STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Northwest Regional Office • 3190 160th Avenue SE • Bellevue, Washington 98008-5452 • (425) 649-7000

September 5, 2014

Alexis McKinnon
Kitsap County Public Works, Solid Waste Division
614 Division Street (MS-27)
Port Orchard, WA 98366

Re: Opinion on Proposed Cleanup of a Property associated with a Site:

- Property Address: Olalla Road & Bandix Road, Olalla, WA 98359
- Facility/Site No.: 7057711
- Site Address: Olalla Road & Bandix Road, Olalla, WA 98359

Dear Ms. McKinnon:

The Washington State Department of Ecology (Ecology) received your request for an opinion on your proposed independent cleanup of a Property associated with the Olalla Landfill Site. This letter provides our opinion. We are providing this opinion under the authority of the Model Toxics Control Act (MTCA), Chapter 70.105D RCW.

A "hazardous waste site" or "site" is any location "where there has been confirmation of a release of a hazardous substance that requires remedial action." WAC 173-340-200. Under MTCA, a site is defined by the nature and extent of contamination associated with one or more releases of hazardous substances. A site can include more than one parcel of real property.

In this letter, the Olalla Landfill Property, or Property, refers to the landfill property owned by Kitsap County Public Works (KCPW). The Olalla Landfill Site, or Site, refers to the area affected by the release of hazardous substances from the Olalla Landfill. The Site includes the portion of the Olalla Landfill Property impacted by the landfill and any offsite property affected by the landfill.

Based on groundwater sampling and analysis results reported in the Olalla Landfill Remedial Investigation/Feasibility Study, the Olalla Landfill Site likely extends beyond the Olalla Landfill property boundary to the adjacent property to the west. (Parametrix, 2014) We understand the adjacent property owner has refused property access to allow investigation of the groundwater plume. Because of this, the Olalla Landfill Site is not fully characterized outside of the landfill property. Sampling of off-site drinking water wells during the remedial investigation (RI) and

twice in earlier years, however, provides some characterization of off-site downgradient groundwater conditions.

Issues Presented and Opinion

1. Upon completion of the proposed cleanup, will further remedial action likely be necessary at the Property to clean up contamination associated with the Site?

   Ecology has determined that further remedial action MAY be necessary at the Property to clean up contamination associated with the Site.

2. Upon completion of the proposed cleanup, will further remedial action likely still be necessary elsewhere at the Site?

   Ecology has determined that further remedial action MAY be necessary elsewhere at the Site.

This opinion is based on an analysis of whether the remedial action meets the substantive requirements of MTCA, Chapter 70.105D RCW, and it's implementing regulations, Chapter 173-340 WAC (collectively "substantive requirements of MTCA"). The analysis is provided below.

Description of the Property and the Site

This opinion applies only to the Property and the Site described below. This opinion does not apply to any other sites that may affect the Property. Any such sites, if known, are identified separately below.

1. **Description of the Property.**

   The Property includes the following tax parcel in Kitsap County, which was affected by the Site and will be addressed by your cleanup:

   - 012201-1-029-2003.

   Enclosure A includes a legal description of the Property. **Enclosure B** includes a diagram of the Site that illustrates the location of the Property within the Site.

2. **Description of the Site.**

   The Site is defined by the nature and extent of contamination associated with the following releases from the landfill:

   - Arsenic, iron, manganese, and vinyl chloride to groundwater.
   - Arsenic to surface water.

   Those releases may have affected more than one parcel of real property, including the parcel identified above.

Enclosure B includes a detailed description and diagrams of the Site, as currently known to Ecology.

3. **Identification of Other Sites that may affect the Property.**

Please note a parcel of real property can be affected by multiple sites. At this time, we have no information that the Property is affected by other sites.

Basis for the Opinion

This opinion is based on the information contained in the following documents:

1. Parametrix. *Olalla Landfill Remedial Investigation Feasibility Study*. May 2014. Prepared for Kitsap County Department of Public Works Solid Waste Division. (Parametrix, 2014)
2. Quarterly and annual environmental monitoring reports submitted to Kitsap Public Health District and the Department of Ecology in accordance with the requirements of chapter 173-304 WAC between January 2008 and December 2013.

Those documents are kept in the Central Files of the Northwest Regional Office of Ecology (NWRO) for review by appointment only. You can make an appointment by calling the NWRO resource contact at (425) 649-7235.

This opinion is void if any of the information contained in those documents is materially false or misleading.

Analysis of the Cleanup

1. **Cleanup of the Property located within the Site.**

Ecology has concluded that, upon completion of your proposed cleanup, **further remedial action MAY** be necessary at the Property to clean up contamination associated with the Site. That conclusion is based on the following analysis:

a. **Characterization of the Site.**

Ecology has determined your characterization of the Site is sufficient to establish cleanup standards for the Site and select a cleanup for the Property. The site is described above and in **Enclosure B.**

Groundwater at Olalla Landfill has been monitored quarterly since 1992. The current monitoring network includes nine wells, five of which monitor the downgradient property boundary. Samples collected are analyzed for volatile organic compounds (VOCs), conventional parameters, total coliform, and metals common to landfill leachate. As a result, a large and comprehensive database of groundwater quality and elevation measurements exists.

Surface water samples were collected during quarterly monitoring events, when surface water was present.

In addition to groundwater and surface water monitoring, RI activities included excavating test pits in the Phase II Area where MSW was not believed to be present. MSW was not found in the test pits; mostly construction and demolition debris and fill dirt covered with vegetated soil were encountered in the Phase II area. The RI also included analyzing landfill gas samples for VOCs to evaluate landfill gas as a source of VOCs in groundwater. Landfill gas was determined to not be a source of VOCs in groundwater.

The characterization is sufficient to characterize the contaminants present in groundwater and surface water. The downgradient extent of contaminants in groundwater, however, has not been defined because an adjacent property owner refused to allow KCPW access. Even so, cleanup standards - cleanup levels and a point of compliance - can be established and a cleanup remedy proposed.

The constituents of concern and the maximum concentrations detected are reported in the Olalla Remedial Investigation/Feasibility Study (RI/FS) report (Parametrix, 2014) as:

- Groundwater – arsenic (2.77 µg/L), iron (2,150 µg/L), manganese (6,240 µg/L), and vinyl chloride (0.16 µg/L)
- Surface water – arsenic (0.737 µg/L)
- Soil – none
- Landfill gas – none

b. **Establishment of cleanup standards for the Site.**

Ecology has determined the cleanup levels and point of compliance you established for the Site meet the substantive requirements of MTCA.

The report established groundwater cleanup levels based on the use of groundwater for drinking water supplies and using MTCA Method B Levels from the Cleanup Levels and Risk Calculation (CLARC) Database. Cleanup levels and their bases are as follows:

- Arsenic: 1.29 µg/L (based on background concentrations in groundwater)
- Iron: 300 µg/L [based on the State secondary Maximum Contaminant Level (MCL)]
- Manganese: 50 µg/L (based on the State secondary MCL)

- Vinyl chloride: 0.29 µg/L [based on adjusting the MCL downward to a concentration representing a 1×10^{-5} excess cancer risk in accordance with WAC 173-340-720(7)(b).]

For arsenic in surface water, the proposed cleanup level is 1.29 µg/L and is based on the protection of groundwater.

The RI/FS report proposed a conditional point of compliance (POC) at the downgradient property boundary for the protection of groundwater migrating off of the property.

The cleanup standards meet the substantive requirements of MTCA:

- They are at least as stringent as all applicable state and federal laws
- Method B CLARC database values were used
- Surface water to groundwater cross media contamination was addressed
- Natural background concentration for arsenic was established
- Monitoring procedures are in place for demonstrating compliance with cleanup standards

MTCA allows for a conditional POC for groundwater where it is not practicable to meet the cleanup level throughout the site within a reasonable restoration time frame. In such cases, Ecology may approve a conditional POC, provided the point is located as close to the source of contamination as possible. [Ecology publication Focus No. 94-130, November 2007 (revised).] A conditional POC near the downgradient property boundary at the Olalla Landfill is allowed because:

- Removing the source – that is, the landfilled refuse – is not practical.
- The ground surface drops off steeply at the downgradient edges of the Phase I and Phase II areas. The placement of monitoring wells closer to the edge of the waste than the location of the proposed POC wells is not practical.

c. **Selection of cleanup for the Property.**

Ecology has determined the cleanup you proposed for the Property meets the substantive requirements of MTCA. Your proposed cleanup meets minimum cleanup requirements and will not exacerbate conditions or preclude reasonable cleanup alternatives elsewhere at the Site.

The proposed cleanup action for the Olalla Landfill is Alternative 1, Monitored Natural Attenuation, which includes:

- Ongoing quarterly groundwater and surface water monitoring
- Quarterly data reports
- Evaluation of effectiveness of the alternative at 5-year intervals, including human exposure to landfill-impacted groundwater by sampling off-site drinking water wells
- No later than 10 years after beginning the cleanup action, re-evaluation of performance data and re-consideration of viable alternatives, including Alterative 2, Geomembrane cap over Phase I, for the cleanup action.

Previous actions taken at the Olalla Landfill include construction of an engineered cover over the Phase I area, a soil cover over the Phase II area, a surface water management system, and a landfill gas collection and flare/vent system. These improvements and control systems will continue to be maintained in accordance with the facility's Post-Closure Plan, prepared and implemented in accordance with WAC 173-304-407.

The proposed alternative is described and discussed in the RI/FS report (Parametrix, 2014). The proposed cleanup action meets the minimum requirements in WAC 173-340-360(2), Minimum requirements for cleanup actions.

Protective of human health and the environment: The existing cap and soil cover reduce the leaching potential through the waste and prevent contact with waste materials. Off-site drinking water wells are sampled periodically to confirm landfill-impacted groundwater is not affecting drinking water supplies.

Compliance with cleanup standards: Cleanup levels and a point of compliance were established in accordance with WAC 173-340-720. While the restoration period (time to reach cleanup levels at the POC) is uncertain and could take longer than 10 years, the cleanup action includes an evaluation, no later than 10 years from implementation, of progress toward meeting cleanup standards with a re-consideration of other cleanup actions.

The cleanup action **Complies with applicable state and federal laws** and **Provides for Compliance Monitoring.** Ongoing groundwater monitoring continues to monitor performance of the action and compliance with cleanup levels.

In addition, as described in the RI/FS report (Parametrix, 2014), the proposed cleanup action adequately addresses the "Other requirements" and "Ground water cleanup actions" of WAC 173-340-360(2) (b) and (c).

Institutional controls include control of property access and financial assurance for ongoing monitoring and maintenance. An Environmental Covenant will be put in place when the landfill ends its post-closure period. Up until that time, the landfill will operate under a permit issued by the Kitsap Public Health District. The permit requires, among other things, access controls and financial assurance for the post-closure period.

The proposed cleanup action does not exacerbate conditions at the site or preclude other alternatives.

2. **Cleanup of the Site as a whole.**

Ecology has concluded that **further remedial action** may still be necessary elsewhere at the Site upon completion of your proposed cleanup. In other words, while your proposed cleanup MAY constitute the final action for the Property, it may constitute only an **"interim action"** for the Site as a whole.

The cleanup of the Site as a whole remains an unknown until investigation can occur on the downgradient property. Ecology recommends KCPW repeat their request for downgradient access during the 5-year evaluations. Knowing downgradient conditions will allow KCPW to better assess the restoration period and plan accordingly for financial needs associated with the Site.

Limitations of the Opinion

1. **Opinion does not settle liability with the state.**

Liable persons are strictly liable, jointly and severally, for all remedial action costs and for all natural resource damages resulting from the release or releases of hazardous substances at the Site. This opinion **does not:**

- Change the boundaries of the Site.
- Resolve or alter a person's liability to the state.
- Protect liable persons from contribution claims by third parties.

To settle liability with the state and obtain protection from contribution claims, a person must enter into a consent decree with Ecology under RCW 70.105D.040(4).

2. **Opinion does not constitute a determination of substantial equivalence.**

To recover remedial action costs from other liable persons under MTCA, one must demonstrate that the action is the substantial equivalent of an Ecology-conducted or Ecology-supervised action. This opinion does not determine whether the action you proposed will be substantially equivalent. Courts make that determination. *See* RCW 70.105D.080 and WAC 173-340-545.

3. **Opinion is limited to proposed cleanup.**

This letter does not provide an opinion on whether further remedial action will actually be necessary at the Property upon completion of your proposed cleanup. To obtain such an opinion, you must submit a report to Ecology upon completion of your cleanup and request such an opinion.

4. **State is immune from liability.**

The state, Ecology, and its officers and employees are immune from all liability, and no cause of action of any nature may arise from any act or omission in providing this opinion. *See* RCW 70.105D.030(1)(i).

Contact Information

Thank you for choosing to clean up your Property under the MTCA process. As you conduct your cleanup, please do not hesitate to contact us. We look forward to continuing working with you.

If you have any questions about this opinion, please contact me by phone at 425-649-7015 or by e-mail at madeline.wall@ecy.wa.gov.

Sincerely,

Madeline Wall

Madeline Wall, P.E.
NWRO Waste 2 Resources Program

MW/SE

Enclosures (2): A – Legal Description of the Property
B – Description and Diagrams of the Site (including the Property)

cc: Pat Campbell, Kitsap County Public Works
David Dinkuhn, P. E., Parametrix
Doug Kunkel, LG, LHG, Environmental Partners, Inc.
Jan Brower, Kitsap Public Health District
Grant Holdcroft, Kitsap Public Health District
Peter Christiansen, Ecology, Waste 2 Resources
Krystyna Kowalik, LG, LHG, Ecology, Waste 2 Resources

Enclosure A

Legal Description of the Property

The legal description of the Olalla Landfill Property is as follows:

The North 1590 feet of the east half of the Northeast Quarter of Section 1, Township 22 North, Range 1 East, W.M., Kitsap County, Washington; except for the North 50 feet; and except the East 50 feet.

Enclosure B

Description and Diagrams of the Site (Including the Property)

Olalla Landfill Site Description and History
September 5, 2014

The Olalla Landfill is a closed municipal solid waste landfill located at the corner of Bandix Road and Burley-Olalla Road, approximately 0.75 miles east of Highway 16 in Kitsap County, Washington. The landfill, owned by Kitsap County Public Works (KCPW), was closed in the late 1980s in accordance with the closure requirements of chapter 173-304 WAC. KCPW now operates the closed landfill in accordance with the post-closure requirements of chapter 173-304 WAC under a permit issued by Kitsap Public Health District (KPHD). The landfill consists of 12 acres of a 45-acre parcel that includes a drop box facility known as the Olalla Recycling and Garbage Facility. The drop box facility area was not used as a landfill and is separated from the landfill by a fence and locked gate.

The landfill consists of an area of municipal solid waste capped by a low-permeability soil barrier and a vegetated protective soil cap (Phase I Area) and an area of mostly construction and demolition debris and fill dirt covered with vegetated soil (Phase II Area). A gravel perimeter access road surrounds both areas.

The unlined landfill is situated in an old gravel pit. The landfill area contains a groundwater monitoring well network, a passive landfill gas collection system, a surface water conveyance system, a stormwater detention/infiltration pond, public access controls, and a surrounding vegetation buffer.

Hazardous Substance Released

Based on results of quarterly environmental monitoring conducted from 1992 to the present and a Remedial Investigation/Feasibility Study (RI/FS) conducted between 2010 and 2013, chemicals typically associated with municipal solid waste landfills are present in groundwater beneath the landfill property. Those chemical are: arsenic, iron, manganese, and vinyl chloride.

Results of surface water sampling found arsenic in samples from the perimeter ditch and the detention pond inlet at levels exceeding the state groundwater protection standard of 0.05 µg/L.

Landfill gas samples collected during the RI did not contain detectable levels of chlorinated VOCs. Other VOCs detected in the gas samples (Freon 11, 12, and 114, acetone, heptane, hexane, and toluene) have not been detected in groundwater (Freon 11 and 12), not analyzed in groundwater because they are not part of the solid waste permit parameter list (Freon 114, heptanes, hexane), is a laboratory solvent commonly detected in groundwater samples at low levels (acetone), or has not been detected in groundwater since 2007 (toluene).

The constituents of concern and maximum concentrations detected are reported in the RI report as:

- Groundwater – arsenic (2.77 µg/L), iron (2,150 µg/L), manganese (6,240 µg/L), and vinyl chloride (0.16 µg/L)
- Surface water – arsenic (0.737 µg/L)

- Soil – none
- Landfill gas – none

Source of contamination

The source of contaminants in groundwater is the landfill. Leachate leaking from the landfill through subsurface soil into groundwater carries contaminants such as vinyl chloride and creates a reducing environment that can result in naturally occurring metals in the soil to go into solution resulting in elevated levels of metals such as arsenic, iron, and manganese in the groundwater. Landfill gas migrating from the landfill can also contribute to the reducing environment and can carry volatile compounds into groundwater.

Surface water at the landfill does not contact waste. Elevated levels of arsenic in surface water may be the result of naturally occurring arsenic is the area soils.

Cleanup Standards

The RI/FS report proposed a conditional point of compliance at the downgradient property boundary. The report proposed groundwater cleanup levels as follows:

- Arsenic: 1.29 µg/L (based on background concentrations in groundwater)
- Iron: 300 µg/L (based on the State secondary MCL)
- Manganese: 50 µg/L (based on the State secondary MCL)
- Vinyl chloride: 0.29 µg/L (based on an adjusted MCL)

For arsenic in surface water, the proposed cleanup level is 1.29 µg/L and is based on the protection of groundwater. Most surface water infiltrates onsite.

Extent of contamination

Arsenic, iron, and manganese are present at levels exceeding groundwater cleanup standards at the downgradient property boundary. The County has been refused access to adjacent downgradient property for further investigation.

Arsenic detected in surface water is at levels below the cleanup level.

Geology/hydrogeology

The hydrostratigraphy beneath the landfill comprises granular deposits emplaced during the Vashon glaciation. The geologic formations underlying the landfill contain three distinct occurrences of groundwater beneath the landfill. From shallowest to deepest they are: the shallow perched groundwater zone, which is perched on top of the ice-contact deposits (Qvi) and is found only in the northern portion of the property at MW-5, MW-5A, and the South Kitsap County Transfer Station Well; the uppermost unconfined aquifer, which occurs in the advance

outwash deposits (Qva); and the deeper confined aquifer, which occurs in the Olympia Beds (Qob).
The general groundwater flow direction beneath the landfill is consistent throughout the year and is generally toward the northwest. During the RI, groundwater elevations ranged from approximately 268 feet NGVD in the upgradient well MW-1 to 248 feet NGVD in the downgradient well MW-10. Depth to water ranged from about 18 feet below ground surface (bgs) in downgradient well MW-6 to 80 feet bgs in upgradient well MW-1. Groundwater flow velocity was estimated to average approximately 2 feet per day.

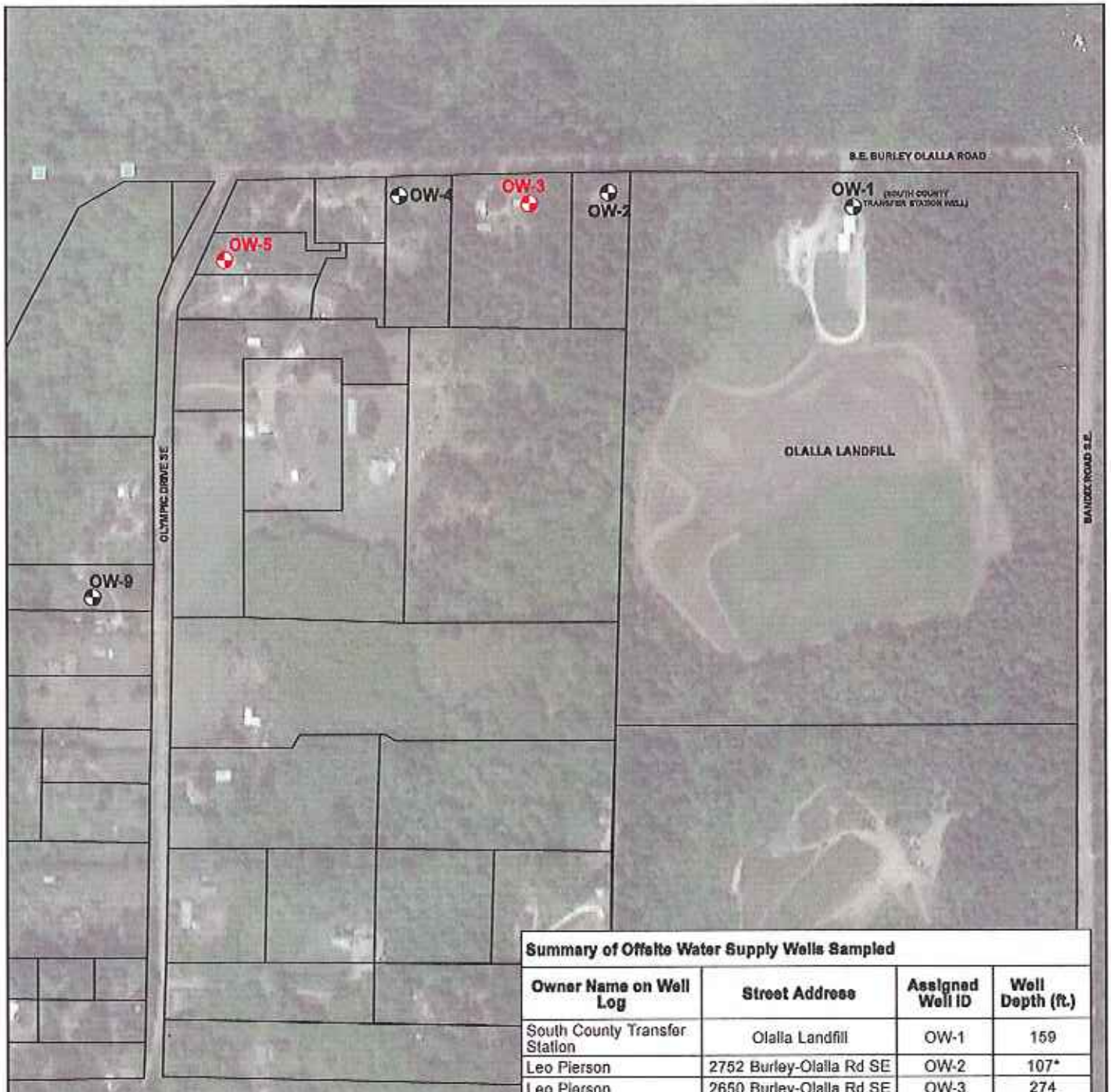
Exposure Pathway

The potential exposure pathway is ingestion of groundwater. The source of drinking water for downgradient residents is groundwater. Offsite wells were sampled and tested in 1995, 1997, and during the RI, and no indication of landfill impacts were noted. Three of the six drinking water wells sampled during the RI are screened in the upper aquifer, where landfill monitoring wells are screened. Two of the drinking water wells are screened in the deeper confined aquifer. One well does not have adequate records to determine depth, but is believed to be screened in the upper aquifer based on dissolved oxygen measurements.

Site/Property Diagrams

The following diagrams from the Olalla Landfill Remedial Investigation/Feasibility Study (Parametrix, 2014) are provided to illustrate landfill property layout and site conditions:

- Figure 2-2 Offsite Water Supply Well Sampling Locations
- Figure 2-5 Landfill Gas Flare Locations and Underground Piping System *(Shows overall facility layout and monitoring locations)*
- Figure 4-1 Hydrogeologic Cross Section Alignments
- Figure 4-2a Geologic Cross Section A-A′
- Figure 4-2b Geologic Cross Section B-B′
- Figure 4-2c Geologic Cross Section C-C′
- Figure 4-2d Geologic Cross Section D-D′
- Figure 2-2 *altered to show approximate boundary of Olalla Landfill Site*



Summary of Offsite Water Supply Wells Sampled			
Owner Name on Well Log	**Street Address**	**Assigned Well ID**	**Well Depth (ft.)**
South County Transfer Station	Olalla Landfill	OW-1	159
Leo Pierson	2752 Burley-Olalla Rd SE	OW-2	107*
Leo Pierson	2650 Burley-Olalla Rd SE	OW-3	274
Leo Pierson	2590 Burley-Olalla Rd SE	OW-4	unknown
Gene Ryker	13041 Olympic Drive SE	OW-5	279
Shoemaker	13320 Olympic Drive SE	OW-9	61

SOURCES:
- BREMERTON-KITSAP COUNTY HEALTH DISTRICT MEMORANDUM TITLED "OLALLA LANDFILL DOMESTIC WELL SURVEY INFORMATION" OCTOBER 23, 1996
- ECOLOGY WELL LOG DATABASE (WEBSITE)
- KITSAP COUNTY PARCEL LOCATOR (WEBSITE)
- GOOGLE EARTH

KEY:
* Well information provided by owner. Well log not available in KCHD records or Ecology Well Log database.
: OFFSITE WELL LOCATION (UPPER AQUIFER)
: OFFSITE WELL LOCATION (DEEPER AQUIFER)
: PARCEL BOUNDARY

N

0 100 200 400

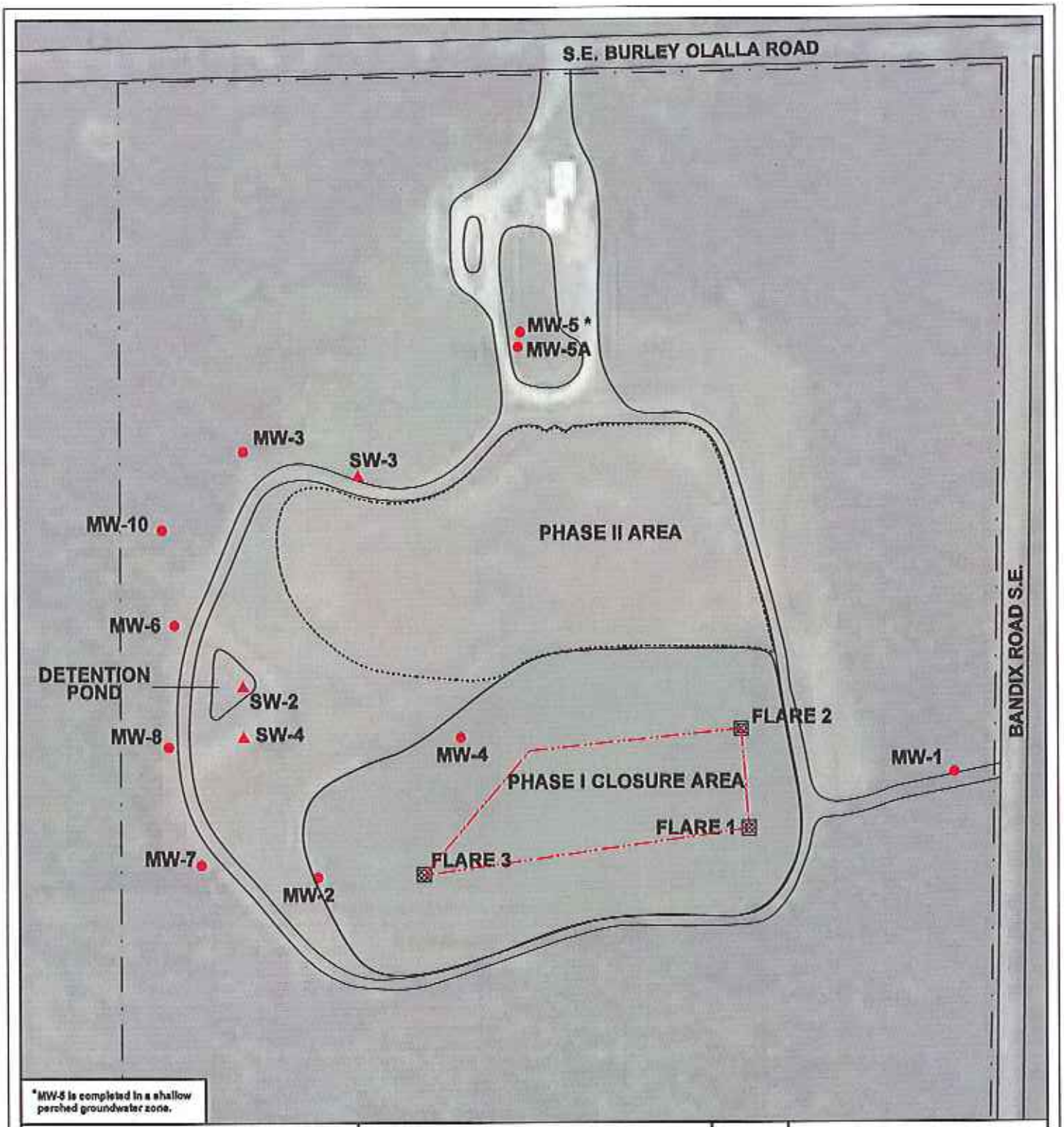
SCALE: 1" = 400'

ENVIRONMENTAL PARTNERS INC
295 NE Gilman Boulevard, Suite 201
Issaquah, Washington 98027

FIGURE 2-2

OFFSITE WATER SUPPLY WELL SAMPLING LOCATIONS
KITSAP COUNTY, WASHINGTON

PROJECT	60101.0 OLALLA, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
LOCATION	OLALLA LANDFILL RI/FS KITSAP COUNTY, WASHINGTON		
SHEET	DRAWN BY	REVIEWED BY	DATE
1 of 1	ALW	DCK	12/13/12



*MW-5 is completed in a shallow perched groundwater zone.

KEY:
- — · — : APPROXIMATE PROPERTY BOUNDARY
- : PERIMETER ACCESS ROAD
- MW-2 : MONITORING WELL
- SW-2 : SURFACE WATER SAMPLING LOCATION
- : LANDFILL GAS FLARE
- : APPROXIMATE ALIGNMENT OF UNDERGROUND LANDFILL GAS PIPING SYSTEM

N

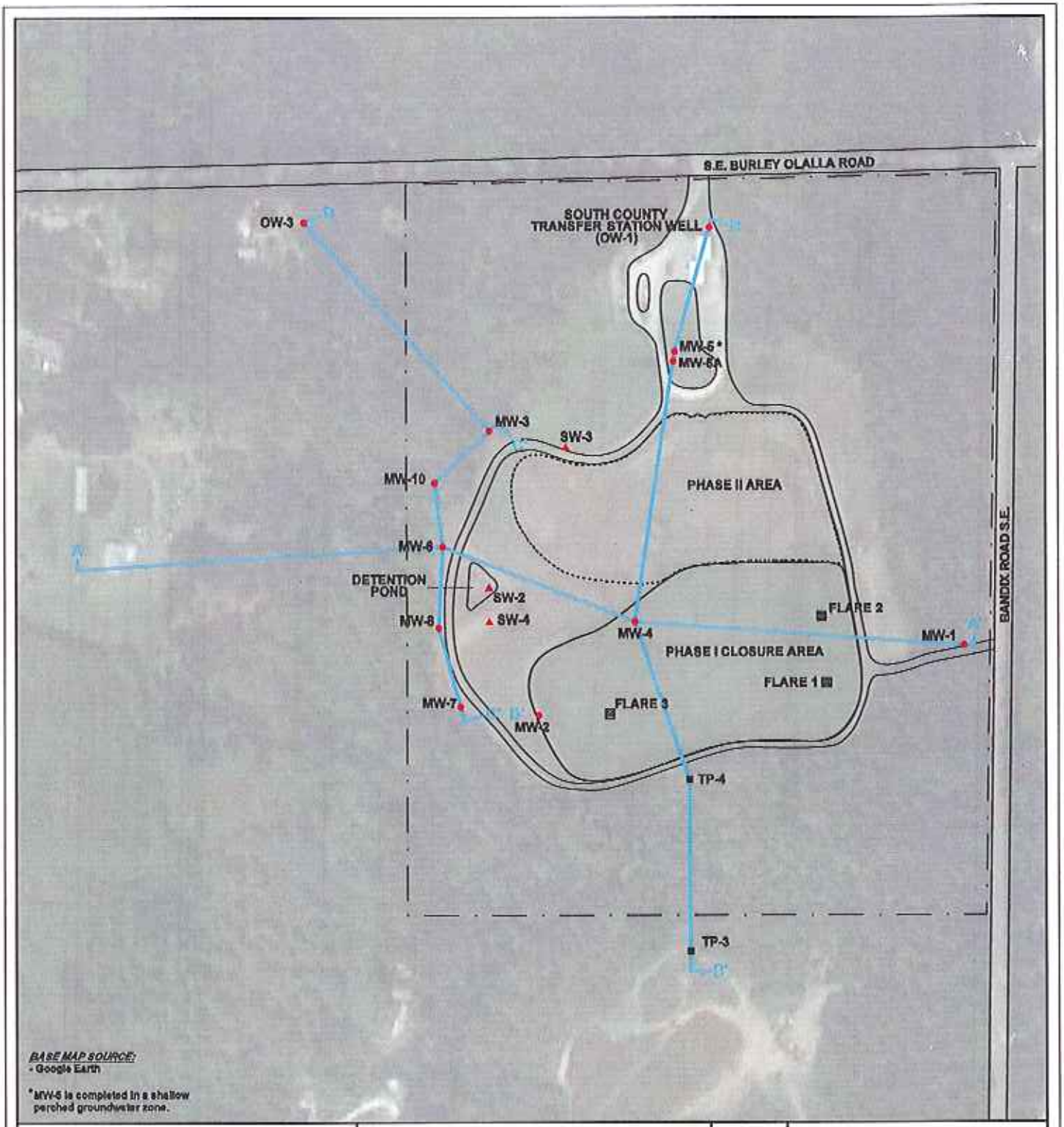
0 50 100 200

SCALE: 1" = 200'

EPI ENVIRONMENTAL PARTNERS INC
293 NE Gilman Boulevard, Suite 201
Issaquah, Washington 98027

FIGURE 2-5
LANDFILL GAS FLARE LOCATIONS AND UNDERGROUND PIPING SYSTEM
KITSAP COUNTY, WASHINGTON

PROJECT	60101.0 OLALLA, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
LOCATION	OLALLA LANDFILL KITSAP COUNTY, WASHINGTON		
SHEET 1 of 1	DRAWN BY ARM	REVIEWED BY DCK	DATE 02/14/12

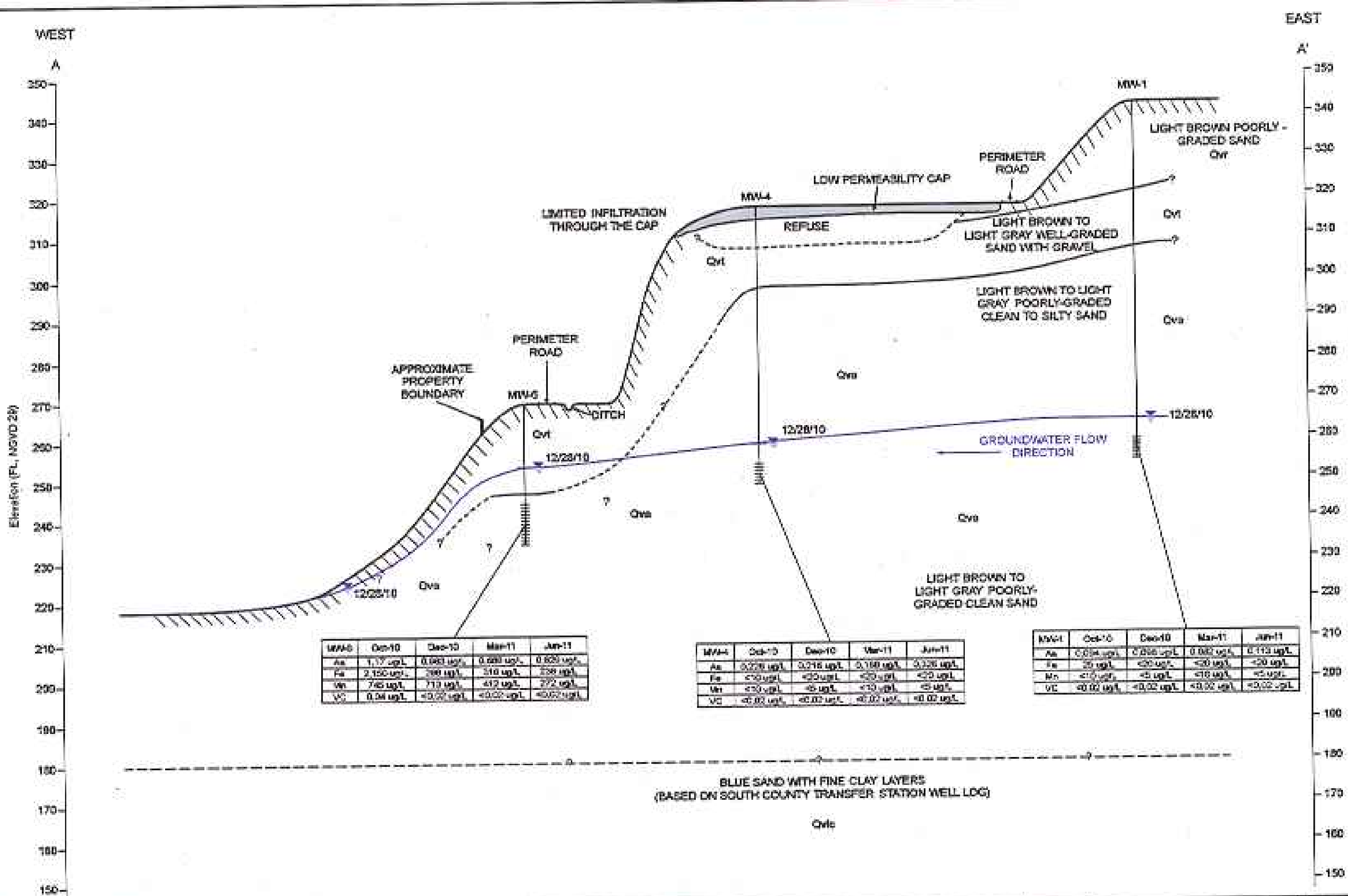


ENVIRONMENTAL PARTNERS INC
295 NE Gilman Boulevard, Suite 201
Issaquah, Washington 98027

FIGURE 4-1

HYDROGEOLOGIC CROSS SECTION ALIGNMENTS
KITSAP COUNTY, WASHINGTON

PROJECT	60101.0 OLALLA, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
LOCATION	OLALLA LANDFILL KITSAP COUNTY, WASHINGTON		
SHEET 1 of 1	DRAWN BY ALW	REVIEWED BY DCK	DATE 12/13/12



MW-6	Oct-10	Dec-10	Mar-11	Jun-11
As	1.17 ug/L	0.983 ug/L	0.680 ug/L	0.829 ug/L
Fe	2,150 ug/L	288 ug/L	310 ug/L	238 ug/L
Mn	745 ug/L	713 ug/L	412 ug/L	272 ug/L
VC	0.04 ug/L	<0.02 ug/L	<0.02 ug/L	<0.02 ug/L

MW-4	Oct-10	Dec-10	Mar-11	Jun-11
As	0.226 ug/L	0.216 ug/L	0.180 ug/L	0.328 ug/L
Fe	<10 ug/L	<20 ug/L	<20 ug/L	<20 ug/L
Mn	<10 ug/L	<5 ug/L	<10 ug/L	<5 ug/L
VC	<0.02 ug/L	<0.02 ug/L	<0.02 ug/L	<0.02 ug/L

MW-1	Oct-10	Dec-10	Mar-11	Jun-11
As	0.094 ug/L	0.096 ug/L	0.082 ug/L	0.113 ug/L
Fe	26 ug/L	<20 ug/L	<20 ug/L	<20 ug/L
Mn	<10 ug/L	<5 ug/L	<10 ug/L	<5 ug/L
VC	<0.02 ug/L	<0.02 ug/L	<0.02 ug/L	<0.02 ug/L

KEY

- GROUND SURFACE
- LITHOLOGIC CONTACT, DASHED WHERE INFERRED.
- MONITORING WELL AND SCREENED INTERVAL
- WATER LEVEL ON 12/28/10

SCALE 1" = 20'

Qvr	**Recessional Outwash Deposits** - Stratified sand and gravel moderately well sorted to well sorted; less common silty sand and silt. Exposed primarily on floors of outwash channels that trend south-southwest between flutes molded by glacial flow.
Qvi	**Ice-Contact Deposits** - Deposits similar in texture to unit Qvr but locally containing much higher percentage of silt intermixed with granular sediments; also includes lenses and pods of till.
Qvt	**Till** - Compact very poorly sorted sediment containing subrounded to well-rounded clasts; glacially transported and deposited. Generally forms undulating surface a few tens of meters thick. Also found sporadically within areas mapped as unit Qvr.
Qva	**Advance Outwash Deposits** - Well-bedded sand and gravel; deposited by streams and rivers that issued from front of advancing ice sheet. Generally unoxidized; almost devoid of silt or clay, except near base of unit.
Qvlc	**Lawton Clay** - Laminated to massive silt, clayey silt, and silty clay; deposited in proglacial or lowland lakes.

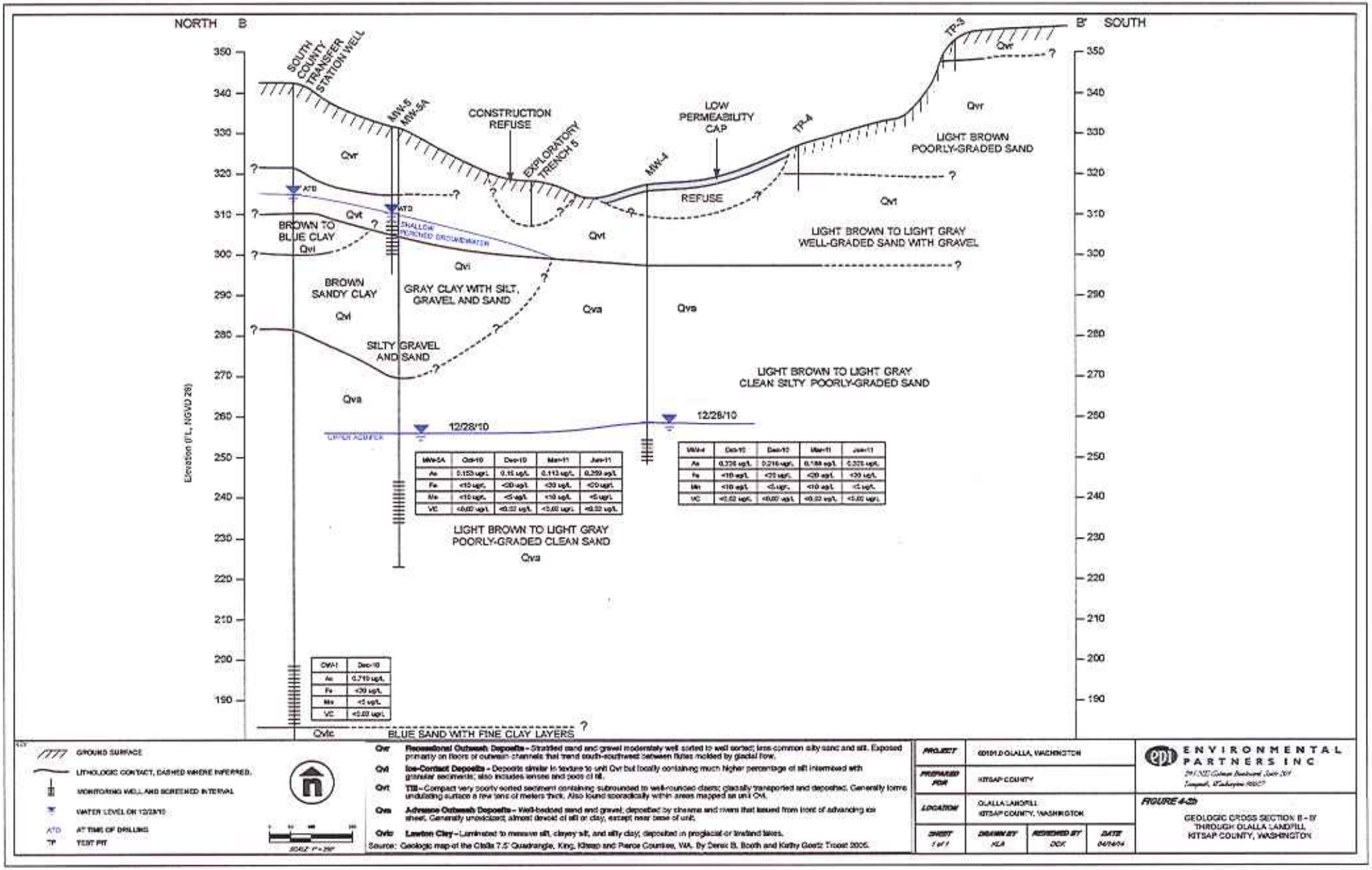
Source: Geologic map of the Olalla 7.5' Quadrangle, King, Kitsap and Pierce Counties, WA. By Derek B. Booth and Kathy Goetz Troost 2005.

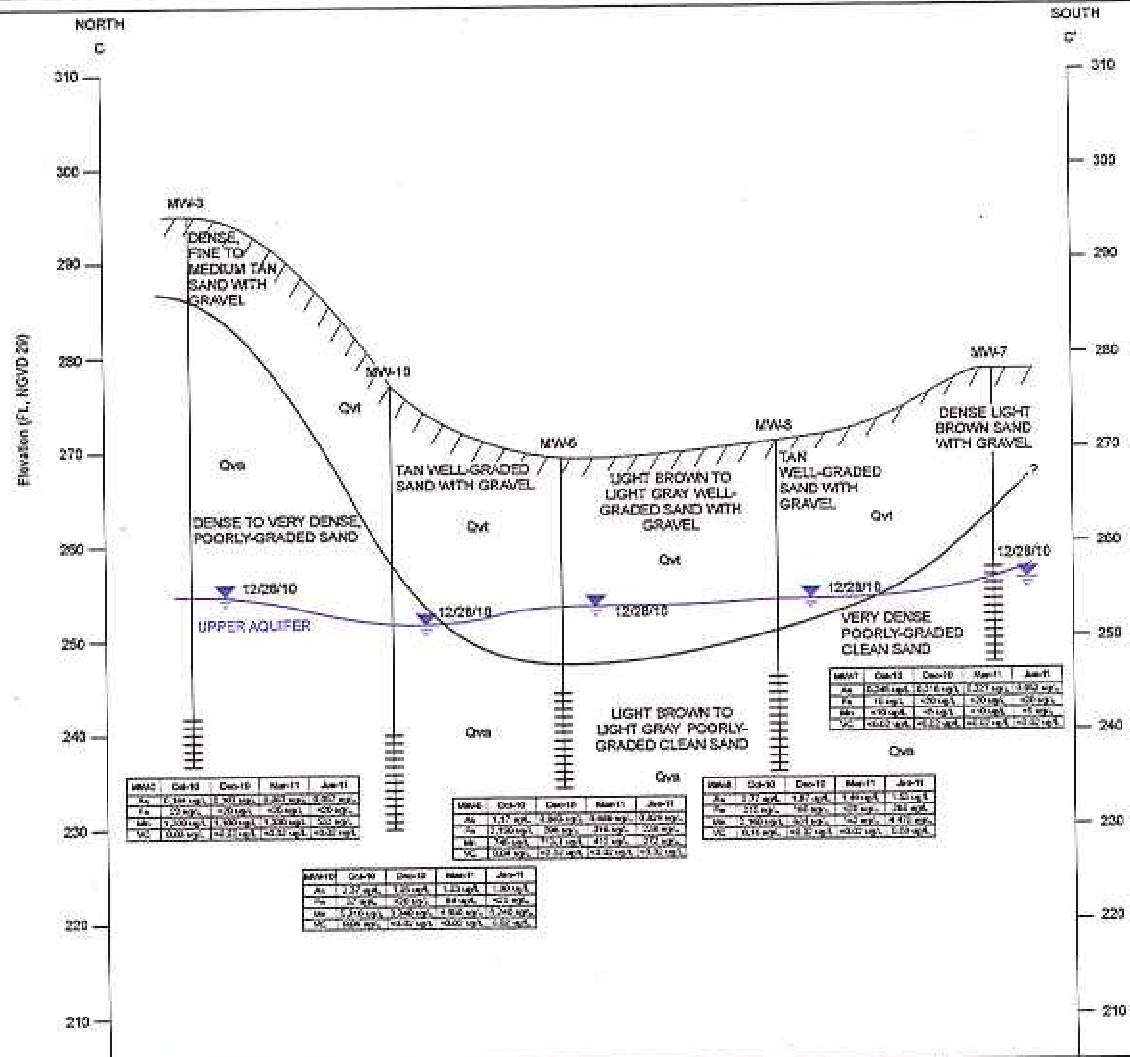
PROJECT	00101.0 OLALLA, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
LOCATION	OLALLA LANDFILL KITSAP COUNTY, WASHINGTON		
SHEET 1 of 1	DRAWN BY KLF	REVIEWED BY DCK	DATE 03/2011

ENVIRONMENTAL PARTNERS INC

FIGURE 4-2a

GEOLOGIC CROSS SECTION A - A'
THROUGH OLALLA LANDFILL
KITSAP COUNTY, WASHINGTON


NORTH
B
B'
SOUTH
SOUTH COUNTY TRANSFER STATION WELL
MW-5
MW-5A
CONSTRUCTION REFUSE
EXPLORATORY TRENCH 5
MW-4
LOW PERMEABILITY CAP
TP-4
TP-3
Qvr
LIGHT BROWN POORLY-GRADED SAND
REFUSE
Qvt
BROWN TO BLUE CLAY
Qvi
ATD
SHALLOW PERCHED GROUNDWATER
LIGHT BROWN TO LIGHT GRAY WELL-GRADED SAND WITH GRAVEL
BROWN SANDY CLAY
GRAY CLAY WITH SILT, GRAVEL AND SAND
Qva
SILTY GRAVEL AND SAND
LIGHT BROWN TO LIGHT GRAY CLEAN SILTY POORLY-GRADED SAND
12/28/10
UPPER AQUIFER
LIGHT BROWN TO LIGHT GRAY POORLY-GRADED CLEAN SAND
Qvic
BLUE SAND WITH FINE CLAY LAYERS
Elevation (FT, NGVD 29)
350
340
330
320
310
300
290
280
270
260
250
240
230
220
210
200
190
MW-5A
Oct-10
Dec-10
Mar-11
Jun-11
As
0.153 ug/L
0.15 ug/L
0.113 ug/L
0.259 ug/L
Fe
<10 ug/L
<20 ug/L
<20 ug/L
<20 ug/L
Mn
<10 ug/L
<5 ug/L
<10 ug/L
<5 ug/L
VC
<0.02 ug/L
<0.02 ug/L
<0.02 ug/L
<0.02 ug/L
MW-4
Dec-10
Mar-11
Jun-11
As
0.226 ug/L
0.216 ug/L
0.188 ug/L
0.226 ug/L
Fe
<10 ug/L
<20 ug/L
<20 ug/L
<20 ug/L
Mn
<10 ug/L
<5 ug/L
<10 ug/L
<5 ug/L
VC
<0.02 ug/L
<0.02 ug/L
<0.02 ug/L
<0.02 ug/L
OW-1
Dec-10
As
0.719 ug/L
Fe
<20 ug/L
Mn
<5 ug/L
VC
<0.02 ug/L
GROUND SURFACE
LITHOLOGIC CONTACT, DASHED WHERE INFERRED.
MONITORING WELL AND SCREENED INTERVAL
WATER LEVEL ON 12/28/10
ATD AT TIME OF DRILLING
TP TEST PIT
SCALE: 1" = 200'
Qvr Recessional Outwash Deposits – Stratified sand and gravel moderately well sorted to well sorted; less common silty sand and silt. Exposed primarily on floors of outwash channels that trend south-southwest between flutes molded by glacial flow.
Qvi Ice-Contact Deposits – Deposits similar in texture to unit Qvr but locally containing much higher percentage of silt intermixed with granular sediments; also includes lenses and pods of till.
Qvt Till – Compact very poorly sorted sediment containing subrounded to well-rounded clasts; glacially transported and deposited. Generally forms undulating surface a few tens of meters thick. Also found sporadically within areas mapped as unit Qvi.
Qva Advance Outwash Deposits – Well-bedded sand and gravel, deposited by streams and rivers that issued from front of advancing ice sheet. Generally unoxidized; almost devoid of silt or clay, except near base of unit.
Qvlc Lawton Clay – Laminated to massive silt, clayey silt, and silty clay; deposited in proglacial or lowland lakes.
Source: Geologic map of the Olalla 7.5' Quadrangle, King, Kitsap and Pierce Counties, WA. By Derek B. Booth and Kathy Goetz Troost 2005.
PROJECT 60191.0 OLALLA, WASHINGTON
PREPARED FOR KITSAP COUNTY
LOCATION OLALLA LANDFILL KITSAP COUNTY, WASHINGTON
SHEET 1 of 1
DRAWN BY KLA
REVIEWED BY DCK
DATE 04/14/14
ENVIRONMENTAL PARTNERS INC
FIGURE 4-2b
GEOLOGIC CROSS SECTION B - B' THROUGH OLALLA LANDFILL KITSAP COUNTY, WASHINGTON



GROUND SURFACE

LITHOLOGIC CONTACT, DASHED WHERE INFERRED

MONITORING WELL AND SCREENED INTERVAL

WATER LEVEL ON 12/28/10

Qvr	**Recessional Outwash Deposits** - Stratified sand and gravel moderately well sorted to well sorted; less common silty sand and silt. Exposed primarily on floors of outwash channels that trend south-southwest between flutes molded by glacial flow.
Qvi	**Ice-Contact Deposits** - Deposits similar in texture to unit Qvr but locally containing much higher percentage of silt intermixed with granular sediments; also includes lenses and pods of till.
Qvt	**Till** - Compact very poorly sorted sediment containing subrounded to well-rounded clasts; glacially transported and deposited. Generally forms undulating surface a few tens of meters thick. Also found sporadically within areas mapped as unit Qvi.
Qva	**Advance Outwash Deposits** - Well-bedded sand and gravel deposited by streams and rivers that issued from front of advancing ice sheet. Generally unoxidized; almost devoid of silt or clay, except near base of unit.
Qvlc	**Lawton Clay** - Laminated to massive silt, clayey silt, and silty clay; deposited in proglacial or lowland lakes.

Source: Geologic map of the Olalla 7.5' Quadrangle, King, Kitsap and Pierce Counties, WA. By Derek B. Booth and Kathy Goetz Troost 2005.

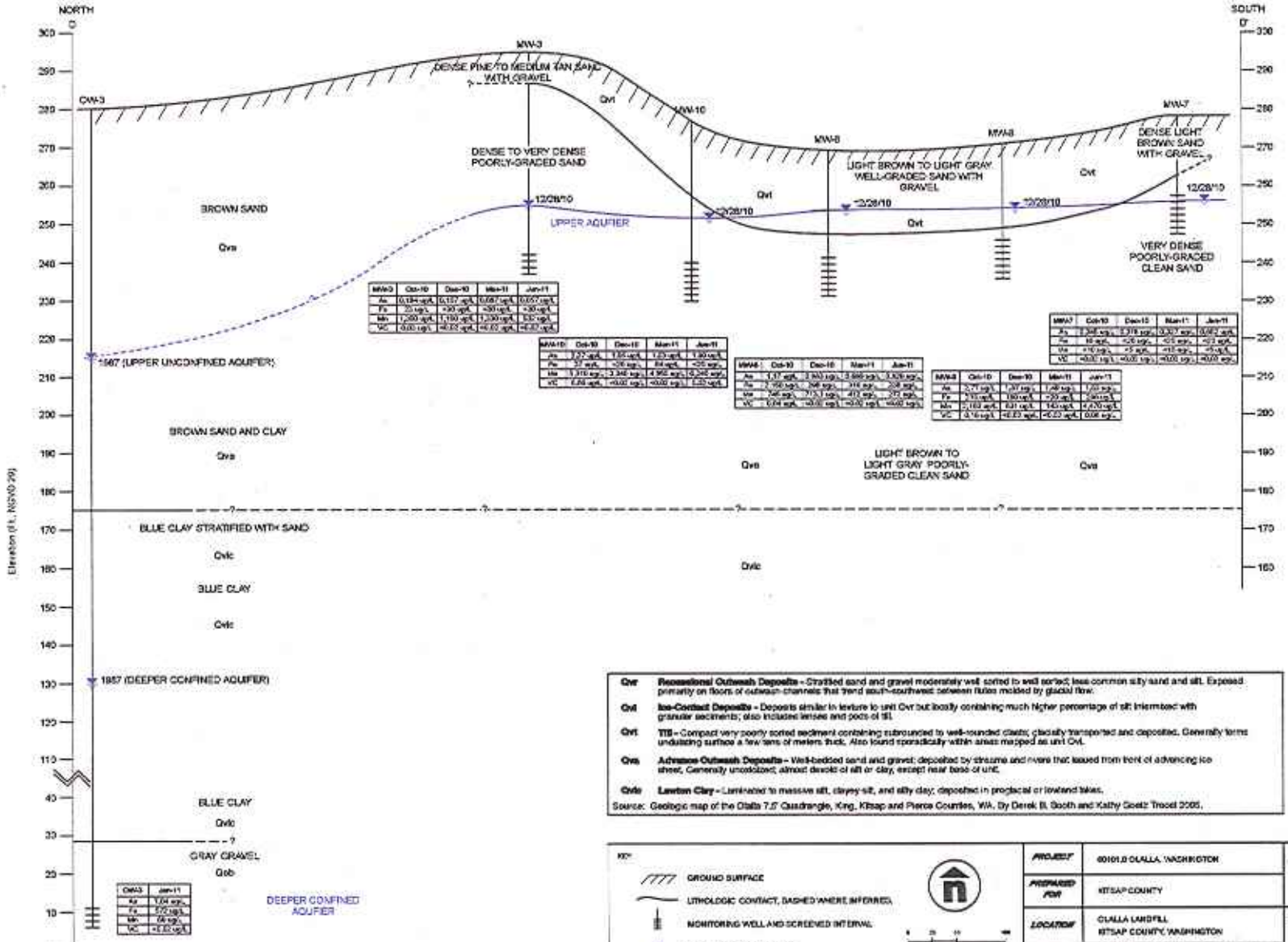
PROJECT	80101.0 OLALLA, WASHINGTON
PREPARED FOR	KITSAP COUNTY
LOCATION	OLALLA LANDFILL KITSAP COUNTY, WASHINGTON

SHEET	DRAWN BY	REVIEWED BY	DATE
1 of 1	KLB	DCK	[illegible]

ENVIRONMENTAL PARTNERS INC

FIGURE 4-2c

GEOLOGIC CROSS SECTION C - C' THROUGH OLALLA LANDFILL KITSAP COUNTY, WASHINGTON



Qvr	**Recessional Outwash Deposits** – Stratified sand and gravel moderately well sorted to well sorted; less common silty sand and silt. Exposed primarily on floors of outwash channels that trend south-southwest between flutes molded by glacial flow.
Qvi	**Ice-Contact Deposits** – Deposits similar in texture to unit Qvr but locally containing much higher percentage of silt interbedded with granular sediments; also includes lenses and pods of till.
Qvt	**Till** – Compact very poorly sorted sediment containing subrounded to well-rounded clasts; glacially transported and deposited. Generally forms undulating surface a few tens of meters thick. Also found sporadically within areas mapped as unit Qvl.
Qva	**Advance Outwash Deposits** – Well-bedded sand and gravel; deposited by streams and rivers that issued from front of advancing ice sheet. Generally uncompacted; almost devoid of silt or clay, except near base of unit.
Qvlc	**Lawton Clay** – Laminated to massive silt, clayey silt, and silty clay; deposited in proglacial or lowland lakes.

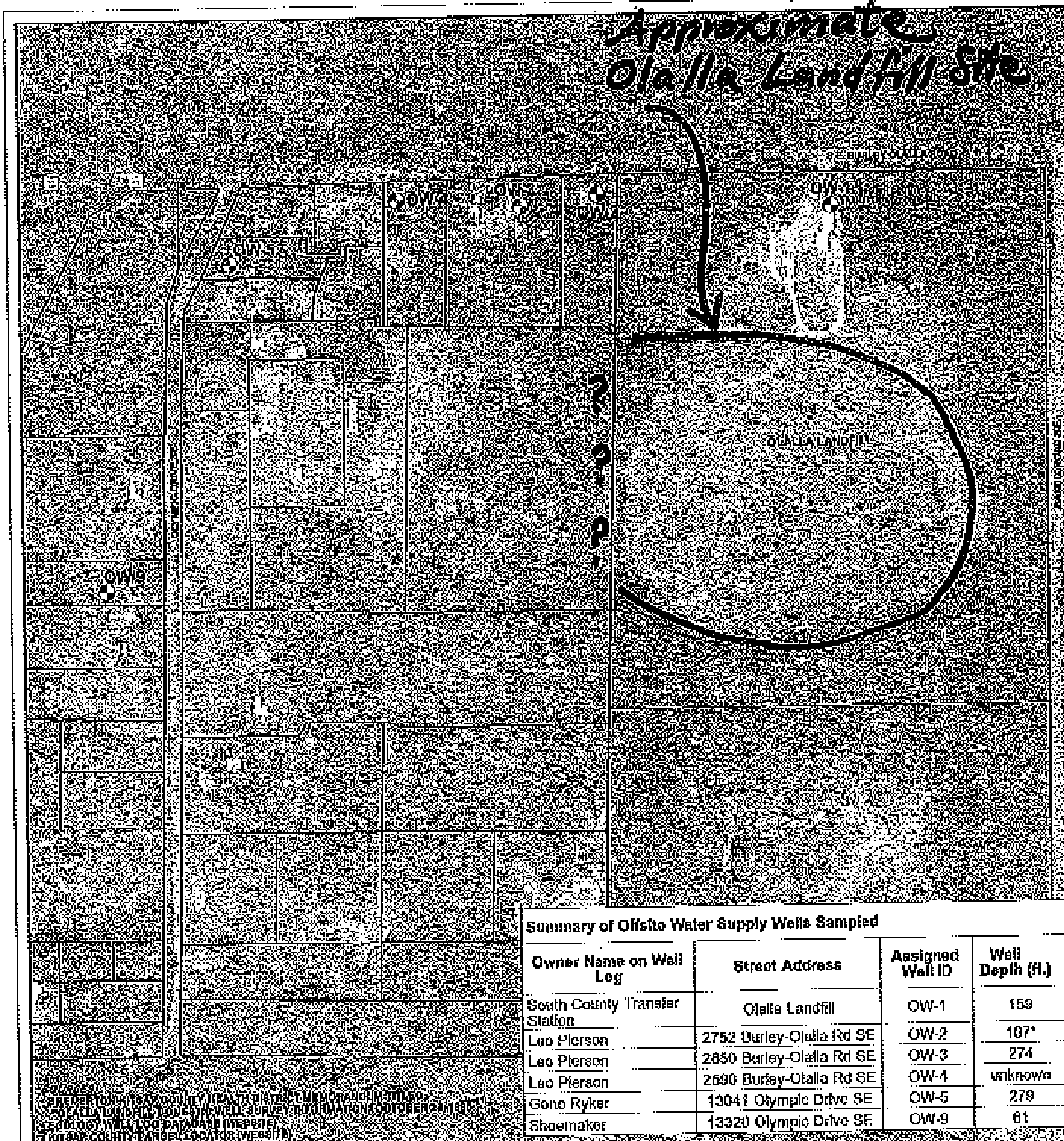
Source: Geologic map of the Olalla 7.5' Quadrangle, King, Kitsap and Pierce Counties, WA. By Derek B. Booth and Kathy Goetz Troost 2005.

PROJECT	60101.0 OLALLA, WASHINGTON		
PREPARED FOR	KITSAP COUNTY		
LOCATION	OLALLA LANDFILL KITSAP COUNTY, WASHINGTON		
SHEET 1 of 1	DRAWN BY RLA	REVIEWED BY DCH	DATE 02/13/12

ENVIRONMENTAL PARTNERS INC
201 Hill Cabaret Boulevard, Suite 201
Issaquah, Washington 98027

FIGURE 4-2d

GEOLOGIC CROSS SECTION D - D'
THROUGH OLALLA LANDFILL
KITSAP COUNTY, WASHINGTON



Summary of Offsite Water Supply Wells Sampled

Owner Name on Well Log	Street Address	Assigned Well ID	Well Depth (ft.)
South County Transfer Station	Olalla Landfill	OW-1	159
Leo Pierson	2752 Burley-Olalla Rd SE	OW-2	187*
Leo Pierson	2650 Burley-Olalla Rd SE	OW-3	274
Leo Pierson	2690 Burley-Olalla Rd SE	OW-4	unknown
Gene Ryker	13041 Olympic Drive SE	OW-5	279
Shoemaker	13320 Olympic Drive SE	OW-9	61

KEY:

* Well information provided by owner. Well log not available in KCHD records or Ecology Well Log database.

: OFFSITE WELL LOCATION (UPPER AQUIFER)

: OFFSITE WELL LOCATION (DEEPER AQUIFER)

: PARCEL BOUNDARY

0 100 200 400

SCALE: 1" = 400'

ENVIRONMENTAL PARTNERS INC

295 NE Gilman Boulevard, Suite 201
Issaquah, Washington 98027

FIGURE 2-2

OFFSITE WATER SUPPLY WELL
SAMPLING LOCATIONS
KITSAP COUNTY, WASHINGTON

PROJECT	50101.0 OLALLA, WASHINGTON
PREPARED FOR	KITSAP COUNTY
LOCATION	OLALLA LANDFILL RI/FS KITSAP COUNTY, WASHINGTON

SHEET	DRAWN BY	REVIEWED BY	DATE
1 of 1	AHY	DOK	12/13/12