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City of Longview Mint Farm Regional Water Treatment Plant

Preliminary Design Report

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Prepared for

City of Longview
1525 Broadway
Longview, WA 98632

K/J Project No. 0997003.00

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1.1 Background and Introduction

1.1.1 Regional Water Treatment Plant Nearing End of Useful Life

The City of Longview and the Cowlitz County Public Utility District No. 1 (PUD) own the existing Regional Water Treatment Plant (RWTP) on the Cowlitz River which provides potable water to customers in their respective service areas. The City is the majority owner and operates the RWTP. Additionally, the PUD has executed an inter-local agreement with the Beacon Hill Sewer District (BHSD) to operate and likely acquire the PUD potable water distribution system within the next four years. Throughout this Preliminary Design Report, although the City of Longview is managing the project and contracting with consultants, use of the term "City" generally means the combined efforts of the City of Longview, PUD, and BHSD.

The RWTP performance, capacity, and service life was evaluated and documented in the most recent Water System Plan prepared for the City of Longview and the PUD (Kennedy/Jenks Consultants 2005). This study showed that major equipment and facilities at the RWTP have reached the end of their service life, and that the RWTP intake has become increasingly unreliable due to continuing silt and debris accumulation. In addition, the intake does not meet fish screening requirements. As a consequence, the City potable water supply is not consistently reliable and the City intends to construct facilities necessary to re-establish a reliable source of potable water supply to provide a peak production capacity of at least 20 million gallons per day (mgd) to customers in their respective service areas.

1.1.2 Examining Groundwater as a New Source of Water Supply

For almost 30 years, the RWTP has experienced significant impact from sediments in the Cowlitz River due to the 1980 eruption of Mt. St. Helens. Given the increasing and precarious nature of sediment movement and deposition in the Cowlitz River, efforts to reduce or control sediment accumulation at the RWTP intake and upgrade fish screening will require extensive and expensive repairs and replacement of facilities, and may ultimately be unsuccessful. That risk, along with the aged and deteriorated condition of the RWTP, prompted the City to consider alternative sources of water supply.

The option of building a new groundwater facility at the Mint Farm Industrial Park was identified previously as a way to provide the City with a long-term, reliable water supply, less expensively and more quickly than rehabilitating the RWTP and Cowlitz River intake. To begin evaluating the potential of groundwater as a new source of water, the City commissioned a number of studies examining groundwater at the Mint Farm Industrial Park. Studies prepared included the following, along with various peer reviews and a value engineering review conducted by independent engineering firms:

- *Source Analysis, City of Longview, PACE Engineers Inc., 27 October 2006* – A source of supply and feasibility study for a Mint Farm groundwater supply.

- *Proposed Mint Farm Wellfield Area Environmental Review, GSI Water Solutions, Inc., 5 May 2008* – An assessment of potential contaminant sites in and around the Mint Farm.
- *Pilot Study for Potential Microfiltration Plant on Groundwater, PACE Engineers Inc., 11 July 2006* – A brief pilot study of deep aquifer groundwater treatability.

The studies concluded the groundwater in the deep aquifer at the Mint Farm would be a good source for the City's municipal water supply.

1.1.3 Preparing This Preliminary Design Report on Mint Farm Groundwater Option

In March 2009, the City retained Kennedy/Jenks Consultants to perform more extensive studies of the Mint Farm groundwater option. The initial objective of Kennedy/Jenks' efforts was to assess the assumptions and conclusions developed in previous work through a comprehensive site investigation and prepare a Preliminary Design Report (PDR) detailing the findings of the investigation. The PDR work included investigating the environmental condition of the Mint Farm site, conducting a rigorous and thorough water quality investigation upon which a Human Health Risk Assessment of the Mint Farm aquifer could be based, conducting field investigation and documentation of the deep groundwater aquifer hydrogeologic characteristics, and preparing an initial Wellhead Protection Plan incorporating the water quality and hydrogeologic findings. The work of the draft comprehensive PDR was accomplished between March and mid-December 2009.

The PDR is divided into three parts:

- Part 1, Basis of the Design - Addresses the fundamental treatability of the Mint Farm deep aquifer, presents treatability pilot study results, provides an engineering and cost analysis to select the best treatment alternative, and provides preliminary design information.
- Part 2, Hydrogeology and Water Quality Considerations - Presents results from the broad hydrogeologic investigation and health risk and water quality assessment. Begins outlining the required management tools to protect the new groundwater supply.
- Part 3, Environmental Permitting and Archaeological Investigations - Presents the environmental permitting process and archeological assessments necessary to gain state and federal approval for the project.

Findings to date are summarized in the following sections of this Executive Summary.

1.2 PDR Part 1 – Basis of Design Report

In Part 1, fundamental water treatment engineering criteria were used to examine previously proposed treatment alternatives, develop and investigate new treatment alternatives, and provide preliminary design and cost information.

The work of Part 1 included reviewing and validating previous project reports; field-piloting proposed alternatives where there was inadequate field treatment data; developing an alternatives evaluation procedure and ranking the proposed treatment processes; and preparing a planning-level cost estimate for the recommended treatment process as part of a preliminary design package.

Part 1 also included examining alternative pipeline routes by which the new treatment plant would be connected to the existing distribution system.

1.2.1 Water Treatment Conclusions

- ***Iron and manganese found to be the only elements that require treatment.*** Sampling and analysis of groundwater in the deep aquifer below the Mint Farm indicated that the only constituents requiring treatment are iron and manganese. Iron and manganese are not a human health concern, but they may cause unpleasant taste or odors and may result in staining of clothes and fixtures if left untreated.

- ***Arsenic present but below safe drinking-water limits.*** Arsenic detected at the final selected Mint Farm wellfield site is below state and federal drinking-water limits. Although treatment is not required, arsenic levels in the groundwater will be reduced during the process to reduce iron levels in the groundwater.

- ***Filtration including oxidation is recommended*** to remove iron and manganese.

- ***Greensand granular media is preferred groundwater treatment method.*** A pilot study tested the performance of several different forms of granular media for treating groundwater at the Mint Farm. The pilot study showed that greensand granular media met the treated water goals for iron and manganese removal and is the preferred treatment for this groundwater. Arsenic, though present at the site below safe drinking-water levels, was also found to be readily and effectively removed by the greensand filtration process. Other treatment process findings include:
  - A filter flow rate of about 4 gallons per minute per square foot (gpm/ft^2) was established as an appropriate rate of treatment, well in line with industry standards for this process.
  - Facilities design should allow for a filter-to-waste period following a filter backwash to mitigate iron and manganese concentration in the filter effluent. Additionally, the facilities design should include backwash water settling and recovery to increase the efficiency of use of the groundwater supply.
  - At start-up of a new regional water treatment plant, water characteristics and changing flow directions in the distribution system may cause transitional issues during the shift from the City's surface-water source to the groundwater source. The City should perform a flushing program to mitigate sloughing within the distribution system pipes, and should prepare a public outreach program to explain possible complaints about the greater hardness of the groundwater.

- ***Cost analysis comparing greensand filtration of Mint Farm groundwater with rehabilitation of existing plant identified the Mint Farm option as the most cost-effective method.*** After Part 1 work concluded that greensand filtration would provide excellent water quality, and Part 2 work concluded the Mint Farm aquifer would provide a near-endless supply of high quality water, cost analyses determined the Mint Farm option has lower initial capital cost and lower long-term operational costs compared to the option of rehabilitating the existing RWTP.

1.2.2 Evaluation of Treatment Alternatives

Once pilot testing demonstrated that filtration including oxidation should be used to treat the deep aquifer groundwater, the City needed to further analyze feasible filtration technologies – including those considered previously – and confirm the best one to use.

- ***Five phases of evaluation.*** Filtration alternatives were evaluated in five phases: identification and briefing of project stakeholders; discussion and selection of filtration alternatives; discussion and selection of evaluation criteria; preliminary work for stakeholder preparation to evaluate; and final workshop evaluation and selection.

- ***Two filtration alternatives targeted.*** Because of the previous project work and the body of knowledge on water filtration treatment, two feasible filtration technologies were selected for evaluation: granular media filtration and membrane filtration. The pilot test described above indicated that the granular filtration technology to be evaluated should be greensand granular media filtration.

- ***Evaluation criteria encompassed stakeholders' primary concerns.*** The criteria for evaluation were established and weighted on the basis of stakeholder concerns. They were capital cost, net present value, operability, performance, flexibility, complexity, capacity, and regulatory acceptance. The alternatives were compared using these criteria and evaluation matrices.

- ***Greensand filtration scored highest of filtration methods.*** The alternatives evaluation established that greensand filtration is the preferred process for treating Mint Farm groundwater. Membrane filtration was found to be less efficient and more costly, and it scored lower.

- ***Cost analysis comparing filtration alternatives with existing plant rehabilitation also identified greensand filtration as most cost-effective method.*** Because cost is significant to the City in all decisions made about this project, the costs of the two targeted filtration methods and the cost of rehabilitating the existing treatment plant were compared. (This comparison provided cost perspective even though existing plant rehabilitation is not considered a viable alternative because of the continued vulnerability of this source water to silt-laden flow that plugs the intake system, consequent higher maintenance costs, limitations on capacity, risk of flood-induced water quality degradation, and risk of contamination with contaminants of emerging concern.) The results showed that using a groundwater supply at the Mint Farm along with greensand filtration was significantly lower in capital and net present value cost than either rehabilitation of the existing treatment plant or membrane filtration of Mint Farm groundwater.

1.2.3 Summary of Proposed Features for Mint Farm Regional Water Treatment Plant (MFRWTP)

Site Located on 10 acres of the Mint Farm Industrial Park. The proposed MFRWTP site will be situated on an approximately 10-acre site in the south-central portion of the Mint Farm Industrial Park in Longview, Washington. A vicinity map of the site is shown on Figure ES, and a preliminary layout of the facilities is shown on Figure ES-1. The proposed site will be developed in accordance with the Mint Farm covenants and other applicable regulations. Among other things, these regulations stipulate several features of the proposed work – building setbacks from property lines, building facades and exterior features, landscaping, requirements for site access and roads, and provisions for a stormwater storage and treatment bioswale.

Greater than sufficient quantity, plus good quality. Test wells in the area indicate not only that groundwater quality can easily be treated to potable standards, as discussed above, but also that the volume of water available from the aquifer is more than sufficient to meet maximum day water demands within the MFRWTP service areas through 2059.

The new MFRWTP may ultimately have as many as six groundwater production wells, although the currently planned construction effort includes installation of only three well casings and four well pumps (one well casing was installed during the Part 2 testing program). Construction activity within the wellhead sanitary protection zone (100 foot radius around each groundwater well) should be minimized.

Treatment process information. The preliminary treatment process design includes nine greensand filters and various chemical systems (hypochlorite, sodium hydroxide, fluorosilicic acid) with metering pumps and storage tanks. Ancillary processes include a blowoff/plant drain pump station, two air scour blowers, two backwash storage tanks, two backwash return pumps, two backwash waste pumps, three Geotubes™, a bladder surge tank, a standby generator, a new transformer, and all other mechanical, electrical, and instrumentation required to make a complete and operable facility.

Structures to be located onsite. Several new structures will be located on the proposed site, including four well houses for the groundwater pumps, a filter gallery building that contains the air scour blowers and face piping of the greensand filters, two backwash storage tanks for backwash water recovery, an office/treatment building for operations activities and chemical storage, and sludge drying beds for the Geotubes™. For some of the larger structures, pre-loading of the site will be required to consolidate soils underneath the buildings.

New transmission main. A new transmission main is proposed to connect the MFRWTP to the existing distribution system and reservoirs. Approximately 6,000 feet of 30-inch ductile iron pipe is proposed for the transmission main. The 30-inch force main alignment generally heads east from the RWTP, to a Weyerhaeuser Railroad Right of Way (ROW), then north along a set of railroad tracks to a connection with an existing 20-inch diameter main near Ocean Beach Highway. Additionally, a 12-inch spur from the 30-inch water main will connect with a 12-inch water main in the vicinity of Hemlock Street near the railroad tracks, and a connection will be made to the 12-inch water main in Weber Avenue. The transmission main traverses mostly undeveloped areas, and there are few utility crossings and interferences anticipated for the project. When following the railroad tracks the force main will be installed just outside of the toe of the railroad tracks, within the Weyerhaeuser ROW, between a gas main and a protected wetland. Utility crossings are anticipated at Weber Avenue.

1.2.4 Planning-Level Estimate of Probable Construction Cost

A planning-level estimate of probable construction cost for the proposed MFRWTP is given below. The accuracy of the estimate should be considered to be within -15 percent to +30 percent of the total cost shown, consistent with a preliminary estimate (Estimate Class 4) as defined by the Association for the Advancement of Cost Engineering (AACE).

Table ES-1: Estimate of Probable Cost

Cost Breakdown	Estimate of Probable Cost
Incidentals (Mobilization, Bonds, Insurance, etc)	$1,500,000
General Site Work and Yard Piping	$1,786,900
Groundwater Wells and Well Buildings	$1,902,000
Pressure Filters and Filter Gallery Building	$5,565,329
Backwash Storage Tanks	$2,295,760
Office/Treatment Building	$1,101,228
Solids Dewatering and Drying System	$85,966
Transmission Main	$1,272,218
Electrical, Instrumentation, and Controls	$1,308,763
Subtotal	$16,818,965
Contractor Overhead and Profit at 15%	$2,522,845
Subtotal	$19,341,809
Taxes at 7.9% (Materials and Labor)	$1,528,003
Subtotal	$20,869,812
Engineering Allowance (on all except major equipment) at 30%	$4,419,877
Engineering Allowance (on major equipment) at 10%	$613,689
Subtotal	$25,903,378
Escalation to Midpoint of Construction (Jan. 2012) at 4.0%	$1,036,135
Estimate of Probable Construction Cost	**$26,940,000**

1.3 PDR Part 2 – Hydrogeology and Water Quality Considerations

Concurrent with the water treatment investigation and piloting, a major effort of the PDR was to document the characteristics and suitability of the Mint Farm deep aquifer to serve as a raw drinking water source in perpetuity for the City to replace the existing Cowlitz River raw water source. PDR Part 2 evaluated water quality of the shallow and deep groundwater at the Mint Farm, and evaluated the relative water quality of the Mint Farm groundwater compared to surface water from the Cowlitz River and the Columbia River.

The hydrogeological characterization and water quality assessment of the Mint Farm deep aquifer were based on a field program that consisted of the installation of a network of 17 paired shallow and deep sentinel wells in the Mint Farm area, the installation of a test production well (PW-1), and collection of potential raw source water samples. Groundwater and soil samples and field measurements were collected, and more than 14,500 tests were performed to facilitate hydrogeologic characterization and water quality assessment of the Mint Farm aquifer.

1.3.1 Conclusions on Aquifer Characteristics

- ***Shallow and deep aquifers.*** Groundwater in the Longview-Kelso Basin consists of shallow and deep aquifer systems. The deep aquifer system is further subdivided into a gravel aquifer and a sand aquifer. The sand aquifer underlies the majority of the eastern and northern Longview-Kelso Basin. The gravel aquifer is limited to the southwestern portion of the basin, and this aquifer is the target aquifer for the Mint Farm water supply.

    - The shallow aquifer system is primarily recharged from precipitation and secondarily from the Cowlitz River. Discharge from the shallow aquifer system is to the Consolidated Diking Improvement District (CDID) drainage ditches.

    - The deep gravel aquifer is primarily recharged from the Columbia River, whereas the deep sand aquifer is primarily recharged from the Cowlitz River and secondarily from precipitation. Groundwater in the deep aquifer system ultimately discharges through the sand aquifer and lower permeability materials to the CDID drainage ditches.

- ***A barrier exists between shallow and deep aquifers.*** A confining layer consisting of silt and clay layers overlies the eastern two-thirds of the Longview-Kelso Basin. The confining layer serves as a barrier that restricts the movement of groundwater between the shallow and deep aquifer systems.

- ***Groundwater modeling showed minimal drawdown.*** Groundwater modeling conducted to evaluate the sustainability of long-term pumping from the deep gravel aquifer for the Mint Farm Wellfield calculated approximately 6 feet of drawdown to meet the City's 50-year maximum day demand. That drawdown is a very small amount compared to the volume of water being withdrawn, and is limited to a close proximity to each well. Test pumping of a production well shown no drawdown impact 60-feet or more away from the well. The source of water to the Mint Farm Wellfield was found to be the Columbia River, transmitted through the gravel aquifer. Source water enters the aquifer at locations where the Columbia River has cut through the clay and silt layers and the channel intersects the gravel unit west of the Mint Farm site.

- ***Planned pumping rates are sustainable.*** The Mint Farm Wellfield is capable of sustaining the planned pumping rates. Figure ES-2 provides a conceptual 3D drawing of groundwater flow through the gravel pumping during operation of the Mint Farm Wellfield.

- ***Modeled travel times from source.*** Groundwater modeling indicates that travel times for water from the Columbia River source areas to reach the Mint Farm Wellfield range from approximately 2 years to over 10 years (Figure ES-3).

- ***Analyses showed surface contaminants would not reach production wells.*** Wellfield recharge pathway analyses were conducted for three different water demand scenarios to evaluate the potential for contaminants released at the surface to reach the Mint Farm production wells. The results indicate that no contamination reached the Mint Farm production wells within 30-year time frame modeled.

1.3.2 Conclusions of Water Quality and Environmental Risk Assessment

- ***No constituents of concern detected above screening levels in deep groundwater.*** Samples of shallow Mint Farm soil, the Columbia and Cowlitz Rivers, shallow and deep groundwater monitoring wells, and a test production well, were analyzed for over 300 constituents identified as constituents of concern based on drinking water regulations, historical activities in the area, and unregulated contaminants of emerging concern. No analytes were detected in any deep groundwater samples at concentrations above their respective screening levels.

- ***Deep aquifer and river sources would meet all drinking water quality regulations.*** The Environmental Risk Assessment results indicate that with appropriate treatment, the deep aquifer and the Columbia and Cowlitz Rivers would meet all state and federal water quality regulations as safe sources of drinking water supply.

- ***Naturally occurring iron and manganese need treatment.*** At their levels detected in the deep aquifer, removal of iron and manganese (naturally occurring groundwater constituents) is required to prevent objectionable aesthetic concerns.

- ***Arsenic detected below health-based screening level.*** In the deep groundwater, arsenic was detected below the health-based screening level, but above the level at which the state requires reporting in the annual Consumer Confidence Report. The proposed treatment process for iron and manganese removal will also remove arsenic to a level below that requiring identification in the Consumer Confidence Report.

1.3.3 Preliminary Conclusions on Wellhead Protection Plan

- ***Deep aquifer would not be impacted by surface contaminants.*** Spills, leaks or discharges of potential contaminants on or near the surface at the Mint Farm Industrial Park or the industrial areas for Weyerhaeuser and Chinook Ventures will not directly impact the deep aquifer due primarily to the presence of the silt/clay confining layer.

- ***Minimal potential threat of river entrance for contaminants.*** Potential sources of contamination may enter the deep aquifer through the Columbia River. However, the tremendous flow of the Columbia River, as well as the fact that the recharge area is at the bottom of the river, will dilute and flush away most any contaminant and minimize the potential threat to the Mint Farm deep aquifer.

1.3.4 Physical Setting

Longview is situated along the north bank of the Columbia River in southwest Washington and is bounded on the east by the Cowlitz River. The proposed groundwater wellfield is located in the western part of the city in an area known as the Mint Farm Industrial Park as shown on Figure ES. The site had been used for agricultural operations, including mint and grass farming, until about 1975. The wellfield is located near industrial and commercial businesses, managed wetlands, and undeveloped property.

The Longview-Kelso Basin covers approximately 17 square miles in the vicinity of Longview, Washington, near the confluence of the Cowlitz and Columbia Rivers. General subsurface conditions in the Longview-Kelso Basin consist of a valley eroded into the underlying bedrock. Near the surface over a large portion of the Basin is a clayey silt deposit that typically thickens to the south toward the Columbia River. This deposit tends to be present in the eastern portion of the basin but varies from thin to absent in areas of the western portion of the basin. This clayey silt deposit forms an effective confining layer in the areas where it is present.

1.3.5 Field Investigations

The conclusions discussed above are drawn partly based on various field investigations performed for the project. From February to July 2009, eight shallow and nine deep sentinel (monitoring) wells were installed to facilitate aquifer characterization of the Mint Farm area (Figure ES). The total depths of the deep sentinel wells range from 240 to 370 feet below ground surface (ft bgs). Most of the deep borings were drilled to the bottom of the coarse/gravel alluvial deposit/top of bedrock contact. The shallow sentinel wells were completed in a thick sequence of generally silty sediments at depths ranging from 30 to 50 ft bgs.

Based on the information gathered from installation of the monitoring wells, a test 18-inch-diameter production well (PW-1) was constructed into the deep aquifer. After completion, this well was pumped continuously for 36 days and water quality samples were tested before, during, and after this long-duration pump test.

The field program consisted of the installation, field measurements, and water quality testing of the monitoring and test wells, including the following:

- Geochemical sampling of groundwater and soil from the sentinel wells to support aquifer characterization and water quality evaluation for the Environmental Risk Assessment.

- Transducers were installed in all sentinel wells to record fluctuations in groundwater elevation for aquifer characterization. In addition, transducers were installed in production well PW-1 and two private domestic water wells at residences on Mt. Solo.

- The sentinel wells and nearby private wells were sampled to characterize groundwater quality in the Mint Farm area. Surface water samples were collected from the Columbia and Cowlitz Rivers.

- A long-term aquifer test was conducted at test production well PW-1 to evaluate aquifer conditions. PW-1 was pumped at 3,900 gallons per minute (gpm) for 36 days.

The hydrogeological characterization was based on the data collected during the field program. A summary of the aquifer evaluation is provided below.

1.3.6 Groundwater Aquifer

Two distinct ground groundwater systems are present at the wellfield site, a shallow system and a deep aquifer system. Three general geologic units underlie the Mint Farm area: (1) a low-permeability zone consisting of silt, silty sand, clay with interbedded fine-grained sand, (2) a fine- to medium-grained sand unit, and (3) an unconsolidated coarse-grained deposit of gravel and cobbles with minor occurrences of sand.

1.3.6.1 Shallow Groundwater System

The shallow groundwater system consists primarily of fine-grained silt and clays with silty sand interbeds. This unit that overlies much of the basin area is a thick silt/clay unit that, where present, acts as a confining layer to the underlying sand and gravel aquifers. Where it is absent, the sand and gravel aquifers are considered to behave as unconfined systems.

The upper fine-grained materials consist of silt with varying percentages of clay and fine sand. The upper silt/clay sequence is thickest in the southern part of the Mint Farm area, nearer to the Columbia River, where it ranges from 100 to 200 feet thick; this layer thins appreciably to the north and east. At both the SW-4/DW-4 and SW-3/DW-3 sentinel well locations, the surficial silt deposits are only about 15 feet thick and are underlain by the fine- to medium-grained sand of the sand unit discussed below.

1.3.6.2 Deep Groundwater System

The deep groundwater system forms the primary water-bearing zones and can be further subdivided into a sand aquifer and a gravel aquifer that have distinct hydrogeologic characteristics.

The sand aquifer consists of fine- to medium-grained sand with minor amounts of very fine sand and silt, and is prevalent across the northern portion of the Mint Farm area. The sand aquifer ranges in thickness from approximately 30 feet in sentinel wells located to the south along Industrial Way to approximately 250 feet in sentinel wells DW-3 and DW-4 located to the north and east. The sand aquifer is found primarily in the areas where the gravel is absent; however, a thin extension of the sand does overlie the gravel layer in several areas

The gravel aquifer is present in the southwestern part of the Longview-Kelso Basin. In deep sentinel wells installed just south of the Mint Farm area along Industrial Way, the gravel unit ranges from about 100 to 150 feet in thickness. In the area of sentinel well DW-4 at the northern edge of the Site, a 1- to 2-foot thickness of gravel is encountered just above bedrock. At the DW-3 sentinel well location east of the site, the gravel unit is approximately 50 feet thick.

1.3.7 Hydrogeological Conceptual Model

The hydrogeological conceptual model summarizes the key hydrogeological data from the Longview-Kelso Basin and is an interpretation of how groundwater flows through the Basin. This narrative discussion is based upon the hydrogeologic data collected and compiled for this project, and from previous investigations.

The primary groundwater recharge sources for the Basin are precipitation and infiltration from rivers. The primary groundwater outflows from the Basin are discharges to the CDID drainage network. Much of the Basin is only slightly higher than the elevations of the Columbia and

Cowlitz Rivers. The CDID maintains 35 miles of stormwater collection ditches that have been constructed across the Basin for flood protection. The system consists of six primary pumping stations with a total capacity of 628,000 gpm that discharge to the Columbia and Cowlitz Rivers. Active pumping of these ditches has resulted in lowering of the shallow groundwater levels. Water levels in the drainage ditches are maintained at levels several feet below the typical stage of the Columbia River with the lowest water levels maintained in the western portions of the Basin.

The interactions of the aquifer heterogeneity and the groundwater-surface water interactions with the rivers and drains cause a complex groundwater flow pattern in the Basin.

The shallow groundwater flow is dominated by the CDID drainage ditches. Geochemical data indicate that the source of groundwater recharge in the shallow deposits is primarily from local precipitation. Groundwater flow is localized with flow through the shallow deposits and discharge to the nearest CDID drainage ditches.

Groundwater flow in the deep sand aquifer is primarily from southeast to northwest across the Basin. Geochemical data indicate that the primary source of groundwater recharge in the sand aquifer is from precipitation and infiltration from the Cowlitz River. Discharge from the sand aquifer is predominantly to the CDID drainage ditches in the western portion of the Basin where the confining layer is thin to absent.

Groundwater flow in the gravel aquifer is from west to east. Geochemical data indicate that the primary source of groundwater recharge for the gravel aquifer is the Columbia River. Geologic data indicate that the confining layer varies from thin to absent in the western portion of the Basin. A portion of the gravel aquifer underneath the Columbia River is not overlain by the confining layer, thus allowing direct contact between the gravel aquifer and the Columbia River. Groundwater from the river is interpreted to flow into and through the gravel aquifer and discharge to the sand aquifer along the areas where the sand and gravel aquifers are in direct contact. Flow from the sand aquifer then discharges to the CDID ditches, where it is pumped back into the river.

1.3.8 Water Quality

An Environmental Risk Assessment was performed to characterize the water quality of the Mint Farm deep aquifer and to evaluate the potential health risks associated with use of the groundwater aquifer as a drinking water source. Water quality was analyzed for more than 300 chemicals identified as constituents of concern based on drinking water regulations, historical activities in the area, unregulated contaminants of emerging concern, or that would help indicate the source or character of the groundwater in the Mint Farm area. Samples were collected and analyzed from the shallow soil, shallow groundwater wells, deep groundwater wells, potential surface water sources, and production wells.

Potential health risks were evaluated for exposures associated with se of the Mint Farm deep aquifer as a drinking water source. A screening level risk evaluation was conducted for the deep aquifer, as well as the other potential raw water sources sampled (the Columbia and Cowlitz Rivers). In the screening level evaluation, detected concentrations were compared directly against health-based screening levels for drinking water. For chemicals not regulated in drinking water, appropriate screening levels were determined from technical information about the specific chemical. The presence of a chemical at concentrations below its screening level can generally be assumed not to pose a significant, long-term (chronic) or short-term or sudden (acute) threat to human health.

No analytes were detected in any deep groundwater samples at concentrations above their respective screening levels. Arsenic concentrations in the deep groundwater aquifer were below the screening level 10 (µg/l), but some concentrations were above the level that requiring reporting in the City's annual Consumer Confidence Report on drinking water quality (5 µg/l). Additionally, iron and manganese were found at concentrations that are not a human health concern, but treatment would be required to prevent objectionable aesthetic issues. The proposed treatment process to remove iron and manganese will also remove arsenic such that the treated water would have an arsenic concentration less than that requiring reporting in the Consumer Confidence Report.

The Environmental Risk Assessment results indicate that with appropriate treatment, the deep aquifer would meet all State and federal water quality regulations as a safe source of drinking water supply. However, the removal of iron and manganese (naturally occurring groundwater constituents) is required to prevent aesthetic issues and meet State regulations. Based on the results of the groundwater modeling, the water quality of the deep groundwater is not anticipated to change significantly in the future from that evaluated in the Environmental Risk Assessment.

1.3.9 Wellfield Impact Analysis

A three-dimensional numerical groundwater model was developed and calibrated using the United States Geological Survey code MODFLOW 2000 (Harbaugh et al. 2000). The purpose of the numerical model was to test the hydrogeological conceptual model that was developed for this study and to evaluate the impacts of long-term groundwater production at the proposed Mint Farm Wellfield. Data in the model included geologic factors that control groundwater flow, key physical features of the study area, surface water-groundwater interactions (e.g., the Columbia River), hydrologic water balance components (e.g., precipitation and flow to drainage canals), and the distribution of aquifer properties (e.g., aquifer thickness and hydraulic conductivity).

Model calibration is the process of comparing model results to measured data to test the model's ability to simulate observed conditions. During model calibration, aquifer properties and boundary conditions are varied within an acceptable range until the closest fit is achieved between the simulated and measured data. The amount and type of data that are available in large part dictate the model calibration steps. The model was calibrated against two independent data sets:

- The base-case MODFLOW model was calibrated using river stages, river gradients, and sentinel well groundwater elevations for the period 12 September 2009 through 24 September 2009. The base-case model was found to be in good agreement with the observed data.

- A pumping-case model was also calibrated against data from the PW-1 long-term aquifer pumping test. The MODFLOW Model was found to reasonably match the aquifer response observed during the pumping test.

- In the conceptual model, groundwater flow in the Longview-Kelso Basin is dominated by the Columbia River and the CDID drainage ditches. This conceptual model was tested by the MODFLOW Model. Using an acceptable range of aquifer parameters and boundary conditions, the conceptual model was found to be a valid representation of groundwater flow in the Longview-Kelso Basin.

Once calibrated, the MODFLOW model was used to evaluate the sustainability of long-term pumping from the deep gravel aquifer for the Mint Farm Wellfield at full build-out. The total simulated production was 12 million gallons per day (mgd), divided equally among six production wells spaced 200 feet apart. This pumping rate represents the average day demand at full buildout; maximum day demand was not used because it is a scenario that occurs with limited frequency during the year and is a short duration event lasting only several days in length. Also included was an additional 4.1 mgd of pumping at the neighboring properties of Puget Sound Energy and Chinook Ventures. Drawdown at the wellfield was calculated to be approximately 6 feet at full build-out. That drawdown is a very small amount compared to the volume of water being withdrawn, and is limited to a close proximity to each well.

The groundwater modeling indicates that the Mint Farm Wellfield is capable of sustaining the planned pumping rates, and that water from the Columbia River recharges the deep gravel aquifer.

1.3.9.1 Delineation of Source Areas

The model was also used to delineate the aquifer source areas for use in developing the Wellhead Protection Plan (WHPP) and evaluating potential impacts to groundwater quality. The particle-tracking program MODPATH (Pollock 1994) was used to delineate the Mint Farm wellfield source areas. MODPATH calculates groundwater flow paths based on the hydraulic gradient calculated by the MODFLOW simulation.

The MODFLOW model estimated that over 99 percent of the water pumped at the Mint Farm wellfield was ultimately derived from the Columbia River. Source water enters the aquifer at locations where the Columbia River channel intersects the gravel unit west of the Mint Farm site (Figure ES-3). The MODPATH analysis indicates that travel times for water from the Columbia River source areas to reach the Mint Farm Wellfield ranges from approximately 2 years to over 10 years (Figure ES-3). This travel time through the gravel aquifer provides the natural filtration that maintains the high quality of water in the aquifer.

1.3.9.2 Pathway Analysis for Potential Future Contamination

A screening-level environmental analysis was conducted to evaluate the potential for contaminants released at the surface to reach the Mint Farm Wellfield, based on the groundwater model. Changes to shallow groundwater flow patterns and potential threats to groundwater quality caused by 12 mgd average annual pumping at the Mint Farm Wellfield were evaluated with three model scenarios.

In the first scenario, forward particle tracking from identified potentially contaminating activities (PCAs) indicated that groundwater flow paths from these PCAs do not extend beyond the surficial soil or the silt/clay confining layer during the 30-year time frame modeled. The model simulation indicated that pumping at the Mint Farm Wellfield does not noticeably alter the shallow groundwater flow patterns. Groundwater flow in the shallow aquifer during full build-out pumping at the Mint Farm Wellfield is still primarily directed towards the CDID drainage ditches.

Two hypothetical worst-case contamination simulations were modeled to evaluate the potential for contaminants to reach the aquifer. For these simulations, a constant concentration source was applied over a large area set at a hypothetical value of 100 percent in the shallow aquifer. One area was the Mint Farm Industrial Park and the other was the Weyerhaeuser and Chinook Ventures area. This defines a hypothetical worst-case scenario of widespread contamination. By using a value of 100 percent, the pathway analysis can evaluate the percentage of the shallow aquifer water that reaches the Mint Farm Wellfield.

For both the Mint Farm and Weyerhaeuser/Chinook scenarios, the maximum percentage of the surface contamination found in any Mint Farm production well after 30 years was 0.000001 percent or eight orders of magnitude smaller than the concentration at the surface. This value is essentially a mathematical artifact of the use of numerical methods. For all practical purposes, these results indicate that contaminants at the surface would not reach the Mint Farm Wellfield. Therefore, the modeling does not identify any complete pathways between potentially contaminating activities in the Mint Farm area and the deep groundwater aquifer.

The shallow and unconfined areas above the deep aquifer and between the river and the Mint Farm wells do not contribute to the target gravel unit and it is unlikely that a surface contaminant would penetrate into the deep aquifer. Additionally, higher pressure in the deeper aquifer would prevent a contaminant from traveling from the shallow aquifer down into the deep aquifer.

1.3.10 Preliminary Wellhead Protection Plan (WHPP)

1.3.10.1 Survey Form and Source Area Delineation

The Washington State Department of Health (DOH) requires completion of a Susceptibility Assessment Survey Form for each new and existing well used as a source of drinking water. The form was developed to assist the water utility and the state in evaluating the hydrologic setting of the water source and assessing the source's overall susceptibility to contamination from surface activities.

The WHPP also requires delineation of the source areas. Figure ES-3 provides an illustration of the source area delineation determined by the groundwater model for the Mint Farm wells. Water from the Columbia River percolates into the deep water-bearing gravel and travels thousands of feet to the Mint Farm Wellfield. Therefore, the City’s wellhead protection plan should be focused as follows:

- In all likelihood, a spill of light non-aqueous phase liquid would float on the river surface and would not impact the deep aquifer. However, major spills consisting of dense non-aqueous phase liquid could sink to the river bottom and present some concern. In both cases however, the compound would be flushed downstream rapidly. Although impact to the deep aquifer is unlikely, a method to quickly report nearby spills in the river to the City should be developed as part of this program.

- Protective measures within the wellhead protection zone should focus on preventing construction or drilling methods that could penetrate to the deeper aquifer, such as pilings, piers, or other penetrations for new buildings and structures.

- The prevention of spills or surface contamination of any kind within the wellhead protection zone is essential, even if the likelihood of penetration to the deep aquifer is remote. This is typically already addressed by building, fire, and hazardous material codes, but the WHPP should ensure an adequate level of protection is provided.

1.3.10.2 Potential Contamination Sources of Concern

An inventory of potential sources of groundwater contamination in the delineated time-of-travel zones is an essential element of wellhead protection. Phase I and II Environmental Site Assessments were completed in 2009 to assess site conditions for the Mint Farm Wellfield. Although numerous sites that may pose environmental risks were listed on various State and federal records, no sites thoroughly penetrated the confining layers above the deep aquifer. Analytical soil and groundwater data results of the Phase II investigation indicated that organic and inorganic constituents are present in the soils and shallow groundwater in the area; with only a few exceptions, these concentrations are either below their respective comparison levels or are background concentrations.

Because of the thickness of the confining layer above the deep aquifer in the 6-month and 1-year travel zones shown on Figure ES-3, the primary sources of potential contamination are facilities that extend through the confining layer such as wells, borings, or pilings, and the lower water of the Columbia River itself. The hydraulic gradient of the deep aquifer (the pressure in the water-bearing zone) also serves to protect the aquifer from a spill and or the effects of drilling or pile driving. If the deep aquifer were penetrated, the aquifer pressure would prevent all but the heaviest contaminants from reaching the flowing portion of the aquifer.

Spills, leaks or discharges of potential contaminants on or near the surface will not directly impact the deeper aquifer. However, these sources of contamination may enter the Columbia River through either the shallow aquifer or the drainage ditches. If surface contamination does reach the Columbia River, the tremendous flow of the river, as well as the fact that the recharge area is at the bottom of the river, minimizes the potential threat.

1.4 PDR Part 3 – Environmental Permitting and Archaeological Investigations

As part of this report, and as required by the WSDOH and the National Environmental Protection Act (NEPA), a permitting process for environmental and archeological concerns was initiated. There are two basic processes required for the permitting of a facility such as a water supply and treatment plant at the Mint Farm. The State Environmental Protection Act (SEPA) provisions are normally required for State-funded projects constructed within Washington State, and the NEPA, a federal permitting process, is required for projects obtaining federal funding. The Mint Farm water supply project falls under both NEPA and SEPA requirements; however, the local agency can adopt the NEPA findings to support the SEPA determination.

Archaeological site assessment is a relatively new requirement for all projects in Washington. A licensed or a state-certified archaeologist must investigate project sites such as the Mint Farm to establish the absence of any historic or prehistoric activities on the site. More commonly these would be tribal activities.

Environmental permitting and archaeological investigation efforts are ongoing. General findings to date are:

- The Mint Farm project site is a previously disturbed site with mitigated wetlands. Except for the presence of existing man-made wetlands, there are no other regulated wetlands in the construction area.

- There appear to be no major constraints from a permitting perspective for the construction of a new Mint Farm RWTP or an associated pipeline due to environmental conditions; the alternative to build new will have less impact to the environment than doing in-water work in the Cowlitz River necessary to keep the existing RWTP in use.

No historic or prehistoric remnants were found as a result of the archaeological work conducted for this project. Landau Associates archaeological probes were conducted every 30 meters in and around the proposed treatment plant site, as well as along the proposed alignment of the pipeline connecting the treatment plant to the existing distribution system. This alignment is intended to follow next to an existing railroad and gas pipeline right-of-way (ROW), but preliminary design and negotiations with the owner are still pending.

Figure ES: Vicinity Map

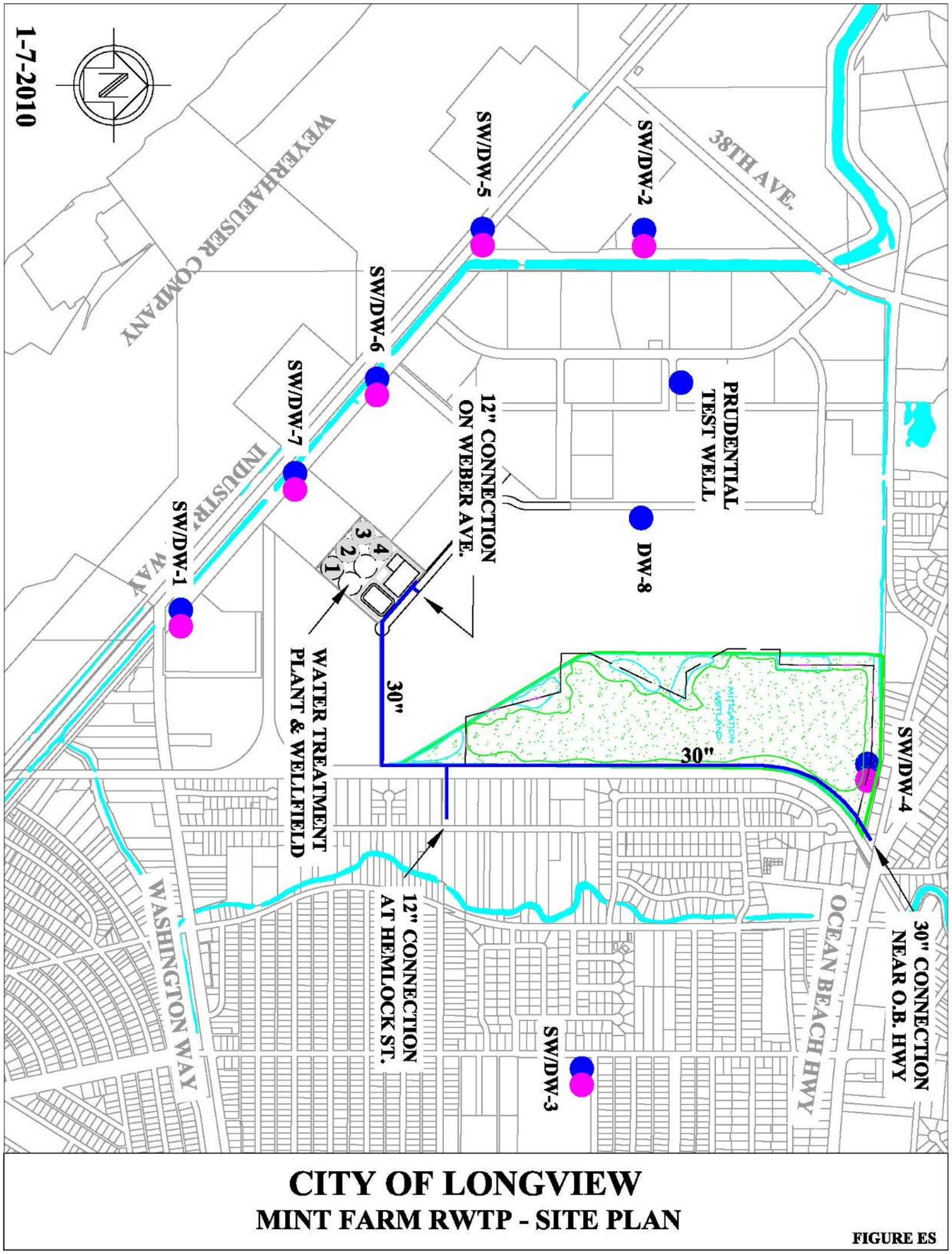

Figure ES-1: Site Plan

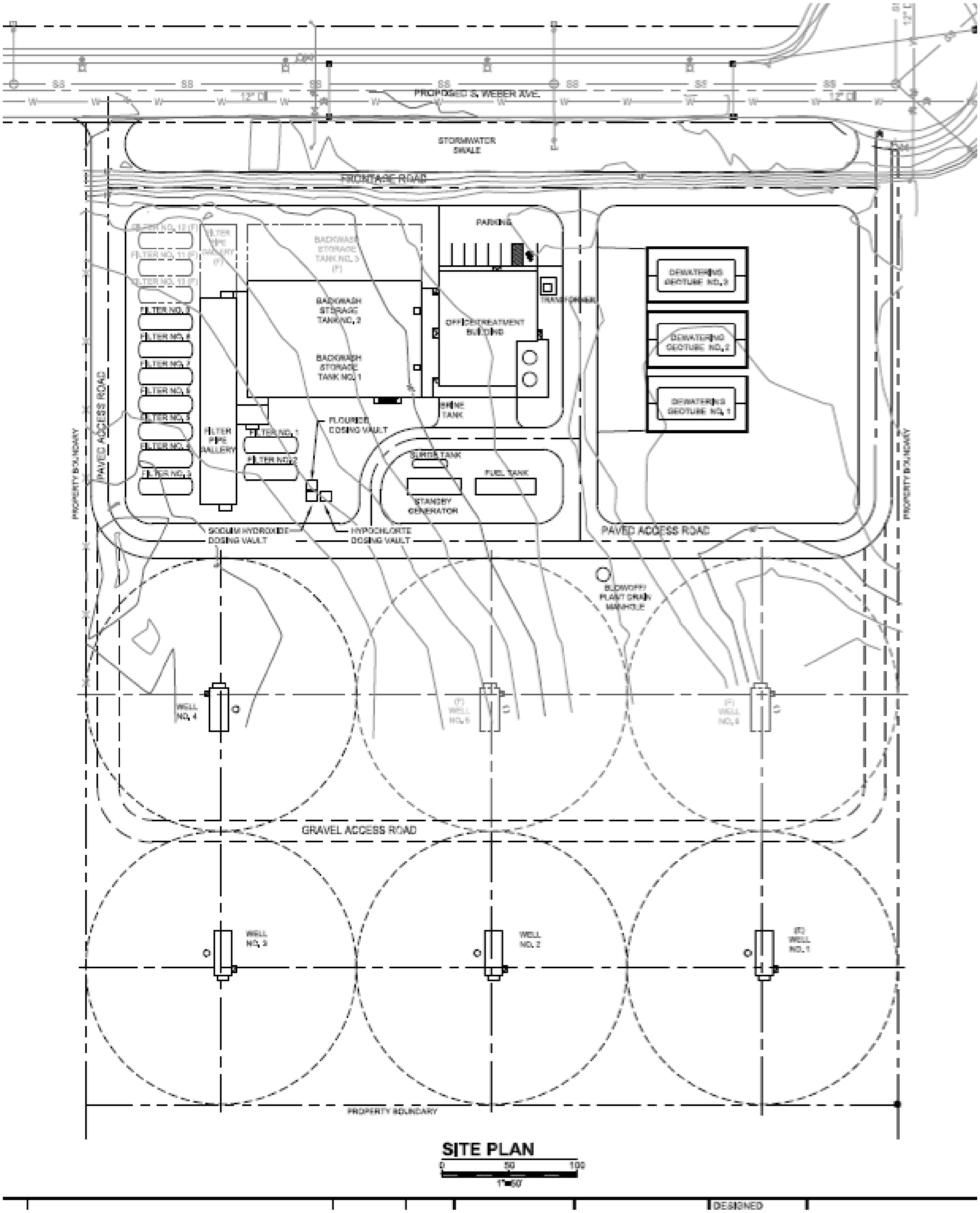

Figure ES-2: Recharge Paths

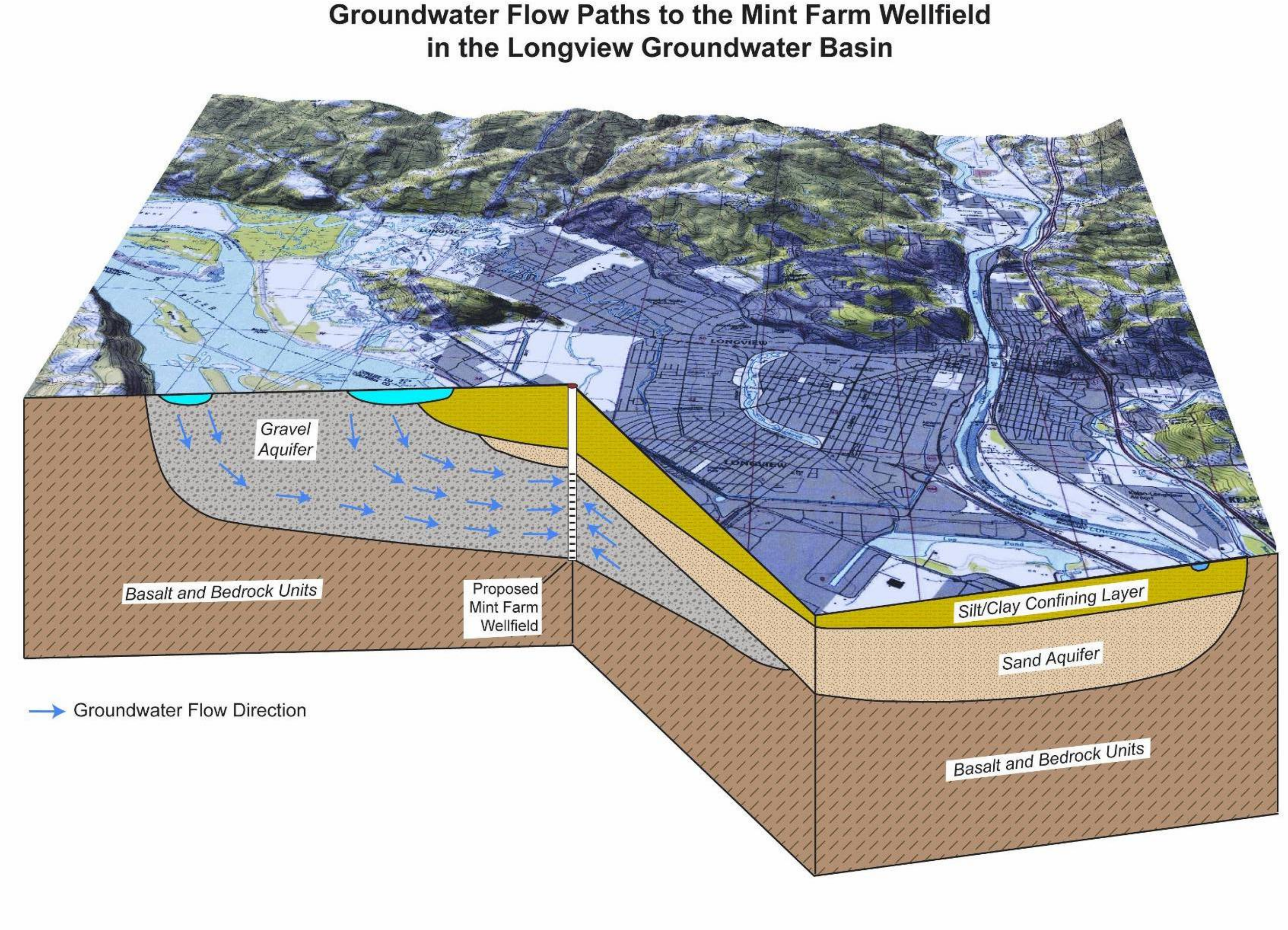

Figure ES-3: Source Areas and Time of Travel

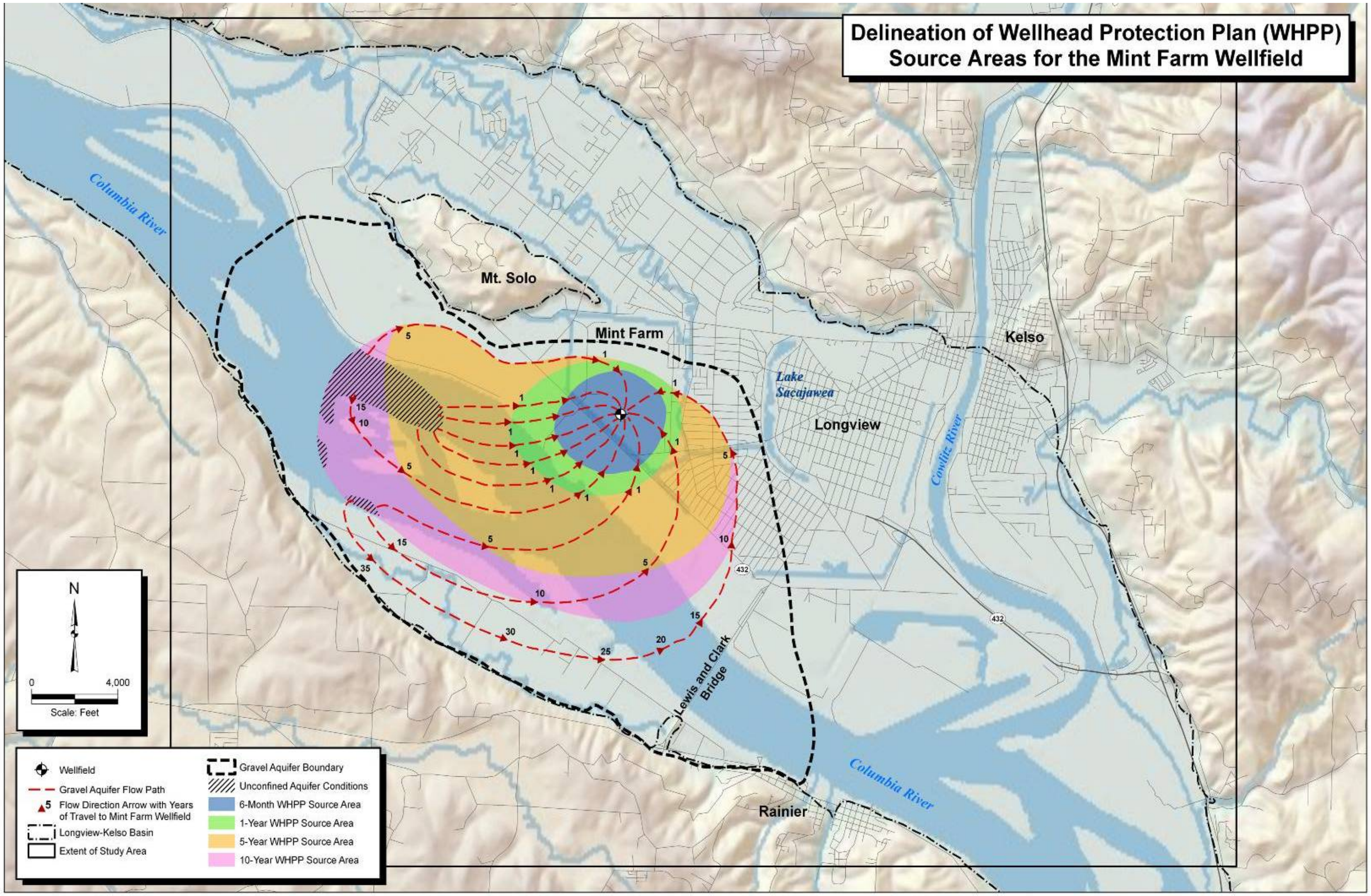

Figure ES-4: Soil Cross-Section

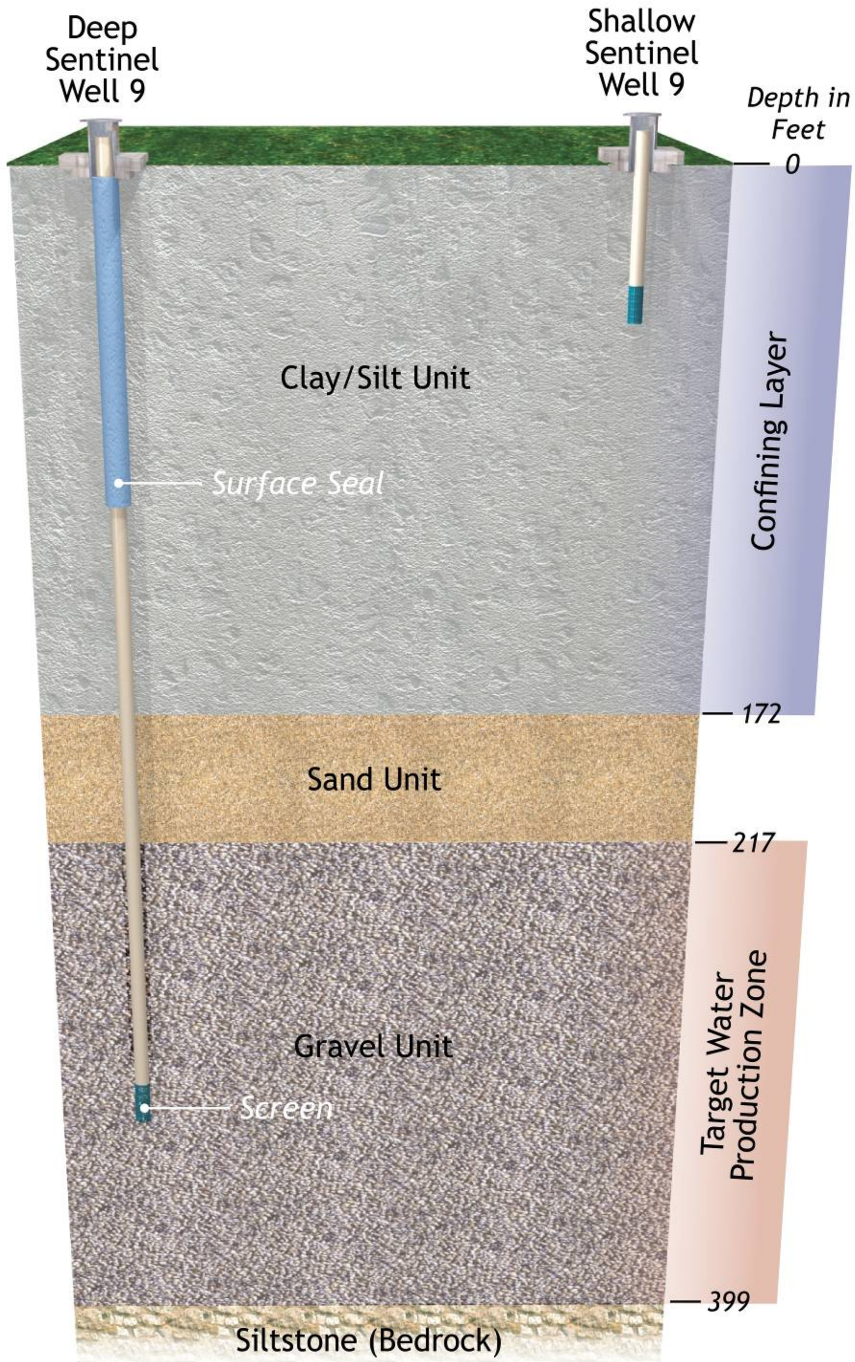

Table A: Summary of Water Quality for Human Health Risk Assessment, Mint Farm Industrial Park Area - City of Longview, WA

					Screening Level		Surface Water		Deep Groundwater Aquifer																
				Location			RSW-1 (Columbia River)	RSW-3 (Cowlitz River)	RSW-2 (Puget Sound Energy)	Chinook Ventures	PW-1	PW-1	PW-1	DW-9	DW-9	DW-8	DW-7	DW-7	DW-6	DW-5	DW-4	DW-3	DW-2	DW-1	DW-1
				Date			06/08/2009	06/08/2009	06/08/2009	07/14/2009	10/05/2009	11/04/2009	11/11/2009	08/13/2009	11/12/2009	06/09/2009	06/10/2009	11/12/2009	06/10/2009	06/11/2009	06/11/2009	06/12/2009	06/12/2009	06/09/2009	11/11/2009
Method	Tier	Analyte	Cas #	Units	Value	Source	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result	Result
General Parameters																									
A2120B	2a	Color, Apparent	COLOR	color unit	--	--	10	10	5	5	25	20	15	10	20	5	ND	25	ND	10	10	10	5	10	15
A2320B	2a	Alkalinity, Total (As CaCO3)	ALK	mg/l	--	--	43	27	104	164	105	102	104	112	89	112	86	87	112	112	170	163	133	85	85
A2340B	2a	Hardness As CaCO3	HARDNESS	mg/l	--	--	43.2	24	87.8	140	99	87	88	92.9	70	87.9	72.5	74	85.9	99.2	134	151	103	69.8	74
A2510B	2a	Conductivity	COND	umhos/cm	--	--	128	83	247	376	240	232	228	435	194	239	197	191	239	273	377	407	293	194	189
A2540C	2a	Total Dissolved Solids (Residue, Filterable)	TDS	mg/l	--	--	62	55	164	235	187	166	175	161	145	160	150	147	161	165	233	247	182	160	144
A4500SIO2C	2a	Silica	7631-86-9	mg/l	--	--	10.7	23.9	58.8	43.1	51	59	59	59.7	55	76.9	70.3	55	64.2	67	54.3	72.5	52.6	74.7	55
A5310C	2a	Total Organic Carbon	TOC	mg/l	--	--	2.2	1.3	0.8	1.9	1.62	1.45	1.29	1.9	1.2	1.5	1.4	1.17	2.5	2.3	4.3	1.8	2.1	1.3	1.28
A5910B	2a	UV254	CASID10075	cm -1	--	--	33.4	40.9	29	0.048	0.039	0.04	0.05	0.037	0.055	0.04	0.04	0.054	0.03	0.03	0.05	0.04	0.04	0.06	0.053
E150.1	2a	pH	pH	pH units	--	--	7.55	7.54	7.56	7.73	7.34	7.91	7.37	7.78	7.38	7.61	7.53	7.22	7.83	8.04	7.55	7.83	8.05	7.46	7.26
E180.1	2a	Turbidity	TURBIDITY	ntu	--	--	6	8	3.6	3.9	2.97	2.01	1.28	3.3	0.99	6.7	3.3	2.58	1.3	0.5	33.7	4.2	11.5	8.8	12
Microbial Parameters																									
A9221E	2a	Fecal Coliform	FECCOLI	mpn/100ml	--	--	ND	11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
A9223B	2a	Coliform	COLIF	mpn/100ml	--	--	205	210	ND	ND	7.4	1.0	ND	2	ND	7	12	ND	1	22	248	ND	7	ND	ND
Contaminants To Be Removed Using Treatment																									
E200.8	2a	Arsenic	7440-38-2	µg/l	10	MCL	0.85	ND	7.24	7.6	6.1	5.7	5.85	3.46	4.14	9.17	2.95	4.3	2.29	3.75	6.32	5.82	4.88	2.44	3.77
E200.7	2a	Iron	7439-89-6	µg/l	26,000	EPA RSL[2]	358	492	1,110	808	1,050	867	901	1,060	637	1,840	1,220	1,220	450	308	5,030	966	895	2,250	2,370
E200.7	2a	Manganese	7439-96-5	µg/l	2,200	MTCA Method B[2]	17.2	17	498	415	681	554	574	587	513	593	671	662	371	233	804	377	216	605	548
Naturally Occuring Minerals and Salts																									
E200.7	2a	Calcium	7440-70-2	µg/l	--	--	11,300	7,100	24,400	36,900	28,200	23,900	25,500	26,500	22,600	24,800	20,800	21,600	24,100	26,400	41,900	44,600	27,000	20,200	21,500
E200.7	2a	Magnesium	7439-95-4	µg/l	--	--	3,630	1,530	6,530	11,500	7,020	6,670	5,790	6,500	5,010	6,280	4,950	4,950	6,270	8,070	7,030	9,730	8,660	4,740	4,810
E200.7	2a	Potassium	7440-09-7	µg/l	--	--	1,170	584	4,040	5,040	3,570	3,620	3,250	3,620	3,200	4,140	3,010	2,950	3,670	4,050	3,740	3,960	5,610	2,730	2,650
E200.7	2a	Silicon	SI	µg/l	--	--	5,630	7,550	24,100	21,500	26,400	27,200	24,700	24,600	25,300	22,600	23,200	24,200	21,100	20,400	24,000	21,500	17,900	23,400	24,500
E200.7	2a	Sodium	7440-23-5	µg/l	--	--	9,470	5,030	9,580	16,400	11,000	10,100	9,280	10,300	8,890	11,500	8,990	8,620	10,800	12,000	23,700	18,800	14,000	8,650	8,850
E300	2a	Bromide	BROMIDE	mg/l	--	--	ND	ND	0.2	ND	NA	NA	NA	ND	ND	NA	NA	ND	NA	NA	0.2	0.2	NA	0.2	ND
E300	2a	Chloride	CHLORIDE	mg/l	--	--	5.4	3.3	12.1	19.2	8.36	7.48	7.56	6.5	5.28	7.9	5.7	6.3	12.3	16.4	18.7	32.4	12.1	5.4	5.17
E300	2a	Fluoride	FL_T	mg/l	4	MCL	ND	ND	0.2	0.3	ND	0.21	0.24	ND	0.27	ND	0.3	0.28	0.2	ND	ND	ND	0.3	0.2	0.31
E300	2a	Nitrogen, Nitrate (As N)	N_NO3	mg/l	10	MCL	0.4	0.3	ND	ND	ND	ND	ND	ND	ND	0.3	0.3	ND	0.3	0.3	0.3	0.3	ND	0.3	ND
E300	2a	Nitrogen, Nitrite	NO2N	mg/l	1	MCL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.1	ND	ND	ND	ND	ND	ND	ND	ND
E350.1	2a	Nitrogen, Ammonia (As N)	N_NH3	mg/l	--	--	ND	ND	0.28	0.26	0.194	0.197	0.213	0.13	ND	0.34	0.25	0.232	0.1	ND	0.51	0.16	ND	0.32	0.345
E365.3	2a	Phosphate, Ortho-	14265-44-2	mg/l	--	--	0.03	0.03	0.58	0.35	NA	NA	NA	0.41	NA	0.25	0.35	NA	0.45	0.53	0.09	0.21	0.34	0.17	NA
E365.3	2a	Phosphorus, Total (As P)		mg/l		--	NA	NA	NA	NA	NA	NA	0.585	NA	0.566	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E365.3	2a	Phosphorus, Total Orthophosphate (As P)		mg/l		--	NA	NA	NA	NA	0.329	0.346	0.575	NA	0.386	NA	NA	0.247	NA	NA	NA	NA	NA	NA	0.102
E300	2a	Sulfate	SULFATE	mg/l	--	--	6.9	5.8	0.3	0.2	0.45	0.57	0.6	0.4	1.42	0.3	2.4	1.61	1.7	0.7	1	0.5	3.4	1.6	1.26
Metals																									
E200.7	2a	Aluminum	7429-90-5	µg/l	37,000	EPA RSL	392	704	54	ND	ND	ND	2.3	23.2	2.5	4.3	4.7	ND	47.6	23.2	1,460	37.9	435	4.3	ND
E200.7	2a	Zinc	7440-66-6	µg/l	4,800	MTCA Method B	22.3	ND	ND	ND	ND	ND	ND	3.6	ND	2.3	ND	ND	ND	ND	8.5	ND	ND	ND	ND
E200.8	2a	Antimony	7440-36-0	µg/l	6	MCL	0.12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.07	ND	ND
E200.8	2a	Barium	7440-39-3	µg/l	2,000	MCL	18.1	4.01	20.4	25.7	14	12	13	13.8	10	25.1	12.9	11	12.5	13.2	24.8	30.9	27.7	12	11
E200.8	2a	Beryllium	7440-41-7	µg/l	4	MCL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.043	ND	0.021	ND	ND
E200.8	2a	Cadmium	7440-43-9	µg/l	5	MCL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.029	ND	0.039	ND	ND
E200.8	2a	Chromium, Total	7440-47-3	µg/l	100	MCL	0.34	0.26	ND	ND	ND	0.2	ND	0.73	ND	ND	ND	ND	ND	ND	2.59	ND	0.63	ND	0.27
E200.8	2a	Copper	7440-50-8	µg/l	1,300	MCL	1.48	2.08	0.33	0.15	0.2	ND	ND	0.3	ND	ND	ND	ND	ND	ND	2.27	0.17	0.8	ND	ND
E200.8	2a	Lead	7439-92-1	µg/l	15	MCL	0.267	0.105	0.061	ND	ND	ND	ND	0.05	ND	ND	ND	ND	0.033	ND	0.355	0.022	0.177	ND	ND
E200.8	2a	Nickel	7440-02-0	µg/l	100	MCL	0.45	0.34	0.26	0.48	0.6	0.7	0.67	1.68	0.63	0.86	0.77	0.61	0.91	0.96	2.59	1.51	1.26	0.74	0.57
E200.8	2a	Silver	7440-22-4	µg/l	50	WA GQC	ND	ND	ND	ND	0.07	0.08	0.033	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
E200.8	2a	Uranium	U	µg/l	30	MCL	0.375	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.025	ND	0.052	ND	ND	ND	ND
Volatile and Synthetic Organics																									
E524.2	2a	Chloroform	00067-66-3	µg/l	80	MCL (total trihalomethanes)	ND	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	0.86	ND	ND	ND	2.4	ND	ND
E525.2	2a	Bis(2-Ethylhexyl) Phthalate	00117-81-7	µg/l	6	MCL	ND	ND	ND	ND	ND	ND	ND	0.68	ND	ND	ND	ND	ND	ND	1	ND	ND	ND	ND
E525.2	2b	Dioctyl Adipate	103-23-1	µg/l	56	EPA RSL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
E525.2	2b	Fluoranthene	00206-44-0	µg/l	640	MTCA Method B	ND	ND	ND	ND	NA	NA	NA	ND	ND	ND	ND	ND	ND	ND	1.8	ND	ND	ND	ND
E525.2	2b	Isophorone	00078-59-1	µg/l	46	MTCA Method B	ND	ND	ND	ND	NA	NA	NA	ND	ND	ND	0.1	ND	ND	ND	ND	ND	ND	ND	ND
Radiation																									
E900	2a	Alpha, Gross	ALPHA	pci/l	15	MCL	1.5	1.5	0.79		-0.56	-3.1	0.21			0.28	3.8		0.34	-0.26	0.57	0.47	-0.5	0.37	
E900	2a	Beta, Gross	BETA	pci/l	50	WA GQC (MCL is 4 millirems/year)	3.8	0.85	6.4	4	2.9	1.2	5.0	3.7	1.2	3.6	3.3	2.0	3.9	2.9	4.2	1.6	6.6	2.4	0.7
E903.1	2a	Radium 226	13982-63-3	pci/l	5	MCL (226, 228 combined)	0.13	-0.01	0.04	0.04	0.05	0.15	-0.05	0.27	0.04	-0.04	-0.01	0.01	-0.05	0.04	0.04	0.07	0.01	0.02	0.03
E904.0	2a	Radium 228	15262-20-1	pci/l	5	MCL (226, 228 combined)	0.99	1.5	0.6	-0.18	1.8	2.9	0.9	0.99	1.0	1.1	0.58	1.3	0.22	0.21	1.2	0.63	0.32	0.41	1.1
Contaminants of Emerging Concern[1]																									
E1694M	3	2-Hydroxy-4-Methoxybenzophenone	131-57-7	ng/l	4,655,000	See HHRA TM	ND	ND	ND	ND	NA	NA	NA	8.9	ND	NA	NA	ND	NA	NA	NA	NA	NA	NA	ND
E1694M	3	Bisphenol A	BPHENOLA	ng/l	800,000	MTCA Method B	ND	ND	ND	ND	NA	NA	NA	76	ND	NA	NA	ND	NA	NA	NA	NA	NA	NA	ND
E1694M	3	Caffeine	CAFFEINE	ng/l	87,500,000	See HHRA TM	ND	ND	ND	ND	NA	NA	NA	5.3	ND	NA	NA	ND	NA	NA	NA	NA	NA	NA	ND
E1694M	3	Fluoxetine	54910-89-3	ng/l	3,400	See HHRA TM	4.2	ND	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	NA	NA	NA	NA	NA	NA	ND
E1694M	3	N,N-Diethyl-3-Methyl Benzamide	134-62-3	ng/l	81,000	See HHRA TM	ND	ND	ND	ND	NA	NA	NA	23	ND	NA	NA	ND	NA	NA	NA	NA	NA	NA	ND
E1694M	3	Sulfamethoxazole	723-46-6	ng/l	151,000	See HHRA TM	2.3	ND	ND	ND	NA	NA	NA	ND	ND	NA	NA	ND	NA	NA	NA	NA	NA	NA	ND

Footnotes:

[1] With the exception of Bisphenol A, these unregulated compounds have been approved for human use as pharmaceuticals or as personal care products. Where detected. these unregulated chemicals were at concentrations of parts per trillion (ppt). Water quality constituents are generally regulated at concentrations of several orders of magnitude greater such as µg/l (parts per billion) and milligrams per liter (mg/l, parts per million). While none of the detected concentrations exceeded available health-based screening levels, the presence of these compounds, especially in groundwater samples, may be attributable to sampling or laboratory contamination.

[2] Washington Dept. of Health regulates iron and manganese due to objectionable aesthetic concerns. The DOH secondary maximum contaminant levels for these metals are:
Iron MCL = 300 ug/l
Manganese MCL = 50 ug/l

General Notes:

Only analytes detected at concentrations greater than or equal to the method reporting limit (MRL) are listed.
Concentrations exceeding respective screening levels are shown in **bold** and shaded**.**

Abbreviations:

NA = not analyzed
ND = not detected at concentrations greater than or equal to MRL
CAS = Chemical Abstract Service
mg/l = milligrams per liter (parts per miilion)
µg/l = micrograms per liter (parts per billion)
ng/l = nanograms per liter (parts per trillion)
pci/l = picocuries per liter
mpn/100 ml = most probable number (MPN) of bacteria per 100 milliliters (ml) in water
umhos = micromhos

Screening Level Sources:

MCL = State or Federal enforceable maximum contaminant level for drinking water.
WA WQC = Washington Administrative Code (WAC) 173-200-040 Table 1 Groundwater Quality Criteria.
MTCA Method B = Washington Department of Ecology (Ecology) Model Toxics Control Act (MTCA) Method B cleanup levels for groundwater.
EPA RSL = United States Environmental Protection Agency (USEPA) Regional Screening Levels for tapwater (April 2009).