Snohomish County
Public Works
Solid Waste

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Dave Somers
County Executive

December 3, 2018

Ching-Pi Wang
Uplands Unit Supervisor
Toxics Cleanup Program
Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452

RE: McCollum Park (Former Emander Landfill) – Request for Agreed Order Completion and Reduction of Groundwater Monitoring Frequency

Mr. Wang:

This memo documents the Snohomish County Public Works – Solid Waste Division (SWD) request for acknowledgement of completion of the Agreed Order that governed the historical remedial construction activities at McCollum Park, site of the former Emander Landfill (Site, Figure 1). Additionally, SWD would like to request a reduction in groundwater monitoring frequency from quarterly to annually based on the consistency of the monitoring data over the last several years.

As discussed in our meeting on January 18, 2018, the conditions of Agreed Order #DE 96 TC-N126 dated January 30, 1996 (Attachment A) have been fulfilled. The conditions under which the Agreed Order would be satisfied included the following required actions (in bold below) and the action taken by SWD to satisfy the requirement:

1) **Preparation of a Remedial Investigation (RI) report to document the nature and extent of contamination at the Site and the potential effects on human health and the environment as identified during previous assessment work:** The RI report was completed by AGI on behalf of SWD and submitted to Ecology in April 1996.
2) **Completion of a Feasibility Study Report to address environmental problems identified during the RI and to document the selection process for the preferrred method of remediation at the Site:** On behalf of SWD, AGI prepared the *Final Report, Feasibility Study* dated April 25, 1996.
3) **Preparation of Compliance Monitoring Plans**: Compliance monitoring of groundwater, surface water, landfill gas, and drinking water wells was performed consistent with AGI's February 29, 1996 *Compliance Monitoring Plan*. Sediment and surface water sampling occurred in July 1998 to evaluate the potential for the landfill to impact North Creek. The Snohomish Health District discontinued monitoring of the downgradient drinking water well in 2017. Quarterly groundwater sampling and landfill gas monitoring activities are ongoing by Snohomish County SWD.

4) **Preparation of a Cleanup Action Plan (CAP):** The CAP was prepared by AGI in April 1996, and remediation of the former landfill site was performed consistent with the CAP. Cleanup activities consisted of:
   a) Grading and surface water controls
   b) In-situ solidification/stabilization of oily sludge waste near the southern-central portion of the former landfill
   c) Capping of the landfill with a High-Density Polyethylene (HDPE) liner, a soil drainage layer, and topsoil
   d) Active landfill gas collection and thermal treatment
   e) Revegetation to minimize erosion
   f) Compliance monitoring of groundwater, surface water, and sediment
   g) Groundwater use restrictions (via protective covenant signed in May 1996)

5) **Periodic Report Preparation:** Monthly progress letter reports were prepared and submitted to Ecology to document remedial activities and any problems or issues encountered during remediation. The monthly reports were prepared from the beginning of construction in August 1995 until December 1996, when the reports were discontinued due to the completion of remedial construction activities.

Since the provisions of the Agreed Order have been satisfied as described above, SWD formally requests acknowledgement that the terms of the Agreed Order are satisfied.

SWD further requests that groundwater monitoring activities be reduced in frequency from quarterly to annually for the following reasons:

1) The groundwater flow direction and gradient are generally consistent from quarter to quarter, and have been stable for the last several years of monitoring.
   a) The overall groundwater flow direction in the shallow zone during the 2017 and the first quarter 2018 monitoring events was southeast, ranging from an azimuth of 157.15 degrees to 143.72 degrees; the shallow zone flow direction azimuth of 208.2 degrees measured during the third quarter of 2017 was disregarded because the absence of groundwater level data for well MW-10 skewed the flow direction calculation. The groundwater gradients in the shallow zone during this time period ranged from 0.0028 to 0.0045 foot/foot.
   b) The overall groundwater flow direction in the deep zone during the 2017 and the first quarter 2018 monitoring events was south-southwest, ranging from an azimuth of 188.53 degrees to 194.11 degrees. The calculated groundwater gradients in the shallow zone during this time period ranged from 0.0013 to 0.0027 foot/foot.
   c) To illiustrate the similarity of historical groundwater flow conditions, groundwater contour maps of the first quarter 2008 and first quarter 2011 sampling events are included in Attachment B. As shown, the groundwater flow conditions were very similar to recent sampling events:
      i) Shallow zone: groundwater flow direction azimuth of 150.02 degrees (-60.02 degrees from the positive x axis) and approximate gradient of 0.0042 ft/ft during the first quarter 2008; groundwater flow direction azimuth of 150.02 degrees (-60.02 degrees from the positive x axis) and approximate gradient of 0.0037 ft/ft during the first quarter of 2011.
      ii) Deep zone: groundwater flow direction azimuth of 193.25 degrees (-103.25 degrees from the positive x axis) and approximate gradient of 0.0015 ft/ft during the first quarter 2008; groundwater flow direction azimuth of 190.85 degrees (-100.85 degrees from the positive x axis) and approximate gradient of 0.0019 ft/ft during the first quarter of 2011.
2) The nature and extent of residual groundwater impacts beneath the Site have been adequately characterized via continuous quarterly monitoring during the 20+ years following the completion of remediation.

a) Overall, groundwater contaminant concentrations are stable. Exceedances to the groundwater standards and statistical prediction limits tend to be limited to certain constituents in each zone; e.g., alkalinity, bicarbonate, calcium, magnesium, and arsenic commonly exceed their prediction limits in downgradient shallow zone wells, while TDS, arsenic, barium, iron, and manganese commonly exceed their prediction limits in deep zone wells. Moreover, exceedances are more prevalent in certain downgradient wells in both zones (e.g., shallow wells BH-05, BH-06, and BH-07 contain the majority of prediction limit exceedances in the shallow zone, while wells MW-16, MW-17, and MW-18 contain the majority of the prediction limit exceedances in the deep zone.

b) Decreasing groundwater concentration trends were more common in the first quarter 2018 when compared to the previous four quarters. As of the first quarter of 2018 (the most recent quarter during which groundwater statistics were performed), eight significant decreasing trends were noted in the shallow wells, and 32 decreasing trends were noted in deep zone monitoring wells. The majority of the decreasing trends in the deep zone during the first quarter 2018 were noted in downgradient wells MW-18 and MW-19 and upgradient well MW-20. In addition, 12 statistically-significant increasing trends in contaminant concentrations were noted in the shallow zone wells, and 24 increasing trends were noted in the deep zone wells during the first quarter 2018. Increasing trends in the shallow zone were most common in downgradient wells BH-06 and BH-07 and upgradient well BH-08. In the deep zone, increasing trends were most common in downgradient wells MW-12 and MW-17 and upgradient well MW-15. A statistical summary of the first quarter 2018 groundwater sampling event is included in the tables in Attachment C.

c) Volatile organic compound (VOC) concentrations are routinely detected in shallow and deep zone wells at the Site; however, VOC concentrations in Site groundwater are generally low. During the first quarter 2018 sampling event, one or more VOCs, including acrylonitrile, chlorobenzene, cis-1,2,-dichloroethene (cis-1,2-DCE), and vinyl chloride were detected in shallow downgradient wells BH-05, BH-06, and BH-07. Additionally, low concentrations of cis-1,2-dichloroethene and/or vinyl chloride were detected in downgradient deep wells MW-16, MW-18, and MW-19 during the first quarter 2018 sampling event. Low concentrations of cis-1,2-DCE and vinyl chloride are the most commonly-detected VOCs in Site groundwater. Vinyl chloride was detected at concentrations up to 1.3 µg/L in the shallow zone and up to 4.21 µg/L in the deep zone from first quarter 2017 to first quarter 2018; cis-1,2-DCE was detected at concentrations up to 0.38 µg/L in shallow wells and up to 1.23 µg/L in the deep zone from first quarter 2017 to first quarter 2018. Attachment C contains tables summarizing the groundwater analytical results for all four quarters of 2017 and the first quarter of 2018.

Given the overall stability in groundwater contaminant concentrations, reducing the groundwater monitoring frequency at the Site from quarterly to annually we believe is warranted. Please let us know if you have any questions about our request. We look forward to your response.

Sincerely,

Brian K. Eytcheson, LG
Environmental Services Section

Matthew Zybas
Director, Solid Waste

Attachments: Attachment A – Agreed Order #DE 96 TC-N126
Attachment B – Groundwater Flow Data and Maps
Attachment C – Groundwater Analytical Summary Tables, 2017

cc: Vian Salih, Environmental Monitoring Supervisor
David Schonhard, Operations Manager
Linda Rhoades Clarke, Superintendent
Kirk Bailey, Engineering Services

Attachment A

Agreed Order #DE 96 TC-N-126

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

In the Matter of Remedial Action by: Snohomish County Public Works (hereinafter, Snohomish County)	))))	MODEL AGREED ORDER No. DE 96 TC-N126

TO: Mr. Peter Hahn
Snohomish County Public Works
Wall Street Building
2930 Wetmore
Everett, WA 98201

I.

Jurisdiction

This Agreed Order ("Order") is issued pursuant to the authority of RCW 70.105D.050(1).

II.

Findings of Fact

Ecology makes the following Findings of Fact, without admission of such facts by Snohomish County. Attachments referenced in this Order are incorporated by reference and are integral and enforceable parts of the Order.

1. Owner and/or Operator

Snohomish County is the current owner and operator of the property currently known as McCollum Park (hereinafter, the Park) located south of 128th Street SE, east of 4th Drive SE, predominantly west of Dumas Road and north of the Mill Creek city limits in south Everett.

2. Operational History

Snohomish County is the owner and operator of record during the time when the property now known as McCollum Park was part of a larger parcel of property (hereinafter, the Historical Property).

Acquisition of the historical property by the County began in 1922. From 1929 to 1947, portions of the Historical Property were operated by the County as a gravel pit. From 1947 to 1967 portions of the Historical Property were operated by the County as a municipal landfill which was known as Emander Landfill (hereinafter, the landfill). The landfill was covered in 1967 and was operated as a park (McCollum Park) from 1969 to the present by the Snohomish County Parks Department. Adjacent property was purchased from the Kelly Family Limited Partnership by Snohomish County and added to the Park in 1994. A portion of this small (two acre) parcel at the south southeastern edge of the Park had been part of the operating landfill, although never legally part of the Historical Property as purchased and operated by Snohomish County. No other previous property owners have been identified at this time.

3. Site Description

The Site covers the entire area designated as the Historical Property. It includes, in addition to the current Park, a right-of-way currently owned by the Washington State Department of Transportation (hereinafter, the WDOT Property) which contains a section of 128th Street SE, a State Highway (SR96). A portion of the landfill lies under this section of 128th Street SE. The Site also includes a right-of-way currently owned by Snohomish County (hereinafter the County Road Property) which contains a section of Dumas Road. The landfill extends under and east of Dumas Road.

Legal descriptions of the properties known as McCollum Park, the Historical Property, and the WDOT property are provided in Appendix A.

4. Study Area

Any area affected by or at risk of being affected by the release(s) of contaminants from the landfill on/at the Historical Property will be considered part of the Study Area. The area affected by the release(s) of contaminant(s) from the landfill is any area found to have soil, surface water, sediment, or ground water impacted by petroleum hydrocarbons, metals, volatile organic compounds, semivolatile organic compounds, polycyclic aromatic hydrocarbons, pesticides, polychlorinated biphenyls, or other chemicals of concern at levels which are higher than background levels for the area and which are detected in locations which can be determined to be contiguous and associated with the release(s) identified or suspected at

the landfill and which are not caused by other releases. Areas identified as being affected by the landfill release(s) and which are therefore part of the Study Area include, but are not limited to, McCollum Park, the WDOT property, and the County Road property.

Appendix B is a map which identifies the Study Area. The Study Area includes known areas of contamination and areas which may affect or be affected by the release(s) of contaminant(s) from the landfill. The Study Area shown in Appendix B includes both the vicinity north of 128th Street SE, areas east and west of McCollum Park, and the vicinity of drinking water wells located south of McCollum Park landfill. These were included in the Study Area to better delineate the ground water hydrology of the area.

5. Previous Investigations

Snohomish County, in preparing to improve 128th Street SE and in developing a Master Plan to act as a guide for reclamation, preservation, and enhancement of the Site for recreation and educational purposes, conducted both environmental and engineering assessments of the Park during the time period from 1986 to 1994.

A. Earth Consultants, Inc. (ECI) excavated 10 test pits across the landfill in 1989 as part of the park Master Plan study. Two of the test pits in the landfill's south-central portion encountered soil saturated with a black liquid containing hydrocarbon constituents apparently derived from a heavy (bunker) oil.

B. Pacific Testing Laboratories, Inc. (PTL) installed four ground water monitoring wells in March 1990, also in support of the park Master Plan study. PTL encountered soil saturated with black liquid during the installation of a well near the two ECI test pits where black liquid had been observed in 1989.

C. Rittenhouse Zeman Associated (RZA) performed a subsurface investigation in February 1992 to support the planned park and ride lot. This study included installing 13 gas probes within the landfill and collecting soil samples and soil gas samples. A soil sample from one gas probe installation in the landfill's southern portion was saturated with a black liquid similar to that encountered by ECI and PTL. This probe was within 200 feet of the two previous discoveries of petroleum contaminated soil. Soil samples documented the presence of low levels of

volatile organic compounds (VOCs), semivolatile organic compounds (SVOCs) and metals. Soil gas samples indicated the presence of VOCs well below State Acceptable Source Impact Levels (ASILs). Water samples were also taken from PTL wells. Ground water samples indicated concentrations of chlorobenzene, naphthalene and metals above 1992 Model Toxics Control Act (MTCA) levels.

D. In December of 1992, Applied Geotechnology, Inc. (AGI) abandoned 3 PTL wells and installed six additional gas probes/piezometers. AGI detected similar compounds to those found by RZA in the soil gas samples.

E. In 1994, AGI installed an additional gas probe and four new ground water monitoring wells. Various VOC's and metals were detected in the ground water at or above either State ground water quality criteria or MTCA Method A cleanup levels.

F. In 1994, Snohomish County (SC) collected ground water samples as part of the pre-Remedial Investigation (pre-RI) activity. Analysis revealed the presence of benzene, 1,2-dichloroethane, trichloroethane, vinyl chloride and arsenic in the ground water above either state Water Quality Standards for Ground Water or MTCA Method A cleanup levels.

Appendix C is a list of the previous Site studies and investigations conducted to assess the Site. This list is included only for the purpose of identifying studies which have been conducted.

6. Sludge Discovery

Snohomish County discovered petroleum contaminated material (hereinafter, sludge) at the Park in November, 1994. Fill was being placed and graded as the northern portion of the Park was being prepared for planned construction. The sludge reportedly rose to the surface on about November 8, 1994 across an area measuring approximately 25 by 35 feet in plan dimension. A berm was placed around the sludge to prevent it from spreading and it subsequently rose an estimated additional foot. On April 26, 1995, a second discovery of sludge occurred when a section of the Park was being prepared for construction. On June 12, 1995, a discovery of hydrocarbon contaminated refuse occurred during the construction of a stormwater retention pond. On June 23, 1995, a third discovery of sludge occurred during grading activities south and west of the Dumas Road park entrance.

(See Appendix B for the location of the emergences.)

III.

Ecology Determinations

1. Snohomish County is an "owner or operator" as defined at RCW 70.105D.020(11) of a "facility" as defined at RCW 70.105D.020(4).

2. The facility is known as McCollum Park and is located south of 128th Street SE, east of 4th Drive SE, predominantly west of Dumas Road and north of the Mill Creek city limits in south Everett.

3. The substances found at the facility as described above are "hazardous substances" as defined at RCW 70.105D.020(7).

4. Based on the presence of these hazardous substances at the facility and all factors known to the Department, there is a release or threatened release of hazardous substances from the facility, as defined at RCW 70.105D.020(19).

5. By letter dated April 14, 1995, Ecology notified Snohomish County of its status as a "potentially liable person" under RCW 70.105D.040 after notice and opportunity for comment.

6. By a letter dated April 17, 1995, Snohomish County voluntarily waived its rights to notice and comment and accepted Ecology's determination that Snohomish County is a "potentially liable person" under RCW 70.105D.040.

7. Pursuant to RCW 70.105D.030(1) and 70.105D.050, the Department may require potentially liable persons to investigate or conduct other remedial actions with respect to the release or threatened release of hazardous substances, whenever it believes such action to be in the public interest.

8. Based on the foregoing facts, Ecology believes the remedial action required by this Order is in the public interest.

IV.

Work to be Performed

Based on the foregoing Facts and Determinations, it is hereby ordered that Snohomish County has or will take the following remedial actions and that these actions have been or will be conducted in accordance with Chapter 173-340 WAC unless otherwise specifically provided for herein. Actions required by this Order are summarized in the Work Plan for the Agreed Order (Appendix D) which is provided as a guide and does not relieve Snohomish County from any requirements of this Section IV. In the event of any conflict between this section and the summary, this section shall govern.

1. Actions Which Have Been Taken

Snohomish County and/or their consultants have taken the necessary steps to identify the nature and extent of the hazardous substance(s) at McCollum Park; to control the source(s) of the release(s) of hazardous substance(s) to soil, ground water, surface water, air, and sediment; and to demonstrate that no ongoing release is occurring at the Site to the satisfaction of the Department of Ecology.

The following tasks were performed by Snohomish County prior to the signing of the Agreed Order. These work tasks were performed to utilize the time available while drafting and negotiating an Agreed Order and include work conducted as a result of or subsequent to the November 8, 1994 sludge discovery at the Park. These work tasks are an integral and enforceable part of the Agreed Order. These tasks were reviewed by Ecology and Ecology has concluded that they were performed in accordance with Chapter 173-340 WAC.

A. Remedial Investigation

During the period of time extending from November 1994 to the present, Snohomish County conducted a Remedial Investigation (hereinafter, an RI) to determine the nature and extent of contamination at the Site. The investigation sought to determine the potential effects on human health and the environment of this contamination. In addition, site hydrologic conditions were investigated to identify the fate and transport of contaminants. The RI was conducted by AGI Technologies (AGI) , (consultants for Snohomish County).

(1) Interviews. Snohomish County conducted interviews of individuals who had some knowledge of the historical operations at the landfill.

- Interviews of 6 individuals indicated that materials which were transported to the former Emander Landfill during the time period from 1947 to 1967 included septic tank septage/waste, bilge water pumped from ships, fuel storage tank bottoms, and other miscellaneous unknown liquids. These materials were alleged to have been dumped in the general area where the County encountered the sludge in November, 1994.

(2) Sludge.

a. AGI conducted an analysis of the sludge chemistry from two of the three separate emergences.

- Sludge from the two analyzed emergences was found to contain total petroleum hydrocarbons (quantified as diesel and heavy oil), metals, volatile organic compounds, polychlorinated biphenyls, polycyclic aromatic hydrocarbons, and other semivolatile organic compounds.

b. AGI evaluated the sludge quantity and distribution. Borings within the landfill indicated the lateral and vertical extent of the sludge below the ground surface.

- Estimated volume of the sludge within the first emergence is approximately 3000 cubic yards.

- Estimated volume of the sludge within the second emergence is approximately 1200 cubic yards.

- Estimated volume of the sludge within the third emergence is approximately 500 cubic yards.

(3) Hydrocarbon Contaminated Refuse. AGI conducted an analysis of the contaminated refuse found in contact with the sludge.

- The refuse was found to contain domestic waste (cans, bottles, paper, wood, plastic, and metal) contaminated with petroleum hydrocarbons (quantified as diesel and heavy oil), metals, VOCs, SVOCs, and polyaromatic

hydrocarbons (PAHs). There is no current estimate of the volume of the contaminated refuse.

(4) Air. AGI conducted an analysis of the air immediately above the first sludge discovery.

- The air sampled directly over the sludge was found to contain volatile organic compounds.

(5) Sediment. AGI conducted an analysis of the freshwater creek bed (North Creek) sediment as part of the RI.

- The sediments were found to contain petroleum hydrocarbons (quantified as diesel and heavy oil), metals, polychlorinated biphenols, polycyclic aromatic hydrocarbons, and other semivolatile organic compounds.

(6) Surface Water. Snohomish County has characterized the infiltration of surface water from the adjacent creek (North Creek) into the landfill and the impact of such surface water infiltration on the movement of contaminants through and/or from the landfill.

- The surface water collected from North Creek and it's tributaries was found to contain metals.

- The surface water from North Creek is connected to the ground water in the landfill. At different times of the year, the water in the creek either infiltrates into the landfill or ground water from the landfill flows into the creek. It has been determined that the surface water from North Creek has minimal effect on the movement of contaminants through the landfill.

(7) Ground Water. Snohomish County has installed monitoring wells to determine the chemistry and flow of the ground water in the vicinity of the landfill.

- The ground water in the southern portion of the Park was found to contain petroleum hydrocarbons (quantified as diesel and heavy oil), metals, and volatile organic compounts. compounds.

- The ground water flow direction in the vicinity of the Site was determined to be generally to the southeast at the northwest corner of the Site and to the south in the southern half of the Site as established by monitoring well elevation readings taken between March 1995 and September 1995 by AGI and Snohomish County Public Works.

(8) Domestic Wells. Snohomish County has identified all downgradient drinking water wells within a half-mile radius of the landfill that may be threatened by current or potential ground water contamination at the Site.

- There are six (6) residential drinking water wells located potentially downgradient of the Site. The well locations are shown on the figure in Appendix B.

(9) Landfill Gas. Snohomish County has installed gas probes to characterize the landfill gases at this Site. The County conducted a survey of the soil gasses at the Site.

- The soil gases were analyzed and found to contain volatile organic compounds.

- AGI reviewed the historical and current soil gas surveys.

B. Feasibility Study

Based on the findings of the draft RI, Snohomish County has evaluated potential means/measures to minimize impacts to human health and the environment from the landfill.

(1) ARARS. Snohomish County has performed an analysis of Applicable or Relevant and Appropriate Requirements (hereinafter, ARARS). The County shall meet these requirements in the performance of activities at the Site. Appendix E contains a list of ARARS.

(2) Identified Problems._ Snohomish County has evaluated techniques to abate problems so far identified by the Remedial Investigation, including efficiencies and cost, and made recommendations for each identified problem area.

a. Landfill Liner - Snohomish County has assessed the feasibility of controlling the infiltration of rainwater into the landfill so as to prevent or minimize the further mobilization of contaminants within the landfill.

- Snohomish County has evaluated the installation of a liner in order to determine the liner's ability to minimize the infiltration of rainwater into the landfill.

b. Ground Water Movement - Snohomish County has assessed the feasibility of controlling the movement of ground water through the landfill so as to prevent or minimize the further mobilization of contaminants within the landfill.

- Snohomish County has evaluated the need to control ground water movement through the landfill. As the liner is designed to prevent surface water from filtering through the refuse and the ground water was determined to lie below the hydrocarbon contaminated landfill contents, it was determined that no action need be taken at this time to control ground water movement if a liner is installed.

c. Landfill Gas Recovery - Snohomish County has assessed the feasibility of controlling the accumulation and/or release of landfill gasses from the landfill.

- Snohomish County has evaluated the installation of a methane gas recovery system to determine the system's ability to collect methane gas generated in the landfill.

d. Sludge - Snohomish County has assessed the potential methods by which the sludge found at the Site could be addressed in order to minimize or eliminate the hydrocarbon contaminated material as an actual or potential source of ground water contamination.

- Snohomish County has prepared an analysis of the benefits and problems associated with each method to include target analytes, long-term leachability, cost (immediate and long-term), structural stability, [long-term matrix stability], TCLP test efficiency, and implementation time. This analysis included a literature search and analysis for any approaches being considered in order to determine applicability of the method in a landfill environment.

- Snohomish County has determined through laboratory testing and statistical analysis the applicability of technology-based methods to stabilize the hydrocarbon contaminated materials found at the Site.

2. Actions Which Will Be Taken

Snohomish County and/or their consultants will take the necessary steps to identify the nature and extent of the hazardous substance(s) at McCollum Park; to control the source(s) of the release(s) of hazardous substance(s) to soil, ground water, surface water, air, and sediment; and to demonstrate that no ongoing release is occurring at the Site to the satisfaction of the Department of Ecology.

The following are tasks to be performed by Snohomish County subsequent to the signing of the Agreed Order. These work tasks are an integral and enforceable part of the Agreed Order.

A. Remedial Investigation Report

The County shall prepare a Remedial Investigation Report in order to document the nature and extent of contamination at the Site and the potential effects on human health and the environment of this contamination as determined in work which has been completed prior to the signing of the Order.

This report shall address the topics of sludge, sediment, surface water, ground water, domestic wells, landfill gas and any other relevant topics. This report shall be subject to Ecology approval.

B. Feasibility Study Report

The County shall prepare a Feasibility Study Report in order to address the environmental problems identified in the Remedial Investigation (RI) and to document the work which has been completed prior to the signing of the Order that evaluated potential means/measures which were considered to minimize impacts to human health and the environment from the landfill, the methods selected for further investigation, and the reasons for those selections.

This report shall address the topics of surface water infiltration, ground water movement, landfill gas recovery, sludge handling and any other relevant topics. This report shall be subject to Ecology approval.

C. Monitoring Plans

The County shall prepare a monitoring plan(s) that shall address the required analytical tests, frequency of monitoring, and the statistical analysis requirements need to characterize ground water, landfill gases, drinking water wells, surface water, and sediment at the Site.

(1) Ground Water. The County will develop and implement a long term ground water monitoring plan to monitor changes in the chemistry and flow of ground water. The monitoring plan is subject to approval by Ecology and the Snohomish County Health District.

(2) Landfill Gases. The County shall develop a soil gas monitoring plan.

The monitoring plan shall be subject to Ecology approval.

(3) Drinking Water Wells. The County shall develop and implement a sampling plan in coordination with the Snohomish County Health District to monitor selected downgradient drinking water wells for contaminants and to monitor changes in the chemistry and flow of the drinking water. Sampling data shall be submitted according to the Washington State Department of Ecology Toxics Cleanup Program Statistical Guidance for Ecology Site Managers, August, 1992 as a reference for the

reporting and analysis of ground water quality. This sampling plan shall be subject to Ecology approval.

(4) Surface Water and Sediment. The County will develop and implement a long term surface water and sediment monitoring plan. The monitoring plan shall be subject to approval by Ecology.

D. Draft Cleanup Action Plan

The County shall prepare a draft Cleanup Action Plan (herein after, a CAP) that implements the recommendations of the Feasibility Study (FS) in order to address the environmental problems identified in the Remedial Investigation (RI) and that implements the Monitoring Plans. Ecology will utilize the draft document to prepare the final Cleanup Action Plan for the Site.

3. Schedule

Scheduled performance and/or deliverables, including Ecology approval of all work plans, are listed below. The duration may be changed by agreement between the signing parties.

Deliverable	Days to complete once Order signed	
Remedial Investigation (R) & Feasibility Study (FS)	draft final	10
	Ecology review	30
	County finalization	20
	Ecology approves final	10
Monitoring Plans & draft Cleanup Action Plan (CAP)	draft final	60
	Ecology review	45
	County finalization	30
	Ecology approves final	10

4. Periodic Reports

Snohomish County shall prepare and submit to Ecology monthly progress reports. These reports shall briefly explain all actions taken, any problems encountered, and progress made during the past month. The reports shall also briefly summarize anticipated activities for the upcoming month and explain any problems related to meeting the project schedule. The reports will be submitted in letter form to the Ecology site manager by the 10th of each month. Snohomish County shall submit monthly progress reports until the completion of all the remedial action tasks required by this Order.

V.

Terms and Conditions of Order

1. Definitions

Unless otherwise specified, the definitions set forth in ch. 70.105D RCW and ch. 173-340 WAC shall control the meanings of the terms used in this Order.

2. Public Notices

WAC 173-340-600(10)(c) requires a 30 day public comment period before this Agreed Order on a state RI/FS becomes effective. Ecology shall be responsible for providing such public notice and reserves the right to modify or withdraw any provisions of this Order should public comment disclose facts or considerations which indicate to Ecology that the Order is inadequate or improper in any respect.

In the event that Ecology proposes modifications to this Order based on public comment, Snohomish County reserves the right to withdraw its consent to this Order.

3. Remedial Action Costs.

Snohomish County shall pay to Ecology costs incurred by Ecology pursuant to this Order. These costs shall include work performed by Ecology or its contractors for investigations, remedial actions, and Order preparation, oversight and administration. Ecology costs shall include costs of direct activities and support costs of direct activities as defined in WAC 173-340-550(2). Snohomish County shall pay the required amount within 90 days of receiving from Ecology an itemized statement of costs that includes a summary of costs incurred, an identification of involved staff, and the amount of time spent by involved staff members on the project. A general description of work performed will be provided with each statement. Itemized statements shall be prepared quarterly. Failure to pay Ecology's costs within 90 days of receipt of an itemized statement of costs will result in interest charge in the amount of 1% per month or part of month.

4. Designated Project Coordinators

The project coordinator for Ecology is:
Mary K. O'Herron
Toxics Cleanup Program
Washington State Department of Ecology
Northwest Regional Office
3190 160th Avenue SE
Bellevue, WA 98008-5452
(206)649-7266

The project coordinator for Snohomish County is:
Roland D. Maynard, P.E
Snohomish County Department of Public Works
Wall Street Building
2930 Wetmore Avenue
Everett, WA 98201
(206)388-6668

The project coordinator(s) shall be responsible for overseeing the implementation of this Order. To the maximum extent possible, communications between Ecology and Snohomish County, and all documents, including reports, approvals, and other correspondence concerning the activities performed pursuant to the terms and conditions of this Order, shall be directed through the project coordinator(s). Should Ecology or Snohomish County change project coordinator(s), written notification shall be provided to Ecology or Snohomish County at least ten (10) calendar days prior to the change.

5. Performance

All future work performed pursuant to this Order shall be under the direction and supervision, as necessary, of a professional engineer or hydrogeologist, or similar expert, with appropriate training, experience and expertise in hazardous waste site investigation and cleanup. Snohomish County shall notify Ecology as to the identity of such engineer(s) or hydrogeologist(s), and of any contractors and subcontractors to be used in carrying out the terms of this Order, no less than fourteen (14) days in advance of their involvement at the Site. Snohomish County shall provide a copy of this Order to all agents, contractors and subcontractors retained to perform work required by this Order and shall ensure that all work undertaken by such agents, contractors and subcontractors will be in compliance with this Order.

Except where necessary to abate an emergency situation, Snohomish County shall not perform any remedial actions at McCollum Park outside that required by this Order unless Ecology concurs, in writing, with such additional remedial actions. Snohomish County shall provide written notification to Ecology no less than thirty (30) days prior to the starting date of the additional remedial actions. Ecology shall provide a written response to Snohomish County no less than fourteen (14) days after receipt of the notification.

6. Access

Ecology or any Ecology authorized representative shall have the authority to enter and freely move about the Site at all reasonable times for the purposes of, inter alia: inspecting records, operation logs, and contracts related to the work being performed pursuant to this Order; reviewing the progress in carrying out the terms of this Order; conducting such tests or collecting samples as Ecology or the project coordinator may deem necessary; using a camera, sound recording, or other documentary type equipment to record work done pursuant to this Order; and verifying the data submitted to Ecology by Snohomish County. By signing this Agreed Order, Snohomish County agrees that this Order constitutes reasonable notice of access, and agrees to allow access to the Site in accordance with applicable Site Health & Safety Plans at all reasonable times for purposes of overseeing work performed under this Order. Ecology shall allow split or replicate samples to be taken by Snohomish County during an inspection unless doing so interferes with Ecology's sampling. Snohomish County shall allow split or replicate samples to be taken by Ecology and shall provide seven (7) days notice before any sampling activity.

7. Public Participation

Snohomish County shall prepare and/or update a public participation plan for the Site. Ecology shall maintain the responsibility for public participation at the Site.

Snohomish County shall help coordinate and implement public participation for the Site.

8. Retention of Records

Snohomish County shall preserve in a readily retrievable fashion, during the pendency of this Order and for ten (10) years from the date of completion of the work performed

pursuant to this Order, all records, reports, documents, and underlying data in its possession relevant to this Order. Should any portion of the work performed hereunder be undertaken through contractors or agents of Snohomish County, then Snohomish County agrees to include in their contract with such contractors or agents a record retention requirement meeting the terms of this paragraph.

9. Dispute Resolution

Snohomish County may request Ecology to resolve disputes which may arise during the implementation of this Order. Such request shall be in writing and directed to the signatory, or his/her successor(s), to this Order. Ecology resolution of the dispute shall be binding and final. Snohomish County is not relieved of any requirement of this Order during the pendency of the dispute and remains responsible for timely compliance with the terms of the Order unless otherwise provided by Ecology in writing.

10. Reservation of Rights/No Settlement

This Agreed Order is not a settlement under ch. 70.105D RCW. Ecology's signature on this Order in no way constitutes a covenant not to sue or a compromise of any Ecology rights or authority. Ecology will not, however, bring an action against Snohomish County to recover remedial action costs paid to and received by Ecology under this Agreed Order. In addition, Ecology will not take additional enforcement actions against Snohomish County to require those remedial actions required by this Agreed Order, provided Snohomish County complies with this Agreed Order.

Ecology reserves the right, however, to require additional remedial actions at the Site should it deem such actions necessary.

Ecology also reserves all rights regarding the injury to, destruction of, or loss of natural resources resulting from the releases or threatened releases of hazardous substances from the landfill.

In the event Ecology determines that conditions at the Site are creating or have the potential to create a danger to the health or welfare of the people on the Site or in the surrounding area or to the environment, Ecology may order Snohomish County to stop further implementation of this Order for such period of time as needed to abate the danger.

11. Transference of Property

No voluntary or involuntary conveyance or relinquishment of title, easement, leasehold, or other interest in any portion of the Site shall be consummated by Snohomish County without provision for continued implementation of all requirements of this Order and implementation of any remedial actions found to be necessary as a result of this Order. Until this Order is satisfied, prior to transfer of any legal or equitable interest Snohomish County may have in the Site or any portions thereof, Snohomish County shall serve a copy of this Order upon any prospective purchaser, lessee, transferee, assignee, or other successor in such interest. At least thirty (30) days prior to finalization of any transfer, Snohomish County shall notify Ecology of the contemplated transfer.

12. Compliance With Applicable Laws

A. All actions carried out by Snohomish County pursuant to this Order shall be done in accordance with all applicable federal, state, and local requirements, including requirements to obtain necessary permits, except as provided in paragraph B of this section.

B. Pursuant to RCW 70.105D.090(1), the substantive requirements of chapters 70.94, 70.95, 70.105, 75.20, 90.48, and 90.58 RCW and of any laws requiring or authorizing local government permits or approvals for the remedial action under this Order will be addressed as such requirements are determined to be applicable and will be made binding and enforceable requirements of the Order.

Snohomish County has a continuing obligation to determine whether additional permits or approvals addressed in RCW 70.105D.090(1) would otherwise be required for the remedial action under this Order. In the event Snohomish County determines that additional permits or approvals addressed in RCW 70.105D.090(1) would otherwise be required for the remedial action under this Order, it shall promptly notify Ecology of this determination. Ecology shall determine whether Ecology or Snohomish County shall be responsible to contact the appropriate state and/or local agencies. If Ecology so requires, Snohomish County shall promptly consult with the appropriate state and/or local agencies and provide Ecology with written documentation from those agencies of the substantive

requirements those agencies believe are applicable to the remedial action. Ecology shall make the final determination on the additional substantive requirements that must be met by Snohomish County and on how Snohomish County must meet those requirements. Ecology shall inform Snohomish County in writing of these requirements. Once established by Ecology, the additional requirements shall be enforceable requirements of this Order. Snohomish County shall not begin or continue the remedial action potentially subject to the additional requirements until Ecology makes its final determination.

Ecology shall ensure that notice and opportunity for comment is provided to the public, Snohomish County and appropriate agencies prior to establishing the substantive requirements under this section.

C. Pursuant to RCW 70.105D.090(2), in the event Ecology determines that the exemption from complying with the procedural requirements of the laws referenced in RCW 70.105D.090(1) would result in the loss of approval from a federal agency which is necessary for the State to administer any federal law, the exemption shall not apply and Snohomish County shall comply with both the procedural and substantive requirements of the laws referenced in RCW 70.105D.090(1), including any requirements to obtain permits.

VI.

Satisfaction of this Order

The provisions of this Order shall be deemed satisfied upon written notification from Ecology that Snohomish County has completed the remedial action required by this Order, as amended by any modifications, and that all other provisions of this Agreed Order have been complied with. Snohomish County may request this notification and response shall not be unreasonably withheld.

VII.

Enforcement

1. Pursuant to RCW 70.105D.050, this Order may be enforced as follows:

   A. The Attorney General may bring an action to enforce this Order in a state or federal court.

   B. The Attorney General may seek, by filing an action, if necessary, to recover amounts spent by Ecology for investigative and remedial actions and orders related to the Site.

   C. In the event Snohomish County refuses, without sufficient cause, to comply with any term of this Order, Snohomish County may be liable for:

      (1) up to three times the amount of any costs incurred by the state of Washington as a result of its refusal to comply; and
      (2) civil penalties of up to $25,000 per day for each day it refuses to comply.

   D. This Order is not appealable to the Washington Pollution Control Hearings Board. This Order may be reviewed only as provided under Section 6 of ch. 70.105D RCW.

Effective date of this Order: January 30, 1996

SNOHOMISH COUNTY

By Gary Weikel 10/25/95
GARY WEIKEL
Executive Director

Approved as to form:

By Jeanette Burrage

Date 10/19/95

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY

By Michael J Gallagher

By Mary Sue Wilson AAG

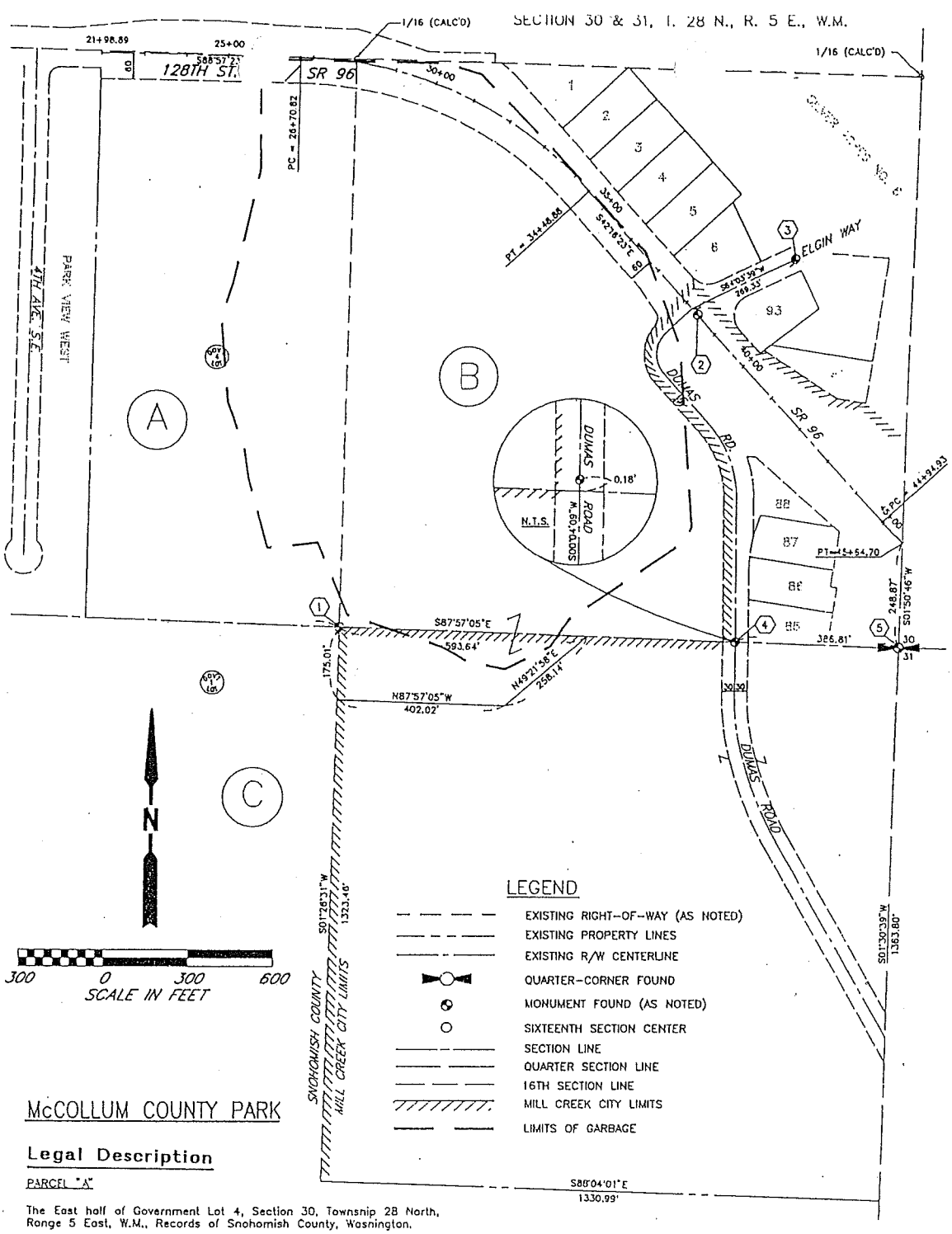
Date 2-1-96

APPENDIX A
LEGAL DESCRIPTIONS OF PROPERTIES

1) McCollum Park

2) Historical Property / Emander Landfill

3) WDOT Property and County Road Property
Note: Legal descriptions are not available for roadways. A map is provided for reference.



McCOLLUM COUNTY PARK

Legal Description

PARCEL "A"

The East half of Government Lot 4, Section 30, Townsnip 28 North, Range 5 East, W.M., Records of Snohomish County, Wasnington.

Except County Roads.

Parcel "B"

That portion of the Southeast quarter of the Southwest quarter of Section 30, Township 28 North, Range 5 East, W.M., In Snohomish County, Washington, lying westerly of the County road, as conveyed to Snohomish County, by deed recorded November 20, 1964 under Recording No. 1741032; and ALSO that portion of the Northeast quarter of the Northeast quarter of Section 31, Township 28 North, Range 5 East, W.M., described as follows:
Beginning at the Northwest Corner of the Northeast quarter of the Northwest quarter of Section 31, Township 28 North, Range 5 East, W.M., being the true point of beginning;
THENCE, South 87°57'05" East along the north line of said section a distance of 593.64 feet;
THENCE South 49°21'58" West a distance of 258.14 feet;
THENCE North 87°57'05" West a distance of 402.02 feet;
THENCE North 01°26'31" East a distance of 175.01 feet to the true point of beginning.

EXCEPT that portion vacated by Snohomish County Resolution No. 79-347.

Situate in the County of Snohomish, State of Washington.

PARCEL "C"

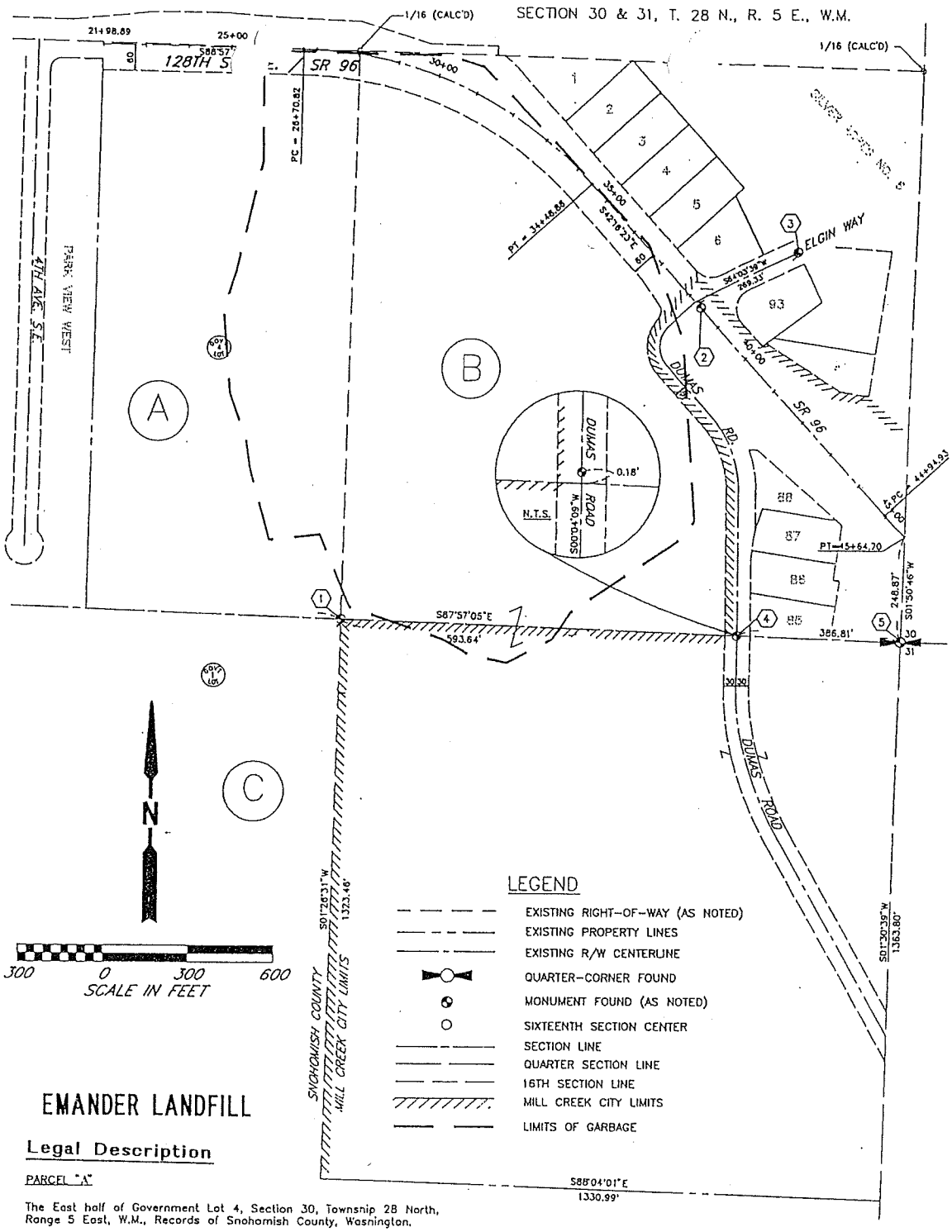
Government Lot 1, Section 31, Township 28 North, Range 5 East, W.M., Records of Snohomish County, Washington.

All Situate in the County of Snohomish, State of Washington.

NOTE: BASIS OF BEARING ASSUMED

	MONUMENT TABLE
(1)	FOUND CONCRETE MONUMENT W/ BRASS DISK & 3 CONCRETE GUARD POSTS (41/823)
(2)	FOUND 6" CONCRETE MONUMENT W/ 1-1/2" BRASS CAP IN CASE (60/901)
(3)	FOUND CONCRETE MONUMENT IN CASE
(4)	FOUND CONCRETE MONUMENT W/ 1/4" ROD IN CASE IN C/L OF DUMAS ROAD (44/641)
(5)	FOUND CONCRETE MONUMENT W/ INVERTED NAIL UNDER 0.5' WATER (44/763)
SNOHOMISH COUNTY SURVEY NO.	2879

Survey # for 128th St. SE



EMANDER LANDFILL

Legal Description

PARCEL "A"

The East half of Government Lot 4, Section 30, Township 28 North, Range 5 East, W.M., Records of Snohomish County, Wasnington.

Except County Roads.

Parcel "B"

That portion of the Southeast quarter of the Southwest quarter of Section 30, Township 28 North, Range 5 East, W.M., in Snohomish County, Washington, lying westerly of the County road, as conveyed to Snohomish County, by deed recorded November 20, 1964 under Recording No. 1741032; and

EXCEPT that portion vacated by Snohomish County Resolution No. 79-347.

Situate in the County of Snohomish, State of Washington.

PARCEL "C"

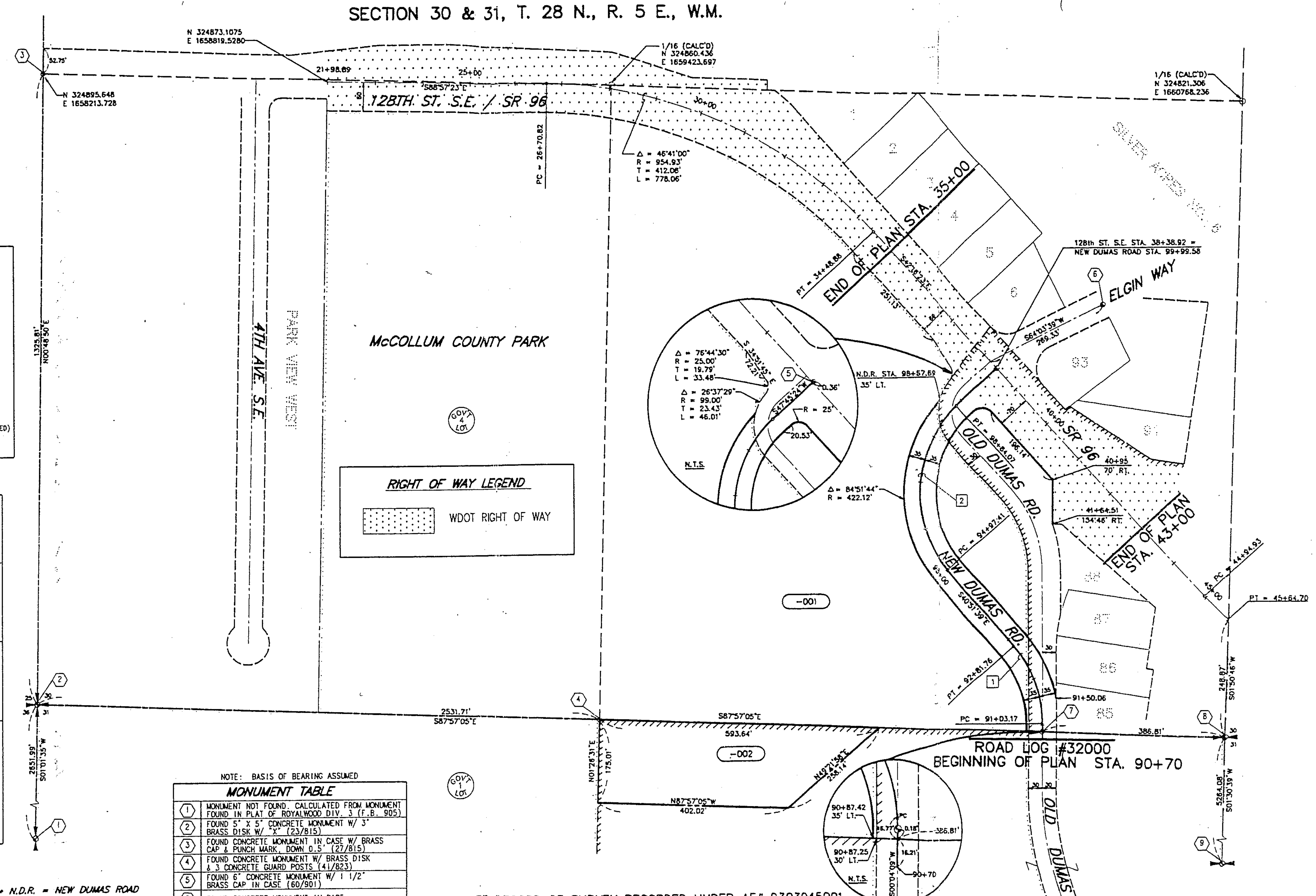
Government Lot 1, Section 31, Township 28 North, Range 5 East, W.M., Records of Snohomish County, Washington.

All Situate in the County of Snohomish, State of Washington.

NOTE: BASIS OF BEARING ASSUMED

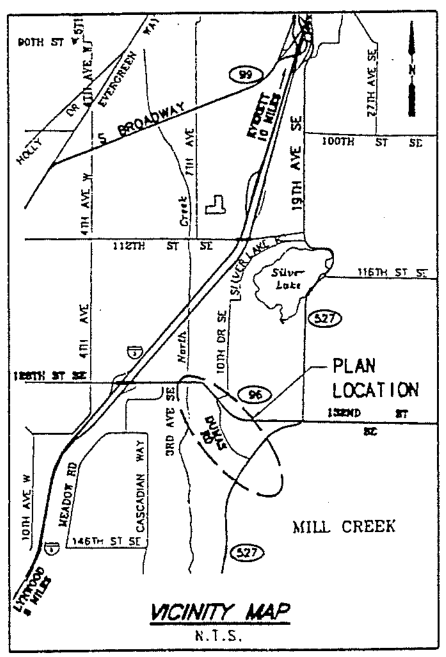
	MONUMENT TABLE
1	FOUND CONCRETE MONUMENT W/ BRASS DISK & 3 CONCRETE GUARD POSTS (41/823)
2	FOUND 6" CONCRETE MONUMENT W/ 1-1/2" BRASS CAP IN CASE (60/901)
3	FOUND CONCRETE MONUMENT IN CASE
4	FOUND CONCRETE MONUMENT W/ 1/4" ROD IN CASE IN C/L OF DUMAS ROAD (44/641)
5	FOUND CONCRETE MONUMENT W/ INVERTED NAIL UNDER 0.5' WATER (44/763)
SNOHOMISH COUNTY SURVEY NO. 2879	

SECTION 30 & 31, T. 28 N., R. 5 E., W.M.



LEGEND

- PROPOSED RIGHT-OF-WAY LINE
- EXISTING RIGHT-OF-WAY (AS NOTED)
- EXISTING EDGE OF PAVEMENT
- PROPERTY LINES
- EXISTING R/W CENTERLINE
- (-084) PROPERTY OWNERSHIP NUMBERS
- QUARTER-CORNER FOUND
- SECTION CORNER FOUND
- MONUMENT FOUND (AS NOTED)
- INTERSECTION POINT
- SIXTEENTH SECTION CENTER
- SECTION LINE
- 16TH SECTION LINE
- PROPERTY LINES (ACQUISITION REQUIRED)
- PROPERTY LINES (NO ACQUISITION REQUIRED)
- MILL CREEK CITY LIMITS



VICINITY MAP
N.T.S.

NOTE: BASIS OF BEARING ASSUMED

MONUMENT TABLE

1	MONUMENT NOT FOUND. CALCULATED FROM MONUMENT FOUND IN PLAT OF ROYALWOOD DIV. 3 (F.B. 905)
2	FOUND 5" X 5" CONCRETE MONUMENT W/ 3" BRASS DISK W/ "X" (23/815)
3	FOUND CONCRETE MONUMENT IN CASE W/ BRASS CAP & PUNCH MARK, DOWN 0.5' (27/815)
4	FOUND CONCRETE MONUMENT W/ BRASS DISK & 3 CONCRETE GUARD POSTS (41/823)
5	FOUND 6" CONCRETE MONUMENT W/ 1 1/2" BRASS CAP IN CASE (60/901)
6	FOUND CONCRETE MONUMENT IN CASE
7	FOUND CONCRETE MONUMENT W/ 1/4" ROD IN CASE IN C/L OF DUMAS ROAD (44/641)
8	FOUND CONCRETE MONUMENT W/ INVERTED NAIL UNDER 0.5' WATER (44/763)
9	FOUND 4 1/2" X 4 1/2" CONCRETE MONUMENT W/ INVERTED NAIL AT 1' ABOVE GROUND ON OLD BARBED WIRE FENCE RUNNINING EAST-WEST (38/811)

• N.D.R. = NEW DUMAS ROAD

*N.D.R. ℄ CURVE DATA

NO.	P.C. STA.	P.T. STA.	DELTA	RADIUS	TANGENT	LENGTH
1	N.D.R. 91+03.17	N.D.R. 92+81.76	40°55'49"	250.00	93.30'	178.59'
2	N.D.R. 94+97.41	N.D.R. 98+84.07	88°37'03"	250.00	244.04'	386.67'

SEE RECORD OF SURVEY RECORDED UNDER AF# 9303045001

OWNERSHIPS

ACQUISITION DOCUMENT (AUDITOR FILE NO.)	PARCEL NO.	NAME	AREA	R/W REQ'D	REMAINDER	EASEMENTS	PERMITS
	32000-91951-001	SNOHOMISH COUNTY PARKS DEPT.	3,234,714	84,841	3,149,873		
	32000-93974-002	KELLY FAMILY LIMITED PARTNERSHIP	1,698,811	87,120	1,611,691		

PLAN CHECK	BY	DATE

DATE	NO.	REVISION	BY

REGION NO.	STATE	FED. AID PROJ. NO.	SHEET NO.
10	WASH.		

DESIGNED BY: McCORMICK
DRAWN BY: LOGGHE
FIELD BOOK(S): 641, 776
DRAWING #

RICHARD F. BROWN, STATE OF WASHINGTON, REGISTERED 9769, PROFESSIONAL LAND SURVEYOR — 2/22/95
OWEN B. CARTER, STATE OF WASHINGTON, REGISTERED 24024, PROFESSIONAL ENGINEER — EXPIRES 5/1/96
JACK BILSBOROUGH, STATE OF WASHINGTON, REGISTERED 22818, PROFESSIONAL ENGINEER — EXPIRES 6/26/95

SNOHOMISH COUNTY ENGINEER

DATE APPROVED

SNOHOMISH COUNTY DEPARTMENT OF PUBLIC WORKS

PROJECT NO. 93-974 91-951

128TH ST. S.E. / DUMAS RD. PARK AND RIDE

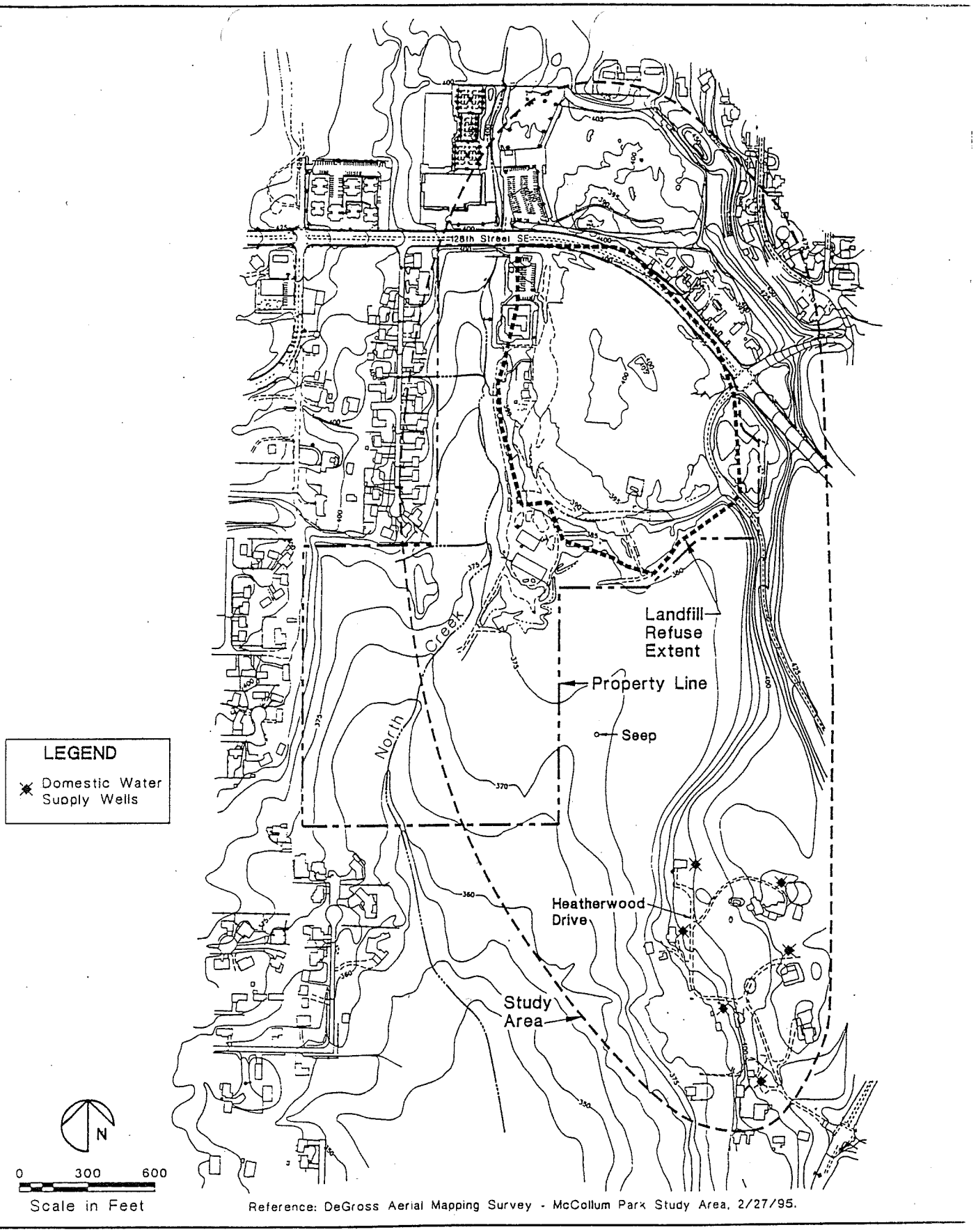
RIGHT OF WAY PLAN

SURVEY NO. 3321 3044

SHEET 1 OF 1 SHEETS

10/10/95
128THDUMAS.3321EX.DWG

APPENDIX B
MAP OF STUDY AREA



Reference: DeGross Aerial Mapping Survey - McCollum Park Study Area, 2/27/95.

AGI TECHNOLOGIES

Study Area

Snohomish Co. Public Works Dept./McCollum Park RI/FS
Snohomish County, Washington

	PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
mccsite.dwg	15,512.275	ALW	17 March 95		ALW	27 Sept. 95

APPENDIX C
LIST OF PREVIOUS SITE STUDIES AND INVESTIGATIONS

PREVIOUS SITE STUDIES AND INVESTIGATIONS
(Listed by date)

Subsurface Investigation and Geotechnical Engineering Study, Phase II, 128th Street S.E. Rehabilitation, Snohomish County, Washington (Rittenhouse-Zeman & Associates, 3/3/86)

Geotechnical Engineering Services, McCollum Park, 128th Street Southeast, Snohomish County, Washington (Earth Consultants Inc., 11/1/89)

Testing Results for Soil and Groundwater Contamination Investigation at McCollum Park, Everett, Washington (Pacific Testing Laboratories, 3/22/90)

McCollum County Park, Master Plan Report, Snohomish County, Washington (Bruce Dees and Associates, 7/6/90)

Geotechnical Report, 128th Street SE/Elgin Way Intersection Improvements, Snohomish County, Washington (Terra Associates, Inc., 11/21/91)

Subsurface Exploration and Geotechnical Engineering Report, McCollum Park - Park & Ride Lot, 128th Street SE, Everett, Washington (RZA AGRA, Inc., 5/22/92)

Environmental Services, Gas Probe Installation and Well Abandonment, McCollum Park, Snohomish County, Washington (Applied Geotechnology Inc., 2/8/93)

Final Environmental Impact Statement: Park and Ride at McCollum Park (Snohomish County Public Works, 1993)

Playfield Cover Evaluation, McCollum Park, Everett, Washington (RZA AGRA, Inc., 12/14/93)

Park-and-Ride at McCollum Park, Draft Supplemental Environmental Impact Statement, Phase 2: Loop Road & Park Improvements (Snohomish County Public Works, 1/29/94)

Park-and-Ride at McCollum Park, Final Supplemental Environmental Impact Statement, Phase 2: Loop Road & Park Improvements (Snohomish County Public Works, 3/25/94)

Environmental Services, Monitoring Well and Gas Probe Installation and Sampling, McCollum Park, Everett, Washington (AGI Technologies, 6/27/94)

McCollum Park Air Sampling, Snohomish County, Washington (AGI Technologies, 12/19/94)

McCollum Park Sludge Assessment; Snohomish County, Washington (AGI Technologies, 1/12/95)

McCollum Park Well Sampling Results for December (Snohomish County, 1/18/95)

Work Plan, Remedial Investigation/Feasibility Study, McCollum Park, Snohomish County, Washington (AGI Technologies, 2/3/95)

McCollum Park Sludge Assessment, Snohomish County, Washington (AGI Technologies, 2/10/95)

Technical Information on Solidification/Stabilization (AGI Technologies, 4/95)

Working Documents for Agreed Order, McCollum Park, Snohomish County, Washington (AGI Technologies, 4/95)

Draft Report, Remedial Investigation McCollum Park, Snohomish County, Washington (AGI Technologies, 5/19/95)

Revised Draft Report, Sludge Solidification /Stabilization Optimization Study, McCollum Park and Emander Landfill, Snohomish County, Washington (AGI Technologies, 6/30/95)

APPENDIX D
WORK PLAN

AGI
TECHNOLOGIES

Work Plan
McCollum Park
Snohomish County, Washington

October 13, 1995

Prepared For :

Snohomish County Public Works
Marion Building
2829 Rucker Avenue
Everett, Washington 98201

AGI Project No. 15,512.284

AGI
TECHNOLOGIES

A Report Prepared For :

Snohomish County Public Works
Marion Building
2829 Rucker Avenue
Everett, Washington 98201

WORK PLAN
McCOLLUM PARK
SNOHOMISH COUNTY, WASHINGTON

October 13, 1995

Alan Carey, CHMM, P.G.
Senior Geologist

Susan Penoyar, P.E.
Associate Engineer

AGI Technologies
300 120th Avenue N.E.
Building 4
Bellevue, Washington 98005
206/453-8383

AGI Project No. 15,512.284

AGI TECHNOLOGIES

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LIST OF FIGURES

1.0 INTRODUCTION

AGI Technologies (AGI) has prepared this Work Plan for Snohomish County Public Works (County). Activities described in the Work Plan will guide the County and their representatives in gathering additional data, developing proposed cleanup levels, evaluating remedial action alternatives, and preparing an RI/FS Draft Cleanup Action Plan (CAP) and Compliance Monitoring Plan (CMP) for the McCollum Park/Former Emander Landfill (landfill) in Snohomish County, Washington. This work will be performed in general accordance with the Washington State Model Toxics Control Act (MTCA, promulgated under Washington Administrative Code [WAC] 173-340). This Work Plan is based on the results of previous site investigations, discussions with County representatives, and MTCA requirements outlined under WAC 173-340.

1.1 OBJECTIVE

This Work Plan describes the technical approach to be followed in completing the Remedial Investigation/Feasibility Study (RI/FS), Draft CAP, and CMP. The primary RI objective is to determine the nature and extent of hazardous substance releases or potential releases from the landfill. The RI results will be used to determine current or potential future risk posed by the landfill to human health and the environment. This information will then be used in conducting the FS to identify and evaluate potential remedial technologies. The Draft CAP will select a remedial alternative in accordance with MTCA selection criteria (WAC 173-340-360). The County will perform compliance monitoring to ensure the cleanup action has attained cleanup and (if appropriate) other performance standards are met (WAC 173-340-410).

1.2 WORK PLAN ORGANIZATION

Sections 2.0 through 6.0 of this Work Plan discuss: site background; previous investigation results, contaminants of concern, and regulatory issues; RI/FS tasks; Draft CAP and CMP preparation; and project management issues.

2.0 SITE BACKGROUND

2.1 LOCATION AND GENERAL DESCRIPTION

McCollum Park ("park") is located approximately 1/2 mile east of Interstate 5 on 128th Street SE in Snohomish County, Washington (see **Figure 1**). The park is part of the McCollum Park/Former Emander Landfill site, which is part of a larger study area (see **Figure 2**). The former landfill, shown on **Figure 3**, comprises most of the northern half of the 78-acre park. To the north of the park, the landfill extends beneath 128th Street SE onto Washington State Department of Transportation (WSDOT) right-of-way. The landfill also extends beneath a portion of Dumas Road on Snohomish County right-of-way. The site ("Historical Property") includes the park, WSDOT right-of-way containing the landfill where it passes beneath 128th Street SE; and Snohomish County right-of-way where it passes beneath Dumas Road. A larger area ("the study area") encompasses areas around the site which have been, or will be, involved in the investigations associated with the site. This includes the park, the study area includes areas in which groundwater and surface water monitoring stations have been installed, residences along Heatherwood Drive, and a golf driving range and trailer park located north of the site. The study area includes known areas of contamination and areas which may affect, or be affected by, the release of contaminants from the landfill.

As of February 1995 (prior to the 1995 construction season), surface elevations varied across the landfill from approximately 383 to 395 feet above Mean Sea Level. The ground surface sloped gently downward from the northern portion of the landfill to the east, west, and south; however, most of the landfill surface has been stripped of vegetation and partially filled/graded in preparation for improvements being implemented as part of the County's McCollum Park Master Plan. Surface water runoff was primarily west to North Creek and south/southeast to two wetland depressions (Dees, 1990). A swimming pool, park ranger's residence, maintenance buildings, and parking lot are located near the landfill's western edge. Two park buildings leased by Washington State University (WSU) Extension Services are located immediately southeast of the landfill.

2.2 HISTORY

The property now comprising the landfill was acquired by Snohomish County beginning in 1922 for use as a gravel pit; gravel was mined there between about 1929 and 1947. The property was subsequently used by the City of Everett as a municipal landfill (known as the Emander Landfill) between about 1947 and 1967. Aerial photos show landfilling operations substantially completed by 1967, and that a soil cover was in place. The site was reportedly turned over to the Snohomish County Parks and Recreation Department in 1969, at which time improvements such as the swimming pool, ranger's residence and maintenance buildings, parking facilities, trails, and playgrounds were constructed. The Snohomish County Parks and Recreation Department built its headquarters southeast of the landfill in 1980; WSU Extension Services has leased these buildings since 1984.

Several landfill gas vents/flares were installed near the swimming pool in the 1970s, and along 128th Street SE in 1985. The eastbound lane of 128th Street SE (which crosses the landfill's northeast edge) was upgraded and stabilized in 1987 to overcome settling problems.

The County purchased a 2-acre parcel of the adjoining property to the south in 1994. This parcel was part of the operating landfill, although never legally part of the historical property purchased and operated by the County.

In 1989, the County began developing a McCollum Park Master Plan. The County Council approved the Master Plan in 1990. The Final Environmental Impact Statement (EIS), issued in 1993, established landfill mitigation measures, including a partial synthetic cover, landfill gas management system, and long-term groundwater monitoring.

The County began construction to implement the Master Plan in the summer of 1994, including roadway improvements, a Community Transit Park & Ride facility, and new playing fields. Considerable amounts of fill were imported and placed across the surface of the landfill to improve subgrade conditions and provide support for the planned improvements.

A wet, sludge-like material emerged to ground surface on about November 8, 1994 during final fill placement and grading in the south central portion of the landfill. The sludge was a dark brown to black viscous liquid containing fine particulate material and exhibiting a very strong organic odor. It covered an area measuring approximately 25 feet by 35 feet in plan dimension. Construction workers placed a berm around the material to prevent it from spreading and it subsequently rose an estimated additional 1 foot. A temporary covered, fenced enclosure was erected around the emergence (see **Figure 3**). Sludge emerged to ground surface in April and June, 1995 at two other locations near the first emergence.

2.3 GEOLOGY AND HYDROGEOLOGY

Geology : As described by R. C. Newcomb (1952), the western third of Snohomish County is situated in the Intercity Plateau of the Puget Sound lowland. The Intercity Plateau is a rolling upland, composed largely of unconsolidated glacial deposits, in contrast to the hard rock deposits to the east.

Much of the plateau is capped by Vashon Till (Till), an unsorted, nonstratified sediment deposited directly by glacial ice during the Vashon Stade of the Fraser Glaciation. Till generally consists of very dense silty to gravelly sand with low permeability. The Vashon Till overlies Vashon Advance Outwash (Advance Outwash), a dense to very dense sand and gravel deposited ahead of the advancing glacier. Advance Outwash is exposed in areas where the overlying Till has been eroded or was not deposited. Minard (1985) mapped the sand exposures along North Creek as Advance Outwash.

RZA AGRA, Inc. explored subsurface conditions at McCollum Park in 1992 by advancing 13 borings to maximum depths of 24 feet below ground surface (bgs), and interpreting previous work (borings, test pits, and monitoring wells) by others (RZA, 1992). They classified native soils at the base of their borings as glacial outwash. Subsurface conditions encountered by AGI in 1994 were consistent with those encountered in RZA's study (AGI, 1994).

Hydrogeology : Site groundwater occurs under water table conditions. Groundwater was encountered within the refuse at depth during drilling, and may occur at various depths and locations within the fill soil across the site. In March 1995, the depth to the water table varied from about 3 to 18 feet bgs, depending on topography. Groundwater flows toward the southeast at the northwest corner of the site and to the south and southwest beneath the southern portion of the landfill (see **Figure 3**). Domestic wells located within a mile of the site are logged as being completed beneath a variable thickness of till, and presumably draw water from Advance Outwash sand.

2.4 WATER SUPPLY SOURCES

Two municipal water districts, Silver Lake and Alderwood, serve McCollum Park and the surrounding area. Both districts obtain their water from Spada Lake through purchase agreements with the City of Everett. The Alderwood Water District serves the area west of 7th Avenue SE and south of 124th Street SE; Silver Lake Water District serves most of the remaining area. Available records indicate eight private water supply wells are also in use within approximately one mile of McCollum Park, including six potentially downgradient of the landfill on Heatherwood Drive.

2.5 CURRENT AND PROPOSED LAND USES

McCollum Park is zoned for forestry and recreational use. Low density residential development borders the park to the east, west, and south, and a golf driving range is located to the north across 128th Street SE. Most land surrounding the park is zoned for suburban or high-density residential development (Dees, 1990). North Creek is classified as a watershed site/sensitive area; development along the creek is strictly controlled.

In addition to the existing park facilities noted in Section 2.2, the County is currently developing the landfill site as part of the McCollum Park Master Plan. The central portion of the landfill will comprise an open meadow with two playfields. Improvements currently under construction in areas closer to the landfill perimeter include access roads and parking for the recreational facilities, pedestrian trails, and parking lots for the Community Transit Park & Ride. A new ranger's residence and an education center/children's museum are also planned.

2.6 NATURAL RESOURCES AND ENVIRONMENT

McCollum Park comprises three distinct areas: open space (the former landfill), woodland, and forested wetland. These areas may be generally characterized as follows (Dees, 1990; Snohomish, 1993):

- The open space, currently undergoing improvements, forms the park's topographic high point. Before improvements, ground surface sloped gently downward to the south, east, and west. This area supported mostly planted and native grasses; deciduous and coniferous trees and low shrubs such as Scotch broom occur along perimeter areas. This area has been partially filled and graded in accordance with Park & Ride plans and specifications.

- Woodlands comprise the southern half of McCollum Park and the area west of the landfill along North Creek. Woodland areas have an undulating topography that generally slopes downward toward the creek; the eastern portions of the woodlands also make up part of the wetlands. Woodland vegetation consists primarily of mixed coniferous/deciduous second-growth forest: western red cedar, hemlock, and Douglas fir; vine maple and red alder; and a variety of small shrubs and scrub brush such as salmonberry and Oregon grape. Stumps from past logging operations remain throughout the woodlands.

- Two forested wetlands occupy portions of the park's eastern edge. The smaller of the two forms a stormwater runoff detention basin between Dumas Road and 128th Street SE. The larger wetland is located south of the WSU Extension Services buildings. Both areas frequently contain ponded water and support typical wetland vegetation such as alder, black cottonwood, Douglas spirea, willow, and rushes.

The Washington Department of Wildlife (WDW) has designated North Creek and the land immediately adjacent to the creek as the North Creek riparian corridor, part of the state's Priority Habitats and Species Program. A 1990 field study of the corridor near 180th Street SE identified numerous species of birds, large and small mammals, reptiles, and amphibians. Some of these species likely use the McCollum Park section of the corridor for habitat and foraging (Snohomish, 1993).

North Creek provides spawning and rearing habitat for numerous resident and anadromous (fish that migrate from the sea up a river to spawn) fish species, including coho, Chinook, and sockeye salmon, and rainbow, steelhead, and cutthroat trout. Coho and Chinook salmon reportedly use North Creek downstream of 128th Street SE; however, the number of anadromous fish using the creek has declined considerably over the past two decades and the creek habitat within McCollum Park is typically limited by low flows during the summer. Recent North Creek fish kills early in the yearly spawning runs may have resulted from roadway and parking lot contaminants washed into the creek by heavy rains at the end of the dry summer months (Snohomish, 1993).

WDW's National Heritage Data System lists no rare, threatened, or endangered species for McCollum Park or the North Creek riparian corridor (Dees, 1990; Snohomish, 1993).

3.0 INITIAL EVALUATION

Section 3.1 summarizes the results of environmental and geotechnical investigations performed at the landfill prior to the sludge emergence. Investigations occurring after the sludge emergence, but prior to the RI are discussed in Section 4.0. These data were evaluated to identify areas requiring further investigation during the RI. Section 3.3 then characterizes landfill contents, specifically sludge, and Section 3.4 discusses the landfill from a regulatory standpoint.

3.1 PRE-EMERGENCE INVESTIGATIONS

Figure 4 shows the locations of borings, test pits, and monitoring wells associated with pre-emergence investigations at the landfill.

1985/86 - RZA : Rittenhouse Zeman Associates (now dba RZA AGRA, Inc. [RZA]) advanced nine soil borings in 1985 and 1986 to determine the thickness and extent of landfill refuse beneath a portion of 128th Street SE then experiencing settling. Refuse thickness in this area ranged from approximately 6 to 20 feet (RZA, 1992).

1989 - ECI : Earth Consultants, Inc. (ECI) excavated 10 test pits across the landfill in 1989 as part of the park Master Plan study. ECI reported refuse thicknesses ranging from approximately 3 to more than 13 feet; soil cover thicknesses ranged from 1 to 4 feet in most locations, but cover was absent in at least one location (TP-7). Two test pits in the landfill's south-central portion (TP-5 and -6) encountered soil saturated with a black liquid containing hydrocarbon constituents apparently derived from a heavy (bunker) oil.

1990 - PTL : Pacific Testing Laboratories, Inc. (PTL) installed four groundwater monitoring wells in March 1990, also in support of the park Master Plan study. Three wells (BH-1A, BH-2B, and BH-4) were installed through landfill refuse into the underlying soil; the fourth (BH-3) was installed outside the refuse limits.

The boring for BH-2B, near the landfill's southern edge, encountered refuse to 19 feet bgs; BH-1A and BH-4 encountered refuse up to 21 feet bgs. BH-2B also encountered soil saturated with the black liquid encountered by the two ECI test pits excavated in this area.

Groundwater samples collected from these wells in 1990 were analyzed for: total dissolved solids; pH; benzene, ethylbenzene, toluene, and total xylenes (BETX); and extraction procedure (EP) toxicity metals. All analytes were below 1990 cleanup levels; however, detection limits for some analytes were higher than current (1995) state and federal standards (RZA, 1992).

1992 - RZA : RZA performed additional subsurface investigation work in February 1992 to support the planned Park & Ride lot. This study included installing 13 gas probes (GP-1 through GP-13) within the landfill and collecting soil samples from the borings, soil gas samples from the gas probes, and water samples from the four PTL groundwater monitoring wells. RZA also performed a geophysical survey that identified the landfill limits, refuse thickness, and soil cover thickness.

Soil cover thickness ranged from approximately 2 to 6 feet; the cover was observed to be absent in some areas, or mixed with refuse. Refuse thickness ranged from approximately 5 to 19 feet. Refuse was mixed with soil in varying percentages: 0 to 25 percent soil at the landfill's extreme southeastern and southwestern edges, and 50 to 75 percent soil elsewhere. Groundwater was encountered within the refuse at depth.

A soil sample from GP-9 at 13-1/2 feet bgs, in the landfill's southern portion, was saturated with a black liquid apparently identical to that encountered by ECI test pits TP-5 and TP-6 and PTL well BH-2B. These explorations were all located within an area approximately 200 feet in diameter.

Groundwater samples were analyzed for volatile and semivolatile organic compounds (VOC, SVOC) by EPA Methods 624 and 625, and metals (arsenic, barium, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc) by EPA Methods 6010/7471. Results indicated concentrations of chlorobenzene, naphthalene, and metals (arsenic, barium, cadmium, chromium, copper, lead, nickel, silver, and zinc) above 1992 MTCA cleanup levels.

The soil sample from GP-9 at 13-1/2 feet bgs was analyzed for VOCs and SVOCs by EPA Methods 8240/8270, polychlorinated biphenyls (PCB) by EPA Method 8080, Toxicity Characteristic Leaching Procedure (TCLP) metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver), and pH. VOCs (trichloroethene, benzene, toluene, ethylbenzene, and total xylenes) were detected at concentrations ranging from 2.3 (benzene) to 63.0 (total xylenes) milligrams per kilogram (mg/kg). SVOCs (1,4-dichlorobenzene, 2-methylphenol, naphthalene, 2-methylnaphthalene, acenaphthene, fluorene, phenanthrene, di-n-butylphthalate, fluoranthene, and pyrene) were detected at concentrations ranging from 12.0 (fluoranthene) to 690.0 mg/kg (2-methylnaphthalene). PCBs were not detected. Arsenic, chromium, and lead were detected at 0.7, 0.2, and 2.5 milligrams per liter (mg/L), respectively, in the TCLP leachate. The pH value for this sample was 4.4, indicating an acidic nature.

An additional soil sample from GP-9, collected at 23-1/2 feet bgs from native soil beneath the landfill, was analyzed for the same parameters as the previous sample except PCBs. VOCs were not detected. SVOC concentrations ranged from 0.049 (anthracene) to 1.9 (di-n-butylphthalate) mg/kg. Barium, at 0.2 mg/L, was the only metal detected in the TCLP leachate.

Soil gas samples were analyzed for VOCs. The highest concentrations, primarily acetone, benzene, cis-1,2-dichloroethene, ethylbenzene, toluene, vinyl chloride, and total xylenes, were detected in samples from GP-9, GP-3, and GP-1. These results were then modeled using EPA's SCREEN air dispersion model to predict worst-case ambient concentrations should the landfill cover be completely removed; results were well below Washington's Acceptable Source Impact Levels (ASIL) for all detected compounds.

1990 To 1992 - County : Surface water samples were collected at different time intervals adjacent to the bridge crossing North Creek near the swimming pool. Samples were analyzed for metals and general water quality parameters.

1992 - County : County representatives collected water samples from two domestic water wells on Heatherwood Drive south of the landfill. Samples were analyzed for metals, VOCs, and general water quality parameters. No exceedances of Groundwater Quality Criteria (WAC 173-200) were detected.

1992 - AGI : In December 1992, AGI abandoned PTL wells BH-1A, BH-2B, and BH-4 and installed six additional gas probes/piezometers (GP-14 through -19) outside the landfill refuse limits. The additional gas probes were installed to monitor subsurface gas concentrations during placement of a rolling surcharge across the landfill surface as part of the site improvements, and for long-term monitoring after construction is completed. The gas probes were screened across the water table to enable water level monitoring.

Soil gas samples were analyzed for VOCs by EPA's Toxic Organics 14 method. Compounds detected were generally similar to those detected during the RZA investigation. The highest concentrations were detected in samples from GP-14, -18, and -19, all located along the landfill's northern perimeter near 128th Street SE.

1994 - AGI : AGI installed an additional gas probe (GP-20) and four new groundwater monitoring wells (BH-5 through -8) outside the landfill refuse limits in March 1994. BH-5 through -7 and GP-20 were installed south of the landfill; BH-8 was installed near the landfill's northeast corner.

Water levels measured in May 1994 indicated groundwater flow to the southeast in the landfill's northern portion, becoming more southerly in the landfill's southern portion. Water levels varied from approximately 3 to 18 feet bgs depending on ground surface elevation.

A soil gas sample collected from GP-20 was analyzed for VOCs by EPA's Toxic Organics 14 method. No compounds were detected at or above their respective method reporting limits.

Two rounds of groundwater samples collected from the four new wells, remaining PTL well BH-3, and two domestic supply wells located southeast of McCollum Park near Heatherwood Drive were analyzed for water quality indicator parameters, VOCs, total and dissolved metals, pesticides, and herbicides. Results are summarized below:

- *Water Quality Indicator Parameters*: Most indicator parameters were elevated in the three downgradient wells (BH-5, -6, and -7) as compared to BH-8 and the residential wells. Conductivity, chemical oxygen demand, tannins and lignins, and total organic carbon, all potential leachate indicators, were significantly higher in the three downgradient wells.

- *VOCs*: VOCs were detected only in the three downgradient wells. Benzene, vinyl chloride, trichloroethene, and 1,2-dichloroethane exceeded either state groundwater quality criteria (WAC 173-200) or MTCA Method A cleanup levels; other ethanes and ethenes for which state cleanup criteria have not been established were also detected.

- *Metals*: Barium, chromium, copper, lead, nickel, and zinc were detected in unfiltered samples from BH-8 and the three downgradient wells; in addition, copper and zinc were each detected in at least one residential well. Thallium was detected at its method reporting limit in BH-7. Arsenic was detected only in the three downgradient wells. Metals detected in filtered samples during second-round sampling confirmed most of the unfiltered metals detections. Arsenic, chromium, and lead in unfiltered samples exceeded either state groundwater quality criteria or MTCA Method A cleanup levels in the downgradient wells; only arsenic exceeded these levels in the dissolved (filtered) state.

Surface water samples collected from North Creek upstream and downstream of the landfill were analyzed for water quality indicator parameters and unfiltered/filtered metals. Results were nearly identical for the two samples; detected metals were all below state surface water quality chronic criteria (WAC 173-201A).

3.2 POTENTIALLY HAZARDOUS SUBSTANCE SOURCES

ECI test pits and RZA borings advanced into the landfill encountered refuse typical of municipal solid waste landfills, including glass, plastic, paper, wood, metal, and concrete demolition debris. As noted in Section 3.1, refuse is mixed with soil in varying percentages throughout the landfill.

Anecdotal information suggests septic tanks, bilge water pumped from ships calling at the Port of Everett, and other liquids were disposed of at the landfill (RZA, 1992). Personnel interviewed by the County in November 1994 indicated fuel storage tank bottoms were deposited at the location of the sludge encountered during previous investigations (AGI, 1995). ECI reported encountering a number of small buckets at this location during their 1989 test pit investigation (ECI, 1989).

Anecdotal evidence indicates sources of petroleum products disposed of at the landfill included the following: Shell's Harbor Island facility; Unocal's facility at Broad and Market Streets in Seattle; Standard Oil's facility at Richmond Beach; the U.S. Air Force (Mukilteo Tank Farm); the U.S. Navy (Pier 91); and Superior Refineries on Highway 9 in Woodinville.

3.3 REGULATORY CLASSIFICATION

The regulatory classification of the landfill and wastes within the landfill must be considered when selecting an appropriate remedial alternative. RI data needs are determined, to some extent, based upon possible remedial alternatives.

Landfill Closure Requirements: Municipal landfills in the State of Washington accepting waste after October 9, 1993 must operate and close under WAC 173-351, Criteria for Municipal Solid Waste Landfills. With some exceptions, landfills accepting waste after November 27, 1989 and prior to October 9, 1993 are subject to closure and post-closure rules under WAC 173-304, Minimum Functional Standards for Solid Waste Handling (MFS).

MFS criteria do not apply to the former Emander landfill, which stopped receiving waste prior to 1989. For pre-MFS landfills, closure may be handled outside the regulatory framework unless it is subject to MTCA requirements. The County treated the sludge emergence as a release of a hazardous substance potentially posing a threat to human health and the environment and reported it to Ecology on November 14, 1994, in compliance with WAC 173-340-300.

Ecology's Site Hazard Assessment (SHA) of the landfill gave it a rating of 1 on the state's Hazardous Sites List, meaning it is (on a scale of 1 to 5) in the highest relative risk category of all Washington State sites assessed at that time by the Washington Ranking Method (WARM) Model. Ecology's SHA scoring was based on the assumption that sludge is the "contaminant source", rather than considering the site a "landfill." Furthermore, because the sludge was disturbed and contained above grade, Ecology scored the site as a "waste pile."

Ecology met with the County on April 6, 1995 and agreed on a process for implementing an Agreed Order. This process allowed construction to proceed without significant delays (and associated monetary penalties) during the time that an Agreed Order was being negotiated between the County and Ecology.

Hazardous/Dangerous Waste Designation : Federal regulations regarding landfill closure are promulgated under the Resource Conservation and Recovery Act (RCRA). RCRA Subtitle D (solid waste) requirements are usually applicable to landfills unless a determination is made that RCRA Subtitle C (hazardous waste) regulations apply. RCRA Subtitle C and Washington Dangerous Waste Regulations (WAC 173-303) apply if the waste is a listed or characteristic hazardous waste under RCRA, a criteria dangerous waste under WAC 173-303-100, and: (1) if the waste was disposed of after November 19, 1980 (effective date of RCRA); or (2) remedial measures constitute current treatment, storage, or disposal of a hazardous waste.

Federal and state landfill RI/FS guidance documents recognize the need for addressing "hot spots" of highly toxic materials within municipal waste landfills, such as the sludge or hydrocarbon-contaminated refuse (HCR) encountered in the south central portion of the landfill. Excavation and disposal of discrete hot spots is often a feasible remedial alternative. This section discusses whether sludge and HCR are a hazardous or dangerous waste.

Federal and Washington State regulations recognize two ways in which a waste can be considered hazardous: by inclusion on a list promulgated under RCRA (listed wastes) or by exhibiting one of the four characteristics discussed below (characteristic wastes). Additionally, Washington regulations recognize three dangerous waste criteria: toxic, persistent, and carcinogenic.

Anecdotal reports (Matter, 1994; Delsman, 1994) indicate petroleum storage tank bottoms were disposed of at the landfill in the area where sludge was encountered previously by ECI and RZA, and where it recently surfaced during construction. Federal regulations (state regulations are identical) list tank bottoms (leaded) from the petroleum refining industry as a hazardous waste (K052). However, tank bottom sludge from petroleum storage, as described in the anecdotal reports, is not included in this definition. Therefore, based on existing information, the sludge encountered at McCollum Park is not a hazardous waste under listed waste criteria.

Hazardous waste characteristics include ignitability, corrosivity, reactivity, and toxicity. The sludge has not been tested for ignitability, corrosivity, and reactivity; furthermore, physical testing before RI activities indicated it would likely not designated hazardous by these characteristics. Toxicity is assessed by TCLP analysis, where water is leached through the sample and the leachate analyzed for VOCs, SVOCs, and metals. When leachate analytes exceed a RCRA-promulgated threshold, the waste is considered a characteristic hazardous waste. RZA (1992) submitted a soil sample from GP-9, described as "heavily oil soaked black soil" for TCLP metals analysis. Arsenic, chromium, and lead were detected in the TCLP leachate, but all concentrations were below characteristic waste designation thresholds.

As described in a Washington State Department of Ecology internal memorandum, entitled "The IARC Listing for Lead and Lead Compounds," metals analyses performed on sludge show relatively high (>1000 mg/kg) lead concentrations in some samples. Three carcinogenic lead compounds (lead phosphate, lead acetate, and lead subacetate) are used by Ecology to determine whether a waste is a dangerous waste by carcinogenic criteria. No federal or state analytical methods have been established to quantify these lead species. AGI used a x-ray spectrometry method to evaluate lead speciation in sludge (AGI, 1995). The results of these analyses shows most lead species are lead sulfate, indicating sludge and HCR are not carcinogenic dangerous waste because of their lead content.

In summary, a variety of historical data and chemical analyses have been used to determine whether sludge and HCR would designate as a hazardous or dangerous waste. All data and analyses evaluated to date indicate sludge and HCR are not hazardous and/or dangerous wastes.

4.0 REMEDIAL INVESTIGATION

The objective of a MTCA RI/FS is to collect, develop, and analyze sufficient information to enable selection of a remedial alternative. The RI will assess the nature and extent of landfill contaminants at the site. The following RI activities will supplement data generated during the previous investigations summarized in Section 3.0:

- Collect and analyze available site background data, including interviews conducted by the County with individuals having some knowledge of historical landfill operations.
- Install groundwater monitoring wells to characterize site hydrogeology and assess the impact of landfill contaminants on groundwater. Collect and analyze groundwater samples. Investigate water supply sources for the Heatherwood Drive residences.
- Characterize site surface water features. Collect and analyze surface water samples to assess whether landfill contaminants in groundwater have migrated to surface water.
- Collect and analyze sediment samples from North Creek and tributaries to assess whether landfill contaminants have adsorbed onto sediments.
- Advance borings and test pits into the landfill to evaluate sludge and HCR quantity and distribution. Collect and analyze sludge samples to assess the material's chemical variability.
- Summarize the County's landfill gas monitoring data and the results of landfill gas chemical analyses reported by AGI and RZA in the RI report.
- Analyze RI data and prepare an RI report.

The following sections discuss each of these activities in detail.

4.1 POST-EMERGENCE INVESTIGATIONS

Following the sludge emergence in November 1994, and prior to completing this RI Work Plan, several investigations were undertaken to gather data about the sludge and gain current knowledge of groundwater quality. The results of these investigations are summarized below.

1994 - County: The County collected a sludge sample from the landfill surface in November 1994 for analysis of VOCs, metals, PCBs, and total petroleum hydrocarbons (TPH). TPH quantified as diesel and heavy oil was detected at 77,000 mg/kg, and lead was detected at 4,700 mg/kg. Toluene, ethylbenzene, and total xylenes were detected at 85, 26, and 128 mg/kg, respectively. No chlorinated VOCs or PCBs were detected.

1994 - AGI : Based on the County's November 1994 results, AGI collected five composite sludge samples in December 1994 to further characterize the sludge and conduct a bench-scale treatability study to evaluate potential sludge solidification and stabilization. Results are presented in a report titled *McCollum Park Sludge Assessment* (AGI 1995).

The samples were analyzed for VOCs, PCBs, polycyclic aromatic hydrocarbons (PAH), metals (barium, cadmium, chromium, and lead species), TPH, and moisture content. All samples contained some combination of VOCs (including BETX and chlorinated solvents) and PAHs. PCB 1242 was detected in one sample at 5.1 mg/kg. Metals concentrations ranged from 550 to 1,200 mg/kg for barium, 4.4 to 8.7 mg/kg for cadmium, 24 to 66 mg/kg for chromium, and 4,200 to 6,800 mg/kg for lead. TPH quantified by EPA Method 8015 was detected in all samples at estimated concentrations ranging from 62,000 to 136,000 mg/kg; TPH quantified by Washington State methods was detected at 580 mg/kg (gasoline), 110,000 mg/kg (diesel), and 230,000 mg/kg (oil). Sample moisture content ranged from 68 to 84 percent by weight.

1994 - County : Groundwater samples were collected from groundwater monitoring wells by County representatives and analyzed for metals, general water quality parameters, VOCs, and SVOCs. Exceedances of Water Quality Standards for Groundwater or MTCA Method A cleanup levels were detected for benzene, 1,2-dichloroethane, vinyl chloride, and arsenic.

1995 - Snohomish Health District (SHD) : Representatives collected groundwater samples from two residential water supply wells on Heatherwood Drive (Cook and Warden wells) in January 1995 and analyzed the Warden well sample for VOCs, the Cook well sample for SVOCs, and both samples for total metals. No VOCs or SVOCs were detected; copper, lead, and zinc were detected at µg/L levels in both samples.

1995 - County : The County excavated a series of test pits and trenches around the landfill perimeter to determine refuse limits. Refuse limits were then surveyed and are shown on the site plans used in this report (**Figure 3**).

4.2 PRE-RI DATA REVIEW

We will analyze available pre-RI site data to develop a comprehensive understanding of the landfill and immediate vicinity. Available data include: interviews with individuals having knowledge of historical landfill operations; several reports and plans/specifications produced by other consultants, including those summarized in Section 3.0; post-emergence investigations as summarized in Section 4.1; historical information regarding the site; utility locations; land use planning and zoning maps and documents; natural resource studies conducted by others in the area; and other data as may be provided by the County. In addition, we will review and interpret current and historical aerial photographs.

We understand the County conducted a thorough review of water supply well logs from the Snohomish Health District. In addition, the County performed a visual reconnaissance of properties potentially downgradient of the landfill in search of undocumented wells. AGI will review the results of these County efforts and well logs available from the Washington State Department of Ecology (Ecology). We further understand the County is considering informing potentially downgradient homeowners to alert them of possible impact from the landfill, and to solicit reporting of private wells. AGI will assist the County in preparation of a letter to send to homeowners.

4.3 GROUNDWATER INVESTIGATION

The groundwater investigation will include: drilling and installing nine deep, one intermediate depth, and three shallow monitoring wells; measuring water levels; collecting and chemically analyzing groundwater samples; and investigate water supply sources for Heatherwood Drive residences. **Figure 5** shows proposed well locations.

We understand the County will provide authorization to access private property or State Highway property north of 128th Street SE. A utility check will be performed to identify buried utilities in the vicinity of all proposed subsurface explorations.

Monitoring wells will be horizontally and vertically surveyed by the County. Horizontal distances should be measured to within 0.5 foot using a theodolite and electronic distance meter (datum: State Plane Coordinate System); elevations will be measured to the nearest 0.01 foot using a level (datum: 1929 National Geodetic Vertical Datum).

The scope of work for the groundwater investigation is as follows:

4.3.1 Well Installation

- Drill three shallow groundwater monitoring well borings by dual wall, reverse circulation or hollow-stem auger methods to approximately 15 to 30 feet bgs. MW9 will be drilled using a skid-mounted hollow-stem auger drill. These wells will supplement the existing network of five wells (BH-3, -5, -6, -7, and -8) to evaluate shallow groundwater quality and flow direction.

- Drill nine deep and one intermediate depth groundwater monitoring wells by dual wall, reverse circulation or cable tool methods to an estimated 80 to 120 feet bgs. These wells are intended to characterize deeper geology/hydrogeology and groundwater quality/flow directions at the site.

- Collect soil samples at 5-foot intervals and at observed changes in drilling conditions. Classify soil samples in accordance with the Unified Soil Classification System.

- Construct monitoring wells using 2-inch-diameter Schedule 40 polyvinyl chloride (PVC) blank pipe and milled slot screens; screen length for all wells will be 10 feet, if applicable. Screen deep wells in the same geologic formation as nearby domestic supply wells, if applicable.

4.3.2 Water Level Monitoring

- Measure the water level in each well, landfill piezometer (see Section 4.5), and available gas probe to the nearest 0.01 foot using an electronic water level sounder. AGI will measure water levels twice during the RI, in conjunction with groundwater sampling. County personnel will collect monthly water level from April through September 1995.

4.3.3 *Hydraulic Properties Testing*

- Conduct three slug tests in shallow wells and three in deep wells. Estimate hydraulic conductivity in deep wells from grain-size analyses. These data will be used to estimate groundwater flow velocities.

4.3.4 *Chemical Analysis*

- Collect water samples from the thirteen RI wells, five pre-RI wells, and one domestic supply well downgradient of the landfill. The RI includes three sampling rounds: one following well installation and development, a second round 1 month later, and a third round 6 months later (in the dry season). Collect one quality assurance (QA) duplicate sample during each round.

- Submit groundwater samples to an analytical laboratory for the following analyses:

Analyte	Method
VOCs	EPA Method 524.2
SVOCs	EPA Method 8270
PAHs	EPA Method 8310
Metals	EPA Method 6010/7000 Series
TPH	WTPH-HCID, -G, or -D extended
PCBs	EPA Method 8080
Minimal Functional Standards (MFS) Leachate Indicators/Cations/Anions	

4.3.5 *Heatherwood Drive Water Supply Survey*

The County will survey water supply wells on Heatherwood Drive. Wells identified in this survey will be physically examined.

4.4 SURFACE WATER INVESTIGATION

The surface water investigation will include: interpreting aerial photographs and topographic maps; field reconnaissance and mapping of surface water features; installing staff gauges for water elevation monitoring; measuring water elevations; identifying six sampling points; and collecting three rounds of samples for chemical analysis.

Samples will be collected from North Creek and identified tributaries both upgradient and downgradient of the landfill. **Figure 6** shows staff gauge and surface water sampling locations, contingent on the season as North Creek is expected to be dry during the August sampling.

4.4.1 *Water Level Monitoring*

- Measure surface water elevations and make observations on a monthly basis, concurrently with groundwater level monitoring.

4.4.2 *Chemical Analysis*

- Collect three rounds of samples concurrently with groundwater sampling. Submit surface water samples to an analytical laboratory for the following analyses:

Analyte	Method
VOCs	EPA Method 524.2
SVOCs	EPA Method 8270
PCBs	EPA Method 8080
Metals	EPA Method 6010/7000 Series
TPH	WTPH-HCID, -G, or -D extended

4.5 SEDIMENT INVESTIGATION

The sediment investigation will include identifying sample locations during the surface water reconnaissance and collecting seven sediment samples for the following chemical analyses:

Analyte	Method
SVOCs	EPA Method 8270
Metals	EPA Method 6010/7000 Series
PCBs	EPA Method 8080
TOC	Standard Method 5310B
Particle Size	Puget Sound Estuary Program Method

Figure 7 shows sediment sampling locations. Eight samples will be collected from North Creek and its tributaries; the seventh will be collected from a seep identified south of the landfill. Samples will be analyzed using the methods listed above with low quantitation limits to achieve Puget Sound Dredged Disposal Analysis (PSDDA) screening levels.

4.6 LANDFILL INVESTIGATION

The landfill investigation will include advancing 29 borings and 16 test pits into the landfill, including the three areas where sludge emerged to ground surface. HCR will also be investigated. Figure 8 shows boring and test pit locations. Up to nine sludge and HCR samples will be collected and submitted for the following chemical analyses:

Analyte	Method
VOCs	EPA Method 8010/8020
SVOCs	EPA Method 8270
Metals	EPA Method 6010/7000 Series
TPH	WTPH, -G, and -D extended, EPA Method 418.1
PCBs	EPA Method 8080
Oil and Grease	EPA Method 413.2
TOC (total organic carbon)	ASA Method 90-3.2

During the landfill investigation, piezometers will be installed in three borings to characterize groundwater occurrence within the landfill. Groundwater samples will not be collected from the piezometers.

4.7 LANDFILL GAS MONITORING DATA SUMMARY

An ongoing landfill gas monitoring program is being implemented by County personnel. The RI will not include additional field work associated with landfill gas; however, available data from previous investigations, including chemical analyses on landfill gas samples reported by AGI and RZA, will be summarized. These data will be important in evaluating the possible impact of various landfill caps, including the potential for lateral migration of gas after capping.

4.8 DATA ANALYSIS AND REPORT PREPARATION

Data from the tasks discussed above will be reduced and analyzed to characterize site hydrogeology, define the extent and characteristics of landfill sludge and HCR, and assess contaminant distributions in groundwater, surface water, and stream sediment. RI and pertinent pre-RI data will be incorporated into the draft RI report.

5.0 FEASIBILITY STUDY

5.1 GENERAL

Landfill refuse is typically not sampled or evaluated for cleanup; refuse material is considered heterogeneous, thus investigation of discrete areas generally does not result in reliable characterization of the refuse as a whole. Instead, industry standard practice characterizes leachate emanating from the landfill and potentially migrating to groundwater. If contaminant levels in groundwater exceed identified cleanup levels, measures are taken to minimize the transfer of leachate to mobile groundwater. Therefore, cleanup levels will be identified for groundwater in the landfill vicinity, and not for landfill refuse material. In addition, cleanup levels will be identified for surface water and stream sediment, if appropriate.

Site-specific cleanup levels will be developed in general accordance with MTCA. MTCA provides three methods, designated A, B, and C, for determining cleanup levels. Method A is intended for routine site cleanup, or sites that involve relatively few chemicals of concern (COC). Method A should not be used for multiple exposure pathways and therefore may not be appropriate for this site. Method B is the standard method and is applicable to all sites. Method C is the conditional method and is used when Method A or B may be impossible to achieve, either because cleanup levels are below background concentrations or because of technical impossibility. Cleanup levels for the McCollum Park site are expected to be developed using Method B or C. Method A cleanup levels will be selected for TPH in accordance with Ecology policy.

The FS provides the framework for developing, screening, and evaluating alternative cleanup actions. MTCA details requirements for the selection of cleanup actions (WAC 173-340-360). These requirements, in conjunction with RI data and established cleanup levels, will be used to evaluate potential cleanup actions at McCollum Park.

5.2 SITE-SPECIFIC CLEANUP LEVELS

5.2.1 *Identification of Chemicals of Concern*

Preliminary COCs are all those chemicals detected during previous sample analysis and those chemicals potentially occurring at the site based on historical site activities. Data collected during the RI will be used to refine this list of COCs.

The toxicity factors of preliminary COCs will be compiled from standard EPA reference sources. These include the EPA Integrated Risk Information Service (IRIS) and the Health Effects Assessment Summary Tables (EPA, 1993; EPA, 1992). Health endpoints for each COC will be assessed. A preliminary COC without a toxicity value will be evaluated further to determine: whether its physical and chemical characteristics make it highly persistent in the environment; whether its degradation byproducts are more toxic than the chemical itself; or whether an applicable or relevant and appropriate requirement (ARAR) exists. For example, no toxicity value has been developed for lead; however, some lead species are recognized as human carcinogens while others are not. Ecology has adopted a cleanup value for lead based on EPA pharmacokinetic modeling; therefore, in this example, lead would be listed as a COC.

5.2.2 *Exposure Pathways and Potential Receptors*

Current and projected populations at and surrounding McCollum Park will be identified from site visits, land use maps, and city master plans. The following populations have been preliminarily identified in the project area:

- Workers at the park construction site
- Workers on adjacent properties
- Residents on adjacent properties
- Commuters
- Park users

Current and potential future exposure scenarios that may result in contact with COCs at the site or through contaminant migration from the site will be identified. Additional potential receptors specifically identified during the Site Hazard Assessment in January 1995 that resulted in the WARM ranking will also be considered.

5.2.3 *Identification of Cleanup Standards*

To address MTCA requirements under Method A, B, or C, cleanup levels will be identified considering:

- Applicable or relevant and appropriate state and federal requirements.
- Risk-based concentrations in environmental media.
- Concentrations that protect against cross-media contamination.
- Area background sediment and water quality data, as available.

Other factors included in MTCA requirements (e.g., aesthetic considerations and analytical detection limits) will also be considered.

Proposed points of compliance will be identified in the Cleanup Action Plan.

Compilation of ARARs : ARARs will be compiled for the COCs detected at the site. Possible ARARs include applicable federal and state regulations, proposed standards, and other criteria for chemicals in groundwater, surface water, soil, sediment, and air. Because MTCA Method B requires that soil (including stream sediments) concentrations be protective of groundwater and surface water, ARARs for groundwater and surface water are relevant in developing both soil and sediment cleanup levels. To prevent surface water contamination via groundwater discharge, MTCA requires that groundwater concentrations meet relevant surface water cleanup levels at the point of discharge. Available ARARs for freshwater will therefore be compiled for all COCs detected in sediment and groundwater to assess potential concerns regarding groundwater discharge to North Creek. ARARs related to the use of groundwater as a drinking water source will also be compiled.

Calculation of Risk-Based Concentrations : Risk-based cleanup levels will be calculated using the risk equations and assumptions presented in MTCA Method B. A risk-based concentration is the concentration of a chemical, using reasonable maximum exposure (RME) conditions, that would result in:

- An individual excess lifetime cancer risk of 1×10^{-6} (one incident of cancer for every 1 million persons) for a chemical classified as a carcinogen.

- A hazard quotient (HQ) of 1 for a chemical that results in a noncarcinogenic effect.

Two sets of risk-based concentrations will be derived. First, unadjusted risk-based concentrations will be derived assuming exposure to only one chemical via one exposure route. These concentrations will be based on a 1×10^{-6} risk for carcinogens and an HQ of 1 for chemicals with noncarcinogenic effects. These risk-based concentrations will then be adjusted in accordance with MTCA to account for exposures to multiple chemicals via multiple exposure routes. Such adjustments ensure that total risks presented by site exposures following cleanup will not exceed the target levels established in MTCA (i.e., a total excess cancer risk of 1×10^{-5} for carcinogens and a hazard index (HI) of 1 for combined exposure to all noncarcinogenic substances producing the same toxic response).

COCs have been identified in groundwater; the RI will indicate whether sediment and surface water contain COCs at elevated levels. Cleanup levels for sediment will be determined by Ecology after a review of RI data, with reference to the *Summary of Guidelines for Contaminated Freshwater Sediment,* Ecology Publication No. 95-308, March 1995.

The highest potential future use of site groundwater will be determined following MTCA Method B or C guidelines. Ecological risks will also be evaluated.

Background Sediment and Water Quality Data : Background (upgradient/upstream) sediment and water quality data will be collected during the sampling phase. Literature regarding area background concentrations will also be reviewed. McCollum Park sediment, groundwater, and surface water may be impacted by contamination from other sites; therefore, it is important, when possible, to determine background concentrations prior to setting cleanup levels for the site.

5.2.4 Selection of Cleanup Levels

Cleanup levels will be selected from the above approaches for each COC present at the site. In most cases, the most stringent cleanup levels will be selected. Cleanup levels will be compared to representative site concentration data as defined in MTCA to evaluate the need for remediation (addressed as part of the FS).

5.3 REMEDIAL TECHNOLOGY IDENTIFICATION AND SCREENING

"Remedial technologies" refer to general categories of technologies such as capping, groundwater extraction, or groundwater treatment. "Process options" represent specific processes used within each remedial technology. For example, capping is a remedial technology and asphalt paving, native soil cover, and a single barrier cap represent some of its process options.

The following general steps will be followed to evaluate remedial technologies:

- The RI results and cleanup levels developed as described in Section 5.2 will be used to identify affected media and corresponding COCs at concentrations above cleanup levels, and possible risks to human health and the environment associated with each media/contaminant combination. If no COC currently exceeds cleanup levels, or could reasonably exceed cleanup levels in the future, the process stops and an FS for groundwater, surface water, and sediment is not required. The FS would then focus only on stabilizing sludge within the landfill.

- Remedial action objectives (RAO) and general response actions (GRA) will be identified based on the nature and extent of COCs in excess of cleanup levels. RAOs describe how the remedial actions are expected to protect human health and the environment. They are usually formulated to be media- and pathway-specific; for example, one RAO may be to prevent the ingestion of contaminated groundwater. RAOs form the basis for developing and evaluating potential remedial actions. GRAs are remedial technologies that may be used, individually or in combinations, to achieve RAOs. GRAs are also generally media- and pathway-specific.

- Promising remedial technologies and process options will be screened using technical and site-specific criteria. In accordance with MTCA requirements, emphasis will be placed on technologies that produce permanent solutions and minimize any remaining untreated hazardous substances (WAC 173-340-360). Surviving technologies will be combined to produce an optimal cleanup alternative for the site.

Identification and screening of remedial technologies will be performed in two steps:

- Remedial technologies and process options will be initially screened on the basis of technical implementability. Criteria include the nature and extent of contamination, site hydrogeology, accessibility of the site to heavy equipment, and other potentially limiting factors. Technologies that cannot be implemented will be eliminated.

- Secondary screening will evaluate those technologies and associated process options surviving initial screening using three criteria: effectiveness and permanence, implementability, and order-of-magnitude costs. Greatest emphasis will be placed on effectiveness and permanence. A technology may not be eliminated based on cost unless other, less costly technologies are equally effective and permanent.

5.4 COMPARATIVE EVALUATION OF PROCESS OPTIONS

Those remedial technologies and process options that survive secondary screening based on effectiveness, implementability, and cost will be evaluated comparatively with respect to MTCA criteria to assess their relative merits and shortcomings.

MTCA's seven requirements for cleanup actions are fully described in WAC 173-340-360, which states that all cleanup actions:

- Shall protect human health and the environment.

- Shall comply with cleanup standards (WAC 173-340-700 through 173-340-760).

- Shall comply with applicable state and federal laws (WAC 173-340-710).
- Shall provide for compliance monitoring (WAC 173-340-410).
- Shall use permanent solutions to the maximum extent practical (WAC 173-340-360 [4], [5], [7], and [8]).
- Shall provide for a reasonable restoration time frame (WAC 173-340-360[6]).
- Shall consider concerns raised by the public (WAC 173-340-360[10] through [13]).

The fifth requirement, that permanent solutions be used to the maximum extent practical, includes seven criteria that must be considered in evaluating cleanup alternatives. These criteria (which overlap somewhat with the first seven requirements) include:

- Overall protection of human health and the environment
- Long-term effectiveness
- Short-term effectiveness
- Permanent reduction of toxicity, mobility, and volume (TMV)
- Implementability
- Cleanup costs
- Community concerns

These technology evaluation criteria and cleanup requirements are fully described in MTCA; however, MTCA does not specifically establish an alternatives analysis process. Consequently, we will combine the cleanup alternative requirements with the evaluation criteria to create a total of 11 cleanup alternative evaluation criteria that, in effect, combine all of the requirements listed above:

- Overall protection of human health and the environment
- Compliance with cleanup levels
- Compliance with state and federal laws (ARARs)
- Compliance monitoring
- Restoration time frame
- Long-term effectiveness
- Short-term effectiveness
- Reduction of toxicity, mobility, and volume

- Implementability
- Cost
- Community concerns

A comparative analysis of the process options will also be performed to identify each option's relative advantages and disadvantages so that trade-offs are evident to decision makers.

5.5 PREFERRED ALTERNATIVE SELECTION AND DETAILED COST ESTIMATE

Based on the results of the evaluation process described above and consultation with the County, a preferred cleanup alternative will be selected. A detailed cost estimate will be provided for the preferred alternative; this estimate will include both capital and operation and maintenance costs.

5.6 REPORT PREPARATION

The FS report will summarize the FS tasks and results; tabulation of results will be included. Conclusions and recommendations will be discussed with the County and agreed to prior to issuing the FS report.

6.0 CLEANUP ACTION PLANS AND COMPLIANCE MONITORING

6.1 DRAFT CLEANUP ACTION PLAN

A Draft CAP will be prepared which identifies the cleanup action and specifies cleanup standards and other requirements, including points of compliance, for the site. Ecology will utilize the draft document to prepare the final CAP for the site.

6.2 COMPLIANCE MONITORING PLAN

A Compliance Monitoring Plan will be prepared to address the required analytical tests, frequency of monitoring, and the statistical analysis requirements needed to confirm the effectiveness of cleanup actions. The Compliance Monitoring Plan will be subject to Ecology approval.

7.0 PROJECT MANAGEMENT

7.1 PROJECT SCHEDULE

Figure 9 presents the schedule for work described in this plan. The schedule shows estimated RI/FS task initiation and completion dates, preparation/delivery dates for the RI and FS reports, and completion dates for the CAP and CMP.

7.2 PROJECT TEAM

Key project personnel are as follows:

AGI:

- Project Manager/FS Manager: Susan Penoyar
- RI Manager: Alan Carey
- Project Geologist: Rebecca Clodfelter
- Project Chemists: Patrick Evans, Mingta Lin

Snohomish County:

- Contract Manager: Rollie Maynard
- Senior Project Manager: Ken Moser
- Field Project Manager: Kirk Bailey
- Site Manager: Ken Miller

The laboratory project manager is Victoria Bayly. Mary O'Herron and Ching-Pi Wang of Ecology's Toxics Cleanup Program will review the project for the state.

7.3 COMMUNICATIONS

Communication between AGI and the County regarding overall project management and contract issues will be between Susan Penoyar and Rollie Maynard. Communications regarding RI field activities will be between Alan Carey and Kirk Bailey or Ken Miller. AGI RI personnel will report to Mr. Carey, who will report to Ms. Penoyar; FS personnel will report directly to Ms. Penoyar.

The project laboratory will transmit preliminary and final chemical results to AGI for QA review.

The RI/FS, Draft Cleanup Action Plan, and Compliance Monitoring Plan will be subject to Ecology approval.

7.4 PUBLIC NOTICE AND PARTICIPATION

Public notice of this independent remedial action will be made in accordance with WAC 173-340-550. Public participation will be provided for in general accordance with the provisions of WAC 173-340-600, as applicable, and with County requirements.

8.0 REFERENCES

AGI Technologies (AGI). 1995. *McCollum Park Sludge Assessment; Snohomish County, Washington.* January 12, 1995.

AGI. 1994. *Environmental Services: Monitoring Well and Gas Probe Installation and Sampling, McCollum Park, Everett, Washington.* June 27, 1994.

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Bruce Dees & Associates. 1990. *McCollum County Park Master Plan Report; Snohomish County, Washington.* July 6, 1990.

Delsman, Arthur. Truck Driver. Edmonds, WA. Personal Communication with Snohomish County. December 8, 1994

Earth Consultants, Inc. 1989. *Geotechnical Engineering Services: McCollum Park, 128th Street Southeast, Snohomish County, Washington.* November 1, 1989.

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Minard, James. 1985. Geologic Map of the Everett 7.5-Minute Quadrangle, Snohomish County, Washington. U.S. Geological Survey Map MF-1748.

Newcomb, R.C. 1952. *Ground-Water Resources of Snohomish County, Washington.* Washington, D.C.: U.S. Geological Survey Water-Supply Paper 1135.

RZA AGRA, Inc. 1992. *Subsurface Exploration and Geotechnical Engineering Report: McCollum Park - Park & Ride Lot, 128th Street SE, Everett, Washington.* May 1992.

Smith, Mackey. 1976. Preliminary Surficial Geologic Map of the Mukilteo and Everett Quadrangles, Snohomish County, Washington. State of Washington Department of Natural Resources Geologic Map GM-20.

Snohomish County Public Works. 1993. *Final Environmental Impact Statement: Park and Ride at McCollum Park.* April 1993.

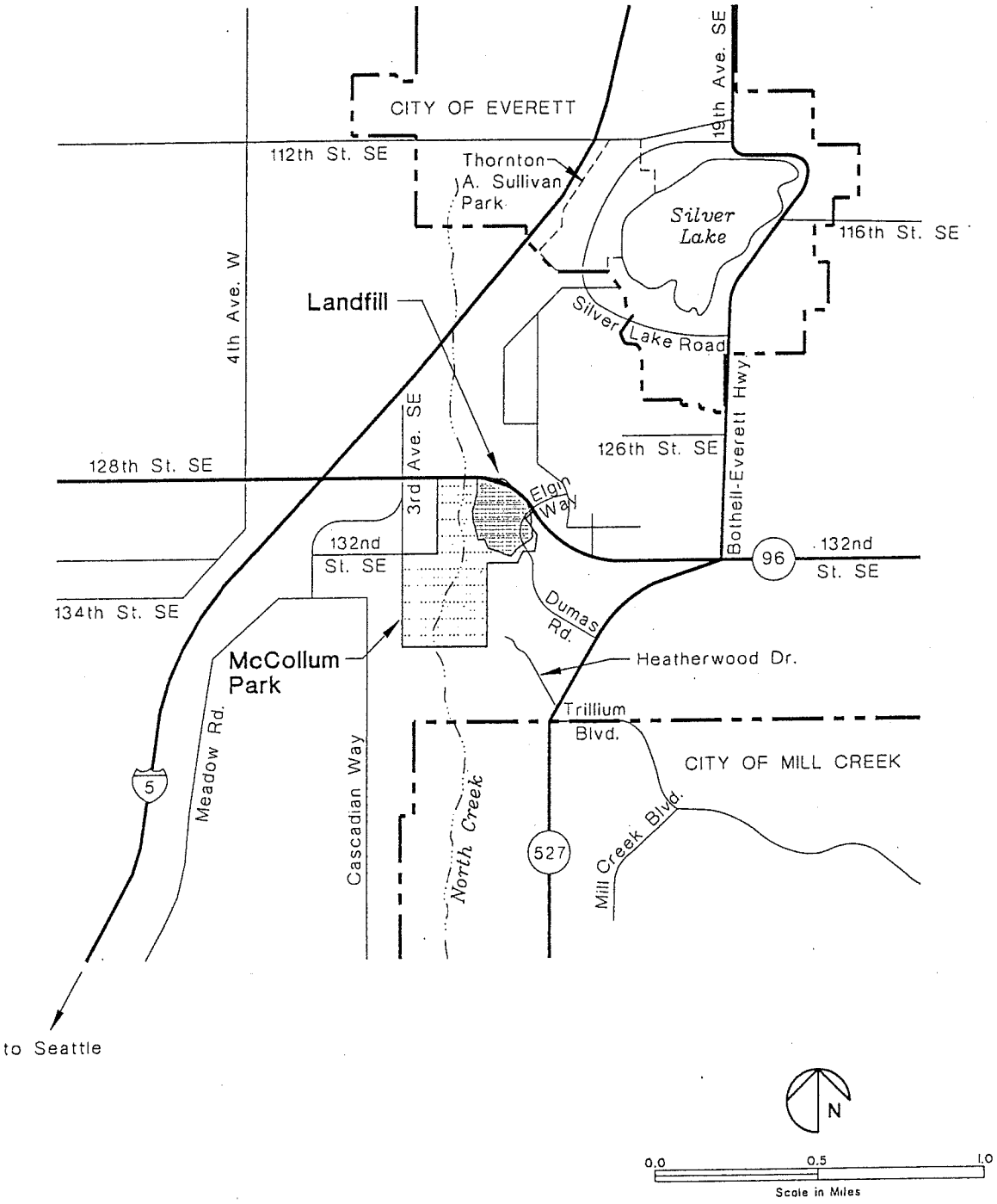
Washington Administrative Code Chapter 173-340: Model Toxics Control Act - Cleanup Regulations (Revised December 25, 1993).

DISTRIBUTION

3 Copies

Washington Department Of Ecology
Toxics Cleanup Program
3190 160th Avenue S.E.
Bellevue, Washington 98009-5452

Attention: Ms. Mary O'Herron



Reference: Snohomish Co. Public Works, McCollum Park and Ride EIS, April 1993.

AGI TECHNOLOGIES

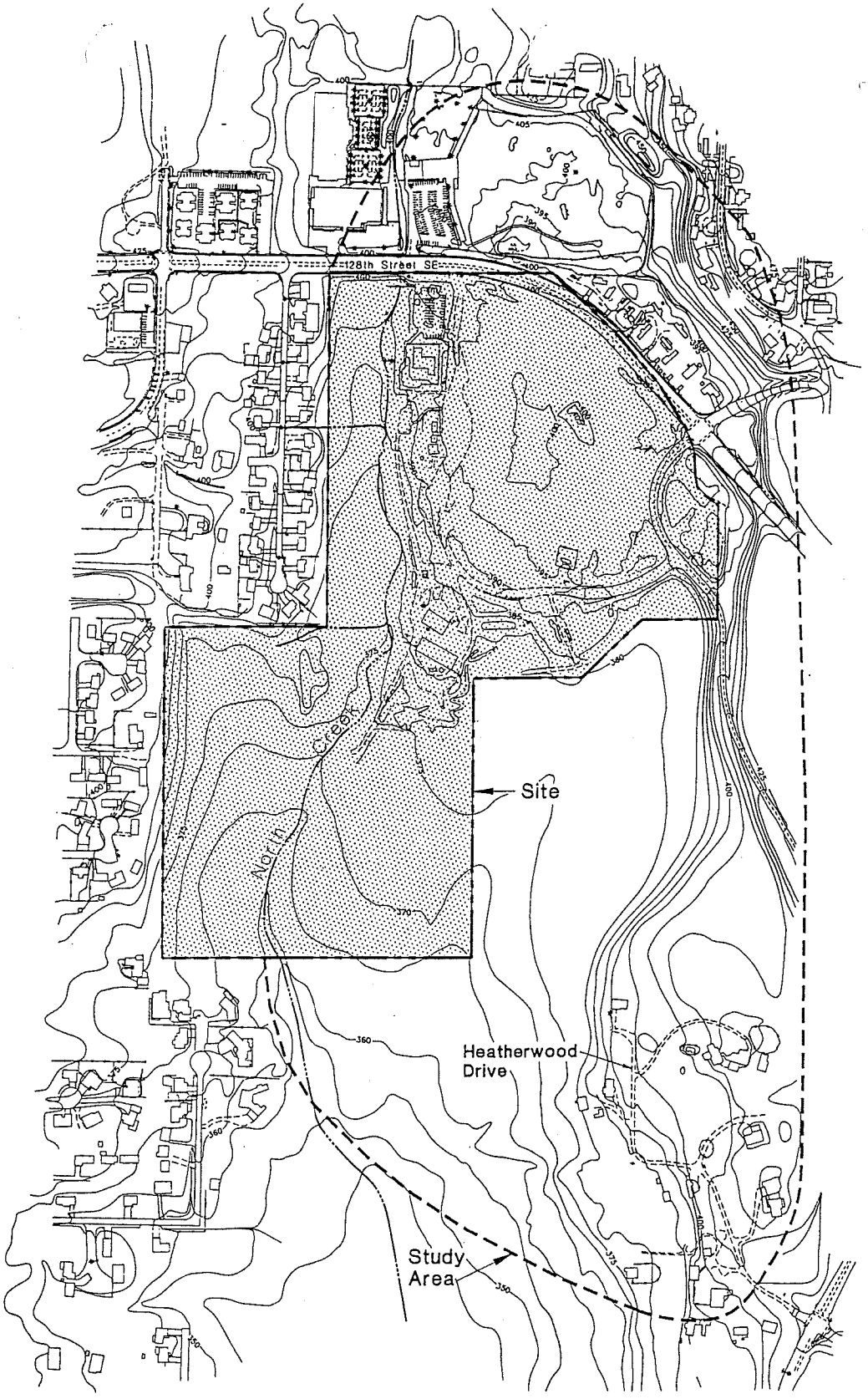
Vicinity Map

Snohomish County/McCollum Park - Former Emander Landfill/Work Plan
Snohomish County, Washington

FIGURE 1

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
15,512.284	ALW	17 March 95	ADC	ALW	10 Oct 95

vicmap.dwg



Reference: DeGross Aerial Mapping Survey - McCollum Park Study Area, 2/27/95.

AGI TECHNOLOGIES

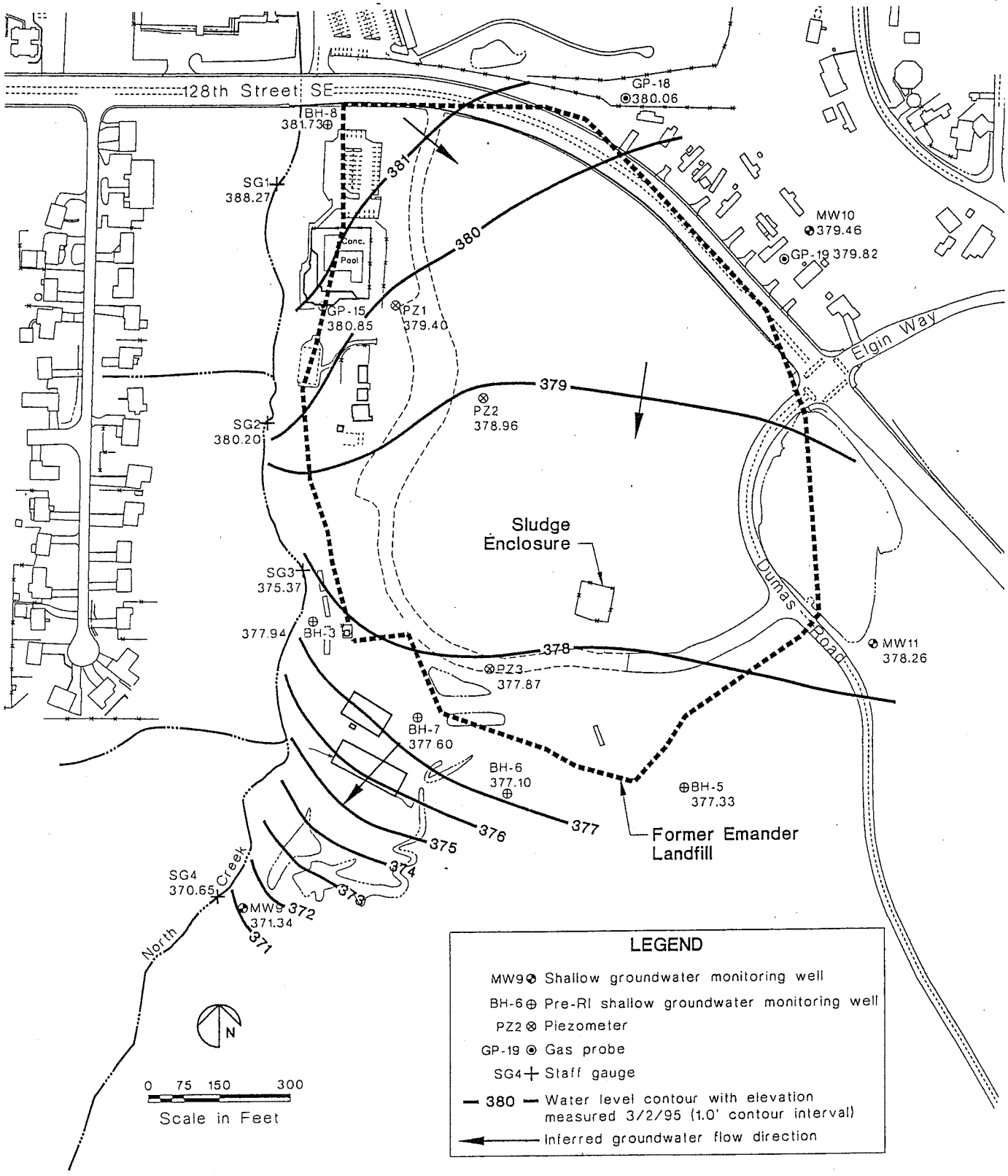
Study Area

Snohomish County/McCollum Park - Former Emander Landfill/Work Plan
Snohomish County, Washington

FIGURE 2

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
15,512.284	ALW	17 March 95	ADC	ALW	10 Oct 95

mccsite.dwg



Reference: DeGross Aerial Mapping Survey - McCollum Park Study Area, 2/27/95

AGI TECHNOLOGIES

Water Table Map - March 1995

Snohomish County/McCollum Park - Former Emander Landfill/Work Plan
Snohomish County, Washington

FIGURE 3

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
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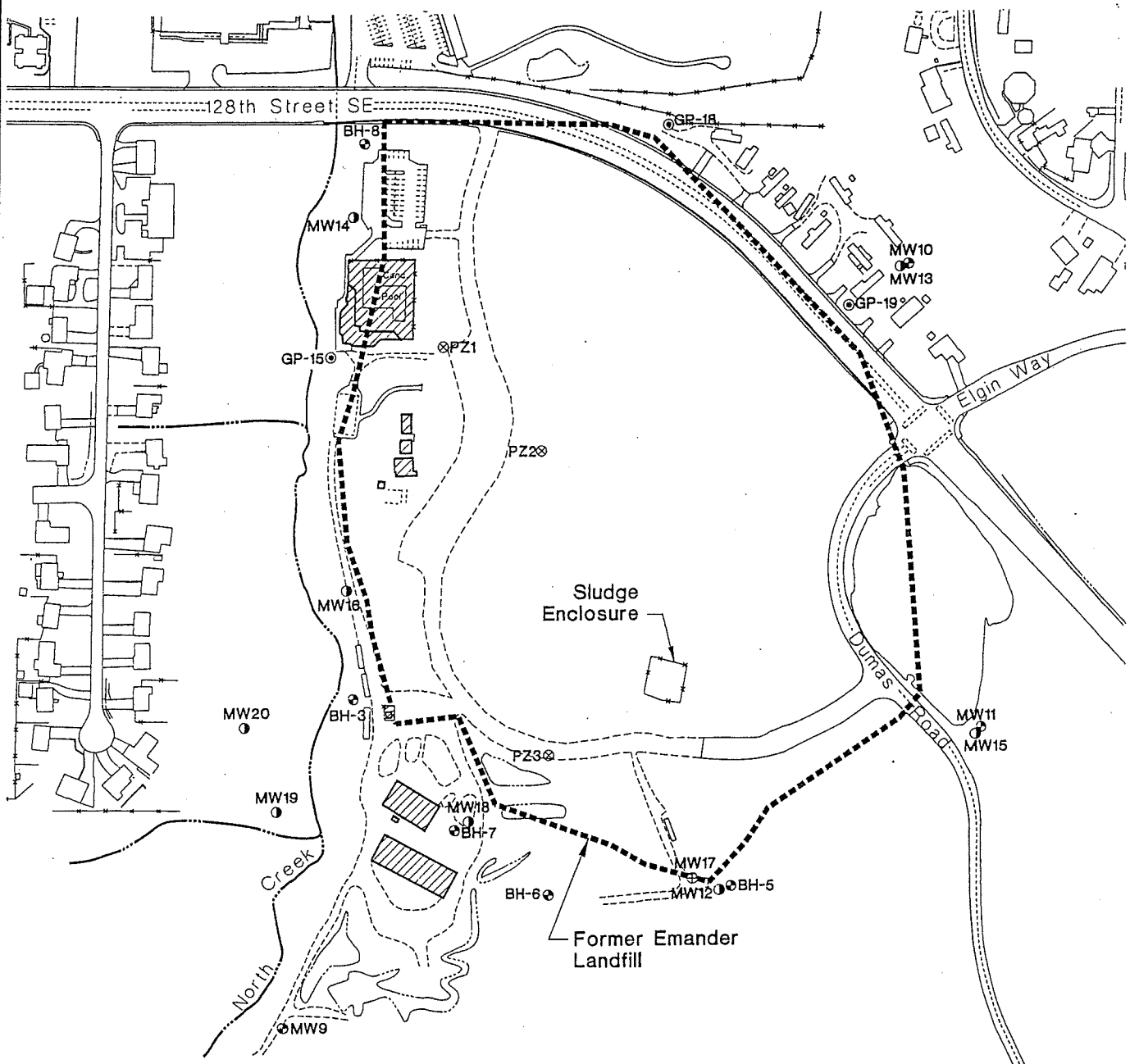


LEGEND

- MW9 ⊘ Shallow groundwater monitoring well
- MW15 ◑ Deep groundwater monitoring well
- MW17 ⊕ Intermediate groundwater monitoring well
- PZ2 ⊗ Piezometer
- BH-6 ⊘ Pre-RI groundwater monitoring well (included in RI well network)
- GP-15 ⊙ Pre-RI gas probe (included in RI well network - water level measurement only)

Reference: DeGross Aerial Mapping Survey - McCollum Park Study Area, 2/27/95

AGI TECHNOLOGIES

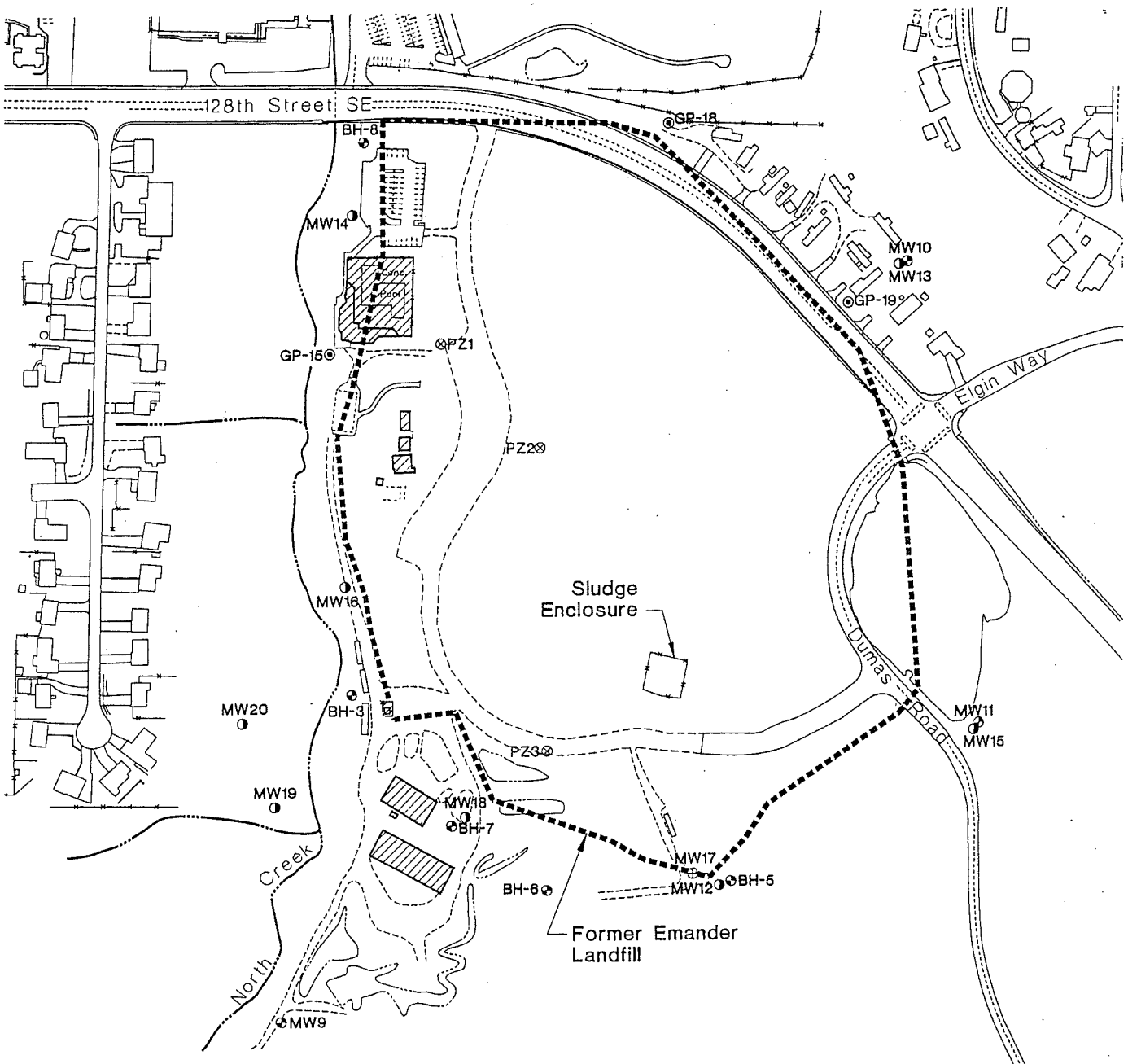
Pre-Emergence Investigation Locations

Snohomish County/McCollum Park - Former Emander Landfill/Work Plan
Snohomish County, Washington

FIGURE 4

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
15,512.284	ALW	17 March 95	ADC	ALW	10 Oct 95

mcpre-ri.dwg



LEGEND

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- MW17 ⊕ Intermediate groundwater monitoring well
- PZ2 ⊗ Piezometer
- BH-6 ⊘ Pre-RI groundwater monitoring well (included in RI well network)
- GP-15 ⊙ Pre-RI gas probe (included in RI well network - water level measurement only)

Reference: DeGross Aerial Mapping Survey - McCollum Park Study Area, 2/27/95

AGI TECHNOLOGIES

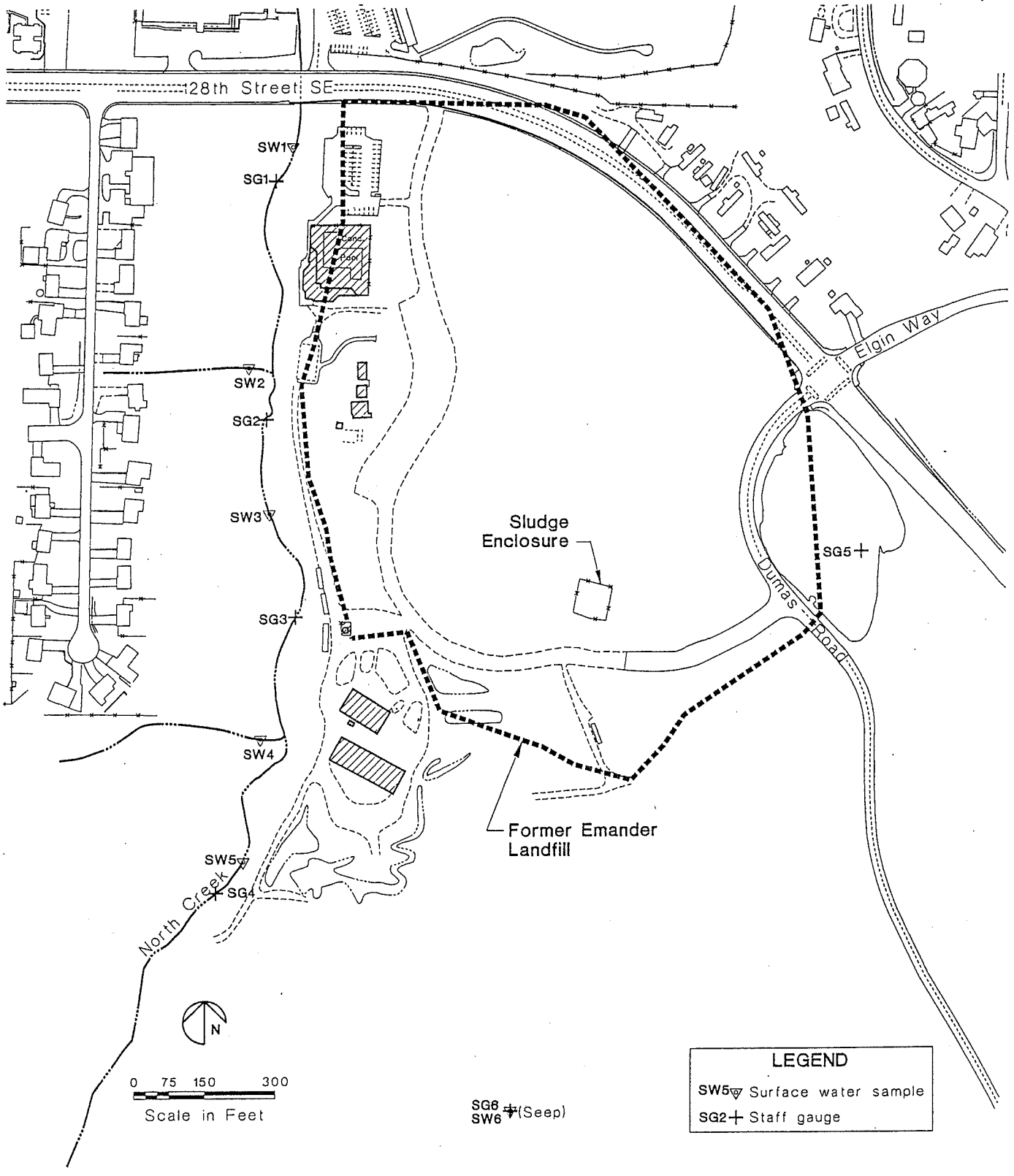
RI Groundwater Monitoring Well Locations

Snohomish County/McCollum Park - Former Emander Landfill/Work Plan
Snohomish County, Washington

FIGURE 5

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
15,512.284	ALW	17 March 95	ADC	ALW	10 Oct 95

gwsamp.dwg



Reference: DeGross Aerial Mapping Survey - McCollum Park Study Area, 2/27/95

AGI TECHNOLOGIES

RI Surface Water Sample and Staff Gauge Locations

Snohomish County/McCollum Park - Former Emander Landfill/Work Plan
Snohomish County, Washington

FIGURE 6

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
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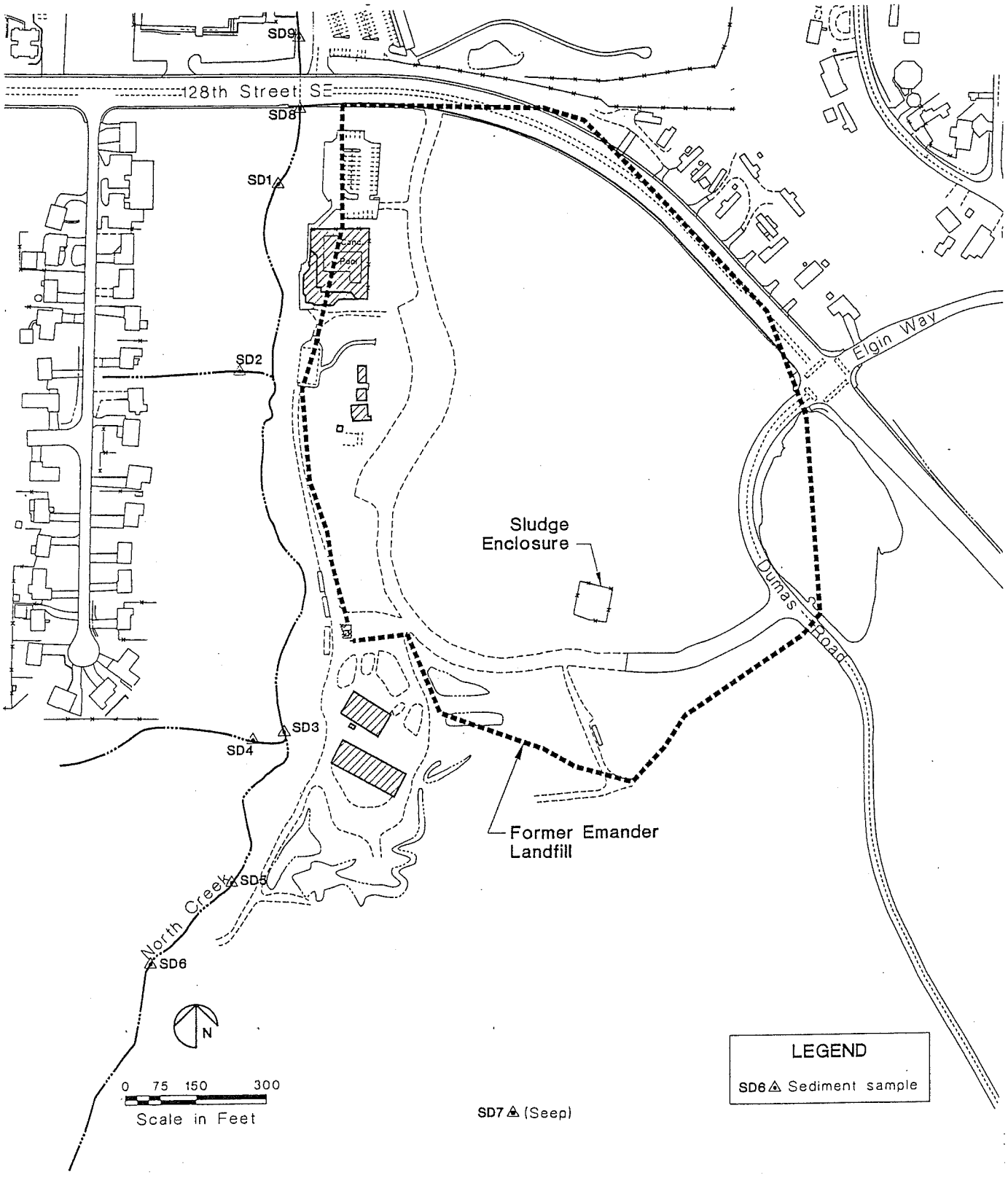


Reference: DeGross Aerial Mapping Survey - McCollum Park Study Area, 2/27/95

AGI TECHNOLOGIES

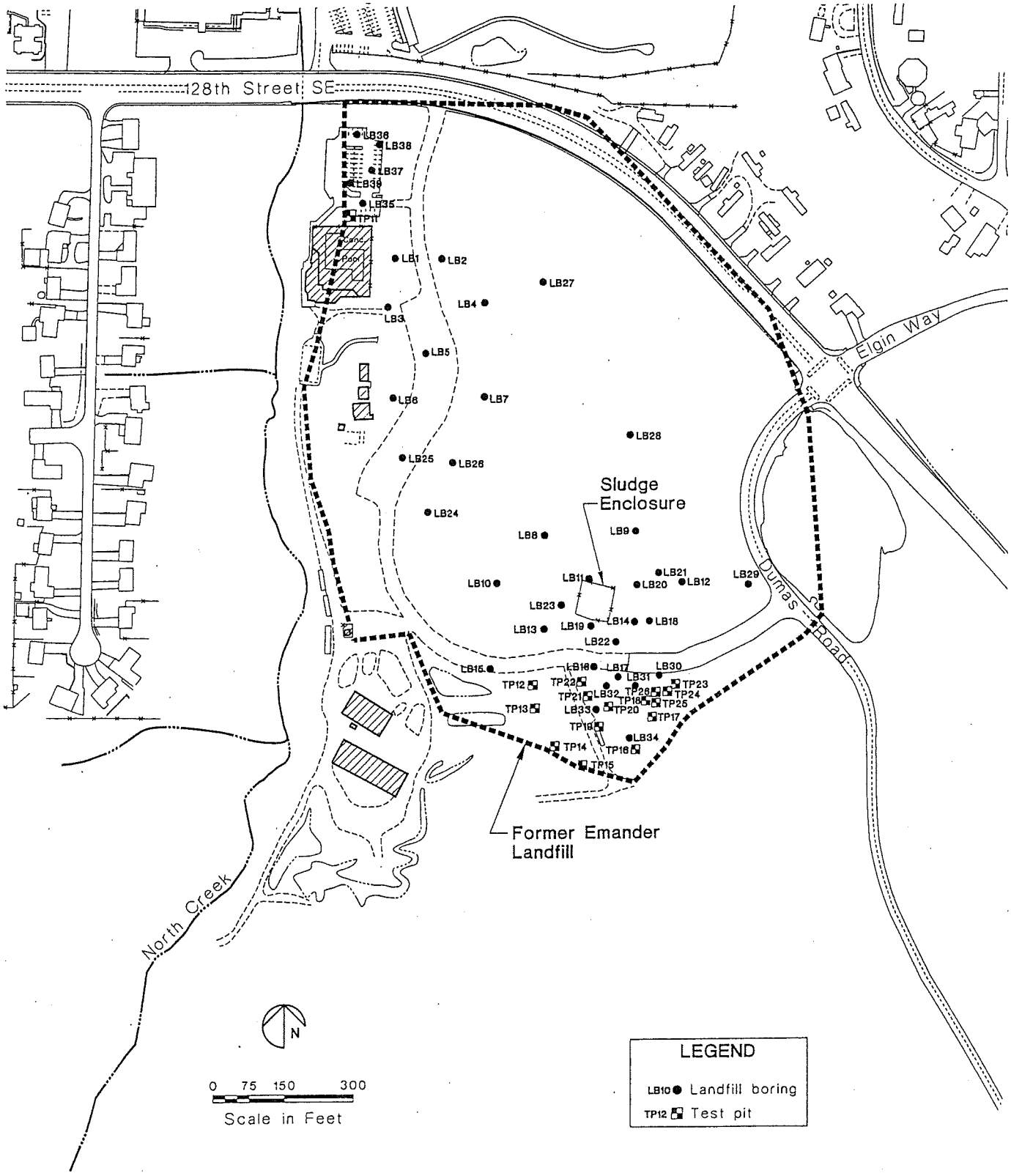
RI Sediment Sample Locations

Snohomish County/McCollum Park - Former Emander Landfill/Work Plan
Snohomish County, Washington

FIGURE 7

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
15,512.284	ALW	17 March 95	APC	ALW	10 Oct 95

sedsamp.dwg



Reference: DeGross Aerial Mapping Survey - McCollum Park Study Area, 2/27/95

AGI TECHNOLOGIES

RI Landfill Boring and Test Pit Locations

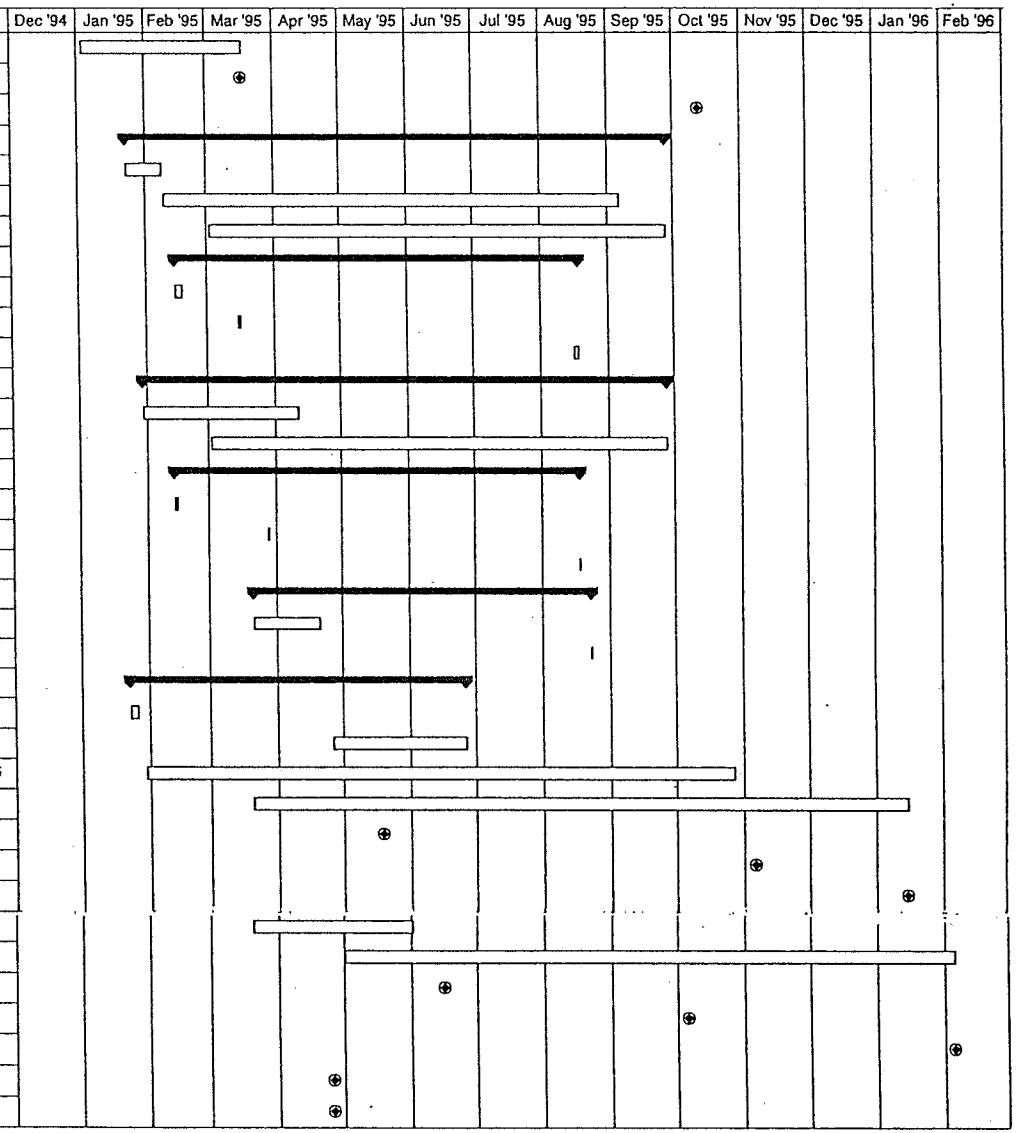
Snohomish County/McCollum Park - Former Emander Landfill/Work Plan
Snohomish County, Washington

FIGURE 8

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
15,512.284	ALW	17 March 95	ADC	ALW	10 Oct 95

mcboring.dwg

ID	Name	Begin	End
1	**Initial Planning**	1/3/95	3/17/95
2	Draft Work Plan	3/17/95	3/17/95
3	Work Plan	10/13/95	10/13/95
4	**Groundwater Investigation**	1/23/95	9/27/95
5	Install Initial Wells	1/23/95	2/8/95
6	Install Supplemental Wells	2/9/95	9/6/95
7	Water Level Monitoring	3/2/95	9/27/95
8	**Groundwater Sampling**	2/14/95	8/18/95
9	Round 1	2/14/95	2/17/95
10	Round 2	3/15/95	3/16/95
11	Round 3	8/16/95	8/18/95
12	**Surface Water Investigation**	1/30/95	9/27/95
13	Mapping	1/30/95	4/11/95
14	Water Level Monitoring	3/2/95	9/27/95
15	**Surface Water Sampling**	2/13/95	8/18/95
16	Round 1	2/13/95	2/14/95
17	Round 2	3/28/95	3/28/95
18	Round 3	8/18/95	8/18/95
19	**Sediment Investigation**	3/21/95	8/23/95
20	Initial Sample Collection	3/21/95	4/20/95
21	Supplemental Sample Collection	8/23/95	8/23/95
22	**Landfill Investigation**	1/23/95	6/26/95
23	Initial Borings	1/23/95	1/26/95
24	Supplemental Borings and Test Pits	4/26/95	6/26/95
25	**Data Analysis**	1/30/95	10/27/95
26	**RI Report Preparation**	3/20/95	1/15/96
27	Draft RI Report	5/19/95	5/19/95
28	Revised Draft RI Report	11/6/95	11/6/95
29	Final RI Report	1/15/96	1/15/96
30	**Evaluation of Remedial Technologies/Cleanup Levels**	3/20/95	6/1/95
31	**FS Report Preparation**	5/1/95	2/5/96
32	Draft FS Report	6/16/95	6/16/95
33	Revised Draft FS Report	10/6/95	10/6/95
34	Final FS Report	2/5/96	2/5/96
35	Draft Cleanup Action Plan (CAP)	4/26/95	4/26/95
36	Draft Compliance Monitoring Plan (CMP)	4/26/95	4/26/95



Task

Summary

Deliverable Document ⊕

AGI TECHNOLOGIES

Project Schedule

Snohomish County/McCollum Park - Former Emander Landfill/Work Plan

Snohomish County, Washington

FIGURE 9

PROJECT NO.	DRAWN	DATE	APPROVED	REVISED	DATE
15,512.284	ALW	13 Oct 95	APC	ALW	10/13/95

APPENDIX E
ARARS

SECTION I: CHEMICAL-SPECIFIC ARARs

Federal

40 CFR Part 141; National Primary Drinking Water Regulations

40 CFR Part 143; National Secondary Drinking Water Regulations

State

WAC 173-340; The Model Toxics Control Act Cleanup Regulation

WAC 173-200; Washington Groundwater Quality Standards

WAC 246-290; Public Water Supplies

SECTION II: ACTION-SPECIFIC ARARs

Federal

40 CFR Part 50; National Primary and Secondary Ambient Air Quality Standards

40 CFR Part 61; National Emission Standards for Hazardous Air Pollutants

40 CFR Part 257; Criteria for Classification of Solid Waste Disposal Facilities and Practices

40 CFR Part 258; Criteria for Municipal Solid Waste Landfills

40 CFR Part 261; Identification and Listing of Hazardous Waste

40 CFR Part 262; Standards Applicable to Generators of Hazardous Waste

40 CFR Part 263; Standards Applicable to Transporters of Hazardous Waste

WAC 173-218; Washington Underground Injection Control Program

WAC 173-220; NPDES Permit Program

WAC 173-154; Protection of Upper Aquifer Zones

WAC 173-200; Washington Groundwater Quality Standards

WAC 173-160; Minimum Standards for Construction and Maintenance of Wells

Washington State Department of Ecology; Area of Contamination Interprogram Policy

SECTION III: LOCATION-SPECIFIC ARARs

Federal

15 CFR Part 923; Coastal Zone Management Program Development and Approval Regulations

16 U.S.C. 661 et seq.; Fish and Wildlife Coordination Act

50 CFR Part 226; Designated Critical Habitat

State

Summary of Guidelines for Contaminated Freshwater Sediments; Washington State Department of Ecology Publication No. 95-308; March 1995

WAC 232-12; Endangered, Threatened and Sensitive Species

Washington State Wellhead Protection Program

E.O. 89-10; Protection of Wetlands

Local

SCC 32.10.570 et seq.; Critical Areas Ordinance

40 CFR Part 268; Land Disposal Restrictions

40 CFR Part 122; Administered Permit Programs The National Pollutant Discharge Elimination System (NPDES)

40 CFR Part 131 and Tuesday November 19, 1991 Federal Register - 40 CFR Part 131, Amendments to the Water Quality Standards; Water Quality Standards

40 CFR Part 136; Guidelines Establishing Test Procedures for the Analysis of Pollutants

29 CFR Part 1910.120; Hazardous Waste Operations and Emergency Response

State

WAC 173-340; Model Toxics Control Act Cleanup Regulation

WAC 192-11; State Environmental Policy Act Rules

Regulations I and III; Puget Sound Air Pollution Control Agency (PSAPCA)

WAC 173-400; General Regulations for Air Pollution Sources

WAC 173-460; Controls for New Sources of Toxic Air Pollutants

WAC 173-470; Ambient Air Quality Standard for Particulate Matter

WAC 173-304; Minimum Functional Standards for Solid Waste Handling

WAC 173-303; Dangerous Waste Regulations

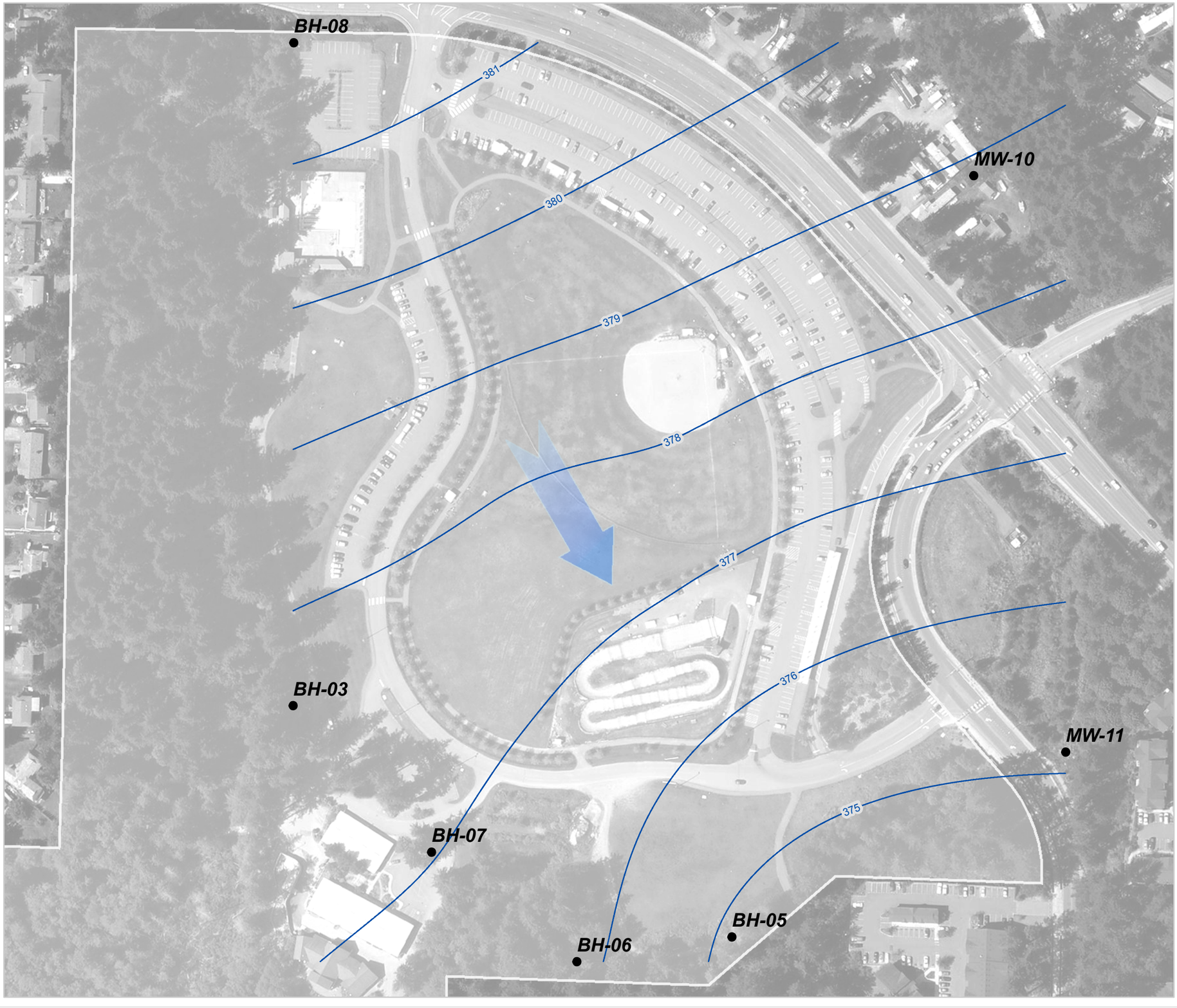
WAC 220-110; Hydraulic Code Rules

WAC 173-201A; Washington Water Quality Standards

WAC 173-216; State Waste Discharge Permit Program

Attachment B

Groundwater Flow Data and Maps



McCollum Park (Emander Landfill)

Shallow Aquifer Water Elevation Contours 1st Quarter 2008

DIRECTION OF GROUNDWATER FLOW
.00663 ft/day
2.42 ft/year
-60.02 degrees to the positive x-axis

PARCEL BOUNDARY

SUBJECT PROPERTY BOUNDARY

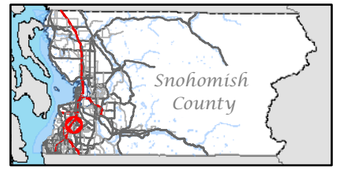
1 FT CONTOUR

WELL LOCATION

WELL_ID	SAMP_DATE	MEAS_HEAD
BH-03	3/11/2008	377.56
BH-05	3/11/2008	374.87
BH-06	3/11/2008	376.22
BH-07	3/11/2008	377.02
BH-08	3/11/2008	381.73
MW-10	3/11/2008	378.88
MW-11	3/11/2008	375.11

0 0.01 0.02 0.04 0.06 0.08 Miles

0 60 120 240 360 480 Feet

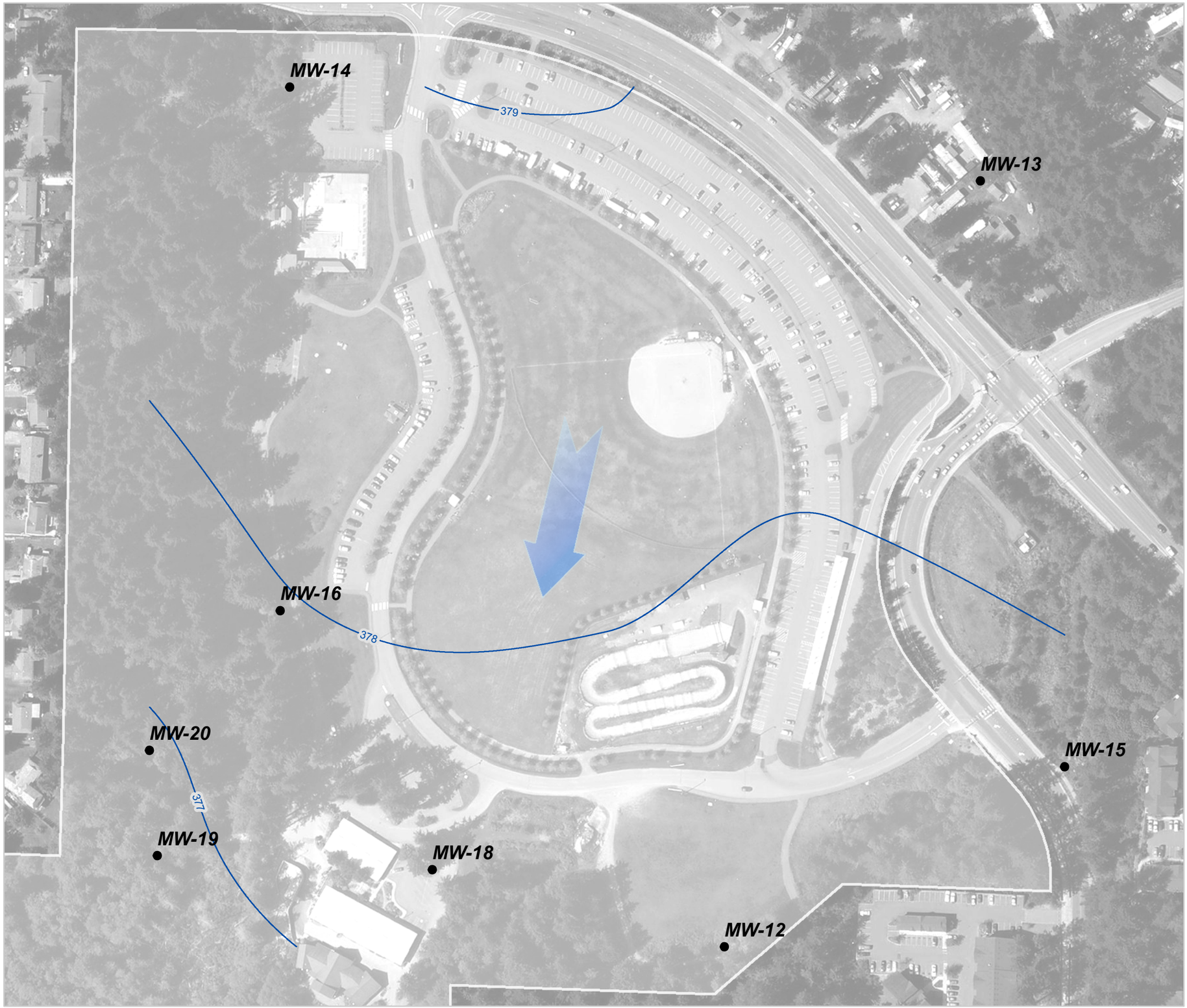


N W E S

Snohomish County
Public Works
Solid Waste Division
July 25, 2011

McCollum Park (Emander Landfill)

Deep Aquifer Water Elevation Contours 1st Quarter 2008



DIRECTION OF GROUNDWATER FLOW
.0237 ft/day
8.66 ft/year
-103.25 degrees to the positive x-axis

PARCEL BOUNDARY

SUBJECT PROPERTY BOUNDARY

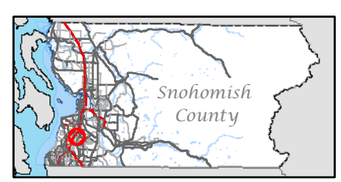
1 FT CONTOUR

WELL LOCATION

WELL_ID	SAMP_DATE	MEAS_HEAD
MW-12	3/11/2008	377.01
MW-13	3/11/2008	378.72
MW-14	3/11/2008	378.88
MW-15	3/11/2008	377.76
MW-16	3/11/2008	377.91
MW-18	3/11/2008	377.36
MW-19	3/11/2008	376.83
MW-20	3/11/2008	376.88

0 0.01 0.02 0.04 0.06 0.08 Miles

0 60 120 240 360 480 Feet

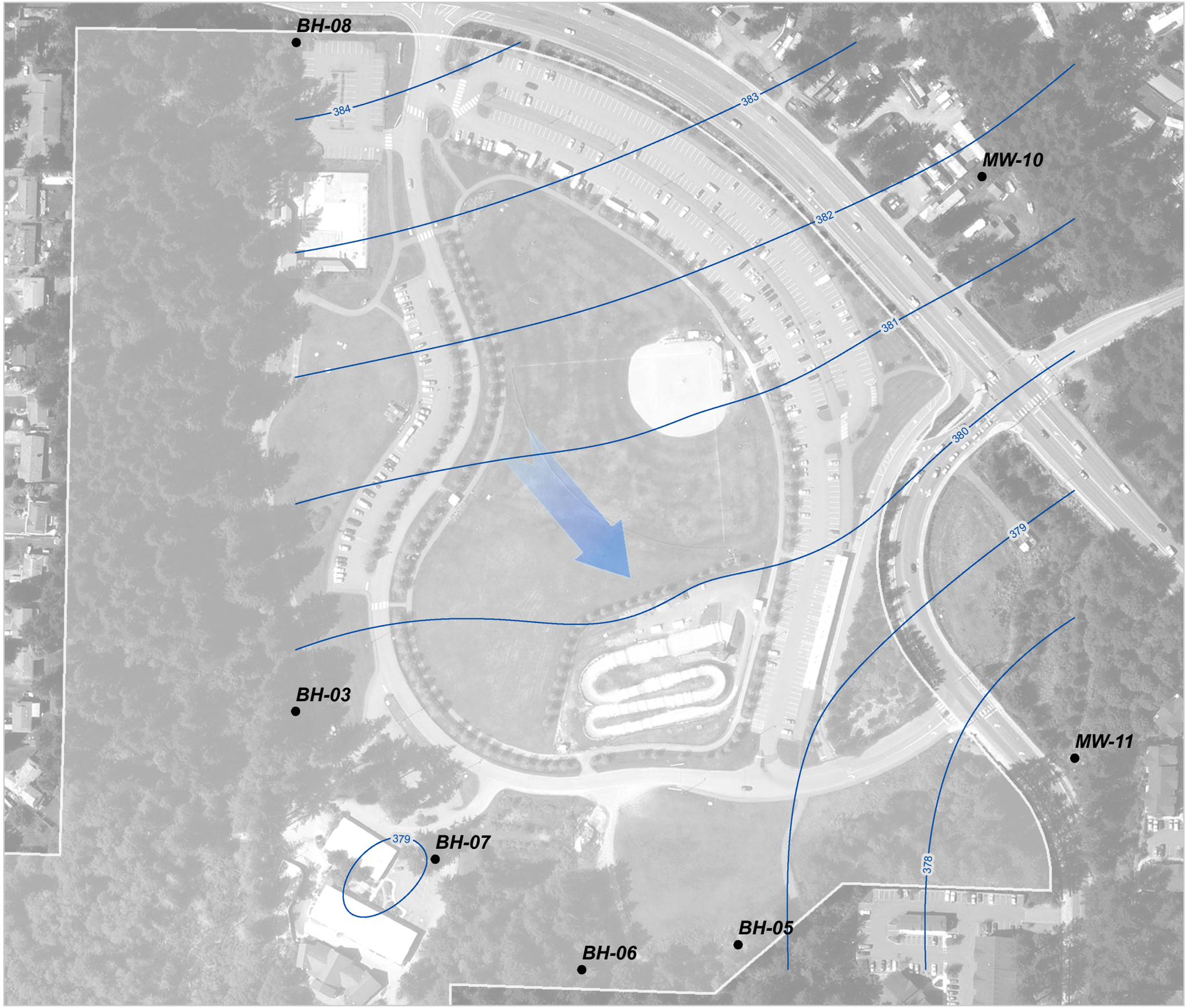


N W E S

Snohomish County
Public Works
Solid Waste Division
July 25, 2011

McCollum Park (Emander Landfill)

Shallow Aquifer Water Elevation Contours 1st Quarter 2011



DIRECTION OF GROUNDWATER FLOW
.00591 ft/day
2.16 ft/year
-60.28 degrees to the positive x-axis

PARCEL BOUNDARY

SUBJECT PROPERTY BOUNDARY

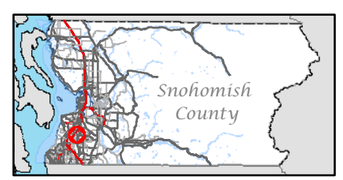
1 FT CONTOUR

WELL LOCATION

WELL_ID	SAMP_DATE	MEAS_HEAD
BH-03	3/15/2011	379.65
BH-05	3/15/2011	379.33
BH-06	3/15/2011	379.98
BH-07	3/15/2011	379.02
BH-08	3/15/2011	384.50
MW-10	3/15/2011	381.74
MW-11	3/15/2011	377.21

0 0.01 0.02 0.04 0.06 0.08 Miles

0 60 120 240 360 480 Feet

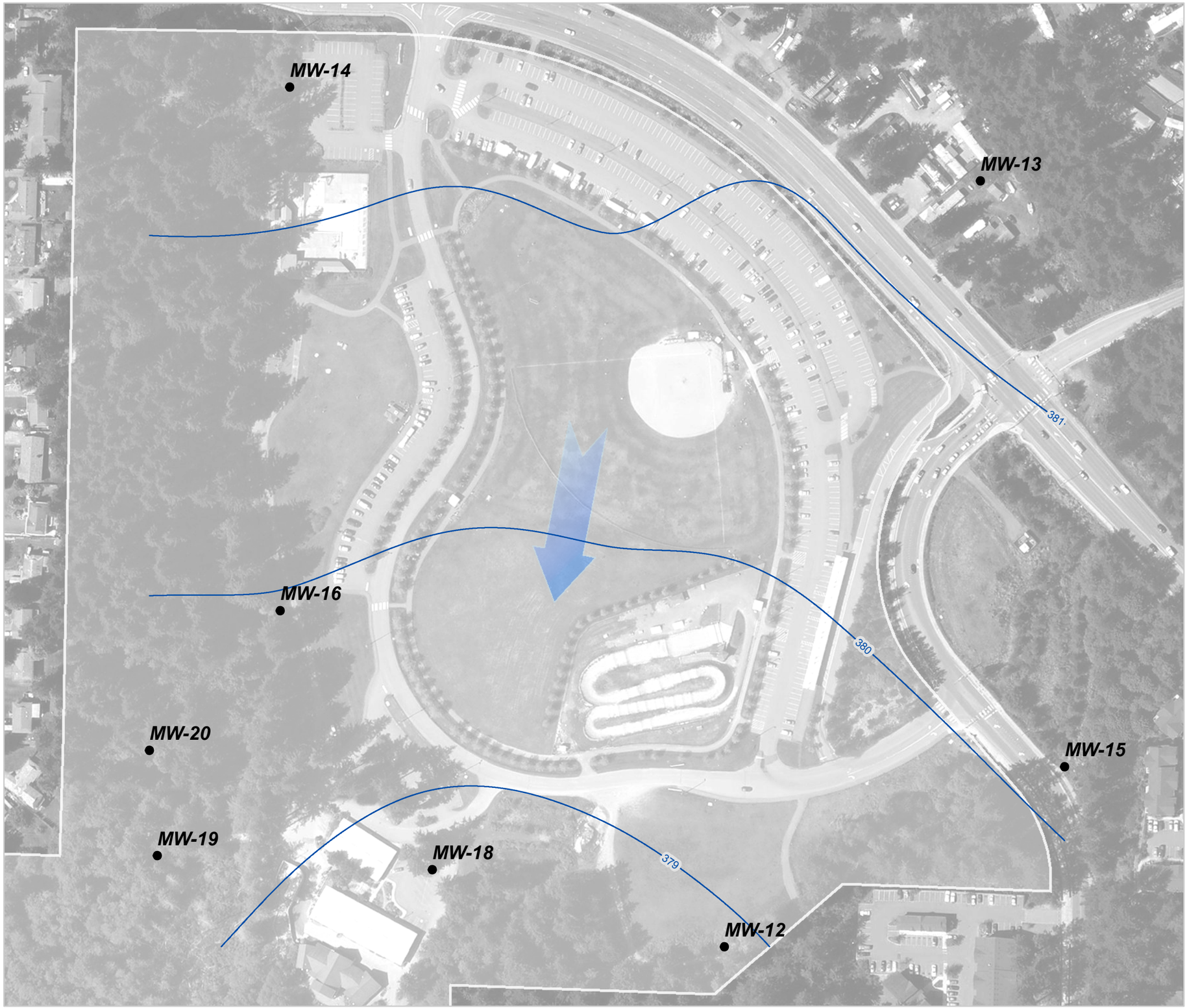


N W E S

Snohomish County
Public Works
Solid Waste Division
July 25, 2011

McCollum Park (Emander Landfill)

Deep Aquifer Water Elevation Contours 1st Quarter 2011



DIRECTION OF GROUNDWATER FLOW
.0303 ft/day
1.11 ft/year
-100.85 degrees to the positive x-axis

PARCEL BOUNDARY

SUBJECT PROPERTY BOUNDARY

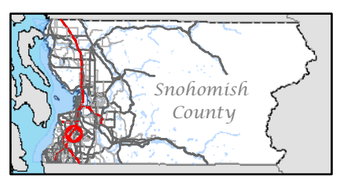
1 FT CONTOUR

WELL LOCATION

WELL_ID	SAMP_DATE	MEAS_HEAD
MW-12	3/15/2011	378.90
MW-13	3/15/2011	381.39
MW-14	3/15/2011	381.30
MW-15	3/15/2011	380.18
MW-16	3/15/2011	379.93
MW-18	3/15/2011	378.73
MW-19	3/15/2011	379.32
MW-20	3/15/2011	379.51

0 0.01 0.02 0.04 0.06 0.08 Miles

0 60 120 240 360 480 Feet



N W E S

Snohomish County
Public Works
Solid Waste Division
July 25, 2011

Site: **Cathcart Landfill - Shallow Aquifer**

Measurement Date: **3/11/2008**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
BH-03A	222.89	1076.77	**377.56**	1
BH-05	899.19	716.67	**374.87**	1
BH-06	658.91	680.07	**376.22**	1
BH-07	436.29	849.69	**377.02**	1
BH-08	223.90	2097.01	**381.73**	1
MW-11	1414.68	1002.71	**375.11**	1
MW-10	1268.20	1884.23	**378.88**	1
8	0	0	0	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

222.89	899.19	658.91	436.3	223.9	1415	1268	0
1076.77	716.67	680.07	849.7	2097.01	1003	1884	0
377.56	374.87	376.22	377	381.73	375.1	378.9	0

{[P]t[P]}

5142515.913	5980854.744	1930244
5980854.744	11810718.8	3141925
1930244.458	3141924.661	996740

{[P]t[P]}'

7.14873E-07	3.88654E-08	-1.5E-06
3.88654E-08	5.26568E-07	-1.7E-06
-1.5069E-06	-1.7351E-06	9.39E-06

{[P]t[P]}'[P]t

-0.00036776	0.000105767	-6.9E-05	-2E-04	-0.000333669	5E-04	4E-04	0
-7.9454E-05	-0.00023812	-0.00027	-2E-04	0.000450576	-7E-05	4E-04	0
0.001341437	0.000921871	0.00136	0.001	-0.000391156	-3E-04	-0.002	0

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	5.59086E-06
B	-9.6826E-06
C	0.002669724

Groundwater Gradient:	**0.0042**	
Conductivity (ft/day):	**1.542**	
Effective porosity:	**30%**	
GW velocity:	**0.02153**	**ft/day**
	7.86	**ft/year**
Flow direction:	**-60.00**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Deep Aquifer**

Measurement Date: **3/11/2008**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
MW-12	881.62	719.01	**377.01**	1
MW-13	1271.94	1888.36	**378.72**	1
MW-14	213.79	2027.73	**378.88**	1
MW-15	1401.93	991.00	**377.76**	1
MW-16	193.95	1231.98	**377.91**	1
MW-18	430.16	834.63	**377.36**	1
MW-19	11.87	855.95	**376.83**	1
MW-20	0.30	1017.50	**376.88**	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

881.62	1271.94	213.79	1402	193.95	430.2	11.87	0.3
719.01	1888.36	2027.73	991	1231.98	834.6	856	1018
377.01	378.72	378.88	377.8	377.91	377.4	376.8	376.9

{[P]t[P]}

4628994.292	5467027.58	1664889	
5467027.58	13158987.43	3615417	
1664889.363	3615416.739	1141074	

{[P]t[P]}'

4.59093E-07	-5.1718E-08	-5.1E-07	
-5.17184E-08	5.92756E-07	-1.8E-06	
-5.05976E-07	-1.8026E-06	7.33E-06	

{[P]t[P]}'[P]t

0.000176802	0.000294653	-0.0002	4E-04	-0.000165888	-4E-05	-2E-04	-2E-04
-0.000299015	0.000370855	0.000508	-2E-04	3.89941E-05	-2E-04	-2E-04	-8E-05
0.001019845	-0.00127305	-0.00099	3E-04	0.000449678	0.001	0.001	9E-04

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	-9.1384E-07
B	-3.8799E-06
C	0.002661439

Groundwater Gradient:	**0.0015**	
Conductivity (ft/day):	**15.584**	
Effective porosity:	**30%**	
GW velocity:	**0.07780**	**ft/day**
	28.40	**ft/year**
Flow direction:	**-103.25**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Shallow Aquifer**

Measurement Date: **3/15/2011**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
BH-03A	222.89	1076.77	**379.65**	1
BH-05	899.19	716.67	**379.33**	1
BH-06	658.91	680.07	**379.98**	1
BH-07	436.29	849.69	**379.02**	1
BH-08	223.90	2097.01	**384.5**	1
MW-11	1414.68	1002.71	**377.21**	1
MW-10	1268.20	1884.23	**381.74**	1
8	0	0	0	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

222.89	899.19	658.91	436.3	223.9	1415	1268	0
1076.77	716.67	680.07	849.7	2097.01	1003	1884	0
379.65	379.33	379.98	379	384.5	377.2	381.7	0

{[P]t[P]}

5142515.913	5980854.744	1945289
5980854.744	11810718.8	3164931
1945288.85	3164931.208	1011919

{[P]t[P]}'

7.15637E-07	3.86771E-08	-1.5E-06
3.86771E-08	5.25126E-07	-1.7E-06
-1.49669E-06	-1.7168E-06	9.23E-06

{[P]t[P]}'[P]t

-0.000367064	0.000103472	-7.1E-05	-2E-04	-0.000334141	5E-04	4E-04	0
-7.77084E-05	-0.0002401	-0.00027	-2E-04	0.000449759	-7E-05	4E-04	0
0.001323858	0.000926896	0.001355	0.001	-0.000384373	-4E-04	-0.002	0

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	4.92405E-06
B	-8.5604E-06
C	0.002647389

Groundwater Gradient:	**0.0037**	
Conductivity (ft/day):	**1.542**	
Effective porosity:	**30%**	
GW velocity:	**0.01917**	**ft/day**
	7.00	**ft/year**
Flow direction:	**-60.09**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Deep Aquifer**

Measurement Date: **3/15/2011**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
MW-12	881.62	719.01	**378.90**	1
MW-13	1271.94	1888.36	**381.39**	1
MW-14	213.79	2027.73	**381.30**	1
MW-15	1401.93	991.00	**380.18**	1
MW-16	193.95	1231.98	**379.93**	1
MW-18	430.16	834.63	**378.73**	1
MW-19	11.87	855.95	**379.32**	1
MW-20	0.30	1017.50	**379.51**	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

881.62	1271.94	213.79	1402	193.95	430.2	11.87	0.3
719.01	1888.36	2027.73	991	1231.98	834.6	856	1018
378.9	381.39	381.3	380.2	379.93	378.7	379.3	379.5

{[P]t[P]}

4628994.292	5467027.58	1674873
5467027.58	13158987.43	3637562
1674873.191	3637562.299	1154645

{[P]t[P]}'

4.59108E-07	-5.1482E-08	-5E-07
-5.1482E-08	5.94248E-07	-1.8E-06
-5.03773E-07	-1.7974E-06	7.26E-06

{[P]t[P]}'[P]t

0.000176863	0.000294608	-0.0002	4E-04	-0.000165779	-4E-05	-2E-04	-2E-04
-0.000299162	0.000371152	0.000509	-2E-04	3.92207E-05	-2E-04	-2E-04	-8E-05
0.001014075	-0.0012663	-0.00098	3E-04	0.000445957	0.001	0.001	9E-04

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	-9.5389E-07
B	-4.9799E-06
C	0.002649276

Groundwater Gradient:	**0.0019**	
Conductivity (ft/day):	**15.584**	
Effective porosity:	**30%**	
GW velocity:	**0.09942**	**ft/day**
	36.29	**ft/year**
Flow direction:	**-100.84**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Shallow Aquifer**

Measurement Date: **3/21/2017**

	[**X**] matrix			[**D**] matrix									
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D									
BH-03A	222.89	1076.77	**379.44**	1	Pt								
BH-05	899.19	716.67	**379.08**	1		222.89	899.19	658.91	436.3	223.9	1415	0	0
BH-06	658.91	680.07	**378.44**	1		1076.77	716.67	680.07	849.7	2097.01	1003	0	0
BH-07	436.29	849.69	**379.02**	1		379.44	379.08	378.44	379	385.16	377.4	0	0
BH-08	223.90	2097.01	**385.16**	1									
MW-11	1414.68	1002.71	**377.36**	1	{[P]t[P]}								
7	0	0	0	1		3534184.673	3591274.258	1460240					
8	0	0	0	1		3591274.258	8260396.107	2445727					
9	0	0	0	1		1460239.832	2445727.084	865298.1					
10	0	0	0	1									
11	0	0	0	1	{[P]t[P]}'								
12	0	0	0	1		1.16721E-06	4.64258E-07	-3.3E-06					
13	0	0	0	1		4.64258E-07	9.26687E-07	-3.4E-06					
14	0	0	0	1		-3.28194E-06	-3.4027E-06	1.63E-05					
15	0	0	0	1									
16	0	0	0	1	{[P]t[P]}'[P]t								
17	0	0	0	1		-0.000485241	0.000138147	-0.00016	-3E-04	-2.91804E-05	9E-04	0	0
18	0	0	0	1		-0.000189814	-0.00020831	-0.00035	-3E-04	0.000736635	3E-04	0	0
19	0	0	0	1		0.001793881	0.000793744	0.001696	0.002	-0.001587704	-0.002	0	0
20	0	0	0	1									

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	4.59458E-06
B	-1.0906E-05
C	0.002656267

Groundwater Gradient:	**0.0045**	
Conductivity (ft/day):	**1.542**	
Effective porosity:	**30%**	
GW velocity:	**0.02290**	**ft/day**
	8.36	**ft/year**
Flow direction:	**-67.15**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Deep Aquifer**

Measurement Date: **3/21/2017**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
MW-12	881.62	719.01	**379.05**	1
MW-14	213.79	2027.73	**382.32**	1
MW-15	1401.93	991.00	**380.57**	1
MW-16	193.95	1231.98	**379.96**	1
MW-18	430.16	834.63	**379.15**	1
MW-19	11.87	855.95	**379.17**	1
MW-20	0.30	1017.50	**379.90**	1
8	0	0	0	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

881.62	213.79	1401.93	194	430.16	11.87	0.3	0
719.01	2027.73	991	1232	834.63	856	1018	0
379.05	382.32	380.57	380	379.15	379.2	379.9	0

{[P]t[P]}

3011162.928	3065146.961	1190850
3065146.961	9593083.943	2920579
1190849.878	2920579.241	1010899

{[P]t[P]}'

6.7277E-07	2.18571E-07	-1.4E-06
2.18571E-07	9.36611E-07	-3E-06
-1.424E-06	-2.9634E-06	1.12E-05

{[P]t[P]}'[P]t

0.000210514	4.26104E-05	0.000618	-1E-04	-6.80855E-05	-3E-04	-3E-04	0
-0.00025716	0.000812943	0.000107	7E-05	-0.000247841	-3E-04	-2E-04	0
0.000869933	-0.00202066	-0.00066	3E-04	0.001171304	0.002	0.001	0

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	-1.6649E-06
B	-7.0563E-06
C	0.002653787

Groundwater Gradient:	**0.0027**	
Conductivity (ft/day):	**15.584**	
Effective porosity:	**30%**	
GW velocity:	**0.14192**	**ft/day**
	51.80	**ft/year**
Flow direction:	**-103.28**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Shallow Aquifer**

Measurement Date: **6/6/2017**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
BH-03A	222.89	1076.77	**377.56**	1
BH-05	899.19	716.67	**378.00**	1
BH-06	658.91	680.07	**377.59**	1
BH-07	436.29	849.69	**378.45**	1
BH-08	223.90	2097.01	**381.89**	1
MW-11	1414.68	1002.71	**376.36**	1
7	0	0	0	1
8	0	0	0	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

222.89	899.19	658.91	436.3	223.9	1415	0	0
1076.77	716.67	680.07	849.7	2097.01	1003	0	0
377.56	378	377.59	378.5	381.89	376.4	0	0

{[P]t[P]}

3534184.673	3591274.258	1455894
3591274.258	8260396.107	2434006
1455894.082	2434006.438	858721

{[P]t[P]}'

1.16923E-06	4.59847E-07	-3.3E-06
4.59847E-07	9.15439E-07	-3.4E-06
-3.28575E-06	-3.3744E-06	1.63E-05

{[P]t[P]}'[P]t

-0.000484809	0.000138903	-0.00016	-3E-04	-2.87009E-05	9E-04	0	0
-0.000185828	-0.00020597	-0.00035	-3E-04	0.000733992	3E-04	0	0
0.001788355	0.000788497	0.001695	0.002	-0.001587089	-0.002	0	0

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	3.77979E-06
B	-6.4975E-06
C	0.0026553

Groundwater Gradient:	**0.0028**	
Conductivity (ft/day):	**1.542**	
Effective porosity:	**30%**	
GW velocity:	**0.01455**	**ft/day**
	5.31	**ft/year**
Flow direction:	**-59.81**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Deep Aquifer**

Measurement Date: **6/6/2017**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
MW-12	881.62	719.01	**377.69**	1
MW-14	213.79	2027.73	**379.94**	1
MW-15	1401.93	991.00	**379.74**	1
MW-16	193.95	1231.98	**378.57**	1
MW-18	430.16	834.63	**378.56**	1
MW-19	11.87	855.95	**378.68**	1
MW-20	0.30	1017.50	**379.29**	1
8	0	0	0	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

881.62	213.79	1401.93	194	430.16	11.87	0.3	0
719.01	2027.73	991	1232	834.63	856	1018	0
377.69	379.94	379.74	378.6	378.56	378.7	379.3	0

{[P]t[P]}

3011162.928	3065146.961	1187449
3065146.961	9593083.943	2910708
1187449.068	2910707.886	1005089

{[P]t[P]}'

6.71914E-07	2.15744E-07	-1.4E-06
2.15744E-07	9.28557E-07	-2.9E-06
-1.41861E-06	-2.944E-06	1.12E-05

{[P]t[P]}'[P]t

0.000211699	4.21316E-05	0.000617	-1E-04	-6.79329E-05	-3E-04	-3E-04	0
-0.000254059	0.000810458	0.000105	7E-05	-0.00024666	-3E-04	-2E-04	0
0.000861415	-0.00201882	-0.00065	3E-04	0.001171222	0.002	0.001	0

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	-8.637E-07
B	-3.4348E-06
C	0.002650007

Groundwater Gradient:	**0.0013**	
Conductivity (ft/day):	**15.584**	
Effective porosity:	**30%**	
GW velocity:	**0.06943**	**ft/day**
	25.34	**ft/year**
Flow direction:	**-104.11**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Shallow Aquifer**

Measurement Date: **9/19/2017**

	[**X**] matrix			[**D**] matrix									
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D									
BH-03A	222.89	1076.77	**376.92**	1	Pt								
BH-05	899.19	716.67	**377.11**	1		222.89	899.19	658.91	436.3	223.9	0	0	0
BH-06	658.91	680.07	**376.80**	1		1076.77	716.67	680.07	849.7	2097.01	0	0	0
BH-07	436.29	849.69	**377.28**	1		376.92	377.11	376.8	377.3	381.05	0	0	0
BH-08	223.90	2097.01	**381.05**	1									
6	0	0	0	1	{[P]t[P]}								
7	0	0	0	1		1532865.17	2172760.475	921303.1					
8	0	0	0	1		2172760.475	7254968.763	2052007					
9	0	0	0	1		921303.1139	2052006.652	713798.2					
10	0	0	0	1									
11	0	0	0	1	{[P]t[P]}'								
12	0	0	0	1		5.65641E-06	1.98477E-06	-1.3E-05					
13	0	0	0	1		1.98477E-06	1.43394E-06	-6.7E-06					
14	0	0	0	1		-1.30065E-05	-6.684E-06	3.74E-05					
15	0	0	0	1									
16	0	0	0	1	{[P]t[P]}'[P]t								
17	0	0	0	1		-0.00150452	0.001603727	0.000176	-8E-04	0.000472415	0	0	0
18	0	0	0	1		-0.000532925	0.000291742	-0.00024	-4E-04	0.000904436	0	0	0
19	0	0	0	1		0.004001977	-0.00238032	0.000978	0.003	-0.002675962	0	0	0
20	0	0	0	1									

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	-5.2097E-06
B	-9.7144E-06
C	0.002681281

Groundwater Gradient:	**0.0041**	
Conductivity (ft/day):	**1.542**	
Effective porosity:	**30%**	
GW velocity:	**0.02113**	**ft/day**
	7.71	**ft/year**
Flow direction:	**-118.20**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Deep Aquifer**

Measurement Date: **9/19/2017**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
MW-12	881.62	719.01	**376.99**	1
MW-14	213.79	2027.73	**379.03**	1
MW-15	1401.93	991.00	**377.92**	1
MW-16	193.95	1231.98	**377.85**	1
MW-18	430.16	834.63	**376.98**	1
MW-19	11.87	855.95	**376.93**	1
MW-20	0.30	1017.50	**377.39**	1
8	0	0	0	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

881.62	213.79	1401.93	194	430.16	11.87	0.3	0
719.01	2027.73	991	1232	834.63	856	1018	0
376.99	379.03	377.92	377.9	376.98	376.9	377.4	0

{[P]t[P]}

3011162.928	3065146.961	1183245
3065146.961	9593083.943	2900919
1183245.234	2900918.821	997992.7

{[P]t[P]}'

6.72216E-07	2.16725E-07	-1.4E-06
2.16725E-07	9.31327E-07	-3E-06
-1.42696E-06	-2.9641E-06	1.13E-05

{[P]t[P]}'[P]t

0.000210516	4.23113E-05	0.000618	-1E-04	-6.78907E-05	-3E-04	-3E-04	0
-0.000256731	0.000811333	0.000107	7E-05	-0.000246864	-3E-04	-2E-04	0
0.000874408	-0.00202872	-0.00066	3E-04	0.001175803	0.002	0.001	0

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	-1.1492E-06
B	-4.6874E-06
C	0.002663394

Groundwater Gradient:	**0.0018**	
Conductivity (ft/day):	**15.584**	
Effective porosity:	**30%**	
GW velocity:	**0.09413**	**ft/day**
	34.36	**ft/year**
Flow direction:	**-103.78**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Shallow Aquifer**

Measurement Date: **12/5/2017**

	[**X**] matrix			[**D**] matrix									
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D									
BH-03A	222.89	1076.77	**378.01**	1	Pt								
BH-05	899.19	716.67	**378.16**	1		222.89	899.19	658.91	436.3	223.9	1415	0	0
BH-06	658.91	680.07	**377.80**	1		1076.77	716.67	680.07	849.7	2097.01	1003	0	0
BH-07	436.29	849.69	**378.23**	1		378.01	378.16	377.8	378.2	383.69	375.6	0	0
BH-08	223.90	2097.01	**383.69**	1									
MW-11	1414.68	1002.71	**375.62**	1	{[P]t[P]}								
7	0	0	0	1		3534184.673	3591274.258	1455537					
8	0	0	0	1		3591274.258	8260396.107	2437594					
9	0	0	0	1		1455536.797	2437594.147	859995.7					
10	0	0	0	1									
11	0	0	0	1	{[P]t[P]}'								
12	0	0	0	1		1.16361E-06	4.60148E-07	-3.3E-06					
13	0	0	0	1		4.60148E-07	9.22039E-07	-3.4E-06					
14	0	0	0	1		-3.27365E-06	-3.3922E-06	1.63E-05					
15	0	0	0	1									
16	0	0	0	1	{[P]t[P]}'[P]t								
17	0	0	0	1		-0.000482644	0.000138114	-0.00016	-3E-04	-3.0602E-05	9E-04	0	0
18	0	0	0	1		-0.000186917	-0.00020825	-0.00035	-3E-04	0.00073498	3E-04	0	0
19	0	0	0	1		0.001786224	0.000796248	0.001701	0.002	-0.001585301	-0.002	0	0
20	0	0	0	1									

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	6.06579E-06
B	-9.0775E-06
C	0.002656767

Groundwater Gradient:	**0.0041**	
Conductivity (ft/day):	**1.542**	
Effective porosity:	**30%**	
GW velocity:	**0.02112**	**ft/day**
	7.71	**ft/year**
Flow direction:	**-56.25**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Deep Aquifer**

Measurement Date: **12/5/2017**

		[**X**] matrix		[**D**] matrix									
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D									
MW-12	881.62	719.01	**377.94**	1	Pt								
MW-14	213.79	2027.73	**380.13**	1		881.62	213.79	1401.93	194	430.16	11.87	0.3	0
MW-15	1401.93	991.00	**378.85**	1		719.01	2027.73	991	1232	834.63	856	1018	0
MW-16	193.95	1231.98	**378.96**	1		377.94	380.13	378.85	379	377.98	378	378.5	0
MW-18	430.16	834.63	**377.98**	1									
MW-19	11.87	855.95	**377.99**	1	{[P]t[P]}								
MW-20	0.30	1017.50	**378.46**	1		3011162.928	3065146.961	1186280					
8	0	0	0	1		3065146.961	9593083.943	2908952					
9	0	0	0	1		1186280.084	2908952.173	1003453					
10	0	0	0	1									
11	0	0	0	1	{[P]t[P]}'								
12	0	0	0	1		6.71906E-07	2.16485E-07	-1.4E-06					
13	0	0	0	1		2.16485E-07	9.31673E-07	-3E-06					
14	0	0	0	1		-1.4219E-06	-2.9568E-06	1.12E-05					
15	0	0	0	1									
16	0	0	0	1	{[P]t[P]}'[P]t								
17	0	0	0	1		0.000210626	4.21121E-05	0.000618	-1E-04	-6.77393E-05	-3E-04	-3E-04	0
18	0	0	0	1		-0.000256751	0.000811497	0.000107	7E-05	-0.000246884	-3E-04	-2E-04	0
19	0	0	0	1		0.000871945	-0.00202345	-0.00066	3E-04	0.001172463	0.002	0.001	0
20	0	0	0	1									

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	-8.5906E-07
B	-4.8425E-06
C	0.002656244

Groundwater Gradient:	**0.0019**	
Conductivity (ft/day):	**15.584**	
Effective porosity:	**30%**	
GW velocity:	**0.09618**	**ft/day**
	35.11	**ft/year**
Flow direction:	**-100.06**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Shallow Aquifer**

Measurement Date: **3/20/2018**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
BH-03A	222.89	1076.77	**378.56**	1
BH-05	899.19	716.67	**378.33**	1
BH-06	658.91	680.07	**377.80**	1
BH-07	436.29	849.69	**378.40**	1
BH-08	223.90	2097.01	**383.06**	1
MW-11	1414.68	1002.71	**376.10**	1
7	0	0	0	1
8	0	0	0	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

222.89	899.19	658.91	436.3	223.9	1415	0	0
1076.77	716.67	680.07	849.7	2097.01	1003	0	0
378.56	378.33	377.8	378.4	383.06	376.1	0	0

{[P]t[P]}

3534184.673	3591274.258	1456424
3591274.258	8260396.107	2437613
1456424.407	2437612.836	860546.8

{[P]t[P]}'

1.16453E-06	4.5896E-07	-3.3E-06
4.5896E-07	9.18601E-07	-3.4E-06
-3.27096E-06	-3.3788E-06	1.63E-05

{[P]t[P]}'[P]t

-0.000484497	0.000138552	-0.00016	-3E-04	-2.97907E-05	9E-04	0	0
-0.000187667	-0.00020728	-0.00035	-3E-04	0.000734785	3E-04	0	0
0.001791481	0.000792306	0.001693	0.002	-0.00158582	-0.002	0	0

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	5.6827E-06
B	-7.7409E-06
C	0.002652782

Groundwater Gradient:	**0.0036**	
Conductivity (ft/day):	**1.542**	
Effective porosity:	**30%**	
GW velocity:	**0.01861**	**ft/day**
	6.79	**ft/year**
Flow direction:	**-53.72**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Site: **Cathcart Landfill - Deep Aquifer**

Measurement Date: **3/20/2018**

	[**X**] matrix			[**D**] matrix
Well ID	**X-axis**	**Y-axis**	**GW Elev.**	D
MW-12	881.62	719.01	**378.11**	1
MW-14	213.79	2027.73	**380.99**	1
MW-15	1401.93	991.00	**379.45**	1
MW-16	193.95	1231.98	**379.55**	1
MW-18	430.16	834.63	**378.39**	1
MW-19	11.87	855.95	**378.42**	1
MW-20	0.30	1017.50	**378.99**	1
8	0	0	0	1
9	0	0	0	1
10	0	0	0	1
11	0	0	0	1
12	0	0	0	1
13	0	0	0	1
14	0	0	0	1
15	0	0	0	1
16	0	0	0	1
17	0	0	0	1
18	0	0	0	1
19	0	0	0	1
20	0	0	0	1

Pt

881.62	213.79	1401.93	194	430.16	11.87	0.3	0
719.01	2027.73	991	1232	834.63	856	1018	0
378.11	380.99	379.45	379.6	378.39	378.4	379	0

{[P]t[P]}

3011162.928	3065146.961	1187751
3065146.961	9593083.943	2913389
1187751.036	2913389.253	1006175

{[P]t[P]}'

6.71948E-07	2.17142E-07	-1.4E-06
2.17142E-07	9.34221E-07	-3E-06
-1.42194E-06	-2.9614E-06	1.12E-05

{[P]t[P]}'[P]t

0.000210878	4.22138E-05	0.000618	-1E-04	-6.77714E-05	-3E-04	-3E-04	0
-0.000256574	0.000812517	0.000107	7E-05	-0.000247419	-3E-04	-2E-04	0
0.000869768	-0.00202383	-0.00066	3E-04	0.001172474	0.002	0.001	0

{[P]t[P]}'[P]t [D] = [**A**] matrix

A	-8.9823E-07
B	-5.9855E-06
C	0.002656004

Groundwater Gradient:	**0.0023**	
Conductivity (ft/day):	**15.584**	
Effective porosity:	**30%**	
GW velocity:	**0.11838**	**ft/day**
	43.21	**ft/year**
Flow direction:	**-98.53**	**degrees from the positive x-axis**

This spreadsheet is from the paper, "A Spreadsheet Method For Estimating Hydraulic Gradient With Heads From Multiple Wells" submitted to Ground Water, March, 2002. To use the program, enter the coordinates for the well locations in the columns labeled x and y (part of the [**X**] matrix), and the water levels in the z column. The matrices are automatically updated and the gradient magnitude and direction are calculated in cell H36 and H41.

Attachment C

Groundwater Analytical Summary Tables, 2017

Groundwater Analytical Summary - Shallow Wells: First Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/22/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch		D	V	Tr	Ch	3/22/17	D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																					
Alkalinity (as CaCO3)	normal	**39.9737**	--	**72**					26					42					**430**					**46**			I		Well not accessible					14				
Ammonia Nitrogen	nonpar	**0.12**	--	0.014					**0.237**			D		**0.227**					**43.6**					0.006										0.005	U			
Bicarbonate	nonpar	**92**	--	72					26					42					**430**					46			I							14				
Calcium, Dissolved	normal	**19.9442**	--	11.5					8.08					8.42			I	N	**65.9**					11.5			I							8.11				
Chemical Oxygen Demand	nonpar	**32**	--	16					18					23					**74**					13										13				
Chloride	lognor	**53.915**	**250**	7.4					6.9					1.3					31.3					6.9										7				
Conductivity (umhos/cm)	lognor	**487.4501**	**700**	180					95					98					**960**					140										110				
Magnesium, Dissolved	normal	**7.0321**	--	**10.9**					2.59					4.18					**15.7**			D		5.84			I							3.33				
Nitrate Nitrogen (mg-N/L)	lognor	**31.8526**	**10**	0.1					0.01	U				0.072					0.01	U				1.8										1.9				
Nitrite Nitrogen (mg-N/L)	nonpar	**0.015**	**1**	0.001	U				0.001	U				0.002					0.001	U				0.001	U									0.006				
pH (std units)	nonpar	**4.90-7.40**	**6.5-8.5**	6.82					**6.24**			D		**6.49**					6.52					**6.14**										**5.62**				
Potassium, Dissolved	nonpar	**4.94**	--	0.96					1.19					2.3					**35.8**					0.76										1.42				
Sodium, Dissolved	normal	**53.8755**	**20**	6.82					2.65					2.61					**21.9**					5.74										5.83				
Sulfate	normal	**35.9821**	**250**	9.2					5.8					5.1					6.8					8.2										18.3				
Total Dissolved Solids	lognor	**338.9264**	**500**	110					49					56					**400**					23										1	U			
Total Organic Carbon	nonpar	**29**	--	0.6					3.5					8.4					9.1					1.5										1.9				
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																					
Antimony	nonpar	**0.01**	**0.006**	0.00041					0.0002	U				0.00029					0.0002	U				0.0002	U				Well not accessible					0.00036				
Arsenic	nonpar	**0.001**	**0.00005**	**0.000445**					**0.00274**					**0.681**					**0.0119**			I		**0.0001**			D							**0.000116**				
Barium	nonpar	**0.0531**	**1**	0.0076					0.0079					0.0107					**0.771**			I		0.0077										0.0315				
Beryllium	nonpar	**0.0041**	**0.004**	0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U									0.0003	U			
Cadmium	nonpar	**0.0005**	**0.005**	0.000028					0.000025	U				0.000029					0.000025	U				0.000091										0.000112				
Chromium	nonpar	**0.0043**	**0.05**	0.005	U				0.005	U				0.005	U				0.005	U				**0.0061**										0.005	U			
Cobalt	nonpar	**0.006**	--	**0.007**					**0.008**					**0.009**					0.005	U				0.005										0.005	U			
Copper	nonpar	**0.019**	**1**	0.005	U				0.005	U				0.01					0.005	U				0.005	U									0.009				
Iron	nonpar	**0.284**	**0.3**	0.025					**2.06**					0.102					**14.7**			I		0.026										0.075				
Lead	nonpar	**0.0047**	**0.05**	0.00005	U				0.000055					**0.097**					0.00005	U				0.000063										0.00005	U			
Manganese	nonpar	**0.0364**	**0.05**	**0.066**					**0.4383**					**0.2273**					**4.585**					0.0087										0.0079				D
Nickel	nonpar	**0.011**	**0.1**	0.002	U				0.004					0.004					0.002	U				0.005										0.002	U			
Selenium	nonpar	**0.001**	**0.01**	0.00025	U				0.00025	U				0.00025	U				**0.00148**					0.00025	U									0.00025	U			
Silver	nonpar	**0.0009**	**0.05**	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00016				
Thallium	nonpar	**0.001**	**0.002**	0.000017					0.00001	U				0.00001	U				0.00001	U				0.000024										0.00001	U			
Vanadium	nonpar	**0.008**	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Zinc	nonpar	**0.036**	**5**	0.002	U				0.003					0.005					0.002	U				0.002										0.002	U			
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																					
1,1,1-Trichloroethane	NA	NA	**200**	1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethane	nonpar	**1.0**	**1**	1	U				1	U				1	U				1	U				1	U									1	U			

Groundwater Analytical Summary - Shallow Wells: First Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/22/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch		D	V	Tr	Ch	3/22/17	D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																					
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dibromo-3-chloropropane	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dichloroethane	nonpar	1.0	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
1,2-Dichloropropane	NA	NA	0.6	0.6	U				0.6	U				0.6	U				0.6	U				0.6	U									0.6	U			
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U				1	U									1	U			
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
Acetone	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				0.01	U				0.53					0.01	U									0.01	U			
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U									1	U			
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U				1	U									1	U			
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Chlorobenzene	nonpar	1.0	--	0.2	U				0.2	U				0.2	U				0.2	U		I		0.2	U									0.2	U			
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Chloroform	nonpar	2.1	7	1	U				1	U				1	U				1	U				1	U									1	U			
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
cis-1,2-Dichloroethene	nonpar	1.0	--	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
cis-1,3-Dichloropropene	nonpar	1.0	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Dibromomethane	NA	NA	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U									1	U			
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U				2	U									2	U			
o-Xylene	nonpar	1.2	--	1	U				1	U				1	U				1	U				1	U									1	U			
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U									1	U			
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U				0.8	U									0.8	U			
Toluene	nonpar	1.4	--	1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
trans-1,4-Dichloro-2-butene	nonpar	5.0	--	5	U				5	U				5	U				5	U				5	U									5	U			
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U				1	U									1	U			
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			

D: U = Indicates compound was not detected at the given reporting limit.

V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.

Tr: I=increasing Trend, D=Decreasing Trend;

Ch: Y indicates a change in trend from previous quarter; N means no change in trend.

The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.

NA: Not applicable - too few data points to evaluate statistically

Groundwater Analytical Summary - Deep Wells: First Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																												Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/22/17	D	V	Tr	Ch	3/22/17	D	V	Tr	Ch	3/22/17	D	V	Tr	Ch		D	V	Tr	Ch	3/22/17	D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																													
Alkalinity (as CaCO3)	normal	182.2846	--	76			I		58			I		290					130					660					96			D		120					Well not accessible					98			I	
Ammonia Nitrogen	nonpar	0.1	--	0.012					0.015					0.065					14.3					0.06					0.005	U				0.005	U									0.005	U			
Bicarbonate	nonpar	170	--	76			I		58			I		290					130					660					96			D		120										98			I	
Calcium, Dissolved	normal	33.2346	--	14.6			I		13			I		50.2					9.93					95.9			I		16.7			D		19.8										19.4			I	
Chemical Oxygen Demand	nonpar	28	--	10	U				11					16					10	U				33			D		16					10	U									10	U			
Chloride	normal	14.2105	250	11.3			I		10.4			I		7.8					6.7					10.2			D		7.1					7.2										9.0				
Conductivity (umhos/cm)	normal	434.8776	700	230			I		170					560					320					1100					220			D		270			D							270				
Magnesium, Dissolved	normal	29.5077	--	14.2			I		7.36			I		39.3					8.23					85.5			I		15			D		16.7										17.1			I	
Nitrate Nitrogen (mg-N/L)	lognor	5.046	10	2.1					0.86			D		0.010	U				0.01	U				0.01	U				0.6			I		0.56			I							2.5				
Nitrite Nitrogen (mg-N/L)	nonpar	0.002	1	0.001	U				0.002					0.001	U				0.001	U				0.001	U				0.004					0.001										0.001	U			
pH (std units)	normal	6.42-8.16	6.5-8.5	7.33			D		6.40			D		7.10			D		7.11			D		6.78			D		7.20			D		7.18			D							7.35			D	
Potassium, Dissolved	normal	3.2894	--	2.02			I		0.83			I		1.66					3.79					4.38			D		1.64					1.54										2.71			I	
Sodium, Dissolved	normal	8.1291	20	5.92			I		8.03					8.12			D		7.65			I		25.5			D		6.76			D		7.37										6.68				
Sulfate	lognor	21.3499	250	14.4					7.3					7.3					13.3					0.9					8.5					9.8			I							14.9				
Total Dissolved Solids	nonpar	250	500	150					81					320					360					710					140			D		120										160				
Total Organic Carbon	nonpar	27	--	1.5					0.5	U				1.7					3.7					7.8					0.5	U				0.53										0.79				
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																													
Antimony	nonpar	0.01	0.006	0.0002	U				0.00086					0.00071					0.0002	U				0.0002	U				0.0002	U				0.0002	U				Well not accessible					0.00065				
Arsenic	nonpar	0.006	0.00005	0.00166					0.000326					0.0169					0.00605			D		0.016					0.000529					0.000449										0.00201				
Barium	nonpar	0.0189	1	0.0099					0.01					0.0219					0.0228					0.0598					0.0111					0.0128										0.0082				
Beryllium	nonpar	0.0005	0.004	0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U									0.0003	U			
Cadmium	nonpar	0.0001	0.005	0.000025	U				0.000051					0.000028					0.000029					0.000025	U				0.000025	U				0.000025	U									0.000025	U			
Chromium	normal	0.007	0.05	0.0083					0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.0055				
Cobalt	nonpar	0.006	--	0.007					0.006					0.007					0.009					0.005	U				0.005	U				0.005	U									0.005	U			
Copper	nonpar	0.008	1	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Iron	nonpar	0.043	0.3	0.016					0.016					0.555					0.136					1.05			I		0.005	U				0.005	U									0.005	U			
Lead	nonpar	0.004	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Manganese	nonpar	0.0184	0.05	0.0018					0.0508					2.198					1					2.585					0.0081					0.0081			D							0.0010				
Nickel	nonpar	0.03	0.1	0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U									0.002	U			
Selenium	nonpar	0.001	0.01	0.00094					0.00025	U				0.00036					0.00025	U				0.00029					0.00025	U				0.00028										0.00039				
Silver	nonpar	0.0007	0.05	0.00005	U				0.0002					0.00005	U				0.00005	U				0.00005	U				0.00008					0.0001										0.00041				
Thallium	nonpar	0.001	0.002	0.00001	U				0.000029					0.000032					0.00001	U				0.00001	U				0.00001	U				0.00001	U									0.000025				
Vanadium	nonpar	0.015	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Zinc	nonpar	0.015	5	0.006					0.003					0.006					0.004					0.002	U				0.002	U				0.002	U									0.002	U			
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																													
1,1,1-Trichloroethane	NA	NA	200	1	U				1	U				1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethane	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dibromo-3-chloropropane	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dichloroethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
1,2-Dichloropropane	nonpar	1.0	0.6	0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U									0.6	U			
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acetone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			

Groundwater Analytical Summary - Deep Wells: First Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																												Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/21/17	D	V	Tr	Ch	3/22/17	D	V	Tr	Ch	3/22/17	D	V	Tr	Ch	3/22/17	D	V	Tr	Ch		D	V	Tr	Ch	3/22/17	D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																													
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				Well not accessible					0.3	U			
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Chlorobenzene	nonpar	1.0	--	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Chloroform	nonpar	1.0	7	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
cis-1,2-Dichloroethene	NA	NA	--	0.2	U				0.2	U				**1.23**					0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
cis-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Dibromomethane	NA	NA	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U				2	U				2	U				2	U									2	U			
o-Xylene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U									0.8	U			
Toluene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
trans-1,4-Dichloro-2-butene	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				0.01	U				**0.23**					0.01	U				**1.6**					**0.04**					**0.03**										0.01	U			

D: U = Indicates compound was not detected at the given reporting limit.
V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.
Tr: I=increasing Trend, D=Decreasing Trend;
Ch: Y indicates a change in trend from previous quarter; N means no change in trend.
The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.
* = Non-detect; exceedance due to elevated laboratory reporting limit
NA: Not applicable - too few data points to evaluate statistically

Groundwater Analytical Summary - Shallow Wells: Second Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/7/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch		D	V	Tr	Ch	6/7/17	D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																			
Alkalinity (as CaCO3)	normal	39.9737	--	68					130					130			I	Y	460					42			I	N	Well not accessible					18				
Ammonia Nitrogen	nonpar	0.12	--	0.005	U				0.336			D	N	1.3					42.2					0.005	U									0.02				
Bicarbonate	nonpar	92	--	68					130					130			I	Y	460					42			I	N						18				
Calcium, Dissolved	normal	19.9442	--	9.21					9.3					22.8			I	N	69.9					7.76			I	N						5.24				
Chemical Oxygen Demand	nonpar	32	--	10	U				19					19					26					10	U									10	U			
Chloride	lognor	53.915	250	7.5					3.0					5.5					33.4					5.4										3.6				
Conductivity (umhos/cm)	lognor	487.4501	700	170					110					260					1000					120										96				
Magnesium, Dissolved	normal	7.0321	--	8.15					2.88					11			I	Y	16.9			D	N	4.09			I	N						2.68				
Nitrate Nitrogen (mg-N/L)	lognor	31.8526	10	0.25					0.027					0.015					0.59					0.83										1.8				
Nitrite Nitrogen (mg-N/L)	nonpar	0.015	1	0.004					0.001					0.006					0.001					0.007										0.005				
pH (std units)	nonpar	4.90-7.40	6.5-8.5	6.94					6.15			D	N	6.15					6.54					6.36										5.34				
Potassium, Dissolved	nonpar	4.94	--	0.66					1.26					4.72					39					0.41										0.98				
Sodium, Dissolved	normal	53.8755	20	5.61					3.06					4.21					23.4					4.74										4.81				
Sulfate	normal	35.9821	250	9.3					3.7					3.9					12.2					7.6										18.9				
Total Dissolved Solids	lognor	338.9264	500	140					97					180					620					100										63				
Total Organic Carbon	nonpar	29	--	0.78					5.1					7.9					10					1.3										0.98				
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																			
Antimony	nonpar	0.01	0.006	0.0002	U				0.0002	U				0.0002	U				0.0002	U				0.0002	U				Well not accessible					0.00020	U			
Arsenic	nonpar	0.001	0.00005	0.000503					0.00456					0.00787					0.0134			I	N	0.000093			D	N						0.000049				
Barium	nonpar	0.0531	1	0.0052					0.0088					0.0343					0.813			I	N	0.0038										0.0123				
Beryllium	nonpar	0.0041	0.004	0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U									0.0003	U			
Cadmium	nonpar	0.0005	0.005	0.000025	U				0.000025	U				0.000035					0.000025	U				0.000025	U									0.000025	U			
Chromium	nonpar	0.0043	0.05	0.005	U				0.005	U				0.006					0.005	U				0.005	U									0.005	U			
Cobalt	nonpar	0.006	--	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Copper	nonpar	0.019	1	0.005	U				0.005	U				0.01	U				0.005	U				0.005	U									0.005	U			
Iron	nonpar	0.284	0.3	0.005	U				2.9					3.19					16.6			I	N	0.005										0.005	U			
Lead	nonpar	0.0047	0.05	0.00005	U				0.050000	U				0.00005	U				0.00005	U				0.00005	U									0.000057				
Manganese	nonpar	0.0364	0.05	0.0716					0.4976					1.55					4.687					0.0014										0.0069			D	N
Nickel	nonpar	0.011	0.1	0.002	U				0.002	U				0.002	U				0.002	U				0.002	U									0.002	U			
Selenium	nonpar	0.001	0.01	0.00026					0.00025	U				0.0014					0.00283					0.00025	U									0.00025	U			
Silver	nonpar	0.0009	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Thallium	nonpar	0.001	0.002	0.00001	U				0.00001	U				0.00001	U				0.00001	U				0.00001	U									0.00001	U			
Vanadium	nonpar	0.008	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Zinc	nonpar	0.036	5	0.002	U				0.002	U				0.002	U				0.002	U				0.002	U									0.002	U			
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																			
1,1,1-Trichloroethane	NA	NA	200	1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethane	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U									1	U			

Groundwater Analytical Summary - Shallow Wells: Second Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/7/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch		D	V	Tr	Ch	6/7/17	D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																					
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dibromo-3-chloropropane	NA	NA	0.2	5	U				5	U				5	U				5	U				5	U									5	U			
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dichloroethane	nonpar	1.0	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
1,2-Dichloropropane	NA	NA	0.6	0.6	U				0.6	U				0.6	U				0.6	U				0.6	U									0.6	U			
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U				1	U									1	U			
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
Acetone	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				0.01	U				0.5					0.01	U									0.01	U			
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U									1	U			
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U				1	U									1	U			
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Chlorobenzene	nonpar	1.0	--	0.2	U				**0.25**					**0.4**					1.78			I		0.2	U									0.2	U			
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Chloroform	nonpar	2.1	7	1	U				1	U				1	U				1	U				1	U									1	U			
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
cis-1,2-Dichloroethene	nonpar	1.0	--	0.2	U				0.2	U				0.2	U				**0.21**					0.2	U									0.2	U			
cis-1,3-Dichloropropene	nonpar	1.0	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Dibromomethane	NA	NA	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U									1	U			
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U				2	U									2	U			
o-Xylene	nonpar	1.2	--	1	U				1	U				1	U				1	U				1	U									1	U			
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U									1	U			
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U				0.8	U									0.8	U			
Toluene	nonpar	1.4	--	1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
trans-1,4-Dichloro-2-butene	nonpar	5.0	--	5	U				5	U				5	U				5	U				5	U									5	U			
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U				1	U									1	U			
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				0.01	U				0.11					0.25					0.01	U									0.01	U			

D: U = Indicates compound was not detected at the given reporting limit.

V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.

Tr: I=increasing Trend, D=Decreasing Trend;

Ch: Y indicates a change in trend from previous quarter; N means no change in trend.

The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.

NA: Not applicable - too few data points to evaluate statistically

Groundwater Analytical Summary - Deep Wells: Second Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																																Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/7/17	D	V	Tr	Ch	6/7/17	D	V	Tr	Ch	6/7/17	D	V	Tr	Ch		D	V	Tr	Ch	6/7/17	D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																													
Alkalinity (as CaCO3)	normal	182.2846	--	80			I	N	60			I	N	330					92					690					120			D	N	120					Well not accessible					100			I	N
Ammonia Nitrogen	nonpar	0.1	--	0.005	U				0.005	U				0.043					11.1					0.067					0.015					0.022										0.026				
Bicarbonate	nonpar	170	--	80			I	N	60			I	N	330					92					690					120			D	N	120										100			I	N
Calcium, Dissolved	normal	33.2346	--	12.1			I	N	9.1			I	N	38.1					7.46					76.6			I	N	14.6			D	N	14.7										17.3			I	N
Chemical Oxygen Demand	nonpar	28	--	10	U				10	U				10	U				10	U				15			D	N	10	U				10	U									10	U			
Chloride	normal	14.2105	250	9.9			I	N	9.3			I	N	8.4					6.9					11.2			D	N	7.1					6.6										9.6				
Conductivity (umhos/cm)	normal	434.8776	700	220			I	N	160					590					240					1000					250			D	N	270			D	N						270				
Magnesium, Dissolved	normal	29.5077	--	11.4			I	N	58.8			I	N	29.9					6.1					71.0			I	N	13.6			D	N	13.4										15.6			I	N
Nitrate Nitrogen (mg-N/L)	lognor	5.046	10	2.4					0.33			D	N	1.900					0.031					0.45					0.58			I	N	0.66			I	N						1.2				
Nitrite Nitrogen (mg-N/L)	nonpar	0.002	1	0.001					0.002					0.002					0.001					0.004					0.029					0.002										0.001	U			
pH (std units)	normal	6.42-8.16	6.5-8.5	6.97			D	N	5.95			D	N	7.15			D	N	6.95			D	N	6.89			D	N	7.08			D	N	7.08			D	N						7.31			D	N
Potassium, Dissolved	normal	3.2894	--	1.85			I	N	0.7			I	N	1.34					2.57					3.94			D	N	1.85					1.55										2.76			I	N
Sodium, Dissolved	normal	8.1291	20	4.93			I	N	5.76					6.43			D	N	5.91			I	N	23.6			D	N	6.72			D	N	6.47										6.72				
Sulfate	lognor	21.3499	250	14.8					8.4					6.8					9.3					6.4					8.8					8.6			I	N						15.8				
Total Dissolved Solids	nonpar	250	500	160					140					400					140					710					190			D	N	220										210				
Total Organic Carbon	nonpar	27	--	0.5	U				0.72					2.2					4.9					9.0					0.65					0.62										0.5	U			
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																													
Antimony	nonpar	0.01	0.006	0.0002	U				0.0002	U				0.0002	U				0.0002	U				0.0002	U				0.0002	U				0.0002	U				Well not accessible					0.0002	U			
Arsenic	nonpar	0.006	0.00005	0.0019					0.000398					0.0192					0.00558			D	N	0.0146					0.000547					0.000448										0.0021				
Barium	nonpar	0.0189	1	0.0076					0.0066					0.0157					0.0127					0.0463					0.0096					0.0089										0.007				
Beryllium	nonpar	0.0005	0.004	0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U									0.0003	U			
Cadmium	nonpar	0.0001	0.005	0.000025	U				0.000025	U				0.000025	U				0.000025	U				0.000025	U				0.000025	U				0.000025	U									0.000025	U			
Chromium	normal	0.007	0.05	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Cobalt	nonpar	0.006	--	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Copper	nonpar	0.008	1	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Iron	nonpar	0.043	0.3	0.014					0.022					0.348					0.097					0.569			I	N	0.005	U				0.005	U									0.005	U			
Lead	nonpar	0.004	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Manganese	nonpar	0.0184	0.05	0.003					0.0145					1.558					0.7505					2.126					0.0065					0.0058			D	N						0.001				
Nickel	nonpar	0.03	0.1	0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U									0.002	U			
Selenium	nonpar	0.001	0.01	0.00088					0.00025	U				0.00056					0.00025	U				0.00034					0.00032					0.00038										0.00047				
Silver	nonpar	0.0007	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Thallium	nonpar	0.001	0.002	0.00001	U				0.00001	U				0.00001	U				0.00001	U				0.00001	U				0.00001	U				0.00001	U									0.00001	U			
Vanadium	nonpar	0.015	--	0.01					0.01					0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.012				
Zinc	nonpar	0.015	5	0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U									0.002	U			
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																													
1,1,1-Trichloroethane	NA	NA	200	1	U				1	U				1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethane	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dibromo-3-chloropropane	NA	NA	0.2	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dichloroethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
1,2-Dichloropropane	nonpar	1.0	0.6	0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U									0.6	U			
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acetone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			

Groundwater Analytical Summary - Deep Wells: Second Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																												Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/6/17	D	V	Tr	Ch	6/7/17	D	V	Tr	Ch	6/7/17	D	V	Tr	Ch	6/7/17	D	V	Tr	Ch		D	V	Tr	Ch	6/7/17	D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																													
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U			
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U			
Chlorobenzene	nonpar	1.0	--	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			
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U			
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Chloroform	nonpar	1.0	7	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
cis-1,2-Dichloroethene	NA	NA	--	0.2	U				0.2	U				**1.11**					0.2	U				**0.26**					0.2	U				0.2	U				0.2	U				0.2	U			
cis-1,3-Dichloropropene	NA	NA	0.2	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			
Dibromomethane	NA	NA	--	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			
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U				2	U				2	U				2	U				2	U				2	U			
o-Xylene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U			
Toluene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
trans-1,3-Dichloropropene	NA	NA	0.2	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			
trans-1,4-Dichloro-2-butene	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U				5	U				5	U			
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U				1	U			
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U				5	U				5	U			
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				0.01	U				**0.18**					0.01	U				**2.2**					**0.06**					**0.04**					0.01	U				0.01	U			

D: U = Indicates compound was not detected at the given reporting limit.
V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.
Tr: I=increasing Trend, D=Decreasing Trend;
Ch: Y indicates a change in trend from previous quarter; N means no change in trend.
The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.
* = Non-detect; exceedance due to elevated laboratory reporting limit
NA: Not applicable - too few data points to evaluate statistically

Groundwater Analytical Summary - Shallow Wells: Third Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				9/19/17	D	V	Tr	Ch	9/20/17	D	V	Tr	Ch	9/20/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch		D	V	Tr	Ch		D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																			
Alkalinity (as CaCO3)	normal	39.9737	--	72					150					320			I	Y	410					Not sampled - insufficient water					Well not accessible					Not sampled - insufficient water				
Ammonia Nitrogen	nonpar	0.12	--	0.007					0.776			D	N	2.4					83.8																				
Bicarbonate	nonpar	92	--	72					150					320			I	Y	410																				
Calcium, Dissolved	normal	19.9442	--	12.1					45.8					80.3			I	N	59.5																				
Chemical Oxygen Demand	nonpar	32	--	10	U				10	U				19					11																				
Chloride	lognor	53.915	250	7.7					11.2					21.4					45.0																				
Conductivity (umhos/cm)	lognor	487.4501	700	180					370					700					1000																				
Magnesium, Dissolved	normal	7.0321	--	10.9					13.6					36.4			I	Y	14.7			D	N																
Nitrate Nitrogen (mg-N/L)	lognor	31.8526	10	0.26					0.01	U				0.01	U				0.01	U																				
Nitrite Nitrogen (mg-N/L)	nonpar	0.015	1	0.005					0.002					0.002			D	Y	0.047																				
pH (std units)	nonpar	4.90-7.40	6.5-8.5	7.24					6.07			D	N	6.23					6.69																				
Potassium, Dissolved	nonpar	4.94	--	1.01					3.84					12.5					40.8																				
Sodium, Dissolved	normal	53.8755	20	6.61					1.19					2.01					21.0																				
Sulfate	normal	35.9821	250	11.0					20.0					17.3					5.0																				
Total Dissolved Solids	lognor	338.9264	500	130					390					400					380																				
Total Organic Carbon	nonpar	29	--	1.2					5.3					13.0					10																				
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																			
Antimony	nonpar	0.01	0.006	0.0002	U				0.0002	U				0.0002	U				0.0002	U				Not sampled - insufficient water					Well not accessible					Not sampled - insufficient water				
Arsenic	nonpar	0.001	0.00005	0.000451					0.00838					0.0136					0.0137			I	N																
Barium	nonpar	0.0531	1	0.0063					0.0432					0.11					0.577			I	N																
Beryllium	nonpar	0.0041	0.004	0.0003	U				0.0003	U				0.0003	U				0.0003	U																				
Cadmium	nonpar	0.0005	0.005	0.000025	U				0.000025	U				0.00007					0.000025	U																				
Chromium	nonpar	0.0043	0.05	0.005	U				0.005					0.005	U				0.005	U																				
Cobalt	nonpar	0.006	--	0.005	U				0.005	U				0.005	U				0.005	U																				
Copper	nonpar	0.019	1	0.005	U				0.005	U				0.005	U				0.005	U																				
Iron	nonpar	0.284	0.3	0.005	U				13.8			I	Y	9.75			I	Y	1.86			I	N																
Lead	nonpar	0.0047	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U																				
Manganese	nonpar	0.0364	0.05	0.0921			I	Y	2.785					4.116					4.241			D	Y																
Nickel	nonpar	0.011	0.1	0.002	U				0.004					0.004					0.002	U																				
Selenium	nonpar	0.001	0.01	0.00025	U				0.00098					0.00389					0.00256																				
Silver	nonpar	0.0009	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U																				
Thallium	nonpar	0.001	0.002	0.00001	U				0.00001	U				0.000039					0.00001	U																				
Vanadium	nonpar	0.008	--	0.01	U				0.01	U				0.01	U				0.01	U																				
Zinc	nonpar	0.036	5	0.002	U				0.002	U				0.002	U				0.002	U																				
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																			
1,1,1-Trichloroethane	NA	NA	200	1	U				1	U				1	U				1	U				Not sampled - insufficient water					Well not accessible					Not sampled - insufficient water				
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U																				
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U																				
1,1-Dichloroethane	nonpar	1.0	1	1	U				1	U				1	U				1	U																				

Groundwater Analytical Summary - Shallow Wells: Third Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				9/19/17	D	V	Tr	Ch	9/20/17	D	V	Tr	Ch	9/20/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch		D	V	Tr	Ch		D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																				
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				Not sampled - insufficient water					Well not accessible					Not sampled - insufficient water				
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U																
1,2-Dibromo-3-chloropropane	NA	NA	0.2	5	U				5	U				5	U				5	U																
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U																
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U																
1,2-Dichloroethane	nonpar	1.0	0.5	0.5	U				0.5	U				0.5	U				0.5	U																
1,2-Dichloropropane	NA	NA	0.6	0.6	U				0.6	U				0.6	U				0.6	U																
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U																
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U																
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U																
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U																
Acetone	NA	NA	--	5	U				5	U				5	U				5	U																
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				**0.52**					**1.03**																	
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U																
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U																
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U																
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U																
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U																
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U																
Chlorobenzene	nonpar	1.0	--	0.2	U				1.47					**1.37**					1.78			I														
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U																
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U																
Chloroform	nonpar	2.1	7	1	U				1	U				1	U				1	U																
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U																
cis-1,2-Dichloroethene	nonpar	1.0	--	0.2	U				0.2	U				**0.38**					**0.21**																	
cis-1,3-Dichloropropene	nonpar	1.0	0.2	0.2	U				0.2	U				0.2	U				0.2	U																
Dibromomethane	NA	NA	--	0.01	U				0.01	U				0.01	U				0.01	U																
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U																
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U																
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U																
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U																
o-Xylene	nonpar	1.2	--	1	U				1	U				1	U				1	U																
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U																
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U																
Toluene	nonpar	1.4	--	1	U				1	U				1	U				1	U																
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U																
trans-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U																
trans-1,4-Dichloro-2-butene	nonpar	5.0	--	5	U				5	U				5	U				5	U																
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U																
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U																
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U																
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				**0.16**					**1.3**					0.25																	

D: U = Indicates compound was not detected at the given reporting limit.

V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.

Tr: I=increasing Trend, D=Decreasing Trend;

Ch: Y indicates a change in trend from previous quarter; N means no change in trend.

The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.

NA: Not applicable - too few data points to evaluate statistically

Groundwater Analytical Summary - Deep Wells: Third Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																																Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				9/20/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/20/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch		D	V	Tr	Ch	9/20/17	D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																													
Alkalinity (as CaCO3)	normal	182.2846	--	80			I	N	58			I	N	280					110			I	Y	610					110			D	N	96					Well not accessible					90			I	N
Ammonia Nitrogen	nonpar	0.1	--	0.005	U				0.014					0.005	U				10.9					0.051					0.005	U				0.007										0.094				
Bicarbonate	nonpar	170	--	80			I	N	58			I	N	280					110			I	Y	610					110			D	N	96										90			I	N
Calcium, Dissolved	normal	33.2346	--	17.4			I	N	13.4			I	N	45.2					10.7					88.2			I	N	17.4			D	N	19.6			D	Y						19.7			I	N
Chemical Oxygen Demand	nonpar	28	--	10	U				10	U				10	U				10	U				10	U		D	N	10	U				10	U									10	U			
Chloride	normal	14.2105	250	10.3			I	N	9.9			I	N	7.0					5.9					9.1			D	N	6.1			D	Y	6.7			D	Y						10.5				
Conductivity (umhos/cm)	normal	434.8776	700	240			I	N	170					530					260					1100					250			D	N	230			D	N						280				
Magnesium, Dissolved	normal	29.5077	--	15.7			I	N	6.86			I	N	34.1					9.23					79.8				Y	16.4			D	N	17.1			D	Y						17.8			I	N
Nitrate Nitrogen (mg-N/L)	lognor	5.046	10	2.6					0.54			D	N	0.01	U				0.01	U				0.01	U				0.5			I	N	0.69			I	N						2.4				
Nitrite Nitrogen (mg-N/L)	nonpar	0.002	1	0.001	U				0.001					0.001	U				0.001	U				0.001					0.003					0.001										0.001	U			
pH (std units)	normal	6.42-8.16	6.5-8.5	6.98			D	N	6.76			D	N	7.29				Y	6.93			D	N	7.19			D	N	7.16			D	N	7.28			D	N						7.03			D	N
Potassium, Dissolved	normal	3.2894	--	2.86			I	N	0.95			I	N	1.80					4.14					4.2			D	N	1.56					1.53										2.92			I	N
Sodium, Dissolved	normal	8.1291	20	1.09				Y	7.74					7.53			D	N	1.18			I	N	24.5			D	N	6.59			D	N	7.17			D	Y						1.17				
Sulfate	lognor	21.3499	250	12.9					7.3					5.9					10.3					0.66			D	Y	9.3					8.7				Y						16.9				
Total Dissolved Solids	nonpar	250	500	150					120					340					140					640					170				Y	150										150				
Total Organic Carbon	nonpar	27	--	0.59					0.62					1.9					4.5					8.3					0.76					7.2										0.5	U			
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																													
Antimony	nonpar	0.01	0.006	0.0002	U				0.0002	U				0.0002	U				0.0002	U				0.0002	U				0.0002	U				0.0002	U				Well not accessible					0.0002	U			
Arsenic	nonpar	0.006	0.00005	0.00199					0.000355					0.0179					0.00551			D	N	0.016					0.00057					0.000475										0.00218				
Barium	nonpar	0.0189	1	0.0107			I	Y	0.0087					0.0164					0.0109					0.0502					0.0111			D	Y	0.0125										0.009				
Beryllium	nonpar	0.0005	0.004	0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U									0.0003	U			
Cadmium	nonpar	0.0001	0.005	0.000025	U				0.000027					0.000025	U				0.000025	U				0.000025	U				0.000025	U				0.000025	U									0.000025	U			
Chromium	normal	0.007	0.05	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Cobalt	nonpar	0.006	--	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Copper	nonpar	0.008	1	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Iron	nonpar	0.043	0.3	0.027					0.007					0.344					0.155					0.332			I	N	0.005	U				0.005	U									0.005	U			
Lead	nonpar	0.004	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Manganese	nonpar	0.0184	0.05	0.0042					0.0552					1.811			D	Y	1.187			I	Y	25.42					0.0084			D	Y	0.007			D	N						0.003				
Nickel	nonpar	0.03	0.1	0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U									0.002	U			
Selenium	nonpar	0.001	0.01	0.00088					0.00025	U				0.0004					0.00025	U				0.00038					0.00036					0.00034										0.00056				
Silver	nonpar	0.0007	0.05	0.00012					0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Thallium	nonpar	0.001	0.002	0.00001	U				0.00001	U				0.00001	U				0.00001	U				0.00001	U				0.00001	U				0.00001	U									0.00001	U			
Vanadium	nonpar	0.015	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Zinc	nonpar	0.015	5	0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U				0.002	U									0.002	U			
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																													
1,1,1-Trichloroethane	NA	NA	200	1	U				1	U				1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethane	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dibromo-3-chloropropane	NA	NA	0.2	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dichloroethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
1,2-Dichloropropane	nonpar	1.0	0.6	0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U									0.6	U			
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acetone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			

Groundwater Analytical Summary - Deep Wells: Third Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																												Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				9/20/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/20/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch	9/19/17	D	V	Tr	Ch		D	V	Tr	Ch	9/20/17	D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																													
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				Well not accessible					0.3	U			
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Chlorobenzene	nonpar	1.0	--	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									**0.2**				
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Chloroform	nonpar	1.0	7	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
cis-1,2-Dichloroethene	NA	NA	--	0.2	U				0.2	U				**1.23**					0.2	U				**0.25**					0.2	U				0.2	U									0.2	U			
cis-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Dibromomethane	NA	NA	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U				2	U				2	U				2	U									2	U			
o-Xylene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U									0.8	U			
Toluene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
trans-1,4-Dichloro-2-butene	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				0.01	U				**0.4**					0.01	U				**4.21**					**0.16**					**0.1**										0.01	U			

D: U = Indicates compound was not detected at the given reporting limit.
V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.
Tr: I=increasing Trend, D=Decreasing Trend;
Ch: Y indicates a change in trend from previous quarter; N means no change in trend.
The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.
* = Non-detect; exceedance due to elevated laboratory reporting limit
NA: Not applicable - too few data points to evaluate statistically

Groundwater Analytical Summary - Shallow Wells: Fourth Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				12/5/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch		D	V	Tr	Ch		D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																			
Alkalinity (as CaCO3)	normal	39.9737	--	82					45					65			I	N	440					62			I	N	Well not accessible					Not sampled - insufficient water				
Ammonia Nitrogen	nonpar	0.12	--	0.005	U				0.363			D	N	0.45					44					0.006													
Bicarbonate	nonpar	92	--	82					45					65			I	N	440					62			I	N									
Calcium, Dissolved	normal	19.9442	--	12.8					16.1					16.8			I	N	64					14.4			I	N									
Chemical Oxygen Demand	nonpar	32	--	10	U				14					22					30					10	U											
Chloride	lognor	53.915	250	7.6					3.5					3.2					30.6					1.2												
Conductivity (umhos/cm)	lognor	487.4501	700	190					150					160					990					200												
Magnesium, Dissolved	normal	7.0321	--	11.9					5.23					7.56			I	N	16.0			D	N	7.33			I	N									
Nitrate Nitrogen (mg-N/L)	lognor	31.8526	10	0.096					0.01	U				0.01	U				0.01	U				0.88												
Nitrite Nitrogen (mg-N/L)	nonpar	0.015	1	0.003					0.002					0.001			D	N	0.002					0.002												
pH (std units)	nonpar	4.90-7.40	6.5-8.5	6.92					6.36			D	N	6.43					6.47					6.20												
Potassium, Dissolved	nonpar	4.94	--	1.06					2.28					4.07					44.0					0.91												
Sodium, Dissolved	normal	53.8755	20	7.55					4.72					4.57					22.8					7.1												
Sulfate	normal	35.9821	250	9.0					11.0					8.3					2.7					11.2												
Total Dissolved Solids	lognor	338.9264	500	140					110					150					410					110												
Total Organic Carbon	nonpar	29	--	0.63					4.9					11					8.8					1.3												
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																			
Antimony	nonpar	0.01	0.006	0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				Well not accessible					Not sampled - insufficient water				
Arsenic	nonpar	0.001	0.00005	0.000536					0.00618					0.002					0.023			I	N	0.000121			D	N									
Barium	nonpar	0.0531	1	0.0067					0.0148					0.0233					0.87			I	N	0.008												
Beryllium	nonpar	0.0041	0.004	0.0005	U				0.0005	U				0.0005	U				0.0005	U				0.0005	U											
Cadmium	nonpar	0.0005	0.005	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U											
Chromium	nonpar	0.0043	0.05	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U											
Cobalt	nonpar	0.006	--	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U											
Copper	nonpar	0.019	1	0.008					0.006					0.01					0.009					0.005	U											
Iron	nonpar	0.284	0.3	0.01	U				4.63			I	N	0.264			I	N	11.5			I	N	0.01												
Lead	nonpar	0.0047	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U											
Manganese	nonpar	0.0364	0.05	0.0767			I	N	0.847					0.4336					4.744			D	N	0.005	U											
Nickel	nonpar	0.011	0.1	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U											
Selenium	nonpar	0.001	0.01	0.0003	U				0.0003	U				0.0003	U				0.00174					0.0003	U											
Silver	nonpar	0.0009	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U											
Thallium	nonpar	0.001	0.002	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U											
Vanadium	nonpar	0.008	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U											
Zinc	nonpar	0.036	5	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U											
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																			
1,1,1-Trichloroethane	NA	NA	200	1	U				1	U				1	U				1	U				1	U				Well not accessible					Not sampled - insufficient water				
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U											
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U											
1,1-Dichloroethane	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U											

Groundwater Analytical Summary - Shallow Wells: Fourth Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				12/5/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch		D	V	Tr	Ch		D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																			
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				Well not accessible					Not sampled - insufficient water				
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U				1	U												
1,2-Dibromo-3-chloropropane	NA	NA	0.2	5	U				5	U				5	U				5	U				5	U												
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U												
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U												
1,2-Dichloroethane	nonpar	1.0	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U												
1,2-Dichloropropane	NA	NA	0.6	0.6	U				0.6	U				0.6	U				0.6	U				0.6	U												
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U				1	U												
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U												
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U												
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U				5	U												
Acetone	NA	NA	--	5	U				5	U				5	U				**6.4**					5	U												
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				0.06					0.38					0.01	U												
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U												
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U												
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U				1	U												
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U												
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U				1	U												
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U												
Chlorobenzene	nonpar	1.0	--	0.2	U				**0.62**					**1.37**					**0.43**			I		0.2	U												
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U												
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U												
Chloroform	nonpar	2.1	7	1	U				1	U				1	U				1	U				1	U												
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U												
cis-1,2-Dichloroethene	nonpar	1.0	--	0.2	U				0.2	U				**0.38**					**0.23**					0.2	U												
cis-1,3-Dichloropropene	nonpar	1.0	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U												
Dibromomethane	NA	NA	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U												
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U												
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U												
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U				1	U												
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U				2	U												
o-Xylene	nonpar	1.2	--	1	U				1	U				1	U				1	U				1	U												
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U												
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U				0.8	U												
Toluene	nonpar	1.4	--	1	U				1	U				1	U				1	U				1	U												
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U				1	U												
trans-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U												
trans-1,4-Dichloro-2-butene	nonpar	5.0	--	5	U				5	U				5	U				5	U				5	U												
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U				1	U												
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U												
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U				5	U												
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				0.01	U				**1.3**					0.01	U				**0.25**													

D: U = Indicates compound was not detected at the given reporting limit.

V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.

Tr: I=increasing Trend, D=Decreasing Trend;

Ch: Y indicates a change in trend from previous quarter; N means no change in trend.

The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.

NA: Not applicable - too few data points to evaluate statistically

Groundwater Analytical Summary - Deep Wells: Fourth Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																																Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				12/6/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch		D	V	Tr	Ch	12/5/17	D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																													
Alkalinity (as CaCO3)	normal	182.2846	--	80			I	N	62			I	N	300					110			I	N	680					110			D	N	110					Well not accessible					110			I	N
Ammonia Nitrogen	nonpar	0.1	--	0.007					0.005	U				0.055					16.3					0.051					0.005					0.005										0.005	U			
Bicarbonate	nonpar	170	--	80			I	N	62			I	N	300					110			I	N	680					110			D	N	110										110			I	N
Calcium, Dissolved	normal	33.2346	--	14.9			I	N	14.9			I	N	56.6					9.89					92.7			I	N	16.4			D	N	17.9			D	N						20.1			I	N
Chemical Oxygen Demand	nonpar	28	--	10	U				10	U				10	U				10	U				16			D	N	10	U				10	U									10	U			
Chloride	normal	14.2105	250	10.3			I	N	10.3			I	N	7.7					7.9					10.3			D	N	6.0			D	N	6.1			D	N						9.8				
Conductivity (umhos/cm)	normal	434.8776	700	240			I	N	180					580					280					1100					260			D	N	260			D	N						280				
Magnesium, Dissolved	normal	29.5077	--	14.2			I	N	7.22			I	N	38.4					7.93					84.8					15.1			D	N	15.5			D	N						18.6			I	N
Nitrate Nitrogen (mg-N/L)	lognor	5.046	10	2.5					0.66			D	N	0.017					0.01	U				0.01	U				0.45			I	N	0.75			I	N						2.2				
Nitrite Nitrogen (mg-N/L)	nonpar	0.002	1	0.001	U				0.001	U				0.001	U				0.001	U				0.003					0.002					0.001	U									0.001	U			
pH (std units)	normal	6.42-8.16	6.5-8.5	7.29			D	N	6.30			D	N	7.06					7.17			D	N	6.93			D	N	7.01			D	N	6.95			D	N						7.17			D	N
Potassium, Dissolved	normal	3.2894	--	2.27			I	N	0.92			I	N	2.22					5.04					4.58			D	N	1.53					1.43										2.92			I	N
Sodium, Dissolved	normal	8.1291	20	5.76					9.28					8.29			D	N	7.17			I	N	25.5			D	N	6.93			D	N	7.36			D	N						7.05				
Sulfate	lognor	21.3499	250	14.1					7.8					6.9					10.3					0.86			D	N	9.5					8.2										13.2				
Total Dissolved Solids	nonpar	250	500	170					120					360					140					700					160					170										180				
Total Organic Carbon	nonpar	27	--	0.5	U				0.66					1.9					3.8					8.6					0.56					0.56										0.5	U			
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																													
Antimony	nonpar	0.01	0.006	0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				Well not accessible					0.0003	U			
Arsenic	nonpar	0.006	0.00005	0.00199					0.000329					0.0229					0.00803			D	N	0.0164					0.00062					0.000531										0.00234				
Barium	nonpar	0.0189	1	0.0079			I	N	0.0101					0.0211					0.0198					0.0541					0.0101			D	N	0.0106										0.008				
Beryllium	nonpar	0.0005	0.004	0.0005	U				0.0005	U				0.0005	U				0.0005	U				0.0005	U				0.0005	U				0.0005	U									0.0005	U			
Cadmium	nonpar	0.0001	0.005	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Chromium	normal	0.007	0.05	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Cobalt	nonpar	0.006	--	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Copper	nonpar	0.008	1	0.005	U				0.005	U				0.011					0.005	U				0.02					0.008					0.005	U									0.01				
Iron	nonpar	0.043	0.3	0.012					0.01	U				0.602					0.146					0.922			I	N	0.031					0.01	U									0.01	U			
Lead	nonpar	0.004	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Manganese	nonpar	0.0184	0.05	0.005	U				0.0635					2.284			D	N	0.5641			I	N	2.504					0.0079			D	N	0.0068			D	N						0.005	U			
Nickel	nonpar	0.03	0.1	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Selenium	nonpar	0.001	0.01	0.00108					0.0003	U				0.00041					0.0003	U				0.0003	U				0.0003	U				0.0003	U									0.00043				
Silver	nonpar	0.0007	0.05	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Thallium	nonpar	0.001	0.002	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Vanadium	nonpar	0.015	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Zinc	nonpar	0.015	5	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																													
1,1,1-Trichloroethane	NA	NA	200	1	U				1	U				1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethane	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dibromo-3-chloropropane	NA	NA	0.2	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dichloroethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
1,2-Dichloropropane	nonpar	1.0	0.6	0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U									0.6	U			
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acetone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			

Groundwater Analytical Summary - Deep Wells: Fourth Quarter 2017
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																												Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				12/6/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/6/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch	12/5/17	D	V	Tr	Ch		D	V	Tr	Ch	12/5/17	D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																													
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				Well not accessible					0.3	U			
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Chlorobenzene	nonpar	1.0	--	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Chloroform	nonpar	1.0	7	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
cis-1,2-Dichloroethene	NA	NA	--	0.2	U				0.2	U				**1.13**					0.2	U				**0.21**					0.2	U				0.2	U									0.2	U			
cis-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Dibromomethane	NA	NA	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U				2	U				2	U				2	U									2	U			
o-Xylene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U									0.8	U			
Toluene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
trans-1,4-Dichloro-2-butene	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				0.01	U				**0.16**					0.01	U				**1.41**					**0.04**					0.01	U									0.01	U			

D: U = Indicates compound was not detected at the given reporting limit.

V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.

Tr: I=increasing Trend, D=Decreasing Trend;

Ch: Y indicates a change in trend from previous quarter; N means no change in trend.

The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.

* = Non-detect; exceedance due to elevated laboratory reporting limit

NA: Not applicable - too few data points to evaluate statistically

Groundwater Analytical Summary - Shallow Wells: First Quarter 2018
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				3/21/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch	3/21/18	D	V	Tr	Ch	3/21/18	D	V	Tr	Ch		D	V	Tr	Ch	3/20/18	D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																			
Alkalinity (as CaCO3)	normal	38.5385	--	76					34					48			I	N	410					46			I	N	Well not accessible					18				
Ammonia Nitrogen	lognor	13.9534	--	0.009					0.254				Y	0.665					82.2					0.005										0.016				
Bicarbonate	normal	38.5929	--	76					34					48			I	N	410					46			I	N						18				
Calcium, Dissolved	normal	20.0639	--	12.3					10.4					11.3			I	N	64.9					12.5				Y						8.34				
Chemical Oxygen Demand	nonpar	26	--	11					10	U				19					24					10	U									10	U			
Chloride	lognor	50.4742	250	7.5					5.5					1.4					22.3					7.8			D	Y						5.3				
Conductivity (umhos/cm)	lognor	461.3324	700	190					110					130					1000					150										130				
Magnesium, Dissolved	normal	6.8778	--	11.2					3.9					5.39			I	N	16.6			D	N	6.28			I	N						4.0			D	Y
Nitrate Nitrogen (mg-N/L)	lognor	28.0325	10	0.052					0.028					0.01	U				0.01	U				0.56										2.1				
Nitrite Nitrogen (mg-N/L)	nonpar	0.015	1	0.001	U				0.001	U				0.002			D	N	0.001	U				0.003										0.002				
pH (std units)	nonpar	4.90-7.40	6.5-8.5	6.88					6.54				Y	6.55					6.47					6.21										4.79	*			
Potassium, Dissolved	lognor	4.8315	--	0.22					1.53					3.15					37.9					0.29										0.97				
Sodium, Dissolved	normal	46.2392	20	7.66					3.79					2.95					21.7					5.87										5.89				
Sulfate	normal	35.5701	250	7.6					5.7					6.0					4.4					8.9										15.9				
Total Dissolved Solids	normal	279.7857	500	120					89					99					390					73										94				
Total Organic Carbon	nonpar	29	--	2.2					7.6					11					10.0					7.1										9.30				
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																			
Antimony	nonpar	0.01	0.006	0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				Well not accessible					0.0003	U			
Arsenic	nonpar	0.001	0.00005	0.00044					0.00398					0.00234					0.012			I	N	0.00005	U		D	N						0.000067			D	Y
Barium	lognor	0.0671	1	0.0067					0.0096					0.0137					0.864			I	N	0.0069										0.0208				
Beryllium	nonpar	0.0005	0.004	0.0005	U				0.0005	U				0.0005	U				0.0005	U				0.0005	U									0.0005	U			
Cadmium	normal	0.0003	0.005	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Chromium	nonpar	0.0043	0.05	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Cobalt	nonpar	0.006	--	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Copper	lognor	8.3519	1	0.005	U				0.009					0.014					0.005	U				0.008										0.015				
Iron	lognor	3.2991	0.3	0.01	U				2.93				Y	0.361			I	N	13.2			I	N	0.012										0.01	U			
Lead	nonpar	0.008	0.05	0.0001	U				0.0001	U				0.0001	U				0.0001	U				0.0001	U									0.0001	U			
Manganese	lognor	0.4339	0.05	0.0695			I	N	0.573					0.6305					4.877				Y	0.005	U									0.0098			D	N
Nickel	nonpar	0.01	0.1	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Selenium	nonpar	0.001	0.01	0.00038					0.0003	U				0.0003	U				0.00239					0.00031										0.00032				
Silver	nonpar	0.0009	0.05	0.0001	U				0.0001	U				0.0001	U				0.0001	U				0.0001	U									0.0001	U			
Thallium	nonpar	0.001	0.002	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Vanadium	nonpar	0.005	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Zinc	lognor	21.258	5	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U		D	Y
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																			
1,1,1-Trichloroethane	NA	NA	200	1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethane	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U									1	U			

Groundwater Analytical Summary - Shallow Wells: First Quarter 2018
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																						Upgradient Wells									
				BH-03A					BH-05					BH-06					BH-07					BH-08					MW-10					MW-11				
				3/21/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch	3/21/18	D	V	Tr	Ch	3/21/18	D	V	Tr	Ch		D	V	Tr	Ch	3/20/18	D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																					
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dibromo-3-chloropropane	NA	NA	0.2	5	U				5	U				5	U				5	U				5	U									5	U			
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dichloroethane	nonpar	1.0	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
1,2-Dichloropropane	NA	NA	0.6	0.6	U				0.6	U				0.6	U				0.6	U				0.6	U									0.6	U			
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U				1	U									1	U			
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
Acetone	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				0.01	U				0.58					0.01	U									0.01	U			
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U									1	U			
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U				1	U									1	U			
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Chlorobenzene	nonpar	1.0	--	0.2	U				**0.39**					**0.22**					**1.81**			I		0.2	U									0.2	U			
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Chloroform	nonpar	2.1	7	1	U				1	U				1	U				1	U				1	U									1	U			
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
cis-1,2-Dichloroethene	nonpar	1.0	--	0.2	U				0.2	U				0.2	U				**0.21**					0.2	U									0.2	U			
cis-1,3-Dichloropropene	nonpar	1.0	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Dibromomethane	NA	NA	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U									1	U			
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U				2	U									2	U			
o-Xylene	nonpar	1.2	--	1	U				1	U				1	U				1	U				1	U									1	U			
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U									1	U			
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U				0.8	U									0.8	U			
Toluene	nonpar	1.4	--	1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
trans-1,4-Dichloro-2-butene	nonpar	5.0	--	5	U				5	U				5	U				5	U				5	U									5	U			
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U				1	U									1	U			
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U									1	U			
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U				5	U									5	U			
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				0.01	U				**1.3**					**0.52**	U				0.01	U									0.01	U			

D: U = Indicates compound was not detected at the given reporting limit.

V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.

Tr: I=increasing Trend, D=Decreasing Trend;

Ch: Y indicates a change in trend from previous quarter; N means no change in trend.

The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.

NA: Not applicable - too few data points to evaluate statistically

* = pH lab result; field pH not taken due to meter malfunction

Groundwater Analytical Summary - Deep Wells: First Quarter 2018
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																																Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				3/20/18	D	V	Tr	Ch	3/21/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch	3/21/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch		D	V	Tr	Ch	3/20/18	D	V	Tr	Ch
CONVENTIONAL CHEMISTRY PARAMETERS (mg/L)																																													
Alkalinity (as CaCO3)	normal	181.0443	--	80			I	N	60				Y	290					110			I	N	610					100			D	N	120					Well not accessible					100			I	N
Ammonia Nitrogen	lognor	0.1	--	0.028					0.009					0.053					15.9					0.054					0.005	U				0.006										0.007				
Bicarbonate	normal	181.3277	--	80			I	N	60				Y	290					110			I	N	610					100			D	N	120										100			I	N
Calcium, Dissolved	normal	33.0897	--	16.9			I	N	13.8			I	N	47.8					11.0					85.5			I	N	16.9			D	N	19.7			D	N						19.2			I	N
Chemical Oxygen Demand	nonpar	28	--	10	U				10	U				10	U				10	U				22			D	N	10	U				10	U									10	U			
Chloride	lognor	14.0529	250	9.44				Y	8.2			I	N	7.5			D	Y	8.6					8.8			D	N	5.6			D	N	6.1			D	N						9.4				
Conductivity (umhos/cm)	lognor	433.0286	700	240			I	N	180					550					290					1100					250			D	N	280			D	N						280				
Magnesium, Dissolved	normal	29.4219	--	15.5			I	N	7.44			I	N	38.4					8.5					80.5					16.0			D	N	17.1			D	N						17.6			I	N
Nitrate Nitrogen (mg-N/L)	lognor	4.5514	10	2.5					0.53			D	N	0.071					0.037					0.098					0.70			I	N	0.72			I	N						2.7				
Nitrite Nitrogen (mg-N/L)	nonpar	0.002	1	0.001	U				0.002					0.001	U				0.001	U				0.002					0.002					0.001	U									0.001	U			
pH (std units)	nonpar	6.38-8.10	6.5-8.5	7.34			D	N	6.52			D	N	7.07					7.06			D	N	6.88			D	N	7.13			D	N	7.05			D	N						6.92	*		D	N
Potassium, Dissolved	lognor	3.25	--	2.58			I	N	0.23				Y	0.99					4.91					3.54			D	N	1.19			D	Y	1.30										2.72			I	N
Sodium, Dissolved	normal	8.186	20	5.92					8.45					7.61			D	N	6.76			I	N	25.3			D	N	6.80			D	N	7.47			D	N						6.53				
Sulfate	normal	21.7033	250	12.9					7.5					6.4					8.0					0.43			D	N	8.6					9.2										12.0				
Total Dissolved Solids	normal	250	500	170					120					350					150					650					160					180										200				
Total Organic Carbon	nonpar	20.1549	--	3.4					4.1					5.1					6.0					9.4			D	Y	8.2					6.9										4.3				
DISSOLVED METALS EPA Methods 200.7/200.8 (mg/L)																																													
Antimony	nonpar	0.01	0.006	0.00031					0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				0.0003	U				Well not accessible					0.0003	U			
Arsenic	nonpar	0.006	0.00005	0.00189					0.00027					0.0213					0.00729				Y	0.0216					0.00005	U				0.000476										0.00216				
Barium	lognor	0.0218	1	0.0099				Y	0.0096					0.0194					0.0214					0.0524					0.0113			D	N	0.0126										0.0078				
Beryllium	nonpar	0.0005	0.004	0.0005	U				0.0005	U				0.0005	U				0.0005	U				0.0005	U				0.0005	U				0.0005	U									0.0005	U			
Cadmium	normal	0.0001	0.005	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Chromium	nonpar	0.0071	0.05	0.0059					0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U		I	Y
Cobalt	nonpar	0.006	--	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Copper	lognor	40.0559	1	0.012					0.005	U				0.005	U				0.009					0.011					0.008					0.01										0.01				
Iron	lognor	0.037	0.3	0.01	U				0.01	U				0.45					0.095			I	Y	1.06			I	N	0.01	U				0.01	U									0.01	U			
Lead	nonpar	0.0157	0.05	0.0001	U				0.0001	U				0.0001	U				0.0001	U				0.0001	U				0.0001	U				0.0001	U									0.0001	U			
Manganese	lognor	0.0184	0.05	0.005	U				0.0529					2.064				Y	1.123					2.39					0.009			D	N	0.0074			D	N						0.005	U			
Nickel	nonpar	0.005	0.1	0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
Selenium	nonpar	0.001	0.01	0.00102					0.00036					0.00073					0.0005					0.0006					0.0003	U				0.00048										0.00066				
Silver	nonpar	3.2501	0.05	0.0001	U				0.0001	U				0.0001	U				0.0001	U				0.0001	U				0.0001	U				0.0001	U									0.0001	U			
Thallium	nonpar	0.001	0.002	0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U				0.00005	U									0.00005	U			
Vanadium	nonpar	0.015	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Zinc	lognor	0.033	5	0.005					0.005	U				0.005	U				0.005	U				0.005	U				0.005	U				0.005	U									0.005	U			
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L)																																													
1,1,1-Trichloroethane	NA	NA	200	1	U				1	U				1	U				1	U				1	U				1	U				1	U				Well not accessible					1	U			
1,1,2,2-Tetrachloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1,2-Trichloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethane	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,1-Dichloroethylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2,3-Trichloropropane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dibromo-3-chloropropane	NA	NA	0.2	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
1,2-Dibromoethane	NA	NA	0.001	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
1,2-Dichlorobenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
1,2-Dichloroethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
1,2-Dichloropropane	nonpar	1.0	0.6	0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U				0.6	U									0.6	U			
1,4-Dichlorobenzene	nonpar	4.0	4	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
2-Butanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
2-Hexanone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
4-Methyl-2-Pentanone (MIBK)	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acetone	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Acrylonitrile	NA	NA	0.07	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Benzene	nonpar	1.0	1	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			

Groundwater Analytical Summary - Deep Wells: First Quarter 2018
McCollum Park, Snohomish County, WA

	Statistical Method	Prediction Limit (a)	GW Stds 173-200	Downgradient Wells																												Upgradient Wells									
				MW-12					MW-14					MW-16					MW-17					MW-18					MW-19					MW-20					MW-13					MW-15				
				3/20/18	D	V	Tr	Ch	3/21/18	D	V	Tr	Ch	3/21/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch	3/21/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch	3/20/18	D	V	Tr	Ch		D	V	Tr	Ch	3/20/18	D	V	Tr	Ch
VOLATILE ORGANIC COMPOUNDS (VOCs) EPA Method 8260 (µg/L) (cont.)																																													
Bromodichloromethane	nonpar	1.0	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				Well not accessible					0.3	U			
Bromoform	NA	NA	5	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Bromomethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Disulfide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Carbon Tetrachloride	NA	NA	0.3	0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U				0.3	U									0.3	U			
Chlorobenzene	nonpar	1.0	--	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Chlorodibromomethane	NA	NA	0.5	0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U				0.5	U									0.5	U			
Chloroethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Chloroform	nonpar	1.0	7	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Chloromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
cis-1,2-Dichloroethene	NA	NA	--	0.2	U				0.2	U				**1.13**					0.2	U				**0.30**					0.2	U				0.2	U									0.2	U			
cis-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
Dibromomethane	NA	NA	--	0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U				0.01	U									0.01	U			
Ethylbenzene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
m,p-Xylene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Methyl Iodide	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Methylene Chloride	nonpar	2.0	5	2	U				2	U				2	U				2	U				2	U				2	U				2	U									2	U			
o-Xylene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Styrene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Tetrachloroethylene	NA	NA	0.8	0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U				0.8	U									0.8	U			
Toluene	nonpar	1.0	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,2-Dichloroethene	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
trans-1,3-Dichloropropene	NA	NA	0.2	0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U				0.2	U									0.2	U			
trans-1,4-Dichloro-2-butene	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Trichlorethene (1,1,2-Trichloroethylene)	nonpar	1.0	3	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Trichlorofluoromethane	NA	NA	--	1	U				1	U				1	U				1	U				1	U				1	U				1	U									1	U			
Vinyl Acetate	NA	NA	--	5	U				5	U				5	U				5	U				5	U				5	U				5	U									5	U			
Vinyl Chloride	nonpar	0.2	0.02	0.01	U				0.01	U				**0.31**					0.01	U				**3.41**					**0.10**					0.01	U									0.01	U			

D: U = Indicates compound was not detected at the given reporting limit.

V: E= Exceedance, waiting verification based on subsequent lab data; V= Exceedance verified based on previous lab data; P=Passed, previous exceedance not verified based on current lab data.

Tr: I=increasing Trend, D=Decreasing Trend;

The groundwater standards listed are based on the Washington Administrative Code (WAC) 173-200 groundwater limits as modified by the TMS 91-11 standards - the most restrictive of the two is used.

NA: Not applicable - too few data points to evaluate statistically