alternatives under consideration
- Provision for compliance monitoring

Chapter 3 discusses the chemical-, action- and location-specific ARARs for the site and presents cleanup levels for contaminants of concern by media. To meet the provision for compliance monitoring, the final remedial action would include developing a compliance monitoring plan that demonstrates the effectiveness of the remedial action at meeting remedial action goals.

6.2.3 Other MTCA Requirements

Other requirements for cleanup actions include the use of permanent solutions to the maximum extent practicable, provision for a reasonable restoration time frame, the use of MTCA-preferred technologies, and consideration of public concerns raised during public review of the draft cleanup action plan [WAC 173-340-360(3)(c)].

Criteria Regarding Maximum Use of Permanent Solutions

The use of permanent solutions to the maximum extent practicable is determined according to the following seven criteria:

1. **Overall protectiveness of human health and the environment.** This criterion addresses the degree to which existing risks are reduced and any onsite or offsite risks that may result from implementing the alternative. It also addresses the time required to reduce risk at the site and meet cleanup standards, the degree to which the cleanup action may exceed cleanup standards, and the improvement of overall environmental quality.

2. **Long-term effectiveness.** This criterion addresses the degree of certainty that the alternative will be successful, its long-term reliability, the magnitude of residual risk, and the effectiveness of any controls required to manage treatment residues or remaining wastes.

3. **Short-term effectiveness.** This criterion addresses the protection of human health and the environment during construction and implementation of the alternative, as well as the degree of risk to human health and the environment prior to attainment of cleanup standards.

4. **Permanent reduction in toxicity, mobility, and volume of hazardous substances.** This criterion addresses the adequacy of the alternative in destroying the hazardous substances, the reduction or elimination of hazardous substance releases and sources of releases, the degree of irreversibility of the waste treatment process, and the characteristics and quantity of treatment residuals generated.

5. **Ability to be implemented.** This criterion addresses the technical feasibility of the alternative; the availability of necessary offsite facilities, services, and materials; the administrative and regulatory requirements; scheduling; size; complexity; monitoring requirements; access for construction; operations and monitoring; and integration with existing facility operations and other current or potential remedial actions.

6. **Cleanup costs.** This criterion addresses the cost of an alternative in light of the degree of protection it would provide. A cleanup action is not considered practicable if the incremental cost of the action is substantial and disproportionate to the incremental degree of protection it would achieve over a lower-preference cleanup action. If two or more cleanup action alternatives have an equivalent technology preference, the lower cost alternative may be preferred.

7. **Degree to which community concerns are addressed.** This criterion addresses community concerns, which are aired during the public review and comment periods specified in MTCA. The public involvement process is outlined in the *Bainbridge Island Public Participation Plan* (Bainbridge Island Public Information Coordinating Group, 1995).

During evaluation of the cleanup action alternatives, all of the criteria for permanence were considered except for the degree to which community concerns would be addressed. Community concerns will be addressed as part of the public participation process that includes public review and comment on the RI and FS reports and on the Draft Cleanup Action Plan.

Criteria Regarding a Reasonable Restoration Time Frame

Factors that are typically considered in establishing a reasonable restoration time frame include the following:

- Potential risks posed by the site to human health and the environment
- Practicability of achieving a shorter restoration time frame
- Current and potential future uses of the site, surrounding areas, and associated resources that are or 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 the hazardous substances at the site
- Natural processes that reduce concentrations of hazardous substances and have been documented to occur at the site or under similar site conditions

These factors for providing a reasonable restoration time frame were incorporated into the various criteria selected for evaluation of the cleanup action alternatives in this FS.

Criteria Regarding the Use of MTCA-Preferred Technologies

MTCA specifies technology preferences for the cleanup of hazardous waste sites. These technologies are listed below by order of preference:

- Reuse or recycling
- Destruction or detoxification
- Separation or volume reduction followed by reuse, recycling, destruction, or detoxification of the residual hazardous substance
- Immobilization of hazardous substances
- Onsite or offsite disposal at an engineered facility designed to minimize the future release of hazardous substances and in accordance with ARARs
- Isolation or containment with attendant engineering controls
- Institutional controls and monitoring

MTCA generally requires the use of higher-preference technologies for site cleanup alternatives. However, MTCA also recognizes the need to use engineering controls such as containment for sites with large volumes of materials with relatively low levels of hazardous substances where treatment is impracticable (WAC 173-340-360(9)(c)). Since there is some opportunity to use higher-preference technologies for site cleanup, the "degree to which recycling/reuse/waste minimization are used" was included in this FS as a criterion for evaluation of cleanup action alternatives.

Criteria Used for the Bainbridge Island Landfill Site

On the basis of the discussions above, the following criteria were used to evaluate alternatives for cleanup at the Bainbridge Island Landfill site:

- Overall protectiveness of human health and the environment
- Attainment of cleanup levels and compliance with ARARs
- Short-term effectiveness
- Long-term effectiveness
- Reduction in toxicity/mobility/volume through treatment
- Implementability
- Cost
- Community concerns
- Degree to which recycling/reuse/waste minimization are used

With the exception of community concerns, each of the proposed cleanup alternatives is evaluated below in terms of each of the criteria. Community concerns will be addressed during public review of the RI and FS reports and the Draft Cleanup Action Plan.

6.3 Evaluation of Alternatives

6.3.1 Alternative 1—Waste Consolidation and Containment

Overall Protectiveness of Human Health and the Environment

This alternative would reduce risk to human health and the environment by eliminating the potential for direct contact with wastes and by eliminating or reducing groundwater and surface water contamination. Existing septage pits and some areas of municipal solid waste contain wastes that are exposed at the ground surface or are poorly covered with soil. Consolidation of these wastes would increase the area of the site for future uses. Capping of these wastes would eliminate the potential for direct contact.

Placing a final cover system over the waste would eliminate or substantially reduce infiltration of precipitation into the waste and the resulting production of leachate. Routing surface water around the consolidated waste pile would eliminate leachate generated by infiltrating surface water flowing onto the main landfill. By eliminating or substantially reducing leachate generation, contaminant flow into groundwater and surface water and potential risk of exposure to these media would be correspondingly eliminated or reduced. The potential for subsurface migration of landfill gas would be eliminated by installing a passive gas collection and venting system. Monitoring of the various site media, the final cover system, and other cleanup elements would verify decreased site risks and provide for ongoing maintenance of cleanup facilities. Institutional controls would decrease site risks by preventing unauthorized access to the site and by preventing future site development that could decrease the effectiveness of the final cover system and other cleanup elements.

Attainment of Cleanup Levels and Compliance with ARARs

Subsurface landfill gas concentrations and ambient air emissions do not currently exceed cleanup levels at the site and would not increase as a result of this alternative. Controlled landfill gas venting would greatly reduce or eliminate any release of COCs to groundwater.

Releases of leachate to surface water would be eliminated by this alternative, and leachate-related COCs would therefore be removed from surface water. Although there could be some short-term increases in turbidity during and immediately following construction, these would be eliminated or significantly reduced as revegetation of the site occurs following construction. The revegetation process would be completed within 2 to 3 years, after which surface water cleanup levels would be attained.

The final cover system would eliminate or substantially reduce leachate flows into groundwater and would reduce leachate-related COC concentrations in groundwater. RI results show that significant decreases in COC concentrations in groundwater are currently occurring as a result of natural attenuation in the groundwater flow system. Although offsite COC concentrations do not currently exceed drinking water standards, some COC concentrations exceed cleanup levels. This alternative would maintain offsite COC concentrations in groundwater below drinking water standards and should eventually reduce leachate-related COC concentrations below cleanup levels both onsite and offsite. Because the cleanup levels for some COCs are very low, the time frame for attaining cleanup levels in offsite groundwater is unknown.

Short-Term Effectiveness

Alternative 1 would be immediately effective in eliminating the risk from direct exposure to wastes, increasing the site area available for future uses, and eliminating leachate releases to surface water. Immediately following construction of the final cover system, Alternative 1 would greatly reduce leachate releases to groundwater resulting from continued infiltration of precipitation into the waste. Some dewatering of the waste pile might occur for a short time following construction of the final cover system. After dewatering of the waste pile has stopped, Alternative 1 would eliminate or significantly reduce leachate and landfill gas releases to groundwater.

The only potential short-term impact that has been identified for Alternative 1 would be an increase in turbidity in surface water during and immediately following construction. This short-term impact would decrease as revegetation of the site occurs following construction and would be eliminated in approximately 2 to 3 years.

Long-Term Effectiveness

Alternative 1 would provide long-term effectiveness by continuing to prevent direct contact with wastes, maintaining an increased site area available for future uses, eliminating leachate releases to surface water, and eliminating or substantially reducing leachate and landfill gas releases to groundwater. However, contaminants in the vadose zone will continue to be released to groundwater slowly by downward infiltration and capillary action. Access controls such as fencing would be effective in preventing damage to cleanup facilities from trespassers. Deed restrictions would provide long-term effectiveness by preventing damage to cleanup facilities as a result of future site development. By eliminating leachate releases to groundwater, Alternative 1 would decrease the time for COC concentrations in groundwater to meet cleanup levels over no action.

Long-term effectiveness would be verified by implementing a compliance monitoring plan. The monitoring plan would include sampling and testing of subsurface landfill gas, landfill gas vent emissions, surface water, and groundwater. Sampling and testing results would be evaluated quarterly for the first 5 years after construction is completed. After completion of this initial 5-year monitoring period, monitoring and reporting of results would continue annually and every 5 years in accordance with MTCA requirements. The monitoring program would also include regular inspections of the final cover system and other cleanup facilities. The results of inspections would be used to provide long-term maintenance of site cleanup facilities.

Reduction in Toxicity/Mobility/Volume Through Treatment

This alternative would not permanently reduce the toxicity or volume of hazardous substances at the site. The final cover system would reduce the mobility of hazardous substances from the waste sources into soil, surface water, and groundwater and would prevent increased subsurface migration of landfill gas.

Implementability

Alternative 1 could be readily implemented. It would be necessary to prepare detailed plans and specifications and to obtain approval of the final cover system and surface water control system from agencies of jurisdiction. A high level of quality assurance/quality control would be required while installing the final cover system to verify that the composite barrier layer is placed, seamed, and covered and that other cover system components meet material specifications. Access controls, deed restrictions, and the compliance monitoring program would all be readily implementable.

Cost

The estimated construction cost in current (2000) dollars for Alternative 1 would be $1,480,000 (see Appendix E). The estimated long-term (30-year) operation and maintenance cost for Alternative 1 would be $873,000 (Appendix E). These costs are order-of-magnitude estimates that could vary significantly, depending on actual labor and material costs, competitive market conditions, and other variable factors.

Degree to Which Recycling/Reuse/Waste Minimization Are Used

Alternative 1 would not provide opportunities for recycling, reuse, or waste minimization.

6.3.2 Alternative 2—Waste Reclamation with Permeable Soil Cap

Overall Protectiveness of Human Health and the Environment

The waste reclamation option would remove a large fraction of the contaminant source and place it in disposal sites that meet current disposal site lining standards. This would reduce the risk of contaminant migration from the landfill site. Removing the decomposable waste materials would reduce or eliminate the production of landfill gas at the site, and would reduce the risks associated with gas migration.

Constructing a permeable soil cover over the inert materials that remain in the landfill would provide somewhat less protection than Alternatives 1 and 3. COCs were found in samples of the inert fraction during the RI, but their numbers and concentrations were lower than in both bulk waste and garbage fraction samples. Final COC concentrations in the inert materials would be determined by sampling just prior to regrading, but are expected to be less than or equal to those found in the RI. Constructing the reclamation alternative with a permeable soil cap would require using institutional controls to protect human health.

As discussed in Chapter 5 and the RI Report, Fate and Transport, a permeable cover on the inert waste material would still be protective of groundwater because the COCs are not mobile. A permeable cover will allow aerobic biological activity that may enhance the destruction of residual organic contaminants in the inert fraction and the vadose zone. Therefore, reclamation with a permeable cover will be more protective of groundwater than consolidation and containment in the long run because source contaminants are both removed and destroyed.

Surface water design elements, engineering, and monitoring are needed to prevent surface water contact with contaminants.

Attainment of Cleanup Levels and Compliance with ARARs

This would be the same as Alternative 1 for ambient air emissions and subsurface landfill gas emissions, because these ARARs and cleanup levels have already been met. The effects on leachate and surface water would be the same as Alternative 1.

Alternative 2 may require more time than Alternative 1 to achieve cleanup levels at the point of compliance to protect human health and the environment. The proposed permeable soil cap would allow water and oxygen to continue to infiltrate into the soil below the inert materials. It also may allow a small amount of residual contaminants to be leached from the inert materials into the underlying soil. However, this flushing and leaching also should promote the natural biodegradation of organic contaminants in the inert materials. Soil amendments mixed with the inert fraction to promote the growth of plants and soil-like microbial populations should eventually help convert the inert fraction to a composted soil. Evaluation of COC levels in the inert fraction, determined by sampling after a restoration time period that allows physical and biodegradation of contaminants, may be included in the compliance monitoring plan.

Alternative 2 may be more effective than Alternative 1 in reducing and maintaining groundwater contaminant levels below cleanup levels by removing the decomposable materials. The anaerobic biodegradation of organic materials in landfills produces acids that may cause contaminants to be mobilized more readily than in a neutral environment. Also, a significant part of the total contaminant load in the landfill would be removed in Alternative 2, further decreasing the likelihood that cleanup levels could be exceeded.

Short-Term Effectiveness

Excavating and processing the waste may create a risk of contaminant release to the air, and may create dust and odors. These risks can be mitigated by measures found effective in other landfill reclamation projects, including dust suppressants and watering, and promptly covering excavated waste materials after excavation and processing. The potential for short-term turbidity in downstream surface waters during construction may be slightly greater than Alternative 1, because a greater area of waste materials would be exposed at the surface.

Long-Term Effectiveness

The long-term effectiveness would be better than in Alternative 1 because reclamation would permanently remove the source of COCs in groundwater. Removing the decomposable materials would decrease the potential for contaminant mobilization, because leachate and landfill gas generation would be eliminated.

Long-term effectiveness would be verified by implementing a compliance monitoring plan for soil, surface water, and groundwater. The surface water monitoring program would likely be of a shorter duration than for Alternative 1. Sampling and testing results would be evaluated quarterly, annually, and every 5 years in accordance with MTCA requirements. The monitoring program would also include regular inspections of the cap, the onsite drainage system, and other site facilities. The results of inspections would be used to provide long-term maintenance of site facilities.

It is possible that, through removal of the majority of contaminant sources and ongoing natural attenuation in soil and groundwater, this alternative could result in the permanent long-term attainment of cleanup levels at all points of compliance. The substantial risk reductions and the protection of the drinking water aquifer (the primary remedial action objective) makes the long-term effectiveness of Alternative 2 potentially the highest of the three alternatives.

Reduction in Toxicity/Mobility/Volume Through Treatment

This alternative would reduce the amount of hazardous contaminants onsite by removing approximately one-third of the landfill mass from the site. The material removed also contains the greatest number and highest concentrations of COCs. The mobility of contaminants may also be decreased because of the removal of decomposable organics in the garbage materials, as discussed previously. It is possible that this alternative could reduce all contaminants in the soil, sediment, surface water, and groundwater to cleanup levels at all points of compliance.

Implementability

As noted in Chapter 4, excavation and processing of waste has been documented in 17 landfills in North America, and EPA and other agencies have published studies of the feasibility and economics of landfill reclamation. Excavating and processing waste from the landfill do not require unusual technology. The materials that would be disposed at offsite commercial waste disposal facilities are not significantly different from the materials normally handled by those facilities.

However, landfill reclamation is not a common practice, and difficulties should be anticipated that would add more uncertainty to the costs and schedule for this alternative than for Alternative 1. For example, machinery wear may be greater than anticipated, and production rates may be slower than anticipated because of limited experience with the materials to be excavated from the landfill.

Implementability of soil cover construction over the inert materials would be somewhat better than Alternative 1. The soil-only cap is simpler and there would be less uncertainty because of the decreased potential for differential settlement to cause cap damage.

Cost

The estimated construction cost in current (2000) dollars for Alternative 2 would be $3,502,000 (see Appendix E). This estimated total cost includes $2,200,000 for excavation and processing of the landfill material and replacement of the inert fraction; $1,200,000 for offsite disposal of separated garbage and bulky materials; and $102,000 for cap construction on the inert material. Onsite composting of separated garbage materials would add approximately $440,000 to the total amount. The estimated long-term (30-year) operation and maintenance cost in current (2000) dollars for Alternative 2 would be$705,000 (Appendix E). The long-term costs are lower than those for Alternative 1, but only marginally because the majority of the long-term costs are for groundwater monitoring, which we assume would continue. Long-term costs would be lower if groundwater monitoring requirements can be reduced for the reclamation alternative. These costs are order-of-magnitude estimates that could vary significantly, depending on actual labor and material costs, competitive market conditions, and other variable factors.

Degree to Which Recycling/Reuse/Waste Minimization Are Used

To the extent that reusing inert materials to regrade the site can be considered reuse of waste materials, approximately 81,200 tons of material would be reused in this alternative. Also, if the composting option is used for treatment of the garbage fraction, then another 5,700 tons would be recycled. The compost material could be used beneficially onsite to manufacture topsoil, which would aid in preventing site erosion.

6.3.3 Alternative 3—Waste Reclamation with Impermeable Cap

Overall Protectiveness of Human Health and the Environment

Removing a large fraction of the contaminant source would produce the same level of protectiveness as Alternative 2. Constructing an impermeable cap over the inert materials that remain in the landfill would produce a level of protectiveness similar to Alternative 1, and would provide further decreased risk because of the reduced risk of damage to the cover from settlement. Constructing an impermeable cap may be slightly more protective of human health and the environment than Alternative 2, because the inert fraction would be more isolated from the environment.

Attainment of Cleanup Levels and Compliance with ARARs

This would be the same as Alternative 2 for ambient air emissions, subsurface landfill gas emissions, and the effects on leachate and surface water. Alternative 3 may be more effective than Alternative 2 in achieving early groundwater cleanup levels because rainwater infiltration would be greatly reduced or eliminated relative to Alternative 2. It is possible that by removing the majority of contaminant sources and through ongoing natural attenuation in soil and groundwater, this alternative could permanently attain cleanup levels at all points of compliance.

Short-Term Effectiveness

Short-term effectiveness would be the same as Alternative 2.

Long-Term Effectiveness

The long-term effectiveness of Alternative 3 would be high because a large fraction of the contaminant source would be removed, as in Alternative 2, and the remaining inert material would be covered with an impermeable cap, as in Alternative 1. As with the other alternatives, the long-term effectiveness of Alternative 3 would be verified with a compliance monitoring plan for surface water and groundwater.

Reduction in Toxicity/Mobility/Volume Through Treatment

This would be the same as Alternative 2.

Implementability

Implementability of the reclamation process would be the same as Alternative 2. Implementability of cover cap construction over the inert materials would be the same as for Alternative 1, except that there would be less uncertainty because of the decreased potential for differential settlement to cause cap damage.

Cost

The estimated construction cost in current (2000) dollars for Alternative 3 would be $4,700,000 (see Appendix E). This estimated total cost includes $2,200,000 for excavation and processing of the landfill material, $1,200,000 for offsite disposal of separated garbage and bulky materials, and $1,300,000 for replacement, grading, and cap construction on the inert materials from the landfill. The cost estimate assumes a 60-mil HDPE geomembrane will comprise the impermeable layer. Onsite composting of separated garbage materials would add approximately $440,000 to the total amount. The estimated long-term (30-year) operation and maintenance cost in current (2000) dollars for Alternative 2 would be $705,000 (see Appendix E). The long-term costs are lower than those for Alternative 1, but only marginally because the majority of the long-term costs are for groundwater monitoring, which would continue. Long-term costs would be less than estimated if groundwater monitoring requirements can be reduced for the landfill reclamation alternative. These costs are order-of-magnitude estimates that could vary significantly, depending on actual labor and material costs, competitive market conditions, and other variable factors.

Degree to Which Recycling/Reuse/Waste Minimization Are Used

Recycling, reuse, and waste minimization would be the same as Alternative 2.

CHAPTER 7

Comparative Evaluation of Remedial Action Alternatives

This chapter takes the results of the all the evaluations and analyses completed in the preceding chapters and compares them in order to derive a recommended remedial action alternative. As described below, Kitsap County elected to use an analytical decision process to select the preferred remedial alternative.

7.1 Results of Comparison to MTCA Criteria

In Chapter 6, each alternative was evaluated relative to a set of criteria that was based on MTCA. The alternatives were evaluated against the MTCA threshold criteria of protecting human health and the environment, complying with cleanup standards and other ARARs, and providing for compliance monitoring. All three of the alternatives outlined in Chapter 6 were determined to meet these MTCA threshold criteria.

In addition, Chapter 6 also evaluated the alternatives against six other MTCA criteria:

- Short-term effectiveness
- Long-term effectiveness
- Reduction in toxicity/mobility/volume
- Implementability
- Cost
- Degree to which recycling/reuse/waste minimization are used

Alternatives were assessed either qualitatively or quantitatively against these six criteria. A seventh criterion, the degree to which each alternative addresses community concerns, was identified in Chapter 6. However, evaluation of the alternatives against this criterion was reserved for after the public review and comment period.

In order to compare the alternatives, each alternative was rated against the criteria using five ratings: low, medium-low, medium, medium-high, and high. A numerical value, or "score," was then assigned to each rating. A high score corresponded to the preferred outcome for each criterion, while a low score corresponded to the least preferred outcome. For example, a high rating for long-term effectiveness received a score of 5, and a low rating for cost also received a score of 5. This means that an alternative that is highly effective in the long term and is low in cost would score well on both counts. Table 7-1 compares the scores of the alternatives for the six other MTCA criteria.

As shown in Table 7-1, all three of the alternatives met most of the other criteria. The scores are similar, and no single alternative emerged as the clear choice. If all of the criteria have equal importance, then these total scores indicate that the alternatives are very close to one another at meeting the criteria. However, in order to select the preferred remedial alternative, the relative importance of decision criteria must be determined. For example, if cost is the most important criterion and all others were equal, Alternative 1 would be selected.

Because all three alternatives meet MTCA threshold criteria as well as most or all other MTCA criteria, Kitsap County developed an additional set of criteria to distinguish the preferred alternative. To assist in selecting the remedial alternative, Kitsap County elected to employ analytical decision tools that would include rating the relative importance of the decision criteria. The decision analysis process and steps are described below.

7.2 Selection of Preferred Alternative

Kitsap County selected the preferred remedial alternative by applying an analytic decision process called multiattribute utility analysis, or MUA. The MUA process was used by the decision team to select criteria, assign weights to these criteria, poll stakeholders, consider uncertainty, and ultimately select a preferred alternative. The subsections below briefly introduce the MUA process, present the decision criteria, and provide the scoring and results.

7.2.1 Decision Analysis Process

Two particular strengths of the MUA process are the ability to compare seemingly unlike criteria, such as cost and permanence, and to easily accommodate differing points of view in the modeling process. Because multiple stakeholders commonly have different opinions, the ability to see the impact of such differences on the decision is valuable.

The decision analysis process provides a logical way to organize, analyze, and document a decision problem. The first step is to develop a set of criteria to assist in deciding between the two alternatives. Next, the criteria are weighted. Weighting means comparing the criteria to one another and judging their relative importance. Weighting does not mean that some criteria are important and others are not; it simply means that all criteria are important (or they would not be part of the process), but some are relatively more important than others. Criteria weighting is what affects the impact of criteria on the final score. A large number of criteria, if all similarily weighted, may have the effect of diluting the influence of any single criterion. Conversely, a single criterion that is heavily weighted will dominate the outcome, regardless of the number of other criteria.

Next, performance measures are specified so that each alternative can be measured with regard to how well it meets a given criterion. For example, if cost is selected as a criterion, its score may be measured in dollars. Or, if habitat protection is important, it may be measured in terms of acres of habitat preserved. Sometimes, measurable ("natural") scales such as dollars and acres are not available for a criterion, or subjective scales are desired to expedite a decision. In such cases, "constructed" scales are developed. These are subjective scales that are later translated into a mathematical term. For example, if a company wants to select a new product to market from among three candidate products, the company, among other criteria, wants to anticipate market response. They may develop a scale that ranges from "loves it" to "everyone hates it." The verbal, subjective scale may be assigned values from zero to one hundred, or one to five. Later, the numerical rating may then be used in the analysis.

With weighted criteria and scales, all that is left is to score the performance of each is applied to produce an overall performance score for each alternative. The aggregate function essentially sums the individual scores while accounting for the criteria weighting.

The MUA decision process was applied to the Bainbridge Island Landfill project as shown in Figure 7-1. In the first step, the decision team began with the alternatives defined by previous work on the FS. To simplify the process, only two alternatives were evaluated: Alternative 1, consolidation and containment, and Alternative 2, reclamation with a permeable soil cover. Alternative 3, reclamation with an impervious cap, was not evaluated further because although it would provide many of the benefits of reclamation (such as toxicity and volume reduction), it would also have many of the same restrictions as consolidation and containment (such as greater land use restrictions) and is more expensive.

A decision team convened by Kitsap County met for a full-day workshop to identify criteria for the decision, develop performance measures, and assign weights to the criteria. The team was made up of project staff from Kitsap County Public Works, Prosecuting Attorney, and Risk Management offices, the Bremerton-Kitsap County Health District, Ecology, and CH2M HILL. The workshop was summarized and presented to the decision stewards (senior Kitsap County and Ecology staff), who approved its results. The criteria, measures, and weights were also shared with the public.

Next, the decision team met again and scored the two alternatives against the criteria. The model was examined for sensitivity to changes in scores and weights, and an uncertainty analysis was completed. The results were summarized for review by the decision stewards, who were asked for comments and concurrence on the results and the selection of the preferred remedial alternative. The following subsections provide more detail regarding the implementation of the decision process.

7.2.2 Decision Criteria, Performance Measures, and Weights

As stated above, the decision team met in a one-day workshop and developed seven criteria and assigned them weights. Given the basic condition that both alternatives satisfy the requirements of MTCA, the criteria shown in Figure 7-2 were developed.

The primary objective is to select the preferred alternative: that which satisfies the MTCA requirements, but also best meets Kitsap County's objectives. These objectives include selecting the alternative that accomplishes the following: minimizes net remediation cost to the citizens of Kitsap County, minimizes short- and long-term liability at the landfill site, provides the greatest flexibility for future land use, and best preserves or improves land values. In addition, Kistap County would like to select a remedial action as close to permanent as possible, and one that can accomplish a reasonable restoration time frame. Finally, the preferred alternative should minimize any additional public concerns. These objectives were used as the decision criteria shown in Table 7-2, which also shows the weighting and relative contribution of each criterion.

Three of the criteria, cost, permanence, and additional public concerns, are carried over from the other MTCA criteria already evaluated. The cost and permanence criteria were included because of their high importance to Kitsap County and other stakeholders. Both criteria also were believed to be good at distinguishing the alternatives. Additional public concerns were partly addressed by the team anticipating public concerns based on public feedback received on the project over the past several years. In addition, Kitsap County elected to incorporate public input in the decisionmaking prior to the official RI/FS public comment period. Informal input was solicited from local residents, the City of Bainbridge Island, and the Associated Bainbridge Communities on the decision analysis process, criteria, and weighting during the feasibility study. Respondents ranked permanence and land value, respectively, as their greatest concerns.

7.2.3 Scoring and Results

In the following subsections, each criterion is briefly described, along with the score for each alternative and the units of the scale for each criterion.

Net Remediation Cost to Kitsap County

Net remediation cost to Kitsap County is the cost of remediation minus the amounts that may be recovered from responsible parties or provided by grants from Ecology. Only capital remediation costs were scored; operation and maintenance (O&M) costs, long-term monitoring, and all other costs related to completing the remedial action were not included. For a complete review of the cost analyses and the assumptions used, refer to Appendix E. Cost scores are measured in millions of dollars on an absolute scale:

Consolidation and Containment: 0.74 Reclamation: 1.225

Cost estimates developed in this Feasibility Study were used, assuming a 50 percent matching grant from Ecology. An additional 15 percent matching grant available from Ecology for permanent solutions was assumed for reclamation, for a total match of 65 percent for this alternative. If the 15 percent match for a permanent solution is not obtained, the net cost score for reclamation would be 1.75.

Land Value

Land value is the expected value of the property plus the value of adjacent properties, upon completion of the remedial action. A constructed scale was developed based on expected increases or decreases in land values compared to a hypothetical no action alternative, which is equivalent to the current value. A value of 100 was assigned to a potential "large increase in value of the landfill property and surrounding property." Large expected decreases in values of both properties were scored 0. No change in value scored 50, and a change in value of one property but not the other scored above or below 50 for an increase or decrease, respectively.

Consolidation and Containment: 55 Reclamation: 70

Both actions were expected to result in increases of property values over no action. Reclamation was considered to have a higher potential land value because surrounding property values could increase once groundwater cleanup standards are achieved, the landfill mass was removed, and water supply wells could be drilled within 1000 feet. Fewer land use restrictions expected under reclamation should also result in a higher property value for the site.

Land Use Potential

Land use potential is the relative abundance of options and restrictions of use of the property following remediation. A simple scale was constructed with "full, unrestricted land use" given a score of 100, and "permanent, highly restricted access" a score of 0. Deed restrictions against residential development with controlled access to part of the property were assigned a 50 score.

Consolidation and Containment: 50 Reclamation: 70

Reclamation was perceived by the team as having the potential for a wider range of land uses. It was generally agreed that access restrictions on the engineered cover system anticipated for consolidation and containment would limit land use potential; although engineering solutions may be constructed to allow wider land uses on a cap, the baseline feasibility study alternative and cost estimate assume restricted access and engineering controls.

Liability

Liability considers the potential for litigation against Kitsap County related to the landfill. A simple scale was constructed with no cost of claims representing a score of 100, and high cost of claims scoring 0. A moderate cost of claims scored 50.

Consolidation and Containment: 20 Reclamation: 70

This criterion generated the most discussion and least agreement among the decision team. It was very difficult to estimate the probability of legal claims because any such estimates are highly uncertain. As a result, the team could not reach consensus on this criterion. Reclamation was scored substantially higher in part because if reclamation removes the landfill waste and groundwater cleanup standards are achieved, it is expected that the ban on installing drinking water supply wells within 1,000 feet of the property boundary would be lifted. This ban is a potential avenue for legal claims and is known to be a concern to local residents. Some team members felt that the score should be closer to 50/50 with a slight edge toward reclamation because the short-term liability for reclamation is likely to be higher than consolidation and containment (during construction activities), but reclamation is likely to provide less long-term liability than consolidation and containment.

Permanence of Remedial Action

Permanence is elimination or detoxification of waste with no further action necessary to protect human health and the environment. A constructed scale was developed with a top score of 100 assigned to "no further action" as determined by Ecology. A median score of 50 indicates concentrations of contaminants of concern remain onsite above MTCA cleanup levels with long-term operations, maintenance, and monitoring requirements. A zero score indicated high volumes of waste remain onsite with perpetual operations, maintenance, and monitoring.

Consolidation and Containment: 17 Reclamation: 50

The decision team agreed that the consolidation and containment alternative would always leave a large mass of waste containing low levels of contaminants onsite. Reclamation has the potential to reduce both the volume of waste and contaminant concentrations onsite. It also has the potential to permanently destroy all organic contaminants through naturally-occurring biodegradation. The team also agreed that once groundwater cleanup levels were achieved through monitored natural attenuation, groundwater would be permanently restored under reclamation. Under consolidation and containment, monitoring may need to continue for longer to prove performance of the cap, and groundwater may never be permanently protected.

Reasonable Time Frame

Reasonable restoration time frame is specified but not described in MTCA. The decision team discussed at length what would constitute a "reasonable" restoration time frame, particularly for groundwater. One difficulty in determining a restoration time frame is that few contaminated groundwater sites have been completely restored and few data exist to document time frames. Therefore, a scale was constructed using two absolute endpoints: immediate restoration upon completion of the remedial action (score of 100) and site not restored (score of 0).

Consolidation and Containment: 17 Reclamation: 45

The team scored reclamation higher because they believed that removing the source of groundwater contamination and allowing continued flushing of the vadose zone with infiltrating groundwater would accelerate the groundwater restoration. Consolidation and containment would leave contaminants in the vadose zone that would continue to leach into groundwater for much longer because the impermeable cap would prevent flushing. Residual moisture in the waste beneath the cap would probably continue to contribute contaminants to the vadose zone and groundwater.

Additional Public Concerns

The scale for additional public concerns was constructed to capture a wide range of public concerns that would be reflected in public endorsement or opposition to the selected alternative. A score of 100 represented public endorsement of the remedy and a score of 0 represented insurmountable public opposition. A score of 50 indicated that the public had some objections to the alternative but accepted it overall.

Consolidation and Containment: 45 Reclamation: 75

The scores were based on discussions and informal surveys that the Kitsap County project team members have had with residents, public interest groups, and local government. Since the alternative was introduced in 1999 at a public presentation, reclamation has been well received and supported by most residents and interest groups. This alternative is perceived by the public to be a more permanent solution and would remove contaminants from the site. Local residents also have a strong interest in future potential uses of the site and believe that reclamation would allow more land use options.

Summary of Scoring

The decision process was evaluated using a computer model that is part of a specialty decision analysis software program called Criterium Decision Plus (CDP). This software provides automatic evaluation of MUA decision problems, as well as automated sensitivity and uncertainty analyses and graphical presentation of results.

The model developed by the decision team and endorsed by the decision stewards was built into a CDP model by CH2M HILL. The model takes the scores assigned by the decision team and normalizes them to 100. Each score is then multiplied by the criterion's weight to produce the final weighted and normalized score. Table 7-3 shows the final scores for the two alternatives. Model results show that the reclamation alternative, with an aggregate score of 0.65, is preferred over consolidation and containment, which scored a total of 0.45.

7.2.4 Discussion of Results

Figure 7-3 shows how scores on specific criteria contributed to the total score. This figure shows that consolidation and containment outperformed reclamation on cost, but performed less well on every other criterion. This indicates that Kitsap County is willing to trade off the lower cost of consolidation and containment for the higher performance of reclamation in terms of liability, public concerns, permanence, land use potential, land value, and a reasonable restoration time frame. Kitsap County is willing to invest more of a limited budget in the remedy in order to get more value out of the other criteria. A sensitivity analysis was performed to see if changes in weights would change the preferred alternative. This analysis showed that the model was robust with regard to the assigned weights—only substantial changes in weights would alter the outcome.

Uncertainty in scores also was evaluated. Table 7-4 shows the range of scores used in the uncertainty analysis. The results of the uncertainty analysis showed that there is more certainty in the score for consolidation and containment than in the score for reclamation. This is because the decision team assigned smaller ranges to the scores for the individual criteria. The narrower range of scores reflects the fact that consolidation and containment is a more widely used technology for landfill cleanup and there is much more data from capped landfill sites than from reclaimed landfills. However, even with a higher degree of uncertainty, even the worst expected performance by the reclamation alternative is expected to be better than the best performance by consolidation and containment. Figure 7-4 shows uncertainty in the scores as the smaller bar at the end of the larger bars. The numbers at the end of the bars indicate how frequently the alternative is better than the other. The aggregate score for reclamation is always better than consolidation and containment, even after the risk of uncertain outcomes is considered.

7.3 Recommended Alternative

Based on the results of the decision analysis, Alternative 2, reclamation with a permeable soil cover, is the recommended alternative. Construction of the remedial action is planned to begin in Summer of 2001.

TABLE 7-1
BAINBRIDGE ISLAND LANDFILL FS
Comparison of Proposed Remedial Alternatives with MTCA Requirements

Criteria	Alternative 1: Consolidation and Containment	Alternative 2: Reclamation With Permeable Soil Cover	Alternative 3: Reclamation with Impermeable Cover
Short-Term Effectiveness (Score 1-5)	High (5)	Medium-High (4)	Medium-High (4)
Long-Term Effectiveness (1-5)	Medium-High (4)	High (5)	High (5)
Reduce Toxicity/ Mobility/ Volume of Contaminants (1-5)	Low (1)	Medium-High (4)	Medium-High (4)
Implementability (1-5)	High (5)	Medium-High (4)	Medium-High (4)
Cost (5-1)	Medium-Low (4)	Medium-High (2)	High (1)
Recycling/ Reuse/ Waste Minimization (1-5)	Low (1)	Medium-Low (2)	Medium-Low (2)
Community Concerns	To Be Addressed Later	To Be Addressed Later	To Be Addressed Later
Total "Score" (sum of numbers in parentheses)	**20**	**21**	**20**

TABLE 7-2
BAINBRIDGE ISLAND LANDFILL FS
Kitsap County Decision Criteria

Criterion	Performance Measure	Agreed Weighting	% Contribution to Ranking
Net Remediation Cost to Kitsap County	Dollars	100	22%
Land Value – site and surrounding property	Dollars	43	9%
Land Use Potential	Constructed scale of preferences	53	12%
Long Term Liability	Dollars	85	18%
Permanence of Remedial Action	Constructed scale of preferences	82	18%
Reasonable Time Frame	Constructed scale of preferences	37	8%
Additional Public Concerns	Constructed scale of preferences	63	14%

TABLE 7-3
BAINBRIDGE ISLAND LANDFILL FS
Summary of Decision Analysis Scores

Criterion	Score	
	Consolidation and Containment	**Reclamation**
Net Remediation Cost to Kitsap County[a]	0.74	1.225
Land Value—site and surrounding property	55	70
Land Use Potential	50	70
Long Term Liability	20	70
Permanence of Remedial Action	17	50
Reasonable Time Frame	17	45
Additional Public Concerns	45	75
Aggregate Score	**0.45**	**0.65**

[a] Capital remediation costs only, in millions of dollars

TABLE 7-4
BAINBRIDGE ISLAND LANDFILL FS
Uncertainty in Decision Analysis Scores

Criterion	Range of Scores	
	Consolidation and Containment	**Reclamation**
Net Remediation Cost to Kitsap County	0.52-0.73	1-3
Land Value – site and surrounding property	50-60	65-80
Permanence of Remedial Action	15-20	50-100
Reasonable Time Frame	15-20	40-50

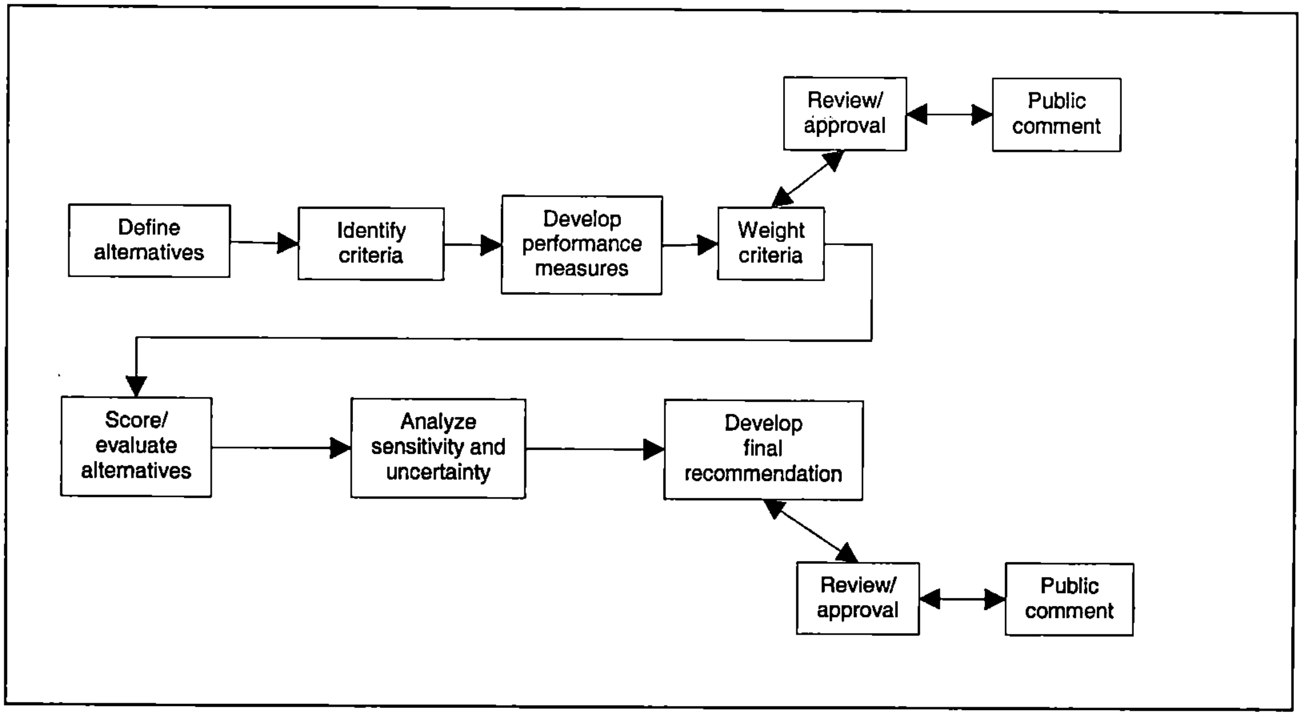

Figure 7-1
Decision Process
Bainbridge Island Landfill FS

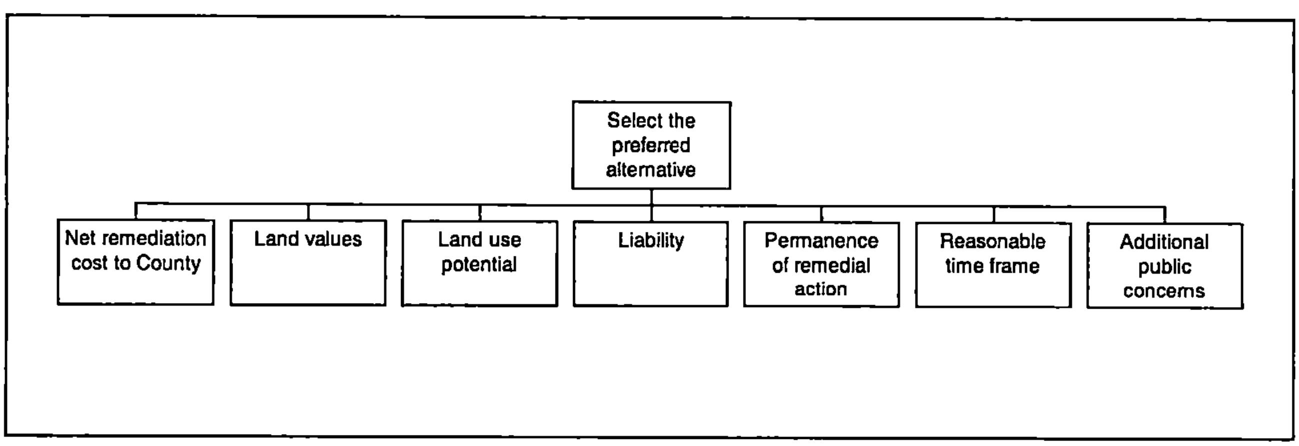

Figure 7-2
Decision Criteria
Bainbridge Island Landfill FS

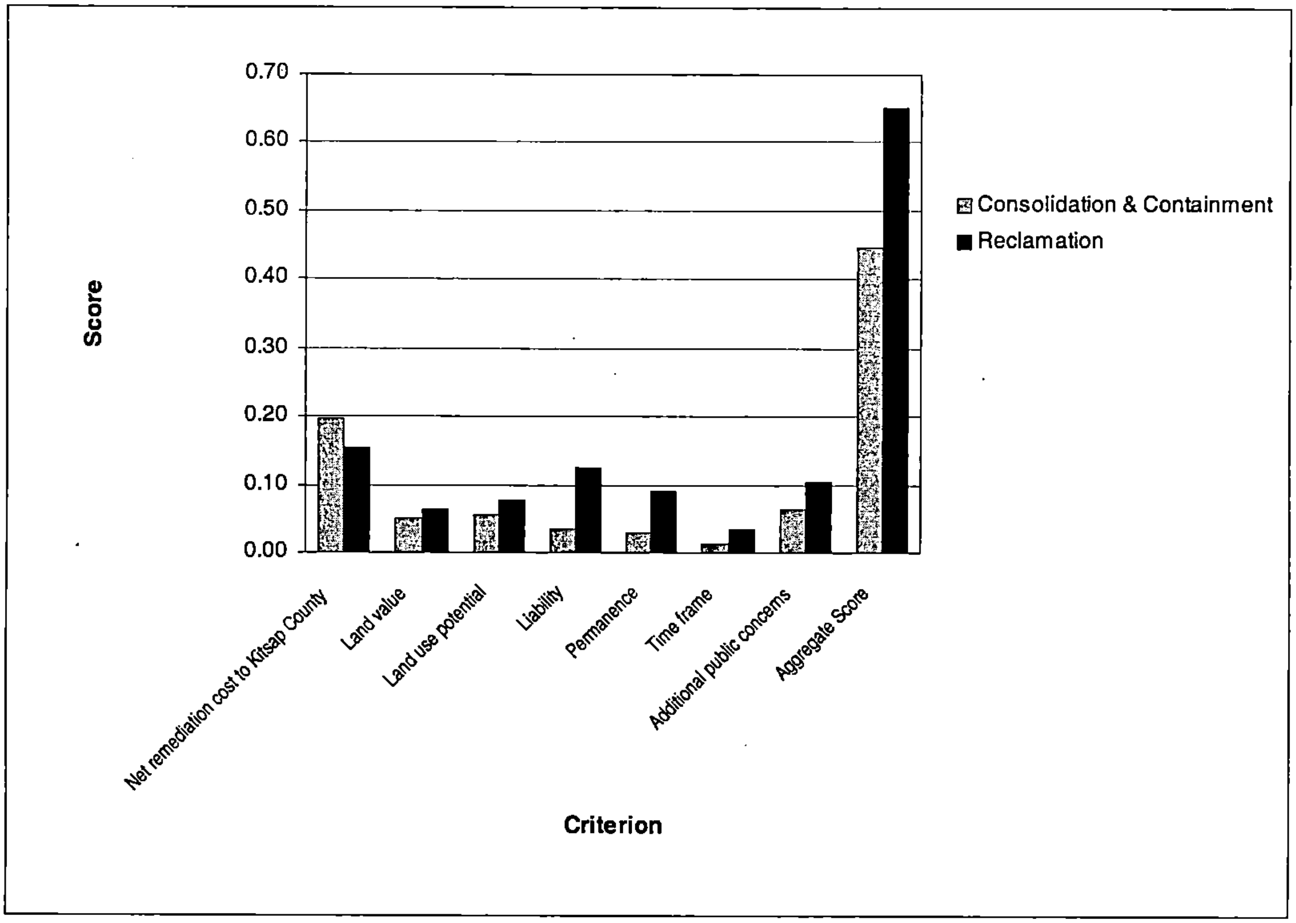

Figure 7-3

Individual Decision Criteria and Aggregate Scores

Bainbridge Island Landfill FS

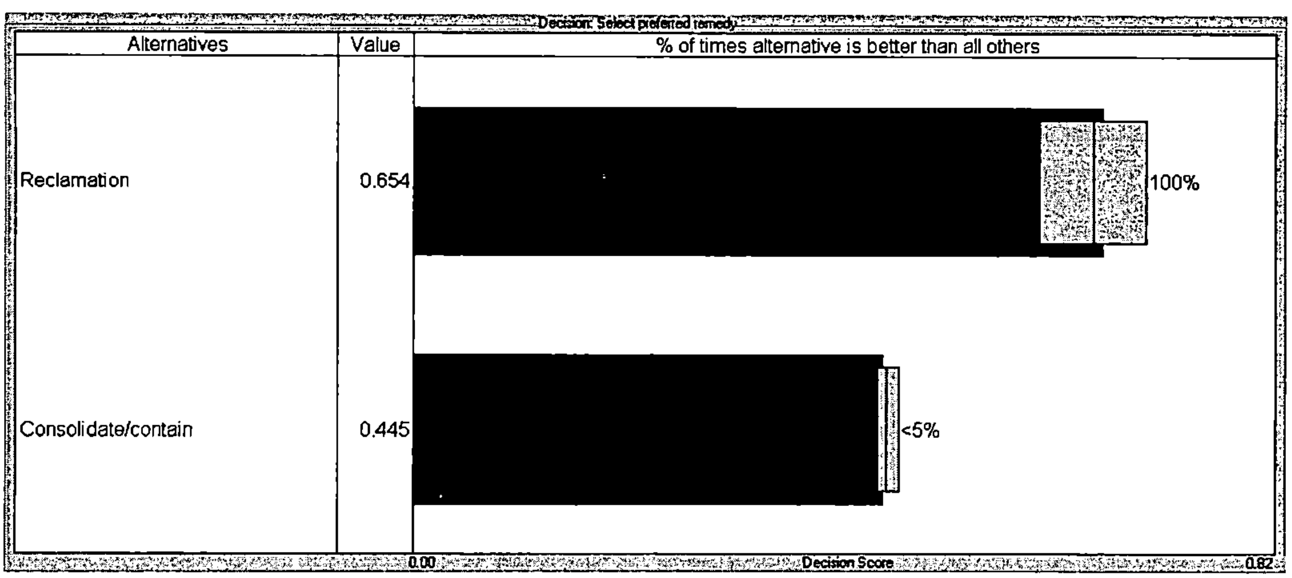

Figure 7-4

Uncertainty in Aggregate Scores

Bainbridge Island Landfill FS

CHAPTER 8

Compliance with the State Environmental Policy Act

The MTCA regulation WAC 173-340-400(4)(a)(xvi) requires that cleanup action plans include any additional information needed to fulfill the applicable requirements of the State Environmental Policy Act (SEPA). Ecology Policy 130A, Coordination of SEPA and MTCA, clarifies the relationship of SEPA and MTCA. Paragraph 9 of Policy 130A states that Ecology is the SEPA lead agency for cleanup actions conducted under MTCA; therefore, Ecology is responsible for preparing an environmental checklist and making a threshold determination. Ecology's threshold determination decides if an environmental impact statement (EIS) will be needed for a cleanup action or if mitigation measures described in an environmental checklist will be sufficient to eliminate or minimize environmental impacts. WAC 197-11-259 of SEPA and Ecology Policy 130A state that for a MTCA cleanup action the environmental checklist should be circulated with a threshold determination by no later than issuance of a draft cleanup action plan.

The remedial alternative at the Bainbridge Island Landfill will be required to comply with SEPA. Although the net result of site cleanup under the recommended alternative, Alternative 2, will be a reduction of long-term environmental impacts, the short-term impacts of implementing the preferred alternative will need to be evaluated in accordance with SEPA requirements. The procedure for SEPA compliance for cleanup at the Bainbridge Island Landfill will include preparing an expanded checklist that identifies possible environmental impacts and describes mitigation measures that will be implemented to eliminate or reduce environmental impacts during the cleanup action. Ecology can elect to prepare the environmental checklist, or they can require Kitsap County to prepare it. If Ecology determines that mitigation measures described in the environmental checklist are sufficient to prevent significant adverse environmental impacts, Ecology will issue for comment a proposed mitigated declaration of non-significance (mitigated DNS) with the environmental checklist to agencies of jurisdiction and the general public. If significant impacts not addressed in the environmental checklist are not identified during the 14-day comment period, the mitigated DNS will be finalized and SEPA compliance will be complete.

8.1 Summary of SEPA Environmental Checklist

The SEPA environmental checklist will include the location and a general description of the proposed cleanup action, a list of government approvals or permits that will be needed, a list of other directly related environmental information, and responses to specific questions regarding environmental elements in the checklist. Because the RI/FS reports discuss alternative cleanup actions and their environmental impacts, the RI/FS reports will be identified as directly related environmental information and incorporated into the environmental checklist by reference. Elements of the environment that must be addressed in the environmental checklist include:

- **Earth**—Topography, soil types, proposed filling and grading, erosion impacts, and controls.
- **Air**—Emissions of dust and odor, proposed control methods.
- **Water**—Location near surface water, placement of fill in or removal from surface water, surface water diversion, discharge of waste materials to surface water or groundwater, stormwater runoff, proposed control methods.
- **Plants** —List of vegetation types on the site, type and amount of vegetation that will be removed or altered, threatened or endangered species known to be on or near the site, measures proposed to preserve or enhance vegetation on the site.
- **Animals**—List of animals and threatened or endangered species that have been observed on or near the site, measures proposed to preserve or enhance wildlife.
- **Energy and Natural Resources**—Types of energy that will be used to complete the project, types of energy conservation features.
- **Environmental Health**—Identification of possible environmental health hazards and proposed control methods, noise impacts and proposed control methods.
- **Land and Shoreline Use**—Zoning, current land use, planning designation, shoreline master plan designation, environmentally sensitive areas, compatibility with existing and projected land uses and plans.
- **Housing**—Impacts to housing and control methods.
- **Aesthetics**—Impacts to views and control methods
- **Light and Glare**—Discussion of light and glare that the project will produce, possible safety hazards and impacts to views, proposed control methods.
- **Recreation**—Location of recreational opportunities in the vicinity of the site, impacts to recreational opportunities, and methods to reduce or control adverse impacts.
- **Historic and Cultural Preservation**—Description of landmarks or evidence of sites of historic, archaeological, scientific, or cultural importance known to be on or next to the site, proposed measures to reduce or control impacts.
- **Transportation**—Requirements for new roads or improvements to existing roads, trips per day generated by the project, proposed measures to mitigate transportation impacts.
- **Public Services**—Identification of increased needs for public services as a result of the project, proposed measures to reduce or control impacts.
- **Utilities**—List of utilities currently available at the site, utilities that are proposed for the project, and construction that might be needed.

Of the various elements of the environment listed above, earth, air, water, environmental health, and transportation will need to be addressed in the most detail in the environmental checklist. Each of these elements is briefly discussed below.

8.1.1 Earth

Increased erosion on the site could be caused by excavating waste for offsite disposal and reclamation, regrading the site with the inert waste fraction, excavating onsite soil for capping, placing the soil cap, and restoring the drainage channel. Impacts from short-term increases in erosion during the cleanup action would be minimized by scheduling major waste excavation and earthwork during the dry summer months and by using temporary water pollution controls during construction. Using erosion control matting in the restored drainage channel and revegetating disturbed areas would minimize long-term increases in erosion.

8.1.2 Air

Odor impacts could result from waste excavation, offsite disposal, and reclamation. Odor would be minimized by limiting the daily area and quantity of waste disturbed, using odor suppressants, and placing cover material over exposed waste at the end of each work day. Dust impacts could result from major earthwork occurring during the dry summer months. Using water or other dust suppressant methods during construction would minimize dust impacts.

8.1.3 Water

Increases in erosion described above in Section 8.1.1, Earth, could affect surface water. Potential impacts would be minimized as described above in Section 8.1.1, Earth. Although the existing surface water flow through the site will be rerouted as a result of the cleanup action, the surface water flow may be restored to the natural channel that existed prior to the site's use as a landfill. The result of the cleanup action will be to restore a previously existing natural channel and to reduce any long-term impacts to surface water. If the restored channel is constructed at a higher elevation than the pre-landfill channel location, the resulting water velocity could be higher than pre-landfill conditions. Improving existing settling ponds at the east end of the site would reduce impacts from increased water velocities.

Short-term impacts to groundwater are not anticipated during the cleanup action. Long-term impacts to groundwater will be favorable, by removing leachable wastes from the site.

8.1.4 Environmental Health

Potential health hazards might result from the excavation of waste for offsite disposal and reclamation. Health hazards will be minimized by implementing a health and safety plan during the cleanup action and by closely monitoring work areas during waste excavation, disposal, and reclamation activities. Noise impacts could result from operating machinery and heavy equipment during the cleanup action; requiring heavy equipment and machinery to be provided with noise suppression devices and limiting working hours will minimize noise impacts on local residents.

8.1.5 Transportation

During the cleanup action, offsite disposal of waste materials will create increased traffic at the site. This increased traffic could interfere with existing traffic to and from the Bainbridge Disposal transfer station facility located on the site. A new access road to Vincent Road will be constructed across the site to mitigate impacts to the transfer station. Coordinating offsite disposal activities to occur on the transfer station's least active days will minimize traffic conflicts with transfer station customers. Using signage and flagging as needed will minimize other potential traffic impacts.

8.2 Other Possible SEPA Activities

If, during the comment period for the proposed mitigated DNS, a comment is received that identifies a potentially significant adverse environmental impact not addressed in the environmental checklist, Ecology might elect to issue a revised environmental checklist and mitigated DNS. The revised documents would discuss the newly identified environmental impact and propose additional mitigation measures. The revised environmental documents would be reissued for agency and public comment. If significant impacts not addressed in the environmental checklist are not identified during the additional 14-day comment period, the revised mitigated DNS would be finalized and SEPA compliance would be completed.

If impacts are identified that cannot be sufficiently addressed in an environmental checklist and mitigated DNS, Ecology will issue a declaration of significance and require preparation of an environmental impact statement (EIS). The EIS process would require initial meetings to determine the scope of the EIS, preparation and circulation of a Draft EIS for agency and public comment, and preparation of a final EIS to respond to comments. The EIS process would add approximately six months to the project schedule.

CHAPTER 9

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APPENDIX A

Overview of Regulatory Requirements and ARARs

An initial review of regulatory criteria and an analysis of applicable, relevant, and appropriate requirements (ARARs) for the site were presented in the *Bainbridge Island Landfill RI/FS Work Plan* (CH2M HILL, 1996) following procedures outlined in WAC 173-340-700 through 760 (MTCA Cleanup Standards). The preliminary lists of contaminants of potential concern (COPCs) that were developed in the RI Report and RI Supplements 1 and 2 used the most stringent standards as screening levels for evaluating the concentrations of contaminants in the waste sources and environmental media.

This appendix first presents a general overview of federal, state, and local regulations that may apply to the landfill site. The regulatory summary is followed by an analysis of ARARs that incorporates regulatory revisions since the Work Plan was prepared. This analysis identifies the most stringent ARAR (MSA) for each parameter in each medium, including soil, sediment, air, surface water, and groundwater.

1 Overview of Federal, State, and Local Requirements

Numerous federal, state, and local laws and their implementing regulations were reviewed to identify ARARs for the site. The following federal laws and regulations were reviewed for consideration as ARARs:

- National Environmental Policy Act (NEPA)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)
- Resource Conservation and Recovery Act (RCRA)
- Federal Water Pollution Control Act (FWPCA)
- Safe Drinking Water Act (SDWA)
- Clean Air Act (CAA)
- Endangered Species Act (ESA)
- Fish and Wildlife Coordination Act
- Occupational Safety and Health Act (OSHA)
- National Pollutant Discharge Elimination System (NPDES)

The following Washington State laws and regulations were reviewed for consideration as ARARs:

- State Environmental Policy Act (SEPA)
- Model Toxics Control Act (MTCA)
- Hazardous Waste Management Act
- Minimal Functional Standards for Landfills (MFS)
- Water Pollution Control Act
- Water Resources Act of 1971

- Groundwater Quality Standards
- Drinking Water Act
- Air Pollution Control Act
- Industrial Safety and Health Act
- Water Well Construction Act
- Washington State Pollutant Discharge Elimination System Permit Program (administration of NPDES)

The following local regulations were reviewed for consideration as ARARs:

- Puget Sound Clean Air Agency (PSCAA) Regulations I and III
- Bremerton-Kitsap County Health District Solid Waste Regulations, Ordinance 1996-11
- City of Bainbridge Island Critical Areas Ordinance, Ordinance 98-20

In many cases, state laws and regulations have been developed under federal provisions. Where possible, federal laws and their associated state and local requirements are presented together in sections below. They are not necessarily reviewed in the order listed above.

1.1 National Environmental Policy Act

The National Environmental Policy Act of 1969 (NEPA) and its major implementing regulation, 40 CFR 6.100(a), require that federal agencies prepare environmental impact statements (EISs) for major federal actions determined to have significant impacts on the quality of the environment. These actions may include those that significantly affect the pattern and type of land use, wetlands at the site, or threatened or endangered species habitats. NEPA is not applicable to the Bainbridge Island Landfill.

1.2 State Environmental Policy Act

The State Environmental Policy Act (SEPA) (WAC 197-11) requires state and local government agencies to prepare EISs for major actions determined to have significant impacts on the quality of the environment. These actions may include those that significantly affect the pattern and type of land use, wetlands at the site, or threatened or endangered species habitats. When both SEPA and NEPA are required, the processes may be combined. SEPA is applicable to Bainbridge Island Landfill because it does not involve a federal action.

1.3 CERCLA and the National Contingency Plan

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and its major implementing regulation, the National Contingency Plan (NCP) (40 CFR 300), identify requirements for CERCLA cleanup sites. The NCP provides risk-based criteria for establishing protective cleanup requirements. For carcinogens, "acceptable exposure levels are generally concentrations that represent an excess upper-bound lifetime cancer risk to an individual of between $1x10^{-4}$ and $1x10^{-6}$" [40 CFR 300.430(e)(2)(i)(A)(2)]. An excess cancer risk of $1x10^{-6}$ is to be used as the point of departure for determining remedial goals. For systemic toxicants, "acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse affect" [40 CFR 300.430(e) (2)(i)(A) (1)]. Although MTCA (described below) takes precedence over CERCLA, and CERCLA contains no specific cleanup levels, CERCLA's general provisions are relevant and appropriate to the Bainbridge Island Landfill.

1.4 Washington State Model Toxics Control Act

MTCA applies to "all facilities where there has been a release or threatened release of a hazardous substance that may pose a threat to human health or the environment" [WAC 173-340-110(1)]. MTCA requires that cleanup actions performed in Washington State protect human health and the environment, comply with the cleanup standards in WAC 173-340-700 through 173-340-760, comply with applicable state and federal laws, and provide compliance monitoring [WAC 173-340-360(2)].

Protective levels for individual carcinogens are defined more stringently under MTCA than under CERCLA, with the maximum acceptable cancer risk set between $1x10^{-5}$ and $1x10^{-6}$. MTCA provides three basic methods, Methods A, B, and C, for establishing chemical-specific cleanup levels (CULs). The method to be used for a particular site depends on the current use and complexity of the site, the proximity of the site to other land uses, and the expected future use. However, if the cleanup levels indicated by these methods are less stringent than other applicable requirements (e.g., Maximum Contaminant Level (MCLs)), MTCA states that the more stringent requirement applies. The methods for establishing CULs are:

- **Method A:** This method applies to sites undergoing routine cleanup or with relatively few hazardous substances; cleanup standards are based on the more stringent of either the MTCA tables (25 hazardous substances) or applicable state and federal laws, or the natural background or practical quantitation limits. For the Bainbridge Island Landfill, Method A may be applicable for those chemicals listed in the Method A tables (WAC 173-340-720, 740). In particular, Method A values for lead and total petroleum hydrocarbons will be used because Method B values are not available for these chemicals.

- **Method B:** This method is applicable to all sites [WAC 173-340-705(1)] unless one or more of the conditions for using Method A or Method C (see below) are demonstrated to exist and the person conducting the cleanup action elects to utilize that method. Method B cleanup levels are set by using a site risk assessment, which must consider 1) how hazardous substances interact; 2) what their combined health effects might be; and 3) how their movement on- and off-site could threaten human health or the environment. Method B risk levels cannot exceed one in 1,000,000 for individual carcinogens and one in 100,000 for the combined carcinogenic risk; levels for non-carcinogens cannot exceed the point at which a substance may cause illness in humans. Method B cleanup levels are applicable to the Bainbridge Island Landfill.

- **Method C:** Method C is considered a "conditional" method that applies if: 1) Method B CULs are below background (if so, Method C CULs are then established at background, but in no case greater than calculated Method C CULs); 2) attainment of Method B CULs has the potential for creating a significantly greater overall threat to human health or the environment; and 3) the site is neither residential nor industrial but may, in the future, be used for recreation or agriculture. Method C cleanup levels are similar to Method B, but the lifetime cancer risk is set at one in 100,000 for both individual substances and for the total risk caused by all substances. Method C cleanup levels are not applicable to the Bainbridge Island Landfill unless Method B levels are unattainable for technical or environmental reasons.

Ecology asked Kitsap County to complete an evaluation of potential exposures to wildlife at the site. The request was made in a letter dated July 20, 1998. In the letter, Ecology gave Kitsap County the option of either conducting a site specific ecological risk assessment or using screening values provided in the letter to "identify where wildlife is threatened" at four areas at the site: the west end area, the septage pits, the surface water drainage, and the landfill cover. Kitsap County decided to use the screening values, and completed the evaluation in the Remedial Investigation (CH2M HILL, 1999).

The screening values provided in the letter are part of the proposed revisions to MTCA (proposed October 1999), although the values continue to change. Currently, these values are not applicable, relevant, or appropriate for use as cleanup levels at the site because they are not yet promulgated. However, Kitsap County will address the intent of the both the proposed regulation and the July 20, 1998, letter by evaluating the extent to which cleanup options in the feasibility study are protective of wildlife.

Under WAC 173-340-708, MTCA also allows the use of natural background concentrations in setting cleanup standards. Natural background soil metals concentrations in surface soil throughout Washington State have been studied and defined by Ecology in a document dated October 1994 (Ecology Publication #94-115). In the document, Ecology presented 90th percentile concentrations for 13 metals including aluminum, arsenic, beryllium, cadmium, copper, copper, iron, lead, manganese, mercury, nickel, and zinc in four regions (Puget Sound, Clark County, Yakima Basin, and Spokane Basin). The 90th percentile metal concentrations for the Puget Sound region is considered to be representative of the background concentrations in Bainbridge Island surface soil in the absence of site-specific background values. These values will be considered as ARARs.

In general, MTCA shows a preference for remedial actions that reuse, recycle, destroy, or detoxify contaminants. However, Ecology recognizes the need to use engineering controls, such as containment, for sites that contain large volumes of relatively low levels of hazardous substances where treatment is impracticable [WAC 173-340-360(9)].

1.5 Federal Resource Conservation and Recovery Act Subtitle C Hazardous Waste Regulations Washington State Hazardous Waste Management Act Washington State Dangerous Waste Regulations

Federal hazardous waste regulations (40 CFR 261 and 264, RCRA Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities) implement the provisions of RCRA Subtitle C and specify requirements for hazardous waste generators and hazardous waste treatment, storage, and disposal facilities (TSDFs). Two determinations must be made to evaluate the applicability of RCRA to the landfill. The first is whether the wastes or contaminated materials at the site are RCRA hazardous wastes; if so, RCRA may be an applicable or a relevant and appropriate requirement. The second is whether "active management" of landfill wastes will occur; if so, the classification of waste as RCRA-hazardous or non-hazardous would determine whether these regulations apply.

Under the RCRA regulations, a material is a hazardous waste if: 1) it is a solid waste; 2) it is not excluded from the regulation as a hazardous waste; and 3) it meets one of the following conditions:

- It exhibits, on analysis, any of the characteristics of a hazardous waste, i.e., ignitability, corrosivity, reactivity, and/or toxicity as determined by a toxicity characteristic leaching procedure (TCLP).
- It has been listed as a hazardous waste in the regulations (40 CFR 261). These listings specifically include wastes from non-specific sources (F-list), wastes from specific sources (K-list), and discarded chemical products (P- and U-lists).
- It is a mixture containing a listed hazardous waste and a non-hazardous solid waste.
- It is derived from a listed hazardous waste.

The distinction between characteristic and listed hazardous wastes is important because the RCRA program requires that they be managed differently in several key respects. Most of these differences result from the "mixture" and "derived-from" rules [40 CFR 261.3(b)(2) and 40 CFR 261.3(c)(2)] and the "contained-in" policy for contaminated environmental media.

In addition to the classification of wastes stipulated by RCRA, wastes must be classified according to the state system (WAC 173-303-104). The state regulation defines the following additional types of dangerous waste (DW):

- WT01: Toxic DW, which can be determined from bioassay data or by book designation
- WP01: Persistent DW, based on concentrations of halogenated hydrocarbons (HHs) or polynuclear aromatic hydrocarbons (PAHs)

Though the addition of "Washington State-only" designations to the waste codes have no meaning outside of the State of Washington, they are necessary for management and transportation purposes within the state.

The regulations covering the RCRA of 1976 and the State Hazardous Waste Management Act of 1976 were promulgated after the landfill ceased accepting waste and, as such, are not applicable to the in-place landfill waste. However, hazardous or dangerous waste that may be identified at the landfill that is exhumed during remedial actions would need to be handled and treated or disposed in accordance with these state and federal hazardous/ dangerous waste regulations (RCRA 40 CFR 261 and 264, and Chapter 173-303 WAC).

1.6 Washington State Minimal Functional Standards for Landfills

The Washington State Minimal Functional Standards for Solid Waste Handling (WAC 173-304) regulation is promulgated under the authority of chapter 70.95 RCW to protect public health, to prevent land, air, and water pollution, and to conserve the state's natural, economic, and energy resources by setting minimum functional performance standards for proper handling of all solid waste, including landfills. WAC 173-304-460 sets the minimal functional standards for 1) protection of groundwater, air quality, and surface waters; 2) landfill design; and 3) maintenance and operation. These regulations specify primarily action- and location-specific requirements for the design, operation, and closure of landfills that stopped accepting waste prior to October 9, 1991. These regulations are applicable to the landfill. Chapter 173-351 WAC is not applicable because it applies only to landfills that received waste on or after October 9, 1991.

1.7 Federal Water Pollution Control Act Washington State Water Pollution Control Act Washington State Water Resources Act of 1971

The Federal Water Pollution Control Act (FWPCA), also known as the Clean Water Act (CWA), establishes the national framework for protecting and enhancing the quality of the nation's waters. The state is authorized to implement the CWA through the Water Pollution Control Act, the Water Resources Act of 1971, and their implementing regulations. Several regulations are reviewed for consideration as ARARs:

- National Pollutant Discharge Elimination System (NPDES), (40 CFR 122 and WAC 173-220)
- Water Quality Standards (40 CFR 131-132 and WAC 173-201A)
- Groundwater Quality Standards (WAC 173-200)

National Pollutant Discharge Elimination System Washington State Pollutant Discharge Elimination System Permit Program

Section 402 of the FWPCA, which establishes the NPDES permitting program (40 CFR 122), is implemented by the state under the state NPDES permit program (WAC 173- 220). The regulations require that no pollutants be discharged to any surface water of the state from a point source, except as authorized by an individual or general permit issued pursuant to WAC 173-220. NPDES is applicable to the landfill.

Ecology requested that the model NPDES permit for Underground Storage Tanks in Washington be an ARAR for petroleum hydrocarbons in surface water because no other surface water standards for petroleum hydrocarbons exist.

Federal Water Quality Standards Washington State Water Quality Standards for Surface Waters

In response to federal water quality standard requirements (40 CFR 131.10), Washington State developed surface quality standards (WAC 173-201A) that apply to all surface waters of the state. The goal of the state regulation is to protect public health and public enjoyment thereof, and the propagation and protection of fish, shellfish, and wildlife. To implement this goal, criteria for chronic and acute concentrations of contaminants are provided in WAC 173-201A-030(2) and WAC 173-201A-040. Toxic criteria for the protection of aquatic life is provided in the federal water quality criteria regulations [40 CFR 131.36(b) (1)], which supersede criteria adopted by the state, except where the state criteria are more stringent than the federal criteria.

The federal and state chronic and acute criteria for aquatic organisms apply to surface water at the landfill. However, the federal human health toxic criteria for ingestion of water and/or organisms would not apply since the surface water at the landfill is not a potable water source.

1.8 Washington State Groundwater Quality Standards

Washington State Groundwater Quality Standards (WAC 173-200) apply to all groundwater of the state, except for cleanup actions under MTCA or CERCLA (WAC 173-200-010(3)(c)). The goal of the regulation is to protect existing and future beneficial uses of groundwater by reducing or eliminating discharge of contaminants to the state's groundwater. To implement this goal, standards were established based on technology-based treatment requirements. The Groundwater Quality Standards specifically state that they are not applicable to MTCA or CERCLA sites, and MTCA standards are at least as stringent as the Groundwater Quality Standards. However, the general goals and provisions of WAC 173-200 may be considered relevant and appropriate to the site.

1.9 Federal Safe Drinking Water Act Washington State Drinking Water Act—Washington State Drinking Water Regulations

The federal Safe Drinking Water Act (SDWA) establishes a national framework for ensuring the quality of drinking water supplies. Two regulations were reviewed for applicability:

- National Primary Drinking Water Regulations (40 CFR 141)
- National Secondary Drinking Water Regulations (40 CFR 143)

National Primary Drinking Water Regulations
Washington State Drinking Water Regulations

The federal primary drinking water standards, adopted by the State of Washington, set MCLs, which are the maximum permissible levels of contaminants in drinking water based on prevention of adverse health effects. The Washington State Department of Health has assumed primary enforcement authority, with regulations that parallel those at the federal level [WAC 246-290-310(4)].

State drinking water regulations apply to public water supply systems, excluding systems serving one single-family residence, and therefore are not applicable to the landfill site itself. However, under MTCA, Ecology has determined that drinking water is the most beneficial use of the groundwater beneath the site; therefore,- drinking water MCLs are relevant and appropriate.

National Secondary Drinking Water Regulations
Washington State Drinking Water Regulations

Secondary drinking water standards specify MCLs that do not endanger public health but may adversely affect odor or appearance of drinking water [WAC 246-290-310(4)]. Secondary MCLs are relevant and appropriate requirements at the landfill for the same reason that the primary MCLs are relevant and appropriate.

1.10 Federal Clean Air Act Washington State Air Pollution Control Act Puget Sound Clean Air Agency Regulations

Air pollution control in the State of Washington is based on a set of local, state, and federal laws and regulations involving three levels of government. The federal government, through the EPA, sets air pollution standards that apply nationally. The state government, through the Department of Ecology, is required to implement those standards. A third level of government, local air pollution control agencies, also have broad responsibilities for implementing air pollution control activities within their single or multi-county jurisdictions.

The federal Clean Air Act (CAA) creates a national framework designed to protect ambient air quality by limiting air emissions. Under authority of the CAA, Washington State adopted the Washington Clean Air Act (Chapter 70.94 RCW). This state act provides for the creation of local air agencies and delegates authority to these local agencies to adopt the state regulations or institute more stringent requirements. The Puget Sound Clean Air Agency (PSCAA), formerly Puget Sound Air Pollution Control Agency, is the local air pollution control agency with jurisdiction over Bainbridge Island Landfill activities to prevent violations of federal, state, and local ambient air quality standards.

The applicable air quality regulations are summarized below:

- New Stationary Source Performance Standards (NSPS) (40 CFR Part 60). Subpart Cc, Emissions Guidelines and Compliance Times for Municipal Solid Waste Landfills, requires that landfills constructed prior to May 30, 1991, comply with the state plan. The state plan is outlined in the General Regulations for Air Pollution Sources, Emission Standards for Certain Source Categories (WAC 173-400-070 (9)). However, the Bainbridge Island Landfill does not meet the three criteria that would require control of the landfill emissions: 1) the landfill has accepted waste after November 8, 1987; 2) the landfill design capacity is greater than 2.5 million cubic meters; and 3) the landfill emissions of non-methane organic compounds is 50 megagrams, or greater, per year. For landfills that do not have to comply with the state plan, the only requirements under NSPS are: 1) submittal of an initial design capacity report, and 2) maintenance of accessible records indicating design capacity, amount of solid waste in-place, and year-by-year waste acceptance rate.

- Controls for New Sources of Toxic Pollutants (WAC 173-460). This regulation establishes acceptable source impact levels (ASILs) for new sources or modification to an existing source that emits Class A or Class B toxic air pollutants. New sources or modifications to existing sources at landfills are subject to this regulation per WAC 173-460-030(b)(iii)(A).

- Cleanup Standards to Protect Air Quality (WAC 173-340-750). MTCA Method B cleanup standards, intended to protect air quality based on estimates of the reasonable maximum exposure expected to occur under both current and future site use conditions, are applicable to the site.

- PSCAA Regulations I and III. Regulation I of PSCAA contains the general regulations for air pollution sources. It establishes technically feasible and reasonably attainable standards and rules generally applicable to the control and/or prevention of the emission of air contaminants. Regulation III of PSCAA, like WAC 173-460, applies to any new source or modification of an existing source that might emit a Class A or Class B toxic air pollutant into the ambient air. The regulation establishes acceptable source impact levels (ASILs) for toxic air pollutants emitted from new or modified sources to prevent air pollution, reduce emissions to the extent reasonably possible, and maintain such levels of air quality to protect human health and the environment. These regulations are applicable.

1.11 Federal Endangered Species Act of 1973

The Endangered Species Act (ESA) of 1973 (P.L. 93-295) as amended (16 USC 1531-1543), was enacted to provide 1) a means of conserving ecosystems upon which endangered and threatened species depend, and 2) a program to conserve such species, including those covered by various treaties and conventions. If it is determined that any federally identified endangered or threatened fish, wildlife, plant species, or their habitats, or federally designated critical habitat are present at or adjacent to the landfill, the ESA would be an applicable requirement.

The U.S. Fish and Wildlife Service and National Marine Fisheries Service were contacted to determine if threatened or endangered species or their habitat are on or adjacent to the landfill property. Only one species, the bald eagle, was identified in a letter dated August 24, 1999, from the U.S. Fish and Wildlife Service. However, the bald eagle is currently being delisted, and delisting is expected by July 2000.

1.12 Federal Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 USC 661) requires federal agencies to be involved in actions that will control or structurally modify any natural body of water for any purpose, in order to protect the fish and wildlife resources that may be affected. The U.S. Fish and Wildlife Service and appropriate state agencies are consulted to ascertain the means and measures necessary to mitigate, prevent, and compensate for project-related losses and to enhance the resources. This regulation may be an ARAR if any modifications to the site result in changes in fish and/or wildlife habitat.

1.13 Federal Occupational Safety and Health Act Washington State Industrial Safety and Health Act—Hazardous Waste Operations and Emergency Response Regulations

Washington State has adopted regulations (WAC 296-62-300) that are at least as stringent or more stringent than those outlined in the federal hazardous waste operations and emergency response regulations (29 CFR 1910.120). Workers involved in cleanup operations required by a government body that include hazardous waste must follow a written health and safety plan designed to identify, evaluate, and control health and safety hazards, and to provide for emergency response for hazardous waste operations. These regulations are applicable to site work.

1.14 Washington State Water Well Construction Act

The Washington State Water Well Construction Act of 1971 (RCW 18.104) required the water well construction be regulated and that water well contractors be regulated and licensed. The regulations governing the minimum standards for construction of wells (WAC 173-160) includes requirements for both water supply wells and resource protection wells (e.g., monitoring wells). The regulation consists of design and construction requirements for surface protective measures, casing, well screen, filter pack, development, and abandonment. The regulations governing regulation and licensing of well contractors and operators (WAC 173-162) consist of the requirements (examinations, fees, and licenses) by the State of Washington for well contractors and operators. These regulations are applicable to any wells that are constructed or abandoned at the Bainbridge Island Landfill.

1.15 City of Bainbridge Island Critical Areas Ordinance

In 1998, the City of Bainbridge Island City Council passed the critical areas ordinance (Ordinance 98-20) to protect critical areas, defined as aquifer recharge areas, fish and wildlife habitats, frequently flooded areas, geologically hazardous areas, and wetland and streams and their protective buffer lands. This ordinance was codified in the Bainbridge Island Municipal Code Chapter 16.20, Critical Areas. The ordinance requires that critical areas of Bainbridge Island be protected by establishing minimal standards for the impact of development of properties that contain or adjoin critical areas. There is no known critical area within the Landfill; therefore, while this ordinance is applicable, it is not likely to be triggered.

2 ARARs

This section assesses the applicable or relevant and appropriate requirements (ARARs) for the Bainbridge Island Landfill. Under MTCA, cleanup actions must comply with legally applicable state and federal requirements (WAC 173-340-710(1)). In addition, Ecology may determine that other requirements, criteria, or limitations are relevant and appropriate. Therefore, requirements that are both applicable, and relevant and appropriate are identified.

"Applicable" requirements include those cleanup standards, control standards, and other environmental protection requirements, criteria, or limitations promulgated under state or federal law that specifically address a hazardous substance, cleanup action, location, or other circumstance at a cleanup site. "Applicable" implies that the remedial action or circumstance at the site satisfies all of the jurisdictional prerequisites of a requirement.

"Relevant and appropriate" requirements include those cleanup standards, control standards, and other environmental requirements, criteria, or limitations promulgated under federal, state, or local law that are not legally applicable to a hazardous substance, cleanup action, location, or other circumstance at a cleanup site. However, these requirements address problems or situations sufficiently similar to those encountered at the site that their use may be well-suited for the site. In some circumstances, a requirement might be relevant but not appropriate for the site-specific situation; in that case, it would not considered an ARAR.

There are three types of ARARs: chemical-specific, location-specific, and action-specific.

- **Chemical-specific ARARs** are laws and regulations that identify health- or risk-based numerical values which, when applied to site-specific conditions, establish cleanup limits for specific hazardous substances. These limits establish the acceptable concentration of a chemical that may be found in, or discharged to, the ambient environment.

- **Location-specific ARARs** are requirements that are driven by the geographical or physical position of the site, rather than the nature of the contaminants or the actions at the site. Location-specific ARARs are typically restrictions or requirements placed on the concentration of hazardous substances or the conduct of activities solely because they occur in a particular location. However, they may also address culturally significant or environmentally sensitive areas that might affect the selection and/or performance of a cleanup action.
- **Action-specific ARARs** are requirements that define acceptable performance, design, or other action-specific controls or restrictions on particular kinds of activities, including identifying and managing solid waste and/or hazardous substances. Action-specific ARARs are usually based on technology or activity.

In general, chemical- and location-specific ARARs provide the basis for determining the objectives and goals of remedial action, whereas the action-specific ARARs provide the basis for determining how the remedial action will be implemented. If ARARs conflict, the most stringent ARAR (MSA) is generally adopted.

2.1 Chemical-Specific ARARs

Chemical-specific ARARs are laws and regulations that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These ARARs generally set health- or risk-based concentration limits or discharge limitations for specific hazardous substances. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied. The media of concern for the site include soil, sediment, air, surface water, and groundwater. Table 3-1[1] lists the chemical-specific ARARs for the media of concern for the Bainbridge Island Landfill.

Soil

Applicable soil cleanup levels include MTCA Method B cleanup levels for soil, MTCA Method A cleanup levels for soil, MTCA ecological indicator concentrations for protection of wildlife, and the Puget Sound background metals concentrations. The more stringent value between MTCA Method B cleanup level for soil and the MTCA ecological indicator concentration for protection of wildlife has been selected as the cleanup level for a given chemical, except when the Puget Sound background metal concentration is higher, in which case this becomes the cleanup level. Chemical-specific ARARs for soil are presented in Table 3-1.

MTCA soil cleanup levels intended to protect shallow groundwater from downward leaching of soil-derived contaminants were included in the RI screening levels (100 times MTCA Method B groundwater cleanup standards). However, they are not applicable criteria, for the following reasons:

[1] All tables referred to in this appendix are included in Chapter 3 of the FS Report.

- Groundwater is very deep at the site, ranging from 60 to more than 120 feet below waste sources. The great thickness of the unsaturated zone allows multiple processes to attenuate contaminants as they migrate toward groundwater.
- Contaminants detected in waste sources generally have not been detected in groundwater at concentrations that exceed RI screening levels.
- The primary groundwater contaminant of concern, vinyl chloride, has not been detected in waste sources. However, trace concentrations of vinyl chloride parent-compounds such as 1,1 DCE have been detected in waste sources.

The mechanisms that transport contaminants from waste sources through the vadose zone to groundwater are complex. Leachate is generated when percolating water contacts waste in the landfill. As the leachate migrates through the vadose zone carrying the dissolved and suspended contaminants, some contaminants may sorb on soil, volatilize, or dissolve into pore water. While partitioned in these three vadose zone phases (soil, soil gas, or pore water), contaminants may undergo chemical and biological transformations. They may also move from one phase into another. Larger structures or particles such as coliform will be filtered out by the fine sand matrix at the site. Although the organic content of the soil is relatively low (0.3 percent, the lowest measured value in native soils from SB1 and SB2), the organic contaminant retardation relative to groundwater and vadose zone velocity will be significant over time, especially for the larger molecular organic contaminants such as PCBs, PAHs and many SVOCs. Contaminant migration velocities in groundwater relative to the groundwater velocity range conservatively from about 1,000 times slower than groundwater for Arochlor 1254 to about the same as the groundwater velocity for vinyl chloride.

The fate of contaminants in the unsaturated zone will be affected by not only sorption/desorption, volatilization, and filtration processes described above, but also by precipitation/dissolution, hydrolysis, biological transformation, and other physical, chemical, and biological transformations.

Volatile contaminants will partition into each vadose zone phase and will be transported at different rates, depending on how long they are in each phase. As they are transported through the vadose zone, individual volatile contaminant molecules will move between all three phases. Dispersion and dilution will not be important attenuation mechanisms in the liquid phase because contaminants will be moving dominantly downward toward groundwater, and because most of the unsaturated transport occurs directly below the waste sources. Dilution and dispersion will decrease contaminant concentrations for those contaminants that are transported by landfill gas in areas outside of the landfill footprint. Additional descriptions of likely fate and transport mechanisms active at the site are presented in Chapter 8 of the RI Report (CH2M HILL, 1999a).

Fate and transport of larger organic molecules (PAHs, SVOC, etc.) is demonstrated under site-specific conditions by the example of Trench 3. This trench contained between 3,600 (based on disposal information from Teed, 1991) and 80,000 gallons (based on the volume of material removed from Trench 3 in 1993 that was stabilized with an unknown volume of kiln dust) of petroleum-based liquid containing 1,000 mg/kg pentachlorophenol, 18.6 percent PAHs (by weight), and metals including lead (lead was up to 800 mg/kg; E&E, 1987). Trench 3 also contained low levels of VOCs (none more than 10 mg/kg). The liquid material was removed in 1993, at least 20 years after it was placed there between 1968 and 1970 (Teed, 1991). The base of the original trench was between 5 and 8 feet below ground surface (estimate based on data from Golder, 1993). In 1996, RI samples of soil from 15 feet below ground surface contained negligible traces of PAHs, no pentachlorophenol or VOCs, and metals concentrations similar to those in samples from 90 feet below the trench location, the maximum depth explored beneath Trench 3. PAHs, pentachlorophenol, and VOCs have not been detected in MW2, the closest well downgradient of the Trench 3 area. This clearly shows that large organic molecules and metals present in liquid form and disposed in an unlined trench exposed to the atmosphere did not migrate more than 10 feet in over 20 years. And more importantly, mobile VOCs also did not migrate more than 10 feet in 20 years.

Although the possibility exists for organic and inorganic contaminants to migrate from the landfill 60 to 120 feet through the vadose zone to groundwater, it is highly unlikely for any constituents other than volatile organics. MTCA Method B cleanup standards for soil are sufficiently protective of groundwater without applying the more stringent 100 times groundwater standard as specified in WAC 173-340-740(3)(a)(ii)(A), except for volatiles. The Method B 100 times groundwater standards for the volatile chemical group are appropriate.

Sediment

Surface water at the site is intermittent stormwater discharge (see surface water section, below). Therefore, fresh water sediment cleanup standards (not yet promulgated) are not applicable because the proposed standards are for perennial surface water bodies that can support fish and aquatic life. Sediment at the site will be treated as soil. Standards for protection of surface water (MTCA Method B) are applicable because remobilization of sediment by storm runoff and transport downstream to more permanent surface water bodies is possible after completion of the remedial action. Chemical-specific ARARs for sediment are listed in Table 3-1.

Air

Modeled air quality parameters were compared to Ecology ambient source impact levels (ASILs) and residential MTCA Method B cleanup standards (WAC 173-340-750). Methane concentrations were compared to WAC 173-304-460(2)(b), which states that all municipal solid waste landfill units must ensure that the concentration of landfill gas does not exceed the lower explosive limit (100 percent LEL, equal to 5 percent by volume) at the property boundary or beyond. Total non-methane organic compounds calculated in a Tier 1 analysis were compared to EPA's 162 tons per year threshold (40 CFR 60.752(a)(3)). The ARARs for air are MTCA Method B cleanup levels for air and Washington State Minimal Functional Standards for Landfills.

Surface Water

Surface water at the site is intermittent stormwater, flowing only several weeks of the year during and immediately after heavy rains. It is detained in the settling ponds at the east end of the site. Monitoring of station SW5, located approximately 120 yards downstream of the site, indicates that the majority of the flow infiltrates before it reaches this station. Fish and aquatic organisms are not present and cannot be supported in this environment. The water also cannot be a regular source of drinking water. Ecology and Kitsap County agreed that the surface water at the site represents stormwater rather than surface water (meeting June 5, 1998). Therefore, regulatory standards that are based on human consumption of water and/or organisms (i.e., federal freshwater and MTCA Method B cleanup levels for surface water) are not applicable. Federal and state criteria based on acute and chronic effects on aquatic life are applicable because surface water runoff from the site may discharge to surface water bodies that are capable of supporting aquatic life.

Chemical-specific ARARs for surface water are presented in Table 3-1.

Groundwater

Groundwater beneath the site is a source of drinking water for local residents. The well inventory and the domestic well sampling program have confirmed that approximately 31 downgradient residences utilize groundwater from the same aquifer as the site. Therefore, drinking water standards are applicable. Table 3-1 lists the chemical-specific ARARs for groundwater.

Groundwater beneath the site flows offsite to the north-northeast and then turns to flow more easterly. It most likely discharges diffusely to Eagle Harbor. The length of the flow path from the site boundary to Eagle Harbor is approximately 1 mile. The groundwater contamination, based on indicator parameters, extends less than 1,200 feet from the site boundary, a distance of approximately 4,000 feet from Eagle Harbor. Surface water standards therefore are not applicable to groundwater because of the distance between detected contamination and the nearest possible surface water discharge.

2.2 Location-Specific ARARs

Location-specific ARARs address culturally significant or environmentally sensitive areas that might affect activities such as selecting and/or implementing a cleanup action. These areas include floodplains, wetlands, shorelines, sensitive habitat, fault zones, and wilderness areas, as well as areas that have historic significance (e.g., historic landmarks). The laws containing the location-specific requirements identified as part of the ARARs analysis for the FS are summarized in Table 3-2.

Floodplains

The landfill is not located within the 100-year floodplain. Therefore, the requirements related to floodplains are not ARARs.

Wetlands

Wetlands have not been delineated within the landfill boundaries, thus the requirements for wetlands do not apply.

Shorelines

The landfill is not located within 200 feet of a shoreline, therefore the requirements related to shorelines are not applicable.

Sensitive Habitats

The U.S. Fish and Wildlife Service and the National Marine Fisheries Service were contacted for information on threatened or endangered specifies in the area potentially affected by the landfill. Only one species, the bald eagle, was identified in a letter dated August 24, 1999, from the U.S. Fish and Wildlife Service. However, the bald eagle is currently being delisted, and delisting is expected by July 2000.

Historical Significance

The Washington State Office of Archeology and Historic Preservation (OAHP) was contacted for information on potentially significant historical features on or adjacent to the site. A review by the OAHP in the area concluded that there are no recorded cultural resources in the area, and no historic places or landmarks are known to exist on or near the site. Therefore, the requirements of the National Archaeological Resources Protection Act and the National Historic Preservation Act are not ARARs.

Critical Areas

Under the Bainbridge Island City Ordinance 98-20, critical areas are defined as aquifer recharge areas, fish and wildlife habitats, frequently flooded areas, geologically hazardous areas, and wetland and streams and their protective buffer lands. There are no known critical areas within the Bainbridge Island Landfill property.

2.3 Action-Specific ARARs

Action-specific ARARs address cleanup actions that may be taken at the site. Potential cleanup actions include institutional controls, monitoring, source controls, collection, containment, treatment, and disposal. The potential action-specific ARARs for possible cleanup actions at the site are summarized in Table 3-3 and are discussed below.

Institutional Controls

WAC 173-340-440 of MTCA requires institutional controls at sites where a cleanup action results in residual concentrations of hazardous substances that exceed Method A or Method B cleanup levels, if conditional points of compliance have been established, or when Ecology determines such controls are required to ensure the continued protection of human health and the environment or the integrity of the cleanup action. The regulation requires that appropriate institutional controls be described in a restrictive deed covenant. In addition, the regulation requires financial assurances whenever the cleanup action includes containment. Because there may be residual concentrations of hazardous substances exceeding cleanup levels at the landfill and the cleanup action likely will include containment, institutional controls described in restrictive deed covenants and financial assurances will be required for site cleanup.

WAC 173-160-205(2) prohibits construction of water supply wells within 1,000 feet of solid waste landfills. Because the landfill is a solid waste landfill, this regulation is applicable. Implementation of this institutional control would require the affected area around the landfill to be mapped, and enforced by the Kitsap County and Ecology.

Dangerous waste regulations may apply to the main landfill waste under a reclamation action. Testing and book designation was conducted as part of the remedial investigation to evaluate the possible presence of hazardous waste in the landfill. None of the material evaluated was designated dangerous or hazardous waste. State-only persistent waste was designated in a portion of the landfill cover soil. Handling of this material will follow procedures outlined in WAC 173-303 if it is disturbed during the remedial action. Other possible dangerous or hazardous waste that may be discovered under a reclamation action would also be characterized, designated, and, if appropriate, managed according to WAC 173-303.

Compliance Monitoring

Preparation of a compliance monitoring plan for the site is an applicable MTCA requirement for cleanup actions (WAC 173-340-410). A groundwater monitoring plan must also be prepared, according to WAC 173-304-490. If the compliance monitoring plan includes installation of additional groundwater monitoring wells or abandonment of existing wells, then work will be required to meet state well construction standards (WAC 173-160). Health and safety monitoring will also be required for personnel conducting sampling and testing or cleanup actions at the site. Health and safety monitoring will be applicable under federal (29 CFR 1910.120) and state (WAC 296-62) regulations.

Consolidation and Containment

Construction of containment facilities as part of site cleanup need to meet the City of Bainbridge Island Building Permit requirements as well as provisions of the State Waste Discharge General Permit Program, and State Minimal Functional Standards for Landfills.

If the landfill remains onsite, provisions of the Bremerton-Kitsap County Board of Health Ordinance Number 1996-11 apply, including standards for methane control in nearby structures. If an air contaminant source, such as a landfill gas collection system, is constructed or modified, then the Puget Sound Clean Air Agency (PSCAA) regulations would apply. These would also apply during remedial actions for issues related to dust and odor control.

Treatment and Disposal

Cleanup actions that include treating and disposing contaminated groundwater must comply with the substantive requirements of WAC 173-240 (submittal of plans and reports for approval) and WAC 173-220 (NPDES permit requirements for point-source disposal of effluent into surface water). These regulations are applicable at the landfill for these types of actions.

Treatment of contaminated groundwater could produce residual solids that may be designated as federal hazardous wastes or state dangerous wastes. If hazardous or dangerous wastes were to be generated, they would need to be managed in accordance with the applicable storage, transport, and treatment or disposal requirements of the State Dangerous Waste Regulations (WAC 173-303).

Constructing a treatment or disposal facility would require new structures, and the City of Bainbridge Island Building Permit Requirements would be applicable. If the new structure is a source of air contaminants, the PSCAA regulations would also be applicable.

Local Construction Codes

If construction activities disturb more than 5 acres, the state's Waste Discharge General Permit Program (WAC 173-226) is applicable.

The Bainbridge Island Municipal Codes for Building and Construction (Title 15) will be applicable. In general, grading and clearing permits from the Building Division of the Bainbridge Island Planning and Community Development Department will be necessary if the proposed remedial actions involve excavation of soil greater than 50 cubic yards.

The Design and Construction Standards and Specifications approved by the City Council of Bainbridge Island in 1997 will also be applicable. The Design and Construction Standards and Specifications Manual includes sections on general design standards, building site requirements, grading, drainage, erosion, and sedimentation control plan requirements.

References

Washington Department of Ecology. 1994. *Natural Background Soil Metals Concentrations in Washington State.* Ecology Publication #94-115. October.

U.S. Fish and Wildlife Service and the National Marine Fisheries Service. 1999. Letter to CH2M HILL. August 24.

APPENDIX B

Supporting Data for Identification of COCs

Appendix B—List of Tables

Table B-1
BAINBRIDGE ISLAND LANDFILL FS
West End Area Samples
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
CONV	TOTAL ORGANIC CARBON		%	6	6	100%			0.17	15	3.6			
CONV	TOTAL SOLIDS		%	6	6	100%			56	90	80			
PEST	4,4'-DDT	50-29-3	µg/kg	1	6	17%	3.7	4.3	5.3	5.3	2.6	2,941		
PHC	DIESEL RANGE HYDROCARBONS		µg/kg	3	6	50%	28,000	31,000	2,700	21,500	14,867	200,000		
PHC	OIL RANGE HYDROCARBONS		µg/kg	2	6	33%	56,000	62,000	35,000	180,000	55,417	200,000		
PNA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	3	6	50%	1.9	2.0	2.0	3.0	1.8	137		
PNA	BENZO(A)PYRENE	50-32-8	µg/kg	4	6	67%	2.5	2.6	0.97	2.0	1.3	137		
PNA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	4	6	67%	1.4	2.7	1.6	15	4.2	137		
PNA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	3	6	50%	2.2	2.5	0.73	3.7	1.6	137		
PNA	CHRYSENE	218-01-9	µg/kg	3	6	50%	6.6	7.4	8.8	37	11	137		
PNA	DIBENZO(A,H)ANTHRACENE	53-70-3	µg/kg	1	6	17%	3.3	3.9	1.3	1.3	1.7	137		
PNA	FLUORANTHENE	206-44-0	µg/kg	1	6	17%	18	21	10	10	9.7	3.20E+06		
PNA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/kg	2	6	33%	2.7	3.1	2.4	3.0	1.9	137		
SVOA	PENTACHLOROPHENOL	87-86-5	µg/kg	1	6	17%	370	410	585	585	261	8,333		
VOA	TOLUENE	108-88-3	µg/kg	1	6	17%	1.1	1.2	4.0	4.0	1.2	160,000		
VOA	TRICHLOROFLUOROMETHANE	75-69-4	µg/kg	1	6	17%	2.2	2.4	3.4	3.4	1.5	240,000		
METAL	ANTIMONY	7440-36-0	µg/kg	3	6	50%	100	120	170	4,200	825			
METAL	ARSENIC	7440-38-2	µg/kg	6	6	100%			310	16,200	4,307	7,300	1	
METAL	BARIUM	7440-39-3	µg/kg	6	6	100%			44,300	1.25E+06	285,350	5.60E+06		
METAL	BERYLLIUM	7440-41-7	µg/kg	5	6	83%	600	600	270	350	303	610		
METAL	CADMIUM	7440-43-9	µg/kg	2	6	33%	210	240	390	5,800	1,108	40,000		
METAL	CHROMIUM	7440-47-3	µg/kg	6	6	100%			21,550	126,000	43,758	100,000	1	
METAL	COPPER	7440-50-8	µg/kg	5	6	83%	12,300	12,300	13,300	245,000	52,533	2.96E+06		
METAL	IRON	7439-89-6	µg/kg	6	6	100%			1.15E+07	1.64E+08	3.95E+07	5.87E+07	1	
METAL	LEAD	7439-92-1	µg/kg	6	6	100%			2,400	1.42E+06	244,775	250,000	1	
METAL	MANGANESE	7439-96-5	µg/kg	6	6	100%			146,500	1.52E+06	438,250	1.12E+07		
METAL	MERCURY	7439-97-6	µg/kg	3	6	50%	50	60	60	105	53	24,000		
METAL	NICKEL	7440-02-0	µg/kg	6	6	100%			22,250	144,000	48,175	1.60E+06		
METAL	SELENIUM	7782-49-2	µg/kg	2	6	33%	110	120	205	1,100	257	400,000		
METAL	SILVER	7440-22-4	µg/kg	5	6	83%	360	360	390	2,100	708	400,000		
METAL	THALLIUM	7440-28-0	µg/kg	5	6	83%	110	110	140	290	157	5,600		
METAL	TIN	7440-31-5	µg/kg	2	6	33%	1,000	1,000	2,000	478,000	80,333	4.80E+07		
METAL	ZINC	7440-66-6	µg/kg	6	6	100%			23,400	1.66E+06	306,258	2.40E+07		

Notes:

[a] Mean value is calculated assigning nondetects a value of one half the detection limit.
[b] See associated screening level table.

Table B-2
BAINBRIDGE ISLAND LANDFILL FS
Septage Pits
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
CONV	TOTAL SOLIDS		%	16	16	100%			26	85	45			
PEST	4,4'-DDD	72-54-8	µg/kg	16	18	89%	3.9	3.9	220	2,200	831	4,167		
PEST	4,4'-DDE	72-55-9	µg/kg	16	18	89%	3.9	3.9	120	330	213	2,941		
PEST	ALPHA CHLORDANE	5103-71-9	µg/kg	11	18	61%	1.9	140	28	200	83			
PEST	AROCLOR 1254	11097-69-1	µg/kg	16	18	89%	38	39	1,000	2,750	1,505	1,600	8	
PEST	AROCLOR 1260	11096-82-5	µg/kg	12	18	67%	38	2,600	550	960	759			
PEST	DIELDRIN	60-57-1	µg/kg	16	18	89%	3.9	3.9	140	470	219	63	16	
PEST	GAMMA CHLORDANE	57-74-9	µg/kg	10	18	56%	1.9	250	78	220	98	769		
PEST	TOTAL PCBS	1336-36-3	µg/kg	16	16	100%			1,650	3,310	2,233	130	16	
PHC	DIESEL RANGE HYDROCARBONS		µg/kg	15	18	83%	30,000	58,000	120,000	2.70E+06	782,167	200,000	14	
PHC	GAS RANGE HYDROCARBONS		µg/kg	4	18	22%	12,000	42,000	600,000	940,000	169,278	100,000	4	
PHC	OIL RANGE HYDROCARBONS		µg/kg	16	18	89%	59,000	59,000	310,000	1.60E+07	3.78E+06	200,000	16	
SVOA	1,2-DICHLOROBENZENE	95-50-1	µg/kg	8	18	44%	78	920	590	65,000	10,966	7.20E+06		
SVOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	6	18	33%	78	930	570	16,000	3,247	41,667		
SVOA	2-METHYLNAPHTHALENE	91-57-6	µg/kg	3	18	17%	78	2,800	2,700	3,600	844			
SVOA	4-CHLOROANILINE	106-47-8	µg/kg	13	18	72%	230	2,500	1,400	14,000	4,527	320,000		
SVOA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	11	18	61%	78	3,100	670	1,200	915	137	11	5
SVOA	BENZO(A)PYRENE	50-32-8	µg/kg	6	18	33%	160	6,300	980	1,700	1,399	137	6	12
SVOA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	1	18	6%	230	9,400	1,400	1,400	1,846	137	1	17
SVOA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	4	18	22%	160	6,300	1,100	1,300	1,314	137	4	14
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	µg/kg	16	18	89%	78	79	810	12,000	3,569	71,429		
SVOA	CHRYSENE	218-01-9	µg/kg	11	18	61%	78	3,100	720	1,500	1,043	137	11	5
SVOA	DIETHYLPHTHALATE	84-66-2	µg/kg	1	18	6%	78	3,100	31,000	31,000	2,299	6.40E+07		
SVOA	FLUORANTHENE	206-44-0	µg/kg	1	18	6%	230	9,400	1,300	1,300	1,841	3.20E+06		
SVOA	NAPHTHALENE	91-20-3	µg/kg	2	18	11%	78	3,100	540	570	612	3.20E+06		
SVOA	PHENANTHRENE	85-01-8	µg/kg	15	18	83%	78	890	480	2,600	902			
SVOA	PYRENE	129-00-0	µg/kg	12	18	67%	78	3,100	830	1,400	1,084	2.40E+06		
VOA	1,2,3-TRICHLOROBENZENE	87-61-6	µg/kg	4	18	22%	5.7	14	110	260	48			
VOA	1,2,4-TRICHLOROBENZENE	120-82-1	µg/kg	6	18	33%	5.7	13	4.3	1,300	247	8,000		
VOA	1,2,4-TRIMETHYLBENZENE	95-63-6	µg/kg	4	18	22%	1.2	2.8	1,890	4,700	675			
VOA	1,2-DICHLOROBENZENE	95-50-1	µg/kg	14	18	78%	1.1	2.5	2.1	71,000	8,714	72,000		
VOA	1,3,5-TRIMETHYLBENZENE	108-67-8	µg/kg	4	18	22%	1.2	2.9	423	1,200	169			
VOA	1,3-DICHLOROBENZENE	541-73-1	µg/kg	6	18	33%	1.3	2.9	3.0	3,650	658			
VOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	10	18	56%	1.5	3.3	3.2	19,000	2,758	182	4	
VOA	2-BUTANONE	78-93-3	µg/kg	4	18	22%	5.7	14	140	430	65	480,000		
VOA	2-HEXANONE	591-78-6	µg/kg	1	18	6%	5.7	160	110	110	23			
VOA	4-ISOPROPYLTOLUENE	99-87-6	µg/kg	5	18	28%	1.2	2.8	3.4	1,750	245			
VOA	ACETONE	67-64-1	µg/kg	9	18	50%	8.2	20	19	2,000	273	80,000		

Table B-2
BAINBRIDGE ISLAND LANDFILL FS
Septage Pits
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
VOA	CARBON DISULFIDE	75-15-0	µg/kg	4	18	22%	1.1	2.7	39	140	19	80,000		
VOA	CHLOROBENZENE	108-90-7	µg/kg	3	18	17%	1.1	33	31	150	14	16,000		
VOA	ETHYLBENZENE	100-41-4	µg/kg	5	18	28%	1.1	2.7	4.1	410	46	80,000		
VOA	ISOPROPYLBENZENE	98-82-8	µg/kg	4	18	22%	1.6	3.8	73	200	30	64,000		
VOA	M,P-XYLENE	1330-20-7	µg/kg	5	18	28%	2.3	5.5	11	1,400	138			
VOA	METHYLENE CHLORIDE	75-09-2	µg/kg	5	18	28%	2.3	13	28	357	43	583		
VOA	NAPHTHALENE	91-20-3	µg/kg	4	18	22%	5.7	14	295	900	141	32,000		
VOA	N-BUTYLBENZENE	104-51-8	µg/kg	4	18	22%	2.3	5.5	525	1,100	201			
VOA	N-PROPYLBENZENE	103-65-1	µg/kg	4	18	22%	1.4	3.5	320	1,100	146			
VOA	O-XYLENE	95-47-6	µg/kg	5	18	28%	1.2	2.9	4.2	740	81	1.60E+06		
VOA	SEC-BUTYLBENZENE	135-98-8	µg/kg	4	18	22%	1.2	3.0	290	675	105			
VOA	TETRACHLOROETHENE	127-18-4	µg/kg	4	18	22%	1.1	33	2.8	51	9.1	86		
VOA	TOLUENE	108-88-3	µg/kg	7	18	39%	1.1	2.7	2.0	1,135	107	160,000		
VOA	TRICHLOROFLUOROMETHANE	75-69-4	µg/kg	6	18	33%	2.3	65	3.5	8.6	9.7	240,000		
METAL	ANTIMONY	7440-36-0	µg/kg	16	18	89%	120	120	4,500	9,800	6,101			
METAL	ARSENIC	7440-38-2	µg/kg	18	18	100%			1,800	24,150	13,889	7,300	16	
METAL	BARIUM	7440-39-3	µg/kg	18	18	100%			63,500	1.56E+06	1.01E+06	5.60E+06		
METAL	BERYLLIUM	7440-41-7	µg/kg	9	18	50%	230	380	230	460	219	610		
METAL	CADMIUM	7440-43-9	µg/kg	16	18	89%	230	240	6,300	25,400	13,308	40,000		
METAL	CHROMIUM	7440-47-3	µg/kg	18	18	100%			39,700	62,500	52,669	100,000		
METAL	COPPER	7440-50-8	µg/kg	18	18	100%			17,800	1.05E+06	678,244	2.96E+06		
METAL	IRON	7439-89-6	µg/kg	18	18	100%			1.02E+07	2.19E+07	1.53E+07	5.87E+07		
METAL	LEAD	7439-92-1	µg/kg	18	18	100%			3,500	1.00E+06	340,900	250,000	14	
METAL	MANGANESE	7439-96-5	µg/kg	18	18	100%			72,300	391,000	177,267	1.12E+07		
METAL	MERCURY	7439-97-6	µg/kg	16	18	89%	60	60	5,700	21,100	8,967	24,000		
METAL	NICKEL	7440-02-0	µg/kg	18	18	100%			22,100	56,000	38,758	1.60E+06		
METAL	SELENIUM	7782-49-2	µg/kg	6	18	33%	2,300	5,600	560	6,300	2,505	400,000		
METAL	SILVER	7440-22-4	µg/kg	17	18	94%	350	350	600	46,300	28,065	400,000		
METAL	THALLIUM	7440-28-0	µg/kg	2	18	11%	190	380	130	160	134	5,600		
METAL	TIN	7440-31-5	µg/kg	16	18	89%	100	1,000	371,000	625,000	460,364	4.80E+07		
METAL	ZINC	7440-66-6	µg/kg	18	18	100%			30,300	7.19E+06	2.51E+06	2.40E+07		

Notes:

[a] Mean value is calculated assigning nondetects a value of one half the detection limit.
[b] See associated screening level table.

Table B-3
BAINBRIDGE ISLAND LANDFILL FS
Garbage Waste Fraction
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
PEST	4,4'-DDD	72-54-8	µg/kg	4	8	50%	7.5	220	5.7	100	35	4,167	MTCA Method B		
PEST	4,4'-DDE	72-55-9	µg/kg	1	8	13%	3.3	170	5.1	5.1	22	2,941	MTCA Method B		
PEST	4,4'-DDT	50-29-3	µg/kg	1	8	13%	3.3	170	120	120	32	2,941	MTCA Method B		
PEST	ALDRIN	309-00-2	µg/kg	1	8	13%	1.8	83	1.7	1.7	8.8	59	MTCA Method B		1
PEST	ALPHA CHLORDANE	5103-71-9	µg/kg	4	8	50%	4.4	83	3.4	8.9	12				
PEST	AROCLOR 1242	53469-21-9	µg/kg	3	8	38%	33	3,200	85	460	308				
PEST	AROCLOR 1254	11097-69-1	µg/kg	3	8	38%	33	1,600	38	4,100	681	1,600	MTCA Method B	1	1
PEST	BETA-BHC	319-85-7	µg/kg	1	8	13%	1.7	83	7.0	7.0	9.4	556	MTCA Method B		
PEST	DELTA-BHC	319-86-8	µg/kg	1	8	13%	1.7	83	1.4	1.4	9.2				
PEST	DIELDRIN	60-57-1	µg/kg	2	8	25%	3.3	170	2.5	14	19	63	MTCA Method B		2
PEST	ENDRIN KETONE	53494-70-5	µg/kg	1	8	13%	3.3	170	6.4	6.4	18				
PEST	GAMMA CHLORDANE	57-74-9	µg/kg	4	8	50%	2.1	83	3.2	36	14	769	MTCA Method B		
PEST	GAMMA-BHC (LINDANE)	58-89-9	µg/kg	2	8	25%	1.7	83	3.2	3.2	9.0	769	MTCA Method B		
PEST	METHOXYCHLOR	72-43-5	µg/kg	1	8	13%	17	830	8.2	8.2	84	400,000	MTCA Method B		
PEST	TOTAL PCBS	1336-36-3	µg/kg	6	6	100%			38	4,100	831	130	MTCA Method B	3	
SVOA	1,2-DICHLOROBENZENE	95-50-1	µg/kg	1	8	13%	67	2,900	190	190	345	7.20E+06	MTCA Method B		
SVOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	1	8	13%	67	2,900	180	180	343	41,667	MTCA Method B		
SVOA	2,4-DIMETHYLPHENOL	105-67-9	µg/kg	1	8	13%	200	8,800	280	280	1,006	1.60E+06	MTCA Method B		
SVOA	2-METHYLNAPHTHALENE	91-57-6	µg/kg	5	8	63%	74	2,900	160	5,700	2,161				
SVOA	3,3'-DICHLOROBENZIDINE	91-94-1	µg/kg	2	8	25%	370	15,000	1,015	1,015	1,868	2,222	MTCA Method B		3
SVOA	4-CHLORO-3-METHYLPHENOL	59-50-7	µg/kg	2	8	25%	150	5,900	730	1,000	859				
SVOA	4-METHYLPHENOL	106-44-5	µg/kg	5	8	63%	150	5,900	180	4,000	1,644	400,000	MTCA Method B		
SVOA	4-NITROANILINE	100-01-6	µg/kg	1	8	13%	330	15,000	680	680	1,720				
SVOA	ACENAPHTHENE	83-32-9	µg/kg	4	8	50%	74	2,900	250	5,200	1,466	4.80E+06	MTCA Method B		
SVOA	ANTHRACENE	120-12-7	µg/kg	3	8	38%	79	3,200	160	1,550	705	2.40E+07	MTCA Method B		
SVOA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	4	8	50%	74	2,900	265	1,500	614	137	MTCA Method B	4	2
SVOA	BENZO(A)PYRENE	50-32-8	µg/kg	4	8	50%	150	5,900	170	5,650	1,357	137	MTCA Method B	4	4
SVOA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	4	8	50%	220	8,800	230	8,400	2,011	137	MTCA Method B	4	4
SVOA	BENZO(G,H,I)PERYLENE	191-24-2	µg/kg	3	8	38%	150	5,900	400	5,650	1,331				
SVOA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	4	8	50%	100	4,000	270	3,850	967	137	MTCA Method B	4	2
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	µg/kg	8	8	100%			520	30,000	7,659	71,429	MTCA Method B		
SVOA	BUTYLBENZYLPHTHALATE	85-68-7	µg/kg	3	8	38%	74	2,900	360	7,850	1,383	1.60E+07	MTCA Method B		
SVOA	CARBAZOLE	86-74-8	µg/kg	3	8	38%	74	2,900	150	740	499	50,000	MTCA Method B		
SVOA	CHRYSENE	218-01-9	µg/kg	5	8	63%	74	980	350	4,100	1,397	137	MTCA Method B	5	1
SVOA	DIBENZ(A,H)ANTHRACENE	53-70-3	µg/kg	3	8	38%	220	8,800	600	8,400	1,984	137	MTCA Method B	3	5
SVOA	DIBENZOFURAN	132-64-9	µg/kg	4	8	50%	74	2,900	180	3,400	1,011				
SVOA	DIETHYLPHTHALATE	84-66-2	µg/kg	2	8	25%	74	2,900	90	110	342	6.40E+07	MTCA Method B		
SVOA	DIMETHYLPHTHALATE	131-11-3	µg/kg	1	8	13%	67	2,900	610	610	397	8.00E+07	MTCA Method B		
SVOA	DI-N-BUTYLPHTHALATE	84-74-2	µg/kg	1	8	13%	200	8,800	260	260	1,004	8.00E+06	MTCA Method B		
SVOA	DI-N-OCTYL PHTHALATE	117-84-0	µg/kg	3	8	38%	220	8,800	600	8,400	1,984	1.60E+06	MTCA Method B		
SVOA	FLUORANTHENE	206-44-0	µg/kg	3	8	38%	220	8,800	480	2,500	1,409	3.20E+06	MTCA Method B		
SVOA	FLUORENE	86-73-7	µg/kg	4	8	50%	74	2,900	350	2,750	1,028	3.20E+06	MTCA Method B		
SVOA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/kg	3	8	38%	220	8,800	600	8,400	1,984	137	MTCA Method B	3	5
SVOA	ISOPHORONE	78-59-1	µg/kg	1	8	13%	67	2,900	140	140	338	1.05E+06	MTCA Method B		
SVOA	NAPHTHALENE	91-20-3	µg/kg	5	8	63%	74	2,900	340	33,000	6,937	3.20E+06	MTCA Method B		
SVOA	PENTACHLOROPHENOL	87-86-5	µg/kg	1	8	13%	330	15,000	1,600	1,600	1,835	8,333	MTCA Method B		1
SVOA	PHENANTHRENE	85-01-8	µg/kg	5	8	63%	74	2,900	1,000	3,950	1,511				

Table B-3
BAINBRIDGE ISLAND LANDFILL FS
Garbage Waste Fraction
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
SVOA	PYRENE	129-00-0	µg/kg	5	8	63%	74	2,900	685	3,050	1,237	2.40E+06	MTCA Method B		
METAL	ARSENIC	7440-38-2	µg/kg	8	8	100%			4,400	14,000	7,238	7,300	Puget Sound Background	3	
METAL	BARIUM	7440-39-3	µg/kg	8	8	100%			66,000	821,000	233,775	5.60E+06	MTCA Method B		
METAL	BERYLLIUM	7440-41-7	µg/kg	5	8	63%	200	300	200	300	194	610	Puget Sound Background		
METAL	CADMIUM	7440-43-9	µg/kg	8	8	100%			460	4,600	1,883	40,000	MTCA Method B		
METAL	CHROMIUM	7440-47-3	µg/kg	8	8	100%			31,300	76,000	44,925	100,000	MTCA Method B		
METAL	COPPER	7440-50-8	µg/kg	8	8	100%			44,700	136,000	81,963	2.96E+06	MTCA Method B		
METAL	IRON	7439-89-6	µg/kg	8	8	100%			2.77E+07	8.72E+07	4.89E+07	5.87E+07	Puget Sound Background	2	
METAL	LEAD	7439-92-1	µg/kg	8	8	100%			28,000	310,000	131,750	250,000	MTCA Method B	1	
METAL	MANGANESE	7439-96-5	µg/kg	8	8	100%			305,000	761,000	468,750	1.12E+07	MTCA Method B		
METAL	MERCURY	7439-97-6	µg/kg	7	8	88%	50	50	90	740	288	24,000	MTCA Method B		
METAL	NICKEL	7440-02-0	µg/kg	8	8	100%			33,000	56,000	45,625	1.60E+06	MTCA Method B		
METAL	SELENIUM	7782-49-2	µg/kg	2	8	25%	100	300	100	200	113	400,000	MTCA Method B		
METAL	SILVER	7440-22-4	µg/kg	8	8	100%			30	1,400	334	400,000	MTCA Method B		
METAL	THALLIUM	7440-28-0	µg/kg	1	8	13%	500	1,000	200	200	369	5,600	MTCA Method B		
METAL	VANADIUM	7440-62-2	µg/kg	8	8	100%			35,300	64,900	43,188	560,000	MTCA Method B		
METAL	ZINC	7440-66-6	µg/kg	8	8	100%			133,000	3.73E+06	804,625	2.40E+07	MTCA Method B		

Notes:

Acronyms
METAL = total metals
PEST = pesticides
SVOA = semivolatile organic analysis
VOA = volatile organic analysis

Table B-4
BAINBRIDGE ISLAND LANDFILL FS
Inert Waste Fraction
Statistical Summary by parameter
Parameters Detected In at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
PEST	4,4'-DDD	72-54-8	µg/kg	8	10	80%	11	25	3.6	120	23	4,167	MTCA Method B		
PEST	4,4'-DDE	72-55-9	µg/kg	5	10	50%	3.8	21	4.4	32	10	2,941	MTCA Method B		
PEST	4,4'-DDT	50-29-3	µg/kg	1	10	10%	3.6	73	600	600	65	2,941	MTCA Method B		
PEST	ALDRIN	309-00-2	µg/kg	1	10	10%	1.8	4.5	8.2	8.2	2.0	59	MTCA Method B		
PEST	ALPHA CHLORDANE	5103-71-9	µg/kg	5	10	50%	1.9	12	2.6	150	18				
PEST	ALPHA-BHC	319-84-6	µg/kg	1	10	10%	1.8	4.6	1.6	1.6	1.6	159	MTCA Method B		
PEST	AROCLOR 1242	53469-21-9	µg/kg	5	10	50%	35	300	75	390	117				
PEST	AROCLOR 1254	11097-69-1	µg/kg	2	10	20%	38	230	340	680	128	1,600	MTCA Method B		
PEST	AROCLOR 1260	11096-82-5	µg/kg	1	10	10%	35	170	100	100	41				
PEST	BETA-BHC	319-85-7	µg/kg	3	10	30%	2.1	7.9	2.4	21	4.5	556	MTCA Method B		
PEST	DIELDRIN	60-57-1	µg/kg	1	10	10%	3.5	14	11	11	3.5	63	MTCA Method B		
PEST	ENDOSULFAN SULFATE	1031-07-8	µg/kg	1	10	10%	3.5	7.7	2.2	2.2	2.4				
PEST	ENDRIN	72-20-8	µg/kg	1	10	10%	3.5	4.3	2.0	2.0	2.0	24,000	MTCA Method B		
PEST	ENDRIN ALDEHYDE	7421-93-4	µg/kg	3	10	30%	3.5	12	2.9	7.8	3.3				
PEST	GAMMA CHLORDANE	57-74-9	µg/kg	5	10	50%	1.8	11	3.0	170	22	769	MTCA Method B		
PEST	GAMMA-BHC (LINDANE)	58-89-9	µg/kg	2	10	20%	1.8	2.2	1.6	1.6	1.1	769	MTCA Method B		
PEST	HEPTACHLOR EPOXIDE	1024-57-3	µg/kg	1	10	10%	1.8	2.3	3.0	3.0	1.2	110	MTCA Method B		
PEST	TOTAL PCBS	1336-36-3	µg/kg	7	7	100%			75	1,070	285	130	MTCA Method B	3	
SVOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	2	10	20%	71	86	89	110	51	41,667	MTCA Method B		
SVOA	2-METHYLNAPHTHALENE	91-57-6	µg/kg	8	10	80%	71	72	100	760	202				
SVOA	4-METHYLPHENOL	106-44-5	µg/kg	6	10	60%	140	160	120	340	164	400,000	MTCA Method B		
SVOA	ACENAPHTHENE	83-32-9	µg/kg	8	10	80%	71	72	90	1,800	349	4.80E+06	MTCA Method B		
SVOA	ACENAPHTHYLENE	208-96-8	µg/kg	1	10	10%	71	86	170	170	53				
SVOA	ANTHRACENE	120-12-7	µg/kg	7	10	70%	76	93	110	8,800	1,263	2.40E+07	MTCA Method B		
SVOA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	8	10	80%	71	72	64	1,500	401	137	MTCA Method B	6	
SVOA	BENZO(A)PYRENE	50-32-8	µg/kg	6	10	60%	140	170	110	1,300	316	137	MTCA Method B	4	4
SVOA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	5	10	50%	210	260	190	2,900	539	137	MTCA Method B	5	5
SVOA	BENZO(G,H,I)PERYLENE	191-24-2	µg/kg	3	10	30%	140	170	170	690	160				
SVOA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	5	10	50%	96	120	150	2,400	521	137	MTCA Method B	5	
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	µg/kg	10	10	100%			200	54,000	8,104	71,429	MTCA Method B		
SVOA	BUTYLBENZYLPHTHALATE	85-68-7	µg/kg	8	10	80%	71	72	84	3,450	527	1.60E+07	MTCA Method B		
SVOA	CARBAZOLE	86-74-8	µg/kg	6	10	60%	71	86	79	1,150	293	50,000	MTCA Method B		
SVOA	CHRYSENE	218-01-9	µg/kg	8	10	80%	71	72	120	3,400	878	137	MTCA Method B	6	
SVOA	DIBENZ(A,H)ANTHRACENE	53-70-3	µg/kg	1	10	10%	210	260	380	380	146	137	MTCA Method B	1	9
SVOA	DIBENZOFURAN	132-64-9	µg/kg	8	10	80%	71	72	79	1,200	261				
SVOA	DIETHYLPHTHALATE	84-66-2	µg/kg	2	10	20%	71	86	82	260	65	6.40E+07	MTCA Method B		
SVOA	DIMETHYLPHTHALATE	131-11-3	µg/kg	1	10	10%	71	86	96	96	45	8.00E+07	MTCA Method B		
SVOA	DI-N-BUTYLPHTHALATE	84-74-2	µg/kg	1	10	10%	210	260	1,800	1,800	286	8.00E+06	MTCA Method B		
SVOA	FLUORANTHENE	206-44-0	µg/kg	8	10	80%	210	210	240	3,700	1,045	3.20E+06	MTCA Method B		
SVOA	FLUORENE	86-73-7	µg/kg	8	10	80%	71	72	110	2,300	433	3.20E+06	MTCA Method B		
SVOA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/kg	1	10	10%	210	260	800	800	188	137	MTCA Method B	1	9
SVOA	NAPHTHALENE	91-20-3	µg/kg	8	10	80%	71	72	100	3,500	585	3.20E+06	MTCA Method B		
SVOA	PENTACHLOROPHENOL	87-86-5	µg/kg	1	10	10%	350	430	2,100	2,100	388	8,333	MTCA Method B		
SVOA	PHENANTHRENE	85-01-8	µg/kg	8	10	80%	71	72	230	4,300	1,071				
SVOA	PYRENE	129-00-0	µg/kg	8	10	80%	71	72	130	4,100	1,128	2.40E+06	MTCA Method B		
VOA	1,2,4-TRIMETHYLBENZENE	95-63-6	µg/kg	7	10	70%	1.1	1.2	5.2	52	17				
VOA	1,3,5-TRIMETHYLBENZENE	108-67-8	µg/kg	7	10	70%	1.1	1.2	2.8	8.1	4.3				
VOA	1,3-DICHLOROBENZENE	541-73-1	µg/kg	1	10	10%	1.1	1.4	1.6	1.6	0.71				

Table B-4
BAINBRIDGE ISLAND LANDFILL FS
Inert Waste Fraction
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
VOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	5	10	50%	1.1	1.3	0.60	19	3.2	182	MTCA Method B PGW		
VOA	2-BUTANONE	78-93-3	µg/kg	6	10	60%	5.4	5.9	19	45	22	480,000	MTCA Method B PGW		
VOA	4-ISOPROPYLTOLUENE	99-87-6	µg/kg	7	10	70%	1.1	1.2	1.3	19	5.4				
VOA	ACETONE	67-64-1	µg/kg	6	10	60%	5.4	5.9	134	270	125	80,000	MTCA Method B PGW		
VOA	BENZENE	71-43-2	µg/kg	1	10	10%	1.1	1.4	0.60	0.60	0.61	151	MTCA Method B PGW		
VOA	CARBON DISULFIDE	75-15-0	µg/kg	3	10	30%	1.1	1.3	1.4	1.6	0.88	80,000	MTCA Method B PGW		
VOA	CHLOROBENZENE	108-90-7	µg/kg	1	10	10%	1.1	1.4	4.6	4.6	1.0	16,000	MTCA Method B PGW		
VOA	ETHYLBENZENE	100-41-4	µg/kg	5	10	50%	1.1	1.3	3.0	18	4.8	80,000	MTCA Method B PGW		
VOA	ISOPROPYLBENZENE	98-82-8	µg/kg	7	10	70%	1.1	1.2	2.8	8.1	4.3	64,000	MTCA Method B PGW		
VOA	M,P-XYLENE	1330-20-7	µg/kg	7	10	70%	1.1	1.2	1.2	26	7.0				
VOA	NAPHTHALENE	91-20-3	µg/kg	6	10	60%	5.4	6.8	8.4	570	81	32,000	MTCA Method B PGW		
VOA	N-BUTYLBENZENE	104-51-8	µg/kg	7	10	70%	2.1	2.3	1.9	6.5	2.9				
VOA	N-PROPYLBENZENE	103-65-1	µg/kg	6	10	60%	1.1	1.2	1.3	5.9	2.6				
VOA	O-XYLENE	95-47-6	µg/kg	6	10	60%	1.1	1.3	1.3	11	3.2	1.60E+06	MTCA Method B PGW		
VOA	SEC-BUTYLBENZENE	135-98-8	µg/kg	5	10	50%	1.1	1.2	1.2	4.7	1.7				
VOA	TERT-BUTYLBENZENE	98-06-6	µg/kg	3	10	30%	1.1	1.3	3.6	15	3.0				
VOA	TOLUENE	108-88-3	µg/kg	5	10	50%	1.1	1.3	0.40	2.8	0.97	160,000	MTCA Method B PGW		
VOA	TRICHLOROFLUOROMETHANE	75-69-4	µg/kg	2	10	20%	1.1	1.3	0.50	1.6	0.69	240,000	MTCA Method B PGW		
METAL	ARSENIC	7440-38-2	µg/kg	10	10	100%			1,600	12,000	5,190	7,300	Puget Sound Background	2	
METAL	BARIUM	7440-39-3	µg/kg	10	10	100%			57,100	289,000	111,830	5.60E+06	MTCA Method B		
METAL	BERYLLIUM	7440-41-7	µg/kg	9	10	90%	300	300	200	300	245	610	Puget Sound Background		
METAL	CADMIUM	7440-43-9	µg/kg	10	10	100%			200	4,900	1,566	40,000	MTCA Method B		
METAL	CHROMIUM	7440-47-3	µg/kg	10	10	100%			24,800	61,000	40,630	100,000	MTCA Method B		
METAL	COPPER	7440-50-8	µg/kg	10	10	100%			18,700	981,000	168,640	2.96E+06	MTCA Method B		
METAL	IRON	7439-89-6	µg/kg	10	10	100%			1.67E+07	7.18E+07	3.64E+07	5.87E+07	Puget Sound Background	1	
METAL	LEAD	7439-92-1	µg/kg	10	10	100%			25,000	850,000	220,200	250,000	MTCA Method B	2	
METAL	MANGANESE	7439-96-5	µg/kg	10	10	100%			198,000	580,000	359,500	1.12E+07	MTCA Method B		
METAL	MERCURY	7439-97-6	µg/kg	8	10	80%	50	50	60	370	168	24,000	MTCA Method B		
METAL	NICKEL	7440-02-0	µg/kg	10	10	100%			31,000	56,000	42,200	1.60E+06	MTCA Method B		
METAL	SELENIUM	7782-49-2	µg/kg	2	10	20%	100	100	100	200	70	400,000	MTCA Method B		
METAL	SILVER	7440-22-4	µg/kg	10	10	100%			20	640	235	400,000	MTCA Method B		
METAL	THALLIUM	7440-28-0	µg/kg	3	10	30%	500	600	100	1,000	325	5,600	MTCA Method B		
METAL	VANADIUM	7440-62-2	µg/kg	10	10	100%			38,600	54,400	44,200	560,000	MTCA Method B		
METAL	ZINC	7440-66-6	µg/kg	10	10	100%			93,200	1.15E+06	373,810	2.40E+07	MTCA Method B		

Notes:

Acronyms
METAL = total metals
PEST = pesticides
SVOA = semivolatile organic analysis
VOA = volatile organic analysis

Table B-5
BAINBRIDGE ISLAND LANDFILL FS
Main Landfill Cover Soil
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
SVOA	2-METHYLNAPHTHALENE	91-57-6	µg/kg	3	11	27%	68	73	205,000	330,000	77,753				
SVOA	4-METHYLPHENOL	106-44-5	µg/kg	1	11	9%	140	12,000	7,800	7,800	1,651	400,000	MTCA Method B		
SVOA	ACENAPHTHENE	83-32-9	µg/kg	3	11	27%	68	73	290,000	370,000	90,935	4.80E+06	MTCA Method B		
SVOA	ACENAPHTHYLENE	208-96-8	µg/kg	2	11	18%	68	5,900	3,800	4,200	1,021				
SVOA	ANTHRACENE	120-12-7	µg/kg	3	11	27%	73	78	185,000	420,000	88,209	2.40E+07	MTCA Method B		
SVOA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	3	11	27%	68	73	61,000	76,500	18,798	137	MTCA Method B	3	
SVOA	BENZO(A)PYRENE	50-32-8	µg/kg	3	11	27%	140	150	18,000	22,000	5,688	137	MTCA Method B	3	8
SVOA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	3	11	27%	200	220	33,000	41,000	10,440	137	MTCA Method B	3	8
SVOA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	3	11	27%	92	99	21,000	34,000	7,671	137	MTCA Method B	3	
SVOA	BENZOIC ACID	65-85-0	µg/kg	1	11	9%	680	59,000	710	710	6,423	3.20E+08	MTCA Method B		
SVOA	CARBAZOLE	86-74-8	µg/kg	3	11	27%	68	73	82,000	160,000	34,753	50,000	MTCA Method B	3	
SVOA	CHRYSENE	218-01-9	µg/kg	6	11	55%	68	73	71	130,000	30,049	137	MTCA Method B	4	
SVOA	DIBENZOFURAN	132-64-9	µg/kg	3	11	27%	68	73	220,000	285,000	66,844				
SVOA	FLUORANTHENE	206-44-0	µg/kg	3	11	27%	200	220	300,000	365,000	89,167	3.20E+06	MTCA Method B		
SVOA	FLUORENE	86-73-7	µg/kg	3	11	27%	68	73	290,000	415,000	91,389	3.20E+06	MTCA Method B		
SVOA	NAPHTHALENE	91-20-3	µg/kg	3	11	27%	68	73	450,000	960,000	204,571	3.20E+06	MTCA Method B		
SVOA	PENTACHLOROPHENOL	87-86-5	µg/kg	4	11	36%	340	360	400	710,000	164,693	8,333	MTCA Method B	3	
SVOA	PHENANTHRENE	85-01-8	µg/kg	3	11	27%	68	73	560,000	820,000	184,571				
SVOA	PYRENE	129-00-0	µg/kg	3	11	27%	68	73	180,000	215,000	55,026	2.40E+06	MTCA Method B		
METAL	ARSENIC	7440-38-2	µg/kg	11	11	100%			800	16,000	4,545	7,300	Puget Sound Background	3	
METAL	BARIUM	7440-39-3	µg/kg	11	11	100%			37,400	207,000	65,882	5.60E+06	MTCA Method B		
METAL	BERYLLIUM	7440-41-7	µg/kg	11	11	100%			130	300	202	610	Puget Sound Background		
METAL	CADMIUM	7440-43-9	µg/kg	11	11	100%			40	390	120	40,000	MTCA Method B		
METAL	CHROMIUM	7440-47-3	µg/kg	11	11	100%			23,600	40,800	29,495	100,000	MTCA Method B		
METAL	COPPER	7440-50-8	µg/kg	11	11	100%			9,250	25,500	14,486	2.96E+06	MTCA Method B		
METAL	IRON	7439-89-6	µg/kg	11	11	100%			1.47E+07	2.48E+07	1.85E+07	5.87E+07	Puget Sound Background		
METAL	LEAD	7439-92-1	µg/kg	11	11	100%			1,600	87,000	20,239	250,000	MTCA Method B		
METAL	MANGANESE	7439-96-5	µg/kg	11	11	100%			201,000	1.46E+06	349,818	1.12E+07	MTCA Method B		
METAL	MERCURY	7439-97-6	µg/kg	4	11	36%	40	50	110	860	218	24,000	MTCA Method B		
METAL	NICKEL	7440-02-0	µg/kg	11	11	100%			28,000	37,000	31,914	1.60E+06	MTCA Method B		
METAL	SELENIUM	7782-49-2	µg/kg	4	11	36%	100	100	100	200	77	400,000	MTCA Method B		
METAL	SILVER	7440-22-4	µg/kg	2	11	18%	20	20	30	30	14	400,000	MTCA Method B		
METAL	THALLIUM	7440-28-0	µg/kg	2	11	18%	500	600	200	700	291	5,600	MTCA Method B		
METAL	VANADIUM	7440-62-2	µg/kg	11	11	100%			37,000	50,900	43,068	560,000	MTCA Method B		
METAL	ZINC	7440-66-6	µg/kg	11	11	100%			23,000	104,000	42,264	2.40E+07	MTCA Method B		

Notes:

Acronyms
METAL = total metals
PEST = pesticides
SVOA = semivolatile organic analysis
VOA = volatile organic analysis

Table B-6
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Soil

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen [a]	MTCA Method B for Soil - Non-Carcinogen [a]	MTCA Method B for Protection of GW [a]	Puget Sound Area Natural Background Metal Concentrations [c]	Most Stringent ARAR for Soil	Source of Most Stringent ARAR for Soil
CONV	BIOLOGICAL OXYGEN DEMAND		mg/Kg						
CONV	CHEMICAL OXYGEN DEMAND		mg/Kg						
CONV	CHLORIDE		mg/Kg						
CONV	N-AMMONIA		mg-N/kg						
CONV	NITRATE + NITRITE (NO2+NO3)		mg-N/kg						
CONV	SULFIDE		mg/Kg						
CONV	TOTAL COLIFORM		CFU/g						
CONV	TOTAL ORGANIC CARBON		%						
CONV	TOTAL SOLIDS		%						
HERB	2,4,5-T	93-76-5	µg/kg		800,000			800,000	MTCA Method B
HERB	2,4,5-TP (SILVEX)	93-72-1	µg/kg		640,000			640,000	MTCA Method B
HERB	2,4-D	94-75-7	µg/kg		800,000			800,000	MTCA Method B
HERB	2,4-DB	94-82-6	µg/kg		640,000			640,000	MTCA Method B
HERB	DALAPON	75-99-0	µg/kg		2.40E+06			2.40E+06	MTCA Method B
HERB	DICAMBA	1918-00-9	µg/kg		2.40E+06			2.40E+06	MTCA Method B
HERB	DICHLOROPROP	120-36-5	µg/kg						
HERB	DINOSEB	88-85-7	µg/kg						
HERB	MCPA	94-74-6	µg/kg		40,000			40,000	MTCA Method B
METAL	ANTIMONY	7440-36-0	µg/kg						
METAL	ARSENIC	7440-38-2	µg/kg	1,667	60,000		7,300	7,300	Puget Sound Background
METAL	BARIUM	7440-39-3	µg/kg		5.60E+06			5.60E+06	MTCA Method B
METAL	BERYLLIUM	7440-41-7	µg/kg	233	400,000		610	610	Puget Sound Background
METAL	CADMIUM	7440-43-9	µg/kg		40,000		770	40,000	MTCA Method B
METAL	CALCIUM	7440-70-2	µg/kg						
METAL	CHROMIUM [b]	7440-47-3	µg/kg		100,000		48,150	100,000	MTCA Method B
METAL	COPPER	7440-50-8	µg/kg		2.96E+06		36,360	2.96E+06	MTCA Method B
METAL	IRON	7439-89-6	µg/kg				5.87E+07	5.87E+07	Puget Sound Background
METAL	LEAD [b]	7439-92-1	µg/kg		250,000		16,830	250,000	MTCA Method B
METAL	MANGANESE	7439-96-5	µg/kg		1.12E+07		1.15E+06	1.12E+07	MTCA Method B
METAL	MAGNESIUM	7439-95-4	µg/kg						
METAL	MERCURY	7439-97-6	µg/kg		24,000		70	24,000	MTCA Method B
METAL	NICKEL	7440-02-0	µg/kg		1.60E+06		38,190	1.60E+06	MTCA Method B
METAL	POTASSIUM	7440-09-7	µg/kg						
METAL	SELENIUM	7782-49-2	µg/kg		400,000			400,000	MTCA Method B
METAL	SILVER	7440-22-4	µg/kg		400,000			400,000	MTCA Method B
METAL	SODIUM	7440-23-5	µg/kg						
METAL	THALLIUM	7440-28-0	µg/kg		5,600			5,600	MTCA Method B

Table B-6
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Soil

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen [a]	MTCA Method B for Soil - Non-Carcinogen [a]	MTCA Method B for Protection of GW [a]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Soil	Source of Most Stringent ARAR for Soil
METAL	TIN	7440-31-5	µg/kg		4.80E+07			4.80E+07	MTCA Method B
METAL	VANADIUM	7440-62-2	µg/kg		560,000			560,000	MTCA Method B
METAL	ZINC	7440-66-6	µg/kg		2.40E+07		85,060	2.40E+07	MTCA Method B
PEST	4,4'-DDD	72-54-8	µg/kg	4,167				4,167	MTCA Method B
PEST	4,4'-DDE	72-55-9	µg/kg	2,941				2,941	MTCA Method B
PEST	4,4'-DDT	50-29-3	µg/kg	2,941	40,000			2,941	MTCA Method B
PEST	ALDRIN	309-00-2	µg/kg	59	2,400			59	MTCA Method B
PEST	ALPHA-BHC	319-84-6	µg/kg	159				159	MTCA Method B
PEST	ALPHA CHLORDANE	5103-71-9	µg/kg						
PEST	AROCLOR 1016	12674-11-2	µg/kg		5,600			5,600	MTCA Method B
PEST	AROCLOR 1221	11104-28-2	µg/kg						
PEST	AROCLOR 1232	11141-16-5	µg/kg						
PEST	AROCLOR 1242	53469-21-9	µg/kg						
PEST	AROCLOR 1248	12672-29-6	µg/kg						
PEST	AROCLOR 1254	11097-69-1	µg/kg		1,600			1,600	MTCA Method B
PEST	AROCLOR 1260	11096-82-5	µg/kg						
PEST	TOTAL PCBS	1336-36-3	µg/kg	130				130	MTCA Method B
PEST	BETA-BHC	319-85-7	µg/kg	556				556	MTCA Method B
PEST	DELTA-BHC	319-86-8	µg/kg						
PEST	DIELDRIN	60-57-1	µg/kg	63	4,000			63	MTCA Method B
PEST	ENDOSULFAN I	959-98-8	µg/kg						
PEST	ENDOSULFAN II	33213-65-9	µg/kg						
PEST	ENDOSULFAN SULFATE	1031-07-8	µg/kg						
PEST	ENDRIN	72-20-8	µg/kg		24,000			24,000	MTCA Method B
PEST	ENDRIN ALDEHYDE	7421-93-4	µg/kg						
PEST	ENDRIN KETONE	53494-70-5	µg/kg						
PEST	GAMMA-BHC (LINDANE)	58-89-9	µg/kg	769	24,000			769	MTCA Method B
PEST	GAMMA CHLORDANE	57-74-9	µg/kg	769	4,800			769	MTCA Method B
PEST	HEPTACHLOR	76-44-8	µg/kg	222	40,000			222	MTCA Method B
PEST	HEPTACHLOR EPOXIDE	1024-57-3	µg/kg	110	1,040			110	MTCA Method B
PEST	METHOXYCHLOR	72-43-5	µg/kg		400,000			400,000	MTCA Method B
PEST	TOXAPHENE	8001-35-2	µg/kg	909				909	MTCA Method B
PHC	DIESEL RANGE HYDROCARBONS [b]		µg/kg		200,000			200,000	MTCA Method B
PHC	GAS RANGE HYDROCARBONS [b]		µg/kg		100,000			100,000	MTCA Method B
PHC	MOTOR OIL [b]		µg/kg		200,000			200,000	MTCA Method B
PHC	OIL RANGE HYDROCARBONS [b]		µg/kg		200,000			200,000	MTCA Method B
PNA	ACENAPHTHENE	83-32-9	µg/kg		4.80E+06			4.80E+06	MTCA Method B

Table B-6
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Soil

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen [a]	MTCA Method B for Soil - Non-Carcinogen [a]	MTCA Method B for Protection of GW [a]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Soil	Source of Most Stringent ARAR for Soil
PNA	ACENAPHTHYLENE	208-96-8	µg/kg						
PNA	ANTHRACENE	120-12-7	µg/kg		2.40E+07			2.40E+07	MTCA Method B
PNA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	137				137	MTCA Method B
PNA	BENZO(A)PYRENE	50-32-8	µg/kg	137				137	MTCA Method B
PNA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	137				137	MTCA Method B
PNA	BENZO(G,H,I)PERYLENE	191-24-2	µg/kg						
PNA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	137				137	MTCA Method B
PNA	CHRYSENE	218-01-9	µg/kg	137				137	MTCA Method B
PNA	DIBENZO(A,H)ANTHRACENE	53-70-3	µg/kg	137				137	MTCA Method B
PNA	FLUORANTHENE	206-44-0	µg/kg		3.20E+06			3.20E+06	MTCA Method B
PNA	FLUORENE	86-73-7	µg/kg		3.20E+06			3.20E+06	MTCA Method B
PNA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/kg	137				137	MTCA Method B
PNA	NAPHTHALENE	91-20-3	µg/kg		3.20E+06			3.20E+06	MTCA Method B
PNA	PHENANTHRENE	85-01-8	µg/kg						
PNA	PYRENE	129-00-0	µg/kg		2.40E+06			2.40E+06	MTCA Method B
SVOA	1,2,4-TRICHLOROBENZENE	120-82-1	µg/kg		800,000			800,000	MTCA Method B
SVOA	1,2-DICHLOROBENZENE	95-50-1	µg/kg		7.20E+06			7.20E+06	MTCA Method B
SVOA	1,3-DICHLOROBENZENE	541-73-1	µg/kg						
SVOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	41,667				41,667	MTCA Method B
SVOA	2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1	µg/kg	14,286				14,286	MTCA Method B
SVOA	2,4,5-TRICHLOROPHENOL	95-95-4	µg/kg		8.00E+06			8.00E+06	MTCA Method B
SVOA	2,4,6-TRICHLOROPHENOL	88-06-2	µg/kg	90,909				90,909	MTCA Method B
SVOA	2,4-DICHLOROPHENOL	120-83-2	µg/kg		240,000			240,000	MTCA Method B
SVOA	2,4-DIMETHYLPHENOL	105-67-9	µg/kg		1.60E+06			1.60E+06	MTCA Method B
SVOA	2,4-DINITROPHENOL	51-28-5	µg/kg		160,000			160,000	MTCA Method B
SVOA	2,4-DINITROTOLUENE	121-14-2	µg/kg		160,000			160,000	MTCA Method B
SVOA	2,6-DINITROTOLUENE	606-20-2	µg/kg		80,000			80,000	MTCA Method B
SVOA	2-CHLORONAPHTHALENE	91-58-7	µg/kg		6.40E+06			6.40E+06	MTCA Method B
SVOA	2-CHLOROPHENOL	95-57-8	µg/kg		400,000			400,000	MTCA Method B
SVOA	2-METHYLNAPHTHALENE	91-57-6	µg/kg						
SVOA	2-METHYLPHENOL	95-48-7	µg/kg		4.00E+06			4.00E+06	MTCA Method B
SVOA	2-NITROANILINE	88-74-4	µg/kg						
SVOA	2-NITROPHENOL	88-75-5	µg/kg						
SVOA	3,3'-DICHLOROBENZIDINE	91-94-1	µg/kg	2,222				2,222	MTCA Method B
SVOA	3-NITROANILINE	99-09-2	µg/kg						
SVOA	4,6-DINITRO-2-METHYLPHENOL	534-52-1	µg/kg						
SVOA	4-BROMOPHENYL-PHENYLETHER	101-55-3	µg/kg						
SVOA	4-CHLORO-3-METHYLPHENOL	59-50-7	µg/kg						

Table B-6
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Soil

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen [a]	MTCA Method B for Soil - Non-Carcinogen [a]	MTCA Method B for Protection of GW [a]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Soil	Source of Most Stringent ARAR for Soil
SVOA	4-CHLOROANILINE	106-47-8	µg/kg		320,000			320,000	MTCA Method B
SVOA	4-CHLOROPHENYL-PHENYLETHER	7005-72-3	µg/kg						
SVOA	4-METHYLPHENOL	106-44-5	µg/kg		400,000			400,000	MTCA Method B
SVOA	4-NITROANILINE	100-01-6	µg/kg						
SVOA	4-NITROPHENOL	100-02-7	µg/kg						
SVOA	ACENAPHTHENE	83-32-9	µg/kg		4.80E+06			4.80E+06	MTCA Method B
SVOA	ACENAPHTHYLENE	208-96-8	µg/kg						
SVOA	ANTHRACENE	120-12-7	µg/kg		2.40E+07			2.40E+07	MTCA Method B
SVOA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	137				137	MTCA Method B
SVOA	BENZO(A)PYRENE	50-32-8	µg/kg	137				137	MTCA Method B
SVOA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	137				137	MTCA Method B
SVOA	BENZO(G,H,I)PERYLENE	191-24-2	µg/kg						
SVOA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	137				137	MTCA Method B
SVOA	BENZOIC ACID	65-85-0	µg/kg		3.20E+08			3.20E+08	MTCA Method B
SVOA	BENZYL ALCOHOL	100-51-6	µg/kg		2.40E+07			2.40E+07	MTCA Method B
SVOA	BIS(2-CHLOROETHOXY) METHANE	111-91-1	µg/kg						
SVOA	BIS-(2-CHLOROETHYL) ETHER	111-44-4	µg/kg	909				909	MTCA Method B
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	µg/kg	71,429	1.60E+06			71,429	MTCA Method B
SVOA	BUTYLBENZYLPHTHALATE	85-68-7	µg/kg		1.60E+07			1.60E+07	MTCA Method B
SVOA	CARBAZOLE	86-74-8	µg/kg	50,000				50,000	MTCA Method B
SVOA	CHRYSENE	218-01-9	µg/kg	137				137	MTCA Method B
SVOA	DI-N-BUTYLPHTHALATE	84-74-2	µg/kg		8.00E+06			8.00E+06	MTCA Method B
SVOA	DI-N-OCTYL PHTHALATE	117-84-0	µg/kg		1.60E+06			1.60E+06	MTCA Method B
SVOA	DIBENZ(A,H)ANTHRACENE	53-70-3	µg/kg	137				137	MTCA Method B
SVOA	DIBENZOFURAN	132-64-9	µg/kg						
SVOA	DIETHYLPHTHALATE	84-66-2	µg/kg		6.40E+07			6.40E+07	MTCA Method B
SVOA	DIMETHYLPHTHALATE	131-11-3	µg/kg		8.00E+07			8.00E+07	MTCA Method B
SVOA	FLUORANTHENE	206-44-0	µg/kg		3.20E+06			3.20E+06	MTCA Method B
SVOA	FLUORENE	86-73-7	µg/kg		3.20E+06			3.20E+06	MTCA Method B
SVOA	HEXACHLOROBENZENE	118-74-1	µg/kg	625	64,000			625	MTCA Method B
SVOA	HEXACHLOROBUTADIENE	87-68-3	µg/kg	12,821	16,000			12,821	MTCA Method B
SVOA	HEXACHLOROCYCLOPENTADIENE	77-47-4	µg/kg		560,000			560,000	MTCA Method B
SVOA	HEXACHLOROETHANE	67-72-1	µg/kg	71,429	80,000			71,429	MTCA Method B
SVOA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/kg	137				137	MTCA Method B
SVOA	ISOPHORONE	78-59-1	µg/kg	1.05E+06	1.60E+07			1.05E+06	MTCA Method B
SVOA	N-NITROSO-DI-N-PROPYLAMINE	621-64-7	µg/kg	143				143	MTCA Method B
SVOA	N-NITROSODIPHENYLAMINE	86-30-6	µg/kg	204,082				204,082	MTCA Method B
SVOA	NAPHTHALENE	91-20-3	µg/kg		3.20E+06			3.20E+06	MTCA Method B

Table B-6
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Soil

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen [a]	MTCA Method B for Soil - Non-Carcinogen [a]	MTCA Method B for Protection of GW [a]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Soil	Source of Most Stringent ARAR for Soil
SVOA	NITROBENZENE	98-95-3	µg/kg		40,000			40,000	MTCA Method B
SVOA	PENTACHLOROPHENOL	87-86-5	µg/kg	8,333	2.40E+06			8,333	MTCA Method B
SVOA	PHENANTHRENE	85-01-8	µg/kg						
SVOA	PHENOL	108-95-2	µg/kg		4.80E+07			4.80E+07	MTCA Method B
SVOA	PYRENE	129-00-0	µg/kg		2.40E+06			2.40E+06	MTCA Method B
SVOA	PYRIDINE	110-86-1	µg/kg		80			80	MTCA Method B
VOA	1,1,1,2-TETRACHLOROETHANE	630-20-6	µg/kg	38,462	2.40E+06	168		168	MTCA Method B PGW
VOA	1,1,1-TRICHLOROETHANE	71-55-6	µg/kg		7.20E+07	720,000		720,000	MTCA Method B PGW
VOA	1,1,2,2-TETRACHLOROETHANE	79-34-5	µg/kg	5,000		22		22	MTCA Method B PGW
VOA	1,1,2-TRICHLOROETHANE	79-00-5	µg/kg	17,544	320,000	77		77	MTCA Method B PGW
VOA	1,1,2-TRICHLOROTRIFLUOROETHANE	76-13-1	µg/kg		2.40E+09	4.80E+07		4.80E+07	MTCA Method B PGW
VOA	1,1-DICHLOROETHANE	75-34-3	µg/kg		8.00E+06	80,000		80,000	MTCA Method B PGW
VOA	1,1-DICHLOROETHENE	75-35-4	µg/kg	1,667	720,000	7.3		7.3	MTCA Method B PGW
VOA	1,1-DICHLOROPROPENE	563-58-6	µg/kg						
VOA	1,2,3-TRICHLOROBENZENE	87-61-6	µg/kg						
VOA	1,2,3-TRICHLOROPROPANE	96-18-4	µg/kg	143	480,000	0.63		0.63	MTCA Method B PGW
VOA	1,2,4-TRICHLOROBENZENE	120-82-1	µg/kg		800,000	8,000		8,000	MTCA Method B PGW
VOA	1,2,4-TRIMETHYLBENZENE	95-63-6	µg/kg						
VOA	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	µg/kg	714		3.1		3.1	MTCA Method B PGW
VOA	1,2-DICHLOROBENZENE	95-50-1	µg/kg		7.20E+06	72,000		72,000	MTCA Method B PGW
VOA	1,2-DICHLOROETHANE	107-06-2	µg/kg	10,989		48		48	MTCA Method B PGW
VOA	1,2-DICHLOROPROPANE	78-87-5	µg/kg	14,706		64		64	MTCA Method B PGW
VOA	1,3,5-TRIMETHYLBENZENE	108-67-8	µg/kg						
VOA	1,3-DICHLOROBENZENE	541-73-1	µg/kg						
VOA	1,3-DICHLOROPROPANE	142-28-9	µg/kg						
VOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	41,667		182		182	MTCA Method B PGW
VOA	2,2-DICHLOROPROPANE	590-20-7	µg/kg						
VOA	2-BUTANONE	78-93-3	µg/kg		4.80E+07	480,000		480,000	MTCA Method B PGW
VOA	2-CHLOROETHYLVINYLETHER	110-75-8	µg/kg						
VOA	2-CHLOROTOLUENE	95-49-8	µg/kg		1.60E+06	16,000		16,000	MTCA Method B PGW
VOA	2-HEXANONE	591-78-6	µg/kg						
VOA	4-CHLOROTOLUENE	106-43-4	µg/kg						
VOA	4-ISOPROPYLTOLUENE	99-87-6	µg/kg						
VOA	4-METHYL-2-PENTANONE (MIBK)	108-10-1	µg/kg		6.40E+06	64,000		64,000	MTCA Method B PGW
VOA	ACETONE	67-64-1	µg/kg		8.00E+06	80,000		80,000	MTCA Method B PGW
VOA	ACROLEIN	107-02-8	µg/kg		1.60E+06	16,000		16,000	MTCA Method B PGW
VOA	ACRYLONITRILE	107-13-1	µg/kg	1,852	80,000	8.1		8.1	MTCA Method B PGW
VOA	ALLYL CHLORIDE	107-05-1	µg/kg		4.00E+06	80,000		80,000	MTCA Method B PGW

Table B-6
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Soil

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen [a]	MTCA Method B for Soil - Non-Carcinogen [a]	MTCA Method B for Protection of GW [a]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Soil	Source of Most Stringent ARAR for Soil
VOA	BENZENE	71-43-2	µg/kg	34,483		151		151	MTCA Method B PGW
VOA	BROMOBENZENE	108-86-1	µg/kg						
VOA	BROMOCHLOROMETHANE	74-97-5	µg/kg						
VOA	BROMODICHLOROMETHANE	75-27-4	µg/kg	16,129	1.60E+06	71		71	MTCA Method B PGW
VOA	BROMOETHANE	74-96-4	µg/kg						
VOA	BROMOFORM	75-25-2	µg/kg	126,582	1.60E+06	554		554	MTCA Method B PGW
VOA	BROMOMETHANE	74-83-9	µg/kg		112,000	1,120		1,120	MTCA Method B PGW
VOA	CARBON DISULFIDE	75-15-0	µg/kg		8.00E+06	80,000		80,000	MTCA Method B PGW
VOA	CARBON TETRACHLORIDE	56-23-5	µg/kg	7,692	56,000	34		34	MTCA Method B PGW
VOA	CHLOROBENZENE	108-90-7	µg/kg		1.60E+06	16,000		16,000	MTCA Method B PGW
VOA	CHLOROETHANE	75-00-3	µg/kg						
VOA	CHLOROFORM	67-66-3	µg/kg	163,934	800,000	717		717	MTCA Method B PGW
VOA	CHLOROMETHANE	74-87-3	µg/kg	76,923		337		337	MTCA Method B PGW
VOA	CIS-1,2-DICHLOROETHENE	156-59-2	µg/kg		800,000	8,000		8,000	MTCA Method B PGW
VOA	CIS-1,3-DICHLOROPROPENE	10061-01-5	µg/kg						
VOA	DIBROMOCHLOROMETHANE	124-48-1	µg/kg	11,905	1.60E+06	52		52	MTCA Method B PGW
VOA	DIBROMOMETHANE	74-95-3	µg/kg		800,000	8,000		8,000	MTCA Method B PGW
VOA	DICHLORODIFLUOROMETHANE	75-71-8	µg/kg		1.60E+07	160,000		160,000	MTCA Method B PGW
VOA	ETHYLBENZENE	100-41-4	µg/kg		8.00E+06	80,000		80,000	MTCA Method B PGW
VOA	ETHYLENE DIBROMIDE	106-93-4	µg/kg	12		0.051		0.051	MTCA Method B PGW
VOA	HEXACHLOROBUTADIENE	87-68-3	µg/kg	12,821	16,000	56		56	MTCA Method B PGW
VOA	ISOPROPYLBENZENE	98-82-8	µg/kg		3.20E+06	64,000		64,000	MTCA Method B PGW
VOA	M,P-XYLENE		µg/kg						
VOA	METHYL IODIDE	74-88-4	µg/kg						
VOA	METHYL METHACRYLATE	80-62-6	µg/kg		6.40E+06	64,000		64,000	MTCA Method B PGW
VOA	METHYLENE CHLORIDE	75-09-2	µg/kg	133,333	4.80E+06	583		583	MTCA Method B PGW
VOA	N-BUTYLBENZENE	104-51-8	µg/kg						
VOA	N-PROPYLBENZENE	103-65-1	µg/kg						
VOA	NAPHTHALENE	91-20-3	µg/kg		3.20E+06	32,000		32,000	MTCA Method B PGW
VOA	O-XYLENE	95-47-6	µg/kg		1.60E+08	1.60E+06		1.60E+06	MTCA Method B PGW
VOA	SEC-BUTYLBENZENE	135-98-8	µg/kg						
VOA	STYRENE	100-42-5	µg/kg	33,333	1.60E+07	146		146	MTCA Method B PGW
VOA	TERT-BUTYLBENZENE	98-06-6	µg/kg						
VOA	TETRACHLOROETHENE	127-18-4	µg/kg	19,608	800,000	86		86	MTCA Method B PGW
VOA	TOLUENE	108-88-3	µg/kg		1.60E+07	160,000		160,000	MTCA Method B PGW
VOA	TRANS-1,2-DICHLOROETHENE	156-60-5	µg/kg		1.60E+06	16,000		16,000	MTCA Method B PGW
VOA	TRANS-1,3-DICHLOROPROPENE	10061-02-6	µg/kg						
VOA	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	µg/kg						

Table B-6
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Soil

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen [a]	MTCA Method B for Soil - Non-Carcinogen [a]	MTCA Method B for Protection of GW [a]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Soil	Source of Most Stringent ARAR for Soil
VOA	TRICHLOROETHENE	79-01-6	µg/kg	90,909		398		398	MTCA Method B PGW
VOA	TRICHLOROFLUOROMETHANE	75-69-4	µg/kg		2.40E+07	240,000		240,000	MTCA Method B PGW
VOA	VINYL ACETATE	108-05-4	µg/kg		8.00E+07	800,000		800,000	MTCA Method B PGW
VOA	VINYL CHLORIDE	75-01-4	µg/kg	526		2.3		2.3	MTCA Method B PGW

Notes:

[a] MTCA Method B values are from CLARC II, February 1996.

[b] No Method B values. Values are from Method A table (WAC 173-340, page 70).

[c] Natural background concentrations may be substituted for MTCA Method B values.

Table B-7
BAINBRIDGE ISLAND LANDFILL
Main Landfill Base Soil
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
PEST	ALPHA CHLORDANE	5103-71-9	µg/kg	1	10	10%	1.8	2.0	1.3	1.3	0.98				
PEST	BETA-BHC	319-85-7	µg/kg	1	10	10%	1.8	2.0	3.2	3.2	1.2	556	MTCA Method B		
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	µg/kg	5	10	50%	73	79	120	800	186	71,429	MTCA Method B		
VOA	1,1,1,2-TETRACHLOROETHANE	630-20-6	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	168	MTCA Method B PGW		
VOA	1,1,1-TRICHLOROETHANE	71-55-6	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	720,000	MTCA Method B PGW		
VOA	1,1,2,2-TETRACHLOROETHANE	79-34-5	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	22	MTCA Method B PGW		
VOA	1,1,2-TRICHLOROETHANE	79-00-5	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	77	MTCA Method B PGW		
VOA	1,1,2-TRICHLOROTRIFLUOROETHANE	76-13-1	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	4.80E+07	MTCA Method B PGW		
VOA	1,1-DICHLOROETHANE	75-34-3	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	80,000	MTCA Method B PGW		
VOA	1,1-DICHLOROETHENE	75-35-4	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	7.3	MTCA Method B PGW		
VOA	1,1-DICHLOROPROPENE	563-58-6	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	1,2,3-TRICHLOROBENZENE	87-61-6	µg/kg	4	10	40%	5.4	6.2	1.9	6.1	3.6				
VOA	1,2,3-TRICHLOROPROPANE	96-18-4	µg/kg	3	10	30%	2.2	2.5	2.1	2.5	1.5	0.63	MTCA Method B PGW	3	7
VOA	1,2,4-TRICHLOROBENZENE	120-82-1	µg/kg	4	10	40%	5.4	6.2	1.9	6.1	3.6	8,000	MTCA Method B PGW		
VOA	1,2,4-TRIMETHYLBENZENE	95-63-6	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	µg/kg	3	10	30%	5.4	6.2	5.3	6.1	3.7	3.1	MTCA Method B PGW	3	7
VOA	1,2-DICHLOROBENZENE	95-50-1	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	72,000	MTCA Method B PGW		
VOA	1,2-DICHLOROETHANE	107-06-2	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	48	MTCA Method B PGW		
VOA	1,2-DICHLOROPROPANE	78-87-5	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	64	MTCA Method B PGW		
VOA	1,3,5-TRIMETHYLBENZENE	108-67-8	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	1,3-DICHLOROBENZENE	541-73-1	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	1,3-DICHLOROPROPANE	142-28-9	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	182	MTCA Method B PGW		
VOA	2,2-DICHLOROPROPANE	590-20-7	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	2-BUTANONE	78-93-3	µg/kg	3	10	30%	5.4	6.2	5.3	6.1	3.7	480,000	MTCA Method B PGW		
VOA	2-CHLOROETHYLVINYLETHER	110-75-8	µg/kg	3	10	30%	5.4	6.2	5.3	6.1	3.7				
VOA	2-CHLOROTOLUENE	95-49-8	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	16,000	MTCA Method B PGW		
VOA	2-HEXANONE	591-78-6	µg/kg	3	10	30%	5.4	6.2	5.3	6.1	3.7				
VOA	4-CHLOROTOLUENE	106-43-4	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	4-ISOPROPYLTOLUENE	99-87-6	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	4-METHYL-2-PENTANONE (MIBK)	108-10-1	µg/kg	3	10	30%	5.4	6.2	5.3	6.1	3.7	64,000	MTCA Method B PGW		
VOA	ACETONE	67-64-1	µg/kg	7	10	70%	5.5	5.6	5.3	86	23	80,000	MTCA Method B PGW		
VOA	ACROLEIN	107-02-8	µg/kg	3	10	30%	54	62	53	61	37	16,000	MTCA Method B PGW		
VOA	ACRYLONITRILE	107-13-1	µg/kg	3	10	30%	5.4	6.2	5.3	6.1	3.7	8.1	MTCA Method B PGW		
VOA	BENZENE	71-43-2	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	151	MTCA Method B PGW		
VOA	BROMOBENZENE	108-86-1	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	BROMOCHLOROMETHANE	74-97-5	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	BROMODICHLOROMETHANE	75-27-4	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	71	MTCA Method B PGW		
VOA	BROMOETHANE	74-96-4	µg/kg	3	10	30%	2.2	2.5	2.1	2.5	1.5				
VOA	BROMOFORM	75-25-2	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	554	MTCA Method B PGW		
VOA	BROMOMETHANE	74-83-9	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	1,120	MTCA Method B PGW		
VOA	CARBON DISULFIDE	75-15-0	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	80,000	MTCA Method B PGW		
VOA	CARBON TETRACHLORIDE	56-23-5	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	34	MTCA Method B PGW		
VOA	CHLOROBENZENE	108-90-7	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	16,000	MTCA Method B PGW		
VOA	CHLOROETHANE	75-00-3	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	CHLOROFORM	67-66-3	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	717	MTCA Method B PGW		
VOA	CHLOROMETHANE	74-87-3	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	337	MTCA Method B PGW		
VOA	CIS-1,2-DICHLOROETHENE	156-59-2	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	8,000	MTCA Method B PGW		

Table B-7
BAINBRIDGE ISLAND LANDFILL
Main Landfill Base Soil
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
VOA	CIS-1,3-DICHLOROPROPENE	10061-01-5	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	DIBROMOCHLOROMETHANE	124-48-1	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	52	MTCA Method B PGW		
VOA	DIBROMOMETHANE	74-95-3	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	8,000	MTCA Method B PGW		
VOA	ETHYLBENZENE	100-41-4	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	80,000	MTCA Method B PGW		
VOA	ETHYLENE DIBROMIDE	106-93-4	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	0.051	MTCA Method B PGW	3	7
VOA	HEXACHLOROBUTADIENE	87-68-3	µg/kg	3	10	30%	5.4	6.2	5.3	6.1	3.7	56	MTCA Method B PGW		
VOA	ISOPROPYLBENZENE	98-82-8	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	64,000	MTCA Method B PGW		
VOA	M,P-XYLENE	1330-20-7	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	METHYL IODIDE	74-88-4	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	METHYLENE CHLORIDE	75-09-2	µg/kg	3	10	30%	3.3	11	3.2	3.7	3.1	583	MTCA Method B PGW		
VOA	NAPHTHALENE	91-20-3	µg/kg	4	10	40%	2.6	6.2	5.3	7.9	4.0	32,000	MTCA Method B PGW		
VOA	N-BUTYLBENZENE	104-51-8	µg/kg	3	10	30%	2.2	2.5	2.1	2.5	1.5				
VOA	N-PROPYLBENZENE	103-65-1	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	O-XYLENE	95-47-6	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	1.60E+06	MTCA Method B PGW		
VOA	SEC-BUTYLBENZENE	135-98-8	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	STYRENE	100-42-5	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	146	MTCA Method B PGW		
VOA	TERT-BUTYLBENZENE	98-06-6	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	TETRACHLOROETHENE	127-18-4	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	86	MTCA Method B PGW		
VOA	TOLUENE	108-88-3	µg/kg	3	10	30%	1.1	1.2	0.40	1.1	0.65	160,000	MTCA Method B PGW		
VOA	TRANS-1,2-DICHLOROETHENE	156-60-5	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	16,000	MTCA Method B PGW		
VOA	TRANS-1,3-DICHLOROPROPENE	10061-02-6	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73				
VOA	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	µg/kg	3	10	30%	5.4	6.2	5.3	6.1	3.7				
VOA	TRICHLOROETHENE	79-01-6	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	398	MTCA Method B PGW		
VOA	TRICHLOROFLUOROMETHANE	75-69-4	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	240,000	MTCA Method B PGW		
VOA	VINYL ACETATE	108-05-4	µg/kg	3	10	30%	5.4	6.2	5.3	6.1	3.7	800,000	MTCA Method B PGW		
VOA	VINYL CHLORIDE	75-01-4	µg/kg	3	10	30%	1.1	1.2	1.1	1.2	0.73	2.3	MTCA Method B PGW		
METAL	ARSENIC	7440-38-2	µg/kg	10	10	100%			200	3,000	870	7,300	Puget Sound Background		
METAL	BARIUM	7440-39-3	µg/kg	10	10	100%			27,300	119,000	63,070	5.60E+06	MTCA Method B		
METAL	BERYLLIUM	7440-41-7	µg/kg	10	10	100%			200	300	230	610	Puget Sound Background		
METAL	CADMIUM	7440-43-9	µg/kg	10	10	100%			30	180	52	40,000	MTCA Method B		
METAL	CHROMIUM	7440-47-3	µg/kg	10	10	100%			23,300	36,400	30,520	100,000	MTCA Method B		
METAL	COPPER	7440-50-8	µg/kg	10	10	100%			7,900	14,400	11,130	2.96E+06	MTCA Method B		
METAL	IRON	7439-89-6	µg/kg	10	10	100%			1.47E+07	2.06E+07	1.77E+07	5.87E+07	Puget Sound Background		
METAL	LEAD	7439-92-1	µg/kg	10	10	100%			1,600	9,800	3,680	250,000	MTCA Method B		
METAL	MANGANESE	7439-96-5	µg/kg	10	10	100%			158,000	335,000	222,300	1.12E+07	MTCA Method B		
METAL	NICKEL	7440-02-0	µg/kg	10	10	100%			25,000	53,000	40,100	1.60E+06	MTCA Method B		
METAL	THALLIUM	7440-28-0	µg/kg	1	10	10%	100	600	200	200	130	5,600	MTCA Method B		
METAL	VANADIUM	7440-62-2	µg/kg	10	10	100%			33,900	60,000	43,030	560,000	MTCA Method B		
METAL	ZINC	7440-66-6	µg/kg	10	10	100%			20,100	37,100	28,990	2.40E+07	MTCA Method B		

Notes:

Acronyms
METAL = total metals
PEST = pesticides
SVOA = semivolatile organic analysis
VOA = volatile organic analysis

Table B-8
BAINBRIDGE ISLAND LANDFILL
Base Soil Below Trench 3 Soil Borings
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
CONV	TOTAL ORGANIC CARBON		%	16	16	100%			0.031	1.0	0.12			
CONV	TOTAL SOLIDS		%	16	16	100%			85	96	92			
PNA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	2	16	13%	1.8	1.9	2.2	73	5.5	137		
PNA	BENZO(A)PYRENE	50-32-8	µg/kg	2	16	13%	2.4	2.5	1.9	110	8.1	137		
PNA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	3	16	19%	1.3	1.4	0.93	160	11	137	1	
PNA	BENZO(G,H,I)PERYLENE	191-24-2	µg/kg	2	16	13%	5.2	5.5	5.0	100	8.9			
PNA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	2	16	13%	2.1	2.2	1.8	59	4.7	137		
PNA	CHRYSENE	218-01-9	µg/kg	1	16	6%	6.2	6.7	63	63	6.9	137		
PNA	DIBENZO(A,H)ANTHRACENE	53-70-3	µg/kg	1	16	6%	3.1	33	14	14	9.6	137		
PNA	FLUORANTHENE	206-44-0	µg/kg	1	16	6%	16	18	84	84	13	3.20E+06		
PNA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/kg	2	16	13%	2.6	2.7	8.0	150	11	137	1	
PNA	PYRENE	129-00-0	µg/kg	1	16	6%	9.3	10	50	50	7.6	2.40E+06		
SVOA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	1	16	6%	69	75	62	62	37	137		
SVOA	BENZO(A)PYRENE	50-32-8	µg/kg	1	16	6%	140	150	150	150	76	137	1	15
SVOA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	1	16	6%	140	150	110	110	73	137		15
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	µg/kg	3	16	19%	69	79	70	110	46	71,429		
SVOA	CHRYSENE	218-01-9	µg/kg	1	16	6%	69	75	91	91	39	137		
SVOA	PYRENE	129-00-0	µg/kg	1	16	6%	69	75	100	100	40	2.40E+06		
VOA	ACETONE	67-64-1	µg/kg	11	16	69%	69	180	14	18,000	1,280	80,000		
METAL	ANTIMONY	7440-36-0	µg/kg	3	16	19%	100	110	100	140	65			
METAL	ARSENIC	7440-38-2	µg/kg	15	16	94%	110	110	170	720	465	7,300		
METAL	BARIUM	7440-39-3	µg/kg	16	16	100%			38,600	88,200	48,613	5.60E+06		
METAL	BERYLLIUM	7440-41-7	µg/kg	16	16	100%			150	240	193	610		
METAL	CADMIUM	7440-43-9	µg/kg	1	16	6%	210	230	290	290	118	40,000		
METAL	CHROMIUM	7440-47-3	µg/kg	16	16	100%			22,200	39,300	29,013	100,000		
METAL	COPPER	7440-50-8	µg/kg	16	16	100%			8,500	23,200	11,063	2.96E+06		
METAL	IRON	7439-89-6	µg/kg	16	16	100%			1.41E+07	2.27E+07	1.59E+07	5.87E+07		
METAL	LEAD	7439-92-1	µg/kg	16	16	100%			1,500	4,900	2,038	250,000		
METAL	MANGANESE	7439-96-5	µg/kg	16	16	100%			248,000	421,000	294,000	1.12E+07		
METAL	NICKEL	7440-02-0	µg/kg	16	16	100%			33,500	59,500	45,944	1.60E+06		
METAL	SILVER	7440-22-4	µg/kg	3	16	19%	310	340	360	380	199	400,000		
METAL	THALLIUM	7440-28-0	µg/kg	9	16	56%	100	110	110	140	95	5,600		
METAL	TIN	7440-31-5	µg/kg	13	16	81%	1,000	1,000	1,000	2,000	1,406	4.80E+07		
METAL	ZINC	7440-66-6	µg/kg	16	16	100%			25,700	42,400	29,219	2.40E+07		

Notes: [a] Mean value is calculated assigning nondetects a value of one half the detection limit.
[b] See associated screening level table.

Table B-9
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Sediment

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen[a]	MTCA Method B for Soil - Non-Carcinogen[a]	MTCA Method B for Protection of GW[a]	MTCA Method B for Protection of SW[d]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Sediment	Source of Most Stringent ARAR for Sediment
CONV	BIOLOGICAL OXYGEN DEMAND		mg/kg							
CONV	CHEMICAL OXYGEN DEMAND		mg/kg							
CONV	CHLORIDE		mg/kg							
CONV	N-AMMONIA		mg-N/kg							
CONV	NITRATE + NITRITE (NO2+NO3)		mg-N/kg							
CONV	SULFIDE		mg/kg							
CONV	TOTAL COLIFORM		CFU/g							
CONV	TOTAL ORGANIC CARBON		%							
CONV	TOTAL SOLIDS		%							
HERB	2,4,5-T	93-76-5	µg/kg		800,000				800,000	MTCA Method B
HERB	2,4,5-TP (SILVEX)	93-72-1	µg/kg		640,000				640,000	MTCA Method B
HERB	2,4-D	94-75-7	µg/kg		800,000				800,000	MTCA Method B
HERB	2,4-DB	94-82-6	µg/kg		640,000				640,000	MTCA Method B
HERB	DALAPON	75-99-0	µg/kg		2.40E+06				2.40E+06	MTCA Method B
HERB	DICAMBA	1918-00-9	µg/kg		2.40E+06				2.40E+06	MTCA Method B
HERB	DICHLOROPROP	120-36-5	µg/kg							
HERB	DINOSEB	88-85-7	µg/kg							
HERB	MCPA	94-74-6	µg/kg		40,000				40,000	MTCA Method B
METAL	ANTIMONY	7440-36-0	µg/kg							
METAL	ARSENIC	7440-38-2	µg/kg	1,667	60,000		9.8	7,300	7,300	Puget Sound Background
METAL	BARIUM	7440-39-3	µg/kg		5.60E+06				5.60E+06	MTCA Method B
METAL	BERYLLIUM	7440-41-7	µg/kg	233	400,000		7.9	610	610	Puget Sound Background
METAL	CADMIUM	7440-43-9	µg/kg		40,000		2,025	770	2,025	MTCA Method B PSW
METAL	CALCIUM	7440-70-2	µg/kg							
METAL	CHROMIUM [b]	7440-47-3	µg/kg		100,000			48,150	100,000	MTCA Method B
METAL	COPPER	7440-50-8	µg/kg		2.96E+06		266,461	36,360	266,461	MTCA Method B PSW
METAL	IRON	7439-89-6	µg/kg					5.87E+07	5.87E+07	Puget Sound Background
METAL	LEAD [b]	7439-92-1	µg/kg		250,000			16,830	250,000	MTCA Method B
METAL	MANGANESE	7439-96-5	µg/kg		1.12E+07			1.15E+06	1.12E+07	MTCA Method B
METAL	MAGNESIUM	7439-95-4	µg/kg							
METAL	MERCURY	7439-97-6	µg/kg		24,000			70	24000	MTCA Method B
METAL	NICKEL	7440-02-0	µg/kg		1.60E+06		110,323	38,190	110,323	MTCA Method B PSW
METAL	POTASSIUM	7440-09-7	µg/kg							
METAL	SELENIUM	7782-49-2	µg/kg		400,000				400000	MTCA Method B
METAL	SILVER	7440-22-4	µg/kg		400,000		2.59E+06		400,000	MTCA Method B
METAL	SODIUM	7440-23-5	µg/kg							
METAL	THALLIUM	7440-28-0	µg/kg		5,600				5,600	MTCA Method B
METAL	TIN	7440-31-5	µg/kg		4.80E+07				4.80E+07	MTCA Method B

Table B-9
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Sediment

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen[a]	MTCA Method B for Soil - Non-Carcinogen[a]	MTCA Method B for Protection of GW[a]	MTCA Method B for Protection of SW[d]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Sediment	Source of Most Stringent ARAR for Sediment
METAL	VANADIUM	7440-62-2	µg/kg		560,000				560,000	MTCA Method B
METAL	ZINC	7440-66-6	µg/kg		2.40E+07		1.65E+06	85,060	1,654,846	MTCA Method B PSW
PEST	4,4'-DDD	72-54-8	µg/kg	4,167			0.050		0.050	MTCA Method B PSW
PEST	4,4'-DDE	72-55-9	µg/kg	2,941			0.036		0.036	MTCA Method B PSW
PEST	4,4'-DDT	50-29-3	µg/kg	2,941	40,000		0.036		0.036	MTCA Method B PSW
PEST	ALDRIN	309-00-2	µg/kg	59	2,400		0.0082		0.0082	MTCA Method B PSW
PEST	ALPHA-BHC	319-84-6	µg/kg	159			0.79		0.79	MTCA Method B PSW
PEST	ALPHA CHLORDANE	5103-71-9	µg/kg							
PEST	AROCLOR 1016	12674-11-2	µg/kg		5,600				5600	MTCA Method B
PEST	AROCLOR 1221	11104-28-2	µg/kg							
PEST	AROCLOR 1232	11141-16-5	µg/kg							
PEST	AROCLOR 1242	53469-21-9	µg/kg							
PEST	AROCLOR 1248	12672-29-6	µg/kg							
PEST	AROCLOR 1254	11097-69-1	µg/kg		1,600				1600	MTCA Method B
PEST	AROCLOR 1260	11096-82-5	µg/kg							
PEST	TOTAL PCBS	1336-36-3	µg/kg	130			0.0027		0.0027	MTCA Method B PSW
PEST	BETA-BHC	319-85-7	µg/kg	556			2.8		2.8	MTCA Method B PSW
PEST	DELTA-BHC	319-86-8	µg/kg							
PEST	DIELDRIN	60-57-1	µg/kg	63	4,000		0.0087		0.0087	MTCA Method B PSW
PEST	ENDOSULFAN I	959-98-8	µg/kg							
PEST	ENDOSULFAN II	33213-65-9	µg/kg							
PEST	ENDOSULFAN SULFATE	1031-07-8	µg/kg							
PEST	ENDRIN	72-20-8	µg/kg		24,000		20		20	MTCA Method B PSW
PEST	ENDRIN ALDEHYDE	7421-93-4	µg/kg							
PEST	ENDRIN KETONE	53494-70-5	µg/kg							
PEST	GAMMA-BHC (LINDANE)	58-89-9	µg/kg	769	24,000		3.8		3.8	MTCA Method B PSW
PEST	GAMMA CHLORDANE	57-74-9	µg/kg	769	4,800		0.035		0.035	MTCA Method B PSW
PEST	HEPTACHLOR	76-44-8	µg/kg	222	40,000		0.013		0.013	MTCA Method B PSW
PEST	HEPTACHLOR EPOXIDE	1024-57-3	µg/kg	110	1,040		0.0064		0.0064	MTCA Method B PSW
PEST	METHOXYCHLOR	72-43-5	µg/kg		400,000		836		836	MTCA Method B PSW
PEST	TOXAPHENE	8001-35-2	µg/kg	909			0.045		0.045	MTCA Method B PSW
PHC	DIESEL RANGE HYDROCARBONS [b]		µg/kg		200,000				200,000	MTCA Method B
PHC	GAS RANGE HYDROCARBONS [b]		µg/kg		100,000				100,000	MTCA Method B
PHC	MOTOR OIL [b]		µg/kg		200,000				200,000	MTCA Method B
PHC	OIL RANGE HYDROCARBONS [b]		µg/kg		200,000				200,000	MTCA Method B
PNA	ACENAPHTHENE	83-32-9	µg/kg		4.80E+06		64,279		64,279	MTCA Method B PSW
PNA	ACENAPHTHYLENE	208-96-8	µg/kg							
PNA	ANTHRACENE	120-12-7	µg/kg		2.40E+07		2.59E+06		2.59E+06	MTCA Method B PSW

Table B-9
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Sediment

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen[a]	MTCA Method B for Soil - Non-Carcinogen[a]	MTCA Method B for Protection of GW[a]	MTCA Method B for Protection of SW[d]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Sediment	Source of Most Stringent ARAR for Sediment
PNA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	137			30		30	MTCA Method B PSW
PNA	BENZO(A)PYRENE	50-32-8	µg/kg	137			3.0		3.0	MTCA Method B PSW
PNA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	137			30		30	MTCA Method B PSW
PNA	BENZO(G,H,I)PERYLENE	191-24-2	µg/kg							
PNA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	137			296		137	MTCA Method B
PNA	CHRYSENE	218-01-9	µg/kg	137			2,960		137	MTCA Method B
PNA	DIBENZO(A,H)ANTHRACENE	53-70-3	µg/kg	137			3.0		3.0	MTCA Method B PSW
PNA	FLUORANTHENE	206-44-0	µg/kg		3.20E+06		9,018		9,018	MTCA Method B PSW
PNA	FLUORENE	86-73-7	µg/kg		3.20E+06		345,679		345,679	MTCA Method B PSW
PNA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/kg	137			30		30	MTCA Method B PSW
PNA	NAPHTHALENE	91-20-3	µg/kg		3.20E+06				3.20E+06	MTCA Method B
PNA	PHENANTHRENE	85-01-8	µg/kg							
PNA	PYRENE	129-00-0	µg/kg		2.40E+06		259,259		259,259	MTCA Method B PSW
SVOA	1,2,4-TRICHLOROBENZENE	120-82-1	µg/kg		800,000		22,742		22,742	MTCA Method B PSW
SVOA	1,2-DICHLOROBENZENE	95-50-1	µg/kg		7.20E+06		419,664		419,664	MTCA Method B PSW
SVOA	1,3-DICHLOROBENZENE	541-73-1	µg/kg							
SVOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	41,667			486		486	MTCA Method B PSW
SVOA	2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1	µg/kg	14,286					14,286	MTCA Method B
SVOA	2,4,5-TRICHLOROPHENOL	95-95-4	µg/kg		8.00E+06				8.00E+06	MTCA Method B
SVOA	2,4,6-TRICHLOROPHENOL	88-06-2	µg/kg	90,909			393		393	MTCA Method B PSW
SVOA	2,4-DICHLOROPHENOL	120-83-2	µg/kg		240,000		19,110		19,110	MTCA Method B PSW
SVOA	2,4-DIMETHYLPHENOL	105-67-9	µg/kg		1.60E+06		55,279		55,279	MTCA Method B PSW
SVOA	2,4-DINITROPHENOL	51-28-5	µg/kg		160,000		345,679		160,000	MTCA Method B
SVOA	2,4-DINITROTOLUENE	121-14-2	µg/kg		160,000		251		251	MTCA Method B PSW
SVOA	2,6-DINITROTOLUENE	606-20-2	µg/kg		80,000				80,000	MTCA Method B
SVOA	2-CHLORONAPHTHALENE	91-58-7	µg/kg		6.40E+06				6.40E+06	MTCA Method B
SVOA	2-CHLOROPHENOL	95-57-8	µg/kg		400,000		9,674		9,674	MTCA Method B PSW
SVOA	2-METHYLNAPHTHALENE	91-57-6	µg/kg							
SVOA	2-METHYLPHENOL	95-48-7	µg/kg		4.00E+06				4.00E+06	MTCA Method B
SVOA	2-NITROANILINE	88-74-4	µg/kg							
SVOA	2-NITROPHENOL	88-75-5	µg/kg							
SVOA	3,3'-DICHLOROBENZIDINE	91-94-1	µg/kg	2,222			4.6		4.6	MTCA Method B PSW
SVOA	3-NITROANILINE	99-09-2	µg/kg							
SVOA	4,6-DINITRO-2-METHYLPHENOL	534-52-1	µg/kg							
SVOA	4-BROMOPHENYL-PHENYLETHER	101-55-3	µg/kg							
SVOA	4-CHLORO-3-METHYLPHENOL	59-50-7	µg/kg							
SVOA	4-CHLOROANILINE	106-47-8	µg/kg		320,000				320,000	MTCA Method B
SVOA	4-CHLOROPHENYL-PHENYLETHER	7005-72-3	µg/kg							

Table B-9
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Sediment

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen[a]	MTCA Method B for Soil - Non-Carcinogen[a]	MTCA Method B for Protection of GW[a]	MTCA Method B for Protection of SW[d]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Sediment	Source of Most Stringent ARAR for Sediment
SVOA	4-METHYLPHENOL	106-44-5	µg/kg		400,000				400,000	MTCA Method B
SVOA	4-NITROANILINE	100-01-6	µg/kg							
SVOA	4-NITROPHENOL	100-02-7	µg/kg							
SVOA	ACENAPHTHENE	83-32-9	µg/kg		4.80E+06		64,279		64,279	MTCA Method B PSW
SVOA	ACENAPHTHYLENE	208-96-8	µg/kg							
SVOA	ANTHRACENE	120-12-7	µg/kg		2.40E+07		2.59E+06		2.59E+06	MTCA Method B PSW
SVOA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	137			30		30	MTCA Method B PSW
SVOA	BENZO(A)PYRENE	50-32-8	µg/kg	137			3.0		3.0	MTCA Method B PSW
SVOA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	137			30		30	MTCA Method B PSW
SVOA	BENZO(G,H,I)PERYLENE	191-24-2	µg/kg							
SVOA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	137			296		137	MTCA Method B
SVOA	BENZOIC ACID	65-85-0	µg/kg		3.20E+08				3.20E+08	MTCA Method B
SVOA	BENZYL ALCOHOL	100-51-6	µg/kg		2.40E+07				2.40E+07	MTCA Method B
SVOA	BIS(2-CHLOROETHOXY) METHANE	111-91-1	µg/kg							
SVOA	BIS-(2-CHLOROETHYL) ETHER	111-44-4	µg/kg	909			85		85	MTCA Method B PSW
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	µg/kg	71,429	1.60E+06		356		356	MTCA Method B PSW
SVOA	BUTYLBENZYLPHTHALATE	85-68-7	µg/kg		1.60E+07		125,246		125,246	MTCA Method B PSW
SVOA	CARBAZOLE	86-74-8	µg/kg	50,000					50,000	MTCA Method B
SVOA	CHRYSENE	218-01-9	µg/kg	137			2,960		137	MTCA Method B
SVOA	DI-N-BUTYLPHTHALATE	84-74-2	µg/kg		8.00E+06		291,303		291,303	MTCA Method B PSW
SVOA	DI-N-OCTYL PHTHALATE	117-84-0	µg/kg		1.60E+06				1.60E+06	MTCA Method B
SVOA	DIBENZ(A,H)ANTHRACENE	53-70-3	µg/kg	137			3.0		3.0	MTCA Method B PSW
SVOA	DIBENZOFURAN	132-64-9	µg/kg							
SVOA	DIETHYLPHTHALATE	84-66-2	µg/kg		6.40E+07		2.84E+06		2.84E+06	MTCA Method B PSW
SVOA	DIMETHYLPHTHALATE	131-11-3	µg/kg		8.00E+07				8.00E+07	MTCA Method B
SVOA	FLUORANTHENE	206-44-0	µg/kg		3.20E+06		9,018		9,018	MTCA Method B PSW
SVOA	FLUORENE	86-73-7	µg/kg		3.20E+06		345,679		345,679	MTCA Method B PSW
SVOA	HEXACHLOROBENZENE	118-74-1	µg/kg	625	64,000		0.047		0.047	MTCA Method B PSW
SVOA	HEXACHLOROBUTADIENE	87-68-3	µg/kg	12,821	16,000		2,989		2,989	MTCA Method B PSW
SVOA	HEXACHLOROCYCLOPENTADIENE	77-47-4	µg/kg		560,000		418,160		418,160	MTCA Method B PSW
SVOA	HEXACHLOROETHANE	67-72-1	µg/kg	71,429	80,000		533		533	MTCA Method B PSW
SVOA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/kg	137			30		30	MTCA Method B PSW
SVOA	ISOPHORONE	78-59-1	µg/kg	1.05E+06	1.60E+07		155,767		155,767	MTCA Method B PSW
SVOA	N-NITROSO-DI-N-PROPYLAMINE	621-64-7	µg/kg	143					143	MTCA Method B
SVOA	N-NITROSODIPHENYLAMINE	86-30-6	µg/kg	204,082			973		973	MTCA Method B PSW
SVOA	NAPHTHALENE	91-20-3	µg/kg		3.20E+06				3.20E+06	MTCA Method B
SVOA	NITROBENZENE	98-95-3	µg/kg		40,000		44,855		40,000	MTCA Method B
SVOA	PENTACHLOROPHENOL	87-86-5	µg/kg	8,333	2.40E+06		491		491	MTCA Method B PSW

Table B-9
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Sediment

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen[a]	MTCA Method B for Soil - Non-Carcinogen[a]	MTCA Method B for Protection of GW[a]	MTCA Method B for Protection of SW[d]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Sediment	Source of Most Stringent ARAR for Sediment
SVOA	PHENANTHRENE	85-01-8	µg/kg							
SVOA	PHENOL	108-95-2	µg/kg		4.80E+07		1.11E+08		4.80E+07	MTCA Method B
SVOA	PYRENE	129-00-0	µg/kg		2.40E+06		259,259		259,259	MTCA Method B PSW
SVOA	PYRIDINE	110-86-1	µg/kg		80				80	MTCA Method B
VOA	1,1,1,2-TETRACHLOROETHANE	630-20-6	µg/kg	38,462	2.40E+06	168			168	MTCA Method B PGW
VOA	1,1,1-TRICHLOROETHANE	71-55-6	µg/kg		7.20E+07	720,000	4.17E+06		720,000	MTCA Method B PGW
VOA	1,1,2,2-TETRACHLOROETHANE	79-34-5	µg/kg	5,000		22	648		22	MTCA Method B PGW
VOA	1,1,2-TRICHLOROETHANE	79-00-5	µg/kg	17,544	320,000	77	2,527		77	MTCA Method B PGW
VOA	1,1,2-TRICHLOROTRIFLUOROETHANE	76-13-1	µg/kg		2.40E+09	4.80E+07			4.80E+07	MTCA Method B PGW
VOA	1,1-DICHLOROETHANE	75-34-3	µg/kg		8.00E+06	80,000			80,000	MTCA Method B PGW
VOA	1,1-DICHLOROETHENE	75-35-4	µg/kg	1,667	720,000	7.3	193		7.3	MTCA Method B PGW
VOA	1,1-DICHLOROPROPENE	563-58-6	µg/kg							
VOA	1,2,3-TRICHLOROBENZENE	87-61-6	µg/kg							
VOA	1,2,3-TRICHLOROPROPANE	96-18-4	µg/kg	143	480,000	0.63			0.63	MTCA Method B PGW
VOA	1,2,4-TRICHLOROBENZENE	120-82-1	µg/kg		800,000	8,000	22,742		8,000	MTCA Method B PGW
VOA	1,2,4-TRIMETHYLBENZENE	95-63-6	µg/kg							
VOA	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	µg/kg	714		3.1			3.1	MTCA Method B PGW
VOA	1,2-DICHLOROBENZENE	95-50-1	µg/kg		7.20E+06	72,000	419,664		72,000	MTCA Method B PGW
VOA	1,2-DICHLOROETHANE	107-06-2	µg/kg	10,989		48	5,935		48	MTCA Method B PGW
VOA	1,2-DICHLOROPROPANE	78-87-5	µg/kg	14,706		64			64	MTCA Method B PGW
VOA	1,3,5-TRIMETHYLBENZENE	108-67-8	µg/kg							
VOA	1,3-DICHLOROBENZENE	541-73-1	µg/kg							
VOA	1,3-DICHLOROPROPANE	142-28-9	µg/kg							
VOA	1,4-DICHLOROBENZENE	106-46-7	µg/kg	41,667		182	486		182	MTCA Method B PGW
VOA	2,2-DICHLOROPROPANE	590-20-7	µg/kg							
VOA	2-BUTANONE	78-93-3	µg/kg		4.80E+07	480,000			480,000	MTCA Method B PGW
VOA	2-CHLOROETHYLVINYLETHER	110-75-8	µg/kg							
VOA	2-CHLOROTOLUENE	95-49-8	µg/kg		1.60E+06	16,000			16,000	MTCA Method B PGW
VOA	2-HEXANONE	591-78-6	µg/kg							
VOA	4-CHLOROTOLUENE	106-43-4	µg/kg							
VOA	4-ISOPROPYLTOLUENE	99-87-6	µg/kg							
VOA	4-METHYL-2-PENTANONE (MIBK)	108-10-1	µg/kg		6.40E+06	64,000			64,000	MTCA Method B PGW
VOA	ACETONE	67-64-1	µg/kg		8.00E+06	80,000			80,000	MTCA Method B PGW
VOA	ACROLEIN	107-02-8	µg/kg		1.60E+06	16,000			16,000	MTCA Method B PGW
VOA	ACRYLONITRILE	107-13-1	µg/kg	1,852	80,000	8.1	40		8.1	MTCA Method B PGW
VOA	ALLYL CHLORIDE	107-05-1	µg/kg		4.00E+06	80,000			80,000	MTCA Method B PGW
VOA	BENZENE	71-43-2	µg/kg	34,483		151	4,298		151	MTCA Method B PGW
VOA	BROMOBENZENE	108-86-1	µg/kg							

Table B-9
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Sediment

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen[a]	MTCA Method B for Soil - Non-Carcinogen[a]	MTCA Method B for Protection of GW[a]	MTCA Method B for Protection of SW[d]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Sediment	Source of Most Stringent ARAR for Sediment
VOA	BROMOCHLOROMETHANE	74-97-5	µg/kg							
VOA	BROMODICHLOROMETHANE	75-27-4	µg/kg	16,129	1.60E+06	71	2,788		71	MTCA Method B PGW
VOA	BROMOETHANE	74-96-4	µg/kg							
VOA	BROMOFORM	75-25-2	µg/kg	126,582	1.60E+06	554	21,878		554	MTCA Method B PGW
VOA	BROMOMETHANE	74-83-9	µg/kg		112,000	1,120			1,120	MTCA Method B PGW
VOA	CARBON DISULFIDE	75-15-0	µg/kg		8.00E+06	80,000			80,000	MTCA Method B PGW
VOA	CARBON TETRACHLORIDE	56-23-5	µg/kg	7,692	56,000	34	266		34	MTCA Method B PGW
VOA	CHLOROBENZENE	108-90-7	µg/kg		1.60E+06	16,000	503,416		16,000	MTCA Method B PGW
VOA	CHLOROETHANE	75-00-3	µg/kg							
VOA	CHLOROFORM	67-66-3	µg/kg	163,934	800,000	717	28,334		717	MTCA Method B PGW
VOA	CHLOROMETHANE	74-87-3	µg/kg	76,923		337	13,295		337	MTCA Method B PGW
VOA	CIS-1,2-DICHLOROETHENE	156-59-2	µg/kg		800,000	8,000			8,000	MTCA Method B PGW
VOA	CIS-1,3-DICHLOROPROPENE	10061-01-5	µg/kg							
VOA	DIBROMOCHLOROMETHANE	124-48-1	µg/kg	11,905	1.60E+06	52	2,058		52	MTCA Method B PGW
VOA	DIBROMOMETHANE	74-95-3	µg/kg		800,000	8,000			8,000	MTCA Method B PGW
VOA	DICHLORODIFLUOROMETHANE	75-71-8	µg/kg		1.60E+07	160,000			160,000	MTCA Method B PGW
VOA	ETHYLBENZENE	100-41-4	µg/kg		8.00E+06	80,000	691,358		80,000	MTCA Method B PGW
VOA	ETHYLENE DIBROMIDE	106-93-4	µg/kg	12		0.051			0.051	MTCA Method B PGW
VOA	HEXACHLOROBUTADIENE	87-68-3	µg/kg	12,821	16,000	56	2,989		56	MTCA Method B PGW
VOA	ISOPROPYLBENZENE	98-82-8	µg/kg		3.20E+06	64,000			64,000	MTCA Method B PGW
VOA	M,P-XYLENE		µg/kg							
VOA	METHYL IODIDE	74-88-4	µg/kg							
VOA	METHYL METHACRYLATE	80-62-6	µg/kg		6.40E+06	64,000			64,000	MTCA Method B PGW
VOA	METHYLENE CHLORIDE	75-09-2	µg/kg	133,333	4.80E+06	583	96,022		583	MTCA Method B PGW
VOA	N-BUTYLBENZENE	104-51-8	µg/kg							
VOA	N-PROPYLBENZENE	103-65-1	µg/kg							
VOA	NAPHTHALENE	91-20-3	µg/kg		3.20E+06	32,000			32,000	MTCA Method B PGW
VOA	O-XYLENE	95-47-6	µg/kg		1.60E+08	1.60E+06			1.60E+06	MTCA Method B PGW
VOA	SEC-BUTYLBENZENE	135-98-8	µg/kg							
VOA	STYRENE	100-42-5	µg/kg	33,333	1.60E+07	146			146	MTCA Method B PGW
VOA	TERT-BUTYLBENZENE	98-06-6	µg/kg							
VOA	TETRACHLOROETHENE	127-18-4	µg/kg	19,608	800,000	86	415		86	MTCA Method B PGW
VOA	TOLUENE	108-88-3	µg/kg		1.60E+07	160,000	4.85E+06		160,000	MTCA Method B PGW
VOA	TRANS-1,2-DICHLOROETHENE	156-60-5	µg/kg		1.60E+06	16,000	3.28E+06		16,000	MTCA Method B PGW
VOA	TRANS-1,3-DICHLOROPROPENE	10061-02-6	µg/kg							
VOA	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	µg/kg							
VOA	TRICHLOROETHENE	79-01-6	µg/kg	90,909		398	5,559		398	MTCA Method B PGW
VOA	TRICHLOROFLUOROMETHANE	75-69-4	µg/kg		2.40E+07	240,000			240,000	MTCA Method B PGW

Table B-9
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Sediment

Chem Group	Parameter	CAS #	Units	MTCA Method B for Soil-Carcinogen[a]	MTCA Method B for Soil - Non-Carcinogen[a]	MTCA Method B for Protection of GW[a]	MTCA Method B for Protection of SW[d]	Puget Sound Area Natural Background Metal Concentrations[c]	Most Stringent ARAR for Sediment	Source of Most Stringent ARAR for Sediment
VOA	VINYL ACETATE	108-05-4	µg/kg		8.00E+07	800,000			800,000	MTCA Method B PGW
VOA	VINYL CHLORIDE	75-01-4	µg/kg	526		2.3	292		2.3	MTCA Method B PGW

Notes:

[a] MTCA Method B values are from CLARC II, February 1996.

[b] No Method B values. Values are from Method A table (WAC 173-340, page 70).

[c] Natural background concentrations may be substituted for MTCA Method B values.

[d] Calculated value equal to 100 times the MTCA Method B surface water cleanup level.

Table B-10
BAINBRIDGE ISLAND LANDFILL FS
Sediment
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
CONV	BIOLOGICAL OXYGEN DEMAND		mg/Kg	8	8	100%			33	2,100	868			
CONV	CHEMICAL OXYGEN DEMAND		mg/Kg	8	8	100%			150	230,000	91,644			
CONV	CHLORIDE		mg/Kg	8	8	100%			20	200	74			
CONV	N-AMMONIA		mg-N/kg	8	8	100%			0.38	16	3.9			
CONV	NITRATE + NITRITE (NO2+NO3)		mg-N/kg	8	8	100%			0.49	3.8	1.4			
CONV	SULFIDE		mg/Kg	1	8	13%	0.70	1.3	6.5	6.5	1.2			
CONV	TOTAL ORGANIC CARBON		%	8	8	100%			0.78	4.8	2.7			
CONV	TOTAL SOLIDS		%	8	8	100%			63	88	73			
PHC	DIESEL RANGE HYDROCARBONS		µg/kg	2	8	25%	28,000	39,000	17,000	76,000	24,313	200,000		
PHC	GAS RANGE HYDROCARBONS		µg/kg	1	8	13%	11,000	16,000	7,500	7,500	6,813	100,000		
PHC	OIL RANGE HYDROCARBONS		µg/kg	2	8	25%	56,000	78,000	130,000	1.70E+06	254,188	200,000	1	
PNA	ANTHRACENE	120-12-7	µg/kg	1	7	14%	23	32	380	380	66	2.59E+06		
PNA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	6	7	86%	2.5	2.5	2.1	80	15	30	1	
PNA	BENZO(A)PYRENE	50-32-8	µg/kg	7	7	100%			1.8	70	14	3.0	6	
PNA	BENZO(B)FLUORANTHENE	205-99-2	µg/kg	7	7	100%			6.2	120	29	30	1	
PNA	BENZO(G,H,I)PERYLENE	191-24-2	µg/kg	6	7	86%	6.9	6.9	5.1	41	14			
PNA	BENZO(K)FLUORANTHENE	207-08-9	µg/kg	7	7	100%			1.1	46	10	137		
PNA	CHRYSENE	218-01-9	µg/kg	5	7	71%	8.3	8.7	6.7	390	69	137	1	
PNA	DIBENZO(A,H)ANTHRACENE	53-70-3	µg/kg	6	7	86%	4.1	4.1	1.6	20	5.7	3.0	3	1
PNA	FLUORANTHENE	206-44-0	µg/kg	4	7	57%	18	25	13	270	52	9,018		
PNA	FLUORENE	86-73-7	µg/kg	2	7	29%	17	23	2.1	79	19	345,679		
PNA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/kg	7	7	100%			3.8	52	14	30	1	
PNA	PHENANTHRENE	85-01-8	µg/kg	1	7	14%	23	32	140	140	32			
PNA	PYRENE	129-00-0	µg/kg	3	7	43%	9.9	14	16	140	28	259,259		
SVOA	ACENAPHTHENE	83-32-9	µg/kg	1	8	13%	74	100	59	59	46	64,279		
SVOA	ANTHRACENE	120-12-7	µg/kg	1	8	13%	80	110	190	190	65	2.59E+06		
SVOA	BENZO(A)ANTHRACENE	56-55-3	µg/kg	1	8	13%	74	100	77	77	48	30	1	7
SVOA	BENZOIC ACID	65-85-0	µg/kg	1	8	13%	740	1,000	740	740	467	3.20E+08		
SVOA	CHRYSENE	218-01-9	µg/kg	1	8	13%	74	100	250	250	70	137	1	
SVOA	FLUORENE	86-73-7	µg/kg	1	8	13%	74	100	120	120	53	345,679		
SVOA	PHENANTHRENE	85-01-8	µg/kg	1	8	13%	74	100	160	160	58			
SVOA	PYRENE	129-00-0	µg/kg	1	8	13%	74	100	130	130	55	259,259		
VOA	4-ISOPROPYLTOLUENE	99-87-6	µg/kg	1	8	13%	1.1	1.6	21	21	3.2			
VOA	ACETONE	67-64-1	µg/kg	2	8	25%	8.0	12	10	18	7.2	80,000		
METAL	ARSENIC	7440-38-2	µg/kg	8	8	100%			1,750	17,500	7,006	7,300	3	
METAL	BARIUM	7440-39-3	µg/kg	8	8	100%			46,400	136,500	87,100	5.60E+06		
METAL	BERYLLIUM	7440-41-7	µg/kg	8	8	100%			220	620	344	610	1	
METAL	CADMIUM	7440-43-9	µg/kg	4	8	50%	220	340	240	430	234	2,025		

Table B-10
BAINBRIDGE ISLAND LANDFILL FS
Sediment
Statistical Summary by parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	Number of Detect Samples Exceeding MSA	Number of Nondetect Samples Exceeding MSA
METAL	CHROMIUM	7440-47-3	µg/kg	8	8	100%			24,500	43,800	32,175	100,000		
METAL	COPPER	7440-50-8	µg/kg	8	8	100%			3,600	18,100	12,206	266,461		
METAL	IRON	7439-89-6	µg/kg	8	8	100%			1.38E+07	6.58E+07	2.78E+07	5.87E+07	1	
METAL	LEAD	7439-92-1	µg/kg	8	8	100%			7,150	47,500	19,256	250,000		
METAL	MANGANESE	7439-96-5	µg/kg	8	8	100%			169,000	675,000	368,938	1.12E+07		
METAL	MERCURY	7439-97-6	µg/kg	4	8	50%	50	70	70	200	73	24,000		
METAL	NICKEL	7440-02-0	µg/kg	8	8	100%			29,100	40,800	34,719	110,323		
METAL	SILVER	7440-22-4	µg/kg	1	8	13%	340	510	460	460	238	400,000		
METAL	THALLIUM	7440-28-0	µg/kg	2	8	25%	100	170	170	230	98	5,600		
METAL	TIN	7440-31-5	µg/kg	7	8	88%	1,000	1,000	3,000	7,000	3,563	4.80E+07		
METAL	ZINC	7440-66-6	µg/kg	8	8	100%			34,600	103,000	56,281	1.65E+06		

Notes:

[a] Mean value is calculated assigning nondetects a value of one half the detection limit.

[b] See associated screening level table.

Surface Water

Table B-11
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Surface Water

Chem Group	Parameter	Units	CAS #	Freshwater Acute[a] Federal (FWAFED)	Freshwater Acute[a] State (FWASTATE)	Freshwater Chronic[a] Federal (FWCFED)	Freshwater Chronic[a] State (FWCSTATE)	Most Stringent Surface Water	Source of Most Stringent Surface Water
CL-PHENOL	PENTACHLOROPHENOL	µg/L	87-86-5	19	3.3 [c]	15	2.1 [c]	2.1	FWCSTATE
CONV	ALKALINITY	mg/L CaCO3				20		20	FWCFED
CONV	BICARBONATE (ALKALINITY)	mg/L CaCO3							
CONV	BIOLOGICAL OXYGEN DEMAND	mg/L							
CONV	CARBONATE (ALKALINITY)	mg/L CaCO3							
CONV	CHEMICAL OXYGEN DEMAND	mg/L							
CONV	CHLORIDE	mg/L		860	860	230	230	230	FWCFED and FWCSTATE
CONV	CONDUCTIVITY	UMHOS/CM							
CONV	DISSOLVED OXYGEN	mg/L			>9.5		>9.5	>9.5	FWASTATE and FWCSTATE
CONV	EH	REFMV							
CONV	FECAL COLIFORM	CFU/100 ml			50		50	50	FWASTATE and FWCSTATE
CONV	HARDNESS (BY CALCULATION)	mg/L CaCO3							
CONV	HARDNESS, DISSOLVED	mg/L							
CONV	N-AMMONIA	mg-N/L		[d]	[d]	[d]	[d]		
CONV	N-AMMONIA BY ISE	mg-N/L							
CONV	N-NITRATE	mg-N/L							
CONV	N-NITRITE	mg-N/L							
CONV	NITRATE + NITRITE (NO2+NO3)	mg-N/L							
CONV	PH	STD			6.5 - 8.5	6.5-9	6.5 -8.5	6.5-8.5	FWASTATE and FWCSTATE
CONV	SULFATE	mg/L							
CONV	TEMPERATURE (C)	C			< 16		<16	<16	FWASTATE and FWCSTATE
CONV	TOTAL COLIFORM	CFU/100 ml			<50		<50	<50	FWASTATE and FWCSTATE
CONV	TOTAL DISSOLVED SOLIDS	mg/L							
CONV	TOTAL ORGANIC CARBON	mg/L							
CONV	TOTAL SUSPENDED SOLIDS	mg/L							
CONV	TURBIDITY	NTU			5.0		5.0	5.0	FWASTATE and FWCSTATE
DISS_METAL	ANTIMONY	µg/L	7440-36-0						
DISS_METAL	ARSENIC	µg/L	7440-38-2	340	360	150	190	150	FWCFED
DISS_METAL	BARIUM	µg/L	7440-39-3						
DISS_METAL	BERYLLIUM	µg/L	7440-41-7						
DISS_METAL	CADMIUM	µg/L	7440-43-9	0.54 [b]	0.47 [b]	0.55	0.25	0.25	FWCSTATE
DISS_METAL	CALCIUM	µg/L	7440-70-2						
DISS_METAL	CHROMIUM	µg/L	7440-47-3	120 [b]		16		16	FWCFED
DISS_METAL	COPPER	µg/L	7440-50-8	2.2 [b]	2.8 [b]	1.8	2.2	1.8	FWCFED
DISS_METAL	IRON	µg/L	7439-89-6			1,000		1,000	FWCFED
DISS_METAL	LEAD	µg/L	7439-92-1	7.8 [b]	7.8 [b]	0.30	0.30	0.30	FWCFED and FWCSTATE
DISS_METAL	MAGNESIUM	µg/L	7439-95-4						
DISS_METAL	MANGANESE	µg/L	7439-96-5						
DISS_METAL	MERCURY	µg/L	7439-97-6	1.4	2.1	0.77		0.77	FWCFED
DISS_METAL	NICKEL	µg/L	7440-02-0	94 [b]	284 [b]	10	32	10	FWCFED
DISS_METAL	POTASSIUM	µg/L	7440-09-7						
DISS_METAL	SELENIUM	µg/L	7782-49-2						
DISS_METAL	SILVER	µg/L	7440-22-4	0.13 [b]	0.13 [b]			0.13	FWAFED and FWASTATE
DISS_METAL	SODIUM	µg/L	7440-23-5						
DISS_METAL	THALLIUM	µg/L	7440-28-0						
DISS_METAL	TIN	µg/L	7440-31-5						
DISS_METAL	ZINC	µg/L	7440-66-6	23 [b]	23 [b]	24	21	21	FWCSTATE
HERB	2,4,5-T	µg/L	93-76-5						
HERB	2,4,5-TP (SILVEX)	µg/L	93-72-1						
HERB	2,4-D	µg/L	94-75-7						

Table B-11
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Surface Water

				Freshwater Acute[a]		Freshwater Chronic[a]			
Chem Group	Parameter	Units	CAS #	Federal (FWAFED)	State (FWASTATE)	Federal (FWCFED)	State (FWCSTATE)	Most Stringent Surface Water	Source of Most Stringent Surface Water
HERB	2,4-DB	µg/L	94-82-6						
HERB	DALAPON	µg/L	75-99-0						
HERB	DICAMBA	µg/L	1918-00-9						
HERB	DICHLOROPROP	µg/L	120-36-5						
HERB	DINOSEB	µg/L	88-85-7						
HERB	MCPA	µg/L	94-74-6						
METAL	ANTIMONY	µg/L	7440-36-0						
METAL	ARSENIC	µg/L	7440-38-2						
METAL	BARIUM	µg/L	7440-39-3						
METAL	BERYLLIUM	µg/L	7440-41-7						
METAL	CADMIUM	µg/L	7440-43-9						
METAL	CALCIUM	µg/L	7440-70-2						
METAL	CHROMIUM	µg/L	7440-47-3		116		38	38	FWCSTATE
METAL	COPPER	µg/L	7440-50-8						
METAL	IRON	µg/L	7439-89-6			1,000		1,000	FWCFED
METAL	LEAD	µg/L	7439-92-1						
METAL	MAGNESIUM	µg/L	7439-95-4						
METAL	MANGANESE	µg/L	7439-96-5						
METAL	MERCURY	µg/L	7439-97-6				0.012	0.012	FWCSTATE
METAL	NICKEL	µg/L	7440-02-0						
METAL	POTASSIUM	µg/L	7440-09-7						
METAL	SELENIUM	µg/L	7782-49-2	ND	20	5.0	5.0	5.0	FWCFED and FWCSTATE
METAL	SILVER	µg/L	7440-22-4						
METAL	SODIUM	µg/L	7440-23-5						
METAL	THALLIUM	µg/L	7440-28-0						
METAL	TIN	µg/L	7440-31-5						
METAL	ZINC	µg/L	7440-66-6						
PEST	4,4'-DDD	µg/L	72-54-8		1.1		0.0010	0.0010	FWCSTATE
PEST	4,4'-DDE	µg/L	72-55-9		1.1		0.0010	0.0010	FWCSTATE
PEST	4,4'-DDT	µg/L	50-29-3	1.1	1.1	0.0010	0.0010	0.0010	FWCFED and FWCSTATE
PEST	ALDRIN	µg/L	309-00-2	3.0	2.5		0.0019	0.0019	FWCSTATE
PEST	ALPHA CHLORDANE	µg/L	5103-71-9						
PEST	ALPHA-BHC	µg/L	319-84-6						
PEST	AROCLOR 1016	µg/L	12674-11-2		2.0	0.014	0.014	0.014	FWCFED and FWCSTATE
PEST	AROCLOR 1221	µg/L	11104-28-2		2.0	0.014	0.014	0.014	FWCFED and FWCSTATE
PEST	AROCLOR 1232	µg/L	11141-16-5		2.0	0.014	0.014	0.014	FWCFED and FWCSTATE
PEST	AROCLOR 1242	µg/L	53469-21-9		2.0	0.014	0.014	0.014	FWCFED and FWCSTATE
PEST	AROCLOR 1248	µg/L	12672-29-6		2.0	0.014	0.014	0.014	FWCFED and FWCSTATE
PEST	AROCLOR 1254	µg/L	11097-69-1		2.0	0.014	0.014	0.014	FWCFED and FWCSTATE
PEST	AROCLOR 1260	µg/L	11096-82-5		2.0	0.014	0.014	0.014	FWCFED and FWCSTATE
PEST	TOTAL PCBS	µg/L	1336-36-3						
PEST	BETA-BHC	µg/L	319-85-7						
PEST	DELTA-BHC	µg/L	319-86-8						
PEST	DIELDRIN	µg/L	60-57-1	0.24	2.5	0.056	0.0019	0.0019	FWCSTATE
PEST	ENDOSULFAN I	µg/L	959-98-8	0.22	0.22	0.056	0.056	0.056	FWCFED and FWCSTATE
PEST	ENDOSULFAN II	µg/L	33213-65-9	0.22	0.22	0.056	0.056	0.056	FWCFED and FWCSTATE
PEST	ENDOSULFAN SULFATE	µg/L	1031-07-8						
PEST	ENDRIN	µg/L	72-20-8	0.086	0.18	0.036	0.0023	0.0023	FWCSTATE
PEST	ENDRIN ALDEHYDE	µg/L	7421-93-4						
PEST	ENDRIN KETONE	µg/L	53494-70-5						

Table B-11
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Surface Water

Chem Group	Parameter	Units	CAS #	Freshwater Acute[a] Federal (FWAFED)	Freshwater Acute[a] State (FWASTATE)	Freshwater Chronic[a] Federal (FWCFED)	Freshwater Chronic[a] State (FWCSTATE)	Most Stringent Surface Water	Source of Most Stringent Surface Water
PEST	GAMMA CHLORDANE	µg/L	57-74-9	2.4	2.4	0.0043	0.0043	0.0043	FWCFED and FWCSTATE
PEST	GAMMA-BHC (LINDANE)	µg/L	58-89-9	0.95	2.0		0.080	0.080	FWCSTATE
PEST	HEPTACHLOR	µg/L	76-44-8	0.52	0.52	0.0038	0.0038	0.0038	FWCFED and FWCSTATE
PEST	HEPTACHLOR EPOXIDE	µg/L	1024-57-3	0.52		0.0038		0.0038	FWCFED
PEST	METHOXYCHLOR	µg/L	72-43-5			0.030		0.030	FWCFED
PEST	TOXAPHENE	µg/L	8001-35-2	0.73	0.73	2.00E-04	2.00E-04	2.00E-04	FWCFED and FWCSTATE
PHC	DIESEL RANGE HYDROCARBONS	µg/L							
PHC	GAS RANGE HYDROCARBONS	µg/L							
PHC	OIL RANGE HYDROCARBONS	µg/L							
PNA	ACENAPHTHENE	µg/L	83-32-9						
PNA	ACENAPHTHYLENE	µg/L	208-96-8						
PNA	ANTHRACENE	µg/L	120-12-7						
PNA	BENZO(A)ANTHRACENE	µg/L	56-55-3						
PNA	BENZO(A)PYRENE	µg/L	50-32-8						
PNA	BENZO(B)FLUORANTHENE	µg/L	205-99-2						
PNA	BENZO(G,H,I)PERYLENE	µg/L	191-24-2						
PNA	BENZO(K)FLUORANTHENE	µg/L	207-08-9						
PNA	CHRYSENE	µg/L	218-01-9						
PNA	DIBENZO(A,H)ANTHRACENE	µg/L	53-70-3						
PNA	FLUORANTHENE	µg/L	206-44-0						
PNA	FLUORENE	µg/L	86-73-7						
PNA	INDENO(1,2,3-CD)PYRENE	µg/L	193-39-5						
PNA	NAPHTHALENE	µg/L	91-20-3						
PNA	PHENANTHRENE	µg/L	85-01-8						
PNA	PYRENE	µg/L	129-00-0						
SIM_VOA	1,1-DICHLOROETHENE	µg/L	75-35-4						
SIM_VOA	VINYL CHLORIDE	µg/L	75-01-4						
SVOA	1,2,4-TRICHLOROBENZENE	µg/L	120-82-1						
SVOA	1,2-DICHLOROBENZENE	µg/L	95-50-1						
SVOA	1,3-DICHLOROBENZENE	µg/L	541-73-1						
SVOA	1,4-DICHLOROBENZENE	µg/L	106-46-7						
SVOA	2,2'-OXYBIS(1-CHLOROPROPANE)	µg/L	108-60-1						
SVOA	2,4,5-TRICHLOROPHENOL	µg/L	95-95-4						
SVOA	2,4,6-TRICHLOROPHENOL	µg/L	88-06-2						
SVOA	2,4-DICHLOROPHENOL	µg/L	120-83-2						
SVOA	2,4-DIMETHYLPHENOL	µg/L	105-67-9						
SVOA	2,4-DINITROPHENOL	µg/L	51-28-5						
SVOA	2,4-DINITROTOLUENE	µg/L	121-14-2						
SVOA	2,6-DINITROTOLUENE	µg/L	606-20-2						
SVOA	2-CHLORONAPHTHALENE	µg/L	91-58-7						
SVOA	2-CHLOROPHENOL	µg/L	95-57-8						
SVOA	2-METHYLNAPHTHALENE	µg/L	91-57-6						
SVOA	2-METHYLPHENOL	µg/L	95-48-7						
SVOA	2-NITROANILINE	µg/L	88-74-4						
SVOA	2-NITROPHENOL	µg/L	88-75-5						
SVOA	3,3'-DICHLOROBENZIDINE	µg/L	91-94-1						
SVOA	3-NITROANILINE	µg/L	99-09-2						
SVOA	4,6-DINITRO-2-METHYLPHENOL	µg/L	534-52-1						
SVOA	4-BROMOPHENYL-PHENYLETHER	µg/L	101-55-3						
SVOA	4-CHLORO-3-METHYLPHENOL	µg/L	59-50-7						

Table B-11
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Surface Water

				Freshwater Acute[a]		Freshwater Chronic[a]			
Chem Group	Parameter	Units	CAS #	Federal (FWAFED)	State (FWASTATE)	Federal (FWCFED)	State (FWCSTATE)	Most Stringent Surface Water	Source of Most Stringent Surface Water
SVOA	4-CHLOROANILINE	µg/L	106-47-8						
SVOA	4-CHLOROPHENYL-PHENYLETHER	µg/L	7005-72-3						
SVOA	4-METHYLPHENOL	µg/L	106-44-5						
SVOA	4-NITROANILINE	µg/L	100-01-6						
SVOA	4-NITROPHENOL	µg/L	100-02-7						
SVOA	ACENAPHTHENE	µg/L	83-32-9						
SVOA	ACENAPHTHYLENE	µg/L	208-96-8						
SVOA	ANTHRACENE	µg/L	120-12-7						
SVOA	BENZO(A)ANTHRACENE	µg/L	56-55-3						
SVOA	BENZO(A)PYRENE	µg/L	50-32-8						
SVOA	BENZO(B)FLUORANTHENE	µg/L	205-99-2						
SVOA	BENZO(G,H,I)PERYLENE	µg/L	191-24-2						
SVOA	BENZO(K)FLUORANTHENE	µg/L	207-08-9						
SVOA	BENZOIC ACID	µg/L	65-85-0						
SVOA	BENZYL ALCOHOL	µg/L	100-51-6						
SVOA	BIS(2-CHLOROETHOXY) METHANE	µg/L	111-91-1						
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	µg/L	117-81-7						
SVOA	BIS-(2-CHLOROETHYL) ETHER	µg/L	111-44-4						
SVOA	BUTYLBENZYLPHTHALATE	µg/L	85-68-7						
SVOA	CARBAZOLE	µg/L	86-74-8						
SVOA	CHRYSENE	µg/L	218-01-9						
SVOA	DI-N-BUTYLPHTHALATE	µg/L	84-74-2						
SVOA	DI-N-OCTYL PHTHALATE	µg/L	117-84-0						
SVOA	DIBENZ(A,H)ANTHRACENE	µg/L	53-70-3						
SVOA	DIBENZOFURAN	µg/L	132-64-9						
SVOA	DIETHYLPHTHALATE	µg/L	84-66-2						
SVOA	DIMETHYLPHTHALATE	µg/L	131-11-3						
SVOA	FLUORANTHENE	µg/L	206-44-0						
SVOA	FLUORENE	µg/L	86-73-7						
SVOA	HEXACHLOROBENZENE	µg/L	118-74-1						
SVOA	HEXACHLOROBUTADIENE	µg/L	87-68-3						
SVOA	HEXACHLOROCYCLOPENTADIENE	µg/L	77-47-4						
SVOA	HEXACHLOROETHANE	µg/L	67-72-1						
SVOA	INDENO(1,2,3-CD)PYRENE	µg/L	193-39-5						
SVOA	ISOPHORONE	µg/L	78-59-1						
SVOA	N-NITROSO-DI-N-PROPYLAMINE	µg/L	621-64-7						
SVOA	N-NITROSODIPHENYLAMINE	µg/L	86-30-6						
SVOA	NAPHTHALENE	µg/L	91-20-3						
SVOA	NITROBENZENE	µg/L	98-95-3						
SVOA	PENTACHLOROPHENOL	µg/L	87-86-5	19	3.3 [c]	15	2.1 [c]	2.1	FWCSTATE
SVOA	PHENANTHRENE	µg/L	85-01-8						
SVOA	PHENOL	µg/L	108-95-2						
SVOA	PYRENE	µg/L	129-00-0						
VOA	1,1,1,2-TETRACHLOROETHANE	µg/L	630-20-6						
VOA	1,1,1-TRICHLOROETHANE	µg/L	71-55-6						
VOA	1,1,2,2-TETRACHLOROETHANE	µg/L	79-34-5						
VOA	1,1,2-TRICHLOROETHANE	µg/L	79-00-5						
VOA	1,1,2-TRICHLOROTRIFLUOROETHANE	µg/L	76-13-1						
VOA	1,1-DICHLOROETHANE	µg/L	75-34-3						
VOA	1,1-DICHLOROETHENE	µg/L	75-35-4						

Table B-11
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Surface Water

				Freshwater Acute[a]		Freshwater Chronic[a]			
Chem Group	Parameter	Units	CAS #	Federal (FWAFED)	State (FWASTATE)	Federal (FWCFED)	State (FWCSTATE)	Most Stringent Surface Water	Source of Most Stringent Surface Water
VOA	1,1-DICHLOROPROPENE	µg/L	563-58-6						
VOA	1,2,3-TRICHLOROBENZENE	µg/L	87-61-6						
VOA	1,2,3-TRICHLOROPROPANE	µg/L	96-18-4						
VOA	1,2,4-TRICHLOROBENZENE	µg/L	120-82-1						
VOA	1,2,4-TRIMETHYLBENZENE	µg/L	95-63-6						
VOA	1,2-DIBROMO-3-CHLOROPROPANE	µg/L	96-12-8						
VOA	1,2-DICHLOROBENZENE	µg/L	95-50-1						
VOA	1,2-DICHLOROETHANE	µg/L	107-06-2						
VOA	1,2-DICHLOROPROPANE	µg/L	78-87-5						
VOA	1,3,5-TRIMETHYLBENZENE	µg/L	108-67-8						
VOA	1,3-DICHLOROBENZENE	µg/L	541-73-1						
VOA	1,3-DICHLOROPROPANE	µg/L	142-28-9						
VOA	1,4-DICHLOROBENZENE	µg/L	106-46-7						
VOA	2,2-DICHLOROPROPANE	µg/L	590-20-7						
VOA	2-BUTANONE	µg/L	78-93-3						
VOA	2-CHLOROETHYLVINYLETHER	µg/L	110-75-8						
VOA	2-CHLOROTOLUENE	µg/L	95-49-8						
VOA	2-HEXANONE	µg/L	591-78-6						
VOA	4-CHLOROTOLUENE	µg/L	106-43-4						
VOA	4-ISOPROPYLTOLUENE	µg/L	99-87-6						
VOA	4-METHYL-2-PENTANONE (MIBK)	µg/L	108-10-1						
VOA	ACETONE	µg/L	67-64-1						
VOA	ACROLEIN	µg/L	107-02-8						
VOA	ACRYLONITRILE	µg/L	107-13-1						
VOA	ALLYL CHLORIDE	µg/L	107-05-1						
VOA	BENZENE	µg/L	71-43-2						
VOA	BROMOBENZENE	µg/L	108-86-1						
VOA	BROMOCHLOROMETHANE	µg/L	74-97-5						
VOA	BROMODICHLOROMETHANE	µg/L	75-27-4						
VOA	BROMOETHANE	µg/L	74-96-4						
VOA	BROMOFORM	µg/L	75-25-2						
VOA	BROMOMETHANE	µg/L	74-83-9						
VOA	CARBON DISULFIDE	µg/L	75-15-0						
VOA	CARBON TETRACHLORIDE	µg/L	56-23-5						
VOA	CHLOROBENZENE	µg/L	108-90-7						
VOA	CHLOROETHANE	µg/L	75-00-3						
VOA	CHLOROFORM	µg/L	67-66-3						
VOA	CHLOROMETHANE	µg/L	74-87-3						
VOA	CIS-1,2-DICHLOROETHENE	µg/L	156-59-2						
VOA	CIS-1,3-DICHLOROPROPENE	µg/L	10061-01-5						
VOA	DIBROMOCHLOROMETHANE	µg/L	124-48-1						
VOA	DIBROMOMETHANE	µg/L	74-95-3						
VOA	DICHLORODIFLUOROMETHANE	µg/L	75-71-8						
VOA	ETHYLBENZENE	µg/L	100-41-4						
VOA	ETHYLENE DIBROMIDE	µg/L	106-93-4						
VOA	HEXACHLOROBUTADIENE	µg/L	87-68-3						
VOA	ISOPROPYLBENZENE	µg/L	98-82-8						
VOA	M,P-XYLENE	µg/L							
VOA	METHYL IODIDE	µg/L	74-88-4						
VOA	METHYL METHACRYLATE	µg/L	80-62-6						

Table B-11
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Surface Water

Chem Group	Parameter	Units	CAS #	Freshwater Acute[a] Federal (FWAFED)	Freshwater Acute[a] State (FWASTATE)	Freshwater Chronic[a] Federal (FWCFED)	Freshwater Chronic[a] State (FWCSTATE)	Most Stringent Surface Water	Source of Most Stringent Surface Water
VOA	METHYLENE CHLORIDE	µg/L	75-09-2						
VOA	N-BUTYLBENZENE	µg/L	104-51-8						
VOA	N-PROPYLBENZENE	µg/L	103-65-1						
VOA	NAPHTHALENE	µg/L	91-20-3						
VOA	O-XYLENE	µg/L	95-47-6						
VOA	SEC-BUTYLBENZENE	µg/L	135-98-8						
VOA	STYRENE	µg/L	100-42-5						
VOA	TERT-BUTYLBENZENE	µg/L	98-06-6						
VOA	TETRACHLOROETHENE	µg/L	127-18-4						
VOA	TOLUENE	µg/L	108-88-3						
VOA	TRANS-1,2-DICHLOROETHENE	µg/L	156-60-5						
VOA	TRANS-1,3-DICHLOROPROPENE	µg/L	10061-02-6						
VOA	TRANS-1,4-DICHLORO-2-BUTENE	µg/L	110-57-6						
VOA	TRICHLOROETHENE	µg/L	79-01-6						
VOA	TRICHLOROFLUOROMETHANE	µg/L	75-69-4						
VOA	VINYL ACETATE	µg/L	108-05-4						
VOA	VINYL CHLORIDE	µg/L	75-01-4						
VOA_524	1,1,1,2-TETRACHLOROETHANE	µg/L	630-20-6						
VOA_524	1,1,1-TRICHLOROETHANE	µg/L	71-55-6						
VOA_524	1,1,2,2-TETRACHLOROETHANE	µg/L	79-34-5						
VOA_524	1,1,2-TRICHLOROETHANE	µg/L	79-00-5						
VOA_524	1,1-DICHLOROETHANE	µg/L	75-34-3						
VOA_524	1,1-DICHLOROETHENE	µg/L	75-35-4						
VOA_524	1,1-DICHLOROPROPENE	µg/L	563-58-6						
VOA_524	1,2,3-TRICHLOROBENZENE	µg/L	87-61-6						
VOA_524	1,2,3-TRICHLOROPROPANE	µg/L	96-18-4						
VOA_524	1,2,4-TRICHLOROBENZENE	µg/L	120-82-1						
VOA_524	1,2,4-TRIMETHYLBENZENE	µg/L	95-63-6						
VOA_524	1,2-DIBROMO-3-CHLOROPROPANE	µg/L	96-12-8						
VOA_524	1,2-DIBROMOETHANE	µg/L	106-93-4						
VOA_524	1,2-DICHLOROBENZENE	µg/L	95-50-1						
VOA_524	1,2-DICHLOROETHANE	µg/L	107-06-2						
VOA_524	1,2-DICHLOROPROPANE	µg/L	78-87-5						
VOA_524	1,3,5-TRIMETHYLBENZENE	µg/L	108-67-8						
VOA_524	1,3-DICHLOROBENZENE	µg/L	541-73-1						
VOA_524	1,3-DICHLOROPROPANE	µg/L	142-28-9						
VOA_524	1,4-DICHLOROBENZENE	µg/L	106-46-7						
VOA_524	2,2-DICHLOROPROPANE	µg/L	590-20-7						
VOA_524	4-ISOPROPYLTOLUENE	µg/L	99-87-6						
VOA_524	BENZENE	µg/L	71-43-2						
VOA_524	BROMOBENZENE	µg/L	108-86-1						
VOA_524	BROMOCHLOROMETHANE	µg/L	74-97-5						
VOA_524	BROMODICHLOROMETHANE	µg/L	75-27-4						
VOA_524	BROMOFORM	µg/L	75-25-2						
VOA_524	BROMOMETHANE	µg/L	74-83-9						
VOA_524	CARBON TETRACHLORIDE	µg/L	56-23-5						
VOA_524	CHLOROBENZENE	µg/L	108-90-7						
VOA_524	CHLOROETHANE	µg/L	75-00-3						
VOA_524	CHLOROFORM	µg/L	67-66-3						
VOA_524	CHLOROMETHANE	µg/L	74-87-3						

Table B-11
BAINBRIDGE ISLAND LANDFILL
Development of Most Stringent ARAR for Surface Water

				Freshwater Acute[a]		Freshwater Chronic[a]			
Chem Group	Parameter	Units	CAS #	Federal (FWAFED)	State (FWASTATE)	Federal (FWCFED)	State (FWCSTATE)	Most Stringent Surface Water	Source of Most Stringent Surface Water
VOA_524	CIS-1,2-DICHLOROETHENE	µg/L	156-59-2						
VOA_524	CIS-1,3-DICHLOROPROPENE	µg/L	10061-01-5						
VOA_524	DIBROMOCHLOROMETHANE	µg/L	124-48-1						
VOA_524	DIBROMOMETHANE	µg/L	74-95-3						
VOA_524	DICHLORODIFLUOROMETHANE	µg/L	75-71-8						
VOA_524	ETHYLBENZENE	µg/L	100-41-4						
VOA_524	HEXACHLOROBUTADIENE	µg/L	87-68-3						
VOA_524	ISOPROPYLBENZENE	µg/L	98-82-8						
VOA_524	M,P-XYLENE	µg/L							
VOA_524	METHYLENE CHLORIDE	µg/L	75-09-2						
VOA_524	N-BUTYLBENZENE	µg/L	104-51-8						
VOA_524	N-PROPYLBENZENE	µg/L	103-65-1						
VOA_524	NAPHTHALENE	µg/L	91-20-3						
VOA_524	O-XYLENE	µg/L	95-47-6						
VOA_524	SEC-BUTYLBENZENE	µg/L	135-98-8						
VOA_524	STYRENE	µg/L	100-42-5						
VOA_524	TERT-BUTYLBENZENE	µg/L	98-06-6						
VOA_524	TETRACHLOROETHENE	µg/L	127-18-4						
VOA_524	TOLUENE	µg/L	108-88-3						
VOA_524	TRANS-1,2-DICHLOROETHENE	µg/L	156-60-5						
VOA_524	TRANS-1,3-DICHLOROPROPENE	µg/L	10061-02-6						
VOA_524	TRICHLOROETHENE	µg/L	79-01-6						
VOA_524	TRICHLOROFLUOROMETHANE	µg/L	75-69-4						
VOA_524	VINYL CHLORIDE	µg/L	75-01-4						

Notes:

[a] Federal criteria from Water Pollution Control Act (40 CFR 131).
State criteria from State Water Quality Control Standards (WAC 173-201A).
FWAFED = Federal Freshwater Acute [40 CFR 131.36(b)(1)]
FWASTATE = State Freshwater Acute [WAC 173-201A -040(3)]
FWCFED = Federal Freshwater Chronic [40 CFR 131.36(b)(1)]
FWCSTATE = State Freshwater Chronic [WAC 173-201A-040(3)]
[b] Calculated for Federal and State criteria based on hardness using the mean surface water hardness of 15 mg/L.
[c] Calculated based on a mean pH value of 6.0 std units.
[d] Not to exceed critieria in WAC 173-201A-040 or 40 CFR 131.36.
[e] Standard applies to Total PCBs.
[f] Washington State Underground Storage Tank model NPDES permit.
ND = Not determined. Fractions of selenite and selenate not available.
Conventional criteria included based on protection of Class AA water as per WAC 173-201A-030. Tabular presentation of criteria are a best approximation of written criteria.

Table B-12
BAINBRIDGE ISLAND LANDFILL
Surface Water
Statistical Summary by Parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	Detect Samples Exceeding	Nondetect Samples Exceeding
CONV	ALKALINITY		mg/L CaCO3	26	26	100%			2.3	90	18	20	6	
CONV	BICARBONATE (ALKALINITY)		mg/L CaCO3	26	26	100%			2.3	90	18			
CONV	BIOLOGICAL OXYGEN DEMAND		mg/L	22	25	88%	1.0	1.0	1.0	9.0	3.6			
CONV	CHEMICAL OXYGEN DEMAND		mg/L	26	26	100%			17	82	47			
CONV	CHLORIDE		mg/L	26	26	100%			2.4	5.1	3.8	230		
CONV	CONDUCTIVITY		uMHO/cm	23	23	100%			-6.00E+01	195	53			
CONV	DISSOLVED OXYGEN		mg/L	23	23	100%			6.3	14	10	>9.5	7	
CONV	FECAL COLIFORM		CFU/100 mL	24	26	92%	1.0	2.0	2.0	405	40	50	3	
CONV	HARDNESS (BY CALCULATION)		mg/L CaCO3	13	13	100%			12	81	26			
CONV	N-AMMONIA		mg-N/L	25	26	96%	0.010	0.010	0.013	2.8	0.34			
CONV	N-NITRATE		mg-N/L	26	26	100%			0.037	1.8	0.80			
CONV	N-NITRITE		mg-N/L	9	26	35%	0.010	0.016	0.011	0.023	0.0085			
CONV	NITRATE + NITRITE (NO2+NO3)		mg-N/L	26	26	100%			0.037	1.8	0.80			
CONV	PH		STD	23	23	100%			4.5	7.0	6.0	6.5-8.5	18	
CONV	SULFATE		mg/L	26	26	100%			5.5	34	12			
CONV	TEMPERATURE (C)		C	23	23	100%			3.0	11	7.2	<16		
CONV	TOTAL COLIFORM		CFU/100 mL	22	26	85%	2.0	2.0	2.0	1,000	217	<50	16	
CONV	TOTAL DISSOLVED SOLIDS		mg/L	26	26	100%			50	140	94			
CONV	TOTAL ORGANIC CARBON		mg/L	26	26	100%			8.7	34	18			
CONV	TOTAL SUSPENDED SOLIDS		mg/L	25	26	96%	1.7	1.7	2.0	120	16			
CONV	TURBIDITY		NTU	18	18	100%			-1.00E+01	293	55	5.0	16	
CL-PHENOL	PENTACHLOROPHENOL	87-86-5	µg/L	2	18	11%	0.25	0.25	0.35	0.80	0.18	2.1		
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	µg/L	3	18	17%	1.0	1.0	1.3	3.6	0.78			
SVOA	DIETHYLPHTHALATE	84-66-2	µg/L	1	18	6%	1.0	1.0	1.4	1.4	0.55			
SVOA	NAPHTHALENE	91-20-3	µg/L	2	18	11%	1.0	1.0	1.2	1.4	0.59			
VOA	1,2,4-TRIMETHYLBENZENE	95-63-6	µg/L	2	26	8%	0.20	0.60	0.20	0.40	0.12			
VOA	1,4-DICHLOROBENZENE	106-46-7	µg/L	2	26	8%	0.20	0.60	0.25	0.30	0.12			
VOA	ACETONE	67-64-1	µg/L	3	26	12%	1.0	3.4	0.80	1.7	0.91			
VOA	ACROLEIN	107-02-8	µg/L	1	26	4%	5.0	16	0.60	0.60	2.6			
VOA	CHLOROBENZENE	108-90-7	µg/L	2	26	8%	0.20	0.60	0.20	0.25	0.12			
VOA	ISOPROPYLBENZENE	98-82-8	µg/L	2	26	8%	0.20	0.60	0.20	0.40	0.12			
VOA	M,P-XYLENE	1330-20-7	µg/L	1	26	4%	0.40	1.2	0.10	0.10	0.21			
VOA	NAPHTHALENE	91-20-3	µg/L	5	26	19%	0.50	1.6	0.30	2.6	0.45			
VOA	TOLUENE	108-88-3	µg/L	1	26	4%	0.20	0.60	0.20	0.20	0.11			
VOA	TRICHLOROFLUOROMETHANE	75-69-4	µg/L	1	26	4%	0.20	0.60	0.20	0.20	0.11			
SIM_VOA	VINYL CHLORIDE	75-01-4	µg/L	3	26	12%	0.010	0.010	0.010	0.040	0.0071			
VOA_524	1,2,4-TRIMETHYLBENZENE	95-63-6	µg/L	1	13	8%	0.20	0.20	0.35	0.35	0.12			
VOA_524	1,4-DICHLOROBENZENE	106-46-7	µg/L	1	13	8%	0.20	0.20	0.20	0.20	0.11			
VOA_524	BENZENE	71-43-2	µg/L	1	13	8%	0.20	0.20	0.10	0.10	0.10			
VOA_524	CHLOROBENZENE	108-90-7	µg/L	1	13	8%	0.20	0.20	0.20	0.20	0.11			
VOA_524	ETHYLBENZENE	100-41-4	µg/L	1	13	8%	0.20	0.20	0.20	0.20	0.11			
VOA_524	ISOPROPYLBENZENE	98-82-8	µg/L	1	13	8%	0.20	0.20	0.30	0.30	0.12			
VOA_524	M,P-XYLENE	1330-20-7	µg/L	1	13	8%	0.20	0.30	0.20	0.20	0.14			
VOA_524	NAPHTHALENE	91-20-3	µg/L	4	13	31%	0.20	0.20	0.30	2.6	0.37			
VOA_524	TOLUENE	108-88-3	µg/L	1	13	8%	0.20	0.20	0.10	0.10	0.10			

Table B-12
BAINBRIDGE ISLAND LANDFILL
Surface Water
Statistical Summary by Parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	CAS #	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	Detect Samples Exceeding	Nondetect Samples Exceeding
METAL	ARSENIC	7440-38-2	µg/L	14	26	54%	1.0	2.5	1.0	2.9	1.3			
METAL	BARIUM	7440-39-3	µg/L	26	26	100%			13	51	31			
METAL	CALCIUM	7440-70-2	µg/L	26	26	100%			2,590	30,700	7,114			
METAL	CHROMIUM	7440-47-3	µg/L	13	26	50%	5.0	5.0	5.9	9.8	5.3	38		
METAL	COPPER	7440-50-8	µg/L	21	26	81%	2.0	2.5	2.4	8.7	3.1			
METAL	IRON	7439-89-6	µg/L	26	26	100%			572	4,970	2,268	1,000	21	
METAL	LEAD	7439-92-1	µg/L	12	26	46%	1.0	3.2	1.3	6.0	1.6			
METAL	MAGNESIUM	7439-95-4	µg/L	26	26	100%			1,240	4,830	2,414			
METAL	MANGANESE	7439-96-5	µg/L	26	26	100%			16	193	56			
METAL	NICKEL	7440-02-0	µg/L	5	26	19%	10	10	10	16	6.5			
METAL	POTASSIUM	7440-09-7	µg/L	8	22	36%	500	779	637	4,170	918			
METAL	SELENIUM	7782-49-2	µg/L	2	26	8%	1.0	2.0	1.1	2.0	0.60	5.0		
METAL	SODIUM	7440-23-5	µg/L	19	22	86%	2,140	2,340	2,750	5,955	3,271			
METAL	ZINC	7440-66-6	µg/L	14	26	54%	4.0	17	5.0	34	9.1			
DISS_METAL	ANTIMONY	7440-36-0	µg/L	1	26	4%	1.0	1.8	1.1	1.1	0.54			
DISS_METAL	ARSENIC	7440-38-2	µg/L	11	26	42%	1.0	1.5	1.0	2.0	0.86	150		
DISS_METAL	BARIUM	7440-39-3	µg/L	23	26	88%	6.0	6.4	11	50	18			
DISS_METAL	CALCIUM	7440-70-2	µg/L	22	22	100%			2,810	30,400	7,415			
DISS_METAL	COPPER	7440-50-8	µg/L	20	26	77%	2.0	2.1	2.0	6.3	2.6	1.8	20	6
DISS_METAL	IRON	7439-89-6	µg/L	26	26	100%			190	3,480	827	1,000	5	
DISS_METAL	LEAD	7439-92-1	µg/L	1	26	4%	1.0	1.2	1.6	1.6	0.55	0.30	1	25
DISS_METAL	MAGNESIUM	7439-95-4	µg/L	22	22	100%			1,290	4,760	2,316			
DISS_METAL	MANGANESE	7439-96-5	µg/L	26	26	100%			3.2	183	27			
DISS_METAL	POTASSIUM	7440-09-7	µg/L	12	22	55%	500	837	539	4,135	983			
DISS_METAL	SODIUM	7440-23-5	µg/L	22	22	100%			2,730	8,270	4,608			
DISS_METAL	THALLIUM	7440-28-0	µg/L	1	26	4%	1.0	1.0	1.0	1.0	0.52			
DISS_METAL	ZINC	7440-66-6	µg/L	15	26	58%	4.0	11	4.6	36	8.5	21	3	

Notes:

[a] Mean value is calculated assigning nondetects a value of one half the detection limit
[b] See associated screening level table.

Groundwater

Table B-13
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Groundwater

Chem Group	Parameter	CAS #	Units	Federal [a]		State [b]				
				Federal Primary MCL	Fed Secondary MCL	State Primary MCL	State Secondary MCL	MTCA Method B for GW Carcinogen [c]	MTCA Method B for GW Non-Carc [c]	Most Stringent ARAR for Groundwater
CL-PHENOL	PENTACHLOROPHENOL	87-86-5	µg/L	1.0		1.0		0.73	480	0.73
CONV	ALKALINITY		mg/L CaCO3							
CONV	BICARBONATE (ALKALINITY)		mg/L CaCO3							
CONV	BIOLOGICAL OXYGEN DEMAND		mg/L							
CONV	CARBONATE (ALKALINITY)		mg/L CaCO3							
CONV	CHEMICAL OXYGEN DEMAND		mg/L							
CONV	CHLORIDE		mg/L		250		250			250
CONV	CONDUCTIVITY		UMHOS/CM				700			700
CONV	DISSOLVED OXYGEN		mg/L							
CONV	EH		REFMV							
CONV	FECAL COLIFORM		CFU/100 ml							
CONV	HARDNESS (BY CALCULATION)		mg/L CaCO3							
CONV	HARDNESS, DISSOLVED		mg/L							
CONV	N-AMMONIA		mg-N/L							
CONV	N-AMMONIA BY ISE		mg-N/L							
CONV	N-NITRATE		mg-N/L	10		10		26		10
CONV	N-NITRITE		mg-N/L	1.0		1.0		1.6		1.0
CONV	NITRATE + NITRITE (NO2+NO3)		mg-N/L	10		10				10
CONV	PH		STD		6.5-8.5		6.5-8.5			6.5-8.5
CONV	SULFATE		mg/L		250		250			250
CONV	TEMPERATURE (C)		C							
CONV	TOTAL COLIFORM		CFU/100 ml			1.0				1.0
CONV	TOTAL DISSOLVED SOLIDS		mg/L		500		500			500
CONV	TOTAL ORGANIC CARBON		mg/L							
CONV	TOTAL SUSPENDED SOLIDS		mg/L							
CONV	TURBIDITY		NTU							
DISS_METAL	ANTIMONY	7440-36-0	µg/L	6.0		6.0				6.0
DISS_METAL	ARSENIC	7440-38-2	µg/L	50		50		0.058	4.8	0.058
DISS_METAL	BARIUM	7440-39-3	µg/L	2,000		2,000			1,120	1,120
DISS_METAL	BERYLLIUM	7440-41-7	µg/L	4.0		4.0		0.020	80	0.020
DISS_METAL	CADMIUM	7440-43-9	µg/L	5.0		5.0			8.0	5.0
DISS_METAL	CALCIUM	7440-70-2	µg/L							
DISS_METAL	CHROMIUM	7440-47-3	µg/L	100		100			16,000	100
DISS_METAL	COPPER	7440-50-8	µg/L		1,000				592	592
DISS_METAL	IRON	7439-89-6	µg/L				300			300
DISS_METAL	LEAD	7439-92-1	µg/L	15 [d]					5.0	5.0
DISS_METAL	MAGNESIUM	7439-95-4	µg/L							
DISS_METAL	MANGANESE	7439-96-5	µg/L		50		50		2,240	50
DISS_METAL	MERCURY	7439-97-6	µg/L	2.0		2.0			4.8	2.0
DISS_METAL	NICKEL	7440-02-0	µg/L	100		100			320	100
DISS_METAL	POTASSIUM	7440-09-7	µg/L							
DISS_METAL	SELENIUM	7782-49-2	µg/L	50		50			80	50
DISS_METAL	SILVER	7440-22-4	µg/L		100		100		80	80
DISS_METAL	SODIUM	7440-23-5	µg/L							
DISS_METAL	THALLIUM	7440-28-0	µg/L	2.0		2.0			1.1	1.1
DISS_METAL	TIN	7440-31-5	µg/L						9,600	9,600
DISS_METAL	ZINC	7440-66-6	µg/L		5,000		5,000		4,800	4,800
HERB	2,4,5-T	93-76-5	µg/L						160	160

Table B-13
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Groundwater

				Federal [a]		State [b]				
Chem Group	Parameter	CAS #	Units	Federal Primary MCL	Fed Secondary MCL	State Primary MCL	State Secondary MCL	MTCA Method B for GW Carcinogen [c]	MTCA Method B for GW Non-Carc [c]	Most Stringent ARAR for Groundwater
HERB	2,4,5-TP (SILVEX)	93-72-1	µg/L	50		50			128	50
HERB	2,4-D	94-75-7	µg/L	70		70			160	70
HERB	2,4-DB	94-82-6	µg/L						128	128
HERB	DALAPON	75-99-0	µg/L	200		200			480	200
HERB	DICAMBA	1918-00-9	µg/L						480	480
HERB	DICHLOROPROP	120-36-5	µg/L							
HERB	DINOSEB	88-85-7	µg/L	7.0		7.0				7.0
HERB	MCPA	94-74-6	µg/L						8.0	8.0
METAL	ANTIMONY	7440-36-0	µg/L	6.0		6.0				6.0
METAL	ARSENIC	7440-38-2	µg/L	50		50		0.058	4.8	0.058
METAL	BARIUM	7440-39-3	µg/L	2,000		2,000			1,120	1,120
METAL	BERYLLIUM	7440-41-7	µg/L	4.0		4.0		0.020	80	0.020
METAL	CADMIUM	7440-43-9	µg/L	5.0		5.0			8.0	5.0
METAL	CALCIUM	7440-70-2	µg/L							
METAL	CHROMIUM	7440-47-3	µg/L	100		100			16,000	100
METAL	COPPER	7440-50-8	µg/L		1,000				592	592
METAL	IRON	7439-89-6	µg/L				300			300
METAL	LEAD	7439-92-1	µg/L	15	[d]				5.0	5.0
METAL	MAGNESIUM	7439-95-4	µg/L							
METAL	MANGANESE	7439-96-5	µg/L		50		50		2,240	50
METAL	MERCURY	7439-97-6	µg/L	2.0		2.0			4.8	2.0
METAL	NICKEL	7440-02-0	µg/L	100		100			320	100
METAL	POTASSIUM	7440-09-7	µg/L							
METAL	SELENIUM	7782-49-2	µg/L	50		50			80	50
METAL	SILVER	7440-22-4	µg/L		100		100		80	80
METAL	SODIUM	7440-23-5	µg/L							
METAL	THALLIUM	7440-28-0	µg/L	2.0		2.0			1.1	1.1
METAL	TIN	7440-31-5	µg/L						9,600	9,600
METAL	ZINC	7440-66-6	µg/L		5,000		5,000		4,800	4,800
PEST	4,4'-DDD	72-54-8	µg/L					0.36		0.36
PEST	4,4'-DDE	72-55-9	µg/L					0.26		0.26
PEST	4,4'-DDT	50-29-3	µg/L					0.26	8.0	0.26
PEST	ALDRIN	309-00-2	µg/L					0.0051	0.48	0.0051
PEST	ALPHA CHLORDANE	5103-71-9	µg/L							
PEST	ALPHA-BHC	319-84-6	µg/L					0.014		0.014
PEST	AROCLOR 1016	12674-11-2	µg/L						1.1	1.1
PEST	AROCLOR 1221	11104-28-2	µg/L							
PEST	AROCLOR 1232	11141-16-5	µg/L							
PEST	AROCLOR 1242	53469-21-9	µg/L							
PEST	AROCLOR 1248	12672-29-6	µg/L							
PEST	AROCLOR 1254	11097-69-1	µg/L						0.32	0.32
PEST	AROCLOR 1260	11096-82-5	µg/L							
PEST	TOTAL PCBS	1336-36-3	µg/L					0.011		0.011
PEST	BETA-BHC	319-85-7	µg/L					0.049		0.049
PEST	DELTA-BHC	319-86-8	µg/L							
PEST	DIELDRIN	60-57-1	µg/L					0.0055	0.80	0.0055
PEST	ENDOSULFAN I	959-98-8	µg/L							
PEST	ENDOSULFAN II	33213-65-9	µg/L							

Table B-13
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Groundwater

				Federal [a]		State [b]				
Chem Group	Parameter	CAS #	Units	Federal Primary MCL	Fed Secondary MCL	State Primary MCL	State Secondary MCL	MTCA Method B for GW Carcinogen [c]	MTCA Method B for GW Non-Carc [c]	Most Stringent ARAR for Groundwater
PEST	ENDOSULFAN SULFATE	1031-07-8	µg/L							
PEST	ENDRIN	72-20-8	µg/L	2.0		2.0			4.8	2.0
PEST	ENDRIN ALDEHYDE	7421-93-4	µg/L							
PEST	ENDRIN KETONE	53494-70-5	µg/L							
PEST	GAMMA CHLORDANE	57-74-9	µg/L	2		2		0.067	1.0	0.067
PEST	GAMMA-BHC (LINDANE)	58-89-9	µg/L	0.2		0.2		0.067	4.80	0.067
PEST	HEPTACHLOR	76-44-8	µg/L	0.40		0.40		0.019	8.0	0.019
PEST	HEPTACHLOR EPOXIDE	1024-57-3	µg/L	0.20		0.20		0.0096	0.21	0.0096
PEST	METHOXYCHLOR	72-43-5	µg/L	40		40			80	40
PEST	TOXAPHENE	8001-35-2	µg/L	3.0		3.0		0.080		0.080
PHC	DIESEL RANGE HYDROCARBONS		µg/L						1,000	1,000
PHC	GAS RANGE HYDROCARBONS		µg/L						1,000	1,000
PHC	OIL RANGE HYDROCARBONS		µg/L						1,000	1,000
PNA	ACENAPHTHENE	83-32-9	µg/L						960	960
PNA	ACENAPHTHYLENE	208-96-8	µg/L							
PNA	ANTHRACENE	120-12-7	µg/L						4,800	4,800
PNA	BENZO(A)ANTHRACENE	56-55-3	µg/L					0.012		0.012
PNA	BENZO(A)PYRENE	50-32-8	µg/L	0.20		0.20		0.012		0.012
PNA	BENZO(B)FLUORANTHENE	205-99-2	µg/L					0.012		0.012
PNA	BENZO(G,H,I)PERYLENE	191-24-2	µg/L							
PNA	BENZO(K)FLUORANTHENE	207-08-9	µg/L					0.012		0.012
PNA	CHRYSENE	218-01-9	µg/L					0.012		0.012
PNA	DIBENZO(A,H)ANTHRACENE	53-70-3	µg/L					0.012		0.012
PNA	FLUORANTHENE	206-44-0	µg/L						640	640
PNA	FLUORENE	86-73-7	µg/L						640	640
PNA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/L					0.012		0.012
PNA	NAPHTHALENE	91-20-3	µg/L						320	320
PNA	PHENANTHRENE	85-01-8	µg/L							
PNA	PYRENE	129-00-0	µg/L						480	480
SIM_VOA	1,1-DICHLOROETHENE	75-35-4	µg/L	7.0		7.0		0.073	72	0.073
SIM_VOA	VINYL CHLORIDE	75-01-4	µg/L	2.0		2.0		0.023		0.023
SVOA	1,2,4-TRICHLOROBENZENE	120-82-1	µg/L	70		70			80	70
SVOA	1,2-DICHLOROBENZENE	95-50-1	µg/L	600		600			720	600
SVOA	1,3-DICHLOROBENZENE	541-73-1	µg/L	600		600				600
SVOA	1,4-DICHLOROBENZENE	106-46-7	µg/L	75		75		1.8		1.8
SVOA	2,2'-OXYBIS(1-CHLOROPROPANE)	108-60-1	µg/L					1.3		1.3
SVOA	2,4,5-TRICHLOROPHENOL	95-95-4	µg/L						1,600	1,600
SVOA	2,4,6-TRICHLOROPHENOL	88-06-2	µg/L					8.0		8.0
SVOA	2,4-DICHLOROPHENOL	120-83-2	µg/L						48	48
SVOA	2,4-DIMETHYLPHENOL	105-67-9	µg/L						320	320
SVOA	2,4-DINITROPHENOL	51-28-5	µg/L						32	32
SVOA	2,4-DINITROTOLUENE	121-14-2	µg/L						32	32
SVOA	2,6-DINITROTOLUENE	606-20-2	µg/L						16	16
SVOA	2-CHLORONAPHTHALENE	91-58-7	µg/L						1,280	1,280
SVOA	2-CHLOROPHENOL	95-57-8	µg/L						80	80
SVOA	2-METHYLNAPHTHALENE	91-57-6	µg/L							
SVOA	2-METHYLPHENOL	95-48-7	µg/L						800	800
SVOA	2-NITROANILINE	88-74-4	µg/L							

Table B-13
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Groundwater

				Federal [a]		State [b]				
Chem Group	Parameter	CAS #	Units	Federal Primary MCL	Fed Secondary MCL	State Primary MCL	State Secondary MCL	MTCA Method B for GW Carcinogen [c]	MTCA Method B for GW Non-Carc [c]	Most Stringent ARAR for Groundwater
SVOA	2-NITROPHENOL	88-75-5	µg/L							
SVOA	3,3'-DICHLOROBENZIDINE	91-94-1	µg/L					0.19		0.19
SVOA	3-NITROANILINE	99-09-2	µg/L							
SVOA	4,6-DINITRO-2-METHYLPHENOL	534-52-1	µg/L							
SVOA	4-BROMOPHENYL-PHENYLETHER	101-55-3	µg/L							
SVOA	4-CHLORO-3-METHYLPHENOL	59-50-7	µg/L							
SVOA	4-CHLOROANILINE	106-47-8	µg/L						64	64
SVOA	4-CHLOROPHENYL-PHENYLETHER	7005-72-3	µg/L							
SVOA	4-METHYLPHENOL	106-44-5	µg/L						80	80
SVOA	4-NITROANILINE	100-01-6	µg/L							
SVOA	4-NITROPHENOL	100-02-7	µg/L							
SVOA	ACENAPHTHENE	83-32-9	µg/L						960	960
SVOA	ACENAPHTHYLENE	208-96-8	µg/L							
SVOA	ANTHRACENE	120-12-7	µg/L						4,800	4,800
SVOA	BENZO(A)ANTHRACENE	56-55-3	µg/L					0.012		0.012
SVOA	BENZO(A)PYRENE	50-32-8	µg/L	0.20		0.20		0.012		0.012
SVOA	BENZO(B)FLUORANTHENE	205-99-2	µg/L					0.012		0.012
SVOA	BENZO(G,H,I)PERYLENE	191-24-2	µg/L							
SVOA	BENZO(K)FLUORANTHENE	207-08-9	µg/L					0.012		0.012
SVOA	BENZOIC ACID	65-85-0	µg/L						64,000	64,000
SVOA	BENZYL ALCOHOL	100-51-6	µg/L						4,800	4,800
SVOA	BIS(2-CHLOROETHOXY) METHANE	111-91-1	µg/L							
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	117-81-7	µg/L					6.3		6.3
SVOA	BIS-(2-CHLOROETHYL) ETHER	111-44-4	µg/L	6.0		6.0		0.040	320	0.04
SVOA	BUTYLBENZYLPHTHALATE	85-68-7	µg/L						3,200	3,200
SVOA	CARBAZOLE	86-74-8	µg/L					4.4		4.4
SVOA	CHRYSENE	218-01-9	µg/L					0.012		0.012
SVOA	DI-N-BUTYLPHTHALATE	84-74-2	µg/L						1,600	1,600
SVOA	DI-N-OCTYL PHTHALATE	117-84-0	µg/L						320	320
SVOA	DIBENZ(A,H)ANTHRACENE	53-70-3	µg/L					0.012		0.012
SVOA	DIBENZOFURAN	132-64-9	µg/L							
SVOA	DIETHYLPHTHALATE	84-66-2	µg/L						12,800	12,800
SVOA	DIMETHYLPHTHALATE	131-11-3	µg/L						16,000	16,000
SVOA	FLUORANTHENE	206-44-0	µg/L						640	640
SVOA	FLUORENE	86-73-7	µg/L						640	640
SVOA	HEXACHLOROBENZENE	118-74-1	µg/L	1.0		1.0		0.055	13	0.055
SVOA	HEXACHLOROBUTADIENE	87-68-3	µg/L					0.56	1.6	0.56
SVOA	HEXACHLOROCYCLOPENTADIENE	77-47-4	µg/L	50		50			112	50
SVOA	HEXACHLOROETHANE	67-72-1	µg/L					6.3	16	6.3
SVOA	INDENO(1,2,3-CD)PYRENE	193-39-5	µg/L					0.012		0.012
SVOA	ISOPHORONE	78-59-1	µg/L					92	3,200	92
SVOA	N-NITROSO-DI-N-PROPYLAMINE	621-64-7	µg/L					0.013		0.013
SVOA	N-NITROSODIPHENYLAMINE	86-30-6	µg/L					18		18
SVOA	NAPHTHALENE	91-20-3	µg/L						320	320
SVOA	NITROBENZENE	98-95-3	µg/L						8.0	8.0
SVOA	PENTACHLOROPHENOL	87-86-5	µg/L	1.0		1.0		0.73	480	0.73
SVOA	PHENANTHRENE	85-01-8	µg/L							
SVOA	PHENOL	108-95-2	µg/L						9,600	9,600

Table B-13
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Groundwater

				Federal [a]		State [b]				
Chem Group	Parameter	CAS #	Units	Federal Primary MCL	Fed Secondary MCL	State Primary MCL	State Secondary MCL	MTCA Method B for GW Carcinogen [c]	MTCA Method B for GW Non-Carc [c]	Most Stringent ARAR for Groundwater
SVOA	PYRENE	129-00-0	µg/L						480	480
VOA	1,1,1,2-TETRACHLOROETHANE	630-20-6	µg/L					1.7	240	1.7
VOA	1,1,1-TRICHLOROETHANE	71-55-6	µg/L	200		200			7,200	200
VOA	1,1,2,2-TETRACHLOROETHANE	79-34-5	µg/L					0.22		0.22
VOA	1,1,2-TRICHLOROETHANE	79-00-5	µg/L	5.0		5.0		0.77	32	0.77
VOA	1,1,2-TRICHLOROTRIFLUOROETHANE	76-13-1	µg/L						480,000	480,000
VOA	1,1-DICHLOROETHANE	75-34-3	µg/L						800	800
VOA	1,1-DICHLOROETHENE	75-35-4	µg/L	7.0		7.0		0.073	72	0.073
VOA	1,1-DICHLOROPROPENE	563-58-6	µg/L							
VOA	1,2,3-TRICHLOROBENZENE	87-61-6	µg/L							
VOA	1,2,3-TRICHLOROPROPANE	96-18-4	µg/L					0.0063	48	0.0063
VOA	1,2,4-TRICHLOROBENZENE	120-82-1	µg/L	70		70			80	70
VOA	1,2,4-TRIMETHYLBENZENE	95-63-6	µg/L							
VOA	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	µg/L	0.20		0.20		0.031		0.031
VOA	1,2-DICHLOROBENZENE	95-50-1	µg/L	600		600			720	600
VOA	1,2-DICHLOROETHANE	107-06-2	µg/L	5.0		5.0		0.48		0.48
VOA	1,2-DICHLOROPROPANE	78-87-5	µg/L	5.0		5.0		0.64		0.64
VOA	1,3,5-TRIMETHYLBENZENE	108-67-8	µg/L							
VOA	1,3-DICHLOROBENZENE	541-73-1	µg/L	600		600				600
VOA	1,3-DICHLOROPROPANE	142-28-9	µg/L							
VOA	1,4-DICHLOROBENZENE	106-46-7	µg/L	75		75		1.8		1.8
VOA	2,2-DICHLOROPROPANE	590-20-7	µg/L							
VOA	2-BUTANONE	78-93-3	µg/L						4,800	4,800
VOA	2-CHLOROETHYLVINYLETHER	110-75-8	µg/L							
VOA	2-CHLOROTOLUENE	95-49-8	µg/L						160	160
VOA	2-HEXANONE	591-78-6	µg/L							
VOA	4-CHLOROTOLUENE	106-43-4	µg/L							
VOA	4-ISOPROPYLTOLUENE	99-87-6	µg/L							
VOA	4-METHYL-2-PENTANONE (MIBK)	108-10-1	µg/L						640	640
VOA	ACETONE	67-64-1	µg/L						800	800
VOA	ACROLEIN	107-02-8	µg/L						160	160
VOA	ACRYLONITRILE	107-13-1	µg/L					0.081	8.0	0.081
VOA	ALLYL CHLORIDE	107-05-1	µg/L						800	800
VOA	BENZENE	71-43-2	µg/L	5.0		5.0		1.5		1.5
VOA	BROMOBENZENE	108-86-1	µg/L							
VOA	BROMOCHLOROMETHANE	74-97-5	µg/L							
VOA	BROMODICHLOROMETHANE	75-27-4	µg/L					0.71	160	0.71
VOA	BROMOETHANE	74-96-4	µg/L							
VOA	BROMOFORM	75-25-2	µg/L					5.5	160	5.5
VOA	BROMOMETHANE	74-83-9	µg/L						11	11
VOA	CARBON DISULFIDE	75-15-0	µg/L						800	800
VOA	CARBON TETRACHLORIDE	56-23-5	µg/L	5.0		5.0		0.34	5.6	0.34
VOA	CHLOROBENZENE	108-90-7	µg/L	100		100			160	100
VOA	CHLOROETHANE	75-00-3	µg/L							
VOA	CHLOROFORM	67-66-3	µg/L					7.2	80	7.2
VOA	CHLOROMETHANE	74-87-3	µg/L					3.4		3.4
VOA	CIS-1,2-DICHLOROETHENE	156-59-2	µg/L	70		70			80	70
VOA	CIS-1,3-DICHLOROPROPENE	10061-01-5	µg/L							

Table B-13

BAINBRIDGE ISLAND LANDFILL FS

Development of Most Stringent ARAR for Groundwater

				Federal [a]		State [b]				
Chem Group	Parameter	CAS #	Units	Federal Primary MCL	Fed Secondary MCL	State Primary MCL	State Secondary MCL	MTCA Method B for GW Carcinogen [c]	MTCA Method B for GW Non-Carc [c]	Most Stringent ARAR for Groundwater
VOA	DIBROMOCHLOROMETHANE	124-48-1	µg/L					0.52	160	0.52
VOA	DIBROMOMETHANE	74-95-3	µg/L						80	80
VOA	DICHLORODIFLUOROMETHANE	75-71-8	µg/L						1,600	1,600
VOA	ETHYLBENZENE	100-41-4	µg/L	700		700			800	700
VOA	ETHYLENE DIBROMIDE	106-93-4	µg/L	0.050		0.050		5.15E-04		5.15E-04
VOA	HEXACHLOROBUTADIENE	87-68-3	µg/L					0.56	1.6	0.56
VOA	ISOPROPYLBENZENE	98-82-8	µg/L						640	640
VOA	M,P-XYLENE		µg/L							
VOA	METHYL IODIDE	74-88-4	µg/L							
VOA	METHYL METHACRYLATE	80-62-6	µg/L						640	640
VOA	METHYLENE CHLORIDE	75-09-2	µg/L	5.0		5.0		5.8	480	5.0
VOA	N-BUTYLBENZENE	104-51-8	µg/L							
VOA	N-PROPYLBENZENE	103-65-1	µg/L							
VOA	NAPHTHALENE	91-20-3	µg/L						320	320
VOA	O-XYLENE	95-47-6	µg/L	10,000		10,000			16,000	10,000
VOA	SEC-BUTYLBENZENE	135-98-8	µg/L							
VOA	STYRENE	100-42-5	µg/L	100		100		1.5	1,600	1.5
VOA	TERT-BUTYLBENZENE	98-06-6	µg/L							
VOA	TETRACHLOROETHENE	127-18-4	µg/L	5.0		5.0		0.86	80	0.86
VOA	TOLUENE	108-88-3	µg/L	1,000		1,000			1,600	1,000
VOA	TRANS-1,2-DICHLOROETHENE	156-60-5	µg/L	100		100			160	100
VOA	TRANS-1,3-DICHLOROPROPENE	10061-02-6	µg/L							
VOA	TRANS-1,4-DICHLORO-2-BUTENE	110-57-6	µg/L							
VOA	TRICHLOROETHENE	79-01-6	µg/L	5.0		5.0		4.0		4.0
VOA	TRICHLOROFLUOROMETHANE	75-69-4	µg/L						2,400	2,400
VOA	VINYL ACETATE	108-05-4	µg/L						8,000	8,000
VOA	VINYL CHLORIDE	75-01-4	µg/L	2.0		2.0		0.023		0.023
VOA_524	1,1,1,2-TETRACHLOROETHANE	630-20-6	µg/L					1.7	240	1.7
VOA_524	1,1,1-TRICHLOROETHANE	71-55-6	µg/L	200		200			7,200	200
VOA_524	1,1,2,2-TETRACHLOROETHANE	79-34-5	µg/L					0.22		0.22
VOA_524	1,1,2-TRICHLOROETHANE	79-00-5	µg/L	5.0		5.0		0.77	32	0.77
VOA_524	1,1-DICHLOROETHANE	75-34-3	µg/L						800	800
VOA_524	1,1-DICHLOROETHENE	75-35-4	µg/L	7.0		7.0		0.073	72	0.073
VOA_524	1,1-DICHLOROPROPENE	563-58-6	µg/L							
VOA_524	1,2,3-TRICHLOROBENZENE	87-61-6	µg/L							
VOA_524	1,2,3-TRICHLOROPROPANE	96-18-4	µg/L					0.0063	48	0.0063
VOA_524	1,2,4-TRICHLOROBENZENE	120-82-1	µg/L	70		70			80	70
VOA_524	1,2,4-TRIMETHYLBENZENE	95-63-6	µg/L							
VOA_524	1,2-DIBROMO-3-CHLOROPROPANE	96-12-8	µg/L	0.20		0.20		0.031		0.031
VOA_524	1,2-DIBROMOETHANE	106-93-4	µg/L	0.050		0.050		5.15E-04		5.15E-04
VOA_524	1,2-DICHLOROBENZENE	95-50-1	µg/L	600		600			720	600
VOA_524	1,2-DICHLOROETHANE	107-06-2	µg/L	5.0		5.0		0.48		0.48
VOA_524	1,2-DICHLOROPROPANE	78-87-5	µg/L	5.0		5.0		0.64		0.64
VOA_524	1,3,5-TRIMETHYLBENZENE	108-67-8	µg/L							
VOA_524	1,3-DICHLOROBENZENE	541-73-1	µg/L							
VOA_524	1,3-DICHLOROPROPANE	142-28-9	µg/L							
VOA_524	1,4-DICHLOROBENZENE	106-46-7	µg/L	75		75		1.8		1.8
VOA_524	2,2-DICHLOROPROPANE	590-20-7	µg/L							

Table B-13
BAINBRIDGE ISLAND LANDFILL FS
Development of Most Stringent ARAR for Groundwater

Chem Group	Parameter	CAS #	Units	Federal [a]		State [b]		MTCA Method B for GW Carcinogen [c]	MTCA Method B for GW Non-Carc [c]	Most Stringent ARAR for Groundwater
				Federal Primary MCL	Fed Secondary MCL	State Primary MCL	State Secondary MCL			
VOA_524	4-ISOPROPYLTOLUENE	99-87-6	µg/L							
VOA_524	BENZENE	71-43-2	µg/L	5.0		5.0		1.5		1.5
VOA_524	BROMOBENZENE	108-86-1	µg/L							
VOA_524	BROMOCHLOROMETHANE	74-97-5	µg/L							
VOA_524	BROMODICHLOROMETHANE	75-27-4	µg/L					0.71	160	0.71
VOA_524	BROMOFORM	75-25-2	µg/L					5.5	160	5.5
VOA_524	BROMOMETHANE	74-83-9	µg/L						11	11
VOA_524	CARBON TETRACHLORIDE	56-23-5	µg/L	5.0		5.0		0.34	5.6	0.34
VOA_524	CHLOROBENZENE	108-90-7	µg/L	100		100			160	100
VOA_524	CHLOROETHANE	75-00-3	µg/L							
VOA_524	CHLOROFORM	67-66-3	µg/L					7.2	80	7.2
VOA_524	CHLOROMETHANE	74-87-3	µg/L					3.4		3.4
VOA_524	CIS-1,2-DICHLOROETHENE	156-59-2	µg/L	70		70			80	70
VOA_524	CIS-1,3-DICHLOROPROPENE	10061-01-5	µg/L							
VOA_524	DIBROMOCHLOROMETHANE	124-48-1	µg/L					0.52	160	0.52
VOA_524	DIBROMOMETHANE	74-95-3	µg/L					.	80	80
VOA_524	DICHLORODIFLUOROMETHANE	75-71-8	µg/L						1,600	1,600
VOA_524	ETHYLBENZENE	100-41-4	µg/L	700		700			800	700
VOA_524	HEXACHLOROBUTADIENE	87-68-3	µg/L					0.56	1.6	0.56
VOA_524	ISOPROPYLBENZENE	98-82-8	µg/L						640	640
VOA_524	M,P-XYLENE		µg/L							
VOA_524	METHYLENE CHLORIDE	75-09-2	µg/L	5.0		5.0		5.8	480	5.0
VOA_524	N-BUTYLBENZENE	104-51-8	µg/L							
VOA_524	N-PROPYLBENZENE	103-65-1	µg/L							
VOA_524	NAPHTHALENE	91-20-3	µg/L						320	320
VOA_524	O-XYLENE	95-47-6	µg/L	10,000		10,000			16,000	10,000
VOA_524	SEC-BUTYLBENZENE	135-98-8	µg/L							
VOA_524	STYRENE	100-42-5	µg/L	100		100		1.5	1,600	1.5
VOA_524	TERT-BUTYLBENZENE	98-06-6	µg/L							
VOA_524	TETRACHLOROETHENE	127-18-4	µg/L	5.0		5.0		0.86	80	0.86
VOA_524	TOLUENE	108-88-3	µg/L	1,000		1,000			1,600	1,000
VOA_524	TRANS-1,2-DICHLOROETHENE	156-60-5	µg/L	100		100			160	100
VOA_524	TRANS-1,3-DICHLOROPROPENE	10061-02-6	µg/L							
VOA_524	TRICHLOROETHENE	79-01-6	µg/L	5.0		5.0		4.0		4.0
VOA_524	TRICHLOROFLUOROMETHANE	75-69-4	µg/L						2,400	2,400
VOA_524	VINYL CHLORIDE	75-01-4	µg/L	2.0		2.0		0.023		0.023

Notes:

[a] Federal MCLs established under the Safe Drinking Water Act. Primary MCLs (40 CFR 141); Secondary MCLs (40CFR 143).
[b] State MCLs established under Washington Drinking Water Regulations (WAC 246-290).
[c] MTCA Method B values from CLARC II (February, 1996).
[d] Federal Action Level.

TABLE B-14
BAINBRIDGE ISLAND LANDFILL FS
Summary of Comparison to MSA - Detected Parameters Only

Chemical Group	Parameter	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Nondetect Value	Maximum Nondetect Value	Minimum Detected Value	Maximum Detected Value	MSA	Source of MSA	Detects Exceeding MSA	Exceedance Frequency	Exceedance Factor	Number of Wells with Exceeds	Nondetect Value Greater than MSA
Monitoring Wells																
SIM_VOA	VINYL CHLORIDE	µg/L	46	173	27%	0.010	0.020	0.010	4.8	0.023	MTCA B	44	25.4%		5	
SIM_VOA	1,1-DICHLOROETHENE	µg/L	39	174	22%	0.010	0.020	0.020	0.28	0.073	MTCA B	11	6.3%		2	
VOA	CIS-1,2-DICHLOROETHENE	µg/L	43	174	25%	0.20	0.20	0.10	80	70	State/Federal Primary MCLs	1	0.6%		1	
CL-PHENOL	PENTACHLOROPHENOL	µg/L	3	90	3%	0.25	0.28	0.15	1.2	0.73	MTCA B	1	1.1%		1	
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	µg/L	22	90	24%	1.0	20	0.70	130	6.3	MTCA B	7	7.8%		6	2
METAL	ARSENIC	mg/L	29	174	17%	0.0010	0.0010	0.0010	0.0035	5.83E-05	MTCA B	29	16.7%		12	145
METAL	CHROMIUM	mg/L	92	174	53%	0.0050	0.011	0.0050	0.14	0.10	State/Federal Primary MCLs	1	0.6%		1	
METAL	IRON	mg/L	97	174	56%	0.020	0.020	0.020	3.8	0.30	State Secondary MCL	23	13.2%		13	
METAL	LEAD	mg/L	18	174	10%	0.0010	0.020	8.00E-04	0.0020	0.0050	MTCA B					2
METAL	MANGANESE	mg/L	133	174	76%	0.0010	0.0058	0.0010	6.7	0.050	State/Federal Secondary MCLs	29	16.7%		10	
METAL	THALLIUM	mg/L	4	174	2%	0.0010	0.0015	0.0010	0.0013	0.0011	MTCA B	2	1.1%		2	1
CONV	CONDUCTIVITY	uMHO/cm	172	172	100%			45	7,200	700	State Secondary MCL	45	26.2%		6	
CONV	N-NITRATE	mg-N/L	164	174	94%	0.010	0.010	0.010	16	10	State/Federal Primary MCLs	4	2.3%		1	
CONV	NITRATE + NITRITE (NO2+NO3)	mg-N/L	164	174	94%	0.010	0.10	0.010	16	10	State/Federal Primary MCLs	4	2.3%		1	
CONV	PH	STD	171	171	100%			5.7	7.9	6.5-8.5	State/Federal Secondary MCLs	38[a]	22.0%		11	
CONV	TOTAL COLIFORM	CFU/100 mL	19	160	12%	1.0	2.0	1.0	660	1.0	State Primary MCL	18	11.3%		11	141
CONV	TOTAL DISSOLVED SOLIDS	mg/L	164	174	94%	69	130	67	810	500	State/Federal Secondary MCLs	45	25.9%		7	
Domestic Wells																
SIM_VOA	VINYL CHLORIDE	µg/L	20	148	14%	0.010	0.020	0.010	0.77	0.023	MTCA B	14	9.5%		3	
SIM_VOA	1,1-DICHLOROETHENE	µg/L	1	148	1%	0.010	0.020	0.030	0.030	0.073	MTCA B					
VOA	CIS-1,2-DICHLOROETHENE	µg/L	2	148	1%	0.20	0.20	0.10	0.10	70	State/Federal Primary MCLs					
SVOA	BIS(2-ETHYLHEXYL)PHTHALATE	µg/L	1	27	4%	1.0	1.0	1.9	1.9	6.3	MTCA B					
METAL	ARSENIC	mg/L	11	27	41%	0.0010	0.0010	0.0010	0.026	5.83E-05	MTCA B	11	40.7%		9	16
METAL	CHROMIUM	mg/L	11	27	41%	0.0050	0.0050	0.0050	0.0090	0.10	State/Federal Primary MCLs					
METAL	IRON	mg/L	18	27	67%	0.020	0.020	0.020	1.8	0.30	State Secondary MCL	5	18.5%		4	
METAL	LEAD	mg/L	14	27	52%	0.0010	0.0010	0.0010	0.067	0.0050	MTCA B	2	7.4%		2	
METAL	MANGANESE	mg/L	20	27	74%	0.0010	0.0012	0.0010	0.59	0.050	State/Federal Secondary MCLs	5	18.5%		4	
CONV	CONDUCTIVITY	uMHO/cm	147	147	100%			70	840	700	State Secondary MCL	1	0.7%		1	
CONV	N-NITRATE	mg-N/L	93	97	96%	0.010	0.010	0.011	3.6	10	State/Federal Primary MCLs					
CONV	NITRATE + NITRITE (NO2+NO3)	mg-N/L	93	97	96%	0.010	0.010	0.011	3.6	10	State/Federal Primary MCLs					
CONV	PH	STD	146	146	100%			5.7	8.9	6.5-8.5	State/Federal Secondary MCLs	19[b]	13.0%		11	
CONV	TOTAL COLIFORM	CFU/100 mL	2	27	7%	1.0	2.0	200	395	1.0	State Primary MCL	2	7.4%		2	25
CONV	TOTAL DISSOLVED SOLIDS	mg/L	51	51	100%			57	325	500	State/Federal Secondary MCLs					

a pH "exceedances" are below the lower MSA limit of 6.5.
b 15 samples had pH below the lower MSA limit of 6.5; 4 samples had pH above the upper MSA limit of 8.5.

TABLE B-15
BAINBRIDGE ISLAND LANDFILL FS
Number of Groundwater Samples and Number of Detections - Monitoring Wells

Number of samples collected and analyzed for each parameter in each monitoring well.

Chemical Group	Parameter	BMW01	BMW02	BMW03	BMW04	BMW05	BMW06	BMW07	BMW08	BMW10	BMW11	BMW12	BMW13	BMW14	BMW15	BMW16	BMW17	BMW18	BMW19
Sim Voa	Vinyl Chloride	11	11	10	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Sim_Voa	1,1-Dichloroethene	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Voa	Cis-1,2-Dichloroethene	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Cl-Phenol	Pentachlorophenol	6	6	6	6	6	6	6	6	6	6	6	3	3	3	3	4	4	4
Svoa	Bis(2-Ethylhexyl)Phthalate	6	6	6	6	6	6	6	6	6	6	6	3	3	3	3	4	4	4
Metal	Arsenic	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Metal	Chromium	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Metal	Iron	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Metal	Lead	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Metal	Manganese	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Metal	Thallium	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Conv	Conductivity	11	11	11	11	10	10	11	13	11	11	11	10	10	10	9	4	4	4
Conv	N-Nitrate	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Conv	Nitrate + Nitrite ($NO_2 + NO_3$)	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4
Conv	pH	11	11	11	11	10	10	11	12	11	11	11	10	10	10	9	4	4	4
Conv	Total Coliform	11	11	11	11	11	10	11	11	10	11	11	8	8	7	6	4	4	4
Conv	Total Dissolved Solids	11	11	11	11	11	11	11	13	11	11	11	10	10	10	9	4	4	4

Number of detected concentrations for each parameter in each monitoring well.

Chemical Group	Parameter	BMW01	BMW02	BMW03	BMW04	BMW05	BMW06	BMW07	BMW08	BMW10	BMW11	BMW12	BMW13	BMW14	BMW15	BMW16	BMW17	BMW18	BMW19
Sim_Voa	Vinyl Chloride						11	11					10	10	2			2	
Sim_Voa	1,1-Dichloroethene						10	10					9	10					
Voa	Cis-1,2-Dichloroethene					1	11	10					10	10	1				
Cl-Phenol	Pentachlorophenol						2		1										
Svoa	Bis(2-Ethylhexyl)Phthalate	1	1	1	1	1	4	3	1	1	1	1	1		1	1	1	1	1
Metal	Arsenic		1	3	2	2	11	1	1		1	1	1			1			4
Metal	Chromium	6	5	10	10	10	2	1	6	9	9	8			2	7	1	2	4
Metal	Iron	5	8	5	4	5	11	3	8	9	7	4	7	2	5	7	1	2	4
Metal	Lead	2	1	1	1	1	1	1	2	2	2	2			1	1			
Metal	Manganese	6	9	7	6	8	11	11	10	8	8	2	10	10	6	9	4	4	4
Metal	Thallium			1	1			1				1							
Conv	Conductivity	11	11	11	11	10	10	11	13	11	11	11	10	10	10	9	4	4	4
Conv	N-Nitrate	11	11	11	11	11	6	11	13	11	11	11	5	10	10	9	4	4	4
Conv	Nitrate + Nitrite ($NO_2 + NO_3$)	11	11	11	11	11	5	11	13	11	11	11	6	10	10	9	4	4	4
Conv	pH	11	11	11	11	10	10	11	12	11	11	11	10	10	10	9	4	4	4
Conv	Total Coliform	2	1	1	1			1		3	3	2	1		3	1			
Conv	Total Dissolved Solids	10	10	10	10	10	11	11	12	10	11	10	10	10	10	9	3	4	3

TABLE B-16
BAINBRIDGE ISLAND LANDFILL FS
Number of Groundwater Samples and Number of Detections - Domestic Wells

Chemical Group	Parameter	BOW01	BOW04	BOW09	BOW10	BOW12	BOW15	BOW26	BOW31A	BOW33	BOW35	BOW37	BOW56	BOW64	BOW73	BOW74	BOW84	BOW96	BOW98
Number of samples collected and analyzed for each parameter in each domestic well																			
Sim_Voa	Vinyl Chloride	13	7	11	1	6	6	1	8	11	6	12	12	13	12	6	11	8	4
Svoa	Bis(2-Ethylhexyl)Phthalate	4	1	1	1	1		1	2	1	2	2	1	2	1	2	1	2	2
Metal	Arsenic	4	1	1	1	1		1	2	1	2	2	1	2	1	2	1	2	2
Metal	Iron	4	1	1	1	1		1	2	1	2	2	1	2	1	2	1	2	2
Metal	Lead	4	1	1	1	1		1	2	1	2	2	1	2	1	2	1	2	2
Metal	Manganese	4	1	1	1	1		1	2	1	2	2	1	2	1	2	1	2	2
Conv	Conductivity	13	7	11	1	6	6	1	8	11	6	12	12	12	12	6	11	8	4
Conv	Total Coliform	4	1	1	1	1		1	2	1	2	2	1	2	1	2	1	2	2
Number of detected concentrations for each parameter in each domestic well																			
Sim_Voa	Vinyl Chloride	1	1				1			1		12	1	1	1			1	
Svoa	Bis(2-Ethylhexyl)Phthalate																	1	
Metal	Arsenic		1		1	1		1	2				1	2			1	1	
Metal	Iron	1	1	1	1	1		1	2	1	2			1		1	1	2	2
Metal	Lead	3	1	1					2	1	1			2	1	2			
Metal	Manganese	3	1	1	1	1		1	2	1	1	2				2		2	2
Conv	Conductivity	13	7	11	1	6	6	1	8	11	6	12	12	12	12	6	11	8	4
Conv	Total Coliform							1			1								

TABLE B-17
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Sample Exceedance Ratios and Exceedance Frequencies - Monitoring Wells

Chemical Group	Parameter	BG BMW01	BMW02	BG BMW03	BMW04	BMW05	BMW06	BMW07	BG BMW08	BMW10	BMW11	BG BMW12	BMW13	BMW14	BMW15	BMW16	BMW17	BMW18	BMW19
Exceedance Ratios (Ratios less than one (no exceedences) are not shown - ratios greater than 2 are shaded)																			
Sim_Voa	Vinyl Chloride						56.5	28.9					28.4	208.5	4.8				
Sim_Voa	1,1-Dichloroethene							1.1						3.8					
Voa	Cis-1,2-Dichloroethene													1.1					
Cl-Phenol	Pentachlorophenol						1.6												
Svoa	Bis(2-Ethylhexyl)Phthalate		1.3		1.1			20.8			3.1				1.3			6.1	
Metal	Arsenic		17.1	30.9	20.6	22.3	60.0	17.1	25.7		25.7	20.6	17.1			22.3			34.3
Metal	Chromium							1.4											
Metal	Iron	1.5	5.2	4.2	2.4	6.2	11.9	12.7	4.1	4.9	3.7	3.0	1.2			1.4			
Metal	Manganese					1.4	133.2	3.2	1.1		1.1		12.7	1.3	1.1	1.3		1.2	
Metal	Thallium			1.2				1.2											
Conv	Conductivity						1.7	1.4			1.1		1.8	1.7	10.3				
Conv	Nitrate + Nitrite ($NO_2 + NO_3$)								1.6										
Conv	N-Nitrate								1.6										
Conv	pH																		
Conv	Total Coliform	29.0	4.0	2.0	82.0			40.0		660.0	100.0	20.0	2.0		92.0	16.0			
Conv	Total Dissolved Solids						1.4	1.3		1.3	1.0		1.4	1.5	1.6				
Exceedance Frequencies (Percentage of samples collected that exceed the MSA - percentages greater than 10% are shaded)																			
Sim_Voa	Vinyl Chloride						100%	100%					100%	100%	20%				
Sim_Voa	1,1-Dichloroethene							9.1%						100%					
Voa	Cis-1,2-Dichloroethene													10.0%					
Cl-Phenol	Pentachlorophenol						17%												
Svoa	Bis(2-Ethylhexyl)Phthalate		17%		17%			33%			17%				33%			25%	
Metal	Arsenic		9.1%	27%	18%	18%	100%	9.1%	7.7%		9.1%	9.1%	10.0%			11%			100%
Metal	Chromium							9.1%											
Metal	Iron	9.1%	9.1%	9.1%	9.1%	9.1%	100%	9.1%	7.7%	9.1%	9.1%	9.1%	10.0%			11%			
Metal	Manganese					9.1%	100%	9.1%	7.7%		9.1%		100%	10.0%	10.0%	11%		25%	
Metal	Thallium			9.1%				9.1%											
Conv	Conductivity						80%	82%			36%		40%	100%	100%				
Conv	Nitrate + Nitrite ($NO_2 + NO_3$)								31%										
Conv	N-Nitrate								31%										
Conv	pH		81.8%				60%	55%	17%	9.1%	45%	9.1%	10.0%	30%	30%	11%			
Conv	Total Coliform	18%	9.1%	9.1%	9.1%			9.1%		30%	18%	18%	13%		43%	17%			
Conv	Total Dissolved Solids						100%	100%		9.1%	9.1%		20%	100%	90%				

BG = background well

TABLE B-18
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Sample Exceedance Ratios and Exceedance Frequencies - Domestic Wells

Chemical Group	Parameter	BOW01	BG BOW04	BOW09	BG BOW10	BG BOW12	BG BOW15	BG BOW26	BG BOW31A	BOW33	BOW35	BOW37	BOW56	BOW64	BOW73	BOW74	BOW84	BOW96	BOW98
Exceedance Ratios (Ratios less than one (no exceedences) are not shown - ratios greater than 2 are shaded.)																			
Sim_Voa	Vinyl Chloride											33		1.7				1.3	
Metal	Arsenic		24		72	86		53	449				17	21			17	17	
Metal	Iron				1.9	6.1		5.2	5.0										
Metal	Lead								1.3					13					
Metal	Manganese				2.5	12		5.4	2.0										
Conv	Conductivity															1.2			
Conv	pH																		
Conv	Total Coliform							395			200								
Exceedance Frequencies (Percentage of samples collected that exceed the MSA - percentages greater than 10% are shaded)																			
Sim_Voa	Vinyl Chloride											100%		8%				13%	
Metal	Arsenic		100%		100%	100%		100%	100%				100%	100%			100%	50%	
Metal	Iron				100%	100%		100%	100%										
Metal	Lead								50%					50%					
Metal	Manganese				100%	100%		100%	100%										
Conv	Conductivity															17%			
Conv	pH	8%	14%			17%	17%				33%	8%	8%	8%	25%	100%		13%	
Conv	Total Coliform							100%			50%								

Note: Arsenic, iron, lead, manganese, total coliform, and bis(2-ethylhexyl)phthalate were analyzed in 1 or 2 samples per well, except for well BOW01, for which four samples were analyzed.
Conductivity and vinyl chloride were measured in one to 13 samples per well.
BG = background well

TABLE B-19
BAINBRIDGE ISLAND LANDFILL FS
Parameters Exceeding Groundwater Step 2 COC Criteria

	Exceedance Ratio > 2		Exceedance Frequency > 10 percent	
	Monitoring	Domestic	Monitoring	Domestic
vinyl chloride	X	X	X	X
1,1-DCE	X		X	
pentachlorophenol			X	
bis(2-ethylhexyl)phthalate	X		X	
arsenic	X	X	X	X
iron	X	X	X	X
lead		X		X
manganese	X	X	X	X
conductivity	X		X	X
nitrate			X	
nitrate + nitrite			X	
pH			X	
total coliform	X	X	X	X
TDS			X	

Table B-20
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Statistical Summary by Parameter and Well - Monitoring Wells

Parameter	Date	MSA	BMW01	BMW02	BMW03	BMW04	BMW05	BMW06	BMW07	BMW08	BMW10	BMW11	BMW12	BMW13	BMW14	BMW15	BMW16	BMW17	BMW18	BMW19
Conventionals																				
Conductivity (uMHO/cm)	Jun-96	700	95	112	103	152	107	91	924											
Conductivity (uMHO/cm)	Aug-96	700								185	209	532	112							
Conductivity (uMHO/cm)	Sep-96	700	116	181	122	199	112	601	761	207	175	583	128							
Conductivity (uMHO/cm)	Dec-96	700	93	189	122	190	147	1100	873	268	185	510	138							
Conductivity (uMHO/cm)	Mar-97	700	45	174	120	157	144	1200	855	138	126	824	64							
Conductivity (uMHO/cm)	Apr-97	700												1240	1200	932	380			
Conductivity (uMHO/cm)	Jun-97	700	131	184	125	155	158	1080	918	189	252	703	139	875	1020	990	395			
Conductivity (uMHO/cm)	Sep-97	700	265	143	115	143	133	1060	841	293	229	672	128	629	1070	1080	355			
Conductivity (uMHO/cm)	Dec-97	700	118	174	119	154	150	1060	779	299	233	728	145	518	1080	1090	389			
Conductivity (uMHO/cm)	Mar-98	700	85	131	93	133	108	953	699	140	195	864	102	602	916	796	334			
Conductivity (uMHO/cm)	Jun-98	700	121	176	120	150			960	169	211	781	125	793	1170	1160	500			
Conductivity (uMHO/cm)	Sep-98	700	105	186	120	130	141	1030	735	201	196	711	117	723	1090	1060	442	217	418	193
Conductivity (uMHO/cm)	Dec-98	700	86	176	102	121	120	811	615	129	161	631	98	632	1060	822		168	206	168
Conductivity (uMHO/cm)	Mar-99	700								113				687	1050	1060	379	194	228	331
Conductivity (uMHO/cm)	Jun-99	700								110				678	1090	7200	375	160	328	368
N-Nitrate (mg/N/L)	Jun-96	10	7.3	3.7	0.055	0.24	0.13	0.025	0.16											
N-Nitrate (mg/N/L)	Aug-96	10								5	1.9	2.2	0.22							
N-Nitrate (mg/N/L)	Sep-96	10	5.8	2.3	0.024	0.29	0.23	0.01 U	0.092	11	2.1	2.3	0.24							
N-Nitrate (mg/N/L)	Dec-96	10	4.2	2	0.034	0.62	0.032	1.5	0.3	16	2.5	2.5	7.6							
N-Nitrate (mg/N/L)	Mar-97	10	3	1.6	0.02	0.585	0.18	0.87	0.48	7.8	1.7	2	0.18							
N-Nitrate (mg/N/L)	Apr-97	10												0.012	1.8	0.48	2.2			
N-Nitrate (mg/N/L)	Jun-97	10	2.7	0.9	0.54	0.36	1.6	0.01 U	2	3.2	0.38	1.6	0.026	0.01 U	1.6	2.4	2			
N-Nitrate (mg/N/L)	Sep-97	10	3.4	1.5	0.01	0.52	0.37	0.01 U	1.5	13	2	1.1	0.13	0.01 U	0.98	0.25	2			
N-Nitrate (mg/N/L)	Dec-97	10	3.35	0.22	0.17	0.56	0.52	0.01 U	2.1	12	2.1	1.1	0.17	0.015	1	0.2	2.15			
N-Nitrate (mg/N/L)	Mar-98	10	2.2	1.2	0.031	0.49	0.68	0.019	1	2.9	1.9	1.1	0.22	0.025	0.41	0.27	2.1			
N-Nitrate (mg/N/L)	Jun-98	10	2.4	1.2	0.04	0.38	0.73	0.01 U	1.9	0.8	1.2	1.1	0.16	0.01 U	0.36	0.2	2.2			
N-Nitrate (mg/N/L)	Sep-98	10	2.4	1.4	0.07	0.61	0.49	0.01 U	1.7	5.2	1	0.99	0.16	0.022	0.68	0.14	2.2	3	0.0505	0.615
N-Nitrate (mg/N/L)	Dec-98	10	2	1.2	0.074	0.53	0.55	0.074	1.5	1.5	0.94	1	0.17	0.042	0.48	0.14		3.4	0.115	0.64
N-Nitrate (mg/N/L)	Mar-99	10								0.73				0.225	0.061	0.22	1.7	1.7	0.062	0.69
N-Nitrate (mg/N/L)	Jun-99	10								0.41				0.01 U	0.185	0.096	2.5	2.8	0.26	0.6
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Jun-96	10	7.3	3.7	0.055	0.24	0.13	0.025	0.16											
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Aug-96	10								5	1.9	2.25	0.22							
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Sep-96	10	5.8	2.3	0.024	0.29	0.23	0.01 U	0.11	11	2.1	2.3	0.24							
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Dec-96	10	4.2	2	0.034	0.62	0.032	1.55	0.33	16	2.5	2.6	7.6							
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Mar-97	10	3	1.6	0.02	0.585	0.18	0.89	0.52	7.8	1.7	2	0.18							
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Apr-97	10												0.012	1.9	0.48	2.2			
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Jun-97	10	2.7	0.9	0.54	0.36	1.6	0.01 U	2	3.2	0.39	1.6	0.026	0.01 U	1.7	2.5	2.1			
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Sep-97	10	3.4	1.5	0.01	0.52	0.37	0.01 U	1.5	13	2	1.1	0.13	0.01 U	1.1	0.25	2			
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Dec-97	10	3.35	0.22	0.17	0.57	0.53	0.01	2.1	12	2.1	1.1	0.17	0.015	1.1	0.2	2.15			
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Mar-98	10	2.2	1.2	0.031	0.49	0.68	0.019	1.1	2.9	1.9	1.1	0.22	0.1 U	0.49	0.27	2.1			
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Jun-98	10	2.4	1.2	0.04	0.38	0.73	0.01 U	2	0.8	1.2	1.1	0.16	0.01 U	0.41	0.2	2.2			
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Sep-98	10	2.4	1.4	0.07	0.61	0.49	0.01 U	1.8	5.2	1	0.99	0.16	0.022	0.72	0.14	2.2	3	0.0505	0.615
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Dec-98	10	2	1.2	0.074	0.53	0.55	0.13	1.6	1.5	0.94	1	0.17	0.042	0.51	0.14		3.4	0.115	0.64
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Mar-99	10								0.73				0.245	0.088	0.22	1.7	1.7	0.062	0.69
Nitrate + Nitrite (NO2+NO3) (mg/N/L)	Jun-99	10								0.41				0.01 U	0.21	0.11	2.5	2.8	0.26	0.6
pH (std)	Jun-96	8	7.31	6.3	7.55	7.42	7.46	6.68	6.43											
pH (std)	Aug-96	8								6.68	6.57	6.33	6.98							
pH (std)	Sep-96	8	7.12	6.7	7.71	7.64	7.75	6.27	6.58		7.01	6.84	7.92							
pH (std)	Dec-96	8	7.1	6.51	7.39	7.23	7.05	6.45	6.37	6.83	6.7	6.3	7.41							
pH (std)	Mar-97	8	7.48	6.03	7.5	6.98	6.85	6.44	6.52	6.87	6.85	6.5	6.45							
pH (std)	Apr-97	8												6.71	6.57	6.76	7.07			
pH (std)	Jun-97	8	7.26	6.12	7.52	7.29	7.19	6.34	6.37	6.52	6.31	6.45	7.45	6.7	6.61	6.64	7.11			
pH (std)	Sep-97	8	6.87	5.87	7.43	7.07	7.2	6.49	6.21	6.8	6.66	6.49	7.29	6.84	6.6	6.71	7.08			
pH (std)	Dec-97	8	7.29	6.05	7.49	7.33	7.29	6.49	6.5	6.94	6.71	6.68	7.49	6.88	6.59	6.64	7.06			
pH (std)	Mar-98	8	7.33	6.07	7.56	7.4	7.42	6.67	6.68	7.1	6.91	6.74	7.52	6.97	6.72	6.85	7.26			
pH (std)	Jun-98	8	6.82	6.03	7.42	7.15			6.02	6.1	6.78	6.41	7.4	6.23	5.67	5.78	6.23			
pH (std)	Sep-98	8	7.26	6.19	7.16	7.32	7.24	6.61	6.31	6.58	6.64	6.66	7.35	6.7	6.41	6.52	6.93	6.71	6.99	7.76
pH (std)	Dec-98	8	7.3	6.34	7.42	7.33	7.34	6.57	6.52	6.93	6.84	6.6	7.48	6.79	6.52	6.66		6.93	7.13	7.61
pH (std)	Mar-99	8								7.05				6.82	6.57	6.4	7.14	6.78	6.91	6.83
pH (std)	Jun-99	8								6.49				6.61	6.38	6.49	6.85	6.6	6.96	7.44
Total Coliform (CFU/100 mL)	Jun-96	1	2 U	4	2	62	2 U	2 U	40											
Total Coliform (CFU/100 mL)	Aug-96	1								1 U	2 U	2 U	2 U							
Total Coliform (CFU/100 mL)	Sep-96	1	29	2 U	1 U	2 U	2 U	1 U	2 U	2 U	1 U	100	20							

Table B-20
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Statistical Summary by Parameter and Well - Monitoring Wells

Parameter	Date	MSA	BMW01	BMW02	BMW03	BMW04	BMW05	BMW06	BMW07	BMW08	BMW10	BMW11	BMW12	BMW13	BMW14	BMW15	BMW16	BMW17	BMW18	BMW19
Total Coliform (CFU/100 mL)	Dec-96	1	1 U	2 U	1 U	1 U	1 U	1 U	1 U	2 U	1 U	2 U	1 U							
Total Coliform (CFU/100 mL)	Mar-97	1	1 U	1 U	1 U	1 U	1.5 U	2 U	1 U	2 U	1 U	7	2 U							
Total Coliform (CFU/100 mL)	Apr-97	1												1 U	1 U	1 U	1 U			
Total Coliform (CFU/100 mL)	Jun-97	1	1 U	1 U	1 U	1 U	1 U		1 U	1 U		1 U	1 U	1 U	1 U					
Total Coliform (CFU/100 mL)	Sep-97	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	92	1 U			
Total Coliform (CFU/100 mL)	Dec-97	1	1 U	1 U	1 U	1 U	1 U	2 U	1 U	1 U	5	1	14	2	1 U	2	16			
Total Coliform (CFU/100 mL)	Mar-98	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	660	1 U	1 U	1 U	1 U	4	1 U			
Total Coliform (CFU/100 mL)	Jun-98	1	2	1 U	1 U	1 U	1 U	1 U	1 U	1 U	5	1 U	1 U	1 U	1 U	1 U	1 U			
Total Coliform (CFU/100 mL)	Sep-98	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U
Total Coliform (CFU/100 mL)	Dec-98	1	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U		1 U	1 U	1 U
Total Coliform (CFU/100 mL)	Mar-99	1																1 U	1 U	1 U
Total Coliform (CFU/100 mL)	Jun-99	1																1 U	1 U	1 U
Total Dissolved Solids (mg/L)	Jun-96	500	67	91	89	120	85	665	570											
Total Dissolved Solids (mg/L)	Aug-96	500								150	140	360	100							
Total Dissolved Solids (mg/L)	Sep-96	500	110	120	95	110	91	710	600	180	130	340	88							
Total Dissolved Solids (mg/L)	Dec-96	500	82	140	87	120	120	575	510	220	140	360	85							
Total Dissolved Solids (mg/L)	Mar-97	500	84	110	96	120	110	670	550	170	150	390	97							
Total Dissolved Solids (mg/L)	Apr-97	500												710	720	595	230			
Total Dissolved Solids (mg/L)	Jun-97	500	71	115	81	110	100	650	640	72	630	410	76	505	690	170	220			
Total Dissolved Solids (mg/L)	Sep-97	500	93	125	110	120	120	660	630	250	180	470	120	420	710	770	260			
Total Dissolved Solids (mg/L)	Dec-97	500	86.5	140	92	110	110	620	540	220	150	440	100	340	720	740	250			
Total Dissolved Solids (mg/L)	Mar-98	500	80	120	80	110	87	650	530	120	150	460	100	410	680	585	230			
Total Dissolved Solids (mg/L)	Jun-98	500	83 P	100	84	61 P	95 P	640 P	630	110	120	480 P	85	440	740	750	260			
Total Dissolved Solids (mg/L)	Sep-98	500	69 U	120 U	130 U	120 U	130 U	720	520 R	120 U	110 U	510	110 U	450	720	730	280	130 U	220	100 U
Total Dissolved Solids (mg/L)	Dec-98	500	70	120	74	85	93	560	510	100	120	440	84	380	710	570		130	140	135
Total Dissolved Solids (mg/L)	Mar-99	500								85				465	650	630	250	120	140	180
Total Dissolved Solids (mg/L)	Jun-99	500								110				480	720	810	270	120	230	250
Metals (mg/L)																				
Arsenic	Jun-96	5.83E-05	0.001 U	0.001 U	0.0018 B	0.0012 B	0.0013 B	0.0035 B	0.001 B											
Arsenic	Aug-96	5.83E-05								0.0015 B	0.001 U	0.0015 B	0.0012 B							
Arsenic	Sep-96	5.83E-05	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0027 B	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U							
Arsenic	Dec-96	5.83E-05	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0016 B	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U							
Arsenic	Mar-97	5.83E-05	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 B	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U							
Arsenic	Apr-97	5.83E-05												0.001 U	0.001 U	0.001 U	0.0013 B			
Arsenic	Jun-97	5.83E-05	0.001 U	0.001 U	0.0011 B	0.001 B	0.001 B	0.0023 B	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 B	0.001 U	0.001 U	0.001 U			
Arsenic	Sep-97	5.83E-05	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0024 B	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Arsenic	Dec-97	5.83E-05	0.001 U	0.001 U	0.001 B	0.001 U	0.001 U	0.0019 B	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Arsenic	Mar-98	5.83E-05	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0016 B	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Arsenic	Jun-98	5.83E-05	0.001 U	0.001	0.001 U	0.001 U	0.001 U	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Arsenic	Sep-98	5.83E-05	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.003	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001
Arsenic	Dec-98	5.83E-05	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001
Arsenic	Mar-99	5.83E-05								0.001 U				0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001
Arsenic	Jun-99	5.83E-05								0.001 U				0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002
Chromium	Jun-96	1.00E-01	0.015	0.0491	0.0628	0.0276	0.0399	0.05065	0.142											
Chromium	Aug-96	1.00E-01								0.005 U	0.0122	0.0136	0.0056 B							
Chromium	Sep-96	1.00E-01	0.0111	0.0068 B	0.012	0.0064 B	0.0163	0.0074 B	0.005 U	0.0052 B	0.0206	0.0068 B	0.0222							
Chromium	Dec-96	1.00E-01	0.005 U	0.005 U	0.005 B	0.005 B	0.0065 B	0.005 U	0.005 U	0.005 U	0.0053 B	0.005 U	0.005 U							
Chromium	Mar-97	1.00E-01	0.007 B	0.0069 B	0.0081 B	0.0071 B	0.00715 B	0.005 U	0.005 U	0.005 U	0.009 B	0.0081 B	0.0054 B							
Chromium	Apr-97	1.00E-01												0.005 U	0.005 U	0.0098 B	0.0205			
Chromium	Jun-97	1.00E-01	0.0082 U	0.005 U	0.0106 U	0.0101 U	0.0086 U	0.005 U	0.005 U	0.005 U	0.0122	0.0076 B	0.007 U	0.005 U	0.005 U	0.0055 U	0.0094 B			
Chromium	Sep-97	1.00E-01	0.005 U	0.006 B	0.0148	0.0078 B	0.0068 B	0.005 U	0.005 U	0.0051 B	0.0139	0.0067 B	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U			
Chromium	Dec-97	1.00E-01	0.00745 B	0.0068 B	0.0074 B	0.008 B	0.0123	0.005 U	0.005 U	0.005 U	0.012	0.0057 B	0.0087 B	0.005 U	0.005 U	0.005 U	0.0146			
Chromium	Mar-98	1.00E-01	0.008 B	0.005 U	0.0061 B	0.009 B	0.0068 B	0.005 U	0.005 U	0.00795 B	0.0065 B	0.0053 B	0.0107	0.005 U	0.005 U	0.0051 B	0.0068 B			
Chromium	Jun-98	1.00E-01	0.005 U	0.005 U	0.009	0.008	0.008	0.005 U	0.005 U	0.005 U	0.005 U	0.005	0.005	0.005 U	0.005 U	0.005 U	0.018			
Chromium	Sep-98	1.00E-01	0.009	0.005 U	0.008	0.008	0.008	0.005 U	0.005 U	0.008	0.007	0.005 U	0.005	0.005 U	0.005 U	0.005 U	0.008	0.005	0.005	0.007
Chromium	Dec-98	1.00E-01	0.005 U	0.005 U	0.007	0.007	0.008	0.005 U	0.005 U	0.008	0.005 U	0.005	0.009	0.005 U	0.005 U	0.005 U		0.005 U	0.0055	0.0085
Chromium	Mar-99	1.00E-01								0.005 U				0.005 U	0.005 U	0.005 U	0.005	0.005 U	0.005 U	0.009
Chromium	Jun-99	1.00E-01								0.008				0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.005 U	0.009
Iron	Jun-96	3.00E-01	0.45	1.55	1.27	0.71	1.87	3.555	3.81											
Iron	Aug-96	3.00E-01								1.22	1.48	1.11	0.905							
Iron	Sep-96	3.00E-01	0.0436 B	0.0742 B	0.0428 B	0.0562 B	0.11	1.49	0.0742 B	0.119	0.176	0.0412 B	0.121							
Iron	Dec-96	3.00E-01	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.8495	0.02 U	0.0369 B	0.0393 B	0.02 U	0.02 U							
Iron	Mar-97	3.00E-01	0.02 U	0.0423 B	0.02 U	0.02 U	0.02 U	0.918	0.02 U	0.02 U	0.0382 B	0.0322 B	0.02 U							
Iron	Apr-97	3.00E-01												0.151	0.0826 B	0.0618 B	0.162			

Table B-20
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Statistical Summary by Parameter and Well - Monitoring Wells

Parameter	Date	MSA	BMW01	BMW02	BMW03	BMW04	BMW05	BMW06	BMW07	BMW08	BMW10	BMW11	BMW12	BMW13	BMW14	BMW15	BMW16	BMW17	BMW18	BMW19
Iron	Jun-97	3.00E-01	0.0306 B	0.0216 B	0.0282 B	0.02 U	0.02 U	1.48	0.0276 B	0.02 U	0.0436 B	0.02 U	0.02 U	0.106	0.02 U	0.02 U	0.036 B			
Iron	Sep-97	3.00E-01	0.02 U	0.0411 B	0.0433 B	0.0206 B	0.02 U	1.48	0.02 U	0.021 B	0.0554 B	0.0247 B	0.02 U	0.0227 B	0.02 U	0.0582 B	0.02 U			
Iron	Dec-97	3.00E-01	0.03215 B	0.0569 B	0.02 U	0.11	0.046 B	1.37	0.02 U	0.0305 B	0.109	0.026 B	0.0276 B	0.351	0.0221 B	0.0349 B	0.095 B			
Iron	Mar-98	3.00E-01	0.02 U	0.0289 B	0.02 U	0.02 U	0.022 B	1.54	0.02 U	0.0306 B	0.0622 B	0.02 U	0.0289 B	0.0382 B	0.02 U	0.023 B	0.025 B			
Iron	Jun-98	3.00E-01	0.02 U	0.02	0.03	0.02 U	0.02	1.52	0.02 U	0.02 U	0.02 U	0.03	0.02 U	0.08	0.02 U	0.02 U	0.43			
Iron	Sep-98	3.00E-01	0.03	0.02 U	0.02 U	0.02 U	0.02 U	1.54	0.02 U	0.02 U	0.04	0.02	0.02 U	0.02	0.02 U	0.02 U	0.03	0.12	0.02 U	0.03
Iron	Dec-98	3.00E-01	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	1.28	0.02 U	0.05	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.04		0.02 U	0.09	0.03
Iron	Mar-99	0.30								0.02 U				0.02 U	0.02 U	0.02 U	0.07	0.02 U	0.04	0.08
Iron	Jun-99	0.30								0.02				0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.04
Lead	Jun-96	0.01	0.001 B	0.0015 B	0.001 B	0.001 U	0.0011 B	0.00105 B	0.002 B											
Lead	Aug-96	0.01								0.001 U	0.0011 B	0.0008 B	0.001 U							
Lead	Sep-96	0.01	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U							
Lead	Dec-96	0.01	0.001 U	0.001 U	0.002 U	0.001 U	0.001 U	0.001 U	0.001 U	0.002 U	0.005 U	0.001 U	0.002 U							
Lead	Mar-97	0.01	0.001 U	0.001 U	0.001 U	0.003 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U							
Lead	Apr-97	0.01												0.001 U	0.001 U	0.001 U	0.001 U			
Lead	Jun-97	0.01	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Lead	Sep-97	0.01	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0016 B	0.001 U	0.001 U	0.001 U	0.001 U			
Lead	Dec-97	0.01	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Lead	Mar-98	0.01	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0011 B	0.001 U	0.001 U	0.001 U	0.001 U			
Lead	Jun-98	0.01	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.02 U	0.001 U	0.001	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Lead	Sep-98	0.01	0.001	0.001 U	0.001 U	0.002	0.001 U	0.001 U	0.001 U	0.001	0.001 U	0.001	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Lead	Dec-98	0.01	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U
Lead	Mar-99	0.01								0.002				0.001 U	0.001 U	0.001	0.001	0.001 U	0.001 U	0.001 U
Lead	Jun-99	0.01								0.001 UP				0.001 UP	0.001 UP	0.001 UP	0.001 UP	0.001 UP	0.001 UP	0.001 UP
Manganese	Jun-96	0.05	0.019	0.033	0.041	0.037	0.072	5.055	0.161											
Manganese	Aug-96	0.05								0.0541	0.0339	0.05615	0.0408							
Manganese	Sep-96	0.05	0.0042 B	0.0053 B	0.0054 B	0.0061 B	0.0116 B	6.26	0.0499	0.0184	0.0089 B	0.0188	0.0065 B							
Manganese	Dec-96	0.05	0.0043 U	0.0029 U	0.0036 U	0.0036 U	0.0068 B	5.49	0.0326	0.008 B	0.0058 U	0.0094 B	0.0026 U							
Manganese	Mar-97	0.05	0.0018 B	0.002 B	0.002 B	0.0028 B	0.00355 B	5.38	0.0304	0.0042 B	0.0028 B	0.005 B	0.001 U							
Manganese	Apr-97	0.05												0.635	0.0647	0.0557	0.0681			
Manganese	Jun-97	0.05	0.0019 U	0.0023 U	0.0024 U	0.0026 U	0.0021 U	5.73	0.0486	0.002 U	0.0029 U	0.004 U	0.0012 U	0.427	0.0182	0.0136 B	0.0462			
Manganese	Sep-97	0.05	0.0013 B	0.0028 B	0.00235 B	0.002 B	0.0011 B	6.12	0.0374	0.0038 B	0.0025 B	0.0039 B	0.001 U	0.302	0.0247	0.0067 B	0.0222			
Manganese	Dec-97	0.05	0.00145 B	0.0021 B	0.0011 B	0.0035 B	0.0025 B	5.97	0.029	0.0029 B	0.0029 B	0.0027 B	0.001 U	0.227	0.0186	0.0047 B	0.0197			
Manganese	Mar-98	0.05	0.0011 B	0.0015 B	0.0012 B	0.0014 B	0.0015 B	6.2	0.0371	0.0041 B	0.0018 B	0.001 U	0.001 U	0.322	0.007 B	0.00155 B	0.0107 B			
Manganese	Jun-98	0.05	0.001 U	0.002	0.001	0.001 U	0.001 U	6.45	0.05	0.001 U	0.001	0.001	0.001 U	0.39	0.015	0.001 U	0.017			
Manganese	Sep-98	0.05	0.001 U	0.002	0.001 U	0.001 U	0.001 U	6.66	0.039	0.002	0.001	0.001 U	0.001 U	0.371	0.022	0.001 U	0.005	0.02	0.0595	0.017
Manganese	Dec-98	0.05	0.001 U	0.001	0.001 U	0.001 U	0.001	5.97	0.035	0.002	0.001 U	0.001	0.001 U	0.403	0.025	0.001		0.017	0.0045	0.008
Manganese	Mar-99	0.05								0.001 U				0.4535	0.006	0.001 U	0.004	0.004	0.008	0.013
Manganese	Jun-99	0.05								0.003				0.445	0.01	0.001 U	0.002	0.002	0.003	0.01
Thallium	Jun-96	0.00	0.001 U	0.001 U	0.0013 B	0.001 B	0.001 U	0.001 U	0.001 U											
Thallium	Aug-96	0.00								0.001 U	0.001 U	0.001 U	0.001 U							
Thallium	Sep-96	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0015 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U							
Thallium	Dec-96	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U							
Thallium	Mar-97	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U							
Thallium	Apr-97	0.00												0.001 U	0.001 U	0.001 U	0.001 U			
Thallium	Jun-97	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Thallium	Sep-97	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Thallium	Dec-97	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.0013 B	0.001 U	0.001 U	0.001 U	0.0011 B	0.001 U	0.001 U	0.001 U	0.001 U			
Thallium	Mar-98	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Thallium	Jun-98	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U			
Thallium	Sep-98	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Thallium	Dec-98	0.00	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U		0.001 U	0.001 U	0.001 U
Thallium	Mar-99	0.00								0.001 U				0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
Thallium	Jun-99	0.00								0.001 U				0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U	0.001 U
SIM_VOA (ug/L)																				
1,1-Dichloroethene	Jun-96	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.03	0.04											
1,1-Dichloroethene	Aug-96	0.073								0.01 U	0.01 U	0.01 U	0.01 U							
1,1-Dichloroethene	Sep-96	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.03	0.05	0.01 U	0.01 U	0.01 U	0.01 U							
1,1-Dichloroethene	Dec-96	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.045	0.05	0.01 U	0.01 U	0.01 U	0.01 U							
1,1-Dichloroethene	Mar-97	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.03	0.04	0.01 U	0.01 U	0.01 U	0.01 U							
1,1-Dichloroethene	Apr-97	0.073												0.05	0.11	0.01 U	0.01 U			
1,1-Dichloroethene	Jun-97	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.04	0.06	0.01 U	0.01 U	0.01 U	0.01 U	0.065	0.15	0.01 U	0.01 U			
1,1-Dichloroethene	Sep-97	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.02 M	0.02 M	0.01 U	0.01 U	0.01 U	0.01 U	0.05	0.14	0.01 U	0.01 U			
1,1-Dichloroethene	Dec-97	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.1	0.01 U	0.01 U			

Table B-20
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Statistical Summary by Parameter and Well - Monitoring Wells

Parameter	Date	MSA	BMW01	BMW02	BMW03	BMW04	BMW05	BMW06	BMW07	BMW08	BMW10	BMW11	BMW12	BMW13	BMW14	BMW15	BMW16	BMW17	BMW18	BMW19
1,1-Dichloroethene	Mar-98	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.035	0.05	0.01 U	0.01 U	0.01 U	0.01 U	0.04	0.16	0.01 U	0.01 U			
1,1-Dichloroethene	Jun-98	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.04	0.06	0.01 U	0.01 U	0.01 U	0.01 U	0.05	0.22	0.01 U	0.01 U			
1,1-Dichloroethene	Sep-98	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.04	0.05 M	0.01 U	0.01 U	0.01 U	0.01 U	0.05	0.28	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1-Dichloroethene	Dec-98	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.03	0.04	0.01 U	0.01 U	0.01 U	0.01 U	0.03	0.09	0.01 U		0.01 U	0.01 U	0.01 U
1,1-Dichloroethene	Mar-99	0.073								0.01 U				0.05	0.17	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1-Dichloroethene	Jun-99	0.073								0.02 U				0.04	0.09	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
SVOA (ug/L)																				
Bis(2-Ethylhexyl)Phthalate	Jun-96	6.3	5.6	8.3	3.1	6.8	3.1	6.1	27											
Bis(2-Ethylhexyl)Phthalate	Aug-96	6.3								1 U	1.3	19.65	1 J							
Bis(2-Ethylhexyl)Phthalate	Sep-96	6.3	1 U	1 U	1 U	1 U	1 U	0.7 J	3.4	1 U	1 U	1 U	1 U							
Bis(2-Ethylhexyl)Phthalate	Dec-96	6.3	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U	1 U							
Bis(2-Ethylhexyl)Phthalate	Mar-97	6.3	1 U	1 U	1 U	1 U	1 U	0.9 J	130	1 U	1 U	1 U	1 U							
Bis(2-Ethylhexyl)Phthalate	Apr-97	6.3												1 U	1 U	1 U	1 U			
Bis(2-Ethylhexyl)Phthalate	Jun-97	6.3	1 U	1 U	20 U	1 U	1 U	0.8 J	1 U	3.6	1 U	1 U	0.1 U	1.7	1 U	7.8	4.4			
Bis(2-Ethylhexyl)Phthalate	Jun-98	6.3	1 U	1 U	1 U	1 U	1 U	1 U			1 U	1 U	1 U		1 U	1 U				
Bis(2-Ethylhexyl)Phthalate	Sep-98	6.3							1 U	1 U				1 U			1 U	1 U	1 U	1 U
Bis(2-Ethylhexyl)Phthalate	Dec-98	6.3																1 U	38	1 U
Bis(2-Ethylhexyl)Phthalate	Mar-99	6.3																1 U	1 U	1 U
Bis(2-Ethylhexyl)Phthalate	Jun-99	6.3																4.9	1 U	1.4
VOA (ug/L)																				
Cis-1,2-Dichloroethene	Jun-96	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4	5.7											
Cis-1,2-Dichloroethene	Aug-96	70.000								0.2 U	0.2 U	0.2 U	0.2 U							
Cis-1,2-Dichloroethene	Sep-96	70.000	0.2 U	0.2 U	0.2 U	0.2 U	10	4.8	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U							
Cis-1,2-Dichloroethene	Dec-96	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4.8	8.9	0.2 U	0.2 U	0.2 U	0.2 U							
Cis-1,2-Dichloroethene	Mar-97	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4	9.8	0.2 U	0.2 U	0.2 U	0.2 U							
Cis-1,2-Dichloroethene	Apr-97	70.000												7	53	0.2 U	0.2 U			
Cis-1,2-Dichloroethene	Jun-97	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	3.9	14	0.2 U	0.2 U	0.2 U	0.2 U	7.025	46	0.2 U	0.2 U			
Cis-1,2-Dichloroethene	Sep-97	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4.1	15	0.2 U	0.2 U	0.2 U	0.2 U	6.1	50	0.2 U	0.2 U			
Cis-1,2-Dichloroethene	Dec-97	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	6	15	0.2 U	0.2 U	0.2 U	0.2 U	6.5	63	0.2 U	0.2 U			
Cis-1,2-Dichloroethene	Mar-98	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4.8	20	0.2 U	0.2 U	0.2 U	0.2 U	6.7	67	0.2 U	0.2 U			
Cis-1,2-Dichloroethene	Jun-98	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	4.1	22	0.2 U	0.2 U	0.2 U	0.2 U	6.6	60	0.2 U	0.2 U			
Cis-1,2-Dichloroethene	Sep-98	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	5	18.5	0.2 U	0.2 U	0.2 U	0.2 U	5.4	47 R	0.1 J	0.2 U	0.2 U	0.2 U	0.2 U
Cis-1,2-Dichloroethene	Dec-98	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	5.1	18	0.2 U	0.2 U	0.2 U	0.2 U	4.3	24	0.2 U		0.2 U	0.2 U	0.2 U
Cis-1,2-Dichloroethene	Mar-99	70.000								0.2 U				6	80	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Cis-1,2-Dichloroethene	Jun-99	70.000								0.2 UP				5.3	43	0.2 U	0.2 UP	0.2 UP	0.2 U	0.2 UP
CL-PHENOL (ug/L)																				
Pentachlorophenol	Jun-96	7.29E-04	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U											
Pentachlorophenol	Aug-96	7.29E-04								2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U							
Pentachlorophenol	Sep-96	7.29E-04	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.80E-04 U	2.50E-04 U	1.50E-04 J	2.50E-04 U	2.50E-04 U	2.50E-04 U							
Pentachlorophenol	Dec-96	7.29E-04	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U							
Pentachlorophenol	Mar-97	7.29E-04	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U							
Pentachlorophenol	Apr-97	7.29E-04												2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U			
Pentachlorophenol	Jun-97	7.29E-04	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.00E-04 J	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U			
Pentachlorophenol	Jun-98	7.29E-04	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	0.0012	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U	2.50E-04 U			
Pentachlorophenol	Sep-98	7.29E-04																2.50E-04 U	2.50E-04 U	2.50E-04 U
Pentachlorophenol	Dec-98	7.29E-04																2.50E-04 U	2.50E-04 U	2.50E-04 U
Pentachlorophenol	Mar-99	7.29E-04																2.50E-04 U	2.50E-04 U	2.50E-04 U
Pentachlorophenol	Jun-99	7.29E-04																2.50E-04 U	2.50E-04 U	2.50E-04 U
SIM_VOA (ug/L)																				
Vinyl Chloride	Jun-96	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.775	0.48											
Vinyl Chloride	Aug-96	0.023								0.01 U	0.01 U	0.01 U	0.01 U							
Vinyl Chloride	Sep-96	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.91	0.6	0.01 U	0.01 U	0.01 U	0.01 U							
Vinyl Chloride	Dec-96	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	1.3	0.865	0.01 U	0.01 U	0.01 U	0.01 U							
Vinyl Chloride	Mar-97	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	1.2	0.49	0.01 U	0.01 U	0.01 U	0.01 U							
Vinyl Chloride	Apr-97	0.023												0.55	2.1	0.01 U	0.01 U			
Vinyl Chloride	Jun-97	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	1.1	0.53	0.01 U	0.01 U	0.01 U	0.01 U	0.655	2.9	0.01 U	0.01 U			
Vinyl Chloride	Sep-97	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.5	0.39	0.01 U	0.01 U	0.01 U	0.01 U	0.34	2.7	0.01 U	0.01 U			
Vinyl Chloride	Dec-97	0.023	0.01 U	0.01 U		0.01 U	0.01 U	0.87	0.29	0.01 U	0.01 U	0.01 U	0.01 U	0.15	4.8	0.01 U	0.01 U			
Vinyl Chloride	Mar-98	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	1.05	0.48	0.01 U	0.01 U	0.01 U	0.01 U	0.235	3.4	0.01 U	0.01 U			
Vinyl Chloride	Jun-98	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.86	0.5	0.01 U	0.01 U	0.01 U	0.01 U	0.24	3.6	0.04	0.01 U			
Vinyl Chloride	Sep-98	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	1.1	0.31	0.01 U	0.01 U	0.01 U	0.01 U	0.14	4.4	0.01 U	0.01 U	0.01 U	0.01 J	0.01 U
Vinyl Chloride	Dec-98	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	1.2	0.23	0.01 U	0.01 U	0.01 U	0.01 U	0.08	1.8	0.01 U		0.01 U	0.01 U	0.01 U
Vinyl Chloride	Mar-99	0.023								0.01 U				0.1	2.7	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Vinyl Chloride	Jun-99	0.023								0.02 U				0.09	0.86	0.11	0.02 U	0.02 U	0.02 JM	0.02 U

Table B-21
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Statistical Summary by Parameter and Well - Domestic Wells

Parameter	Date	MSA	BOW01	BOW04	BOW09	BOW10	BOW12	BOW15	BOW26	BOW31A	BOW33	BOW35	BOW37	BOW56	BOW64	BOW73	BOW74	BOW84	BOW96	BOW98
Conventionals																				
Conductivity (uMHO/cm)	Apr-96	700	127	163	103	147	140		150											
Conductivity (uMHO/cm)	Sep-96	700	148							145	190		440	100	80	70		240		
Conductivity (uMHO/cm)	Oct-96	700								118			398		75					
Conductivity (uMHO/cm)	Dec-96	700	219																	
Conductivity (uMHO/cm)	Mar-97	700	124																	
Conductivity (uMHO/cm)	Apr-97	700		102	134		146	125		178	252		540	89		105		315		
Conductivity (uMHO/cm)	Jun-97	700	214	109	120		157	128		144	205		537	100	103	86		324		
Conductivity (uMHO/cm)	Sep-97	700	267	122	133			157		156	228		515	106	99	85		358		
Conductivity (uMHO/cm)	Dec-97	700	239	131	140		197	166		165	262		683	122	106	98		415	322	
Conductivity (uMHO/cm)	Feb-98	700												95	92	75			264	
Conductivity (uMHO/cm)	Mar-98	700	222	115	116		185	144		143	229	152	596	101	94	80	107	329	269	
Conductivity (uMHO/cm)	Jun-98	700	323	148	158		226	135		180	258	203	598	121	126	99	143	385	302	225
Conductivity (uMHO/cm)	Sep-98	700	275		124						240	186	458	106	102	110	134	361	270	362
Conductivity (uMHO/cm)	Dec-98	700	448		125						259	173	537	194	171	180	83	357	478	
Conductivity (uMHO/cm)	Mar-99	700	212		107						229	137	472	109	95	110	840	327	268	232
Conductivity (uMHO/cm)	Jun-99	700	231		108						218	152	396	105	93	99	199	376	273	284
N-Nitrate (mg-N/L)	Apr-96	10	0.48	0.17	0.35	0.01 U	0.016		0.18											
N-Nitrate (mg-N/L)	Sep-96	10	1.2							0.011	1.4		0.3	0.48	0.38	0.08		2.9		
N-Nitrate (mg-N/L)	Oct-96	10								0.01 U			0.355		0.36					
N-Nitrate (mg-N/L)	Dec-96	10	1.7																	
N-Nitrate (mg-N/L)	Mar-97	10	1.6																	
N-Nitrate (mg-N/L)	Mar-98	10	2.6	0.11	0.37		0.015	0.071		0.01 U	1.1	3.45	0.26	0.46	0.27	0.11	1.4	3.1	2.4	
N-Nitrate (mg-N/L)	Jun-98	10	2.7	0.31	0.55		0.038	0.077		0.01 U	1.2	3.3	0.24	0.43	0.26	0.055	1	3.1	2.2	0.87
N-Nitrate (mg-N/L)	Sep-98	10	2.7		0.47						1.2	2.7	0.22	0.47	0.22	0.21	1.25	2.5	1.3	0.68
N-Nitrate (mg-N/L)	Dec-98	10	2.35		0.3						1.3	2.4	0.16	0.5	0.2	0.16	0.72	2.8	2.1	
N-Nitrate (mg-N/L)	Mar-99	10	2		0.44						1.2	1.5	0.19	0.48	0.19	0.73	1.1	2.6	2.2	0.53
N-Nitrate (mg-N/L)	Jun-99	10	2		0.56						1.2	2.2	0.38	0.41	0.18	0.3	3.6	2.95	2.6	0.5
Nitrate + Nitrite (N02+N03) (mg-N/L)	Apr-96	10	0.48	0.17	0.35	0.01 U	0.016		0.18											
Nitrate + Nitrite (N02+N03) (mg-N/L)	Sep-96	10	1.2							0.011	1.4		0.3	0.48	0.38	0.08		2.9		
Nitrate + Nitrite (N02+N03) (mg-N/L)	Oct-96	10								0.01 U			0.355		0.36					
Nitrate + Nitrite (N02+N03) (mg-N/L)	Dec-96	10	1.7																	
Nitrate + Nitrite (N02+N03) (mg-N/L)	Mar-97	10	1.6																	
Nitrate + Nitrite (N02+N03) (mg-N/L)	Mar-98	10	2.6	0.11	0.37		0.015	0.071		0.01 U	1.1	3.45	0.26	0.46	0.27	0.11	1.4	3.1	2.4	
Nitrate + Nitrite (N02+N03) (mg-N/L)	Jun-98	10	2.7	0.31	0.55		0.053	0.077		0.01 U	1.2	3.3	0.24	0.43	0.26	0.055	1	3.1	2.2	0.87
Nitrate + Nitrite (N02+N03) (mg-N/L)	Sep-98	10	2.7		0.47						1.2	2.7	0.22	0.47	0.22	0.21	1.25	2.5	1.3	0.68
Nitrate + Nitrite (N02+N03) (mg-N/L)	Dec-98	10	2.35		0.3						1.3	2.4	0.16	0.5	0.2	0.16	0.72	2.8	2.1	
Nitrate + Nitrite (N02+N03) (mg-N/L)	Mar-99	10	2		0.44						1.2	1.5	0.19	0.48	0.19	0.73	1.1	2.6	2.2	0.53
Nitrate + Nitrite (N02+N03) (mg-N/L)	Jun-99	10	2		0.56						1.2	2.2	0.38	0.41	0.18	0.3	3.6	2.95	2.6	0.5
pH (std)	Apr-96	8	6.87	6.96	7.07	7.04	6.97		7.14											
pH (std)	Sep-96	8								8.02	6.7		6.62	8.94	7.37	6.71		7.05		
pH (std)	Oct-96	8								7.37			6.85		7.23					
pH (std)	Dec-96	8	6.97																	
pH (std)	Mar-97	8	6.58																	
pH (std)	Apr-97	8		6.21	7.45		6.83	6.64		7.3	7.02		6.65	6.98		6.99		7.32		
pH (std)	Jun-97	8	6.88	7.38	7.36		7.21	7.12		7.45	7.23		6.86	7.85	7.69	7.07		7.77		
pH (std)	Sep-97	8	6.88	7.1	6.98			7.05		7.27	6.85		6.83	7.56	7.43	6.74		7.47		
pH (std)	Dec-97	8	6.86	8.11	7.29		7.07	7.39		8.43	6.93		6.85	7.46	8.67	6.55		7.45	8.54	
pH (std)	Feb-98	8												7.36	7.58	6.72			7.59	
pH (std)	Mar-98	8	6.87	7.21	7.32		8.59	7.19		8.25	7.06	6.61	6.67	7.46	7.71	6.57	5.89	7.55	7.45	
pH (std)	Jun-98	8	6.54	6.87	6.77		7.52	5.89		7.06	7.11	6.31	6.84	7.09	6.96	6.15	5.65	7.79	6.89	6.66
pH (std)	Sep-98	8	6.31		6.91						6.71	7.24	6.61	7.13	7.62	6.97	6.41	7.58	7.18	7.36
pH (std)	Dec-98	8	6.69		7.09						6.97	7.04	6.69	7.08	7.17	6.36	5.74	7.5	7.13	
pH (std)	Mar-99	8	6.89		6.98						7.11	7.17	6.37	7.24	7.32	6.57	6.41	7.34	7.5	7.18

Table B-21
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Statistical Summary by Parameter and Well - Domestic Wells

Parameter	Date	MSA	BOW01	BOW04	BOW09	BOW10	BOW12	BOW15	BOW26	BOW31A	BOW33	BOW35	BOW37	BOW56	BOW64	BOW73	BOW74	BOW84	BOW96	BOW98
pH (std)	Jun-99	8	6.51		7.31						6.87	6.48	6.74	7.34	7.38	6.43	6.25	7.48	7.05	7.28
Total Coliform (CFU/100 mL)	Apr-96	1	2 U	2 U	2 U	2 U	2 U		395											
Total Coliform (CFU/100 mL)	Sep-96	1	1 U							2 U	1 U		1 U	2 U	2 U	2 U		1 U		
Total Coliform (CFU/100 mL)	Oct-96	1								2 U			2 U		1 U					
Total Coliform (CFU/100 mL)	Dec-96	1	1 U																	
Total Coliform (CFU/100 mL)	Mar-97	1	2 U																	
Total Coliform (CFU/100 mL)	Mar-98	1										1 U					1 U		1 U	
Total Coliform (CFU/100 mL)	Jun-98	1										200					1 U		1 U	1 U
Total Coliform (CFU/100 mL)	Sep-98	1																		1 U
Total Dissolved Solids (mg/L)	Apr-96	500	82	100	95	140	170		140											
Total Dissolved Solids (mg/L)	Sep-96	500	69							110 P	150		320	57 P	75 P	62 P		190		
Total Dissolved Solids (mg/L)	Oct-96	500								110			325		74					
Total Dissolved Solids (mg/L)	Dec-96	500	130																	
Total Dissolved Solids (mg/L)	Mar-97	500	150																	
Total Dissolved Solids (mg/L)	Mar-98	500										110					81		180	
Total Dissolved Solids (mg/L)	Jun-98	500										130					94		180	310 P
Total Dissolved Solids (mg/L)	Sep-98	500																		210
Total Dissolved Solids (mg/L)	Mar-99	500	150		83						150	110	280	73	68	81	59	240	200	140
Total Dissolved Solids (mg/L)	Jun-99	500	170		100						170	110	270	87.5	69	75	120	255	180	200
Metals (mg/L)																				
Arsenic	Apr-96	5.83E-05	0.001 U	0.0014 B	0.001 U	0.004 B	0.005 B		0.0031 B											
Arsenic	Sep-96	5.83E-05	0.001 U							0.0262	0.001 U		0.001 U	0.001 B	0.0012 B	0.001 U		0.001 B		
Arsenic	Oct-96	5.83E-05								0.0107			0.001 U		0.0011 B					
Arsenic	Dec-96	5.83E-05	0.001 U																	
Arsenic	Mar-97	5.83E-05	0.001 U																	
Arsenic	Mar-98	5.83E-05										0.001 U					0.001 U		0.001 B	
Arsenic	Jun-98	5.83E-05										0.001 U					0.001 U		0.001 U	0.001 U
Arsenic	Sep-98	5.83E-05																		0.001 U
Chromium	Apr-96	1.00E-01	0.0065 B	0.0067 B	0.0069 B	0.005 U	0.005 U		0.005 U											
Chromium	Sep-96	1.00E-01	0.005 U							0.005 U	0.008 B		0.005 U	0.006 B	0.0065 B	0.005 U		0.005 U		
Chromium	Oct-96	1.00E-01								0.005 U			0.005 U		0.009 B					
Chromium	Dec-96	1.00E-01	0.005 U																	
Chromium	Mar-97	1.00E-01	0.006 B																	
Chromium	Mar-98	1.00E-01										0.005 B					0.005 U		0.0062 B	
Chromium	Jun-98	0.10										0.005 U					0.005 U		0.005	0.005 U
Chromium	Sep-98	0.10																		0.005 U
Iron	Apr-96	0.30	0.27	0.06	0.22	0.57	1.83		1.57											
Iron	Sep-96	0.30	0.02 U							1.44	0.095 B		0.02 U	0.02 U	0.0379 B	0.02 U		0.0406 B		
Iron	Oct-96	0.30								1.51			0.02 U		0.02 U					
Iron	Dec-96	0.30	0.02 U																	
Iron	Mar-97	0.30	0.02 U																	
Iron	Mar-98	0.30										0.032 B					0.02 U		0.174	
Iron	Jun-98	0.30										0.02					0.11		0.06	0.1
Iron	Sep-98	0.30																		0.04
Lead	Apr-96	0.01	0.0043	0.0039	0.0021 B	0.001 U	0.001 U		0.001 U											
Lead	Sep-96	0.01	0.0012 B							0.0067	0.0014 B		0.001 U	0.001 U	0.067	0.0024 B		0.001 U		
Lead	Oct-96	0.01								0.0025 B			0.001 U		0.0023 B					
Lead	Dec-96	0.01	0.001 U																	
Lead	Mar-97	0.01	0.0014 B																	
Lead	Mar-98	0.01										0.001 U					0.0013 B		0.001 U	
Lead	Jun-98	0.01										0.001					0.003		0.001 U	0.001 U
Lead	Sep-98	0.01																		0.001 U
Manganese	Apr-96	0.05	0.003	0.003	0.011	0.126	0.589		0.272											
Manganese	Sep-96	0.05	0.0011 B							0.102	0.0018 B		0.0117 B	0.001 U	0.001 U	0.001 U		0.001 U		

Table B-21
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Statistical Summary by Parameter and Well - Domestic Wells

Parameter	Date	MSA	BOW01	BOW04	BOW09	BOW10	BOW12	BOW15	BOW26	BOW31A	BOW33	BOW35	BOW37	BOW56	BOW64	BOW73	BOW74	BOW84	BOW96	BOW98
Manganese	Oct-96	0.05								0.0928			0.0133 B		0.001 U					
Manganese	Dec-96	0.05	0.0012 U																	
Manganese	Mar-97	0.05	0.0016 B																	
Manganese	Mar-98	0.05										0.001 B					0.0016 B		0.0059 B	
Manganese	Jun-98	0.05										0.001 U					0.02		0.003	0.005
Manganese	Sep-98	0.05																		0.001
SIM_VOA (ug/L)																				
1,1-Dichloroethene	Apr-96	0.073	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		0.01 U											
1,1-Dichloroethene	Sep-96	0.073	0.01 U							0.01 U	0.01 U		0.01 U	0.01 U	0.01 U	0.01 U		0.01 U		
1,1-Dichloroethene	Oct-96	0.073								0.01 U			0.01 U		0.01 U					
1,1-Dichloroethene	Dec-96	0.073	0.01 U																	
1,1-Dichloroethene	Mar-97	0.073	0.01 U																	
1,1-Dichloroethene	Apr-97	0.073		0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U	0.01 U	0.01 U		0.01 U		
1,1-Dichloroethene	Jun-97	0.073	0.01 U	0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U	0.01 U	0.01 U		0.01 U		
1,1-Dichloroethene	Sep-97	0.073	0.01 U	0.01 U	0.01 U			0.01 U		0.01 U	0.01 U		0.01 U	0.01 U	0.01 U	0.01 U		0.01 U		
1,1-Dichloroethene	Dec-97	0.073	0.01 U	0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U	0.01 U	0.01 U		0.01 U	0.01 U	
1,1-Dichloroethene	Feb-98	0.073												0.01 U	0.01 U	0.01 U			0.01 U	
1,1-Dichloroethene	Mar-98	0.073	0.01 U	0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	
1,1-Dichloroethene	Jun-98	0.073	0.01 U	0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1-Dichloroethene	Sep-98	0.073	0.01 U		0.01 U						0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1-Dichloroethene	Dec-98	0.073	0.01 U		0.01 U						0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	
1,1-Dichloroethene	Mar-99	0.073	0.01 U		0.03						0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
1,1-Dichloroethene	Jun-99	0.073	0.02 U		0.02 U						0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U
SVOA (ug/L)																				
Bis(2-Ethylhexyl)Phthalate	Apr-96	6.3	1 U	1 U	1 U	1 U	1 U		1 U											
Bis(2-Ethylhexyl)Phthalate	Sep-96	6.3	1 U							1 U	1 U		1 U	1 U	1 U	1 U		1 U		
Bis(2-Ethylhexyl)Phthalate	Oct-96	6.3								1 U			1 U		1 U					
Bis(2-Ethylhexyl)Phthalate	Dec-96	6.3	1 U																	
Bis(2-Ethylhexyl)Phthalate	Mar-97	6.3	1 U																	
Bis(2-Ethylhexyl)Phthalate	Mar-98	6.3										1 U					1 U		1.9	
Bis(2-Ethylhexyl)Phthalate	Jun-98	6.3										1 U					1 U		1 U	1 U
Bis(2-Ethylhexyl)Phthalate	Sep-98	6.3																		1 U
VOA (ug/L)																				
Cis-1,2-Dichloroethene	Apr-96	70.000	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U		0.2 U											
Cis-1,2-Dichloroethene	Sep-96	70.000	0.2 U							0.2 U	0.2 U		0.2 U	0.2 U	0.2 U	0.2 U		0.2 U		
Cis-1,2-Dichloroethene	Oct-96	70.000								0.2 U			0.2 U		0.2 U					
Cis-1,2-Dichloroethene	Dec-96	70.000	0.2 U																	
Cis-1,2-Dichloroethene	Mar-97	70.000	0.2 U																	
Cis-1,2-Dichloroethene	Apr-97	70.000		0.2 U	0.2 U		0.2 U	0.2 U		0.2 U	0.2 U		0.2 U	0.2 U	0.2 U	0.2 U		0.2 U		
Cis-1,2-Dichloroethene	Jun-97	70.000	0.2 U	0.2 U	0.2 U		0.2 U	0.2 U		0.2 U	0.2 U		0.2 U	0.2 U	0.2 U	0.2 U		0.2 U		
Cis-1,2-Dichloroethene	Sep-97	70.000	0.2 U	0.2 U	0.2 U			0.2 U		0.2 U	0.2 U		0.2 U	0.2 U	0.2 U	0.2 U		0.2 U		
Cis-1,2-Dichloroethene	Dec-97	70.000	0.2 U	0.2 U	0.2 U		0.2 U	0.2 U		0.2 U	0.2 U		0.2 U	0.2 U	0.2 U	0.2 U		0.2 U	0.2 U	
Cis-1,2-Dichloroethene	Feb-98	70.000												0.2 U	0.2 U	0.2 U			0.2 U	
Cis-1,2-Dichloroethene	Mar-98	70.000	0.2 U	0.2 U	0.2 UP		0.2 UP	0.2 U		0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	
Cis-1,2-Dichloroethene	Jun-98	70.000	0.2 U	0.2 U	0.2 U		0.2 U	0.2 UP		0.2 U	0.2 U	0.2 U	0.2 U	0.2 UP	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Cis-1,2-Dichloroethene	Sep-98	70.000	0.2 U		0.2 U						0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Cis-1,2-Dichloroethene	Dec-98	70.000	0.2 U		0.2 U						0.2 U	0.2 U	0.1 J	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	
Cis-1,2-Dichloroethene	Mar-99	70.000	0.2 U		0.2 U						0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U	0.2 U
Cis-1,2-Dichloroethene	Jun-99	70.000	0.2 UP		0.2 U						0.2 UP	0.2 U	0.1 J	0.2 U	0.2 UP	0.2 UP	0.2 U	0.2 UP	0.2 U	0.2 UP
SIM_VOA (ug/L)																				
Vinyl Chloride	Apr-96	0.023	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U		0.01 U											
Vinyl Chloride	Sep-96	0.023	0.01 U							0.01 U	0.01 U		0.63	0.01 U	0.01 U	0.01 U		0.01 U		
Vinyl Chloride	Oct-96	0.023								0.01 U			0.77		0.01 U					
Vinyl Chloride	Dec-96	0.023	0.01 U																	

Table B-21
BAINBRIDGE ISLAND LANDFILL FS
Groundwater Statistical Summary by Parameter and Well - Domestic Wells

Parameter	Date	MSA	BOW01	BOW04	BOW09	BOW10	BOW12	BOW15	BOW26	BOW31A	BOW33	BOW35	BOW37	BOW56	BOW64	BOW73	BOW74	BOW84	BOW96	BOW98
Vinyl Chloride	Mar-97	0.023	0.01 U																	
Vinyl Chloride	Apr-97	0.023		0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U		0.53	0.01 U	0.01 U	0.01 U		0.01 U		
Vinyl Chloride	Jun-97	0.023	0.015 M	0.01 M	0.01 U		0.01 U	0.02		0.01 U	0.01 U		0.32	0.01 U	0.01 U	0.01 U		0.01 U		
Vinyl Chloride	Sep-97	0.023	0.01 U	0.01 U	0.01 U			0.01 U		0.01 U	0.01 U		0.3	0.01 U	0.01 U	0.01 U		0.01 U		
Vinyl Chloride	Dec-97	0.023	0.01 U	0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U		0.38	0.02	0.04	0.01 JM		0.01 U	0.03	
Vinyl Chloride	Feb-98	0.023												0.01 U	0.01 U	0.01 U			0.01 U	
Vinyl Chloride	Mar-98	0.023	0.01 U	0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 J	0.01 U	0.43	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	
Vinyl Chloride	Jun-98	0.023	0.01 U	0.01 U	0.01 U		0.01 U	0.01 U		0.01 U	0.01 U	0.01 U	0.39	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Vinyl Chloride	Sep-98	0.023	0.01 U		0.01 U						0.01 U	0.01 U	0.36	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Vinyl Chloride	Dec-98	0.023	0.01 U		0.01 U						0.01 U	0.01 U	0.35	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	
Vinyl Chloride	Mar-99	0.023	0.01 U		0.01 U						0.01 U	0.01 U	0.26	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U	0.01 U
Vinyl Chloride	Jun-99	0.023	0.02 U		0.02 U						0.02 U	0.02 U	0.22	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U	0.02 U

Historical Data

Table B-22
BAINBRIDGE ISLAND LANDFILL FS
Historical Data - Main Landfill Waste
Statistical Summary by Parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA
Inorg	Aluminum	µg/kg	29	29	100%	4.38E+06	2.12E+07	1.15E+07			
Inorg	Antimony	µg/kg	2	29	7%	51,000	55,000	3,655			
Inorg	Arsenic	µg/kg	16	27	59%	2,000	21,000	5,593	7,300	Puget Sound Background	8
Inorg	Barium	µg/kg	29	29	100%	31,900	788,000	194,845	5.60E+06	MTCA Method B	
Inorg	Beryllium	µg/kg	13	28	46%	200	500	161	610	Puget Sound Background	
Inorg	Cadmium	µg/kg	22	29	76%	1,400	36,600	5,245	40,000	MTCA Method B	
Inorg	Calcium	µg/kg	29	29	100%	2.02E+06	3.13E+07	9.10E+06			
Inorg	Chromium	µg/kg	29	29	100%	15,300	127,000	46,776	100,000	MTCA Method B	4
Inorg	Cobalt	µg/kg	29	29	100%	4,000	45,000	13,100			
Inorg	Copper	µg/kg	29	29	100%	11,900	1.85E+06	245,279	2.96E+06	MTCA Method B	
Inorg	Cyanide	µg/kg	1	29	3%	2,500	2,500	86			
Inorg	Iron	µg/kg	29	29	100%	29,500	2.85E+08	5.59E+07	5.87E+07	Puget Sound Background	7
Inorg	Lead	µg/kg	29	29	100%	1,700	1.02E+07	1.44E+06	250,000	MTCA Method B	15
Inorg	Magnesium	µg/kg	29	29	100%	1.23E+06	4.55E+06	3.03E+06			
Inorg	Manganese	µg/kg	28	28	100%	108,000	1.61E+06	521,143	1.12E+07	MTCA Method B	
Inorg	Mercury	µg/kg	15	29	52%	140	1,800	275	24,000	MTCA Method B	
Inorg	Nickel	µg/kg	29	29	100%	21,700	363,000	64,931	1.60E+06	MTCA Method B	
Inorg	Potassium	µg/kg	19	28	68%	243,000	2.13E+06	366,357			
Inorg	Silver	µg/kg	9	29	31%	2,500	4,800	1,214	400,000	MTCA Method B	
Inorg	Sodium	µg/kg	16	29	55%	2,100	1.98E+06	332,107			
Inorg	Tin	µg/kg	12	13	92%	29,000	839,000	295,846	4.80E+07	MTCA Method B	
Inorg	Vanadium	µg/kg	29	29	100%	12,200	48,000	24,652	560,000	MTCA Method B	
Inorg	Zinc	µg/kg	29	29	100%	32,000	4.30E+06	989,717	2.40E+07	MTCA Method B	
Pest/PCB	4,4 '-DDD	µg/kg	2	29	7%	25	33	2.0	4,167	MTCA Method B	
Pest/PCB	4,4'-DDE	µg/kg	4	29	14%	10	130	11	2,941	MTCA Method B	
Pest/PCB	4,4'-DDT	µg/kg	1	29	3%	43	43	1.5	2,941	MTCA Method B	
Pest/PCB	Aldrin	µg/kg	2	29	7%	140	240	13	59	MTCA Method B	2
Pest/PCB	Arochlor 1254	µg/kg	2	29	7%	1,316	12,000	459	1,600	MTCA Method B	1
Pest/PCB	Chlordane	µg/kg	1	29	3%	2,279	2,279	79			
Pest/PCB	Endosulfan Sulfate	µg/kg	1	29	3%	39	39	1.3			
Pest/PCB	Gamma -BHC	µg/kg	1	29	3%	220	220	7.6	769	MTCA Method B	
Pest/PCB	Total PCBs	µg/kg	2	2	100%	1,316	12,000	6,658	1,600	MTCA Method B	1
SVOC	1,2,4-Trichlorobenzene	µg/kg	1	29	3%	69	69	2.4	800,000	MTCA Method B	
SVOC	1,2-Dichlorobenzene	µg/kg	2	29	7%	53	58	3.8	72,000	MTCA Method B PGW	
SVOC	1,3-Dichlorobenzene	µg/kg	1	29	3%	110	110	3.8			
SVOC	1,4-Dichlorobenzene	µg/kg	2	29	7%	71	99	5.9	41,667	MTCA Method B	
SVOC	2-Methylnaphthalene	µg/kg	10	29	34%	140	2,600	358			
SVOC	4-Methylphenol	µg/kg	3	29	10%	65	940	38	400,000	MTCA Method B	
SVOC	Acenaphthene	µg/kg	10	29	34%	89	6,100	763	4.80E+06	MTCA Method B	

Table B-22
BAINBRIDGE ISLAND LANDFILL FS
Historical Data - Main Landfill Waste
Statistical Summary by Parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA
SVOC	Acenaphthylene	µg/kg	1	29	3%	28	28	0.97			
SVOC	Anthracene	µg/kg	11	29	38%	140	4,600	799	2.40E+07	MTCA Method B	
SVOC	Benzo(a)anthracene	µg/kg	5	28	18%	200	3,300	301	137	MTCA Method B	5
SVOC	Benzo(a)pyrene	µg/kg	4	27	15%	93	640	42	137	MTCA Method B	3
SVOC	Benzo(b)fluoranthene	µg/kg	9	29	31%	79	4,500	475	137	MTCA Method B	8
SVOC	Benzo(k)fluoranthene	µg/kg	6	29	21%	47	4,500	221	137	MTCA Method B	4
SVOC	Benzoic acid	µg/kg	2	29	7%	360	4,800	178	3.20E+08	MTCA Method B	
SVOC	Bis(2-ethylhexyl)phthalate	µg/kg	16	29	55%	1,100	350,000	32,693	71,429	MTCA Method B	3
SVOC	Butyl-benzyl-phthalate	µg/kg	14	29	48%	510	15,000	1,407	1.60E+07	MTCA Method B	
SVOC	Chrysene	µg/kg	10	29	34%	110	4,700	816	137	MTCA Method B	9
SVOC	Dibenzofuran	µg/kg	9	28	32%	71	4,300	525			
SVOC	Diethylphthalate	µg/kg	3	29	10%	130	700	35	6.40E+07	MTCA Method B	
SVOC	Dimethylphthalate	µg/kg	1	29	3%	3,100	3,100	107	8.00E+07	MTCA Method B	
SVOC	Di-n-butylphthalate	µg/kg	7	29	24%	1,000	2,000	338	8.00E+06	MTCA Method B	
SVOC	Di-n-octlylphthalate	µg/kg	7	29	24%	400	18,000	1,283	1.60E+06	MTCA Method B	
SVOC	Fluoranthene	µg/kg	14	29	48%	34	22,000	2,753	3.20E+06	MTCA Method B	
SVOC	Fluorene	µg/kg	11	28	39%	12	7,900	936	3.20E+06	MTCA Method B	
SVOC	Naphthalene	µg/kg	11	27	41%	50	6,600	644	32,000	MTCA Method B PGW	
SVOC	Phenanthrene	µg/kg	14	29	48%	83	22,000	3,242			
SVOC	Pyrene	µg/kg	14	29	48%	26	15,000	2,022	2.40E+06	MTCA Method B	
VOC	2-Butanone	µg/kg	4	28	14%	10	310	24	480,000	MTCA Method B PGW	
VOC	2-Hexanone	µg/kg	2	29	7%	11	380	13			
VOC	4-Methyl-3-pentanone	µg/kg	2	29	7%	8.0	11	0.66	64,000	MTCA Method B PGW	
VOC	Acetone	µg/kg	6	29	21%	270	35,000	1,515	80,000	MTCA Method B PGW	
VOC	Benzene	µg/kg	3	29	10%	4.0	18	1.1	151	MTCA Method B PGW	
VOC	Carbon disulfide	µg/kg	4	29	14%	2.0	19	1.0	80,000	MTCA Method B PGW	
VOC	Chlorobenzene	µg/kg	2	29	7%	49	64	3.9	16,000	MTCA Method B PGW	
VOC	Ethylbenzene	µg/kg	17	29	59%	1.0	900	51	80,000	MTCA Method B PGW	
VOC	Methylene chloride	µg/kg	1	29	3%	76	76	2.6	583	MTCA Method B PGW	
VOC	Toluene	µg/kg	17	28	61%	1.0	200	18	160,000	MTCA Method B PGW	
VOC	Total Xylenes	µg/kg	14	29	48%	11	1,300	100			
VOC	Trans-1,2-dichloroethane	µg/kg	2	29	7%	4.0	8.0	0.41			

Notes:
INORG = total metals
PEST = pesticides
PCB = polynuclear aromatic hydrocarbons
SVOC = semivolatile organic compounds
VOC = volatile organic compounds

Table B-23
BAINBRIDGE ISLAND LANDFILL FS
Historical Data - Main Landfill Cover Soil
Statistical Summary by Parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA
Inorg	Aluminum	µg/kg	3	3	100%	8.53E+06	1.05E+07	9.30E+06			
Inorg	Arsenic	µg/kg	2	3	67%	2,600	2,700	1,767	7,300	Puget Sound Background	
Inorg	Barium	µg/kg	3	3	100%	34,200	51,000	42,900	5.60E+06	MTCA Method B	
Inorg	Beryllium	µg/kg	1	3	33%	300	300	100	610	Puget Sound Background	
Inorg	Calcium	µg/kg	3	3	100%	2.00E+06	4.31E+06	2.91E+06			
Inorg	Chromium	µg/kg	3	3	100%	15,100	23,000	18,867	100,000	MTCA Method B	
Inorg	Cobalt	µg/kg	3	3	100%	4,600	7,000	5,900			
Inorg	Copper	µg/kg	3	3	100%	6,200	10,000	8,733	2.96E+06	MTCA Method B	
Inorg	Iron	µg/kg	3	3	100%	9.84E+06	1.34E+07	1.15E+07	5.87E+07	Puget Sound Background	
Inorg	Lead	µg/kg	3	3	100%	3,700	13,000	7,033	250,000	MTCA Method B	
Inorg	Magnesium	µg/kg	3	3	100%	3.37E+06	4.05E+06	3.67E+06			
Inorg	Manganese	µg/kg	3	3	100%	163,000	193,000	182,667	1.12E+07	MTCA Method B	
Inorg	Nickel	µg/kg	3	3	100%	21,100	31,000	26,700	1.60E+06	MTCA Method B	
Inorg	Potassium	µg/kg	2	2	100%	164,000	397,000	280,500			
Inorg	Sodium	µg/kg	1	3	33%	140,000	140,000	46,667			
Inorg	Vanadium	µg/kg	3	3	100%	22,600	28,800	26,467	560,000	MTCA Method B	
Inorg	Zinc	µg/kg	3	3	100%	25,700	60,000	41,433	2.40E+07	MTCA Method B	
Pest/PCB	4,4'-DDD	µg/kg	1	4	25%	15	15	3.8	4,167	MTCA Method B	
Pest/PCB	4,4'-DDE	µg/kg	1	4	25%	4.0	4.0	1.0	2,941	MTCA Method B	
Pest/PCB	Aldrin	µg/kg	1	4	25%	21	21	5.3	59	MTCA Method B	
SVOC	Acenaphthene	µg/kg	1	4	25%	110	110	28	4.80E+06	MTCA Method B	
SVOC	Anthracene	µg/kg	2	4	50%	37	1,200	309	2.40E+07	MTCA Method B	
SVOC	Benzo(a)anthracene	µg/kg	2	4	50%	48	1,100	287	137	MTCA Method B	1
SVOC	Benzo(a)pyrene	µg/kg	1	4	25%	520	520	130	137	MTCA Method B	1
SVOC	Benzo(b)fluoranthene	µg/kg	1	4	25%	1,100	1,100	275	137	MTCA Method B	1
SVOC	Benzo(k)fluoranthene	µg/kg	1	4	25%	460	460	115	137	MTCA Method B	1
SVOC	Chrysene	µg/kg	2	4	50%	58	2,500	640	137	MTCA Method B	1
SVOC	Dibenzofuran	µg/kg	1	4	25%	190	190	48			
SVOC	Fluoranthene	µg/kg	2	4	50%	80	3,600	920	3.20E+06	MTCA Method B	
SVOC	Fluorene	µg/kg	1	4	25%	450	450	113	3.20E+06	MTCA Method B	
SVOC	Naphthalene	µg/kg	1	4	25%	48	48	12	32,000	MTCA Method B PGW	
SVOC	Phenanthrene	µg/kg	2	4	50%	60	840	225			
SVOC	Pyrene	µg/kg	2	4	50%	78	2,500	645	2.40E+06	MTCA Method B	
VOC	Acetone	µg/kg	1	4	25%	7,400	7,400	1,850	80,000	MTCA Method B PGW	
VOC	Ethylbenzene	µg/kg	1	4	25%	2.0	2.0	0.50	80,000	MTCA Method B PGW	

Notes:

INORG = total metals
PEST = pesticides
PCB = polynuclear aromatic hydrocarbons
SVOC = semivolatile organic compounds
VOC = volatile organic compounds

Table B-24
BAINBRIDGE ISLAND LANDFILL FS
Historical Data - Main Landfill Base Soil
Statistical Summary by Parameter
Parameters Detected in at Least One Sample

Chemical Group	Parameter	Units	Number of Detects	Number of Samples	Frequency of Detection	Minimum Detected Value	Maximum Detected Value	Arithmetic Mean [a]	MSA [b]	MSA Source	Number of Detect Samples Exceeding MSA
Inorg	Aluminum	µg/kg	3	3	100%	6.88E+06	9.98E+06	8.86E+06			
Inorg	Arsenic	µg/kg	1	3	33%	2,300	2,300	767	7,300	Puget Sound Background	
Inorg	Barium	µg/kg	3	3	100%	29,300	80,500	48,400	5.60E+06	MTCA Method B	
Inorg	Cadmium	µg/kg	1	3	33%	4,300	4,300	1,433	40,000	MTCA Method B	
Inorg	Calcium	µg/kg	3	3	100%	1.71E+06	4.61E+06	2.96E+06			
Inorg	Chromium	µg/kg	3	3	100%	18,300	37,800	25,100	100,000	MTCA Method B	
Inorg	Cobalt	µg/kg	3	3	100%	4,900	7,700	5,967			
Inorg	Copper	µg/kg	2	3	67%	4,000	75,700	26,567	2.96E+06	MTCA Method B	
Inorg	Iron	µg/kg	3	3	100%	1.02E+07	2.68E+07	1.60E+07	5.87E+07	Puget Sound Background	
Inorg	Lead	µg/kg	3	3	100%	3,600	150,000	54,100	250,000	MTCA Method B	
Inorg	Magnesium	µg/kg	3	3	100%	3.03E+06	3.72E+06	3.28E+06			
Inorg	Manganese	µg/kg	3	3	100%	135,000	284,000	199,000	1.12E+07	MTCA Method B	
Inorg	Mercury	µg/kg	1	3	33%	110	110	37	24,000	MTCA Method B	
Inorg	Nickel	µg/kg	3	3	100%	30,200	33,700	32,267	1.60E+06	MTCA Method B	
Inorg	Potassium	µg/kg	3	3	100%	274,000	458,000	339,667			
Inorg	Sodium	µg/kg	1	3	33%	556,000	556,000	185,333			
Inorg	Vanadium	µg/kg	3	3	100%	20,300	24,400	22,233	560,000	MTCA Method B	
Inorg	Zinc	µg/kg	3	3	100%	28,700	392,000	157,700	2.40E+07	MTCA Method B	
SVOC	2-Methylnaphthalene	µg/kg	1	3	33%	380	380	127			
SVOC	Acenaphthene	µg/kg	1	3	33%	2,400	2,400	800	4.80E+06	MTCA Method B	
SVOC	Anthracene	µg/kg	1	3	33%	1,100	1,100	367	2.40E+07	MTCA Method B	
SVOC	Benzo(a)anthracene	µg/kg	1	3	33%	1,600	1,600	533	137	MTCA Method B	1
SVOC	Butyl-benzyl-phthalate	µg/kg	1	3	33%	300	300	100	1.60E+07	MTCA Method B	
SVOC	Chrysene	µg/kg	1	3	33%	84	84	28	137	MTCA Method B	
SVOC	Dibenzofuran	µg/kg	1	2	50%	1,200	1,200	600			
SVOC	Di-n-butylphthalate	µg/kg	1	2	50%	2,000	2,000	1,000	8.00E+06	MTCA Method B	
SVOC	Di-n-octlylphthalate	µg/kg	1	1	100%	710	710	710	1.60E+06	MTCA Method B	
SVOC	Fluoranthene	µg/kg	2	3	67%	110	4,700	1,603	3.20E+06	MTCA Method B	
SVOC	Fluorene	µg/kg	1	2	50%	1,000	1,000	500	3.20E+06	MTCA Method B	
SVOC	Naphthalene	µg/kg	1	2	50%	240	240	120	32,000	MTCA Method B PGW	
SVOC	Phenanthrene	µg/kg	2	3	67%	71	5,700	1,924			
SVOC	Pyrene	µg/kg	2	3	67%	78	3,300	1,126	2.40E+06	MTCA Method B	
VOC	Ethylbenzene	µg/kg	1	3	33%	1.0	1.0	0.33	80,000	MTCA Method B PGW	

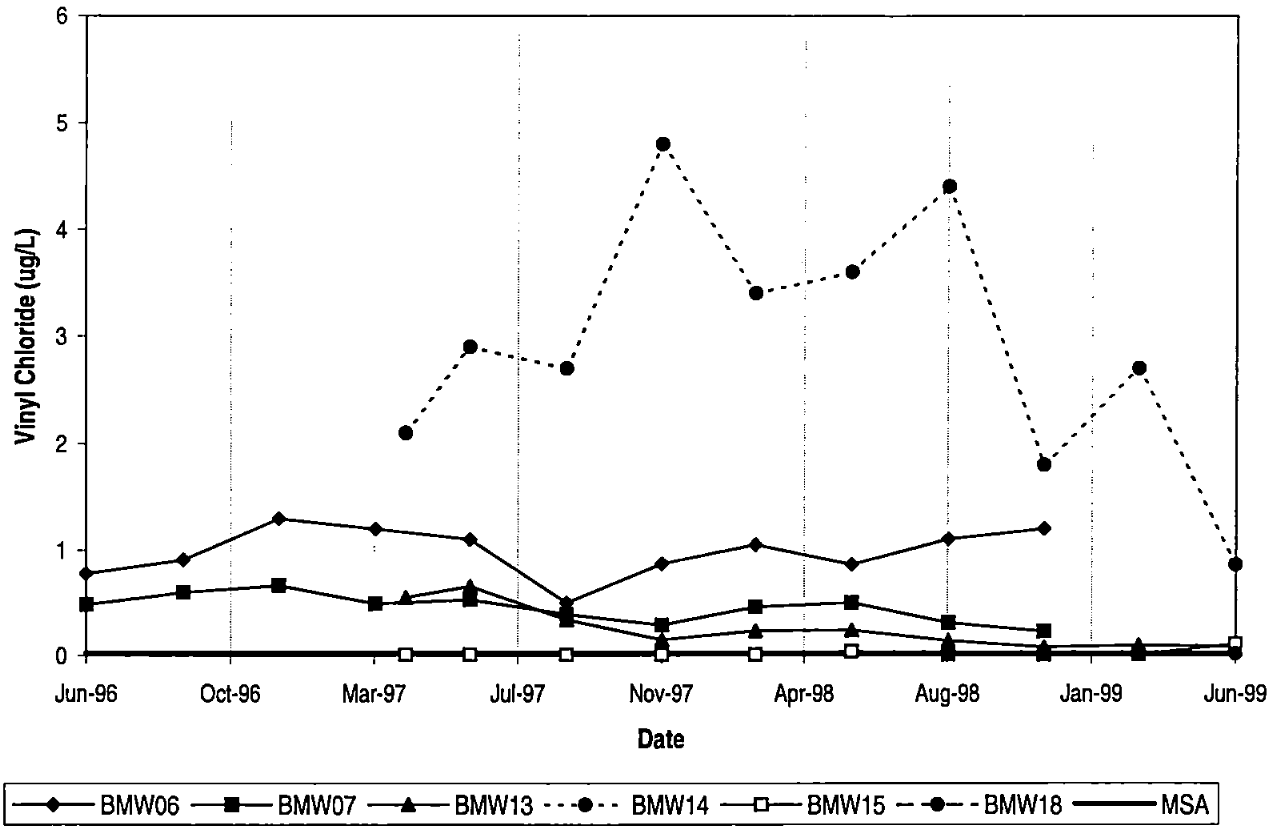
Notes:
INORG = total metals
SVOC = semivolatile organic compounds
VOC = volatile organic compounds

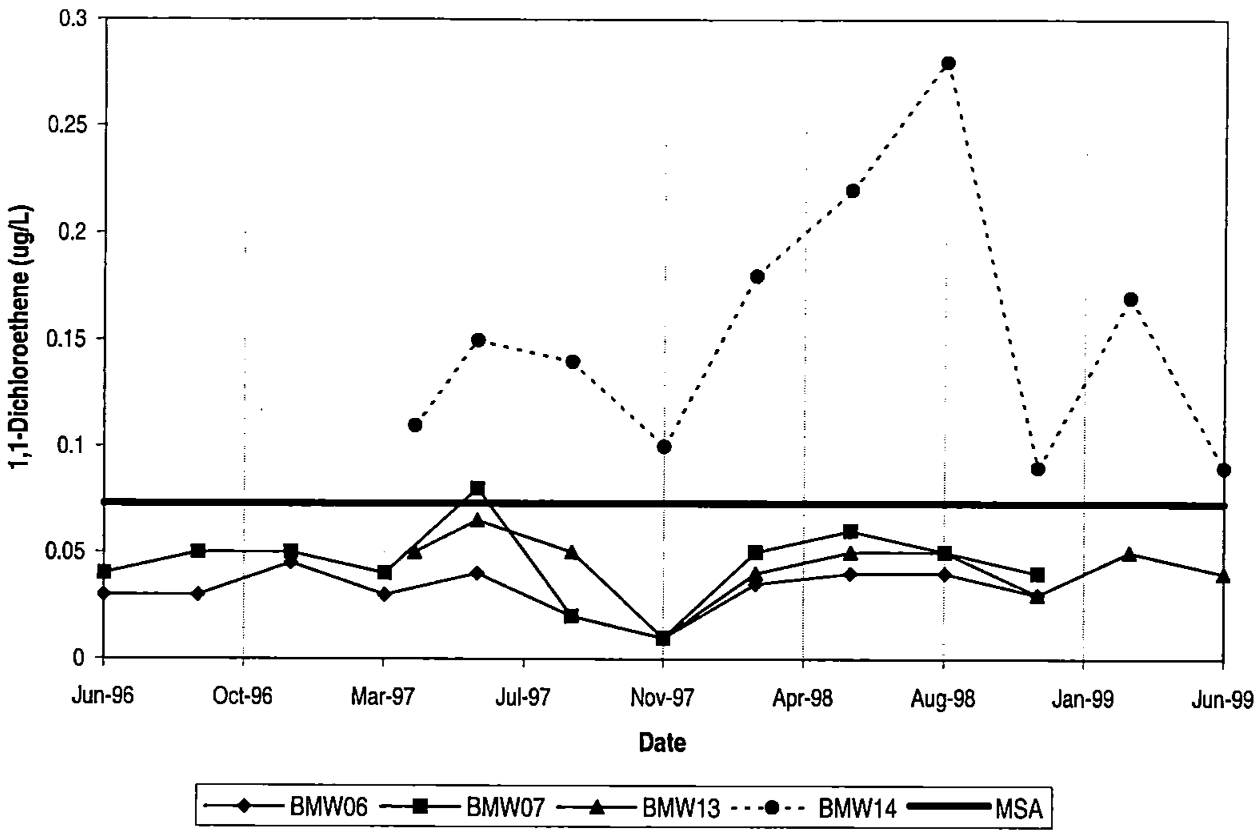
APPENDIX C

Groundwater Time Series Plots

Monitoring Wells

BAINBRIDGE ISLAND LANDFILL FS REPORT
MONITORING WELL TIME SERIES PLOTS

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0.2
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0.1
0.05
0
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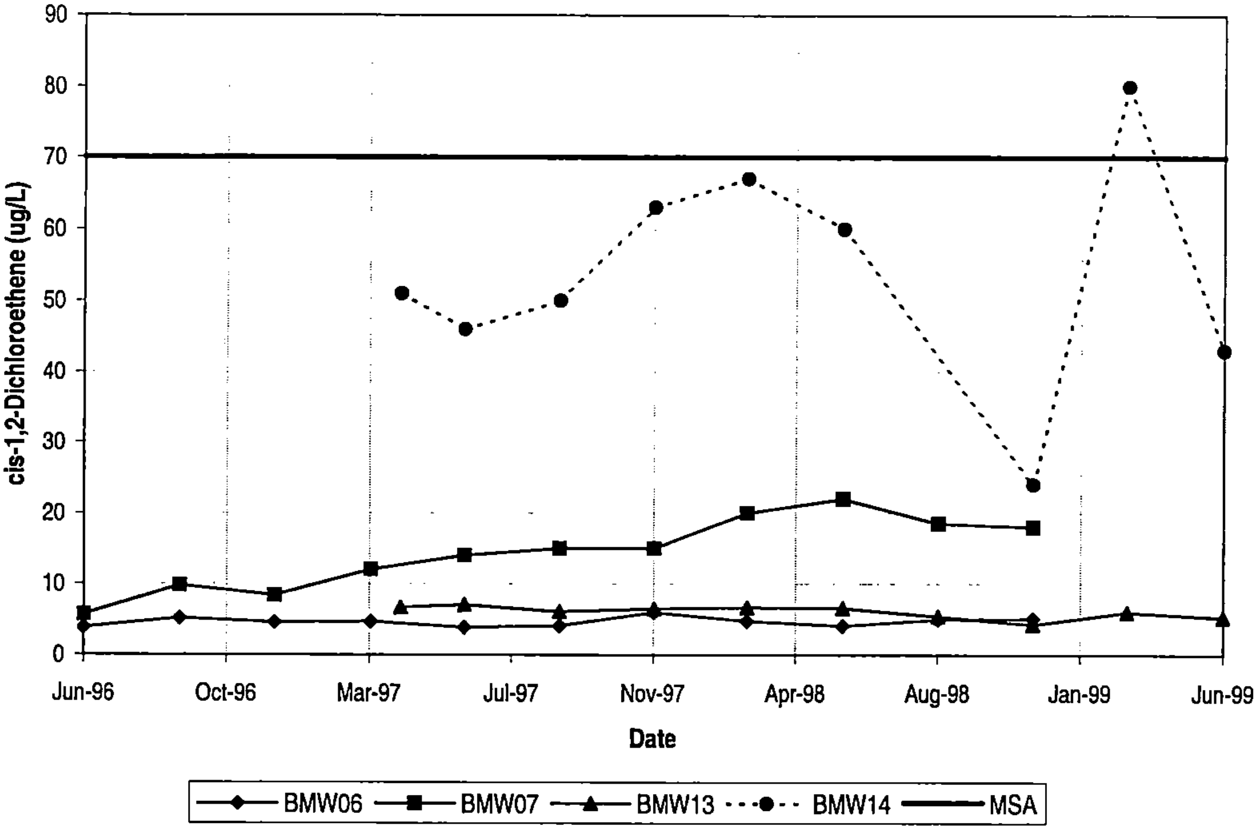
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW06
BMW07
BMW13
BMW14
MSA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70
60
50
40
30
20
10
0
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Jun-96
Oct-96
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Jun-99
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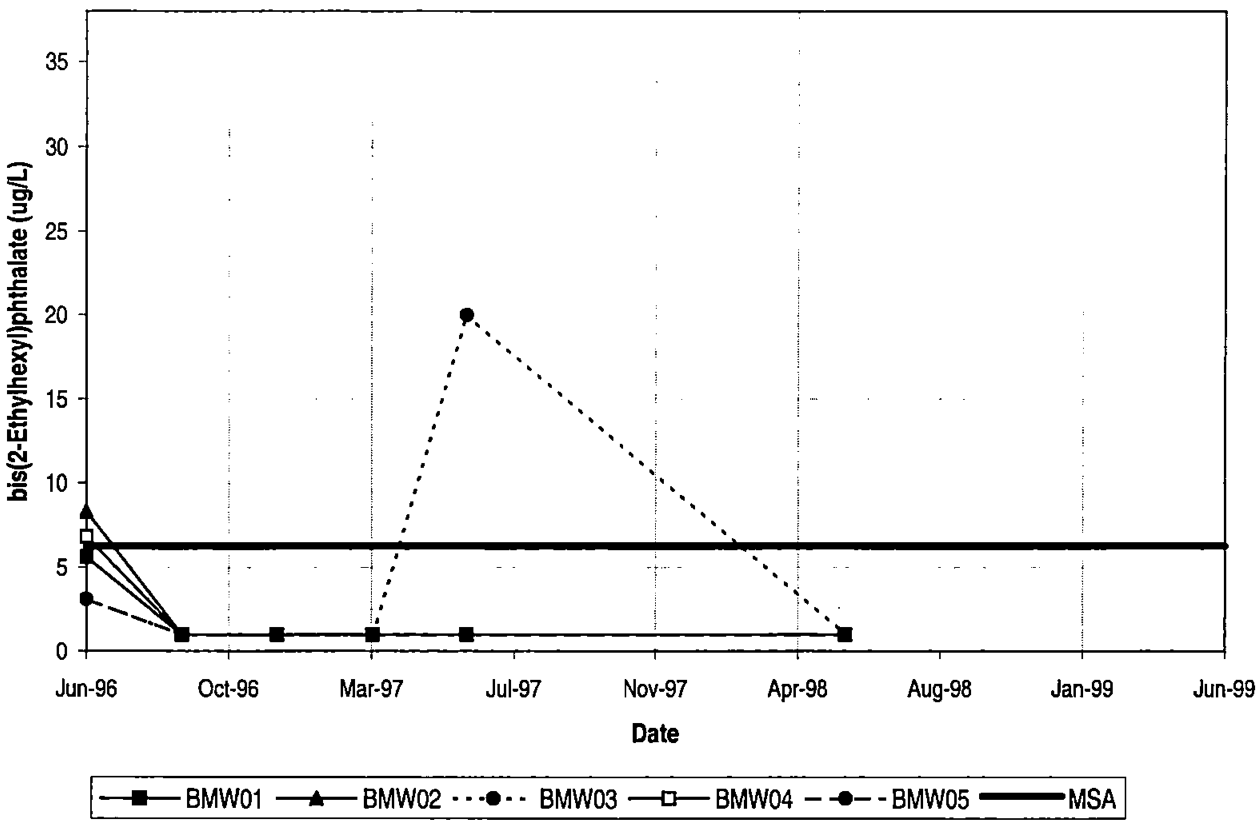
BMW07
BMW13
BMW14
MSA


35
30
25
20
15
10
5
0
bis(2-Ethylhexyl)phthalate (ug/L)
Jun-96
Oct-96
Mar-97
Jul-97
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Date
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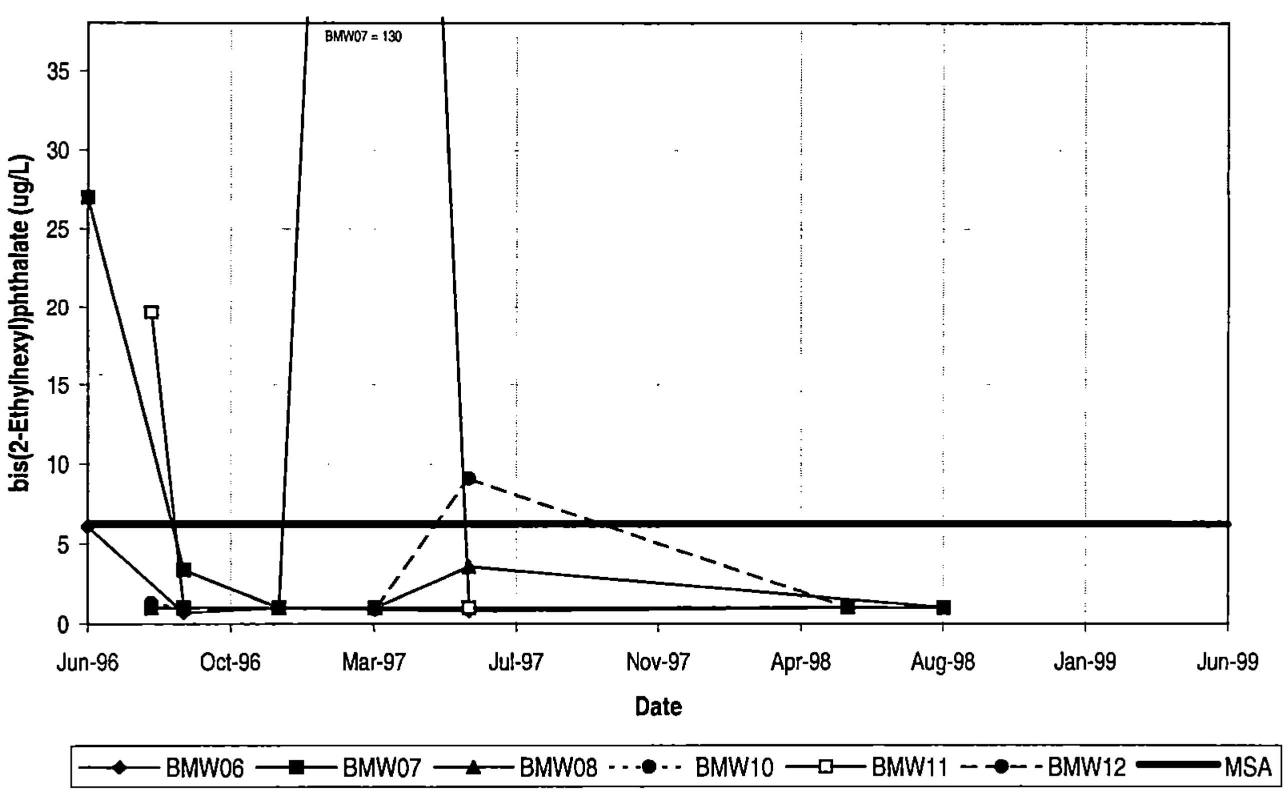
BMW02
BMW03
BMW04
BMW05
MSA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35
30
25
20
15
10
5
0
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Jun-96
Oct-96
Mar-97
Jul-97
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Date
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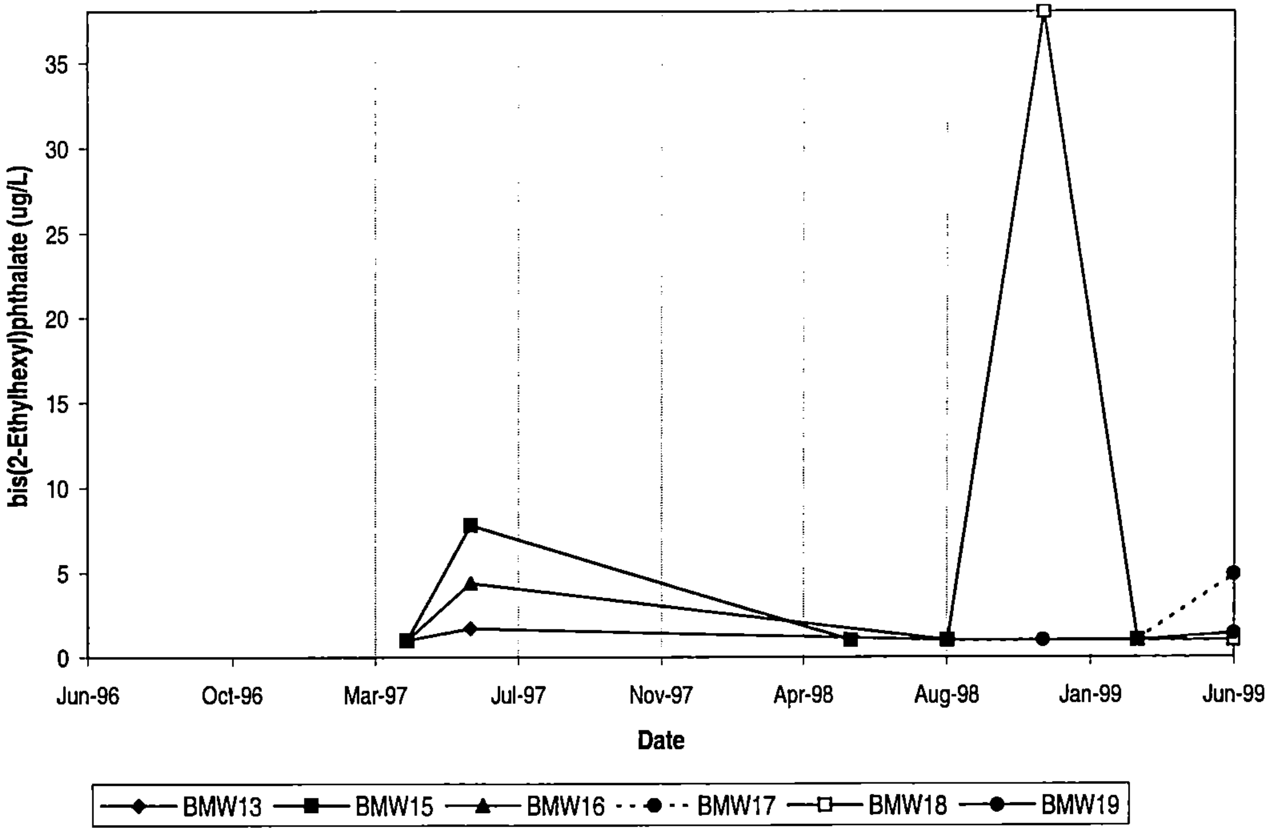
BMW08
BMW10
BMW11
BMW12
MSA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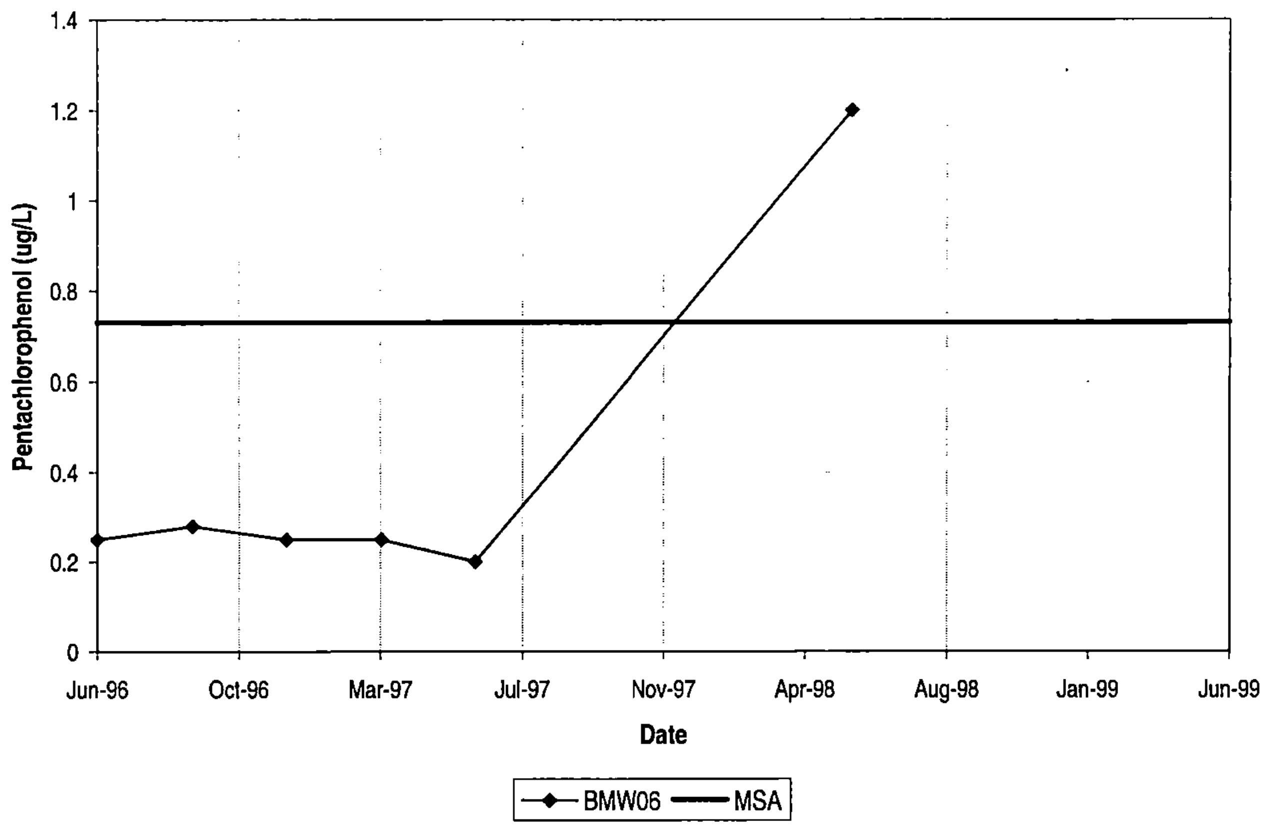
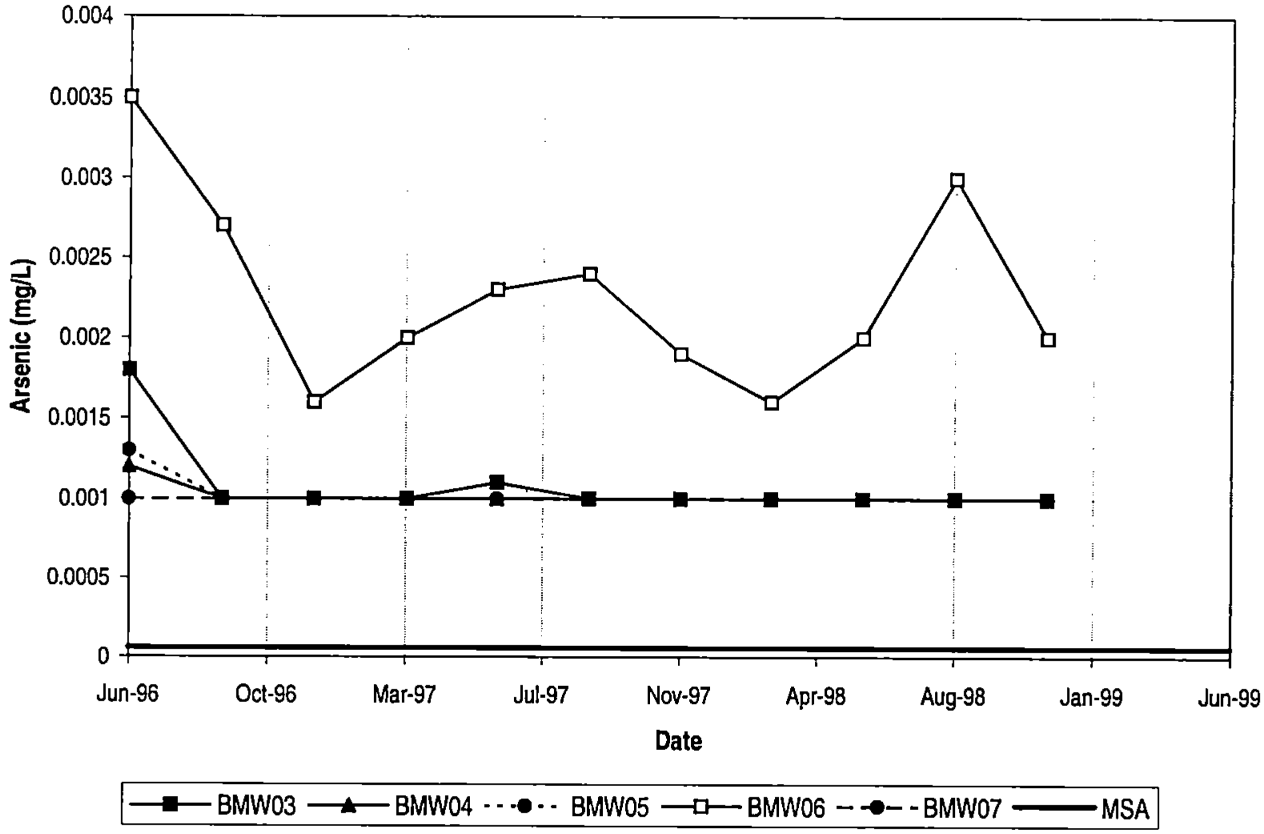
30
25
20
15
10
5
0
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW13
BMW15
BMW16
BMW17
BMW18
BMW19

BAINBRIDGE ISLAND LANDFILL FS REPORT
MONITORING WELL TIME SERIES PLOTS

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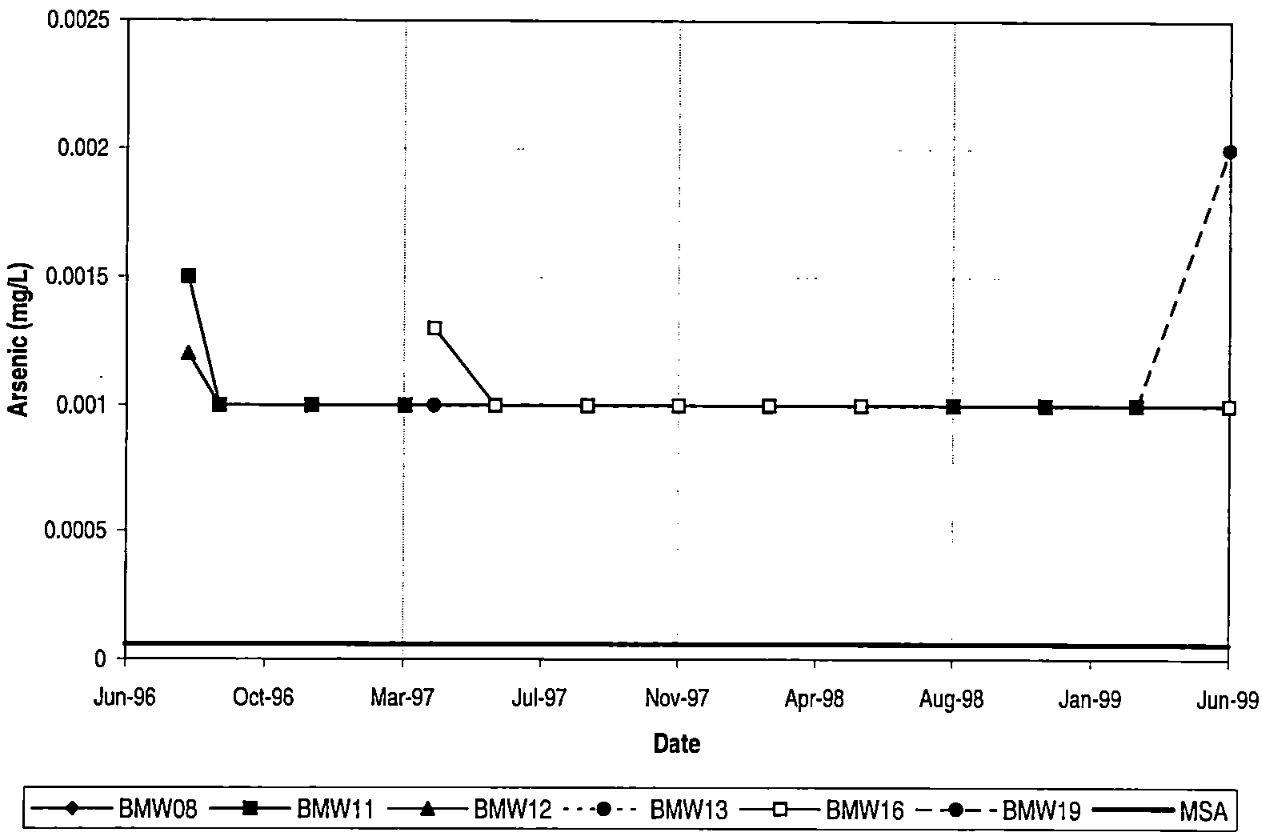
0.003
0.0025
0.002
0.0015
0.001
0.0005
0
Arsenic (mg/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW03
BMW04
BMW05
BMW06
BMW07
MSA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0.002
0.0015
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0.0005
0
Arsenic (mg/L)
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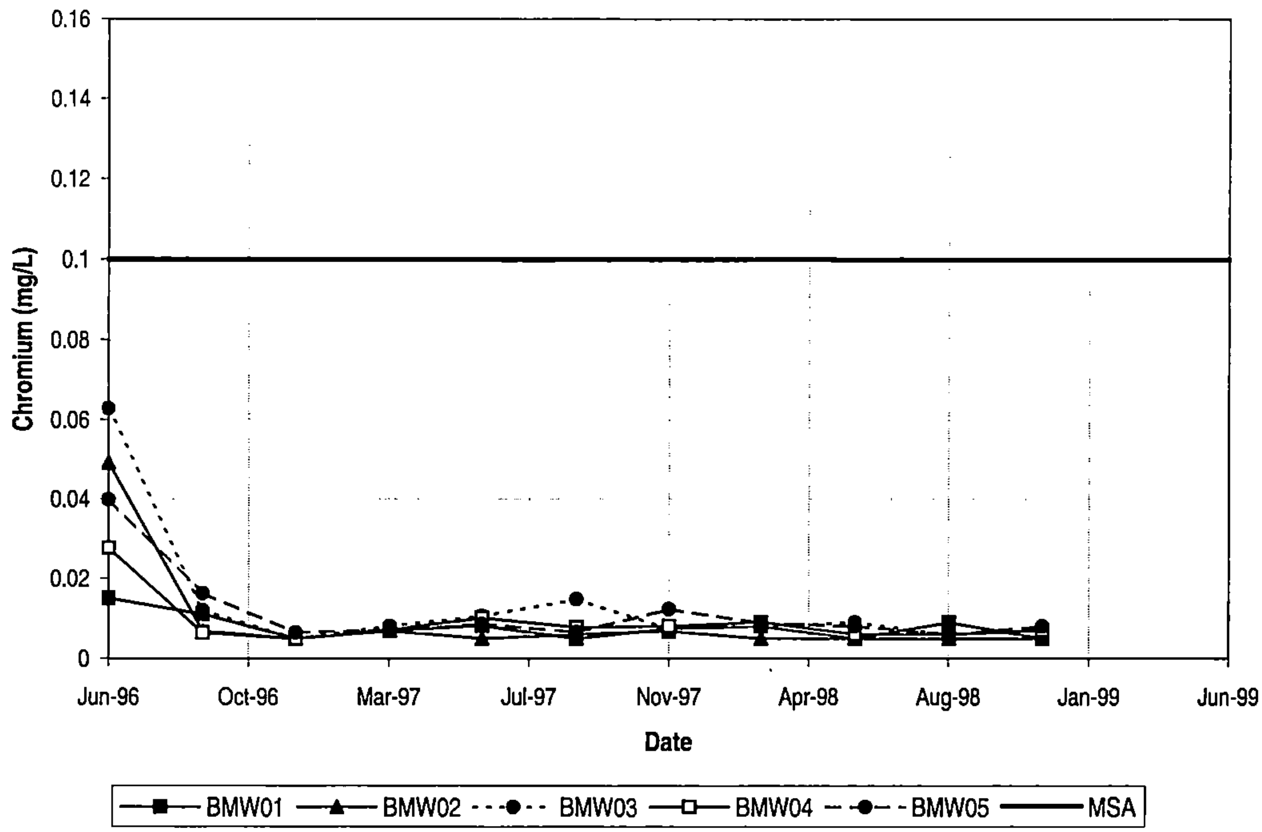
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW08
BMW11
BMW12
BMW13
BMW16
BMW19
MSA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0.08
0.06
0.04
0.02
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Mar-97
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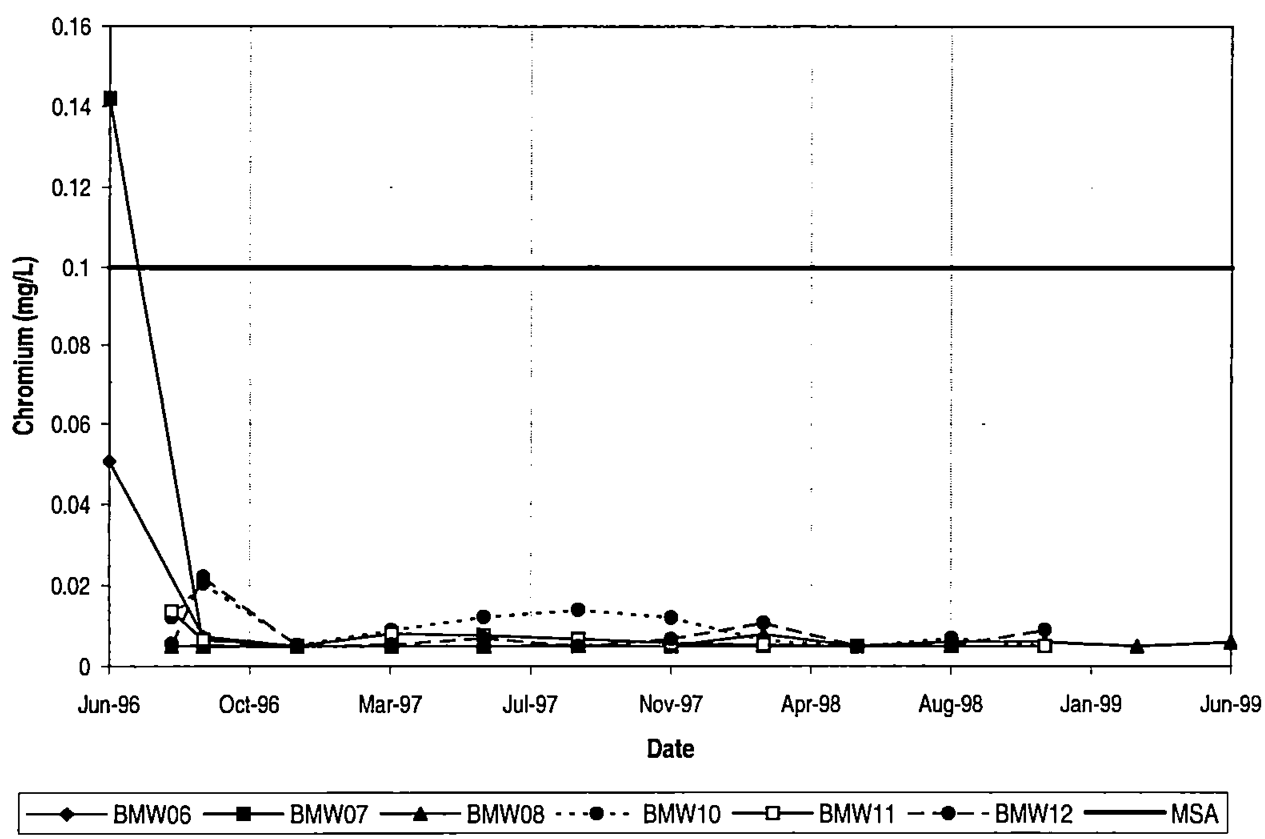
BMW03
BMW04
BMW05
MSA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0.14
0.12
0.1
0.08
0.06
0.04
0.02
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Chromium (mg/L)
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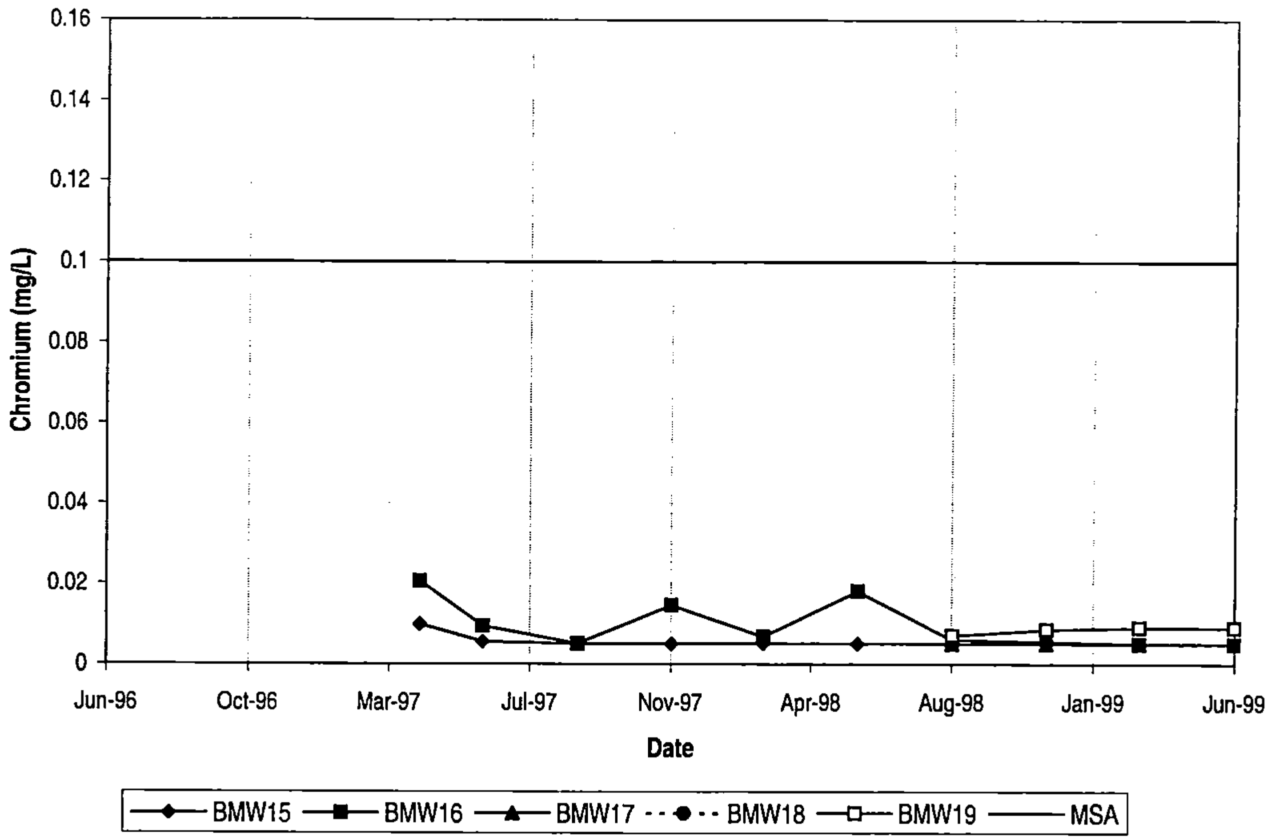
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW06
BMW07
BMW08
BMW10
BMW11
BMW12
MSA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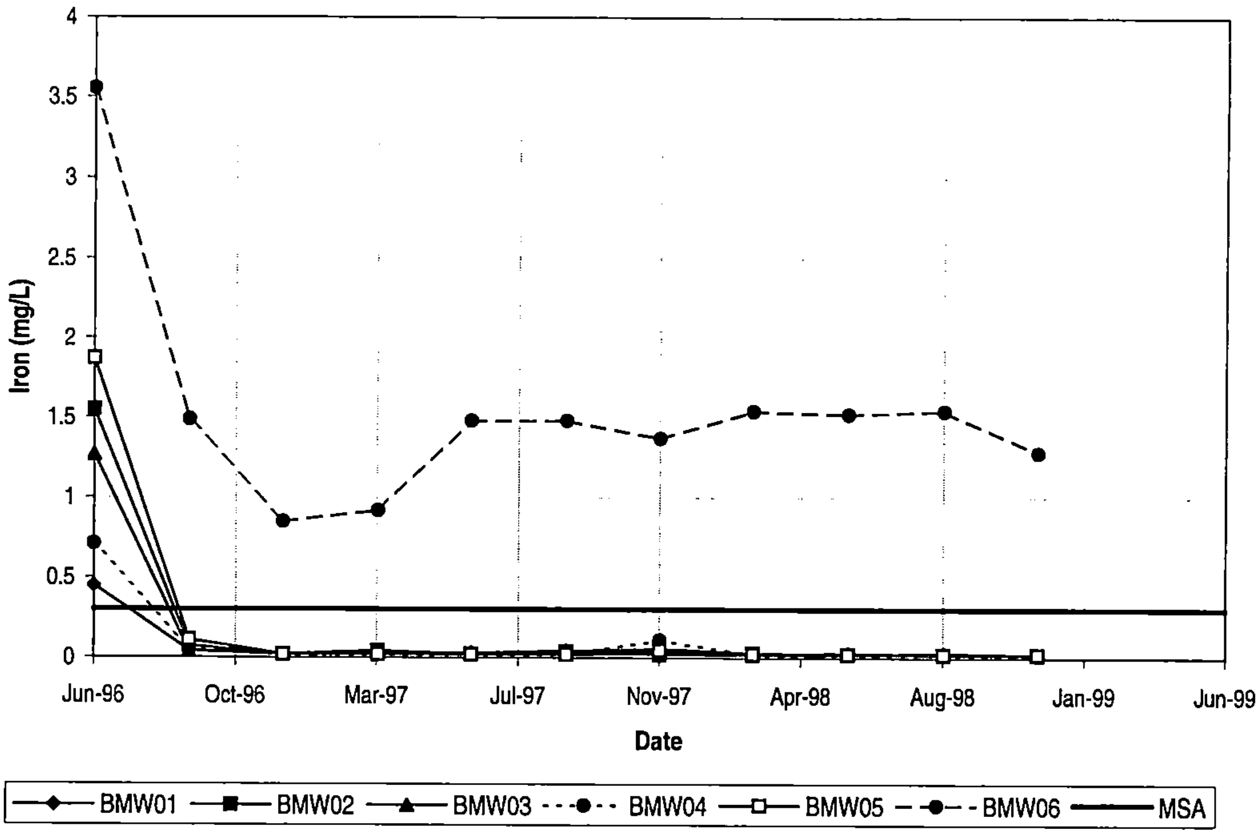
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Chromium (mg/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW15
BMW16
BMW17
BMW18
BMW19
MSA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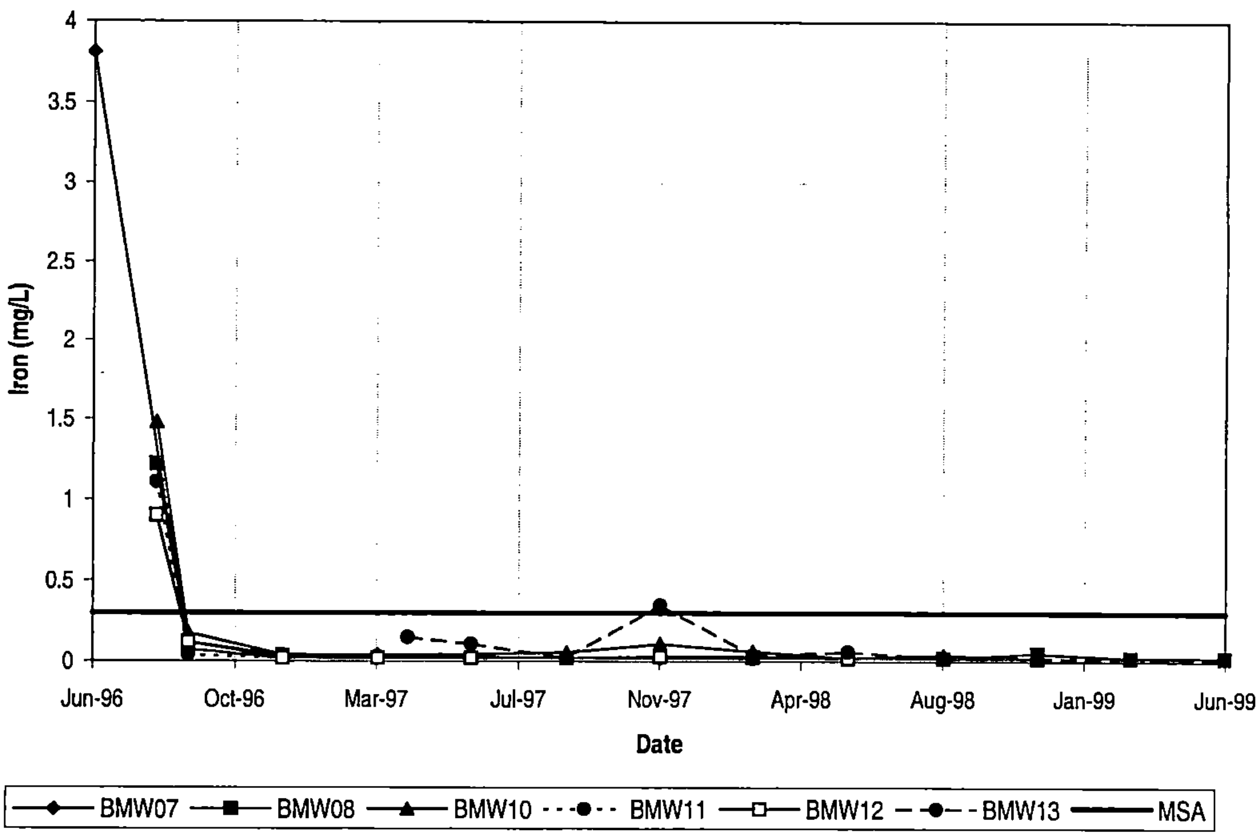
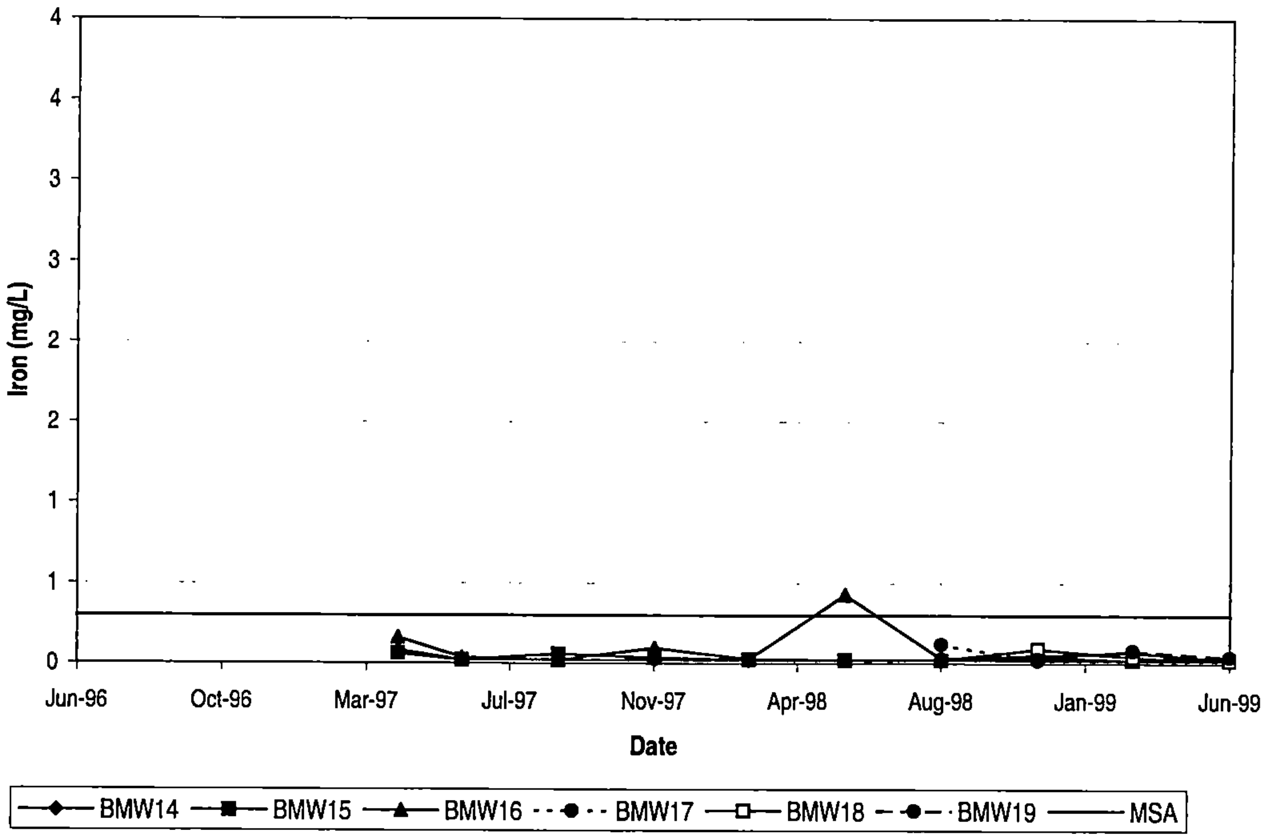
3
2.5
2
1.5
1
0.5
0
Iron (mg/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW01
BMW02
BMW03
BMW04
BMW05
BMW06
MSA


4
3.5
3
2.5
2
1.5
1
0.5
0
Iron (mg/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW07
BMW08
BMW10
BMW11
BMW12
BMW13
MSA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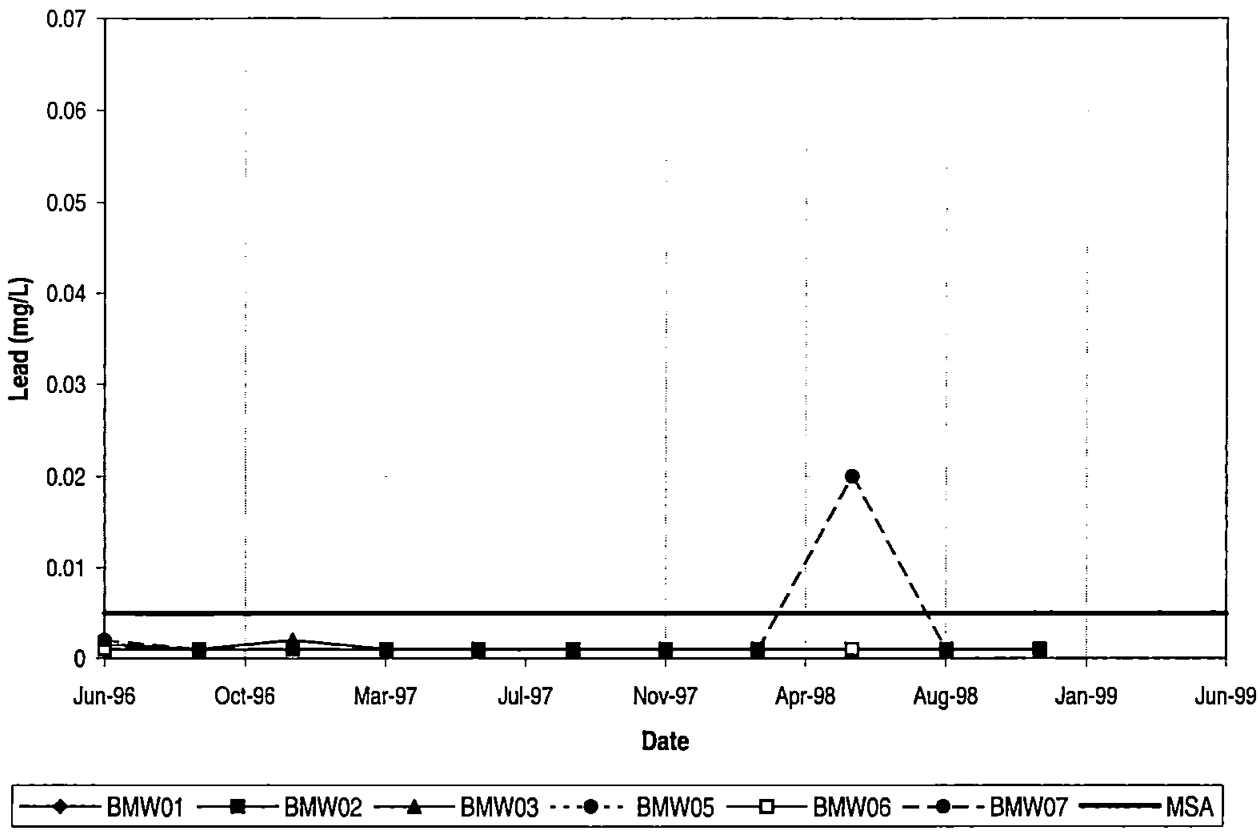
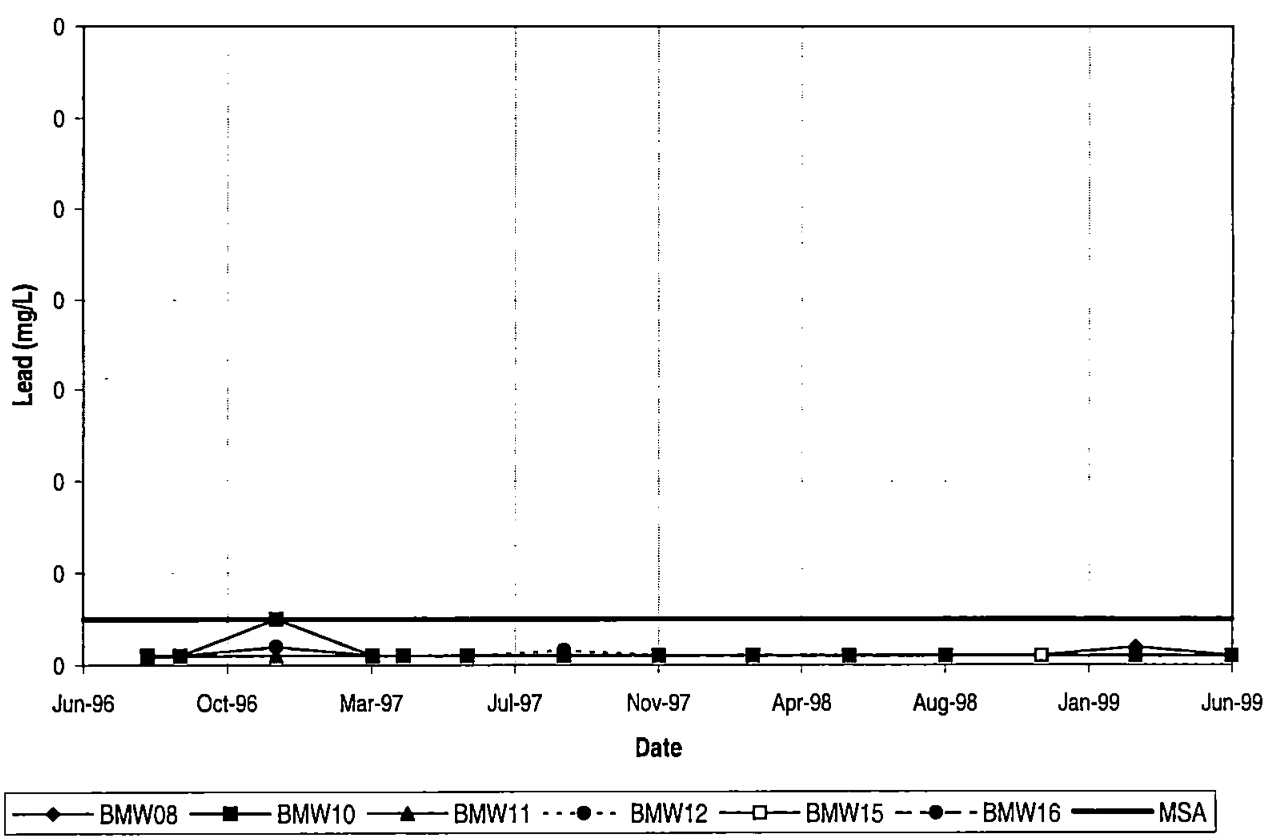
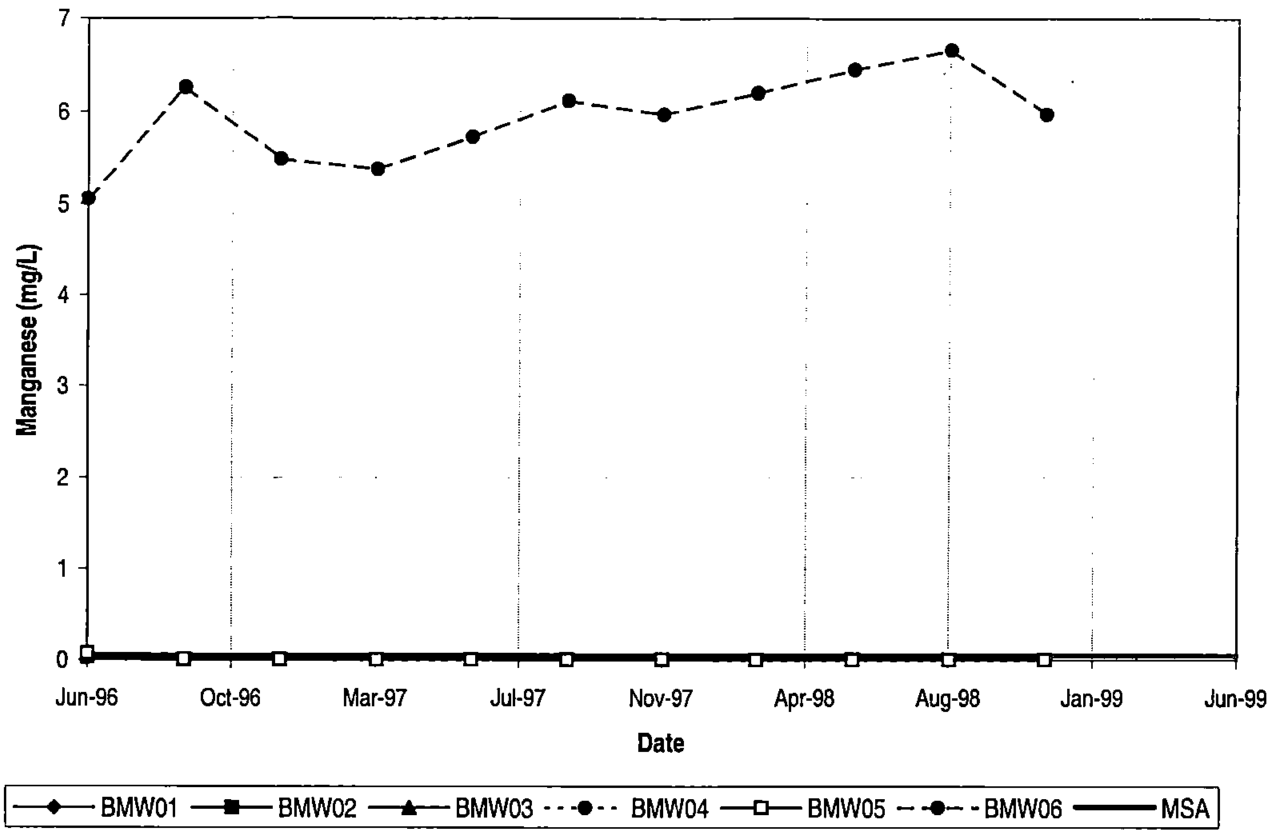
4
3
3
2
2
1
1
0
Iron (mg/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
MSA

BAINBRIDGE ISLAND LANDFILL FS REPORT
MONITORING WELL TIME SERIES PLOTS



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6
5
4
3
2
1
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Oct-96
Mar-97
Jul-97
Nov-97
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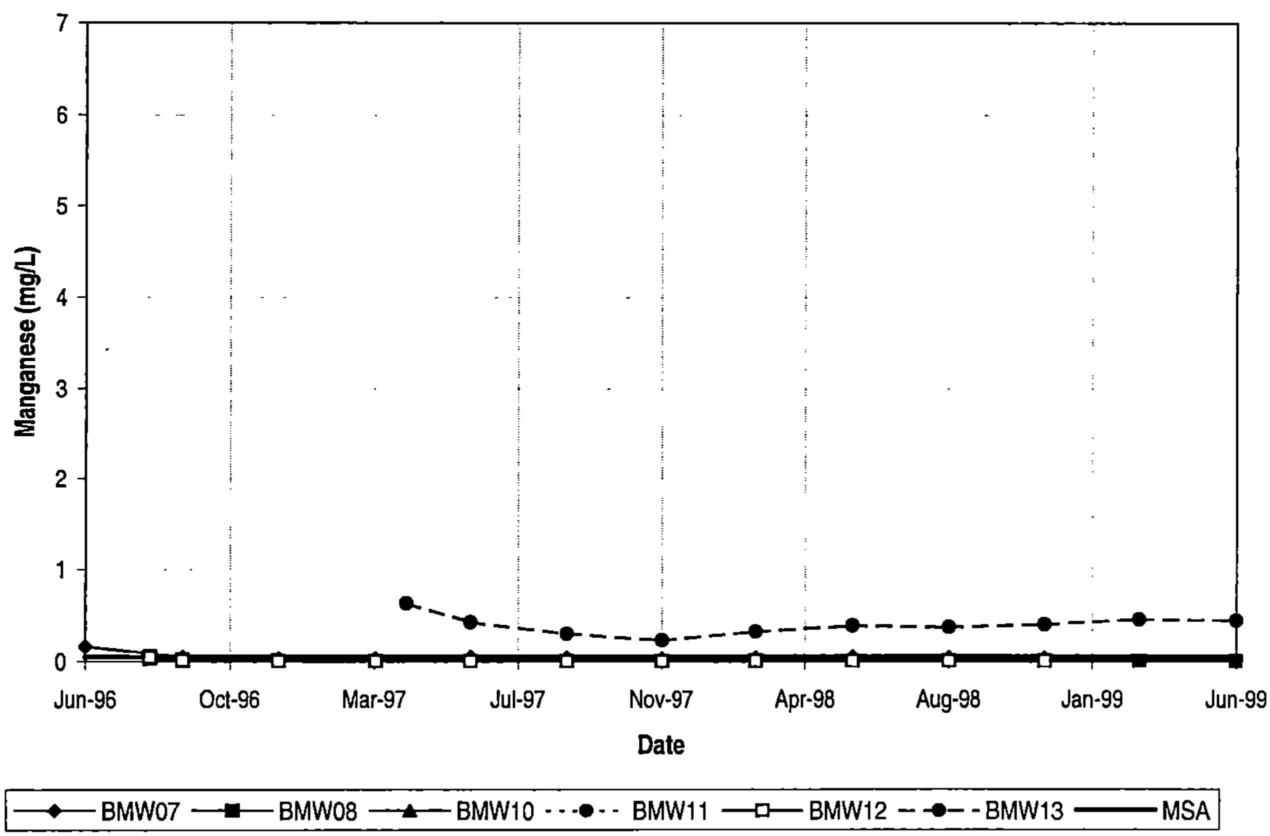
BMW04
BMW05
BMW06
MSA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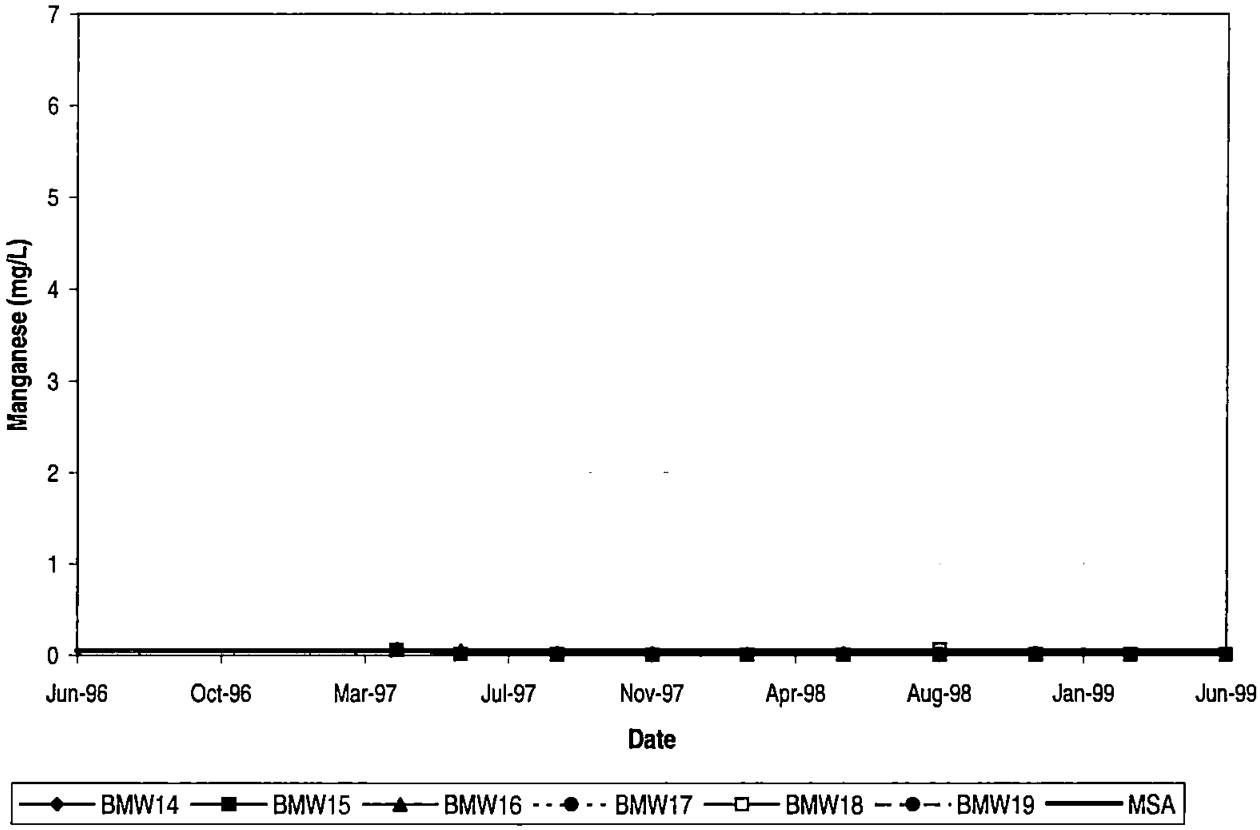
6
5
4
3
2
1
0
Manganese (mg/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW07
BMW08
BMW10
BMW11
BMW12
BMW13
MSA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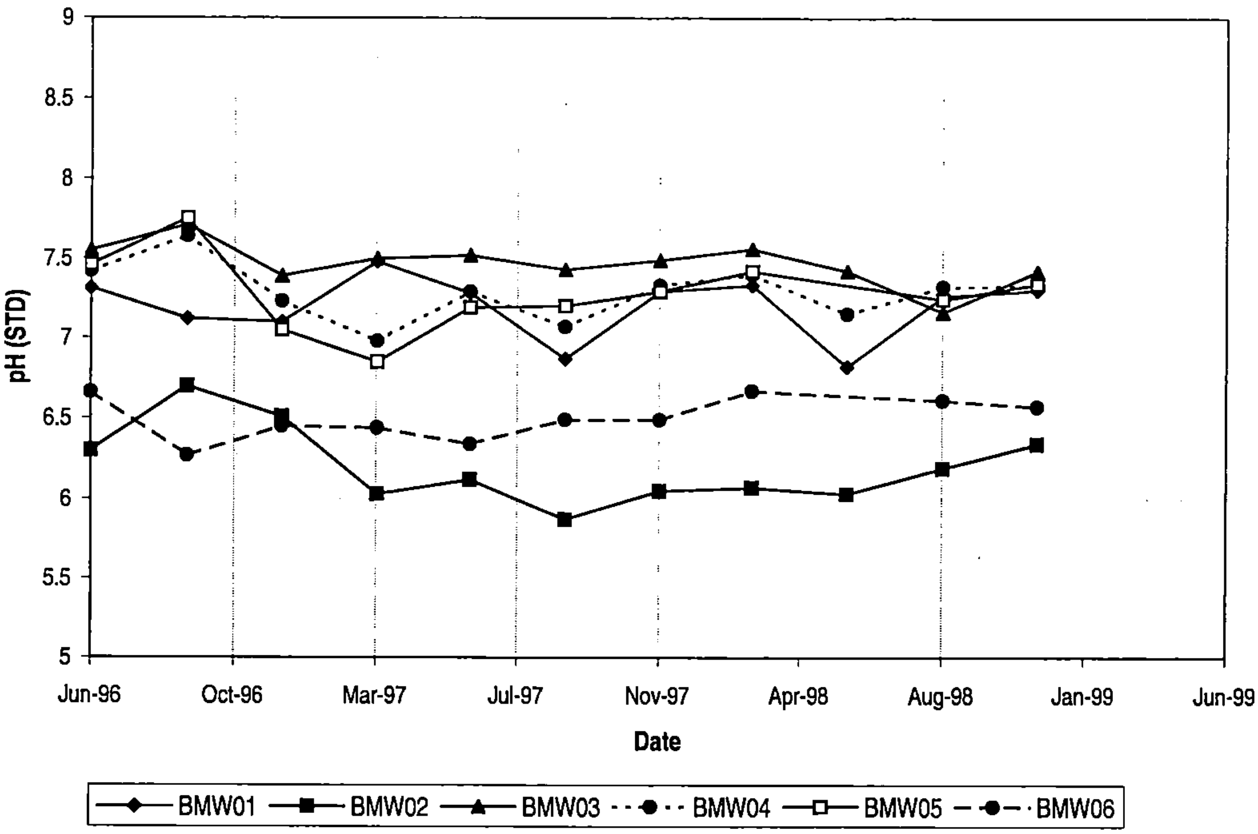
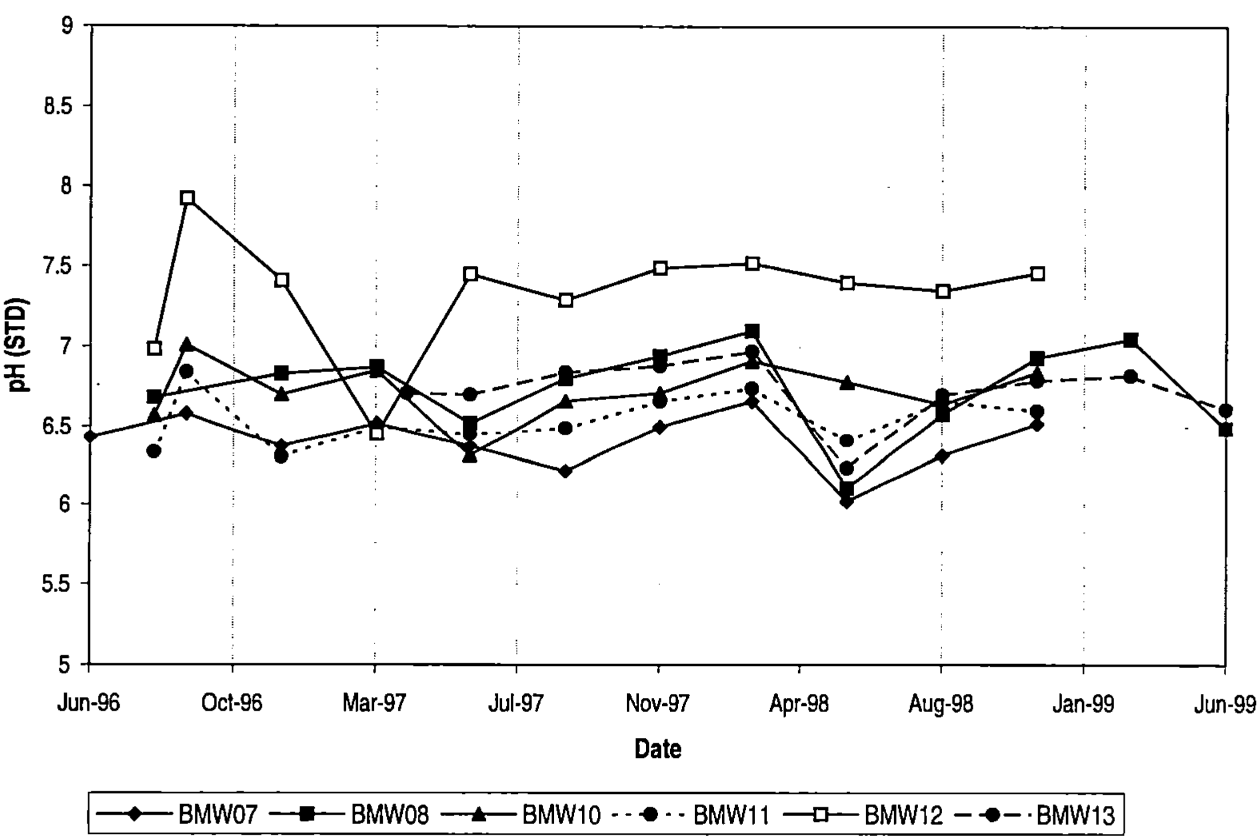
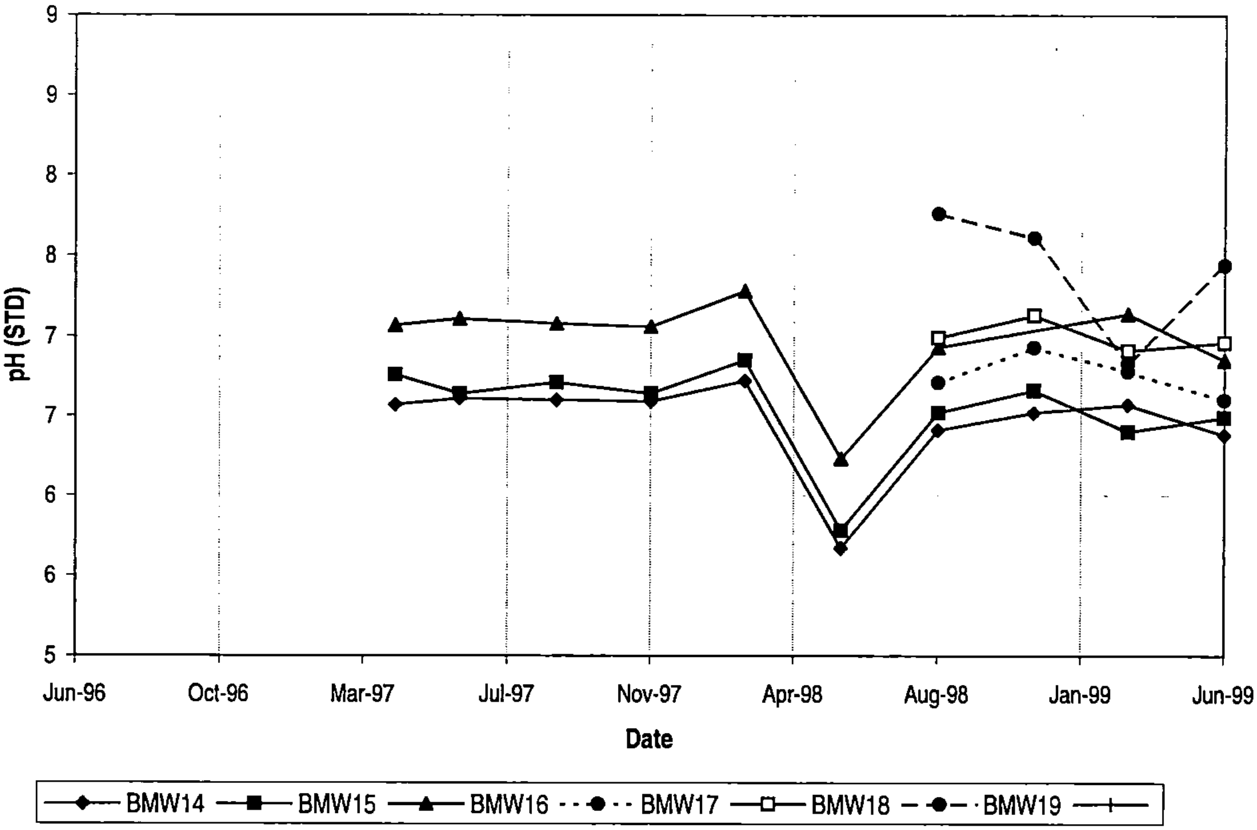
6
5
4
3
2
1
0
Manganese (mg/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
MSA

BAINBRIDGE ISLAND LANDFILL FS REPORT
MONITORING WELL TIME SERIES PLOTS



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9
8
8
7
7
6
6
5
pH (STD)
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Oct-96
Mar-97
Jul-97
Nov-97
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Jan-99
Jun-99
Date
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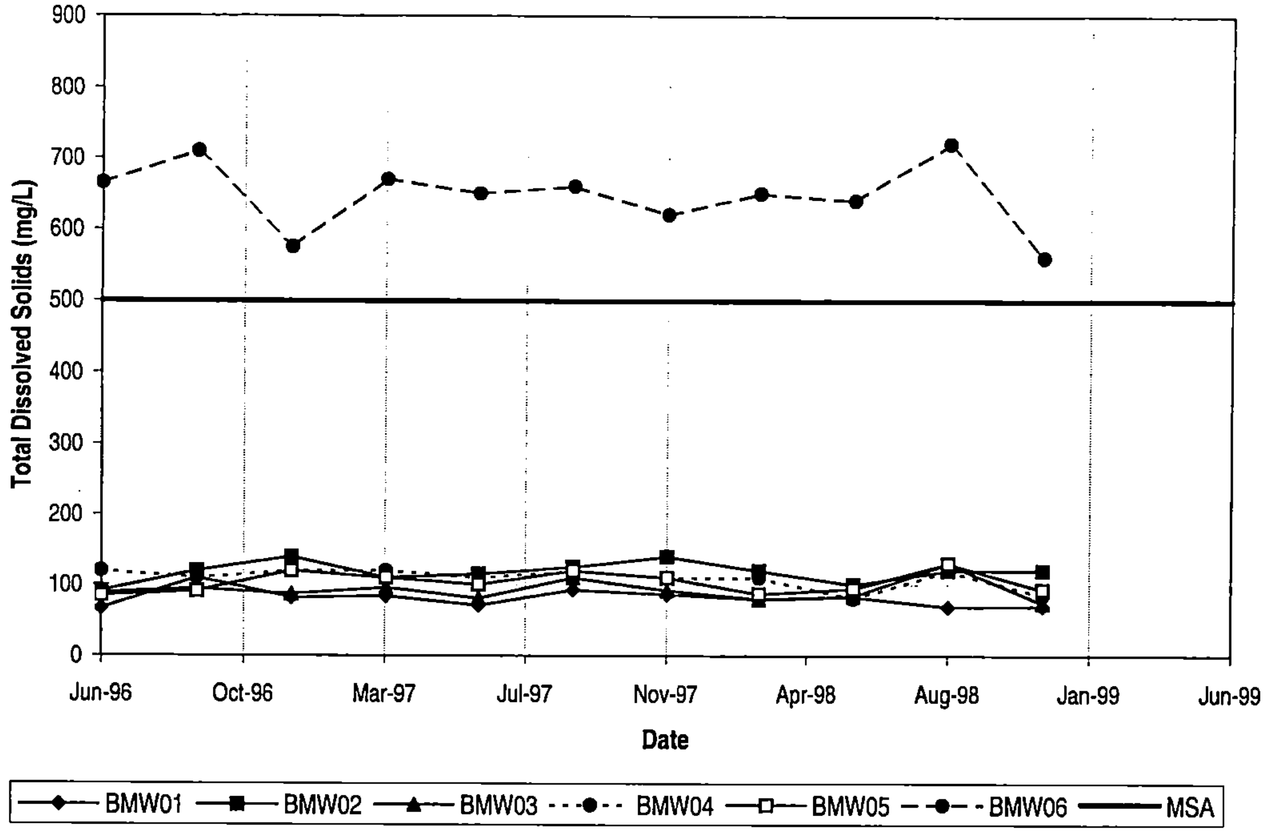
BMW15
BMW16
BMW17
BMW18
BMW19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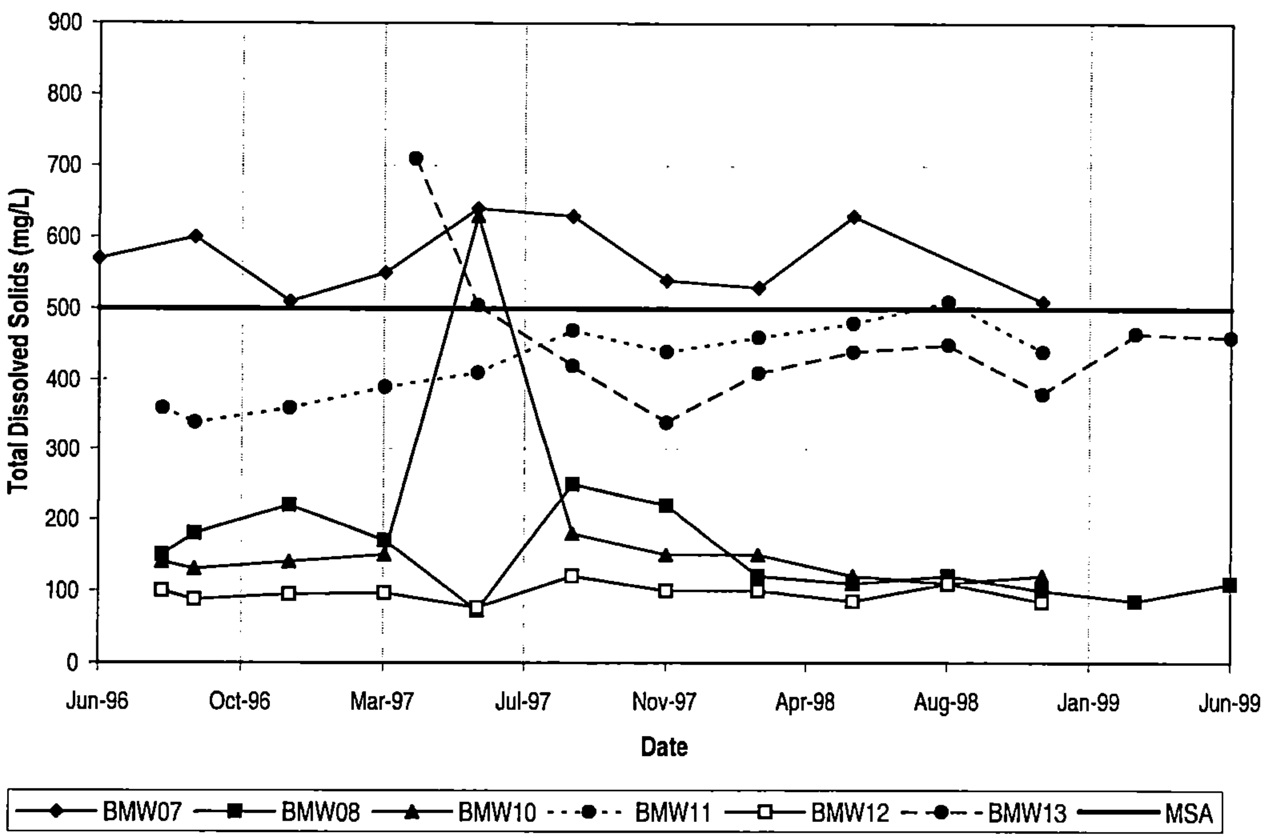
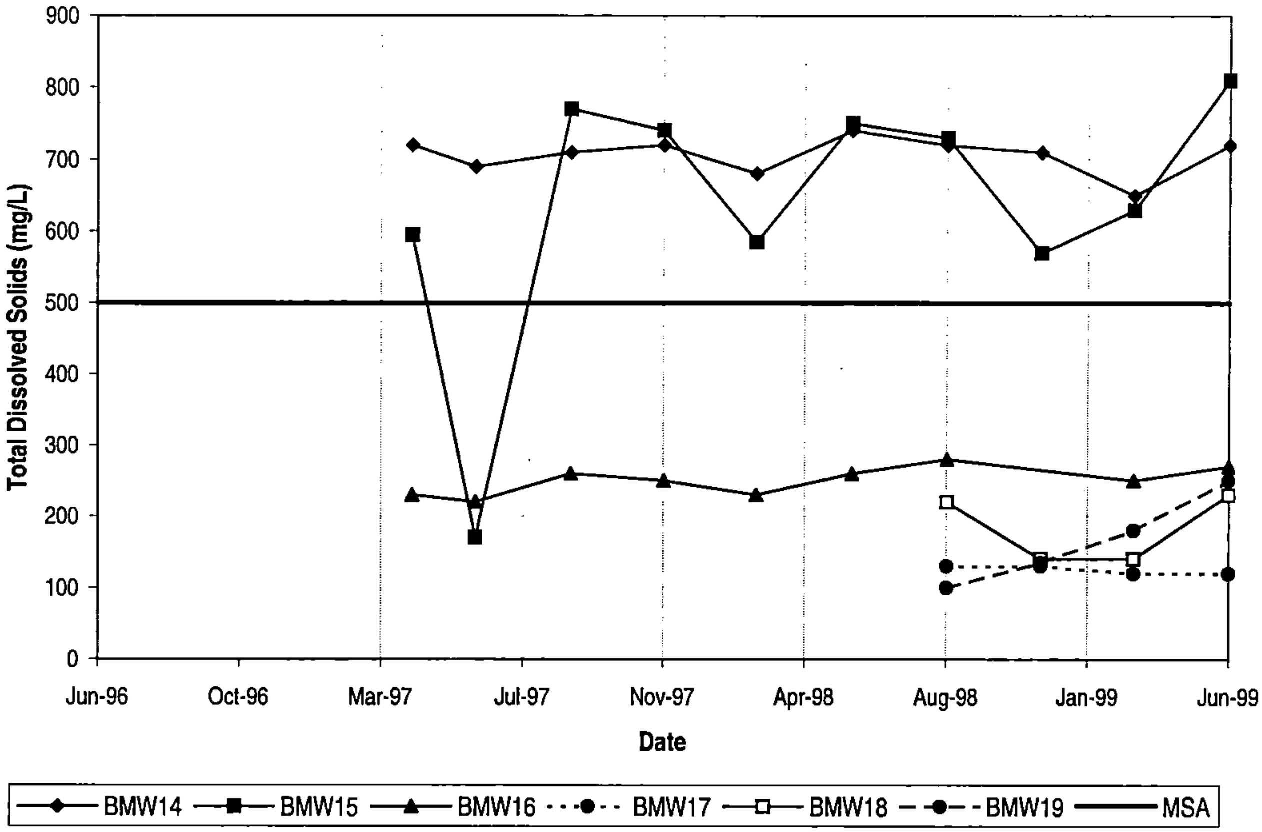
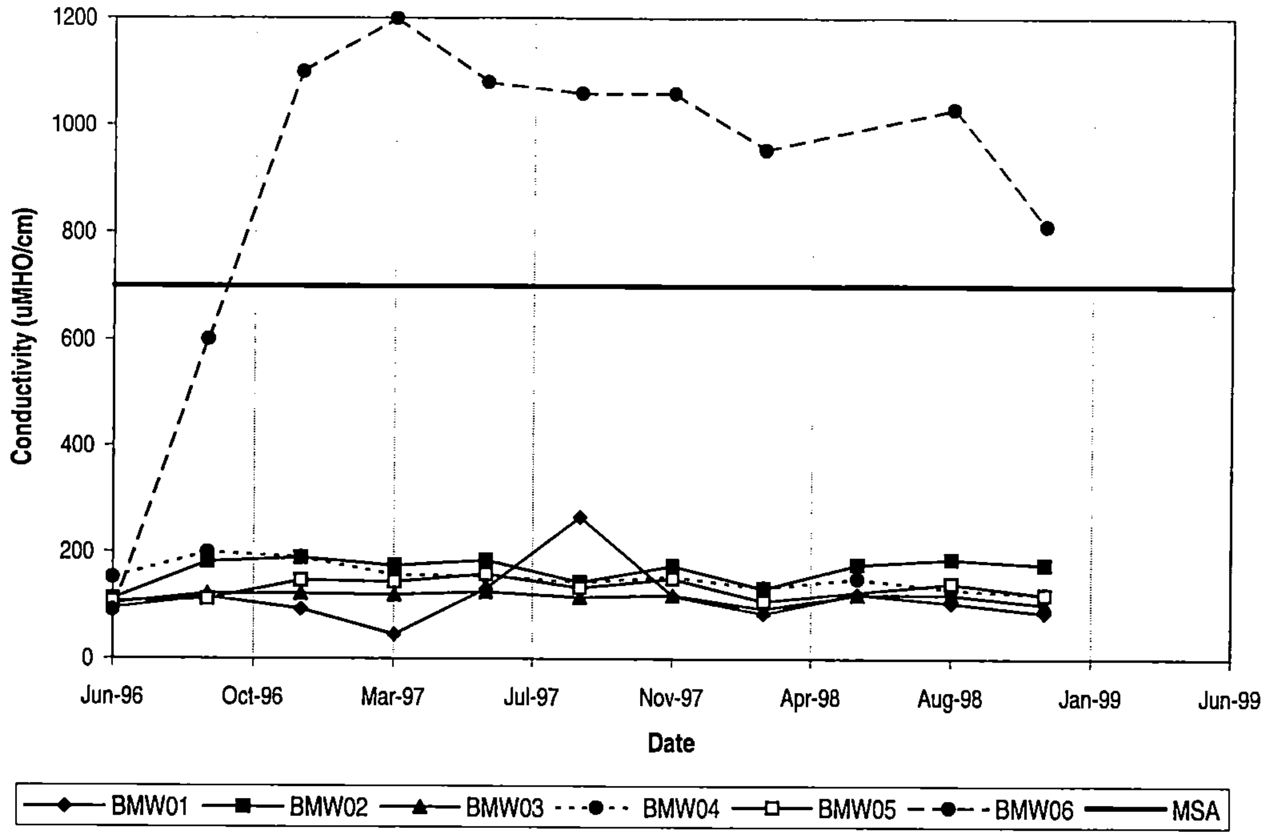
800
700
600
500
400
300
200
100
0
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW01
BMW02
BMW03
BMW04
BMW05
BMW06
MSA

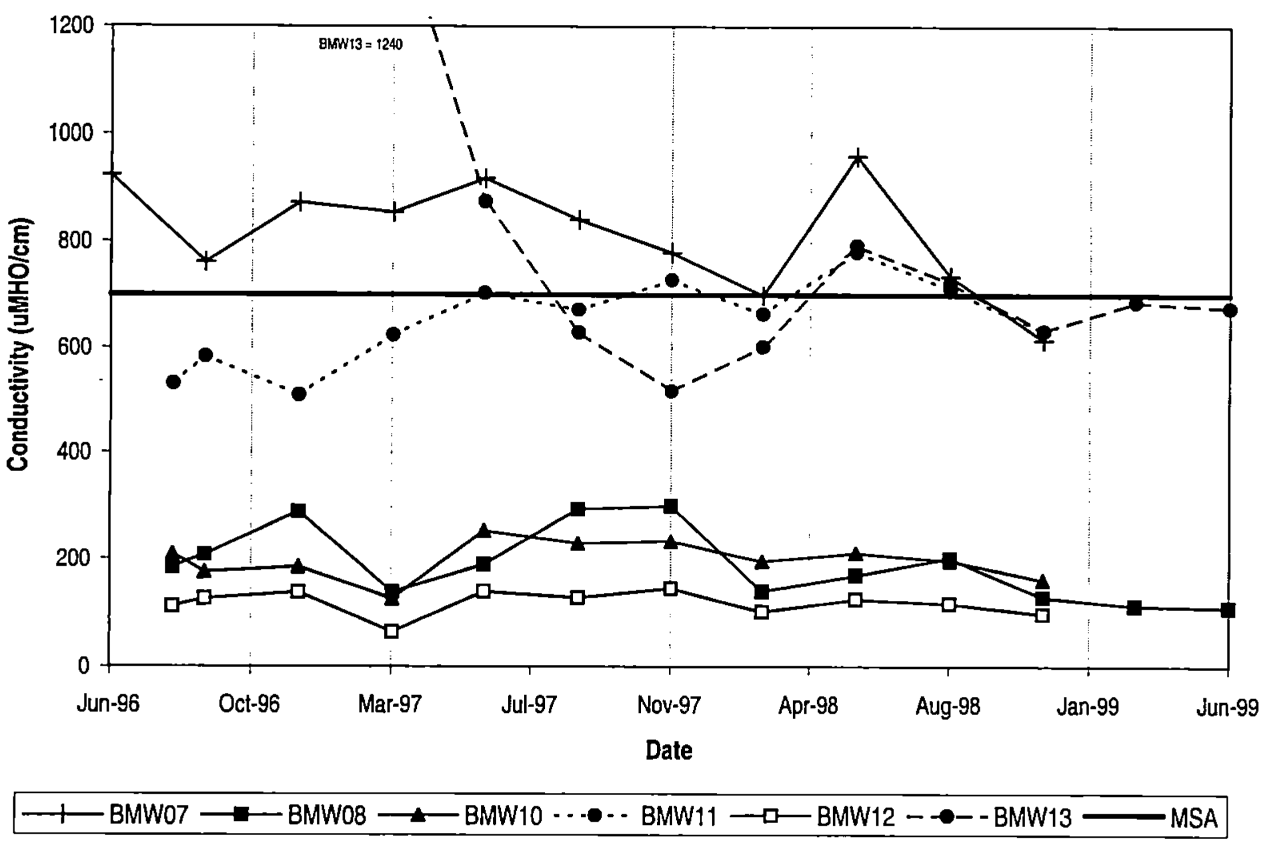

Total Dissolved Solids (mg/L)
900
800
700
600
500
400
300
200
100
0
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW07
BMW08
BMW10
BMW11
BMW12
BMW13
MSA

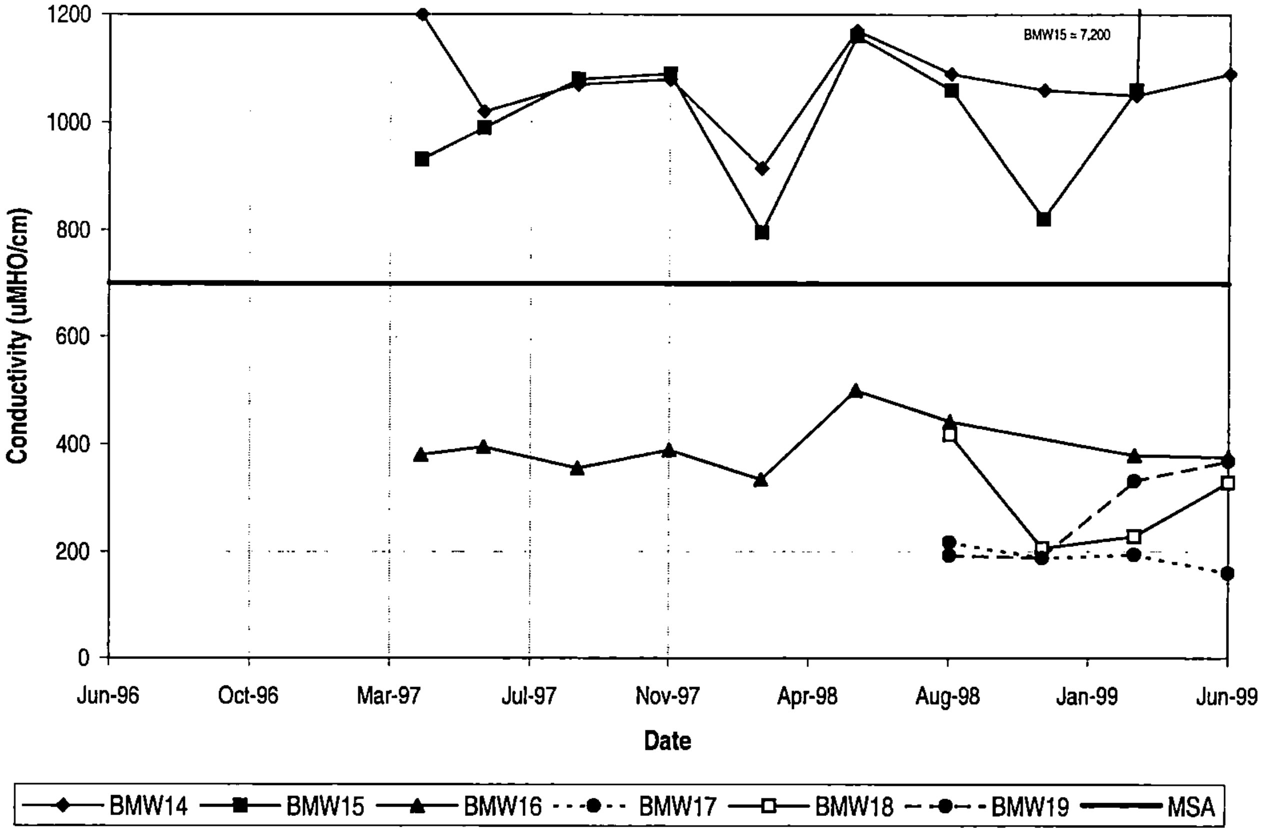
BAINBRIDGE ISLAND LANDFILL FS REPORT
MONITORING WELL TIME SERIES PLOTS

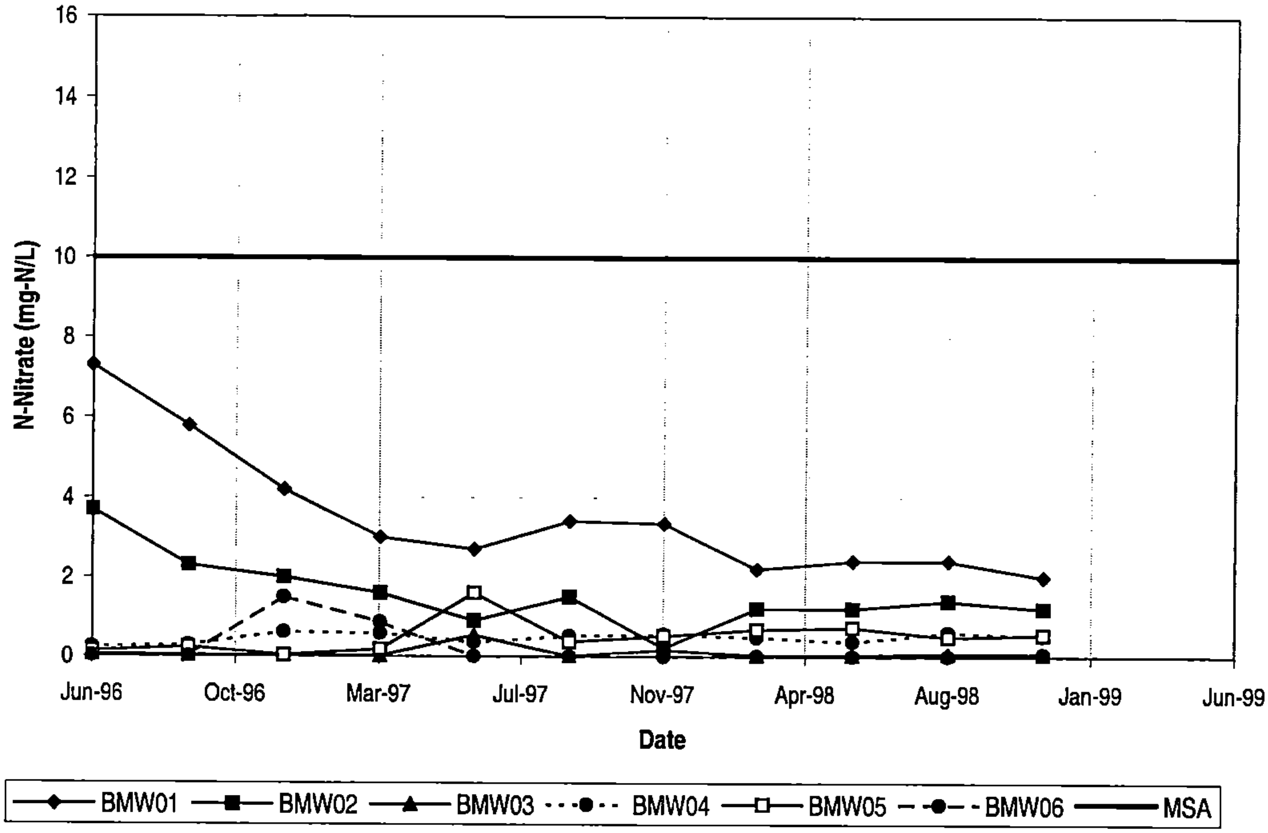


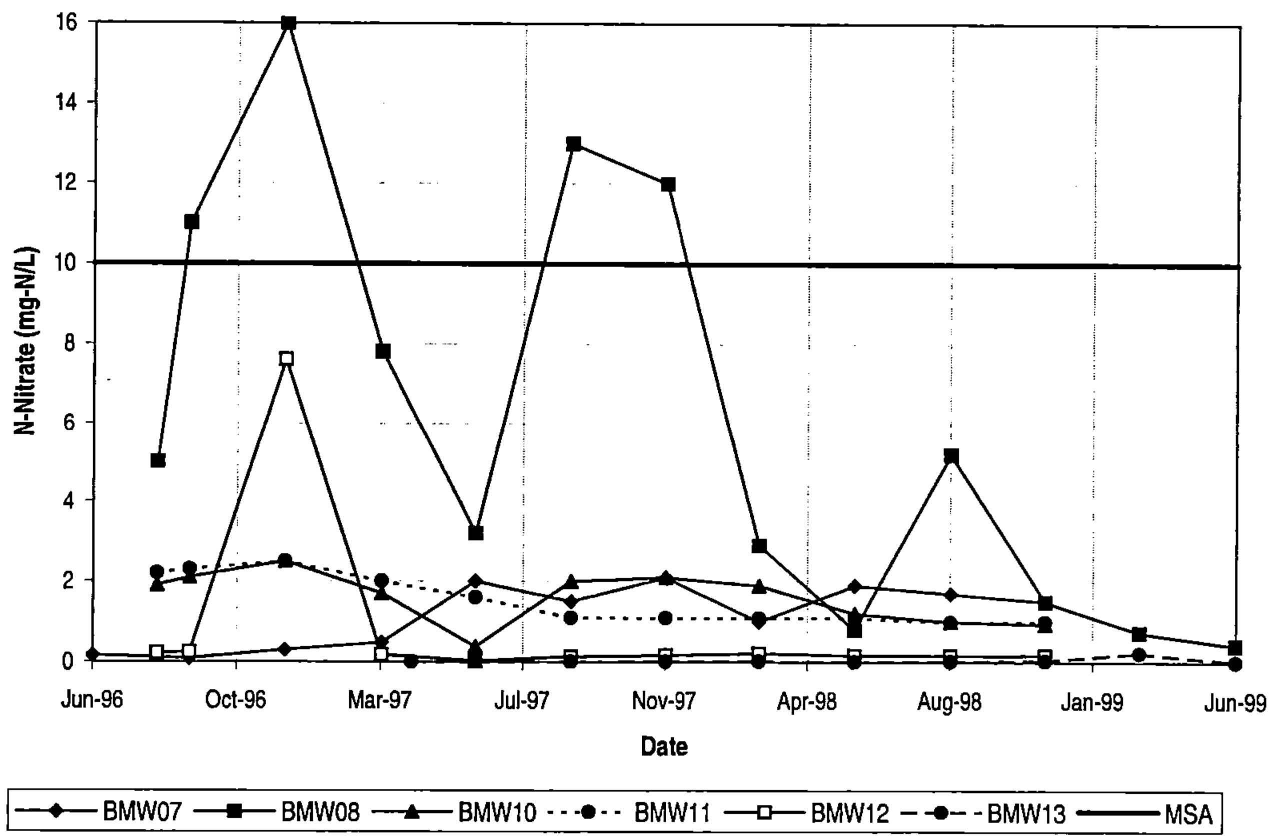
BAINBRIDGE ISLAND LANDFILL FS REPORT
MONITORING WELL TIME SERIES PLOTS

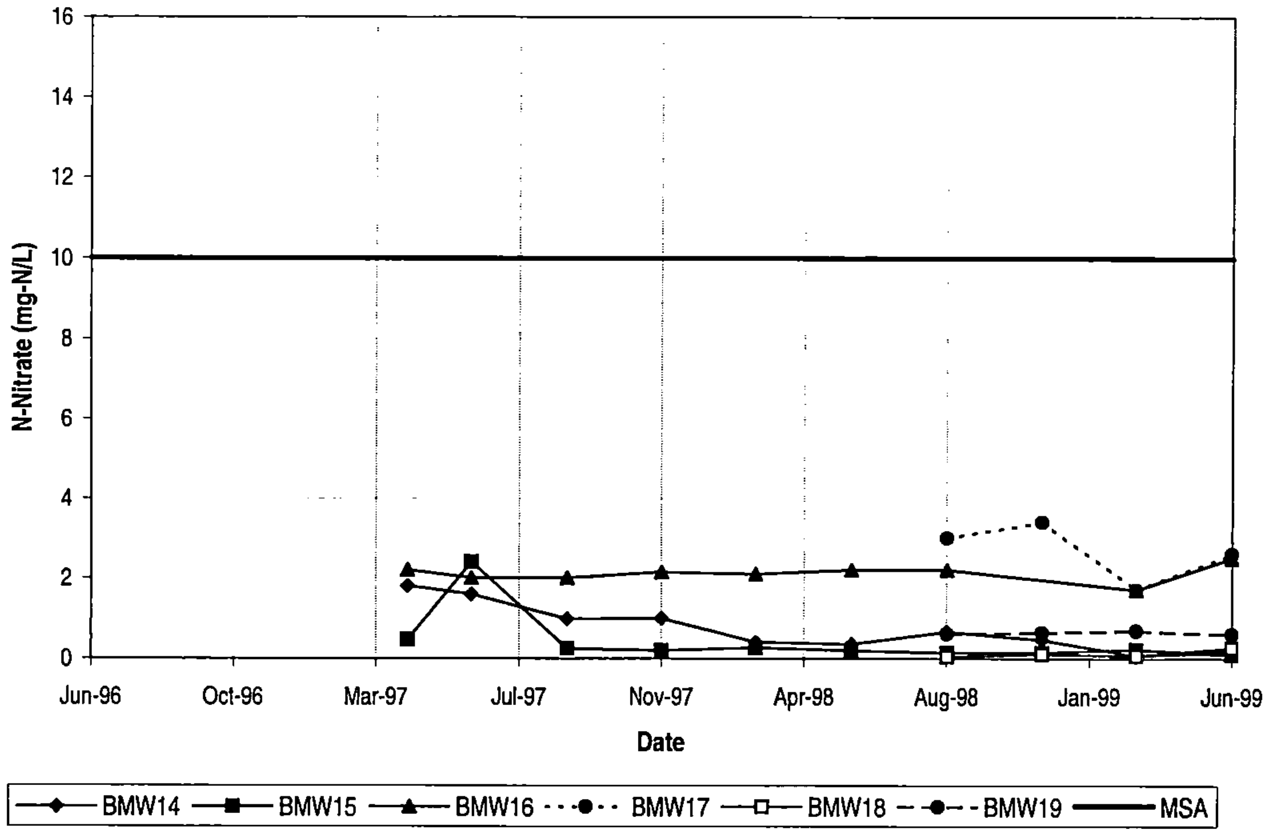


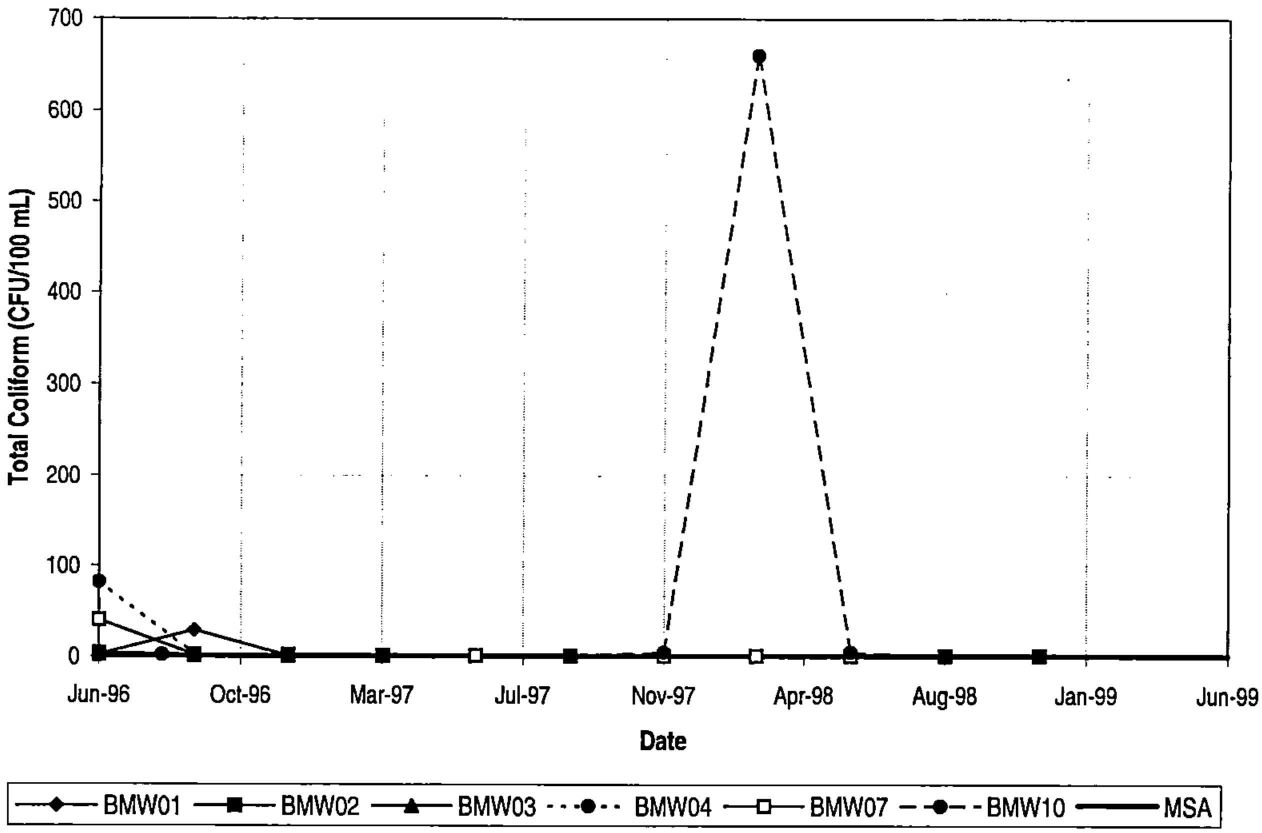


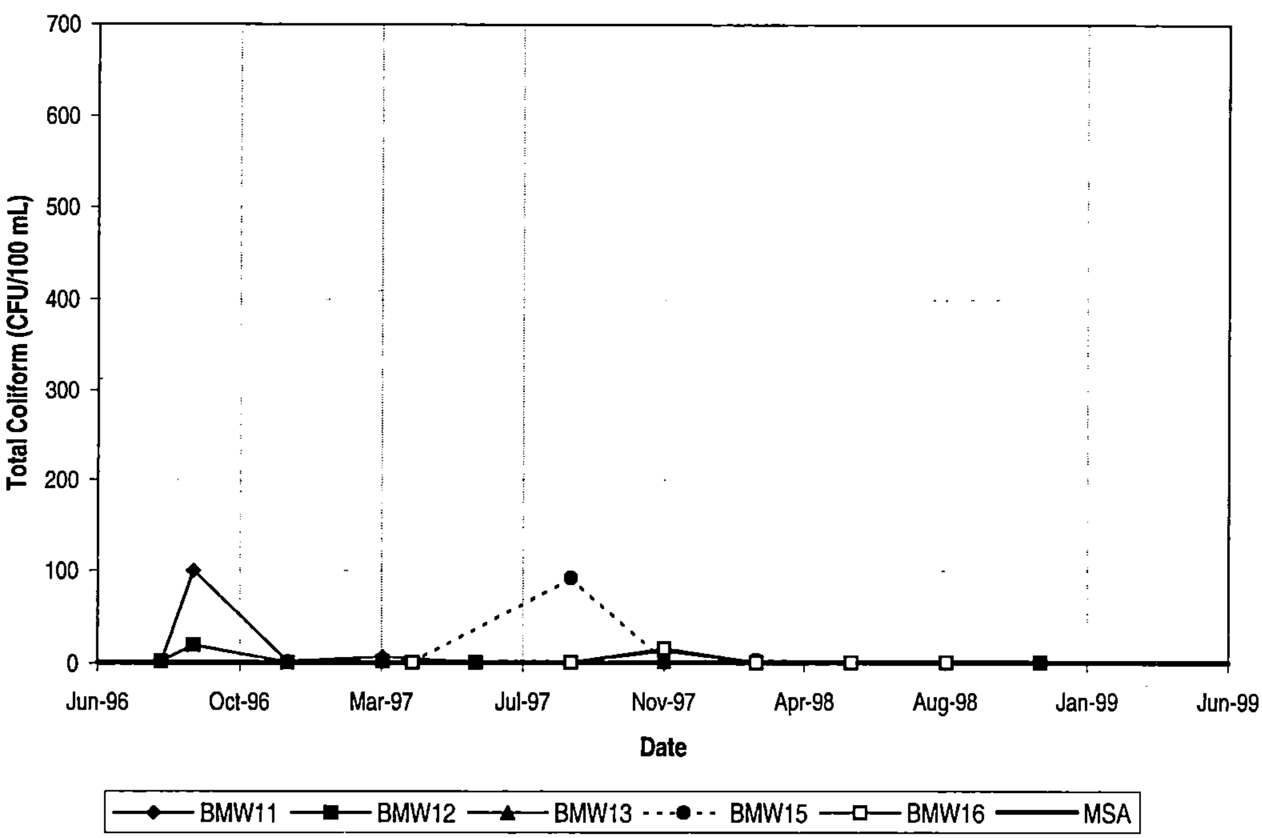

BMW15 = 7,200
1200
1000
800
600
400
200
0
Conductivity (uMHO/cm)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
MSA


16
14
12
10
8
6
4
2
0
N-Nitrate (mg-N/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW01
BMW02
BMW03
BMW04
BMW05
BMW06
MSA


16
14
12
10
8
6
4
2
0
N-Nitrate (mg-N/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW07
BMW08
BMW10
BMW11
BMW12
BMW13
MSA

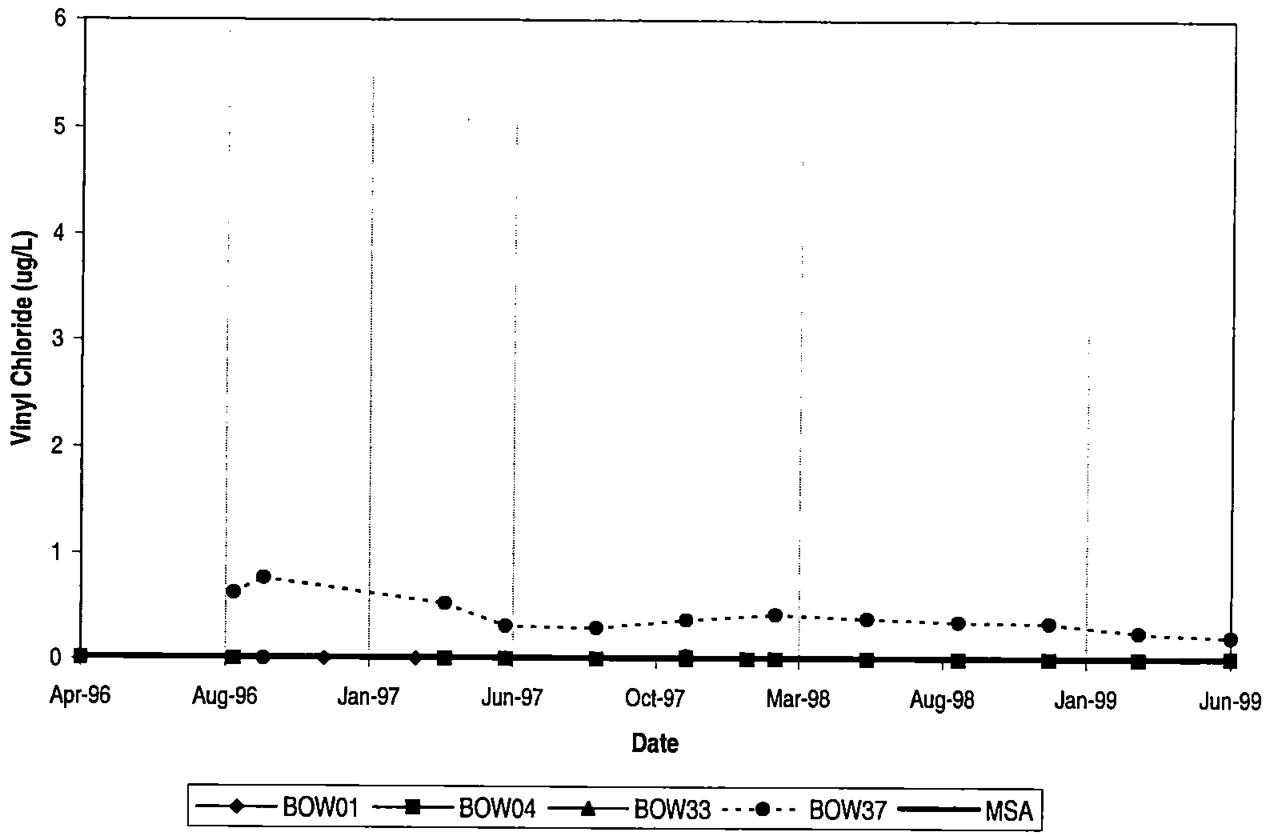

16
14
12
10
8
6
4
2
0
N-Nitrate (mg-N/L)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
MSA

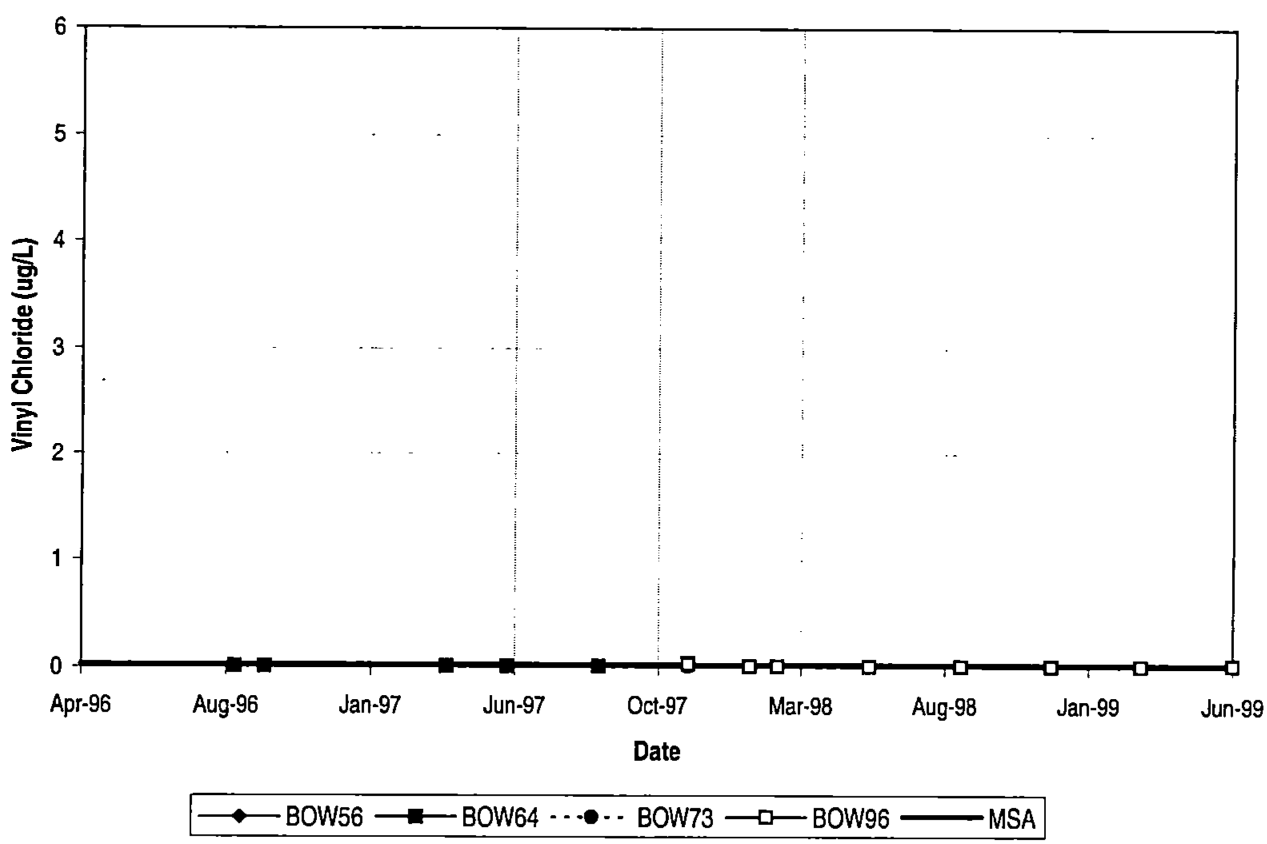

700
600
500
400
300
200
100
0
Total Coliform (CFU/100 mL)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW01
BMW02
BMW03
BMW04
BMW07
BMW10
MSA

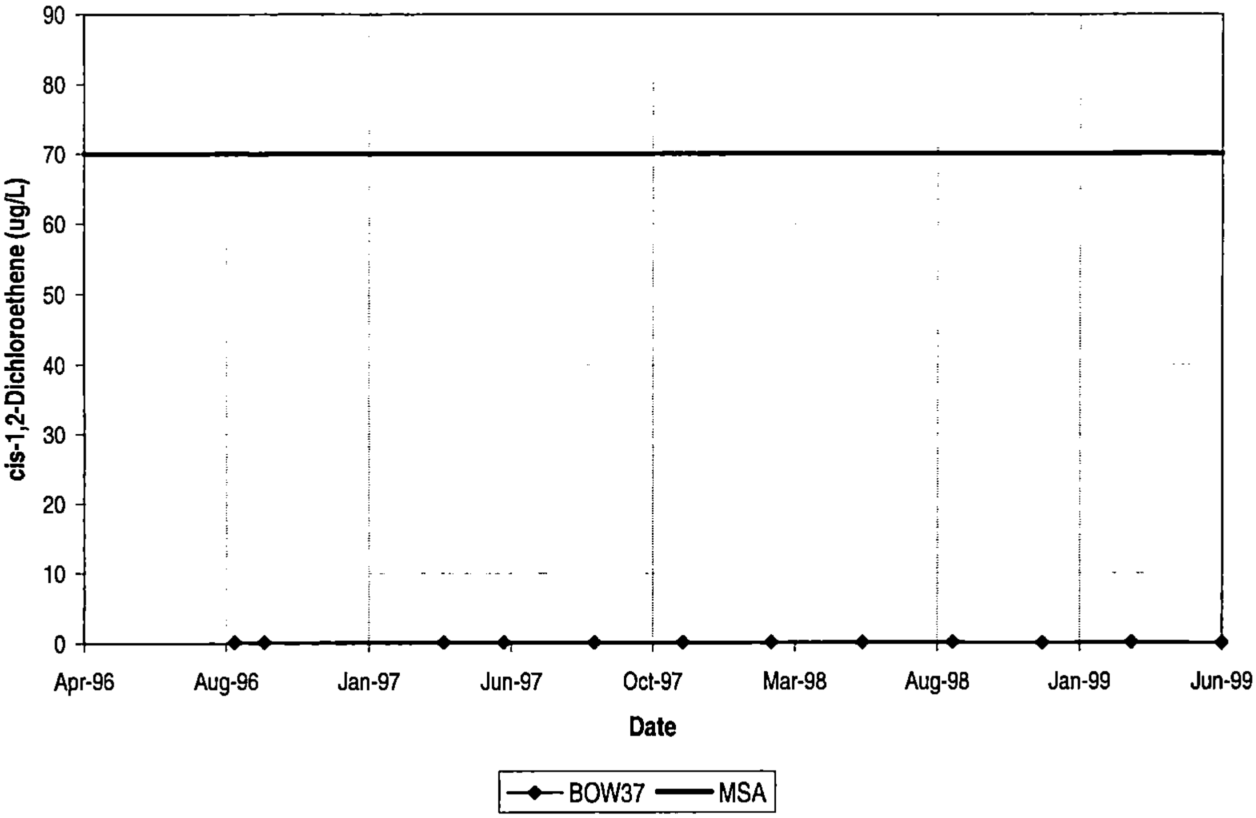

700
600
500
400
300
200
100
0
Total Coliform (CFU/100 mL)
Jun-96
Oct-96
Mar-97
Jul-97
Nov-97
Apr-98
Aug-98
Jan-99
Jun-99
Date
BMW11
BMW12
BMW13
BMW15
BMW16
MSA

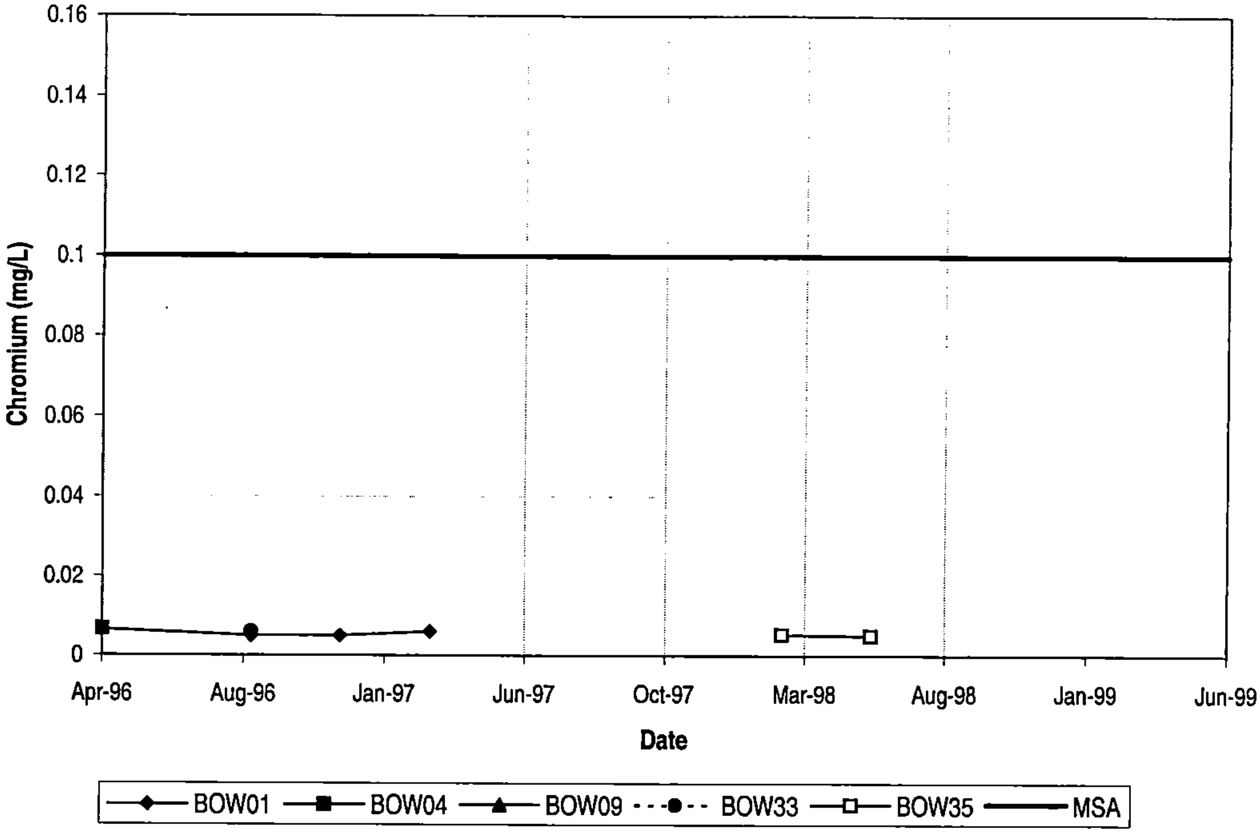
Domestic Wells

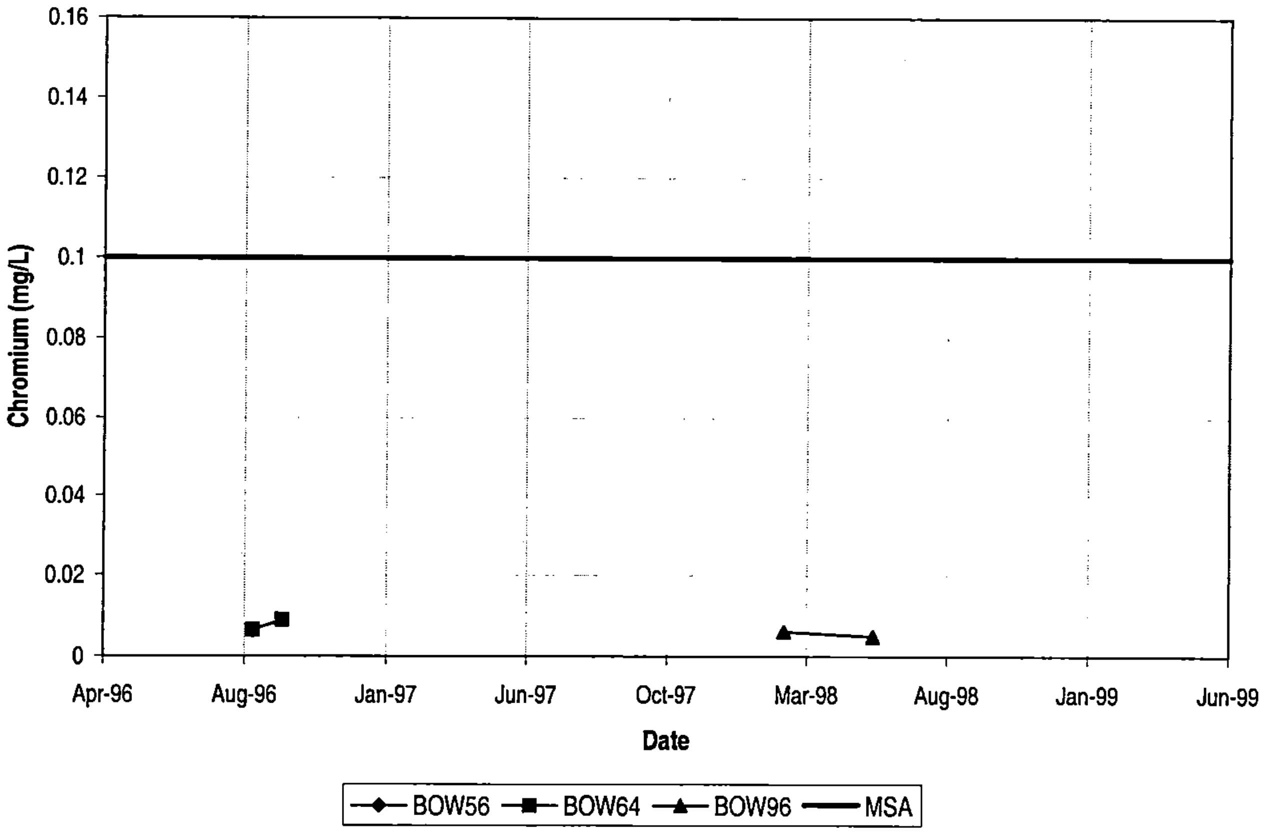
BAINBRIDGE ISLAND LANDFILL FS REPORT
DOMESTIC WELL TIME SERIES PLOTS

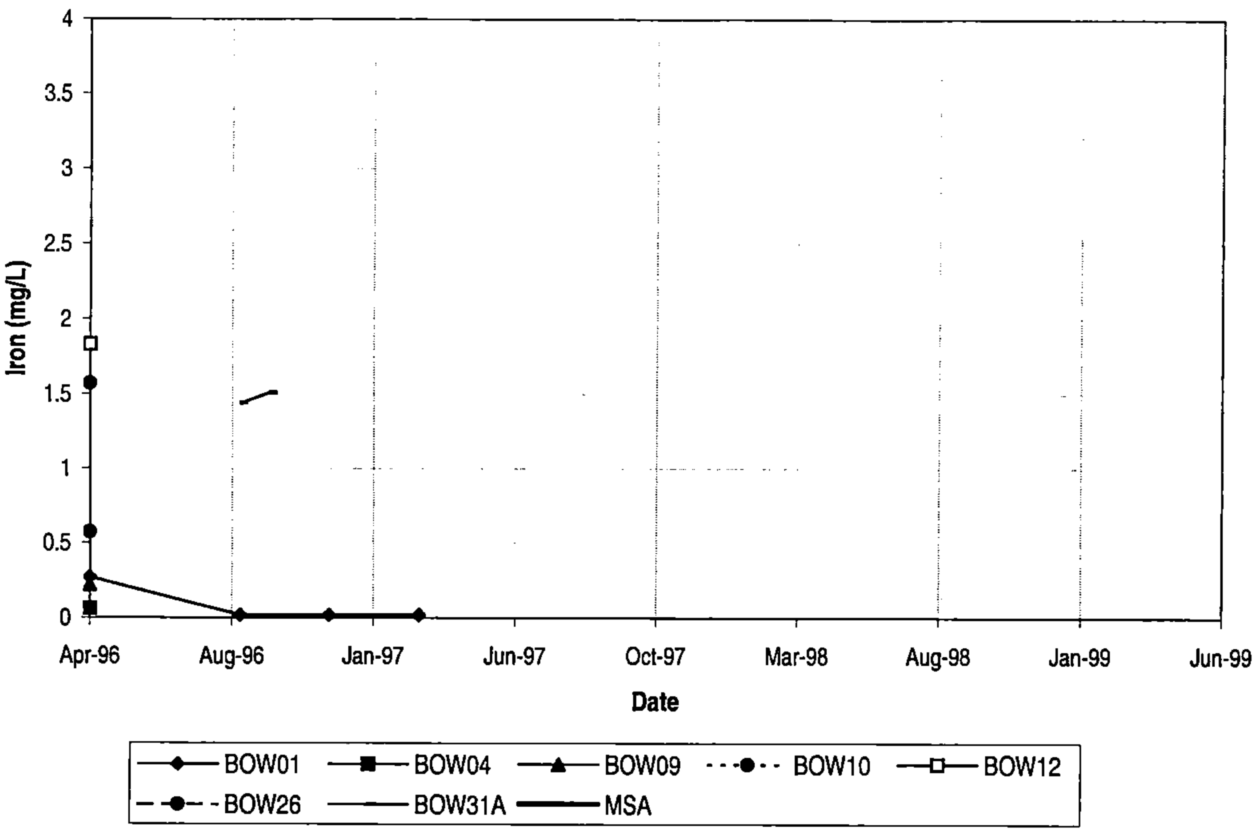


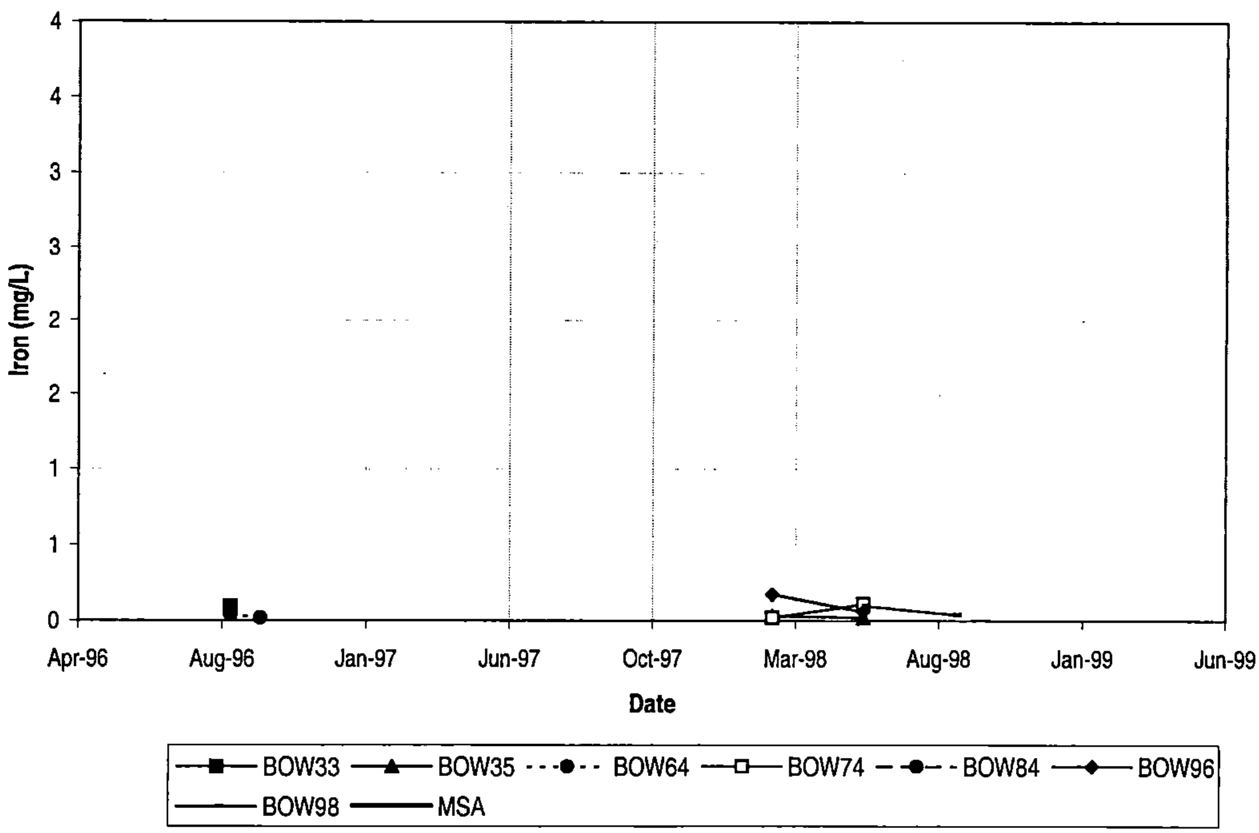



90
80
70
60
50
40
30
20
10
0
cis-1,2-Dichloroethene (ug/L)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW37
MSA

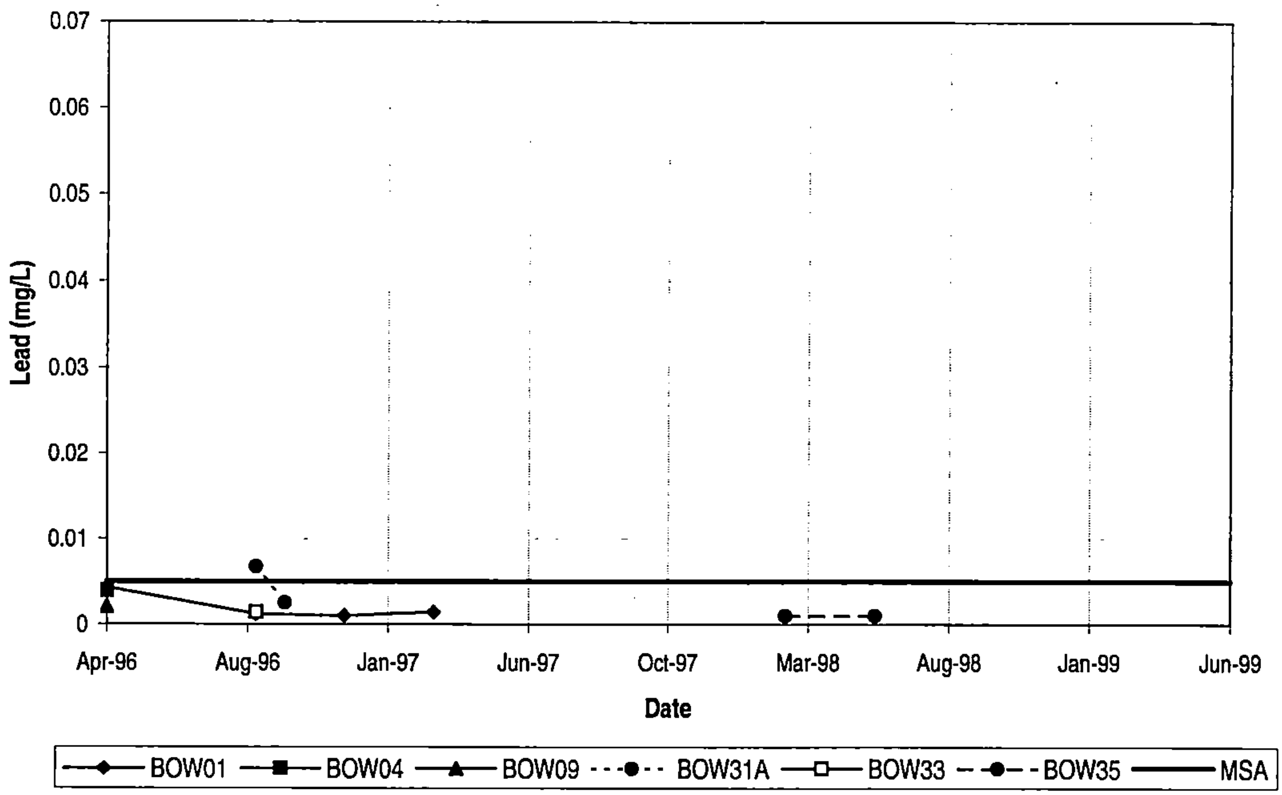

0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Chromium (mg/L)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW01
BOW04
BOW09
BOW33
BOW35
MSA

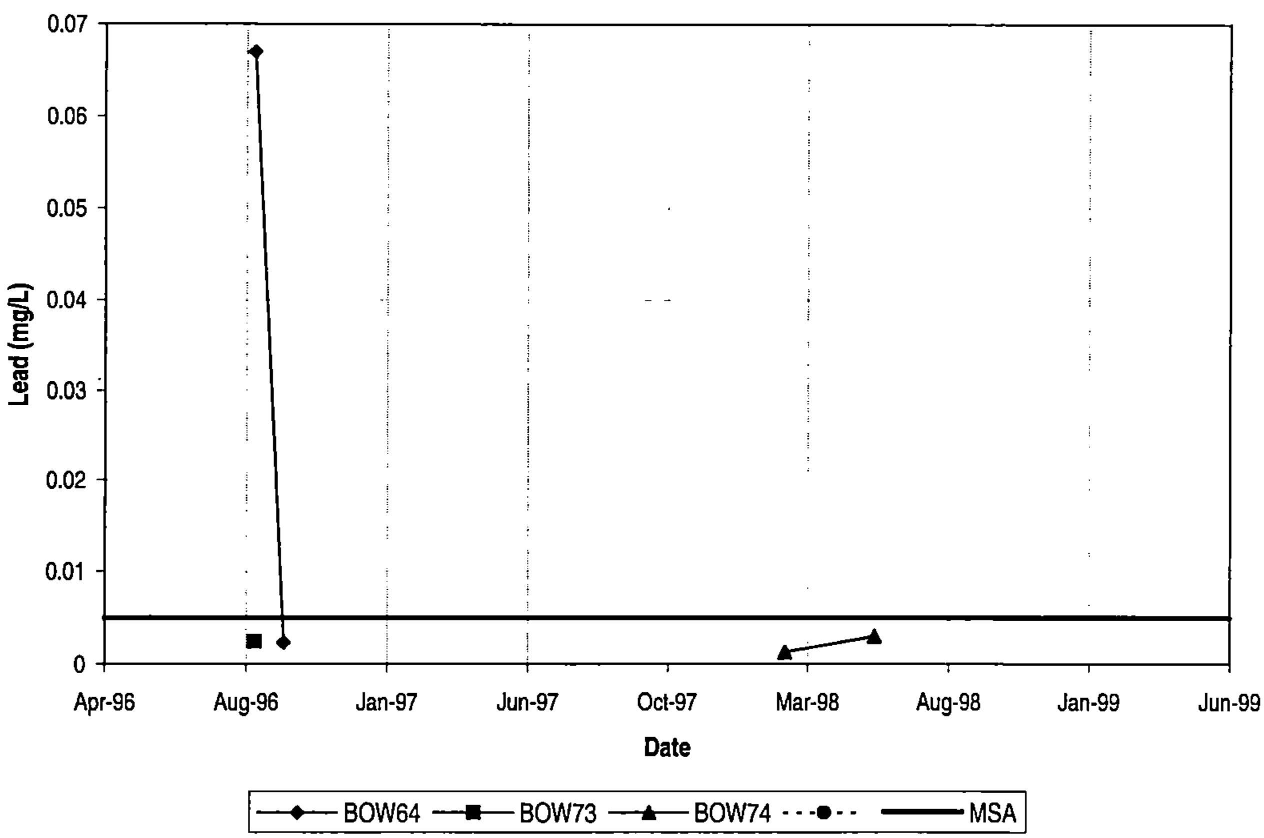

0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Chromium (mg/L)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW56
BOW64
BOW96
MSA

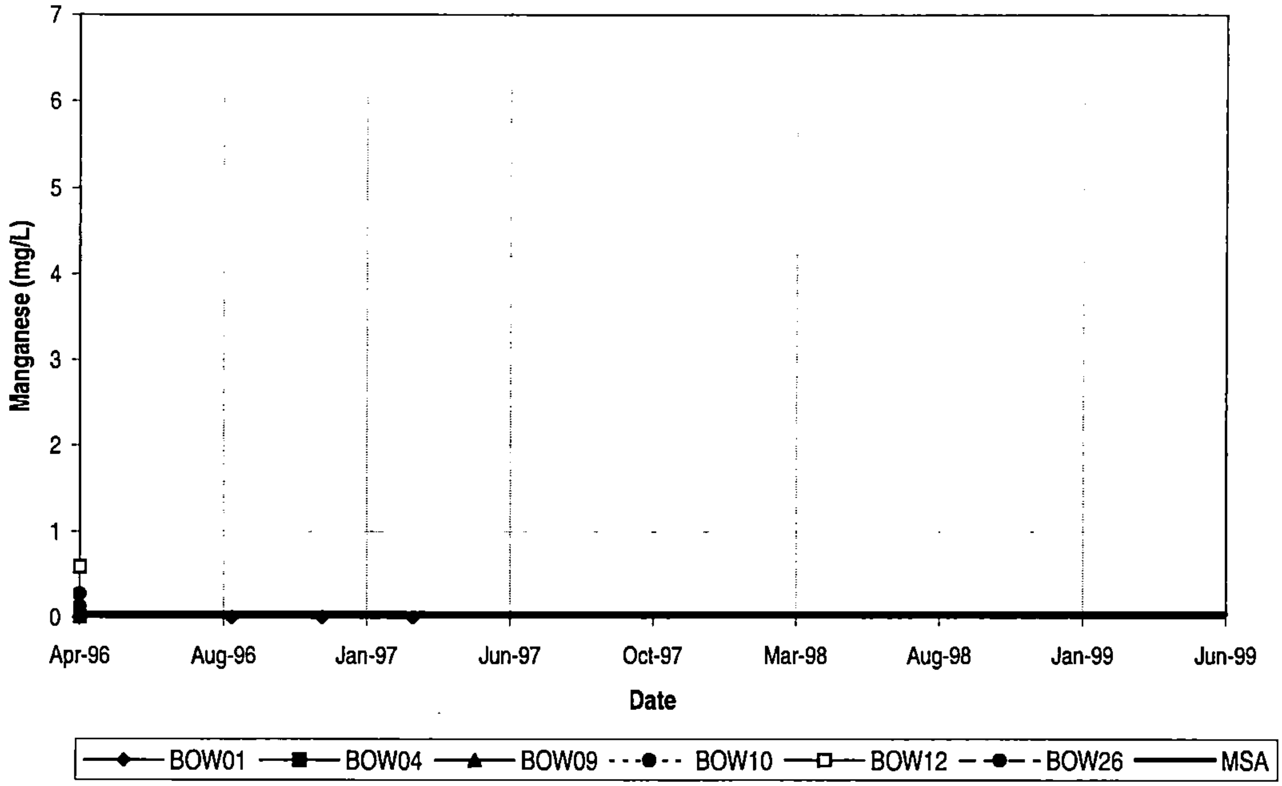

4
3.5
3
2.5
2
1.5
1
0.5
0
Iron (mg/L)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW01
BOW04
BOW09
BOW10
BOW12
BOW26
BOW31A
MSA

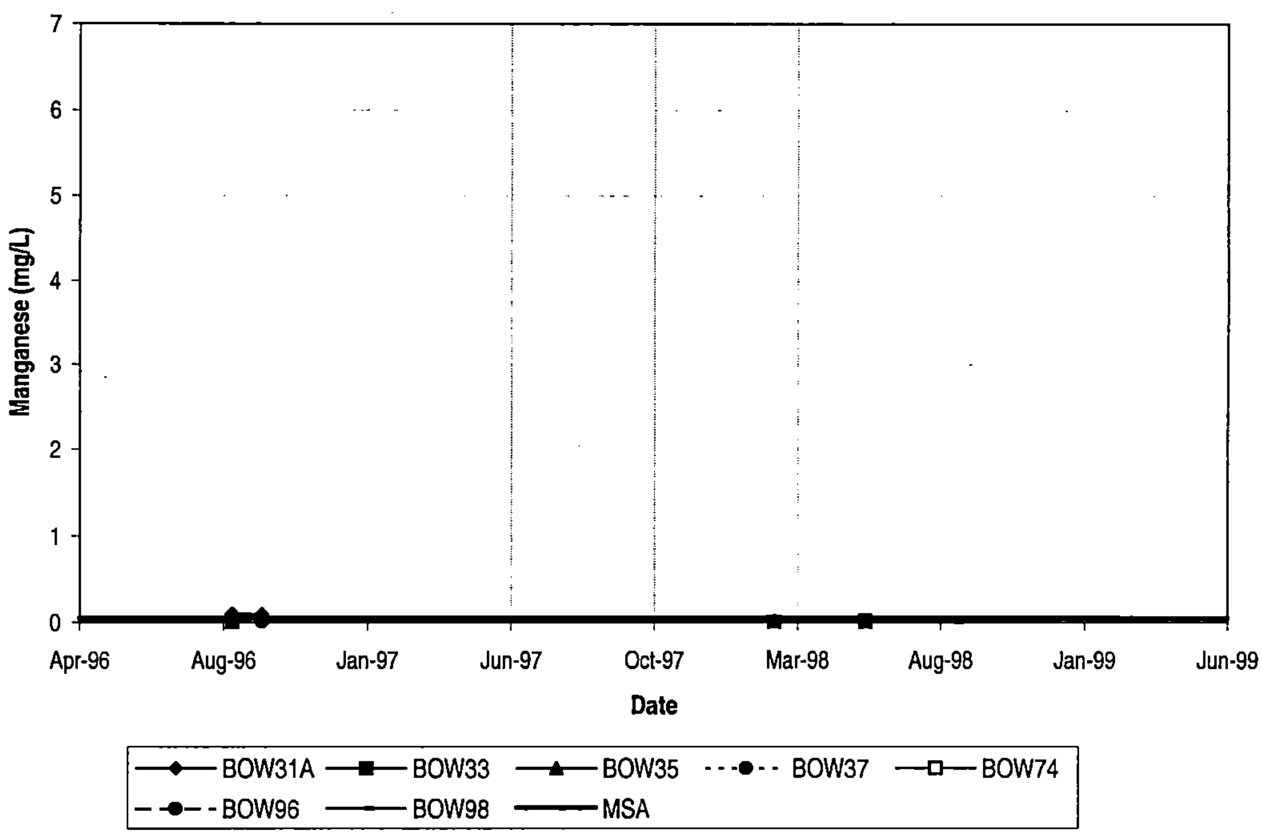

4
4
3
3
2
2
1
1
0
Iron (mg/L)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW33
BOW35
BOW64
BOW74
BOW84
BOW96
BOW98
MSA

BAINBRIDGE ISLAND LANDFILL FS REPORT
DOMESTIC WELL TIME SERIES PLOTS

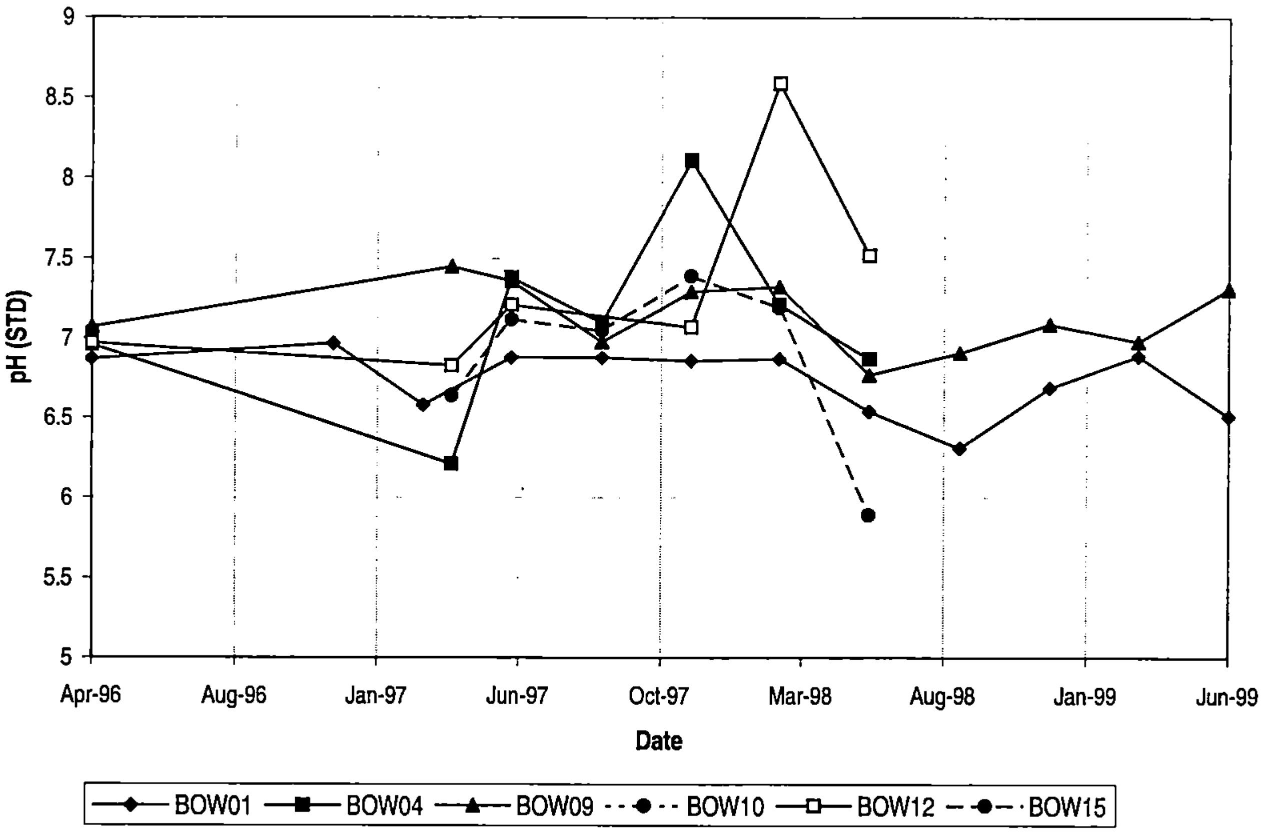


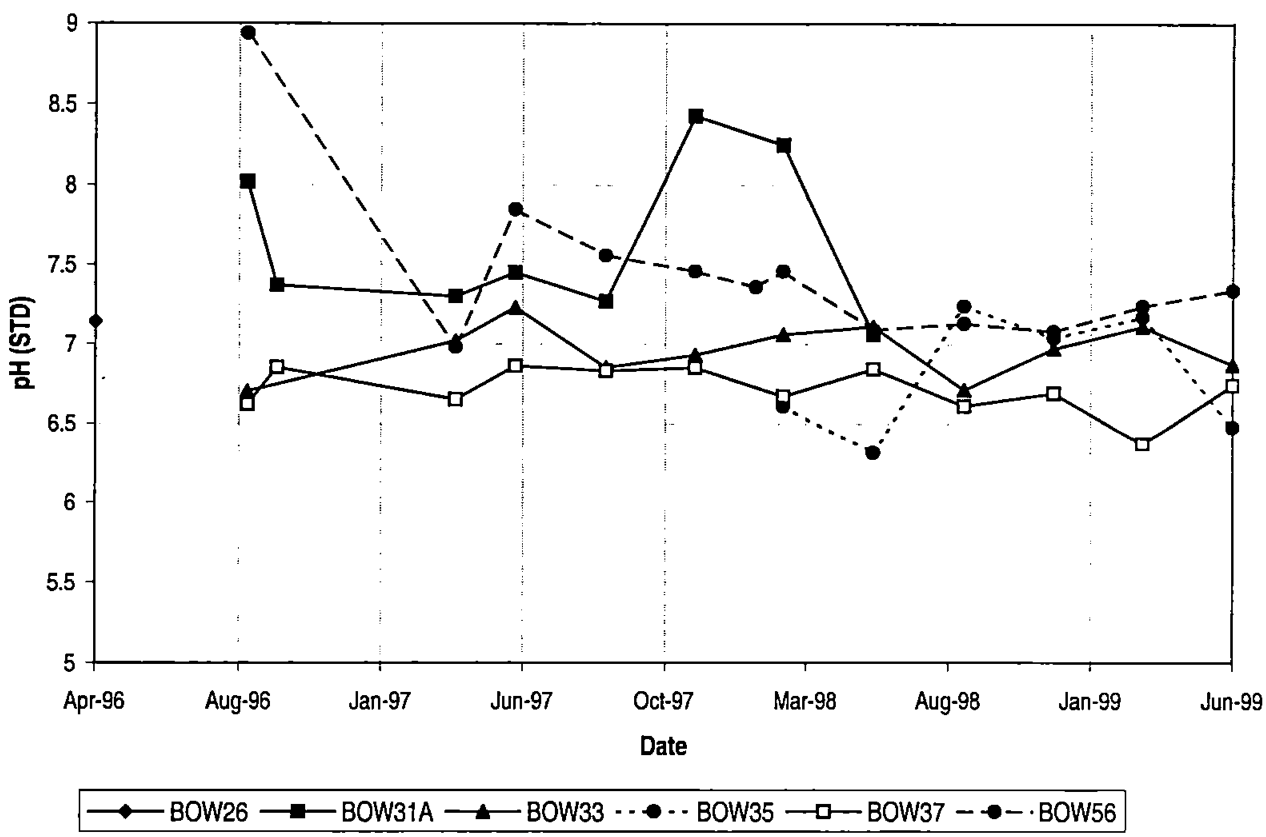



Manganese (mg/L)
7
6
5
4
3
2
1
0
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW01
BOW04
BOW09
BOW10
BOW12
BOW26
MSA

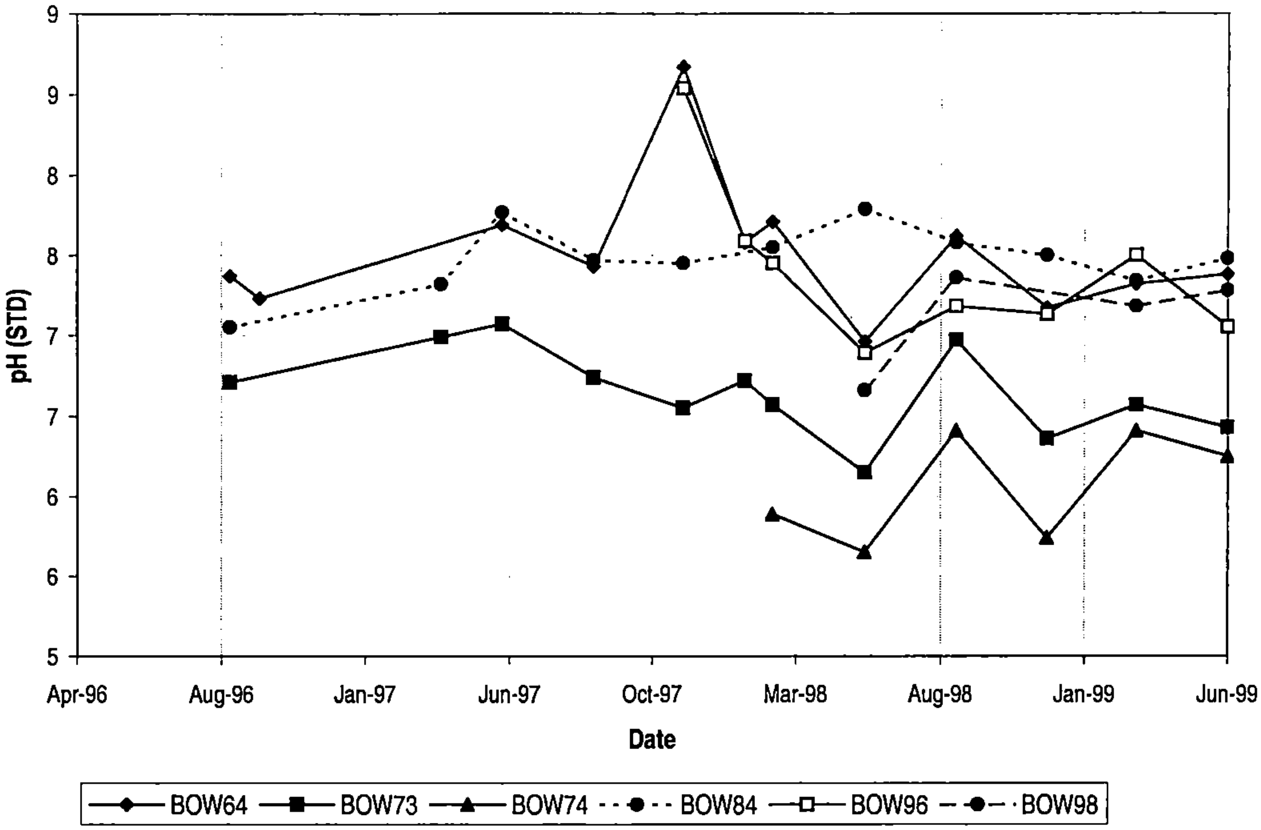

Manganese (mg/L)
7
6
5
4
3
2
1
0
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW31A
BOW33
BOW35
BOW37
BOW74
BOW96
BOW98
MSA

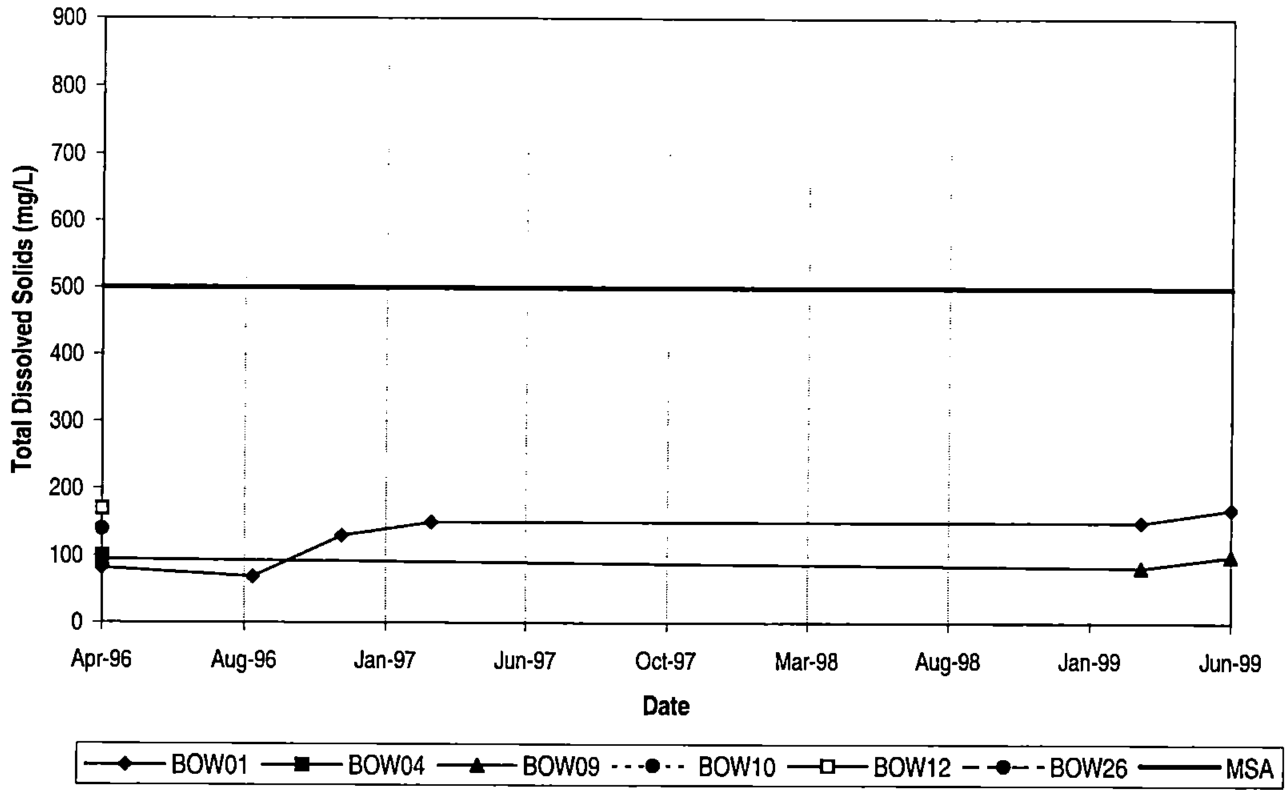
BAINBRIDGE ISLAND LANDFILL FS REPORT
DOMESTIC WELL TIME SERIES PLOTS

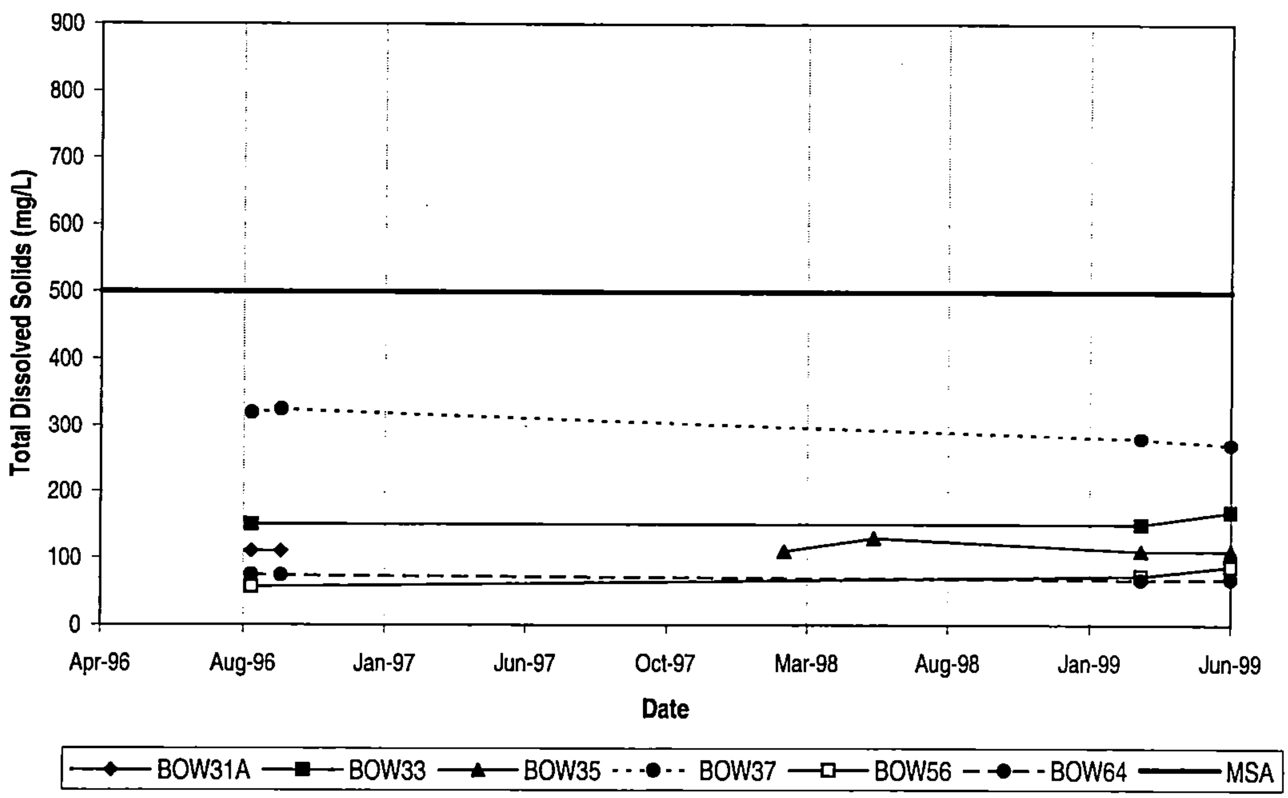


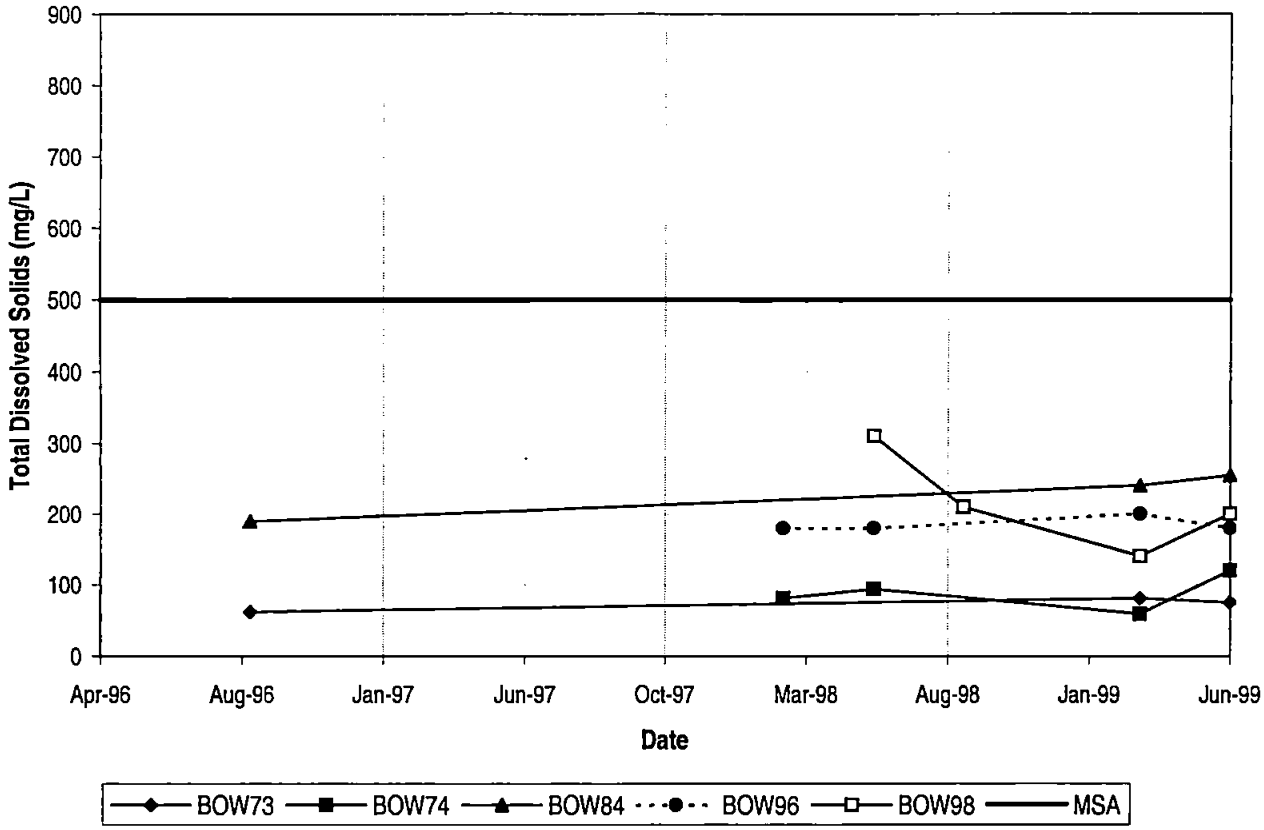


BAINBRIDGE ISLAND LANDFILL FS REPORT
DOMESTIC WELL TIME SERIES PLOTS

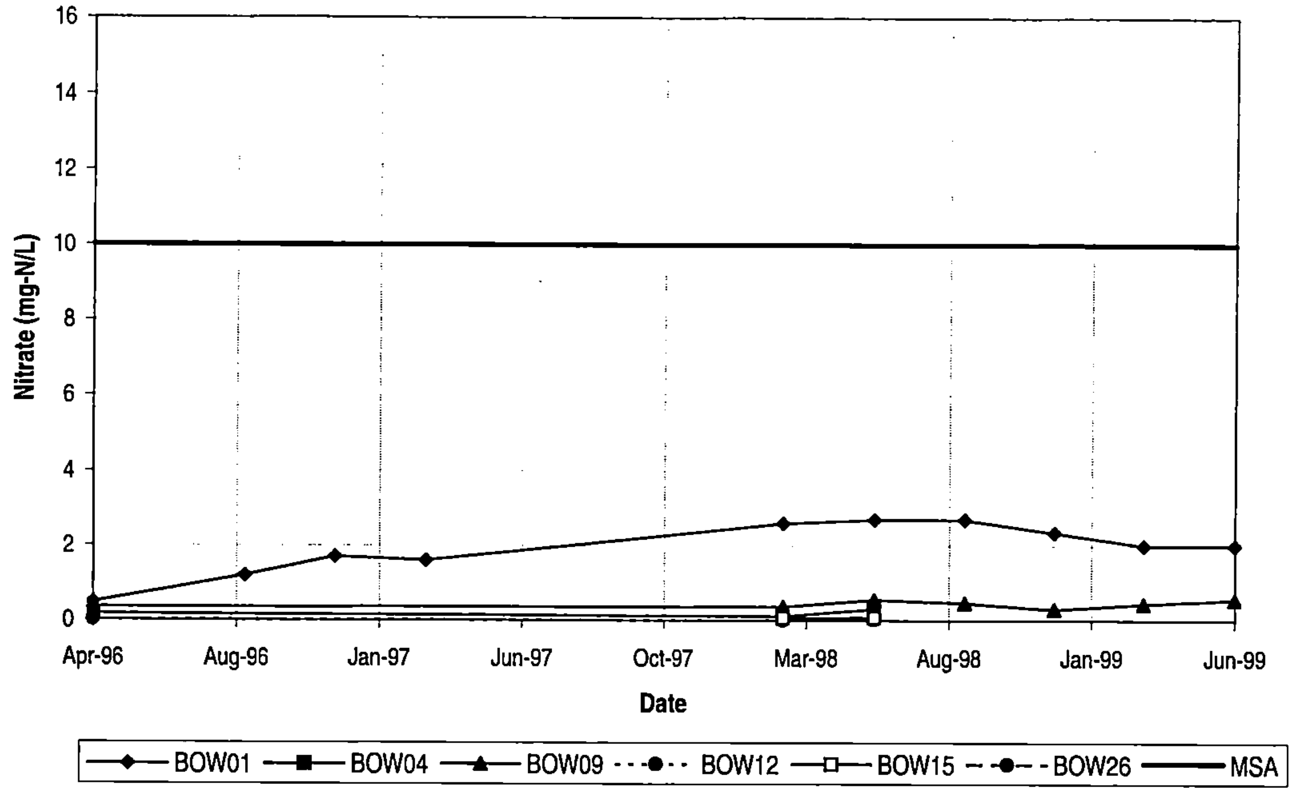


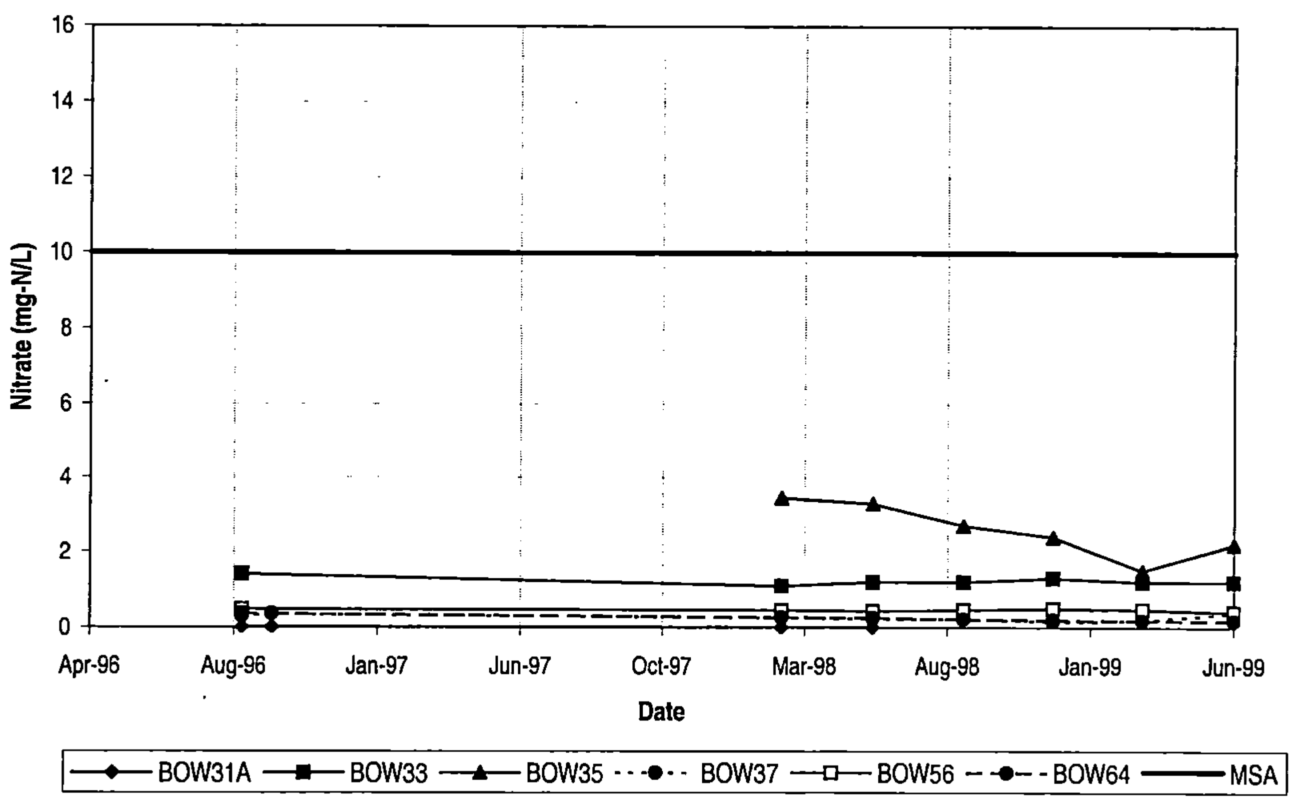

900
800
700
600
500
400
300
200
100
0
Total Dissolved Solids (mg/L)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW01
BOW04
BOW09
BOW10
BOW12
BOW26
MSA

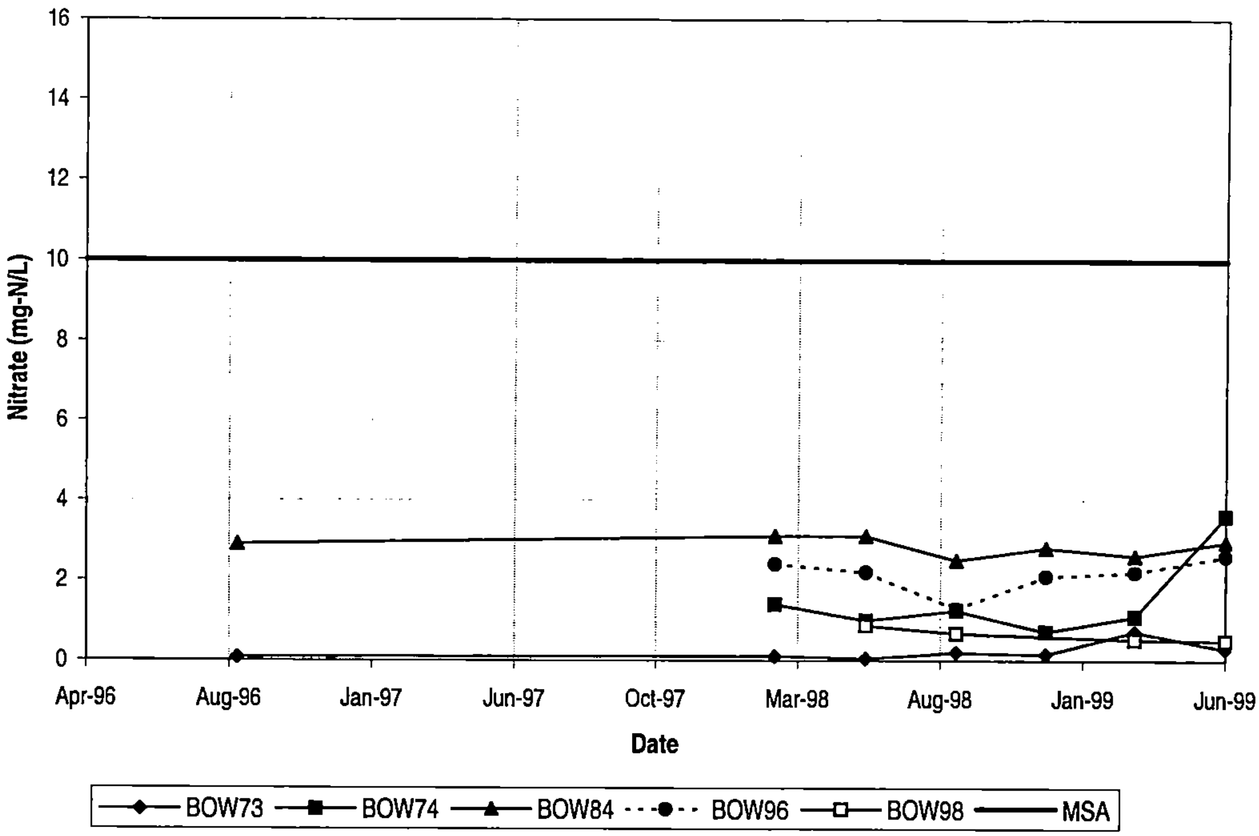

900
800
700
600
500
400
300
200
100
0
Total Dissolved Solids (mg/L)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW31A
BOW33
BOW35
BOW37
BOW56
BOW64
MSA

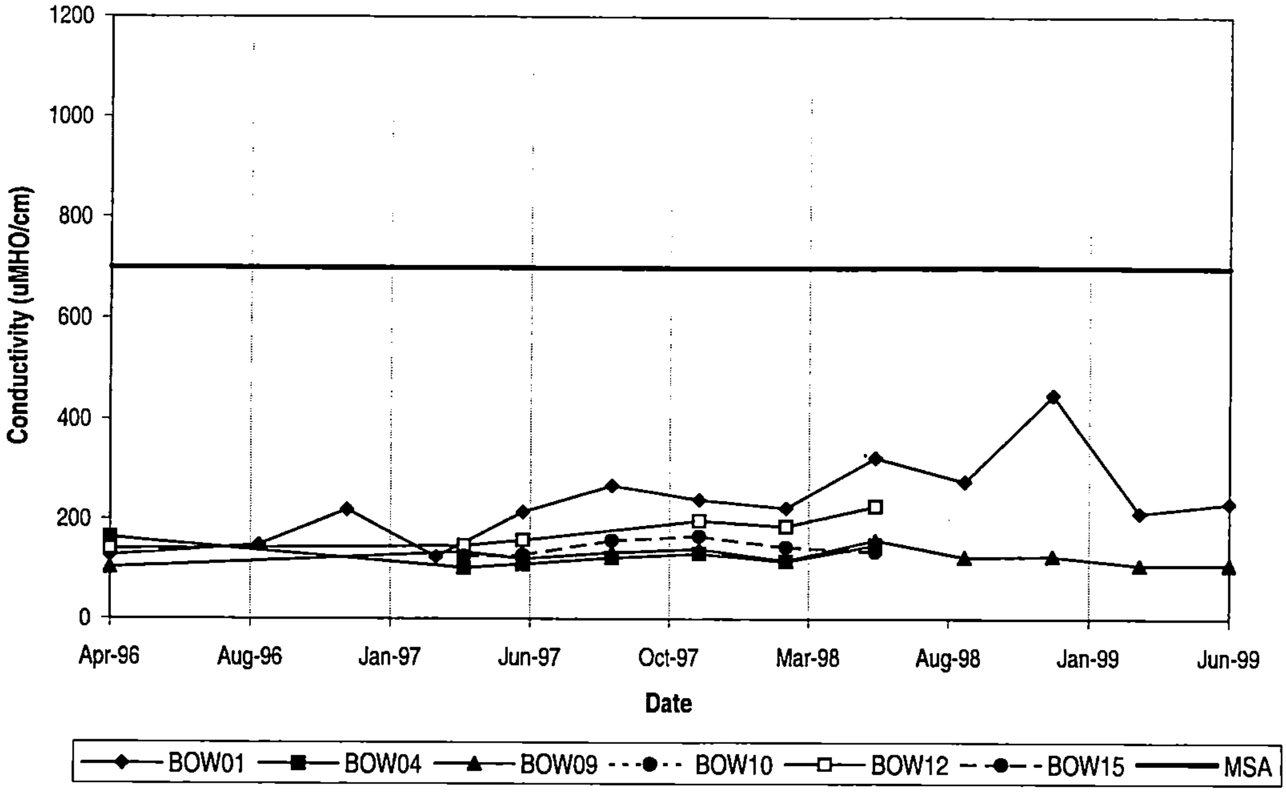

900
800
700
600
500
400
300
200
100
0
Total Dissolved Solids (mg/L)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW73
BOW74
BOW84
BOW96
BOW98
MSA

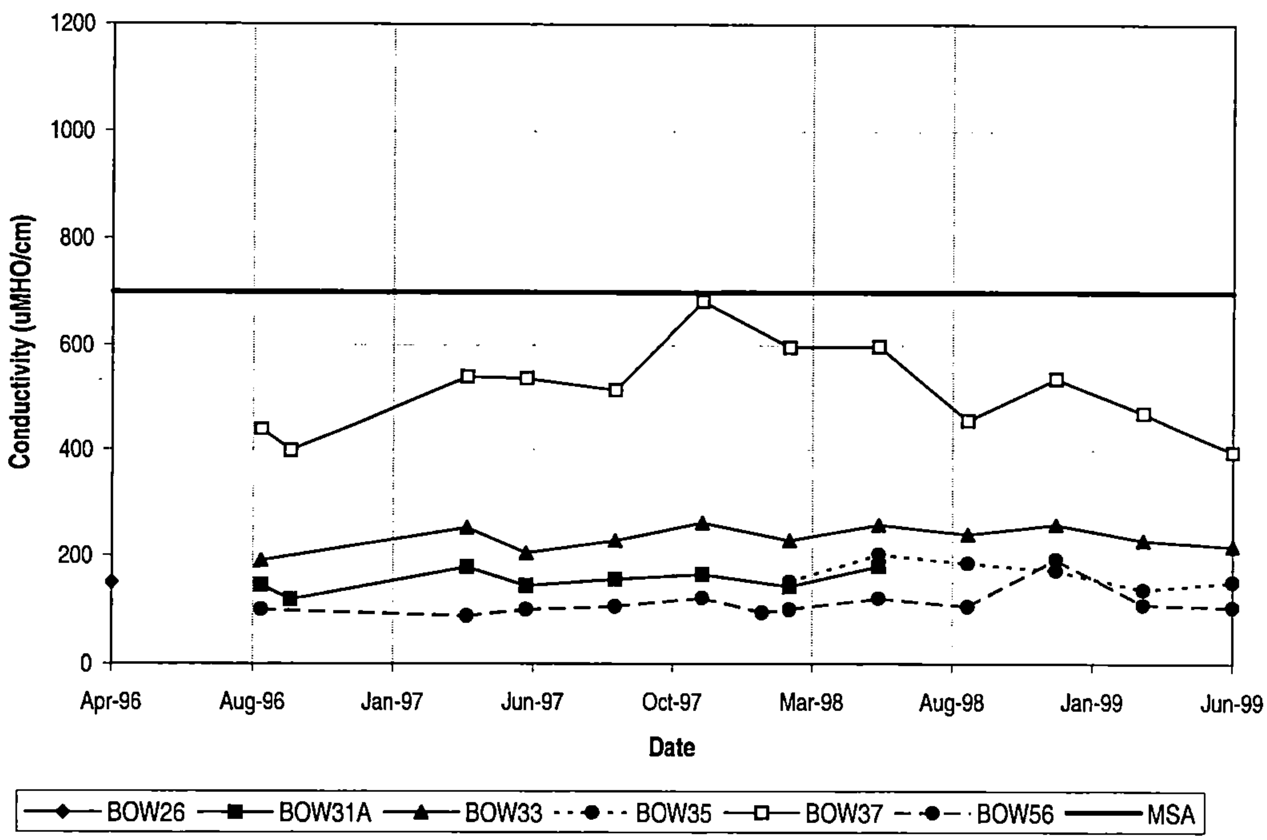
BAINBRIDGE ISLAND LANDFILL FS REPORT
DOMESTIC WELL TIME SERIES PLOTS



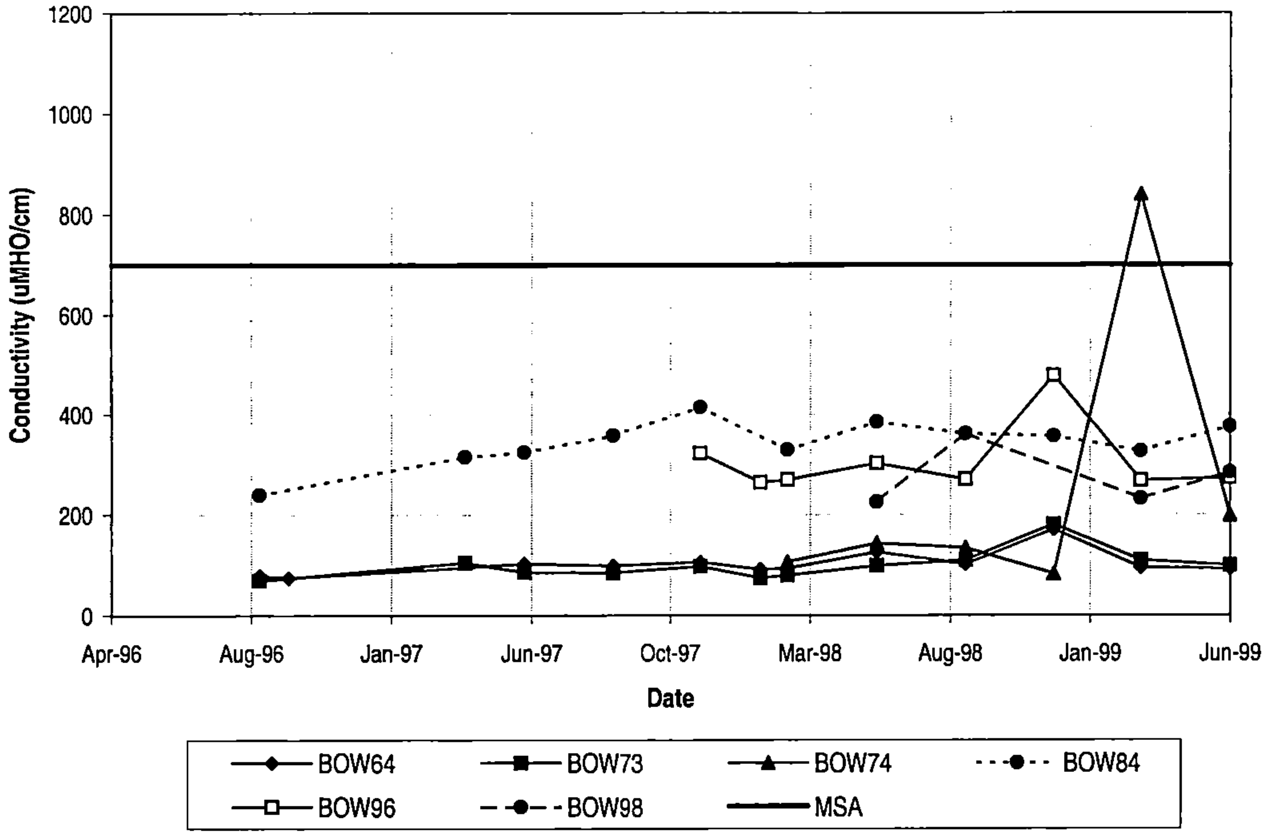



16
14
12
10
8
6
4
2
0
Nitrate (mg-N/L)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW73
BOW74
BOW84
BOW96
BOW98
MSA


1200
1000
800
600
400
200
0
Conductivity (uMHO/cm)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW01
BOW04
BOW09
BOW10
BOW12
BOW15
MSA

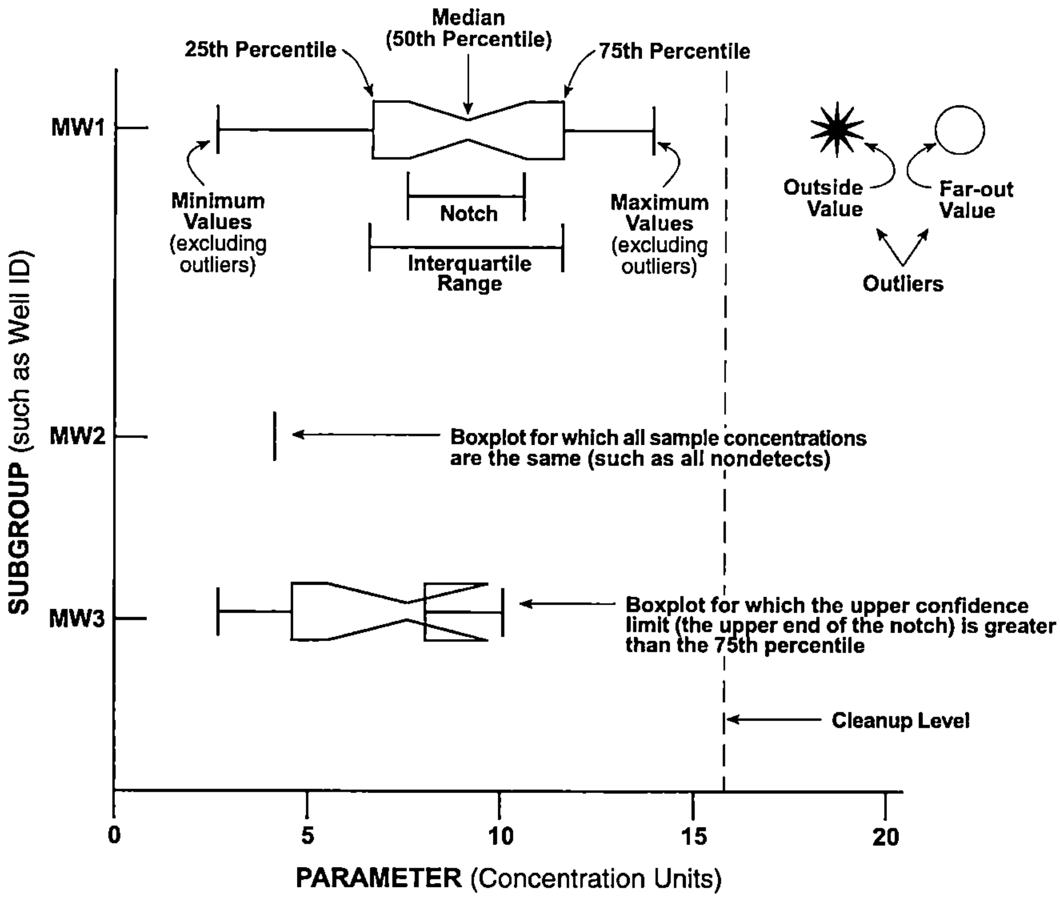

1200
1000
800
600
400
200
0
Conductivity (uMHO/cm)
Apr-96
Aug-96
Jan-97
Jun-97
Oct-97
Mar-98
Aug-98
Jan-99
Jun-99
Date
BOW26
BOW31A
BOW33
BOW35
BOW37
BOW56
MSA

BAINBRIDGE ISLAND LANDFILL FS REPORT
DOMESTIC WELL TIME SERIES PLOTS



APPENDIX D

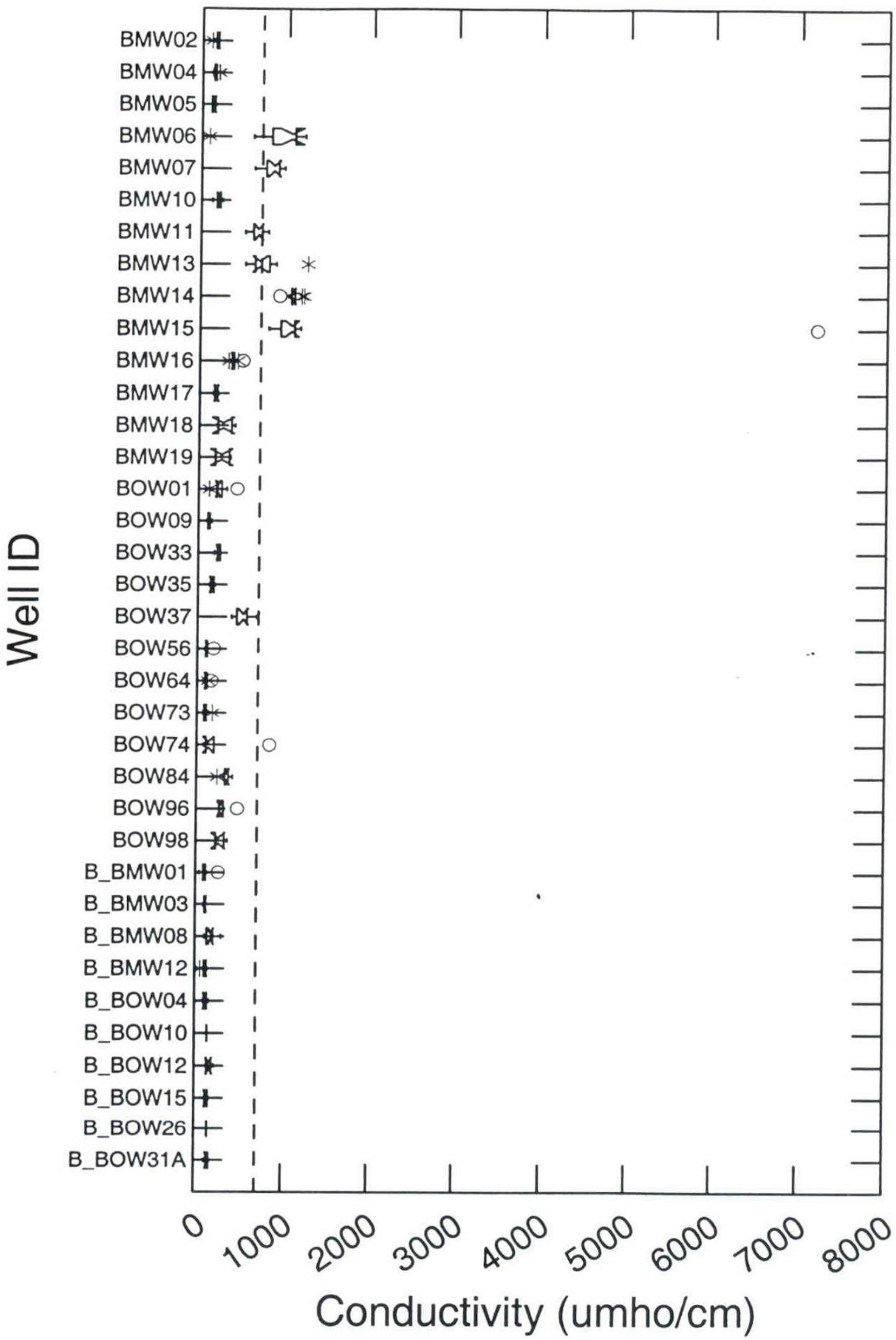
Groundwater Boxplots



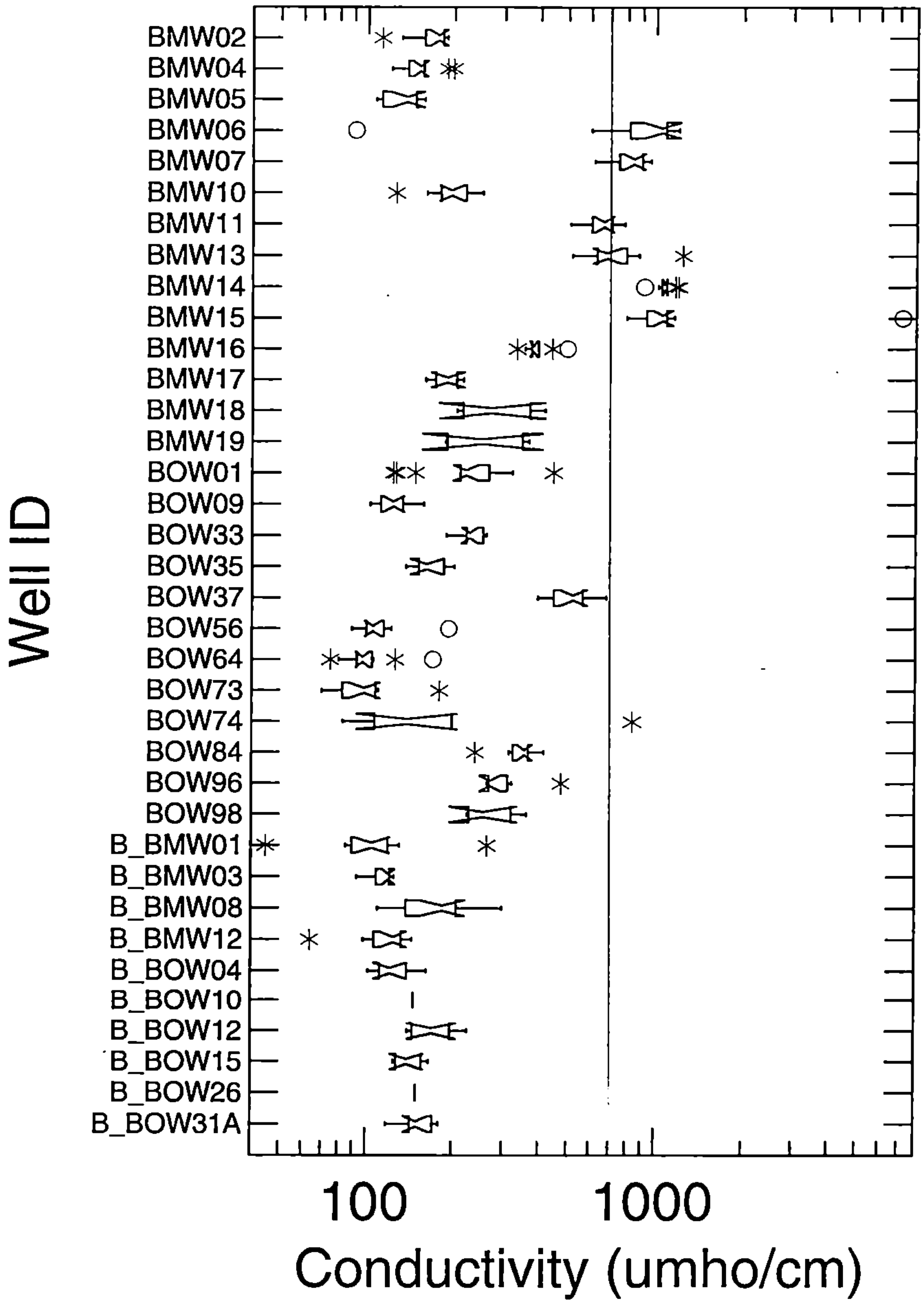
Components. A BOXPLOT identifies the MEDIAN, (50th percentile), the lower and upper quartiles (25th and 75th percentiles), and the RANGE (the spread of the data). The edges of the box demarcate the 25th and 75th percentiles, and so represent the middle 50 percent (INTERQUARTILE RANGE) of the parameter values for the data subset. The narrowest point in the notch is the MEDIAN. The NOTCH represents the approximate 95 percent confidence interval around the median. The lines, or whiskers, extend outward from the box through the range of the data, excluding outliers. Two outliers are defined, based on their distance from the nearest edge of the box, relative to the range of the box. OUTSIDE VALUES lie 1-1/2 to 3 interquartile ranges away from the nearest box edge, and FAR-OUT VALUES lie three or more interquartile ranges away from the nearest box edge. The vertical dashed line represents the CLEANUP LEVEL for the parameter plotted.

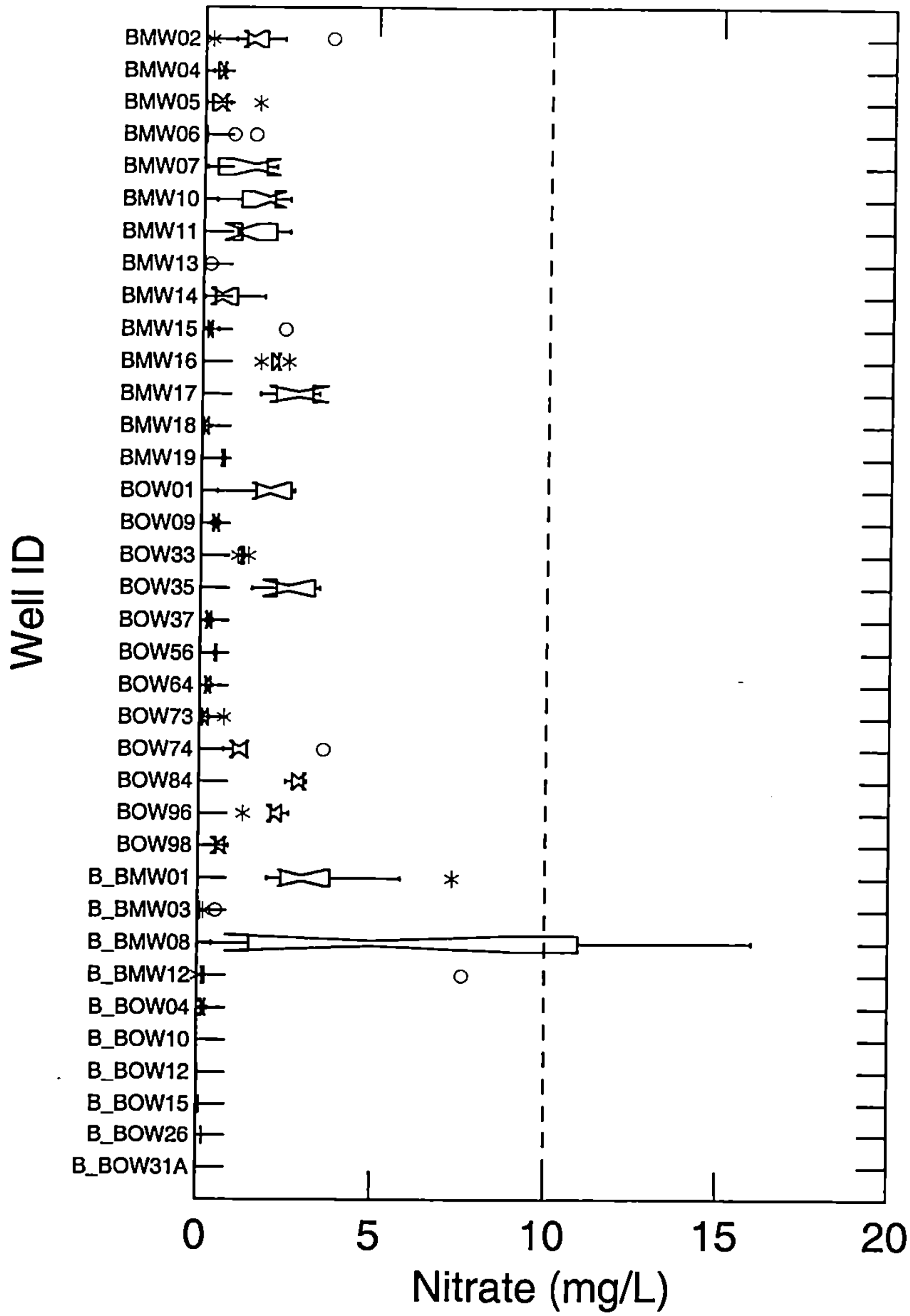
Interpretation. If notches from different subsets of the data overlap completely, one can conclude with approximately 95 percent confidence that the groups have been sampled from a common population. If notches do not overlap at all, one can conclude with approximately 95 percent confidence that the groups represent different populations. Cases of partial overlap require additional statistical tests (e.g., t-Test, ANOVA, Mann-Whitney, or Kruskal-Wallis) to specify the significance of differences among groups.

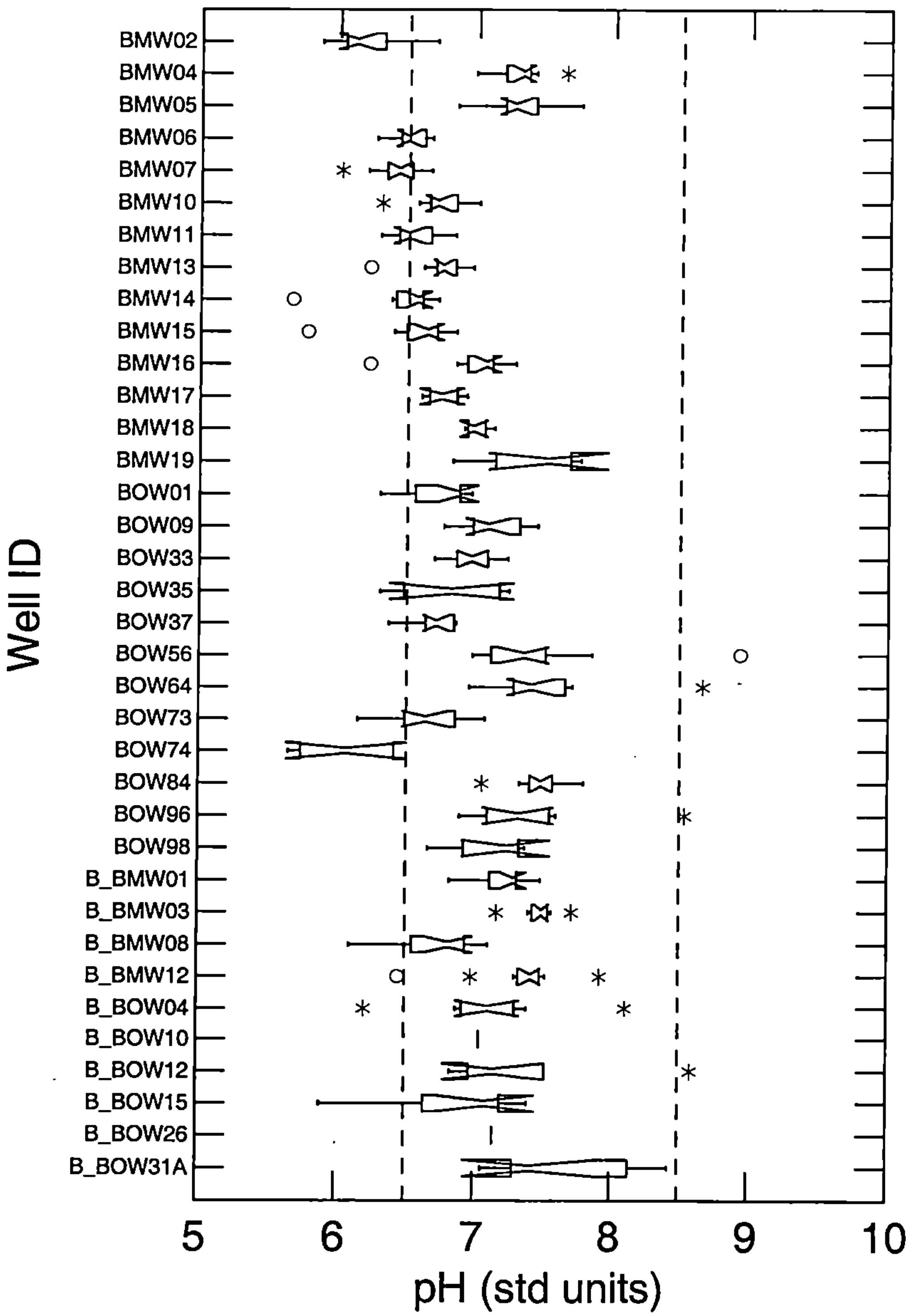
Characteristics of a Boxplot

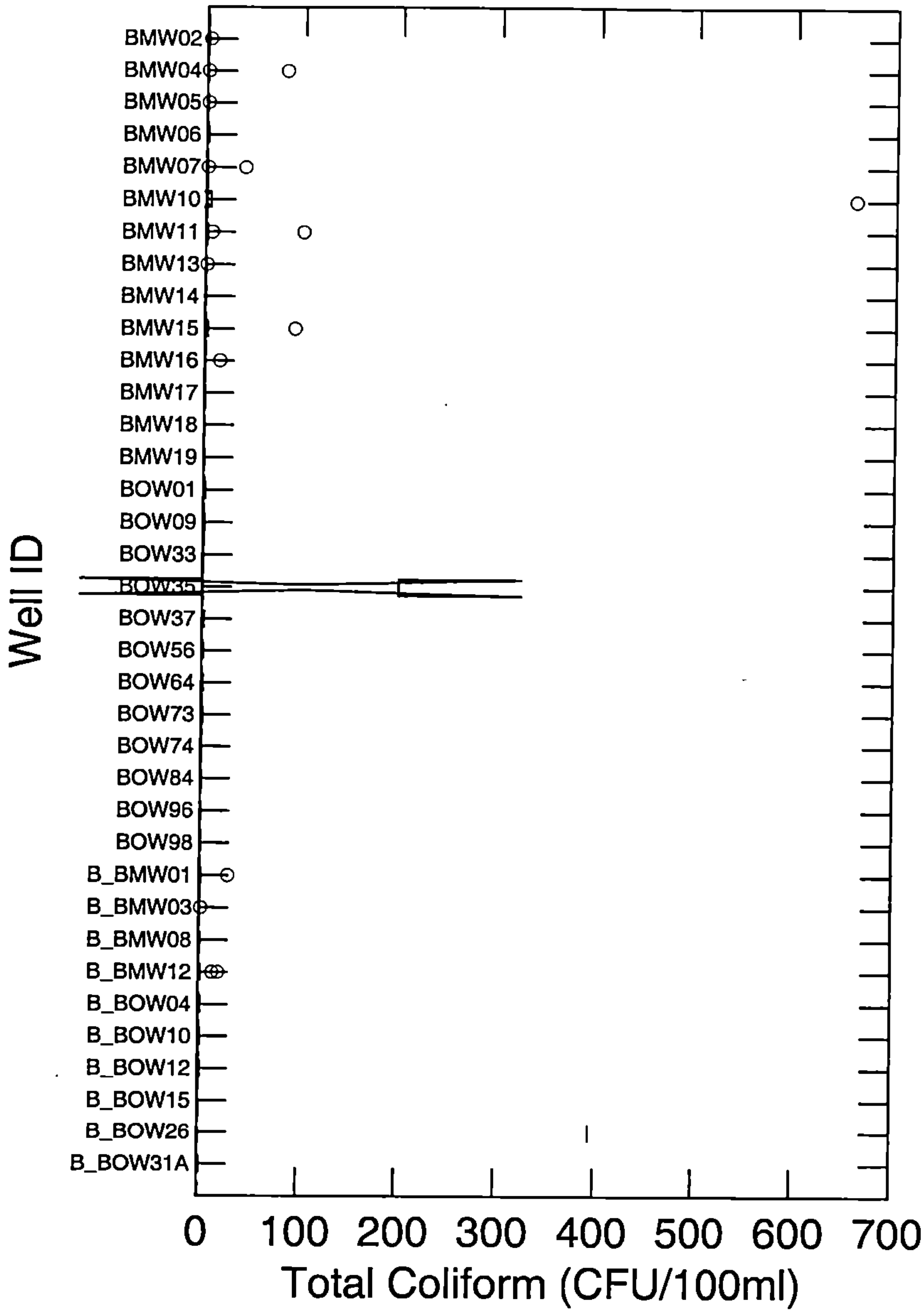


Well ID
BMW02
BMW04
BMW05
BMW06
BMW07
BMW10
BMW11
BMW13
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
BOW01
BOW09
BOW33
BOW35
BOW37
BOW56
BOW64
BOW73
BOW74
BOW84
BOW96
BOW98
B_BMW01
B_BMW03
B_BMW08
B_BMW12
B_BOW04
B_BOW10
B_BOW12
B_BOW15
B_BOW26
B_BOW31A
0
1000
2000
3000
4000
5000
6000
7000
8000
Conductivity (umho/cm)

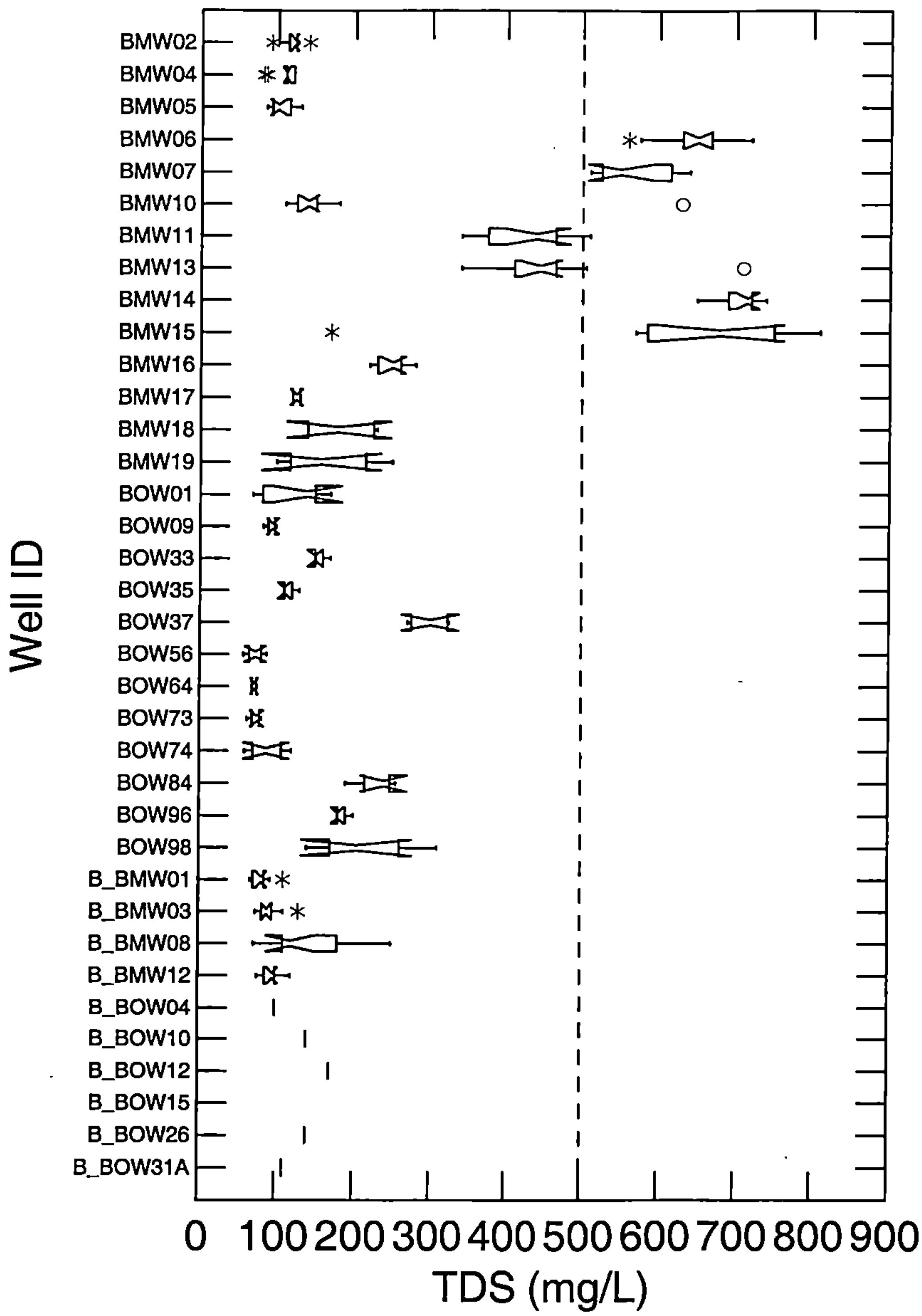

BMW02
BMW04
BMW05
BMW06
BMW07
BMW10
BMW11
BMW13
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
BOW01
BOW09
BOW33
BOW35
BOW37
BOW56
BOW64
BOW73
BOW74
BOW84
BOW96
BOW98
B_BMW01
B_BMW03
B_BMW08
B_BMW12
B_BOW04
B_BOW10
B_BOW12
B_BOW15
B_BOW26
B_BOW31A
Well ID
100
1000
Conductivity (umho/cm)


Well ID
BMW02
BMW04
BMW05
BMW06
BMW07
BMW10
BMW11
BMW13
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
BOW01
BOW09
BOW33
BOW35
BOW37
BOW56
BOW64
BOW73
BOW74
BOW84
BOW96
BOW98
B_BMW01
B_BMW03
B_BMW08
B_BMW12
B_BOW04
B_BOW10
B_BOW12
B_BOW15
B_BOW26
B_BOW31A
0
5
10
15
20
Nitrate (mg/L)


Well ID
BMW02
BMW04
BMW05
BMW06
BMW07
BMW10
BMW11
BMW13
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
BOW01
BOW09
BOW33
BOW35
BOW37
BOW56
BOW64
BOW73
BOW74
BOW84
BOW96
BOW98
B_BMW01
B_BMW03
B_BMW08
B_BMW12
B_BOW04
B_BOW10
B_BOW12
B_BOW15
B_BOW26
B_BOW31A
5
6
7
8
9
10
pH (std units)



Well ID
BMW02
BMW04
BMW05
BMW06
BMW07
BMW10
BMW11
BMW13
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
BOW01
BOW09
BOW33
BOW35
BOW37
BOW56
BOW64
BOW73
BOW74
BOW84
BOW96
BOW98
B_BMW01
B_BMW03
B_BMW08
B_BMW12
B_BOW04
B_BOW10
B_BOW12
B_BOW15
B_BOW26
B_BOW31A
0
100
200
300
400
500
600
700
Total Coliform (CFU/100ml)



Well ID
BMW02
BMW04
BMW05
BMW06
BMW07
BMW10
BMW11
BMW13
BMW14
BMW15
BMW16
BMW17
BMW18
BMW19
BOW01
BOW09
BOW33
BOW35
BOW37
BOW56
BOW64
BOW73
BOW74
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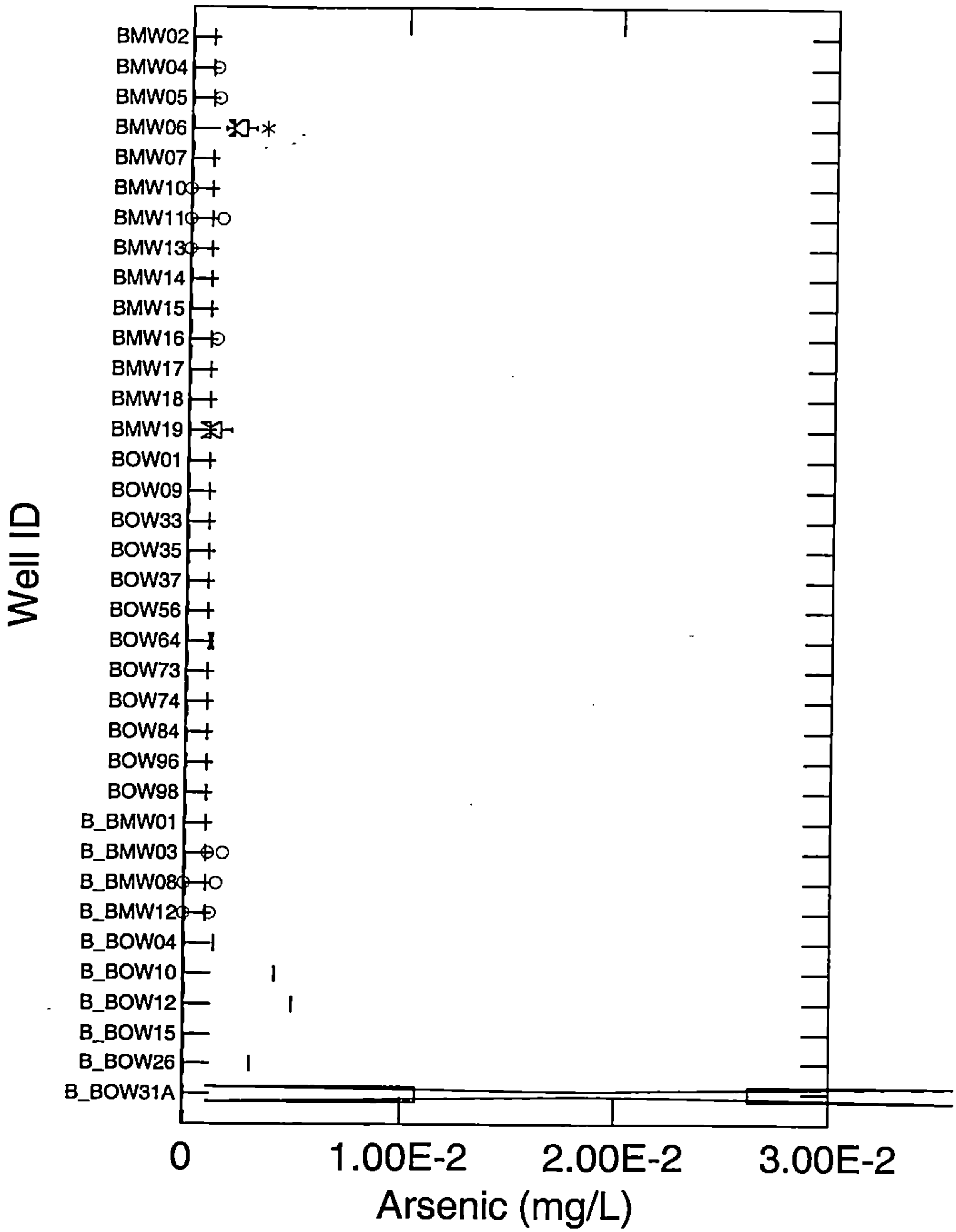
TDS (mg/L)



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2.00E-2
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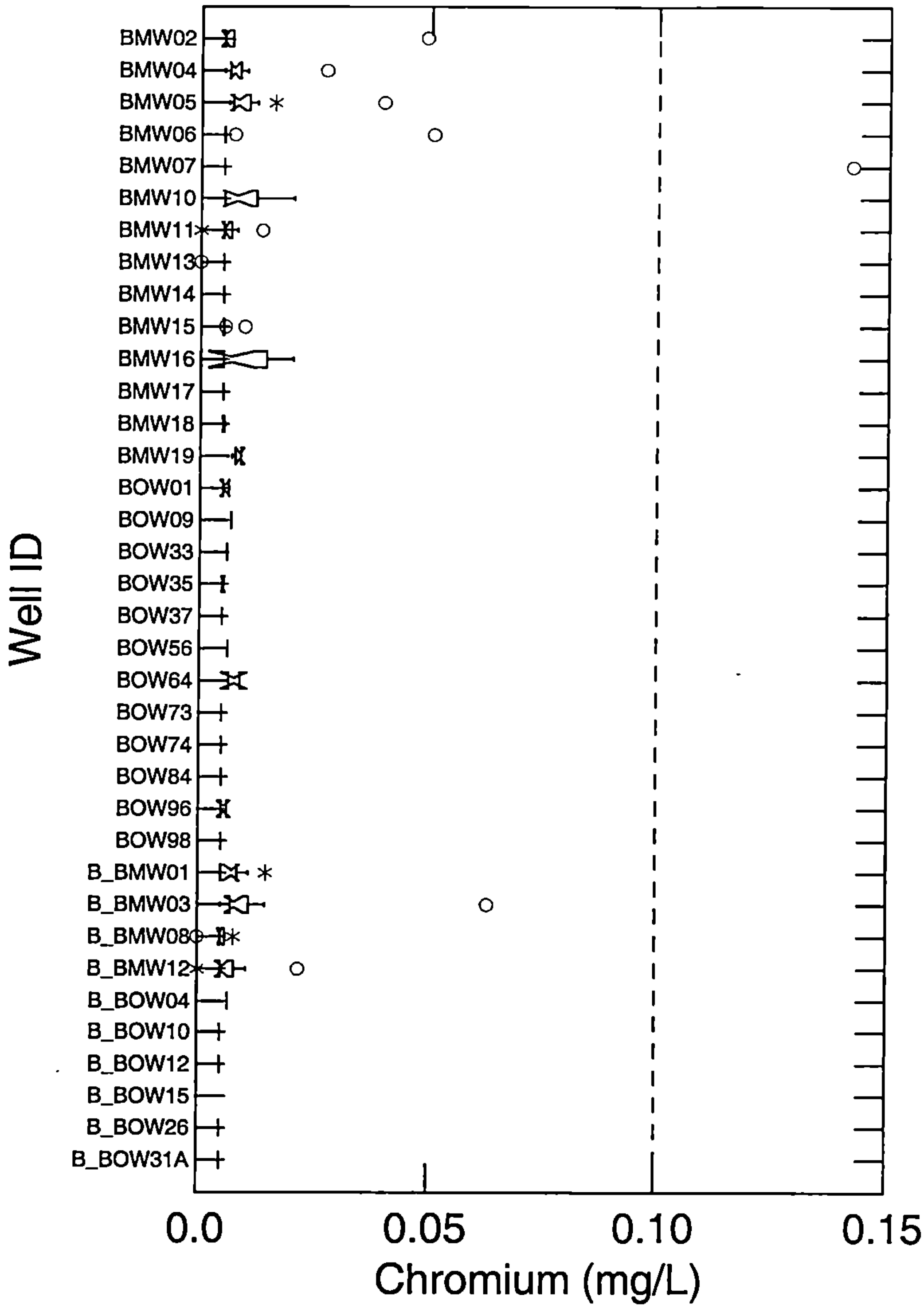
Arsenic (mg/L)



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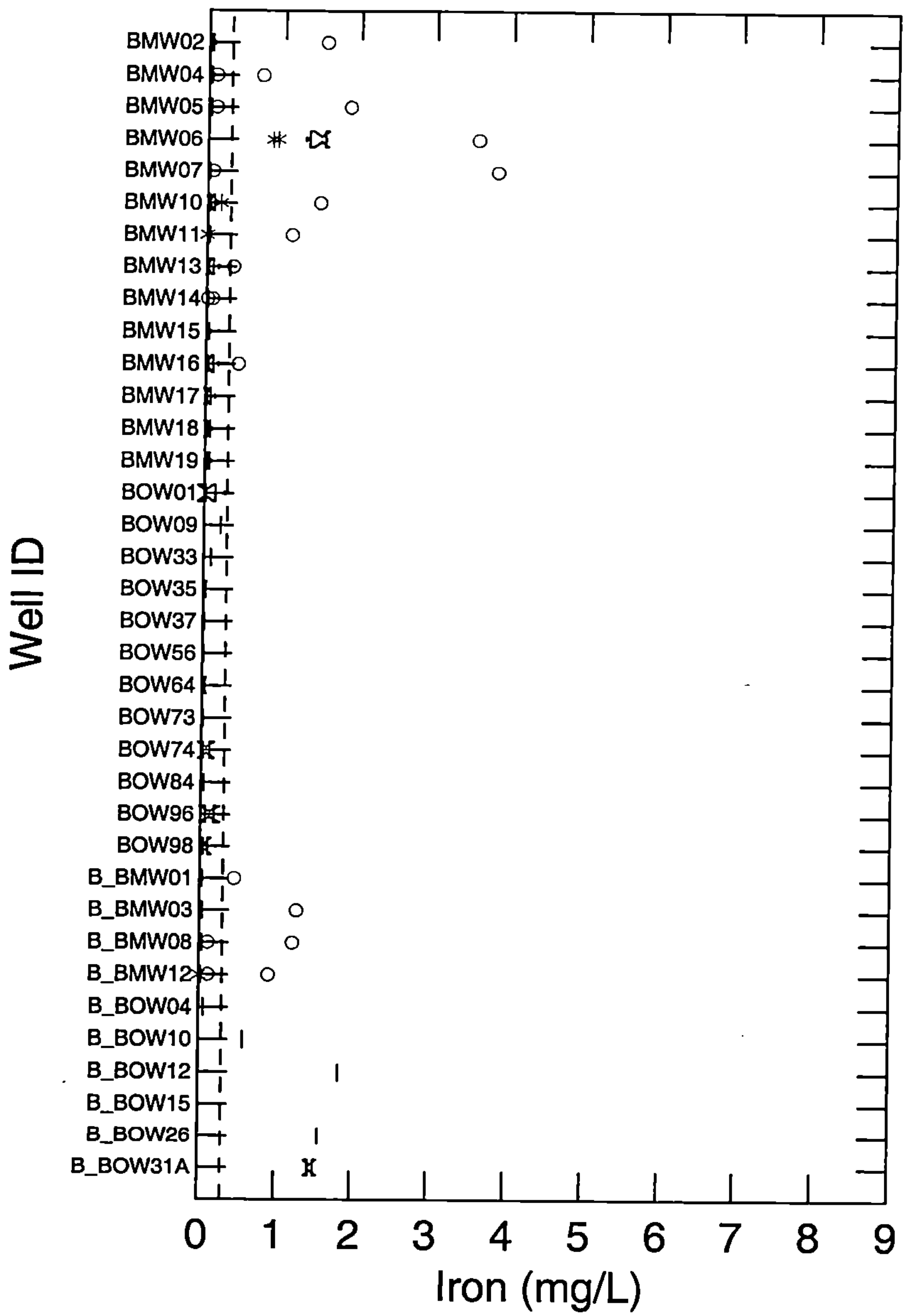
Chromium (mg/L)



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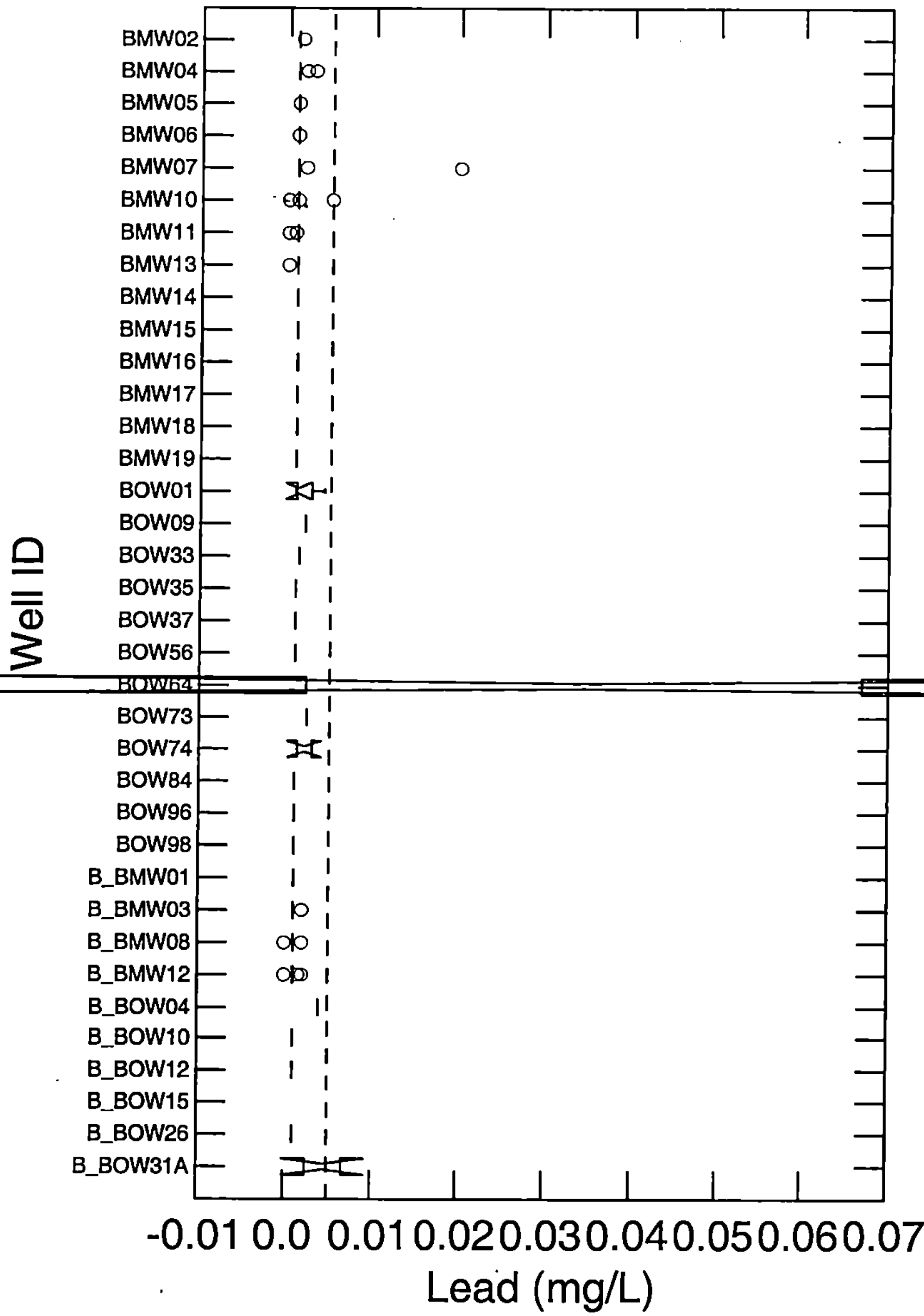
Iron (mg/L)



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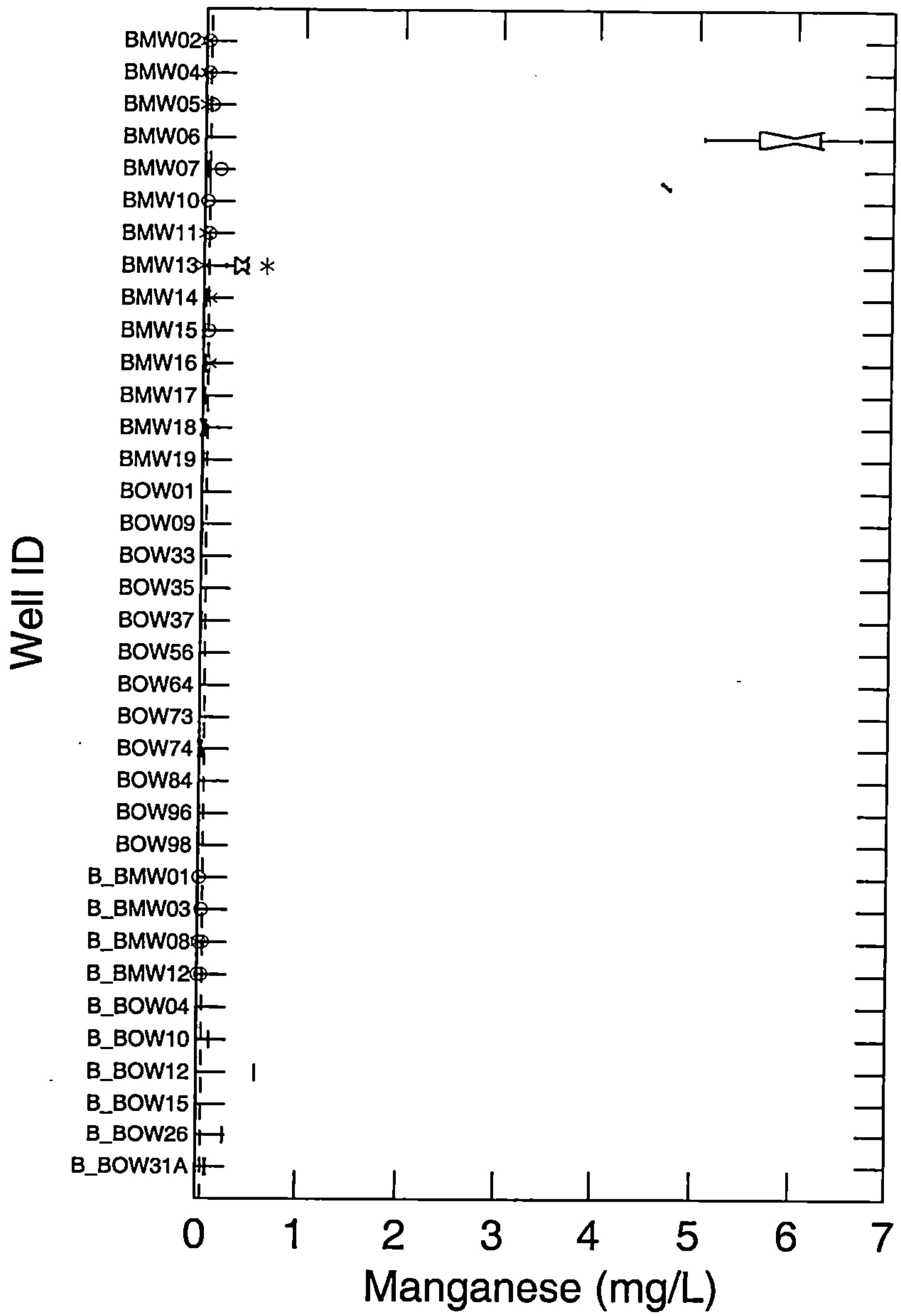
Lead (mg/L)



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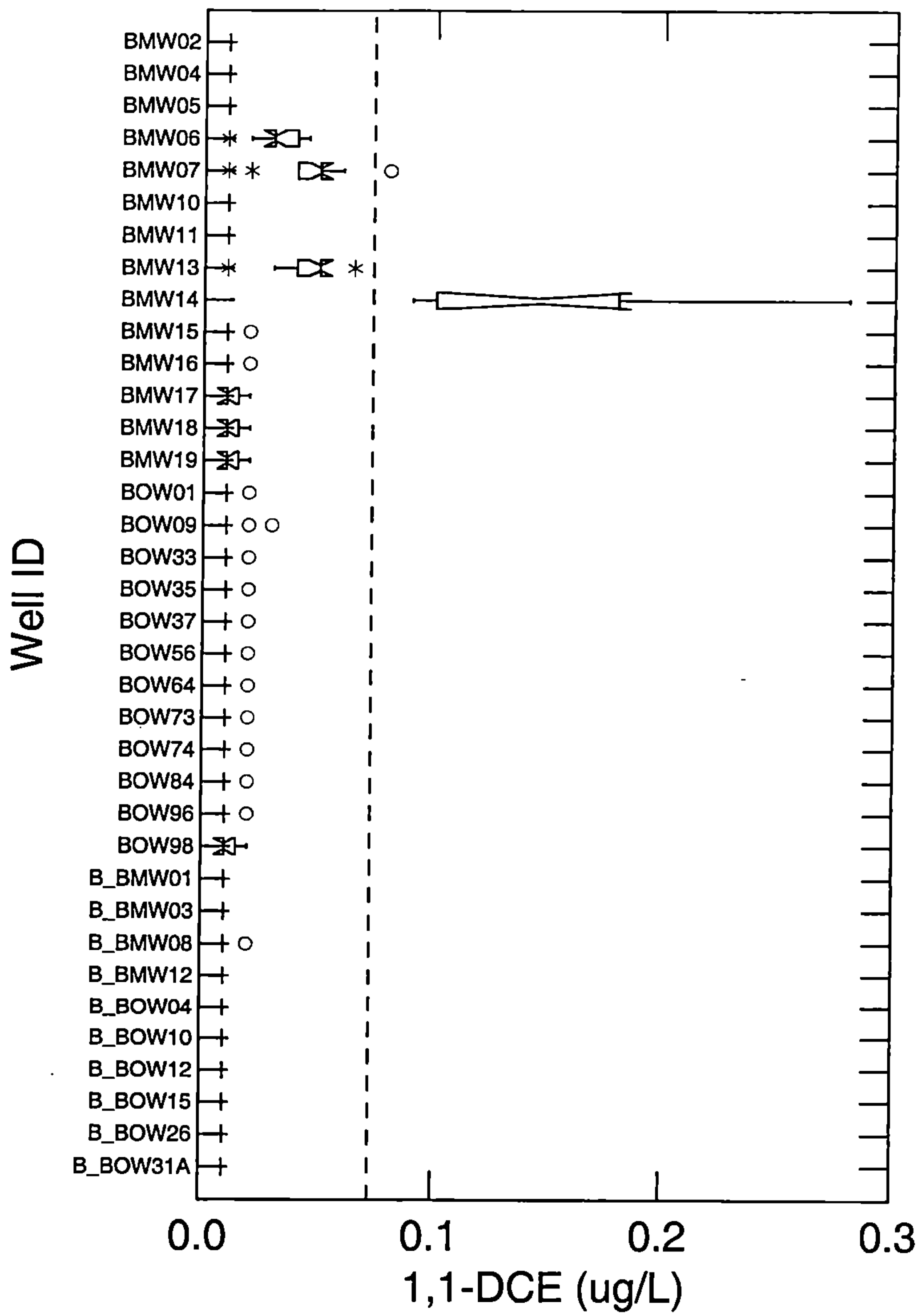
7
Manganese (mg/L)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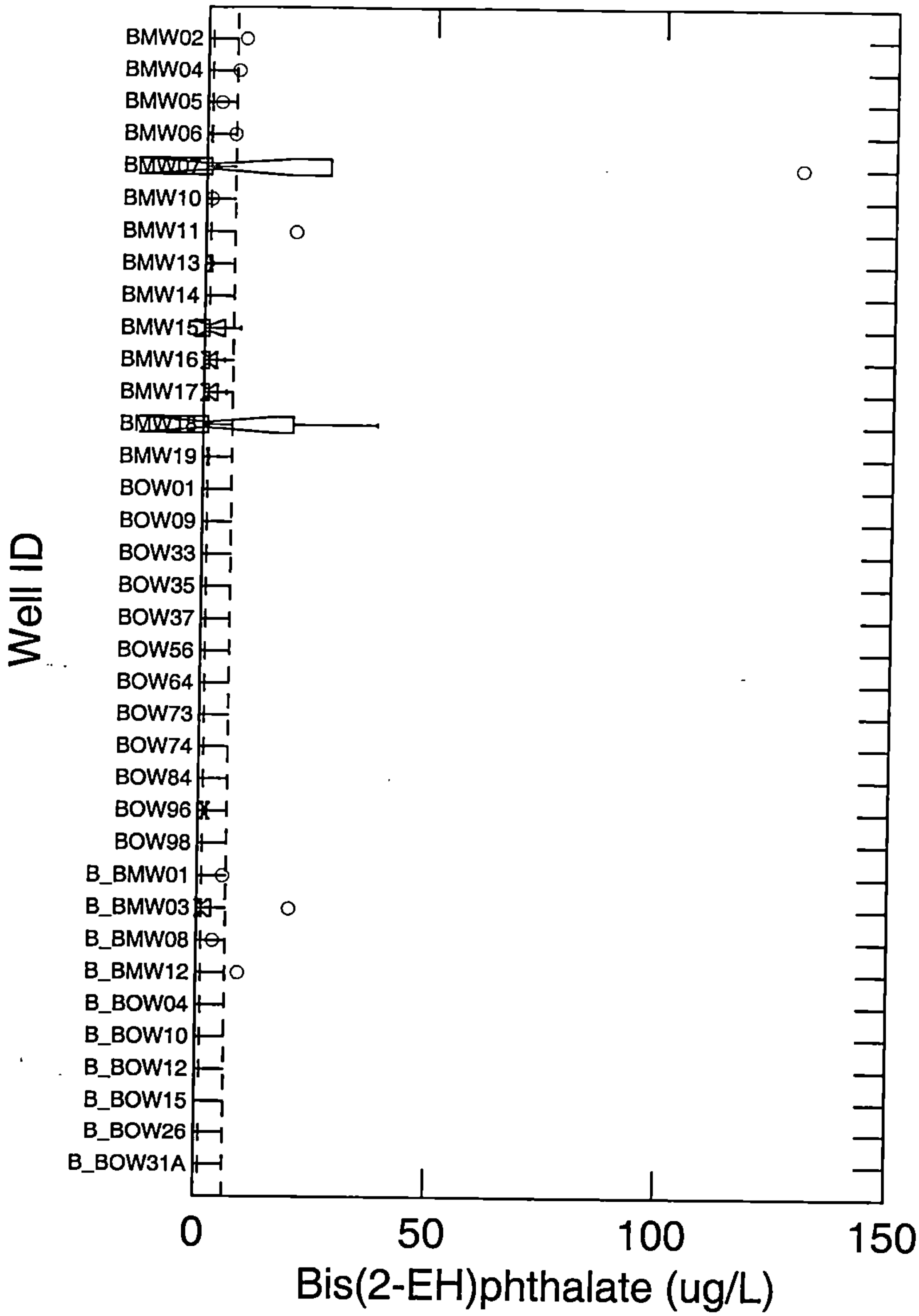

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100
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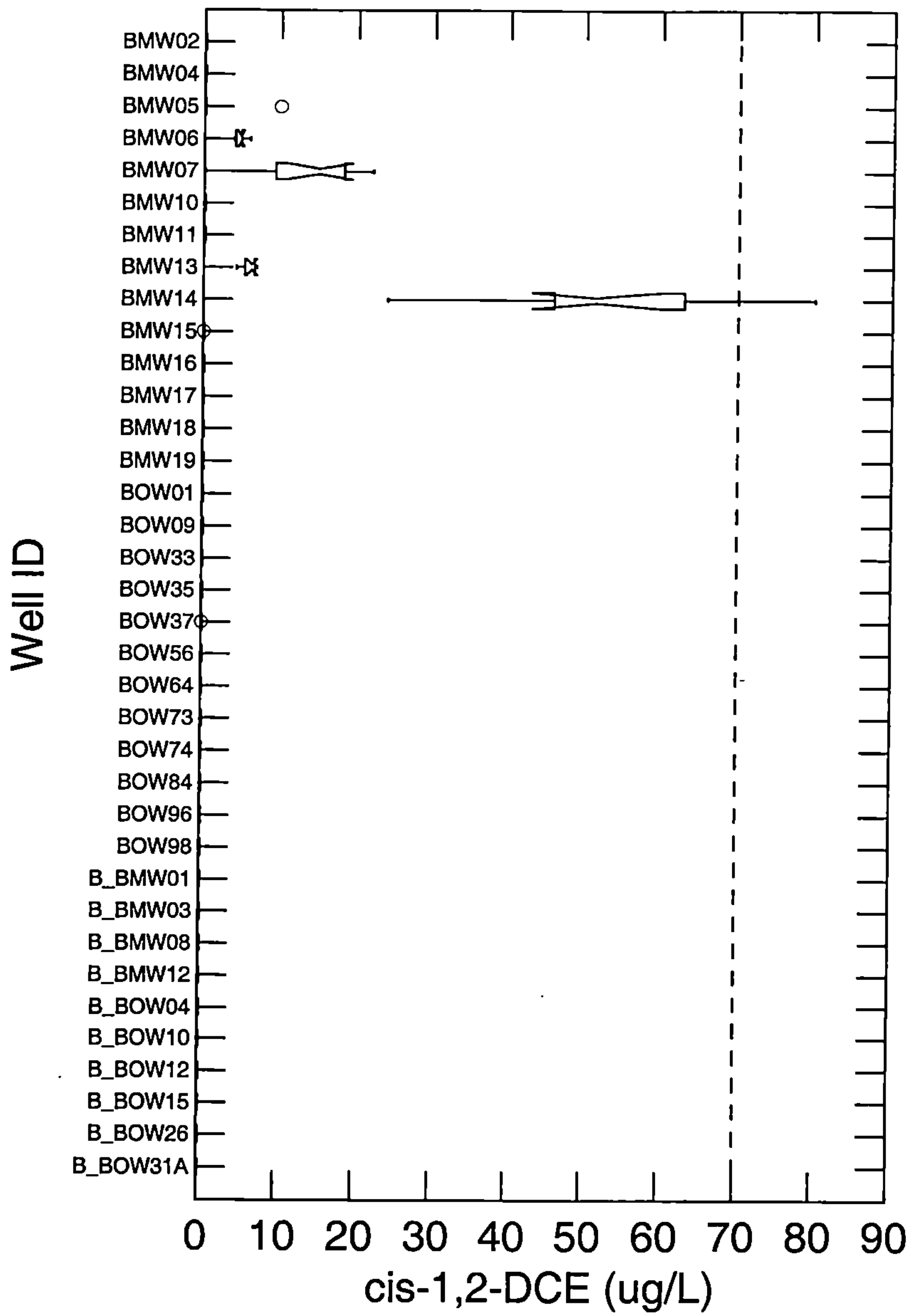
Bis(2-EH)phthalate (ug/L)



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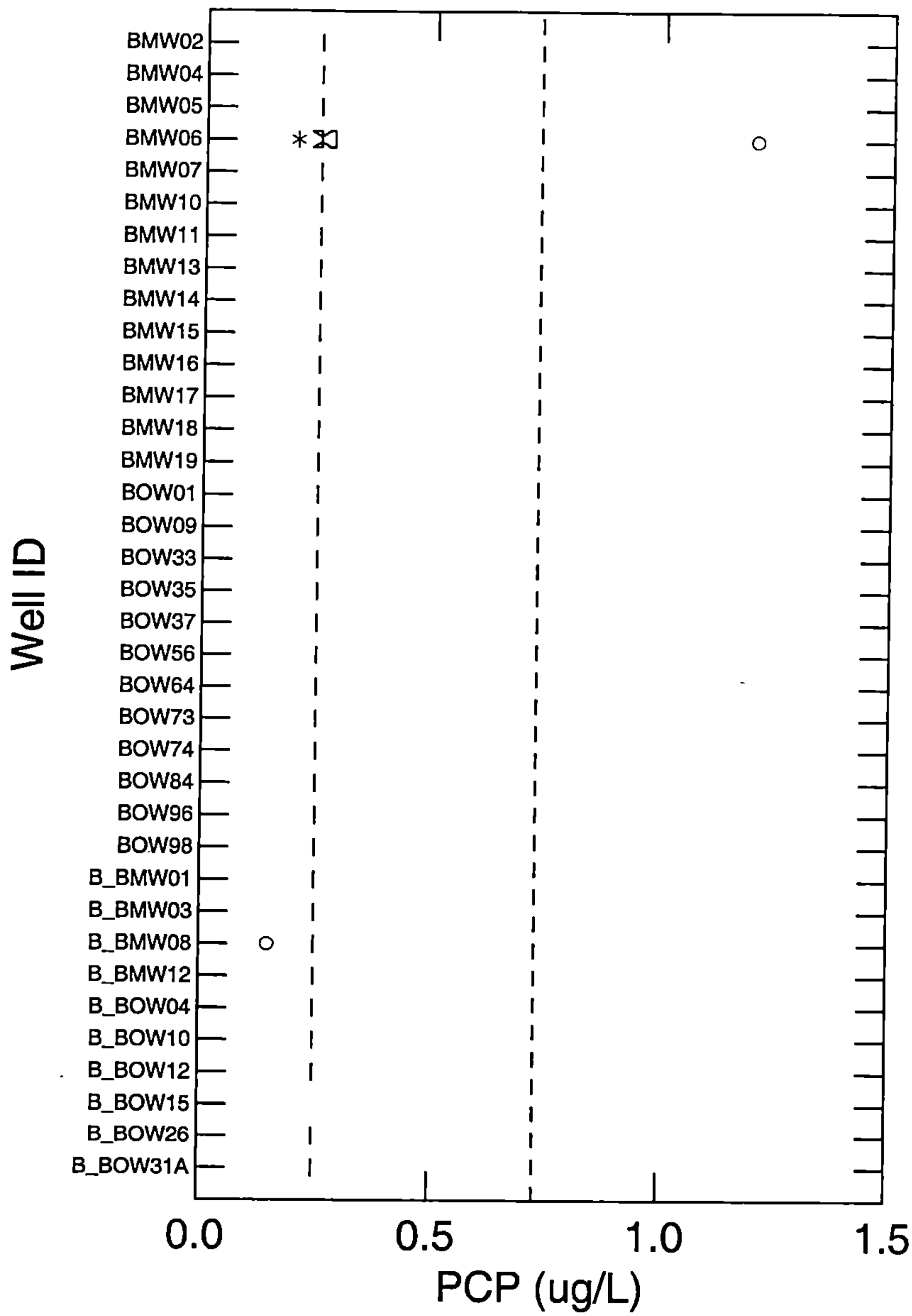

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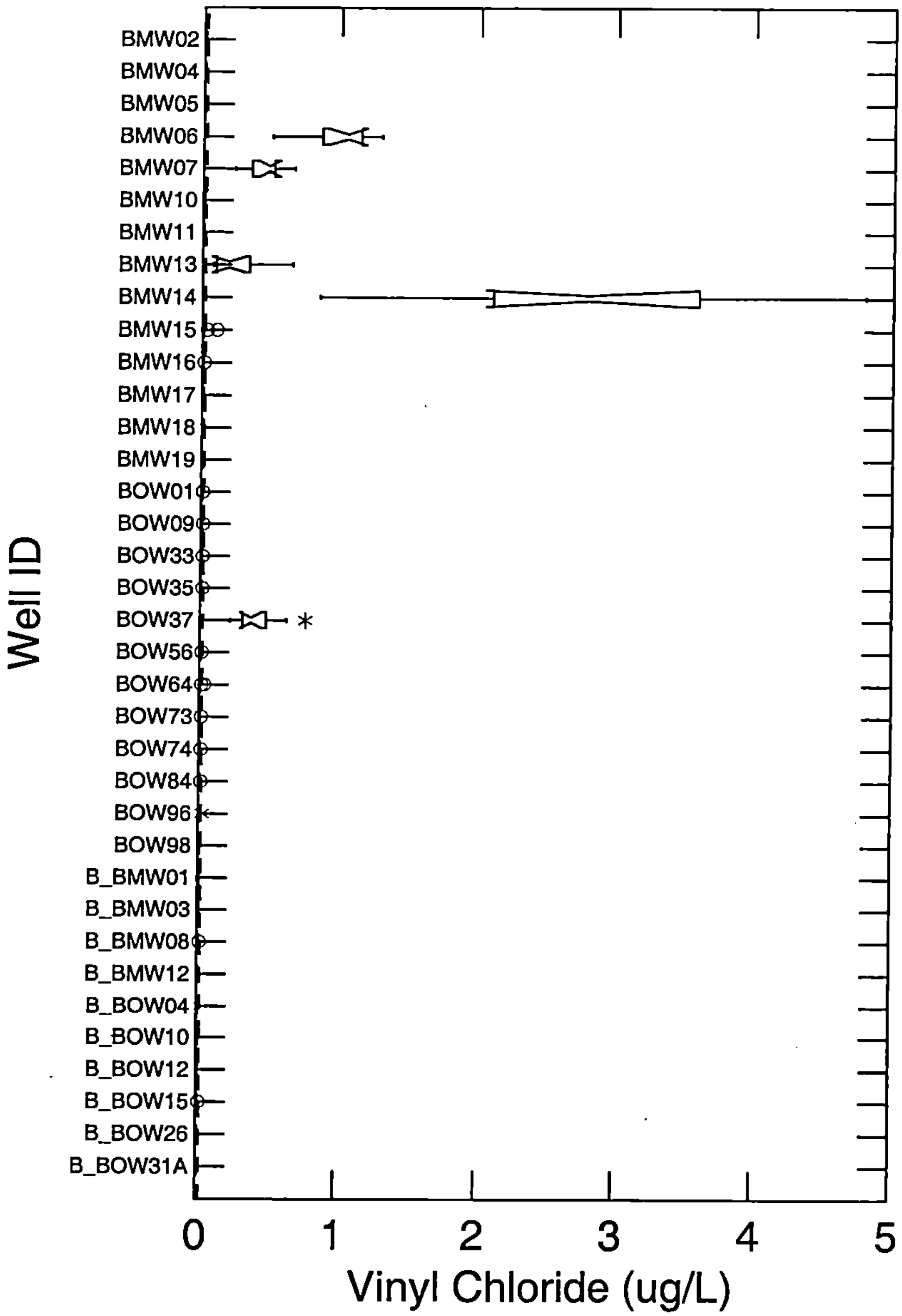
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Vinyl Chloride (ug/L)

APPENDIX E

Cost Estimates

Bainbridge Island Landfill FS
Order of Magnitude Cost Estimate
Consolidation and Containment
BY: D. Hedglin

06/15/2000
152203.A0.12

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT	
Waste Excavation, Haul & Regrade	18,900	CY	$10.00	$189,000	Excavate, load, haul, regrade on landfill
Onsite General Fill Material	14,450	CY	$3.00	$43,350	Low compaction needed
Onsite Compacted Fill Material	6,450	CY	$4.00	$25,800	High compaction needed
Temporary Erosion Control	1	LS	$30,000.00	$30,000	
Seed Disturbed Areas	12	AC	$2,000.00	$24,000	Final cover, borrow, filled, and construction areas
Chain Link Fencing	2,000	LF	$10.00	$20,000	Chain link with barbed wire top
Armor Layer					
18" Subgrade	9,000	CY	$5.00	$45,000	Excavated onsite and placed over relocated waste
6" Prepared subgrade	3,000	CY	$7.00	$21,000	Prepared subgrade graded smooth, processed to 1" minus-add $
Geosynthetic Clay Liner (GCL)	18,000	SY	$4.50	$81,000	Installed
40 Mil LLDPE Geomembrane	18,000	SY	$3.30	$59,400	Installed
18" Sand Drainage Layer	9,000	CY	$20.00	$180,000	Washed and graded sand, installed
Strip Drains (Optional)	3,750	LF	$2.00	$7,500	18" wide, installed
Geotextile (Optional)	18,000	SY	$1.50	$27,000	Installed
12" Topsoil Layer	6,000	CY	$15.00	$90,000	Offsite material, installed
Lined Detention Pond with Outlet	1	LS	$46,000.00	$46,000	Area 5,100 SF, Volume 23,300 CF, geomembrane liner-use $9/s
Roadside/General Purpose Ditches	1,200	LF	$2.00	$2,400	4' wide, V shaped, unlined
Geomembrane Lined Ditch	450	LF	$7.00	$3,150	6' wide, V shaped, asphalt lined
24" Diameter CMP Culvert	30	LF	$72.00	$2,160	Installed-use $3/dia inch
12" Diameter CMP Culvert	30	LF	$36.00	$1,080	Installed-use $3/dia inch
16" Diameter HDPE Pipe	250	LF	$80.00	$20,000	Smooth walled, installed-use $5/dia inch
Energy Dissipator	1	LS	$1,000.00	$1,000	1' riprap, 12'w x 12'l & berm- allow for excavation, waste, geotex
Landfill Gas Collection Trenches	1,600	LF	$11.00	$17,600	Shallow trench w/gravel & CPE Pipe
Landfill Gas Control Vents	12	EA	$500.00	$6,000	Standpipe with fittings - allow per DAH
Misc Detail, Testing & Startup	1	LS	$18,848.80	$18,849	2% of above for details
Subtotal				$961,289	
Contingency	30%			$288,387	
Subtotal				$1,249,675	
Gen. Requirements	10%			$124,968	
Construction Total				$1,374,643	
Sales Tax	8.0%			$109,971	Work might be exempt from sales tax under MTCA
Total (Rounded)				$1,480,000	

NOTE: The above cost opinion does not include engineering, construction management, financing, escalation, land acquisition or O&M costs.
The cost shown has been prepared for guidance in project evaluation from the information available at the time of preparation. The final costs of the project will depend on actual labor and material costs, actual site conditions, productivity, competitive market conditions, final project scope, final schedule and other variable factors. As a result, the final project costs will vary from those presented above.

BAINBRIDGE ISLAND LANDFILL FS REPORT
Consolidation and Containment
Post-Closure Order of Magnitude Cost Estimate

Item Description	Units	Estimated Quantity	Unit Price	Line Total	Totals
FIRST YEAR POST-CLOSURE COSTS					
General Site Maintenance	Days	20	$ 1,200	$24,000	$24,000
Environmental Monitoring					
Quarterly Sampling and Reporting	Qtr	4	$ 10,000.00	$40,000	
Annual Report Preparation	LS	1	$ 10,000.00	$10,000	
					$50,000
Total First Year Post Closure Costs					**$74,000**
SUBSEQUENT ANNUAL POST-CLOSURE COSTS					
General Site Maintenance	Days	5	$ 1,200	$6,000	$6,000
Environmental Monitoring (Quarterly through the first 5 years)					
Quarterly Sampling and Reporting	Qtr	4	$ 10,000.00	$40,000	
Annual Report Preparation	LS	1	$ 10,000.00	$10,000	
					$50,000
Environmental Monitoring (Annually through the last 25 years)					
Quarterly Sampling and Reporting	Yr	1	$ 10,000.00	$10,000	
Annual Report Preparation	LS	1	$ 7,000.00	$7,000	
					$17,000
Summary of Annual Post-Closure Costs					
First Year Cost					$74,000
Second through Fifth Year Annual Costs					$56,000
Sixth through Thirtieth Year Annual Costs					$23,000
Total Post-Closure Costs					
First Year Cost	Yr	1	$74,000	$74,000	$74,000
Second Through Fifth Year Costs	Yrs	4	$56,000	$224,000	$224,000
Sixth through Thirtieth Year Costs	Yrs	25	$23,000	$575,000	$575,000
Total Cost					**$873,000**
Net Present Value (Discount Rate of 5.0%, assuming 8% return and 3% inflation)					**$513,582**

Bainbridge Island Landfill FS **02/11/2000**
Order of Magintude Cost Estimate **152203.A0.12**
Reclamation
BY: A. Pyle, S. Harding, T. Kraemer

Excavate, Process and Regrade Inerts

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT	
Utilities	1	LS		$50,000	
Excavation, Load, Haul	118400	CY	$7	$828,800	Excavate, load and haul to screen plant
Screening	81225	T	$2.67	$216,871	See attached for screen plant operation breakdown
Haul, Regrade and Compact Inerts	68307	CY	$4.00	$273,228	Re-haul inerts into landfill excavation and compact
Temporary Erosion Control	1	LS		$30,000	
Sampling and Analysis	1	LS		$50,000	
Seed Disturbed Areas	12	AC	2000	$24,000	
		Subtotal		**$1,472,899**	
		Contingency (30%)		**$441,870**	
		Gen. Requirements (10%)		**$147,290**	
		Construction Total		**$2,062,058**	
		Sales Tax (8.0%)		**$164,965**	Work might be exempt from sales tax under MTCA
		Total		**$2,227,023**	
		Rounded Total		**$2,200,000**	

NOTE: The above cost opinion does not include engineering, construction management, financing, escalation, land acquistion or O&M costs.
This Cost Opinion has been prepared for guidance in project evaluation from the information available at the time and the limited amount of time given its preparation. The final costs of the project will depend on the actual labor and material cost, site conditions, productivity, final project scope, final project schedule and other variable factors. As a result, the final project costs will vary from the cost presented above. Because of these factors, funding needs must be carefully reviewed prior to making specific financial decisions or establishing final budgets.

Bainbridge Island Landfill FS **02/11/2000**
Order of Magintude Cost Estimate **152203.A0.12**
Reclamation
BY: A. Pyle, S. Harding, T. Kraemer

Bulky Offsite Disposal - Subtitle D

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT
Gate Rate	14,711	T	26.24	$ 386,016.64
Haul Rate	14,711	T	$0.10	$1,471
Distance	200	MI		$294,220
			Subtotal	$680,237
			Contingency (30%)	$204,071
			Construction Total	$884,308
			Sales Tax (8.0%)	$70,745
			Total	**$955,052**

Columbia Ridge Gate Rate
$0.10/T/MI Haul rate

Garbage Offsite Disposal - Subtitle D

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT
Gate Rate	3,961	T	26.24	$ 103,936.64
Haul Rate	3,961	T	$0.10	$396
Distance	200	MI		$79,220
			Subtotal	$183,157
			Contingency (30%)	$54,947
			Construction Total	$238,104
			Sales Tax (8.0%)	$19,048
			Total	**$257,152**

Columbia Ridge Gate Rate
$0.10/T/MI Haul rate

Bainbridge Island Landfill FS **02/11/2000**
Order of Magintude Cost Estimate **152203.A0.12**
Reclamation
BY: A. Pyle, S. Harding, T. Kraemer

Garbage Composting

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT
Mechanical Eqpt	1	LS	143000	$ 143,000.00
Electrical Eqpt	1	LS	$53,000.00	$ 53,000.00
Piping	1	LS	$5,000.00	$ 5,000.00
Subgrade Prep., Temp. drainage	1	LS	$0.00	$ -
Amendments, Feedstock Adjust.	1	LS	$20,000.00	$ 20,000.00
Diesel Power System	1	LS	$15,000.00	$ 15,000.00
On-site Construction Mgmt.	1	LS	$30,000.00	$ 30,000.00
O&M	2	Months	$25,000.00	$ 50,000.00
			Subtotal	$316,000
			Contingency (30%)	$94,800
			Construction Total	$410,800
			Sales Tax (8.0%)	$32,864
			Total	**$443,664**

Inert Offsite Disposal - Subtitle D

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT
Gate Rate	62,525	T	26.24	$ 1,640,656.00
Haul Rate	62,525	T	$0.10	$6,253
Distance	200	MI		$1,250,500
			Subtotal	$2,891,156
			Contingency (30%)	$867,347
			Construction Total	$3,758,503
			Sales Tax (8.0%)	$300,680
			Total	**$4,059,183**

Columbia Ridge Gate Rate
$0.10/T/MI Haul rate

Bainbridge Island Landfill FS
Order of Magintude Cost Estimate
Reclamation
BY: A. Pyle, S. Harding, T. Kraemer

02/11/2000
152203.A0.12

Inert Soil Washing

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT
Inert Material	62,525	T	$75	$4,689,375
			Subtotal	$4,689,375
			Contingency (30%)	$1,406,813
			Construction Total	$6,096,188
			Sales Tax (8.0%)	$487,695
			Total	**$6,583,883**

Based on a 1993 EPA Specification Document, adjusted for inflation, but not adjusted for potential increased efficiency.
Includes Subtitle C disposal.

Inert Onsite Bioremediation

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT
Inert Material	62,525	T	$150	$9,378,750
			Subtotal	$9,378,750
			Contingency (30%)	$2,813,625
			Construction Total	$12,192,375
			Sales Tax (8.0%)	$975,390
			Total	**$13,167,765**

Based on a 1994 EPA Specification Document, adjusted for inflation, but not adjusted for potential increased efficiency.
Heterogenous mixture of many different contaminants at lower levels does not lend itself to efficient bioremediation.

Bainbridge Island Landfill FS **02/11/2000**
Order of Magintude Cost Estimate **152203.A0.12**
Reclamation
BY: A. Pyle, S. Harding, T. Kraemer

Inert Onsite Steam Injection

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT
Inert Material	62,525	T	$100	$6,252,500
Material Placement	1	LS	$127,051	$127,051
			Subtotal	$6,379,551
			Contingency (30%)	$1,913,865
			Construction Total	$8,293,416
			Sales Tax (8.0%)	$663,473
			Total	**$8,956,890**

BY: A. Pyle, S. Harding, T. Kraemer

Inert Stockpile Cap - Soil

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT
Compacted onsite soil cap	10,330	CY	$7	$72,310

Subtotal	$72,310
Contingency (30%)	$21,693
Construction Total	$94,003
Sales Tax (8.0%)	$7,520
Total	**$101,523**

Assumes placement of 2' of onsite compacted soil over 3.2 ac

Inert Stockpile Cap - HDPE

ITEM	QTY	UNIT	TOTAL UNIT COST	TOTAL AMOUNT
60 mil HDPE cap	3.2	AC	$290,400	$929,280

Subtotal	$929,280
Contingency (30%)	$278,784
Construction Total	$1,208,064
Sales Tax (8.0%)	$96,645
Total	**$1,304,709**

Based on Kootenai 14ac cap use $60/sy for 3.2ac

BAINBRIDGE ISLAND LANDFILL FS REPORT
Reclamation
Post-Closure Order of Magnitude Cost Estimate

Item Description	Units	Estimated Quantity	Unit Price	Line Total	Totals
FIRST 5 YEARS POST-CLOSURE COSTS					
General Site Maintenance	Days	10	$ 1,200	$12,000	$12,000
Environmental Monitoring					
Quarterly Sampling and Reporting	Qtr	4	$ 8,000.00	$32,000	
Annual Report Preparation	LS	1	$ 9,000.00	$9,000	
					$41,000
Total Annual Post-Closure Costs Years 1 through 5					**$53,000**
Minimum 5 Years Duration	Years	5	$53,000	$265,000	**$265,000**
SUBSEQUENT ANNUAL POST-CLOSURE COSTS					
General Site Maintenance	Days	3	$ 1,200	$3,600	$3,600
Environmental Monitoring					
Annual Sampling and Reporting	Yr	1	$ 8,000.00	$8,000	
Annual Report Preparation	LS	1	$ 6,000.00	$6,000	
					$14,000
Total Annual Post-Closure Costs Years 6 through 30					**$17,600**
Minimum 25 Years Duration	Years	25	$17,600	$440,000	**$440,000**
Total Post-Closure Costs, Years 1 through 30					**$705,000**
Net Present Value (Discount Rate of 5.0%, assuming 8% return and 3% inflation)					**$423,819**