Chapter 3

Design of the Brightwater Treatment Plant

DRAFT SUPPLEMENTAL ENVIRONMENTAL IMPACT STATEMENT

Brightwater Regional Wastewater Treatment System

Chapter 3
Design of the Brightwater Treatment Plant

King County is implementing design methods to limit damage to facilities and reduce impacts that could result from damaged facilities if an earthquake on the Southern Whidbey Island Fault (SWIF) were to cause very strong ground shaking and/or surface rupture on the Route 9 treatment plant site. An important element in the design is to build Brightwater so that it functions as part of the larger King County wastewater treatment system in the unlikely event that earthquake damage results in plant shutdown.

This chapter describes the integration of Brightwater into the regional wastewater system and the design of Brightwater facilities to meet or exceed existing seismic codes and guidelines. It also discusses whether regulations are in place for siting wastewater facilities near active faults and describes proposed Brightwater facilities and their locations.

3.1 How Would Brightwater Fit Into the Regional Wastewater System?

The Brightwater Regional Wastewater System will be part of the larger system that provides wastewater treatment to King County and portions of southern Snohomish County and northern Pierce County. It is part of the Regional Wastewater Services Plan (RWSP) (King County, 1998) adopted by the King County Council in 1999. The RWSP is the policy basis for a $2.6 billion (in 2003 dollars) capital improvement program that will provide wastewater services to the Greater Seattle area for the next 30 years. The King County Wastewater Treatment Division (formerly Metro) has been providing wastewater services to this area since the mid-1960s. Wastewater generated by homes and businesses in the Lake Washington drainage basin flows into relatively small diameter pipelines owned and maintained by local agencies, and, from there, into larger King County trunk lines and interceptors that convey the wastewater to regional plants for treatment.

The existing regional system includes two large secondary wastewater treatment plants—the West Point Treatment Plant in Seattle and the South Treatment Plant in Renton—and a smaller secondary treatment plant, the Vashon Treatment Plant on Vashon Island. In addition, King County operates two combined sewer overflow treatment plants, 42 pump stations, 19 regulator stations, 330 miles of conveyance pipelines, and marine outfalls for each of the treatment plants.

The area served by the regional wastewater system includes portions of King, Snohomish, and Pierce Counties (see Figure 3-1). The current service area is divided into west and east sections, depending on which treatment plant treats the wastewater. In general, the West Point Treatment Plant receives wastewater from the West Service Area, and the South Treatment Plant receives wastewater from the East Service Area.

Occasionally, flows are redirected from one plant to another based on flow volumes, plant and conveyance capacity, and costs to convey and treat the wastewater. When Brightwater is operational in 2010, it will be fully integrated into King County's overall regional wastewater treatment system, allowing Brightwater flows to be redirected to either the West Point Treatment Plant or the South Treatment Plant, as needed, to meet operational, maintenance, or emergency needs.

3.2 How Is the Brightwater Treatment Plant Being Designed to Lessen Impacts of an Earthquake?

The structural design of the Brightwater Treatment Plant, including aboveground buildings, liquid-holding tanks, and nonstructural elements such as mechanical and electrical systems, will conform with the recommendations of the 2003 International Building Code ("IBC 2003"), with Washington State amendments, or more stringent structural design standards depending on the type of structure. Both structural and nonstructural components of the facilities will be designed to resist the forces associated with predicted levels of ground shaking in accordance with accepted seismic design standards. These levels of ground shaking could result from a large magnitude earthquake occurring on strands of the Southern Whidbey Island Fault that may exist close to the Route 9 treatment plant site (see Chapter 2).

IBC 2003 (International Code Council, 2003a), with Washington State amendments, is the governing code for design of all structures. It has been adopted by the State of Washington and Snohomish County. While IBC 2003 forms the basis of design for Brightwater facilities, wastewater treatment plants include other structures that are not specifically addressed by the IBC. To design these structures, engineers use other codes and references that supplement the IBC. For example, the American Concrete Institute (ACI) standards (ACI, 2001) and documents published by the American Water Works Association (AWWA, 1996 and 2005) are used to design concrete liquid-holding tanks (also called basins). The design of liquid-holding tanks is typically governed by crack-control requirements. Sufficient reinforcing steel is required in the walls to limit crack width such that the structure is considered "water tight." Meeting engineering code-prescribed crack-control requirements under normal loading typically provides strength greater than that explicitly required to resist earthquake forces.

The following sections describe how Brightwater design is incorporating these seismic codes and standards.

3.2.1 International Building Code 2003

Seismic Provisions of IBC 2003

The seismic provisions in IBC 2003 are based on the 2000 edition of *NEHRP* (National Earthquake Hazards Reduction Program) *Recommended Provisions for Seismic*

Regulations for New Buildings and Other Structures (FEMA, 2001). NEHRP provides up-to-date criteria for design and construction of buildings that may be subject to earthquake ground motions. These criteria are applicable anywhere in the United States.

The purpose of the seismic provisions in IBC 2003 is to provide minimum building design standards for structures in order to maintain public safety of building occupants during a very strong earthquake. Structures designed in conformance with the IBC 2003 will, in general, be able to resist the following:

- Minor level of earthquake ground motion (shaking) without damage
- Moderate level of earthquake ground motion without structural damage, but possibly experience some nonstructural damage
- Major level of earthquake ground motion of intensity equal to the strongest earthquake, either experienced or predicted, for the building site, without collapse, although buildings may sustain structural and nonstructural damage

An important concept associated with seismic design codes is that of "life safety." The building codes provide minimum design criteria for structures that take into account the need to protect the health, safety, and welfare of the general public by minimizing the earthquake-related risk to life. "Life safety" does not, however, mean that the building will not sustain some damage. Rather, it indicates that any damage that occurs is not expected to result in risk to life. The IBC and other seismic design reference documents do not take into account economic losses in the event of an earthquake; their focus is purely life safety and protection of the public.

One way the IBC provides for life safety is to assign a structure to a Seismic Use Group as described in the following section. It is important to note that Seismic Use Group I is intended to provide life safety. Structures assigned to Seismic Use Group II or III are designed to a higher seismic standard, thus they are expected to suffer less structural and non-structural damage during an earthquake.

Seismic Use Groups

In the IBC, buildings are assigned to Seismic Use Group I, II, or III as well as to Importance Factor Category I, II, III, or IV. The Seismic Use Group takes into account the intended occupancy and use of the structure and the intended level of operation of the building following an earthquake. The Importance Factor Category is based on the potential to pose risk to life safety if a structure should fail; it is used to determine what the seismic load should be. Structures that would pose greater risk are assigned to a higher category and, therefore, are designed to be more resistant to the design level earthquake.

The IBC 2003 (Table 1604.5) provides guidance for assigning buildings and other structures to Classification I, II, III, or IV. Water treatment plants and wastewater treatment facilities are assigned to Category III. Structures containing highly toxic materials (as defined by IBC Section 307) are assigned to Category IV. The IBC

considers Category III to be equivalent to Seismic Use Group II and Category IV to be equivalent to Seismic Use Group III. The Seismic Use Groups are as follows:

- **Seismic Use Group I:** A structure assigned to this group is one that is not assigned to either Group II or III. It is designed to provide life safety when subjected to the maximum expected level of shaking; however, it may not be operational following an earthquake.
- **Seismic Use Group II:** A structure assigned to this group would result in a public hazard if it were to collapse. Structures assigned to this use group would be expected to have less damage than those assigned to Group I but more damage than those assigned to Group III. The level of damage likely would require restrictions to use or operations until repairs are made.
- **Seismic Use Group III:** A structure assigned to this group is required for post-earthquake recovery or contains substantial quantities of hazardous materials. It is designed to prevent collapse, provide life safety, and remain operational following an earthquake that produces the maximum expected level of shaking.

Consistent with IBC 2003 requirements, the majority of Brightwater facilities are assigned to Seismic Use Group II and the chemical storage and odor control structures are assigned to Seismic Use Group III (Table 3-1). For structures that are a combination of water-holding tanks and buildings, the IBC assigns a Seismic Use Group based on the intended use of the structure.

Table 3-1. IBC 2003 Seismic Use Groups for Brightwater Facilities

Seismic Use Group II	Seismic Use Group III
Plant Operations and Maintenance Building	Headworks/Primary Odor Control
Main Substation	Aeration/MBR Odor Control
Community-Oriented Building	Chemical Storage Facilities
Headworks	Solids Odor Control
Grit Removal	
Headworks Truck Loadout Building	
Sedimentation Support Building	
Primary Sedimentation	
Primary Effluent Screens	
Aeration Basin	
MBR Basins	
Reclaimed Water	
Solids Building	
Digestion Building	
Energy and Cogeneration Building	

Site-Specific Probabilistic Seismic Hazard Analyses

IBC 2003 requires structures in most part of the United States, including the Puget Sound area, to be designed to resist the effects of earthquake-induced ground motion. The estimated level can be based on the U.S Geological Survey (USGS) national hazard maps or on a site-specific probabilistic seismic hazard analysis (PSHA). The IBC allows a PSHA to be used to provide the most up-to-date information about a site when there has been a significant change in the understanding of causes, locations, or frequencies of earthquakes in an area and existing USGS national hazard maps may no longer represent the most current seismic information.

King County conducted a site-specific PSHA to determine the level of shaking that could occur at the Route 9 site based on the current understanding of potential seismic source mechanisms that could affect the site (Appendix B). The site-specific PSHA was conducted to take into account recent findings that active strands of the Southern Whidbey Island Fault were found near and underlying the northern portion of the Route 9 treatment plant site (see Chapter 2 and Appendix A). The PSHA developed earthquake ground motions that could occur at the site considering the potential occurrence of earthquakes on these newly discovered strands. Other sources of potential ground shaking in the Seattle region, such as the Seattle Fault, were also explicitly incorporated into the PSHA. The results of this site-specific PSHA were used to develop seismic criteria for the design of the proposed Brightwater Treatment Plant facilities.

The results of the PSHA determined that levels of peak ground shaking from the maximum considered earthquake could exceed 0.6 times the acceleration of gravity (g). This level of ground shaking most likely would be associated with a large magnitude earthquake occurring on the SWIF. This level of shaking is nearly 4 times the level of shaking felt by people in the area during the 2001 Nisqually earthquake and nearly 25 percent greater than the levels of shaking determined on the basis of current IBC 2003 national hazard maps.

Structural Loading Requirements for Aboveground Buildings

One function of the IBC is to prescribe structural loading requirements for use in the design and construction of aboveground buildings to minimize hazard to life safety. Specific to seismic loads, the intent of the IBC provisions is to:

> Minimize hazard to life for all buildings, increase the expected performance of higher occupancy buildings as opposed to ordinary buildings, and improve the capability of essential facilities to function during and after a design level earthquake (FEMA, 2001).

This design philosophy provides a minimum design criterion for structures that considers the need to protect the health, safety, and welfare of the general public by minimizing the earthquake-related risk to life.

Support for Nonstructural Elements

Support systems for architectural, mechanical, electrical, and other nonstructural systems and for components and elements attached to the buildings and liquid-holding structures will be designed to withstand sliding and overturning forces due to earthquake shaking in accordance with IBC Section 1621. This section of the code requires adequate lateral bracing of pipes, pumps, motor control centers, and other systems to minimize damage due to earthquake-induced ground shaking. Examples of nonstructural seismic bracing include adequate anchor bolts for equipment and lateral bracing for process piping.

3.2.2 Other Measures to Limit and Mitigate the Effects of a Major Earthquake

A number of measures are being taken beyond the requirements of IBC 2003 to reduce the effects on treatment plant facilities of strong ground shaking or fault offsets. One of the most important measures is to shut down the influent pump station to stop flow to the treatment plant if an earthquake were to occur. This would allow time to inspect facilities for damage before restarting the plant, thereby limiting the potential for continued leakage from damaged facilities. Other measures are discussed in the following sections.

Considering Seismic Features in Locating Facilities

New facilities proposed on the Route 9 site are located an approximately equal distance from Lineaments 4 and X (Figure 3-2). A buffer of several hundred feet would separate the proposed plant process facilities from these two most likely sources of fault offset. While Lineament 4 has been identified as an active fault, there is no direct evidence indicating that Lineament X is an active fault. The buffers between the locations of proposed new treatment plant facilities and Lineaments 4 and X would limit potential risk to the new plant facilities.

Designing Water-Tight Liquid Holding Tanks

The majority of the structures at the Brightwater Treatment Plant will be liquid-holding tanks. They will be designed in accordance with American Concrete Institute's *Code Requirements for Environmental Engineering Concrete Structures* (ACI, 2001) to be water tight by limiting the size of cracks allowed to develop in the structure under normal loading. For Brightwater, where all the liquid-holding tanks are concrete structures reinforced with steel, the reinforcing steel specified for crack control provides additional strength beyond that which would be required by code for seismic design.

In addition, most liquid-holding tanks will be either below grade or partially buried in very dense, low-permeability soils. Burying the tanks will tend to minimize the loss of tank contents should a tank be damaged by either strong ground shaking or fault offset.

Buried structures designed to meet crack control requirements for water tightness generally have performed well in earthquakes. There is evidence of such performance in

the 1989 Loma Prieta and 1994 Northridge earthquakes. Only one case was identified where a tank joint at a wastewater treatment plant failed during the Northridge earthquake, releasing water into a gallery. Based on observations following these and other earthquakes, damage is typically limited to piping connections between tanks and to ancillary equipment. Additional discussions of past performance of liquid-holding tanks and pipe connections are provided in Chapter 4.

Isolating Individual Tanks

To minimize impacts from earthquake damage to facilities, individual liquid-holding tanks would be isolated with shutoff valves and gates. These valves would allow the contents of individual piping systems and tanks to be isolated from the system if upstream or downstream damage occurs. Sufficient redundancy would also be available within the treatment process so that individual tanks and conveyance structures could be taken off line while still providing treatment where flows bypass the damaged unit.

Designing Flexible Piping Systems

Piping systems will be designed to be flexible where they connect to structures. Flexible piping systems allow relative movement between the liquid-holding tanks and the piping systems during strong ground shaking. This flexibility minimizes the potential for pipe leaks where the pipes enter the basins. Historically, this location is where most damage has been observed at wastewater treatment plants following the Loma Prieta, Northridge, and Kobe earthquakes, as discussed in Chapter 4.

Following American Society of Civil Engineers Guidance

Structural and nonstructural systems on the plant site will be detailed in accordance with the latest recommendations in the American Society of Civil Engineers guidance document for the seismic design of wastewater treatment plants (Heubach, 2002). This guidance document provides detailed checklists for structural and nonstructural systems. These checklists are based on observations of damage from past earthquakes, thereby introducing past performance experience into the design process.

Designing Chemical Storage Areas to Prevent Mixing of Chemicals

Several chemicals are used in the wastewater treatment and odor control processes. These chemicals would be kept on the Brightwater Treatment Plant site in large bulk chemical storage, handling, and distribution facilities located near the Reclaimed Water Building and near the Headworks/Primary Odor Control Building. In addition, small quantities of chemicals would be stored in the Headworks/Primary Odor Control Building, the Aeration/MBR Odor Control Building, and the Solids Odor Control Building (see Figure 3-2).

Design of the chemical storage, handling, and distribution facilities for the Brightwater Treatment Plant will be in compliance with federal, state, and local codes and guidelines

and industry standards, including the Occupational Safety and Health Administration (OSHA, 2000) and Federal Risk Management (EPA, 2000) plans, the International Fire Code (IFC) (International Code Council, 2003b), and the Chlorine Institute's recommendations for prevention of mixing sodium hypochlorite with acids (Chlorine Institute, Inc., 2000).

As previously stated, chemicals would be stored in bulk quantities at two containment areas at the Brightwater Treatment plant. Alkaline chemicals (sodium hydroxide and sodium hypochlorite) would be stored just northwest of the Reclaimed Water Building near the north end of the plant. Acidic chemicals (ferric chloride, polyaluminum chloride, and citric acid) would be stored just south of the Headworks/Primary Odor Control Building near the south end of the plant. Each containment area would house four to five tanks varying in size between 8,000 and 18,500 gallons. The IFC requires only 20 feet of separation between storage areas for alkaline and acidic chemicals; however, the two chemical storage facilities on the Brightwater Treatment Plant site would be approximately 1,200 feet apart. The 1,200 feet of separation between the alkaline and acidic chemical storage areas would prevent mixing of the two classes of chemicals in the unlikely event that both facilities were to fail in an earthquake.

Providing Easy Access for Repair of Damaged Tanks

Sumps and access hatches are being incorporated into the design of tanks and pipe galleries for the Brightwater Treatment Plant to allow easy access for dewatering of tanks if they should be damaged by an earthquake or need to be taken out of service. A strategy for dewatering these belowground facilities would be documented in the operations manual for Brightwater. This strategy would include specifying the types of dewatering pumps, making the pumps available for immediate use, and establishing the procedure for disposal of tank contents.

Providing Emergency and Auxiliary Power

Emergency and auxiliary power sources would be made available in the event that both power feeds to the plant site were severed. Ultimately, this emergency and auxiliary power would include up to 9 megawatts of onsite power when cogeneration and emergency power generation facilities are online and potential access to approximately 1 megawatt of portable generators from other King County facilities. Both the portable generators and the auxiliary power would provide enough power for full secondary treatment and disinfection prior to discharge to Puget Sound if both power feeds were out of service.

Initially, the emergency power would consist of one onsite essential services generator with 48 hours of diesel fuel supply capable of supplying critical life-safety services and, if treatment facilities and the effluent tunnel remained operational, the ability to provide power for limited preliminary and primary treatment before discharge to Puget Sound. Provisions will be made in the design to add auxiliary power in the future. In addition, King County can provide portable generators from other locations.

3.3 How Are Brightwater Conveyance Facilities Being Designed to Lessen Impacts of an Earthquake?

The pipelines that would convey wastewater to and from the Route 9 site would be contained in a single tunnel along a portion of the conveyance corridor. The pipelines would be made of either welded steel or reinforced fiberglass. The tunnel would be made of bolted and gasketed concrete segments. The combined tunnel would enter the Brightwater Treatment Plant at the south end of the Route 9 site. It would contain four pipelines—two influent force mains (48 and 66 inches inside diameter), one effluent pipe (84 inches inside diameter), and one water reuse pipe (27 inches inside diameter) (Figure 3-3).

By their nature, linear facilities like conveyance pipelines cannot avoid crossing seismic faults. The combined tunnel would cross Lineament X as it enters the south end of the Brightwater site (see Figure 3-2). King County is designing the combined tunnel in a manner that will limit the possibility that the tunnel could be damaged in the unlikely event of a surface rupture on Lineament X. The tunnel and pipelines are being designed to withstand earthquake loads by including features such as pipes with greater thickness and joints that would provide higher performance in an earthquake.

If a rupture were to occur on Lineament X, the effects of ground shaking and fault displacement would most likely cause some of the tunnel sections to strain and deform in response to the large differential loading condition imposed on them. Typical practice in the design of underground structures has been to consider that the tunnel and the ground move simultaneously and design the tunnel to withstand the strains that would occur. Design strategies that will be employed include filling the annular space between the pipes with concrete grout to help minimize leakage or infiltration to cracked or broken pipes. Installing low-strength concrete backfill within the tunnel also would improve the tunnel’s ability to withstand earthquake loads.

If joints on the pipelines within the combined tunnel were to crack or become offset, they could be repaired. It is not anticipated that the cracked or offset joints would prevent the operation of the system, and the tunnel would be expected to remain in service until entry could be made into the pipelines to repair the joints.

If a ground surface rupture were to rupture the tunnel at the south end of the Route 9 site or at other locations along the conveyance corridor, King County would implement a plan that would include rapidly assessing damage, rerouting influent to other treatment facilities, possibly constructing a temporary diversion to the effluent tunnel, repairing the damage, and implementing an emergency flow management plan (see Chapter 4).

3.4 Do Regulations Govern the Siting of Facilities Near Active Faults?

Several jurisdictions in earthquake prone areas have statutes and regulations or ordinances that address fault rupture hazards and allow the location of structures in proximity to a fault. However, neither the State of Washington nor King or Snohomish Counties currently have regulations regarding the placement of structures such as wastewater treatment plants near faults.

3.4.1 California and Utah Seismic Regulations

In California, a state statute known as the Alquist-Priolo Earthquake Fault Zoning Act (Alquist-Priolo Act) and its implementing regulations prohibit, within an officially delineated earthquake fault zone, the construction of new structures for human occupancy across or within 50 feet of an active fault (California Public Resources Code Section 2621.5; California Code of Regulations, Title 14, Section 3603 (a)). This restriction also applies to an alteration or addition to any existing structure for human occupancy if the value of the alteration or addition exceeds 50 percent of the value of the structure (California Public Resources Code Section 2621.7). The Alquist-Priolo Act specifically defines human occupancy as being 2,000 person hours per year. By this definition many of the Brightwater treatment plant facilities would be exempt from the requirements in the Alquist-Priolo Act.

In Utah, some communities along the Wasatch Front, and, in particular, Salt Lake County, have enacted geologic-hazards ordinances that adopt surface-fault rupture hazard special study area maps that define areas where site-specific studies are required prior to approval of certain new development (Salt Lake County, Natural Hazards Area Ordinance, Code of Ordinances, Chapter 19.75). Pursuant to the Salt Lake County Natural Hazards Area Ordinance, “no critical facility (excluding transportation lines or utilities, which by their nature may cross active faults) or structures designed for human occupancy shall be built astride an active fault.” Under the Salt Lake County Ordinance, where required, a fault study report must be prepared establishing a fault setback on either side of the fault following the requirements in the ordinance. No critical facilities (excluding transportation lines or utilities) or structures for human occupancy may be placed within these setbacks (Salt Lake County Code of Ordinances, Chapter 19.75.081).

3.4.2 Applicability to Brightwater

These statutes, regulations, and ordinances do not govern structures in the State of Washington. Brightwater is not subject to either the Alquist-Priolo Act or the Salt Lake County Natural Hazards Area Ordinance. Moreover, if the provisions of either the Alquist-Priolo Act or the Salt Lake County Ordinance did apply to facilities in the State of Washington, they would not preclude or restrict the siting of the proposed Brightwater facilities at the Route 9 site.

The proposed Brightwater facilities at Route 9 are utilities. They would not be structures for human occupancy, with the exception of the StockPot Building, the new Plant Operations Building, and the potential Community-Oriented Building. For the Brightwater Treatment Plant, the StockPot Building is the only structure that is located over an identified active fault. Lineament 4 passes under a corner of the existing StockPot Building. King County is determining whether it is feasible to retain this building as an operations, maintenance, and storage facility (see Chapter 1). If King County decides to utilize the StockPot building, it will investigate whether and to what extent, if at all, a seismic upgrade may be appropriate. Even under California laws, the StockPot Building, if utilized for human occupancy, would not be subject to regulation unless it were to be modified at a cost exceeding 50 percent of its current value. Moreover, no Brightwater treatment facilities will be constructed within buffers between proposed structures and Lineaments 4 and X (see Figure 3-2).

The combined tunnel carrying the influent and effluent pipelines would cross Lineament X, as discussed earlier in this chapter. This type of crossing would be allowed under the California and Salt Lake County regulations, as evidenced by numerous water, wastewater, and petroleum pipelines that cross faults in these two states. Discussions on the design of the Brightwater conveyance system and the Hearing Examiner's decision regarding the adequacy of the seismic discussion in the Brightwater EIS as it related to the conveyance system are provided in Chapter 1.

3.5 What Are the Components of the Brightwater Wastewater Treatment System?

The initial phase of the Brightwater project would provide a treatment capacity of 36 mgd when the plant begins operation in 2010; the expansion phase would provide a capacity of 54 mgd in 2040 in anticipation of the additional capacity that would be needed in 2050. The information presented in this section is for the treatment plant at a capacity of 54 mgd. This Supplemental EIS evaluates the impacts of the "worst-case" scenario when the treatment plant is treating the largest quantity of wastewater (see Chapters 4 and 5).

3.5.1 Overview of Treatment Plant System

The components of the treatment plant system can be categorized into liquid treatment, solids treatment, odor control, and non-process facilities. The following paragraphs describe these four main plant components, while Table 3-2 describes specific processes and their functions, and the number and the capacities or square footage of units in each process.

- **Liquid treatment units.** The function of the liquid treatment units is to remove most organic and inorganic pollutants contained in untreated wastewater.

- **Solids handling and treatment units.** The function of the solids handling and treatment units is to stabilize or reduce the volatile solids in the sludge removed from the liquid stream process to make a biosolids product suitable for beneficial reuse offsite.
- **Odor control system.** The function of the odor control system is to collect and treat odorous air from process units before discharge to the atmosphere. For Brightwater, all process units would be covered or enclosed and odorous air beneath covers and the enclosures (buildings) would be treated in a three-stage chemical odor scrubber followed by polishing in a carbon filter prior to discharge. Components would include a chemical storage and distribution system and odor control units at each of the major liquid and solids process units.
- **Non-process facilities.** The non-process facilities support and maintain the liquid, solids, and odor control treatment systems. These facilities would include, for example, the pipe gallery and underdrain system; the Operations and Maintenance Building where offices, a laboratory, a control room, maintenance, and storage would be located; utilities, such as electrical power and natural gas lines; an underground diesel storage tank; and the stormwater system. Non-process facilities also would include the Community-Oriented Building proposed for construction on the Brightwater site (see Chapter 1 and Figure 3-2).

3.5.2 Emergency Flow Management System

Emergency wastewater overflows could potentially occur during unusual combinations of extremely high storm-influenced flows and multiple equipment and power failures. In the event of a worst-case scenario where the Brightwater facilities were disabled by a major earthquake or other natural disaster, King County would implement a five-part emergency flow management system to protect the public health and environmental quality. The strategy would consist of the following measures:

- Diverting flows to the West Point and South Treatment Plants
- Diverting excess flows into the existing Logboom and North Creek Storage facilities
- Storing flows in new and existing conveyance pipelines
- Using emergency generators to keep new and existing pump stations operational in the event of power outages
- Diverting untreated or partially treated wastewater through the effluent system and outfall to Puget Sound

Table 3-2. Description of Components for 54-mgd Brightwater Treatment Plant

Plant Component	Description	Number and Type of Facility	Approximate Holding Capacity or Dimensions
	LIQUID TREATMENT		
Preliminary Treatment	Preliminary treatment screens untreated wastewater to remove rags, sticks, plastics, and other debris that could plug downstream treatment units. Screenings are conveyed to an enclosed building for storage prior to being hauled offsite for disposal.	5 channels	16,000 gallons of untreated wastewater in each channel
Grit Removal	Grit removal consists of a number of relatively small aerated tanks that provide a wide spot in the flow path for sand, gravel, and other heavy inorganic debris to settle and be removed. Grit slurry is pumped to cyclone separators where grit is removed, washed, and conveyed to an enclosed building for storage and haul off site, similar to screenings. Water removed in the grit separation process is returned to the main flow stream for further treatment.	9 grit tanks	100,000 gallons of untreated wastewater in each tank
Primary Sedimentation	Primary sedimentation includes a number of relatively large tanks that provide a quiescent or non-turbulent zone for heavy organic material to settle and for grease, oil, and scum to float to surface for removal. The heavy solids (i.e., primary sludge) are collected in deep hoppers at the inlet ends of each tank and pumped to the solids handling facility for further treatment. Floating debris is skimmed from the surface and pumped to solids handling. During periods of high flow, chemicals are added to enhance settling, thus the term “chemically enhanced primary clarification” (CEPC).	9 primary sedimentation tanks	480,000 gallons of wastewater in each tank; wastewater will have had screenings and grit removed
Primary Effluent Screening	Primary effluent screening is a second screening process in the flow stream that removes remaining floating or suspended debris prior to discharge to the aeration basins. The process is similar to preliminary treatment with finer mesh screens provided to remove smaller material.	4 screening channels	15,000 gallons of primary effluent in each channel

Table 3-2. Description of Components for 54-mgd Brightwater Treatment Plant (continued)

Plant Component	Description	Number and Type of Facility	Approximate Holding Capacity or Dimensions
Aeration Basins	Aeration basins are large, deep aerated tanks that are managed to provide a culture of microorganisms to remove organic matter from wastewater. The culture, called mixed liquor suspended solids (MLSS), will contain 8,000–10,000 mg/L of microorganisms.	6 aeration basins	1,560,000 gallons of MLSS in each basin
Membrane Bioreactor (MBR) Basins	MBR basins are relatively small, shallow tanks containing membranes that separate the microorganisms from wastewater and provide clear effluent for disinfection and discharge to Puget Sound. Secondary sludge removed by the membranes is pumped to solids handling for treatment. The membranes are either hollow core or plate depending on manufacture; pore size of the membrane is approximately 6 microns.	18 MBR tanks	115,000 gallons of MLSS in each tank
Reclaimed Water Building	The Reclaimed Water Building is the final liquid stream treatment process, providing disinfection of treated wastewater prior to discharge to the effluent conveyance system and Puget Sound. Sodium hypochlorite (similar to household bleach) is used for disinfection. A small contact tank is provided in this process to meet state regulatory requirements for Class A reclaimed water reuse on site.	2 contact channels	50,000 gallons of treated wastewater in each channel
Plant Piping and Channels	Multiple piping and channels convey wastewater between process units. Wastewater is pumped from the influent pump station to preliminary treatment, then flows by gravity through grit removal and primary sedimentation to aeration basins. From the aeration basins, wastewater is pumped to MBR tanks, then flows by gravity through reclaimed water and effluent conveyance system to Puget Sound.	NA	See Table 3-4

Table 3-2. Description of Components for 54-mgd Brightwater Treatment Plant (continued)

Plant Component	Description	Number and Type of Facility	Approximate Holding Capacity or Dimensions
	SOLIDS HANDLING AND TREATMENT		
Thickening Units	The thickening process uses fine mesh belts to remove water by gravity from primary and secondary sludge before digestion. Removing water reduces the volume necessary for the digestion process. Water removed from the sludge is returned to the liquid stream for further treatment. Raw sludge has a concentration of approximately 1% solids (10,000 mg/L); thickened sludge concentration is 5-6% solids (50–60,000 mg/l)	4 gravity belt thickeners 1 raw sludge blend tank 1 thickened sludge storage tank	The gravity belt thickeners are a “flow through” pieces of equipment with a 2-meter-wide belt that contains essentially no sludge 210,000 gallons in the sludge storage tank
Digesters	Digestion is a biological process, similar to aeration basins, but in this case, microorganisms are anaerobic (without oxygen). These organisms stabilize raw sludge to produce digested sludge (biosolids) and methane gas. Biosolids are pumped to digested sludge storage tank before dewatering. Sludge in the digesters is approximately 3.5% solids (35,000 mg/L). Methane gas is collected and used to produce electricity.	6 digesters	1,250,000 gallons of sludge in each digester
Dewatering Units	Dewatering removes water from biosolids to produce cake-like material for transport offsite for beneficial reuse. Dewatering is accomplished in the Solids Building using centrifuges to “spin out the water” and produce the cake. Water removed is returned to the liquid stream for treatment. Cake from the centrifuges is conveyed to hoppers for storage and discharge into trucks for hauling offsite. Cake from the centrifuges is typically 25% solids.	1 biosolids (digested sludge) storage tank 4 centrifuges 2 hoppers	810,000 gallons in the digested sludge storage tank The centrifuges are “flow through” pieces of equipment that contain essentially no biosolids 110 cubic yards per hopper

Table 3-2. Description of Components for 54-mgd Brightwater Treatment Plant (continued)

Plant Component	Description	Number and Type of Facility	Approximate Holding Capacity or Dimensions
	ODOR CONTROL		
Chemical Storage Units	A series of fiberglass tanks store chemicals needed for wastewater disinfection, odor control, CEPC coagulation, and MBR cleaning. Chemicals are "double contained"—each is stored in individual tanks, which are surrounded by a concrete wall to contain contents should one of the tanks fail. Alkaline and acidic chemicals would be stored separately several hundred feet apart to avoid the possibility of mixing.	Sodium hypochlorite (disinfection, odor control, and membrane cleaning) – 3 tanks	Sodium hypochlorite – 18,000 gallons in each tank
		Sodium hydroxide (odor control) – 1 tank	Sodium hydroxide – 18,000 gallons
		Ferric chloride (CEPC coagulation) – 3 tanks	Ferric chloride – 18,000 gallons in each tank
		Polyaluminum chloride (CEPC coagulation) – 1 tank	Polyaluminum chloride – 10,000 gallons
		Citric acid (membrane cleaning) – 1 tank	Citric acid – 10,000 gallons
Headworks/ Primary Odor Control	Headworks/primary odor control provides treatment of odorous air from within Headworks Building, Grit Removal Building, Primary Sedimentation Building, Primary Effluent Screens Building, and Headworks Truck Loadout Building. Three-stage chemical scrubbers followed by carbon adsorption units treat the air before release to the atmosphere. Chemicals are recycled within the odor scrubbers; spent chemicals are returned to the aeration basins for further treatment.	5 three-stage chemical scrubbers and carbon absorption units	Total of 300 gallons of sodium hypochlorite, 300 gallons of sodium hydroxide, and 300 gallons of sulfuric acid
Aeration/MBR Odor Control	Aeration/MBR odor control provides treatment for odorous air from aeration and MBR basins. Three-stage chemical scrubbers followed by carbon adsorption units treat the air before release to the atmosphere. Chemicals are recycled within the odor scrubbers; spent chemicals are returned to the aeration basins for further treatment.	5 three-stage chemical scrubbers and carbon absorption units	Total of 300 gallons of sodium hypochlorite, 300 gallons of sodium hydroxide, and 300 gallons of sulfuric acid

Table 3-2. Description of Components for 54-mgd Brightwater Treatment Plant (continued)

Plant Component	Description	Number and Type of Facility	Approximate Holding Capacity or Dimensions
Solids Building Odor Control	Solids Building odor control provides treatment of odorous air from thickening, dewatering, biosolids storage, and loadout areas. Three-stage chemical scrubbers followed by carbon adsorption units treat the air before release to the atmosphere. Chemicals are recycled within the odor scrubbers; spent chemicals are returned to the aeration basins for further treatment.	4 three-stage chemical scrubbers and carbon absorption units	Total of 300 gallons of sodium hypochlorite, 300 gallons of sodium hydroxide, and 300 gallons of sulfuric acid
	NON-PROCESS FACILITIES		
Pipe Gallery	Pipe gallery provides a utilidor for piping, electrical, and control equipment, as well as access for maintenance and operation of process units. The gallery is completely below finish ground elevation and connects all major liquid and solids process units.	NA	Nominally 20 feet wide by 20 feet high by approximately 1600 feet long
Underdrain	The underdrain system is a series of perforated piping beneath most buried facilities to relieve groundwater pressure on empty tanks. Groundwater collected in the underdrain system is conveyed to the west end of the site for discharge into wetlands.	NA	Approximately 13,000 feet of 6-inch-diameter perforated pipe
Operations Building	The Operations and Maintenance Building provides offices, laboratory, control room, maintenance, and storage for treatment plant operation and maintenance.	NA	Two story building plus basement; total of 45,000 square feet
Community-Oriented Building	The Community-Oriented Building would provide space for educational programs and community gatherings.	NA	One-story building plus basement; total of 27,000 square feet

Table 3-2. Description of Components for 54-mgd Brightwater Treatment Plant (continued)

Plant Component	Description	Number and Type of Facility	Approximate Holding Capacity or Dimensions
Major Utilities	Major utilities to the Route 9 site include electrical power from Snohomish County Public Utility District, natural gas from Puget Sound Energy, and water from Cross Valley Water District and Alderwood Water District. Electrical feed lines provide power to a high-voltage onsite substation via overhead lines. Natural gas and water lines would be buried pipelines.	2 electrical feed lines 1 natural gas pipeline 4 water lines	115 kV Natural gas pipe 6 inch diameter Water line pipes range in size from 12 to 16 inches in diameter
Ancillary Systems	Ancillary systems include equipment and facilities to produce electrical energy onsite for essential services and to augment power supply from the utility.	1 essential services generator, diesel fueled 3 cogeneration engines fueled with methane gas from the digesters 2 turbine generators fueled with natural gas	
Stormwater System	Stormwater system, which provides detention and treatment to the stormwater (rainwater) runoff from plant facilities and landscaping, consists of canals for stormwater detention, sand filters for treatment, and wetlands for polishing of stormwater prior to discharge to surface waters. The sand filters and wetlands are considered ground treatment systems with infrequent and relatively small surface-water ponding. Canals would store water above ground.	NA	Up to 4,300,000 gallons in canals
Diesel Storage Tank	A double-wall tank, buried below ground surface would provide fuel for the essential services generator.	1 buried tank	4,000 gallons

In an emergency situation, the new Brightwater system and the existing conveyance system would have a combined storage capacity of about 18 million gallons (depending on the final configuration of the tunnel). In wet weather, diluted untreated wastewater could bypass the treatment processes at the Brightwater treatment plant site and flow at a rate of up to170 mgd into the effluent conveyance system for eventual discharge into Puget Sound if specific treatment processes were to fail and if the effluent tunnel remained operational (Final EIS, Appendix 3-E).

Wastewater would be discharged to the environment only after all of the emergency flow management measures had been implemented. The goal of the emergency flow management system is to provide maximum emergency response flexibility and limit the impact of overflows during an emergency by directing untreated overflows that may occur to a highly mixed marine environment rather than into an urban freshwater body or through manholes onto public streets.

3.6 Where Would Facilities Be Located On the Route 9 Site in Relation to Seismic Features?

3.6.1 Layout of Treatment Plant Facilities

Proposed facilities on the Route 9 site would be arranged in a logical manner to provide efficient construction and operation of the wastewater treatment system. Untreated wastewater would enter the plant at the south end of the site nearest the conveyance system; liquid treatment units would be arranged in a linear fashion with wastewater flowing from south to north, with the final liquid treatment units—the membrane bioreactor (MBR) basins and reclaimed water facilities—located furthest north on the site. Solids handling and digestion would be grouped near preliminary and primary treatment to reduce the distance required to pump heavy solids and scum. Odor control facilities would be located adjacent to each of the major liquids and solids treatment units. Non-process facilities would be located near the preliminary, primary, and solids handling processes because these processes generally require the most attention by the operations and maintenance staff.

The locations of these treatment facilities relative to Lineaments 4 and X on the Route 9 site are shown in Figure 3-2. New wastewater treatment facilities are located south of Lineament 4 and north of Lineament X. The MBR basins are the treatment process units closest to Lineament 4; the electrical substation is the facility closest to Lineament X.

3.6.2 Plant Facilities Relative to Finished Ground Elevation

The majority of the Brightwater treatment facilities on the Route 9 site are liquid-holding tanks, most of which are located below the finished ground elevation. Figure 3-4 shows the layout with a series of cross section cuts; Figure 3-5 shows the relationship of the

major tanks and buildings to the finished ground level at each cross section cut, labeled A-A' through D-D'. Table 3-3 provides a summary of the total volume contained in each major process unit, the volume that would be located above the ground surface, and the volume that would be located below the ground surface. For comparison, an Olympic size swimming pool holds about 1 million gallons of water.

Table 3-3. Volume of Major Liquid-Holding Tanks for 54-mgd Brightwater Treatment Plant

Unit Process	Total Volume in Million Gallons (MG)	Volume above Ground Surface (MG)	Volume below Ground Surface (MG)
Primary Sedimentation Tanks	5.3	2.1	3.2
Aeration Basins	9.3	0.0	9.3
MBR Basins	2.1	1.6	0.5
Digesters	7.5	5.8	1.7

For Brightwater, the majority of the connections between the process treatment units would be large-diameter pipes that transfer wastewater from the outlet of one process unit to the inlet of the subsequent unit. These connections would be isolated with valves and/or weir walls such that failure of a connection would drain only the interconnecting pipe and outlet channels and boxes and not the entire basin contents. The connections also would be buried below ground so that failure would result in the pipe contents leaking into the groundwater or into underdrain system. Table 3-4 provides a summary of the volume that would be contained in the pipelines between major process units and the quantity that could potentially leak to the groundwater or underdrain system.

Table 3-4. Volume in Connecting Pipes between Process Units for 54-mgd Brightwater Treatment Plant

Pipe Connection	Total Volume in Gallons
Plant influent piping from tunnel portal to headworks	200,000
Primary sedimentation to aeration basins	300,000
Aeration basins to membrane bioreactor (MBR) basins	100,000
Return activated sludge (from MBR basins to aeration basins	400,000
MBR basins to reclaimed water	100,000
Membrane effluent from MBR to effluent collection box	100,000
Reclaimed water to plant effluent collection box	20,000
Plant effluent from plant effluent collection box to tunnel portal	300,000

3.6.3 Combined Tunnel and Pipelines Near Lineament X

The combined tunnel would carry the influent and effluent pipelines and the reclaimed water pipeline (Figure 3-3). It would enter the plant in the southwest portion of the Route 9 site, cross Lineament X, and terminate at the tunnel portal on the treatment plant site (Figure 3-2). Between the portal and the plant facilities, the influent and effluent pipelines would be constructed using surface excavation rather than tunneling. The two influent lines would deliver untreated wastewater to the headworks for preliminary treatment. The effluent pipeline would be buried from the effluent collection box to the tunnel portal. In addition, the reclaimed water pipeline would be buried for future delivery of reclaimed water for beneficial reuse of treated wastewater offsite. All four pipelines would be included in the combined tunnel from the tunnel portal on the Route 9 site to Portal 44 located in north Kenmore.

3.7 References

American Concrete Institute (ACI). 2001. *Code requirements for environmental engineering concrete structures* (ACI 350-01). Farmington Hills, MI: ACI Committee 350.

American Water Works Association (AWWA). 1996. *AWWA standard for circular prestressed concrete water tanks with circumferential tendons* (ANSI/AWWA D115-95, First Edition). Effective June 1, 1996. Denver, CO: American Water Works Association.

American Water Works Association (AWWA). 2005. *AWWA standard: Wire- and strand-wound, circular, prestressed concrete tanks* (ANSI/AWWA D110-04; revision of ANSI/AWWA D110-95). Effective February 1, 2005. Denver, CO: American Water Works Association.

Chlorine Institute, Inc. 2000. *Sodium hypochlorite manual*. Pamphlet 096-E. Edition No. 2. Arlington, VA.

EPA. 2000. *Guidance for implementation of the general duty clause, Clean Air Act, Section 112(v)(1).* EPA 550-B00-002. Washington, DC: U.S. Environmental Protection Agency, Office of Solid Waste and Emergency Response, Chemical Emergency and Prevention Office.

FEMA (Federal Emergency Management Agency). 2001. *NEHRP recommended provisions for seismic regulations for new buildings and other structures. 2000 edition.* Washington, DC: FEMA 368, Building Seismic Safety Council.

Heubach, W. F., Editor. 2002. *Seismic screening checklists for water and wastewater facilities.* Monograph No.22. American Society of Civil Engineers Technical Council on Lifeline Earthquake Engineering.

International Code Council. 2003a. *2003 International Building Code*. Falls Church, VA: International Code Council.

International Code Council. 2003b. *2003 International Fire Code.* Falls Church, VA: International Code Council.

King County. 1998. *Final environmental impact statement for the Regional Wastewater Services Plan*. Seattle, WA: King County Department of Natural Resources, Wastewater Treatment Division.

OSHA. 2000. *Process safety management.* OSHA 3132. U.S. Department of Labor, Occupational Safety and Health Administration.

LIST OF FIGURES

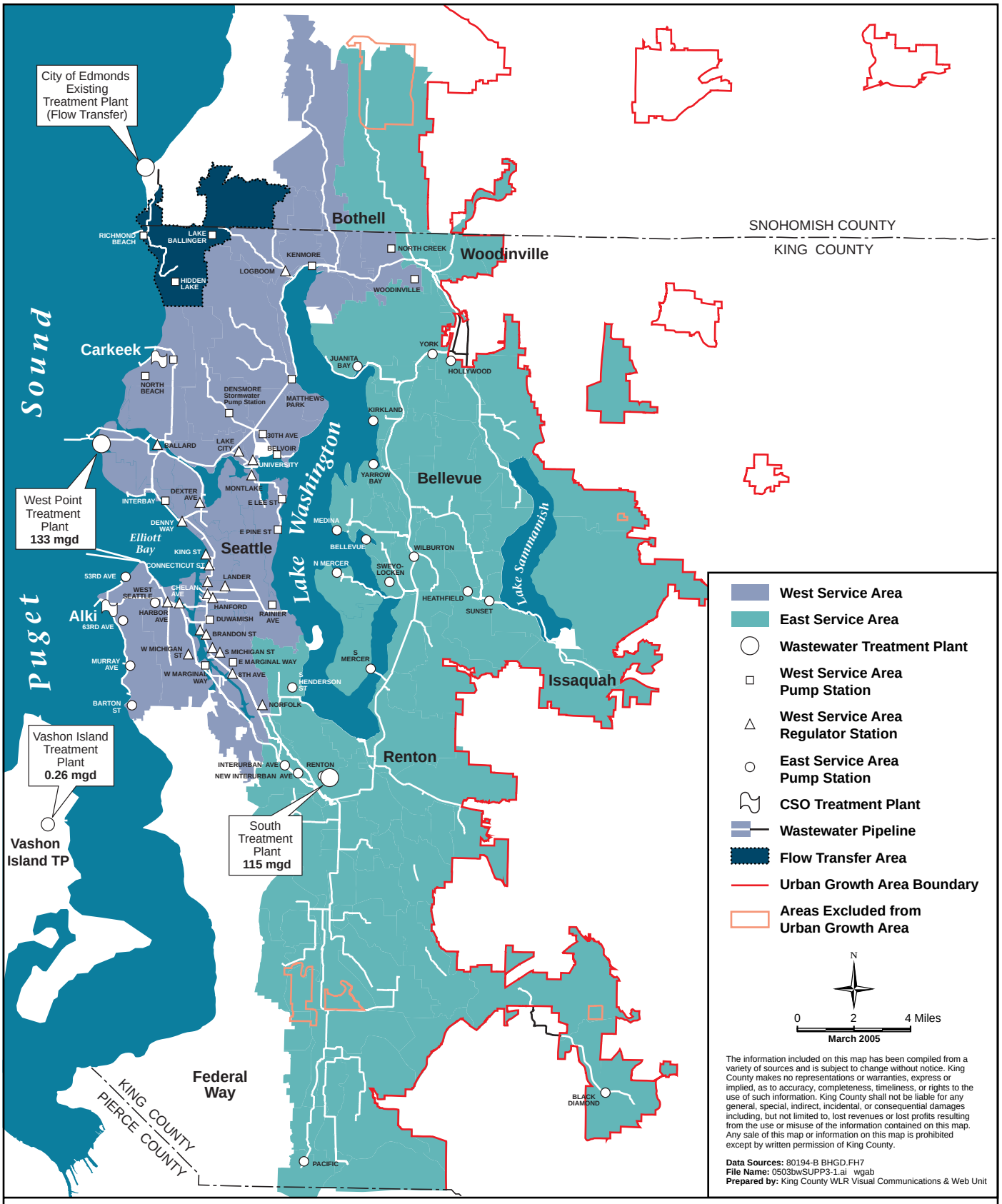
Figure 3-1 Existing Wastewater System

Figure 3-2 Location of Brightwater Treatment Facilities Relative to the Seismic Features on the Route 9 Site

Figure 3-3 Typical Section of Pipelines in Combined Tunnel

Figure 3-4 Locations of Route 9 Treatment Plant Site Cross Sections Shown in Figure 3-5

Figure 3-5 Cross Sections of Route 9 Treatment Plant Site at Locations Shown in Figure 3-4

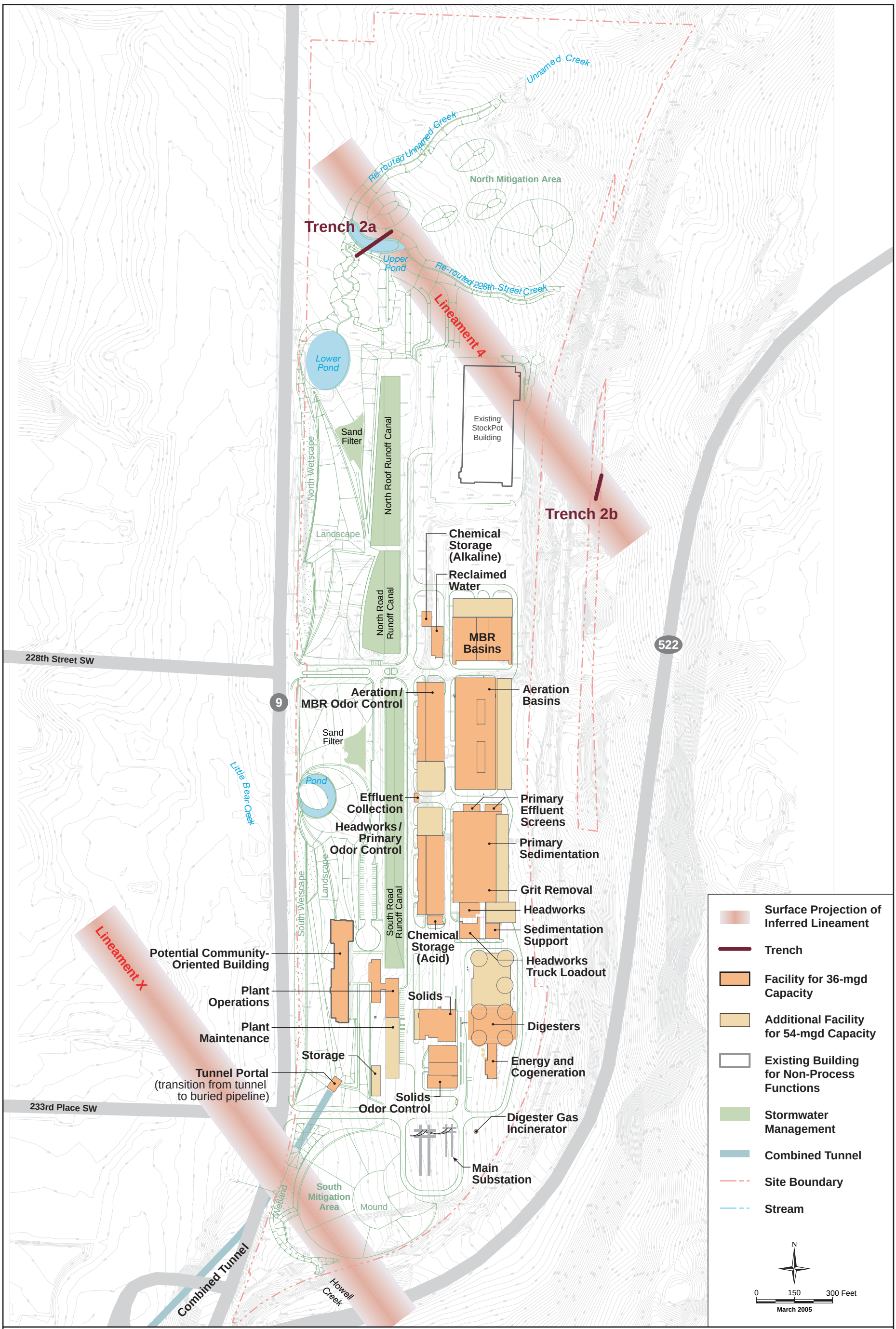


King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

Figure 3-1

Existing Wastewater System

BRIGHTWATER SUPPLEMENTAL EIS



King County
Department of Natural Resources and Parks
Wastewater Treatment Division

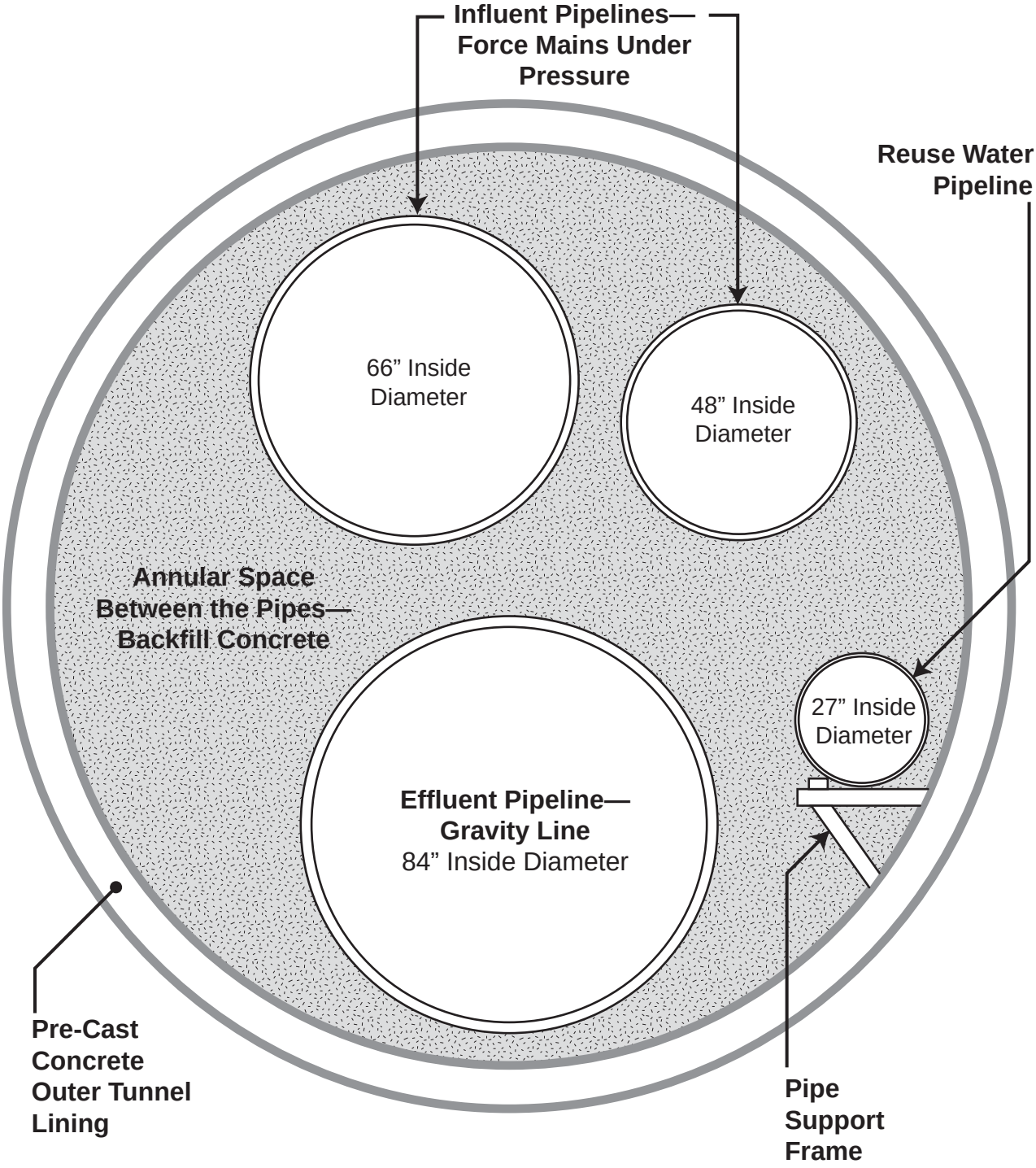
The information included on this map has been compiled from a variety of sources and is subject to change without notice. King County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. King County shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map or information on this map is prohibited except by written permission of King County.

Data Sources: SEA NDM/188397, BW_BWTP_COLOR.dgn
File Name: 0503bwSUPP3-2.ai wgab
Prepared by: King County DNRP Visual Communications & Web Unit

Figure 3-2

Location of Brightwater Treatment Facilities Relative to the Seismic Features on the Route 9 Site

BRIGHTWATER SUPPLEMENTAL EIS



Combined Tunnel

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

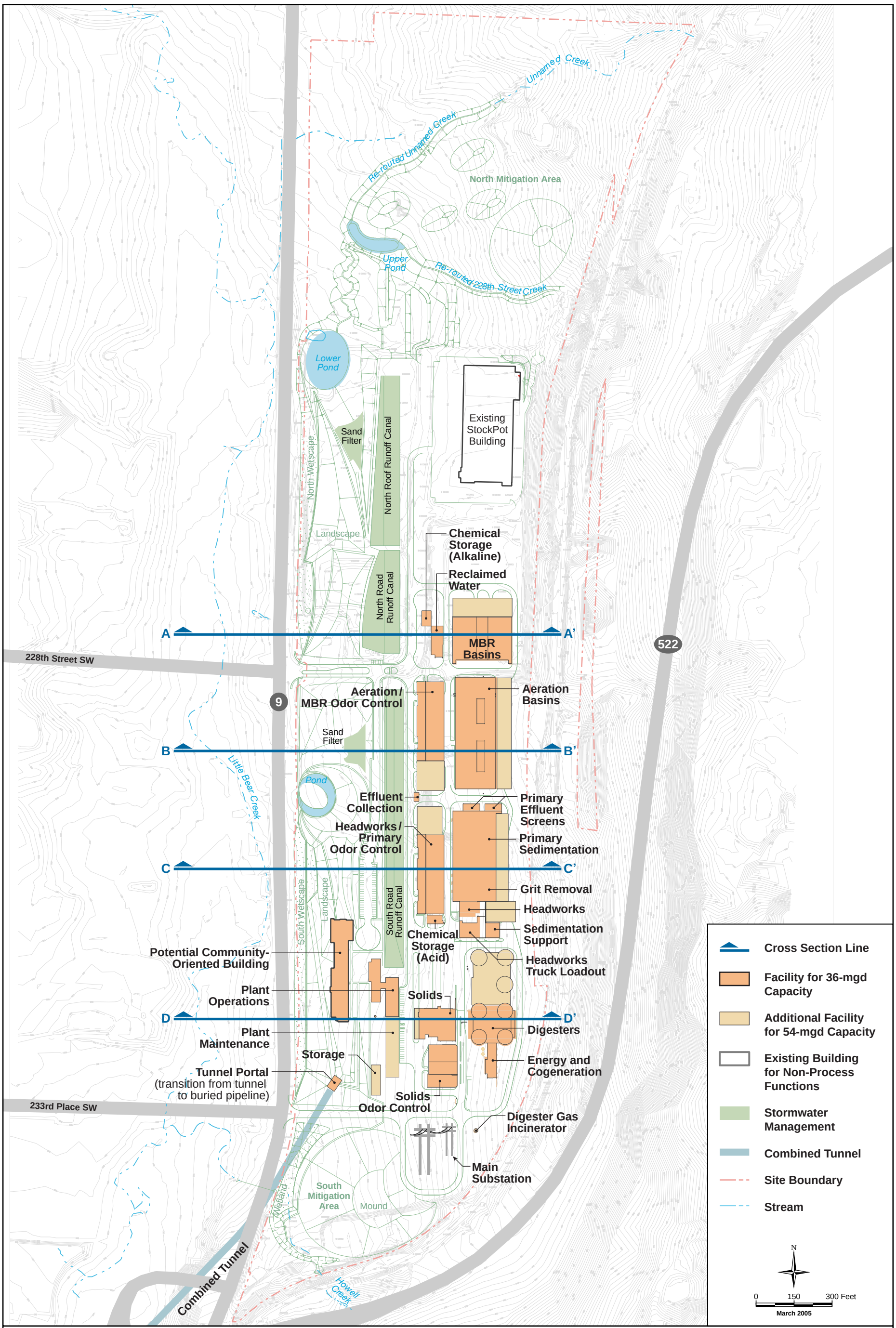
Scale: 3/4” = 1’-0”

Data Sources: MWH Jacobs Associates
File Name: 0503bwSUPP3-3.ai wgab
Prepared by: KC DNRP VC & Web Unit

Figure 3-3

Typical Section of Pipelines in Combined Tunnel

BRIGHTWATER SUPPLEMENTAL EIS



King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

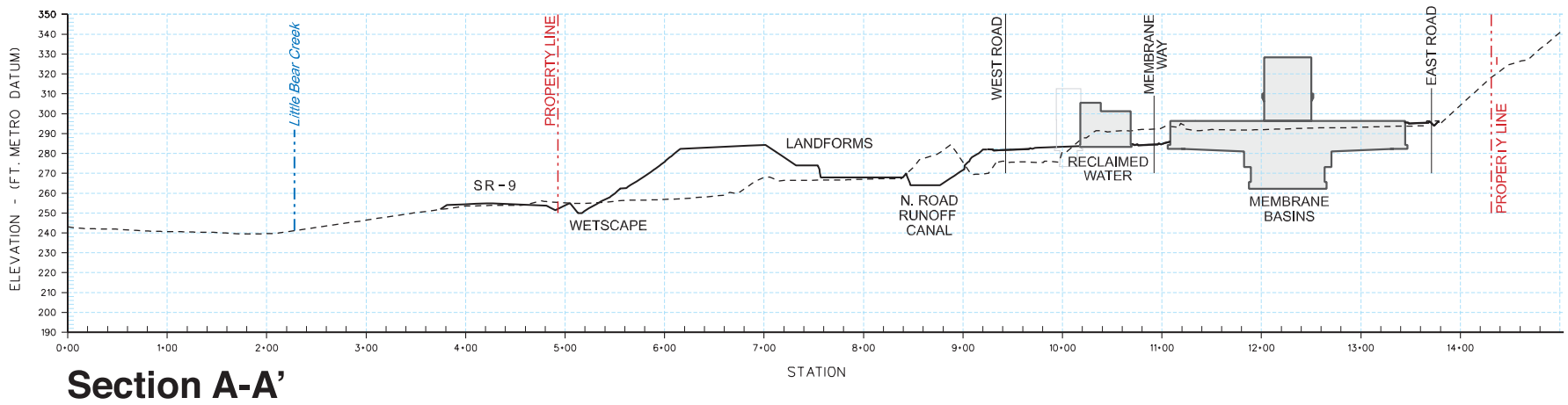
The information included on this map has been compiled from a variety of sources and is subject to change without notice. King County makes no representations or warranties, express or implied, as to accuracy, completeness, timeliness, or rights to the use of such information. King County shall not be liable for any general, special, indirect, incidental, or consequential damages including, but not limited to, lost revenues or lost profits resulting from the use or misuse of the information contained on this map. Any sale of this map or information on this map is prohibited except by written permission of King County.

Data Sources: SEA NDM/188397, BW_BWTP_COLOR.dgn
File Name: 0503bwSUPP3-4.ai wgab
Prepared by: King County DNRP Visual Communications & Web Unit

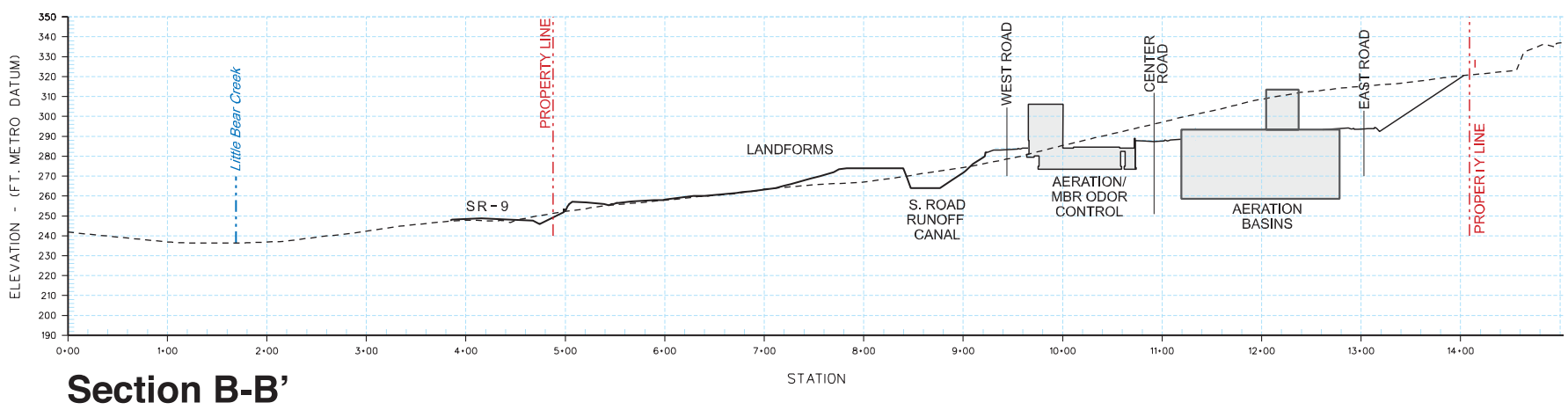
Figure 3-4

Locations of Route 9 Treatment Plant Site Cross Sections Shown in Figure 3-5

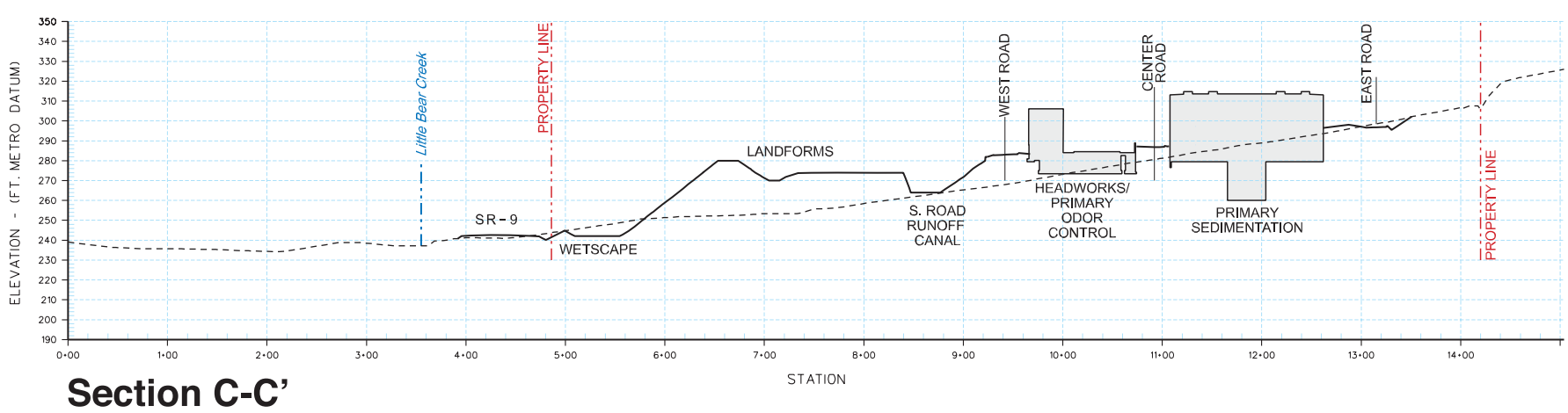
BRIGHTWATER SUPPLEMENTAL EIS



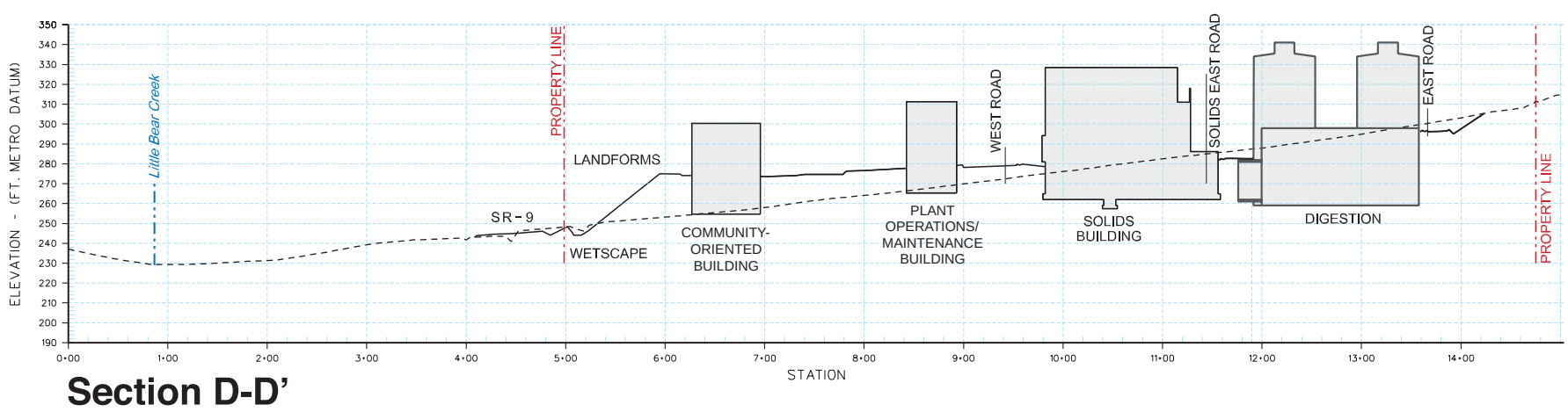
Section A-A'



Section B-B'



Section C-C'



Section D-D'

NOTE:
ELEVATIONS ARE IN METRO DATUM.
TO CONVERT TO NAVD 88, SUBTRACT
96.28 FEET FROM METRO DATUM.

----- Existing Grade
—— Proposed Grade

Figure 3-5

Cross Sections of Route 9 Treatment Plant Site at Locations Shown in Figure 3-4

BRIGHTWATER SUPPLEMENTAL EIS

File Name: 0503bwSUPP3-5.ai wgab
Prepared by: King County DNRP Visual Communications Unit