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West Gresham Stormwater Master Plan

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SUMMARY

This document contains the results of a stormwater master planning effort for the West Gresham study area (WGSA). The West Gresham study area is mostly developed and comprises approximately 5.8 square miles in the northwest corner of the City of Gresham (see Figure 1). The northern half of the study area drains through approximately 28 miles of storm sewer pipes to the Columbia Slough. The southern half of the study area drains to the subsurface through 373 City of Gresham dry wells (see Figure 2). Multnomah County also owns and operates 239 additional dry wells located within the right-of-way in the major arterials of this area. The purpose of this master plan is to address flood control and water quality issues for both the piped and dry well systems. Water quality issues are tied to two state regulatory programs, the total maximum daily load (TMDL) requirements for the Columbia Slough and underground injection control (UIC) requirements for the protection of groundwater quality.

Flood Control:
For the West Gresham Study Area, both the piped system and dry well system were evaluated with respect to their capacity for handling stormwater drainage. The piped system was evaluated using the XP-SWMM hydrologic/hydraulic model with respect to the City of Gresham's Public Works Design Standards. Of the 188 pipe segments modeled, flooding problems were identified in 41 model segments (a model segment may represent more than one pipe segment). Approximately 60% of these problems were associated with the 50-year storm. Based on the very few flooding problems that were actually observed in this area during recent large events, the model was thought to be somewhat conservative (i.e., it was over predicting flows). Therefore, flow monitoring data were collected during the winter of 2003/2004 and the model was calibrated based on these flows to improve the accuracy of the models. The calibration demonstrated that as expected the model was overpredicting flows. It resulted in reduced flow estimates from the model with flooding problems identified in 23 model segments.

For the dry well area, identification of capacity issues was based on field observations and recent infiltration tests conducted by the City. Capacity issues were not identified in this area. The dry wells were also evaluated with respect to nine physical criteria outlined in the Underground Injection Control (UIC) requirements. In general, the West Gresham dry wells met all nine of the UIC physical criteria.

Water Quality:
An evaluation was conducted to identify whether stormwater-related water quality problems should be addressed in the piped and/or dry well systems of the WGSA. To identify these problems, stormwater quality data were evaluated for Gresham. The data were then compared to surface water quality standards for the protection of aquatic life (these apply to the piped system discharging to the Columbia Slough) and to groundwater quality standards for the protection of drinking water (these apply to the dry wells discharging to the subsurface).

Based on the evaluation, parameters of concern with respect to discharges to the Columbia Slough include bacteria, heavy metals, oil & grease, sediments, nutrients and temperature. Parameters of concern with respect to discharges to the subsurface include bacteria and heavy metals. In addition to the ubiquitous problems associated with stormwater runoff in the study

area, spills and illicit discharges also pose a threat to both surface and groundwaters although these are less predictable.

Proposed Management Alternatives
Potential capital improvement project alternatives were proposed for addressing the identified flooding and water quality issues. A total of seven capital improvement projects were proposed to address flooding problems in the piped system and eight potential water quality capital improvement projects were proposed for the piped area. Capital improvement projects were not proposed for the dry well area due to the lack of identified capacity issues and due to the water quality treatment that is already provided by the significant natural filtration medium that is expected to exist between the base of the dry wells and the top of the seasonal high groundwater.

Selected Management Alternatives
Guiding principals were developed to select and rank potential capital improvement projects on a qualitative basis. Using these guiding principals, water quality and flood control projects were first ranked separately. Then the projects were combined and ranked as a whole. Four water quality projects and six flood control projects were selected and ranked for implementation. As significant flooding problems have not been observed in the study area, water quality projects were ranked as higher priority than flood control projects. A list of the selected capital improvement projects in order of priority ranking is provided in the table below. The location of these projects is illustrated in Figure 14.

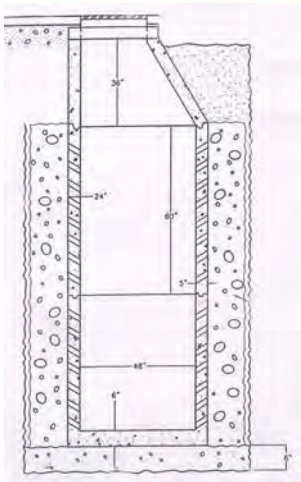
Capital Improvement Project ID	Capital Improvement Project Description	Estimated Construction/Engineering /Administration Costs	Estimated Acquisition Costs
WGWQ-4B	Water quality facility at N of Sandy Blvd. and W of 197th Pl.	$1,135,400	$994,620
WGWQ-4A	Water quality facility at N of Sandy Blvd. and E of 185th.	$1,616,200	$1,415,700
WGWQ-3A	Water quality facility at N. 181st and Sandy Blvd.	$1,922,780	$1,684,320
WGWQ-1A	Water quality facility at N. 162nd Ave.	$2,096,800	$1,836,780
WGFC-3A	South 181st Ave. pipe replacements.	$1,040,100	NA
WGFC-5	Barr Rd./Halsey St. pipe replacements.	$1,247,500	NA
WGFC-4	North 181st Ave. pipe replacements.	$1,044,300	NA
WGFC-2	North 162nd Ave. pipe replacements.	$433,900	NA
WGFC-6	East of 194th Ave. cul-de-sac pipe replacements.	$54,900	NA
WGFC-1	South 162nd Ave. pipe replacements.	$80,100	NA
	Totals	$10,671,980	$5,931,420

TBD = to be determined. NA = does not apply.

Synopsis of Section 1 – This document contains the results of a stormwater master planning effort for the West Gresham area (see the study area shown in Figure 1). The northern half of the study area drains through pipes to the Columbia Slough. The southern half of the study area drains to the subsurface through dry wells (see Figure 2). The purpose of this master plan is to address flood control and water quality issues for both of these systems. Water quality issues are tied to two regulatory programs including total maximum daily load (TMDL) requirements for the Columbia Slough and underground injection control (UIC) requirements for the protection of groundwater quality. The approach to developing a master plan for this area is shown diagramatically in Figure 3.

1.1 NEED FOR THE PLAN

In the spring of 2001, the City of Gresham initiated a project to develop a stormwater master plan for the West Gresham area. This document presents the results of that master planning effort. The area covered by this study is bounded on the west by the Gresham city limits, on the north by the southern boundary of Multnomah County Drainage District No. 1, on the east by the Fairview Creek watershed boundary and on the south by the Division Street vicinity (see Figures 1 and 2). Stormwater runoff from the northern half of the study area drains north through a piped system and discharges to the Columbia Slough. Stormwater runoff from the southern half of the study area discharges to dry wells. Dry wells are essentially bottomless catch basins that penetrate the very permeable subsurface that underlies parts of the metropolitan area.



There are two primary objectives of this stormwater master plan. The first is to develop a plan that enables the City to meet its storm drainage/flood protection criteria as urban development and redevelopment continues in the West Gresham area. Although, the area has not experienced serious flooding to date, the risk of flooding might increase as currently vacant parcels of land are developed. The second objective is to develop capital improvement projects that address stormwater quality issues and hence support compliance with associated regulatory requirements.

Two Primary Plan Objectives:

- *Develop a plan to meet storm drainage/flood protection criteria.*
- *Develop capital projects that address stormwater quality issues.*

In the past, the City of Gresham's drainage program had a single goal – prevention of flooding. The City sought to achieve this goal as cost-effectively as possible by designing and building drainage facilities, as they were needed. But in the 1990s, new regulations were enacted. These rules, enacted pursuant to the Clean Water Act and, more recently, the Endangered Species Act, and the Safe Drinking Water Act required that the City examine its stormwater drainage practices to determine if additional measures should be implemented to protect surface and groundwater quality, fish and other natural resources.

Until the 1990s, the discharge of urban runoff to surface and groundwater bodies was essentially unregulated. In 1995, the Oregon Department of Environmental Quality (DEQ) issued an NPDES stormwater permit to the City of Gresham. The permit allowed the City to discharge urban stormwater to surface water bodies provided the City met certain conditions and implemented an approved stormwater management plan. The City has been progressively implementing the stormwater management plan since 1995. Stormwater drainage practices in areas of Gresham that drain to surface streams now conform with the stormwater management plan. However, stormwater drainage practices in areas that drain to stormwater dry wells have been, until recently, largely unregulated. That changed in September of 2001 when the Oregon Environmental Quality Commission finalized rules with specific requirements related to the discharge of urban stormwater to the subsurface via stormwater dry wells. Thus, all parts of the West Gresham study area are now subject to stormwater quality regulations whether stormwater runoff is routed to the surface or subsurface.

The discharge of stormwater to the Columbia Slough is further complicated by the existence of Total Maximum Daily Loads (TMDLs) for that water body. Because the Columbia Slough is out-of-compliance with ambient water quality standards for many constituents, DEQ has established TMDLs for the water body. Current constituents of concern in the upper reaches of Columbia Slough include dissolved oxygen, pH, nutrients (total phosphorus and dissolved ortho-phosphate), bacteria (E. coli), toxics (total and dissolved lead), and organic compounds (PCBs, DDT/DDE, TCDD, and dieldrin). Water temperature is likely to be added soon. Although current TMDLs do not include numerical limits on the discharge of pollutants in stormwater, they may do so in the future. Thus, surface water discharges of stormwater from the West Gresham area will not only have to comply with Gresham's own stormwater management plan and NPDES permit but also with current and future TMDLs for the Columbia Slough.

1.2 APPROACH TO MASTER PLANNING

The approach for developing the West Gresham Stormwater Master Plan is illustrated in Figure 3. The project approach basically has two sub-approaches. The first sub-approach (shown as shaded on Figure 3) is related to the existing dry well system in the southern portion of the study area. The first step in this sub-approach was to evaluate existing and future capacity issues with respect to the dry wells. If capacity issues were identified as a problem, then they would be evaluated in the second sub-approach with respect to adding the flows to the piped system. If capacity issues were not identified as a problem, then the systems would be evaluated with respect to drinking water quality and UIC regulatory issues. If dry wells were not deemed acceptable with respect to these water quality issues, then development standards or capital improvement project alternatives would be considered.

The second sub-approach was related to the existing piped system in the northern portion of the study area. This system was evaluated with respect to capacity issues using XP-SWMM, a hydrologic/hydraulic model. The piped system was also evaluated with respect to surface water quality issues in the Columbia Slough. Depending on the outcome of these evaluations,

development standards and/or capital improvement projects would be considered to address any identified problems.

1.3 PLAN ORGANIZATION

The remaining sections of the West Gresham Stormwater Master Plan are organized as follows:

- Section 2.0 includes a summary of the West Gresham study area characteristics.
- Section 3.0 describes the flood control evaluation with respect to both the piped and sumped systems.
- Section 4.0 describes the evaluation of the drywells.
- Section 5.0 describes the water quality evaluation for both the piped and sumped systems. Section 6.0 describes the selected management alternatives to address flooding and water quality issues identified in Sections 3.0 and 4.0.
- Section 7.0 describes the proposed implementation schedule for the management alternatives.

Synopsis of Section 2 – The West Gresham study area comprises approximately 5.8 square miles in the northwest corner of Gresham (see Figure 1). It is mostly developed and includes approximately 28 miles of storm sewer pipe and 373 dry wells. Multnomah County owns and operates 239 additional dry wells in the study area which are located along the major arterials.

The West Gresham Study Area (WGSA) is described below in terms of location, topography, land use, rainfall, hydrology and drainage.

Study Area Location

The WGSA comprises approximately 5.8 square miles in the northwest corner of Gresham. Interstate Highway 84 (I-84) runs east and west through the study area and separates two terraced areas.

Topography

The northern terrace ranges in elevation from approximately 10 to 150 feet above mean sea level (msl). The southern terrace slopes gently upward toward the south, with elevations ranging between approximately 150 to 300 ft-msl (USGS, 2001). Grant Butte is located near the southeast boundary of the study area, with an upper elevation of 558 ft-msl. The boundary of the WGSA and the surrounding vicinity are shown in Figure 1.

Land Use

The WGSA is mostly developed with approximately 20 percent currently undeveloped. Land use consists of single family residential, commercial (including mixed residential/commercial), and industrial. Approximately 51% of the WGSA is zoned industrial or commercial, as shown on Figure 4.

The WGSA comprises approximately 5.8 mi^2. Urban stormwater runoff from the northern half of the study area drains through pipes to the Columbia Slough The southern half of the study area drains to the subsurface through dry wells.

Rainfall

The WGSA is located within the Portland metropolitan area. Average annual precipitation is approximately 40 inches (OCS, 2001).

Hydrology and Drainage

There are approximately 28 miles of stormwater pipe in the study area. The piped system conveys stormwater away from developments in the northern half of the study area and discharges it to the Columbia Slough at four major outfalls.

Stormwater runoff from the southern portion of the study area discharges to the subsurface through 373 city-owned dry wells. The locations of the dry wells are shown on Figure 2. The dry wells are generally located south of NE Halsey Street, Sections 31 and 32 (of Township 1 North, Range 3 East) and Sections 5 and 6 (of Township 1 South, Range 3 E). Stormwater dry wells are also used to dispose of runoff from many of the arterial roads and the Tri-Met tracks running

through this area. Two hundred and thirty nine of these dry wells are owned and operated by Multnomah County. County wells are also shown on Figure 2.

Dry wells are generally 20 to 28 feet deep and constructed of vertically stacked perforated concrete rings to enable stormwater to infiltrate the soil. The City currently requires sedimentation chambers upstream of dry wells; however, many older dry wells were constructed without these chambers.

Synopsis of Section 3 – For the West Gresham Study Area, both the piped system and sumped system were evaluated with respect to their capacity for handling stormwater drainage. For the piped area, XP-SWMM was used to model the system. The piped system was evaluated with respect to the City of Gresham's Public Works Design Standards. Problems were defined as instances where stormwater overflowed on to road surfaces during the design storm of concern (i.e., either the 10-year or 50-year storm). Of the 188 pipe segments modeled, flooding problems were identified in 23 segments (a modeled segment may represent more than one pipe segment). Approximately 78% of these problems were associated with the 50-year storm.

3.1 STUDY AREA DRAINAGE PATTERNS

In the West Gresham Study Area, approximately 52% of the average annual runoff is currently drained to the subsurface through dry wells and 48% is drained through pipes to the Columbia Slough. Runoff in both the sumped and piped portion of the study area is expected to increase by approximately 5% as a result of expected future development. The following sections describe the flood control evaluation that was conducted for the piped system in terms of drainage standards (section 3.1), evaluation methods (section 3.2) and results (section 3.3). Section 4.0 describes the evaluation that was conducted for the sumped system.

The study area is mostly developed and runoff is only expected to increase by approximately 5%.

3.2 DRAINAGE STANDARDS

The City of Gresham has established standards for drainage systems within its service area that are designed to protect lives and property. As stated in the City's Public Works Design Standards, major drainage system elements shall meet the following conveyance capacity requirements:

- Laterals (collectors) draining less than 250 acres: convey the runoff from a 10-year 24-hour design storm.
- Trunks draining greater than 250 acres: convey the runoff from a 50-year 24-hour design storm.
- Arterial streets and the drainage system in or under arterial streets: convey the runoff from a 50-year 24-hour design storm.

For this study, the 2-, 10-, 50-, and 100-year 24-hour design storm volumes that were used in the evaluation were obtained from the Rainfall Intensity Duration Curve in the City's Public Works Design Standards Manual. The design storms were assumed to follow the SCS Type IA distribution. Storm events for different return periods are as follows:

- 2-year 24-hour design storm: volume = 2.8 inches; maximum intensity = 0.47 inches/hr
- 10-year 24-hour design storm: volume = 3.6 inches; maximum intensity = 0.61 inches/hr
- 50-year 24-hour design storm: volume = 4.3 inches; maximum intensity = 0.73 inches/hr

- 100-year 24-hour design storm: volume = 5.0 inches; maximum intensity = 0.85 inches/hr

3.3 EVALUATION METHODS

To evaluate flood hazard, a computer model was developed to simulate the hydrologic and hydraulic performance of the piped system. The XP-SWMM model was selected to conduct the evaluation. The XP-SWMM model is a proprietary version of the SWMM (stormwater management model) program, which was developed by the Environmental Protection Agency for the hydrologic, hydraulic and water quality analyses of combined sewer or separate sewer systems in urban environments. The hydrology routine in XP-SWMM converts rainfall into stormwater runoff based on the design storm parameters (e.g., volume and intensity of rainfall) and subbasin characteristics such as topography, land use, vegetation, and soil types. The hydraulics routine in the model then routes the stormwater runoff through the drainage system and enables predictions to be made of stormwater flow rates, water surface elevations, and velocities during design storms.

The existing storm drainage pipes in the West Gresham area were evaluated under both existing and future land use conditions. A schematic plot of the modeled system is shown in Figure 5 and Figures 6a through 6e. In general, the evaluation concentrated on the significant components of the public drainage system; typically, all storm pipes with a diameter of 24" or greater. These pipes represent 13.6 miles of the total 28 miles of storm drainage pipes in the study area.

The piped system study area was evaluated for capacity deficiencies under both existing and future conditions using XP-SWMM.

In order to develop the hydrologic and hydraulic computer models for the existing system, the study area was subdivided into forty-nine subbasins (see Figures 6a through 6e). The subbasin boundaries were digitized into the City's GIS so that the hydrologic data could be generated for each subbasin. Information for the piped system was obtained from the City's GIS and from interpretation of as-built drawings of recent developments.

The initial model results were estimated to be over estimate flows based on actual observed flows during large storm events. Therefore, flow monitoring was recommended so that the model could be calibrated. In the winter of 2003/2004, the City of Gresham monitored flows to obtain field data which could be used to increase the accuracy of the model. Flow monitoring was conducted at two major trunkline storm drains located north of the Boeing site (model nodes 2749-W-006 and 2750-W-012) for the following storm events: November 19, 2003; December 13, 2003; and January 23, 2004.

The calibration was based on comparisons between model-simulated flows and measured flows at nodes 2749-W-006 and 2750-W-012. Comparisons between measured flows and simulated flows at node 2750-W-012 revealed large differences (i.e., the simulated flows were much lower than the measured flows). Adjusting model parameters within a reasonable range of values did not help to reduce the flow differences to the extent necessary. Based on a review with the City

of these significant differences, flow data obtained by field monitoring at node 2750-W-012 were discarded. Flow measurements at this location were considered to be inaccurate not only due to significant differences with model results, but also due to difficulties the City had in calibrating the flow meter during installation.

Comparisons between measured flows and simulated flows at node 2749-W-006 also revealed differences but in this case, simulated flows were higher than measured flows. Using node 2749-W-006 as the calibration point, model parameters were adjusted to reduce differences between simulated and measured flows. These adjustments to model input parameters were applied to the entire West Gresham model, and the calibration was verified with the November 19, 2003, and January 23, 2004, storms. Several model runs were conducted to evaluate the model's sensitivity to changes in input parameters. The results of the sensitivity analysis indicate that the impervious percentage area and the subbasin width were the most sensitive parameters.

Several combinations of calibration adjustments were evaluated to obtain the best calibration to the model (i.e., to reduce differences between simulated and measured flows). The alternative calibration combinations that were evaluated are shown in the following table. The best results were obtained using a 20% reduction in the effective impervious area and a 25% reduction in the subbasin widths (as shown in the lowest three rows of the table). URS recommends the combination of calibration adjustments that are shaded in the table:

Table 3-1
Combinations of Calibration Adjustments and Results for Node 2746-W-006

Alternative Model Adjustments	Storm Event Date	Simulated Flow (cfs)	Measured Flow (cfs)	Percent Difference
No initial Changes	11/19/2003	109.5	55.8	96%
No initial Changes	12/13/2003	62.6	47.8	31%
No initial Changes	1/23/2004	30.8	25.1	22%
15% Reduction Imp. %	11/19/2003	97.5	55.8	75%
15% Reduction Imp. %	12/13/2003	54.2	47.8	14%
15% Reduction Imp. %	1/23/2004	26.6	25.1	6%
25% Reduction imp. %	11/19/2003	84.6	55.8	52%
25% Reduction imp. %	12/13/2003	48.4	47.8	1%
25% Reduction imp. %	1/23/2004	23.7	25.1	-6%
25% Reduction Subbasin Width	11/19/2003	107.9	55.8	93%
25% Reduction Subbasin Width	12/13/2003	59.8	47.8	25%
25% Reduction Subbasin Width	1/23/2004	29.7	25.1	18%
50% Reduction Subbasin Width	11/19/2003	101.8	55.8	82%

Alternative Model Adjustments	Storm Event Date	Simulated Flow (cfs)	Measured Flow (cfs)	Percent Difference
50% Reduction Subbasin Width	12/13/2003	55.7	47.8	17%
50% Reduction Subbasin Width	1/23/2004	28.0	25.1	11%
15% Reduction Imp % & 25% Reduction Subbasin Width	11/19/2003	93.1	55.8	67%
15% Reduction Imp % & 25% Reduction Subbasin Width	12/13/2003	51.9	47.8	9%
15% Reduction Imp % & 25% Reduction Subbasin Width	1/23/2004	25.7	25.1	2%
15% Reduction Imp % & 50% Reduction Subbasin Width	11/19/2003	88.4	55.8	59%
15% Reduction Imp % & 50% Reduction Subbasin Width	12/13/2003	48.5	47.8	1%
15% Reduction Imp % & 50% Reduction Subbasin Width	1/23/2004	24.3	25.1	-3%
20% Reduction Imp % & 25% Reduction Subbasin Width	11/19/2003	87.2	55.8	56%
20% Reduction Imp % & 25% Reduction Subbasin Width	12/13/2003	49.2	47.8	3%
20% Reduction Imp % & 25% Reduction Subbasin Width	1/23/2004	24.4	25.1	-3%

A detailed description of the process and sources of input data that were used to develop the XP-SWMM model are provided in Appendix A. The actual model input data are also provided. Model results are provided in Table 3-2 and illustrated on Figure 5. Table 3-2 includes peak flows and water surface elevations for the relevant design storm under both existing and future conditions. Flooding problems were defined as those circumstances where the model predicted that stormwater would overflow on to road surfaces. In other words, surcharging was considered to be acceptable as long as flows did not reach roadways. The last three columns in the Table 3-2 indicate which conduits are expected to be deficient and when (i.e., under existing and/or future land use conditions) and which capital improvement project is proposed to address the problem. Additional detailed information regarding the model results (e.g., results for all storms modeled) for hydrology and hydraulics are provided in Appendices B and C, respectively.

3.4 RESULTS

One hundred and eighty eight pipe segments were modeled. It should be noted that each pipe segment listed in the table may include several individual pipe runs between manholes if pipe material and size were constant and slope did not change significantly. Of these 188 segments,

Problems were predicted by the model for approximately 22% of the segments modeled.

problems were predicted for 23 segments (see Figure 5). Five problems were predicted for the 10-year storm. All 5 problems predicted for the 10-year storm, were in segments with 50-year design storm criteria. In general, 10-year flooding problems were predicted for the following locations:

- Along 181st St. starting approximately one block north of NE Pacific Ct. and extending one block south of Halsey St.
- Along Halsey St. starting just east of the intersection with 183rd and continuing approximately one block east of 186th St.

For the 10-year event, system performance under existing conditions was the same as system performance for future conditions. This was due to the fact that the future model included simulation of Gresham's detention requirement for new development. Detention is required to maintain the 10 and 25-year peak flows at pre-development levels.

Eighteen problems were predicted for pipes designed for the 50-year storm. An additional 3 problems were predicted for the 50-year storm in pipes that have a 10-yr storm design criteria (last bullet below). In general, 50-year flooding problems were predicted for the following locations.

- At the intersection of 162nd Ave. and Wasco St.
- Along 181st St. starting half block south of Oregon St. and extending to the intersection of San Rafael St.
- Along 181st St starting near the I-84 on ramps and extending to the outfall.
- Along Halsey St. starting one block east of 186th St. and continuing to 190nd Ave.
- Along 195th Ave. starting at San Rafael St. and extending a block north.

For the 50-year event, there was a more significant difference between the system performance under existing conditions and the system performance under future conditions (due to the fact that detention requirements for future development don't address the 50-year storm) with approximately 78% of the problems (i.e., 14 out of 18) occurring under future conditions.

Table 3-1 Hydraulic Performance of West Gresham Storm Drainage System

Structure ID	Node ID		Structure Size/Type	Structure Length	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				Calibrated Flooding Identified For Relevant Design Storm ?	Calibrated When Deficient	Number of CIP to Address The Problem
								Existing Land Use		Future Land Use				
	US	DS		(ft)		Existing	Future	US	DS	US	DS			
2644	2946-W-002	2946-W-001	12-in Dia CONC	399	50	11	11	258.3	219.4	258.3	219.4	Yes (Existing)	50	1
2644-RD	2946-W-002	2946-W-001	Roadway	399	50	1	1	258.3	227.5	258.3	227.5			
2633	2946-W-001	2846-W-001	15-in Dia CONC	241	50	11	13	219.0	208.3	219.2	208.4			
10039	2846-W-001	2846-W-002	36-in Dia CONC	244	50	38	41	208.3	205.4	208.3	205.5			
4586	2846-W-002	2846-W-003	36-in Dia CONC	270	50	38	40	205.4	203.3	205.5	203.4			
2596	2846-W-003	2846-W-004	42-in Dia RC	608	50	55	57	203.3	199.3	203.4	199.3			
4572	2846-W-004	2846-W-005	36-in Dia RC	390	50	56	59	199.3	191.4	199.3	191.6			
737	2846-W-005	2846-W-006	36-in Dia RC	340	50	56	58	191.4	187.3	191.6	187.6			
4556	2846-W-006	2846-W-007	36-in Dia RC	350	50	83	86	187.3	178.2	187.6	178.3			
4556-RD	2846-W-006	2846-W-007	Roadway	350	50	0	0	178.2	178.2	178.3	178.3			
2564	2846-W-007	2746-W-001	36-in Dia RC	418	50	83	86	178.2	166.5	178.3	166.6			
2526	2746-W-001	2746-W-002	48-in Dia RC	22	50	83	86	166.0	165.8	166.1	165.9			
2562	2847-W-007	2847-W-006	30-in Dia CONC	81	10	19	19	171.6	171.2	171.6	171.2			
4549	2847-W-006	2847-W-005	30-in Dia CONC	188	10	19	19	171.2	170.2	171.2	170.2			
2555	2847-W-005	2847-W-004	30-in Dia CONC	172	10	19	19	170.2	169.3	170.2	169.3			
5644	2847-W-004	2747-W-007	36-in Dia CONC	371	10	19	19	169.2	168.1	169.2	168.1			
4534	2747-W-007	2747-W-006	36-in Dia CONC	78	10	19	19	168.1	167.8	168.1	167.8			
10040	2747-W-006	2747-W-005	48-in Dia CONC	105	10	19	19	167.8	167.7	167.8	167.7			
4533	2747-W-005	2747-W-004	48-in Dia CONC	154	10	33	33	167.7	167.3	167.7	167.3			
2524	2747-W-004	2747-W-003	48-in Dia CONC	240	10	33	33	167.3	166.9	167.3	166.9			
2523	2747-W-003	2747-W-002	48-in Dia CONC	270	10	33	33	166.9	166.3	166.9	166.3			
5642	2747-W-002	2747-W-001	48-in Dia CONC	186	10	33	33	166.3	166.0	166.3	166.0			
5641	2747-W-001	2746-W-002	36-in Dia CONC	31	10	33	33	166.0	165.6	166.0	165.6			
5641-RD	2746-W-002	2747-W-001	Roadway	31	10	0	0	166.0	166.0	166.0	166.0			
6025	2746-W-002	2746-W-003	48-in Dia RC	200	50	166	170	165.8	157.1	165.9	157.1			
764	2746-W-003	2746-W-004	48-in Dia RC	622	50	180	184	156.9	131.1	156.9	131.1			
763	2746-W-004	2746-W-005	42-in Dia RC	644	50	180	184	131.1	90.2	131.1	90.3			
763-RD	2746-W-004	2746-W-005	Roadway	644	50	0	0	90.2	90.2	90.2	90.2			
2505	2746-W-005	2746-W-006	42-in Dia RC	196	50	180	184	90.2	76.9	90.2	76.9			
762	2746-W-006	2746-W-007	72-in Dia RC	202	50	207	211	76.6	71.2	76.6	71.2			
4518	2746-W-007	2746-W-008	54-in Dia RC	541	50	207	211	71.2	56.5	71.2	56.7			
2490	2746-W-008	2646-W-001	72-in Dia RC	466	50	207	220	56.5	52.2	56.7	53.1			
2490-RD	2746-W-008	2646-W-001	Roadway	466	50	0	0	52.2	52.2	53.1	53.1			
4511	2646-W-001	2646-W-002	54-in Dia RC	114	50	239	307	52.2	45.1	53.1	48.8	Yes (Future)	50	2
4511-RD	2646-W-001	2646-W-002	Roadway	114	50	0	12	45.1	45.1	53.1	51.1			
2486	2646-W-002	2646-W-003	54-in Dia RC	77	50	243	305	45.1	40.6	48.9	46.6			2 [3]
2486-RD	2646-W-002	2646-W-003	Roadway	77	50	0	0	40.6	40.6	46.6	46.6			
4509	2646-W-003	2646-W-004	48-in Dia RC	291	50	239	289	40.6	27.2	46.6	29.4			2 [3]
4509-RD	2646-W-003	2646-W-004	Roadway	291	50	0	0	27.2	27.2	29.4	29.4			
760	2646-W-004	2646-W-005	72-in Dia RC	241	50	237	291	27.2	25.9	29.4	27.0			
760-RD	2646-W-004	2646-W-005	Roadway	241	50	0	0	25.9	25.9	27.0	27.0			
5913	2646-W-005	2647-W-601	72-in Dia RC	61	50	237	292	25.9	22.9	27.0	23.5			
5551	3048-W-002	3048-W-001	21-in Dia CONC	250	50	9	11	243.8	243.0	248.7	247.3			
5551-RD	3048-W-002	3048-W-001	Roadway	250	50	0	0	243.0	243.0	247.3	247.3			
2730	3048-W-001	2948-W-014	27-in Dia CONC	300	50	23	30	243.0	241.1	247.3	244.2			
2730-RD	3048-W-001	2948-W-014	Roadway	300	50	0	0	241.1	241.1	244.2	244.2			
2723	2948-W-014	2948-W-013	27-in Dia CONC	300	50	23	30	241.1	239.3	244.2	241.0			
2723-RD	2948-W-014	2948-W-013	Roadway	300	50	0	0	239.3	239.3	241.0	241.0			

*** The pipe was designed for a 10-year event and is not planned for improvements for failing to pass the 50-yr event.**

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2. No improvements are proposed for this pipe segment as the problem was resolved as a result of a proposed CIP at another location.

3. Deficiencies were not identified in the model for this pipe segment however improvements made to this pipe segment were necessary to alleviate flooding problems upstream.

4. This segment was also deficient for the 25-yr event. However, this table only includes reporting for the 10-yr and 50-yr events as those are the design criteria that are applied to the pipes in Gresham.

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								Existing Land Use		Future Land Use				
	US	DS		(ft)		Existing	Future	US	DS	US	DS			
10029	2948-W-013	2948-W-012	27-in Dia CONC	53	50	23	30	239.3	238.9	241.0	240.5	Yes (Future)	50	3 [2]
10029-RD	2948-W-013	2948-W-012	Roadway	53	50	0	1	238.9	238.9	241.0	240.5			
2706	2948-W-012	2948-W-011	27-in Dia CONC	377	50	33	37	238.9	233.8	240.5	234.0			
2706-RD	2948-W-012	2948-W-011	Roadway	377	50	0	0	233.8	233.8	240.5	236.5			
2687	2948-W-011	2948-W-010	36-in Dia CONC	363	50	33	37	233.8	232.6	234.0	232.7			
2687-RD	2948-W-011	2948-W-010	Roadway	363	50	0	0	232.6	232.6	232.7	232.7			
10028	2948-W-010	2948-W-009	27-in Dia CONC	122	50	26	26	232.6	232.0	232.7	232.1	Yes (Existing)	50	3
10028-RD	2948-W-010	2948-W-009	Roadway	122	50	7	16	232.6	232.1	232.7	232.2			
2688	2948-W-009	2948-W-008	27-in Dia CONC	111	50	32	33	232.0	230.6	232.1	230.6	Yes (Future)	50	3
2688-RD	2948-W-009	2948-W-008	Roadway	111	50	0	9	230.6	230.6	232.1	230.6			
2660	2948-W-008	2948-W-007	27-in Dia CONC	398	50	29	34	230.6	219.7	230.6	219.9	Yes (Existing)	10	3
2660-RD	2948-W-008	2948-W-007	Roadway	398	50	3	7	230.6	225.8	230.6	225.8			
5550	2948-W-007	2948-W-006	27-in Dia CONC	350	50	34	42	219.7	204.6	219.9	204.7			
5550-RD	2948-W-007	2948-W-006	Roadway	350	50	0	0	204.6	204.6	204.7	204.7			
5675	2948-W-019	2948-W-020	24-in Dia CONC	201	10	10	10	220.1	219.0	220.1	219.0			
5675-RD	2948-W-020	2948-W-019	Roadway	201	10	0	0	220.1	220.1	220.1	220.1			
2658	2948-W-020	2948-W-021	24-in Dia CONC	270	10	10	10	219.0	217.3	219.0	217.3			
2657	2948-W-021	2948-W-022	24-in Dia CONC	208	10	25	25	213.7	211.1	213.7	211.1			
2645	2948-W-022	2948-W-023	24-in Dia CONC	442	10	25	25	211.1	205.6	211.1	205.6		50	*
2645-RD	2948-W-022	2948-W-023	Roadway	442	10	0	0	205.6	205.6	205.6	205.6			
4597	2948-W-023	2948-W-006	24-in Dia CONC	73	10	27	27	205.6	204.5	205.6	204.5		50	*
4597-RD	2948-W-023	2948-W-006	Roadway	73	10	0	0	204.5	204.5	204.5	204.5			
2638	2948-W-006	2948-W-005	30-in Dia CONC	280	50	47	47	204.6	201.2	204.7	201.3	Yes (Existing)	10	3
2638-RD	2948-W-006	2948-W-005	Roadway	280	50	18	35	204.6	201.2	204.7	201.3			
5549	2948-W-005	2848-W-007	30-in Dia CONC	445	50	48	49	201.2	197.8	201.3	199.1	Yes (Existing)	50 [4]	3
5549-RD	2948-W-005	2848-W-007	Roadway	445	50	22	48	201.2	199.2	201.3	199.3			
2624	2848-W-007	2848-W-006	30-in Dia RC	305	50	57	58	197.8	191.0	199.1	192.2	Yes (Future)	50	3
2624-RD	2848-W-007	2848-W-006	Roadway	305	50	0	20	191.0	191.0	199.1	192.2			
2619	2848-W-006	2848-W-005	30-in Dia RC	295	50	57	59	191.0	184.3	192.2	186.9	Yes (Future)	50	3
2619-RD	2848-W-006	2848-W-005	Roadway	295	50	0	26	184.3	184.3	192.2	186.9			
2620	2848-W-005	2848-W-004	36-in Dia CONC	279	50	57	70	184.3	181.9	186.9	183.8	Yes (Future)	50	3
2620-RD	2848-W-005	2848-W-004	Roadway	279	50	0	12	181.9	181.9	186.9	184.1			
5548	2848-W-004	2848-W-003	36-in Dia CONC	396	50	59	80	181.9	176.2	183.8	177.1			3 [3]
5548-RD	2848-W-003	2848-W-004	Roadway	396	50	0	0	181.9	181.9	183.8	183.8			
2591	2848-W-003	2848-W-002	36-in Dia CONC	290	50	59	80	176.2	169.7	177.1	172.3			3 [3]
2582	2848-W-002	2848-W-001	36-in Dia CONC	310	50	59	80	169.7	165.3	172.3	165.6			
2582-RD	2848-W-002	2848-W-001	Roadway	33	50	0	0	165.3	165.3	165.6	165.6			
4553	2848-W-001	2848-W-024	36-in Dia RC	187	50	62	79	165.3	159.7	165.6	160.0			
299	2848-W-024	2848-W-025	36-in Dia RC	42	50	62	79	159.5	157.4	159.9	157.6			
2628	2847-W-013	2847-W-014	36-in Dia CONC	381	50	7	15	200.7	198.7	201.1	199.2			
4593	2847-W-014	2847-W-015	36-in Dia CONC	125	50	7	15	198.7	198.2	199.2	198.6			
2623	2847-W-015	2847-W-016	36-in Dia CONC	408	50	7	15	198.2	196.0	198.6	196.4			
5639	2847-W-016	2848-W-030	42-in Dia CONC	497	50	7	15	196.0	194.2	196.4	194.7			
10087	2848-W-030	2848-W-031	42-in Dia CONC	258	50	7	15	194.2	193.7	194.7	194.1			
10088	2848-W-031	2848-W-032	42-in Dia CONC	98	50	7	15	193.7	193.2	194.1	193.6			
10089	2848-W-032	2848-W-033	42-in Dia CONC	302	50	7	15	193.2	190.6	193.6	190.9			
10090	2848-W-033	2848-W-027	42-in Dia CONC	466	50	7	15	190.6	187.0	190.9	187.4			
6221	2848-W-027	2848-W-028	42-in Dia CONC	344	10	29	29	186.9	180.5	186.9	180.5			
10052	2848-W-028	2848-W-013	42-in Dia CONC	465	10	29	29	180.5	174.7	180.5	174.7			

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								Existing Land Use		Future Land Use				
	US	DS		(ft)		Existing	Future	US	DS	US	DS			
4591	2848-W-013	2848-W-012	42-in Dia RC	47	10	29	29	174.7	174.2	174.7	174.2			
5652	2847-W-001	2847-W-002	24-in Dia RC	129	10	3	3	189.4	186.1	189.4	186.1			
4580	2847-W-002	2847-W-003	24-in Dia RC	101	10	3	3	186.1	183.7	186.1	183.7			
2600	2847-W-003	2848-W-008	24-in Dia RC	404	10	3	3	183.7	180.1	183.7	180.1			
2603	2848-W-008	2848-W-009	24-in Dia RC	382	10	3	3	180.1	177.9	180.1	177.9			
2604	2848-W-009	2848-W-010	30-in Dia RC	355	10	3	3	177.4	175.3	177.4	175.3			
2604-RD	2848-W-009	2848-W-010	Roadway	355	10	0	0	175.2	175.2	175.2	175.2			
4577	2848-W-010	2848-W-011	36-in Dia RC	413	10	3	3	175.2	173.5	175.2	173.5			
4577-RD	2848-W-011	2848-W-010	Roadway	413	10	0	0	175.2	175.2	175.2	175.2			
2605	2848-W-011	2848-W-012	36-in Dia RC	364	10	3	3	173.5	173.0	173.5	173.0			
2605-RD	2848-W-011	2848-W-012	Roadway	364	10	0	0	173.0	173.0	173.0	173.0			
2606	2848-W-012	2848-W-015	48-in Dia RC	433	10	46	46	173.0	169.9	173.0	169.9			
4578	2848-W-015	2848-W-016	48-in Dia RC	331	10	46	46	169.9	167.8	169.9	167.8			
2578	2848-W-016	2848-W-017	54-in Dia RC	502	10	46	46	167.6	165.3	167.6	165.3			
2578-RD	2848-W-017	2848-W-016	Roadway	502	10	0	0	167.6	167.6	167.6	167.6			
4561	2848-W-018	2848-W-017	36-in Dia RC	485	10	13	13	167.0	165.3	167.0	165.3			
2547	2848-W-017	2848-W-026	54-in Dia CONC	495	10	88	88	165.3	160.3	165.3	160.3			
4545	2848-W-026	2848-W-025	54-in Dia CONC	161	10	88	88	160.3	158.2	160.3	158.2			
2550	2848-W-025	2748-W-001	42-in Dia RC	445	50	169	190	155.2	127.8	156.1	135.8			
4543	2748-W-001	2748-W-002	48-in Dia CONC	152	50	168	190	127.8	123.8	135.8	131.1			
4543-RD	2748-W-001	2748-W-002	Roadway	152	50	0	0	123.8	123.8	131.1	131.1			
298	2748-W-002	2748-W-003	48-in Dia CONC	100	50	168	190	123.8	121.1	131.1	128.3			
298-RD	2748-W-002	2748-W-003	Roadway	100	50	0	0	123.8	123.8	131.1	131.1			
4530	2748-W-003	2748-W-004	42-in Dia CONC	375	50	207	228	121.1	102.5	128.3	105.7			
4530-RD	2748-W-003	2748-W-004	Roadway	375	50	0	0	102.5	102.5	105.7	105.7			
5545	2748-W-004	2748-W-005	48-in Dia CONC	425	50	208	213	102.5	90.4	105.7	96.1	Yes (Future)	50	4
5545-RD	2748-W-004	2748-W-005	Roadway	425	50	0	35	90.4	90.4	105.7	96.2			
10030	2748-W-005	2748-W-006	48-in Dia CONC	446	50	207	211	90.4	79.3	96.1	84.7	Yes (Future)	50	4
10030-RD	2748-W-005	2748-W-006	Roadway	446	50	0	7	79.3	79.3	96.1	84.7			
4522	2748-W-006	2748-W-007	48-in Dia CONC	68	50	227	264	79.3	76.0	84.7	82.3	Yes (Future)	50	4
4522-RD	2748-W-006	2748-W-007	Roadway	68	50	0	44	75.9	75.9	84.7	82.4			
297	2748-W-007	2748-W-008	48-in Dia CONC	337	50	228	264	75.9	61.3	82.3	68.6	Yes (Future)	50	4
297-RD	2748-W-007	2748-W-008	Roadway	337	50	0	4	61.3	61.3	82.3	68.6			
5939	2748-W-008	2748-W-009	42-in Dia CONC	368	50	229	246	61.3	37.6	68.6	42.6	Yes (Future)	50	4
5939-RD	2748-W-008	2748-W-009	Roadway	368	50	0	22	37.6	37.6	68.6	42.6			
10032	2748-W-009	2648-W-601	42-in Dia CONC	314	50	227	246	37.6	9.6	42.6	10.3	Yes (Future)	50	4
10032-RD	2748-W-009	2648-W-601	Roadway	314	50	0	23	9.6	9.6	42.6	14.1			
5544	2748-W-010	2748-W-011	30-in Dia HDPE	280	10	12	12	70.6	59.4	70.6	59.4			
10041	2748-W-011	2648-W-001	30-in Dia HDPE	325	10	12	12	59.2	41.5	59.2	41.5			
5944	2648-W-001	2648-W-602	30-in Dia HDPE	25	10	12	12	41.5	41.1	41.5	41.1			
L186	2648-W-602	2748-W-601	Natural	505	10	12	12	41.1	34.3	41.1	34.3			
5946	2748-W-601	2748-W-012	36-in Dia HDPE	55	10	11	11	34.3	33.4	34.3	33.4			
4515	2748-W-012	2748-W-013	36-in Dia HDPE	266	10	11	11	33.3	29.6	33.3	29.6			
296	2748-W-013	2648-W-002	36-in Dia HDPE	294	50	17	30	29.4	15.1	29.6	15.3			
5940	2648-W-002	2648-W-603	48-in Dia CONC	45	50	17	30	9.6	8.3	10.1	8.6			
2671	2949-W-009	2949-W-010	24-in Dia CONC	512	10	9	9	223.9	221.2	223.9	221.2			
2668	2949-W-010	2949-W-011	24-in Dia CONC	154	10	9	9	220.6	203.3	220.6	203.3			
5684	2949-W-011	2949-W-012	24-in Dia CONC	198	10	9	9	203.3	199.8	203.3	199.8			

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Structure ID	Node ID		Structure Size/Type	Structure Length	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				Calibrated Flooding Identified For Relevant Design Storm ?	Calibrated When Deficient	Number of CIP to Address The Problem
								Existing Land Use		Future Land Use				
	US	DS		(ft)		Existing	Future	US	DS	US	DS			
2662	2949-W-012	2549-W-013	30-in Dia CONC	412	10	10	10	199.8	199.6	199.8	199.6			
2662-RD	2949-W-012	2549-W-013	Roadway	412	10	0	0	199.6	199.6	199.6	199.6			
924	2549-W-013	2949-W-014	30-in Dia CONC	280	10	20	20	199.6	199.1	199.6	199.1			
924-RD	2549-W-013	2949-W-014	Roadway	280	10	0	0	199.1	199.1	199.1	199.1			
2639	2949-W-014	2549-W-024	24-in Dia CONC	196	50	21	25	200.2	198.1	201.4	198.2			
2639-RD	2949-W-014	2549-W-024	Roadway	196	50	0	0	198.1	198.1	198.2	198.2			
2634	2549-W-024	2849-W-025	27-in Dia RC	521	50	25	25	198.1	198.0	198.2	198.2	Yes (Existing)	2	5
2634-RD	2549-W-024	2849-W-025	Roadway	521	50	25	32	198.1	198.0	198.2	198.2			
10061	2849-W-025	2849-W-002	27-in Dia RC	68	50	26	26	198.0	198.0	198.2	198.2	Yes (Existing)	2	5
10061-RD	2849-W-025	2849-W-002	Roadway	68	50	19	25	198.0	198.0	198.2	198.2			
2647	2949-W-003	2949-W-008	24-in Dia CONC	200	50	13	16	199.4	198.6	200.3	199.2			
2647-RD	2949-W-003	2949-W-008	Roadway	200	50	0	0	198.2	198.2	198.6	198.6			
2637	2949-W-008	2849-W-001	24-in Dia CONC	199	50	13	16	198.6	198.1	199.2	198.3			
2637-RD	2949-W-008	2849-W-001	Roadway	199	50	0	0	198.1	198.1	198.3	198.3			
6249	2849-W-001	2849-W-002	24-in Dia CONC	36	50	16	16	198.1	198.0	198.3	198.2			
6249-RD	2849-W-001	2849-W-002	Roadway	36	50	0	0	198.0	198.0	198.2	198.2			
4594	2849-W-002	2849-W-026	27-in Dia RC	454	50	30	31	198.0	197.7	198.2	198.0	Yes (Existing)	10	5
4594-RD	2849-W-002	2849-W-026	Roadway	454	50	21	31	198.0	197.7	198.2	198.0			
2636	2849-W-026	2849-W-027	33-in Dia RC	379	50	33	35	197.7	197.0	198.0	197.9	Yes (Existing)	50	5
2636-RD	2849-W-026	2849-W-027	Roadway	379	50	4	23	197.7	197.6	198.0	197.9			
10062	2849-W-027	2849-W-028	42-in Dia RC	141	50	44	46	197.0	196.7	197.9	197.7	Yes (Future)	50	5 [2]
10062-RD	2849-W-027	2849-W-028	Roadway	141	50	0	20	196.7	196.7	197.9	197.7			
723	2849-W-028	2849-W-022	42-in Dia RC	233	50	44	46	196.7	196.2	197.7	197.3	Yes (Future)	50	5 [2]
723-RD	2849-W-028	2849-W-022	Roadway	233	50	0	6	196.2	196.2	197.7	197.6			
5638	2849-W-022	2849-W-021	42-in Dia RC	321	50	44	46	196.2	195.6	197.3	196.6			
5638-RD	2849-W-021	2849-W-022	Roadway	321	50	0	0	196.2	196.2	197.3	197.3			
2635	2849-W-021	2849-W-020	27-in Dia RC	472	10	48	48	194.3	180.6	194.3	180.6			5 [3]
2622	2849-W-020	2849-W-019	27-in Dia RC	475	10	48	48	180.6	167.8	180.6	167.8			5 [3]
4589	2849-W-019	2849-W-018	27-in Dia RC	309	10	48	48	167.8	159.4	167.8	159.4			5 [3]
2602	2848-W027a	2849-W-009	30-in Dia RC	360	10	2	2	165.5	164.4	165.5	164.4			
6149	2849-W-009	2849-W-015	30-in Dia RC	132	10	2	2	164.4	164.0	164.4	164.0			
6148	2849-W-015	2849-W-014	30-in Dia RC	227	10	2	2	164.0	163.2	164.0	163.2			
2607	2849-W-014	2849-W-013	36-in Dia RC	400	10	3	3	163.1	163.0	163.1	163.0			
4579	2849-W-013	2849-W-012	36-in Dia RC	400	10	23	23	163.0	161.4	163.0	161.4			
2608	2849-W-012	2849-W-011	42-in Dia RC	340	10	23	23	161.2	160.2	161.2	160.2			
4581	2849-W-011	2849-W-010	42-in Dia RC	345	10	23	23	160.2	159.7	160.2	159.7			
10068	2849-W-010	2849-W-018	42-in Dia RC	269	10	37	37	159.7	158.6	159.7	158.6			
2610	2849-W-018	2849-W-017	48-in Dia RC	465	50	100	110	158.9	153.9	159.2	154.1			
10067	2849-W-017	2849-W-016	48-in Dia RC	620	50	100	110	153.9	148.6	154.1	148.8			
10063	2849-W-016	2849-W-008	48-in Dia RC	312	50	99	110	148.6	144.8	148.8	145.0			
2566	2848-W-001	2849-W-003	24-in Dia RC	482	10	0	0	165.2	159.9	165.2	159.9			
2545	2849-W-003	2849-W-004	24-in Dia CONC	398	10	0	0	159.9	157.8	159.9	157.8			
2549	2849-W-004	2849-W-005	30-in Dia RC	400	10	0	0	157.3	155.4	157.3	155.4			
4542	2849-W-005	2849-W-006	30-in Dia RC	400	10	0	0	155.4	153.3	155.4	153.3			
4542-RD	2849-W-005	2849-W-006	Roadway	400	10	0	0	153.1	153.1	153.1	153.1			

*** The pipe was designed for a 10-year event and is not planned for improvements for failing to pass the 50-yr event.**

1. A flooding problem was identified if the model showed flow entering the roadway.
In some cases the water just ponded on the roadway and recorded flow rates in the roadway were zero. These were still considered to be flooding problems.

2. No improvements are proposed for this pipe segment as the problem was resolved as a result of a proposed CIP at another location.

3. Deficiencies were not identified in the model for this pipe segment however improvements made to this pipe segment were necessary to alleviate flooding problems upstream.

4. This segment was also deficient for the 25-yr event. However, this table only includes reporting for the 10-yr and 50-yr events as those are the design criteria that are applied to the pipes in Gresham.

5. Flow in this pipe was not shown to exceed capacity for the 10-yr storm until CIPs were applied in other locations. Backwater from downstream conditions caused flow to come out of this pipe during the 10-yr storm.

Table 3-1 Hydraulic Performance of West Gresham Storm Drainage System

Structure ID	Node ID		Structure Size/Type	Structure Length	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				Calibrated Flooding Identified For Relevant Design Storm ?	Calibrated When Deficient	Number of CIP to Address The Problem
								Existing Land Use		Future Land Use				
	US	DS		(ft)		Existing	Future	US	DS	US	DS			
2554	2849-W-006	2849-W-007	33-in Dia RC	355	10	0	0	153.1	151.3	153.1	151.3			
4555	2849-W-007	2849-W-008	33-in Dia RC	500	10	0	0	151.2	144.1	151.2	144.1			
2569	2849-W-008	2749-W-001	48-in Dia RC	406	50	107	132	143.8	122.3	144.0	122.7			
5530	2749-W-001	2749-W-002	48-in Dia CONC	348	50	112	136	122.3	113.6	122.7	113.8			
4536	2749-W-002	2749-W-003	54-in Dia CONC	354	50	112	136	113.4	108.2	113.7	108.5			
4535	2749-W-003	2749-W-004	48-in Dia CONC	585	50	112	136	108.2	91.9	108.5	92.2			
10044	2749-W-004	2749-W-005	48-in Dia CONC	586	50	112	136	91.9	74.9	92.2	75.1			
207	2749-W-005	2749-W-006	54-in Dia CONC	386	50	112	136	74.8	70.6	75.1	71.3			
5527	2749-W-006	2749-W-007	54-in Dia CONC	267	50	139	177	70.6	67.5	71.3	67.7			
L191	2749-W-007	2750-W-016	Natural	1300	50	137	182	67.5	13.9	67.7	16.1			
5953	2750-W-016	2650-W-601	78-in Dia RC	234	50	235	334	13.9	10.5	16.1	11.5			
2632	2850-W-002	2850-W-003	21-in Dia CONC	210	10	8	8	188.3	186.1	188.3	186.1			
787	2850-W-003	2850-W-004	21-in Dia CONC	500	10	8	8	186.1	172.1	186.1	172.1			
4588	2850-W-004	2850-W-005	21-in Dia CONC	490	10	8	8	172.1	158.4	172.1	158.4			
2616	2850-W-005	2850-W-018	21-in Dia CONC	60	10	12	12	157.9	155.6	157.9	155.6			
2616-RD	2850-W-005	2850-W-018	Roadway	60	10	0	0	155.7	155.7	155.7	155.7			
2614	2850-W-018	2850-W-020	24-in Dia HDPE	22	10	11	11	155.6	155.5	155.6	155.5	Yes (Future)	50	*
2614-RD	2850-W-018	2850-W-020	Roadway	22	10	0	0	155.5	155.5	155.5	155.5			
775	2850-W-020	2850-F-026	21-in Dia RC	493	10	16	16	155.5	150.0	155.5	150.0	Yes (Existing)	50 [4]	*
775-RD	2850-W-020	2850-F-026	Roadway	33	10	0	0	155.5	153.1	155.5	153.1			
4570	2850-F-026	2850-W-021	21-in Dia RC	228	10	16	16	150.0	147.4	150.0	147.4	Yes (Future)	50	6 [5]
4570-RD	2850-F-026	2850-W-021	Roadway	228	10	0	0	147.4	147.4	147.4	147.4			
1343	2850-W-021	2850-W-022	24-in Dia HDPE	107	10	16	16	147.4	146.8	147.4	146.8	Yes (Future)	50	*
1343-RD	2850-W-021	2850-W-022	Roadway	107	10	0	0	146.8	146.8	146.8	146.8			
4566	2850-W-022	2850-W-023	24-in Dia HDPE	269	10	16	16	146.8	145.4	146.8	145.4			
2575	2850-W-023	2850-W-025	27-in Dia RC	291	10	16	16	145.4	144.0	145.4	144.0			
10053	2850-W-025	2750-W-006	33-in Dia RC	390	10	27	27	143.2	130.0	143.2	130.0			
2544	2750-W-006	2750-W-007	30-in Dia RC	22	10	27	27	123.6	123.3	123.6	123.3			
5523	2750-W-007	2850-W-024	36-in Dia RC	396	10	27	27	123.1	120.0	123.1	120.0			
5523-RD	2850-W-024	2750-W-007	Roadway	396	10	0	0	123.1	123.1	123.1	123.1			
4548	2850-W-024	2750-W-008	30-in Dia RC	206	10	38	38	120.0	115.9	120.0	115.9			
10045	2750-W-008	2750-W-009	30-in Dia RC	329	10	38	38	115.2	98.8	115.2	98.8			
2521	2750-W-009	2750-W-010	30-in Dia RC	321	10	38	38	98.5	73.9	98.5	73.9			
4531	2750-W-010	2750-W-011	42-in Dia RC	479	10	38	38	73.9	67.9	73.9	67.9			
2517	2750-W-011	2750-W-022	42-in Dia RC	267	10	38	38	67.8	65.7	67.8	65.7			
2517-RD	2750-W-022	2750-W-011	Roadway	267	10	0	0	67.8	67.8	67.8	67.8			
10058	2750-W-022	2750-W-021	42-in Dia RC	55	10	38	38	65.7	65.7	65.7	65.7			
10059	2750-W-021	2750-W-012	42-in Dia RC	50	50	99	138	66.5	63.9	68.1	64.4			
2617	2850-W-006	2850-W-007	36-in Dia HDPE	254	10	6	6	154.2	148.5	154.2	148.5			
4584	2850-W-007	2850-W-008	36-in Dia HDPE	232	10	6	6	148.2	138.5	148.2	138.5			
2595	2850-W-008	2850-W-009	36-in Dia HDPE	269	10	6	6	138.2	122.6	138.2	122.6			
4571	2850-W-009	2850-W-010	36-in Dia HDPE	67	10	16	16	122.6	121.0	122.6	121.0			
2585	2850-W-010	2850-W-011	36-in Dia HDPE	20	10	16	16	120.9	120.0	120.9	120.0			
4567	2850-W-011	2850-W-012	36-in Dia HDPE	107	10	16	16	119.6	113.5	119.6	113.5			
2583	2850-W-012	2850-W-013	36-in Dia HDPE	18	10	16	16	113.3	110.8	113.3	110.8			
4562	2850-W-013	2850-W-014	36-in Dia HDPE	484	10	15	15	109.6	101.6	109.6	101.6			
2551	2850-W-014	2750-W-001	36-in Dia HDPE	143	10	15	15	101.1	95.3	101.1	95.3			
4546	2750-W-001	2750-W-002	36-in Dia HDPE	364	10	16	16	95.1	73.2	95.1	73.2			

*** The pipe was designed for a 10-year event and is not planned for improvements for failing to pass the 50-yr event.**

1. A flooding problem was identified if the model showed flow entering the roadway.
In some cases the water just ponded on the roadway and recorded flow rates in the roadway were zero. These were still considered to be flooding problems.

2. No improvements are proposed for this pipe segment as the problem was resolved as a result of a proposed CIP at another location.

3. Deficiencies were not identified in the model for this pipe segment however improvements made to this pipe segment were necessary to alleviate flooding problems upstream.

4. This segment was also deficient for the 25-yr event. However, this table only includes reporting for the 10-yr and 50-yr events as those are the design criteria that are applied to the pipes in Gresham.

5. Flow in this pipe was not shown to exceed capacity for the 10-yr storm until CIPs were applied in other locations. Backwater from downstream conditions caused flow to come out of this pipe during the 10-yr storm.

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Structure ID	Node ID		Structure Size/Type	Structure Length	Design Storm	Peak Flow (cfs) For Design Storm		Water Surface Elevation For Design Storm (ft)				Calibrated Flooding Identified For Relevant Design Storm ?	Calibrated When Deficient	Number of CIP to Address The Problem
								Existing Land Use		Future Land Use				
	US	DS		(ft)		Existing	Future	US	DS	US	DS			
2522	2750-W-002	2750-W-003	48-in Dia HDPE	400	10	15	15	73.2	70.4	73.2	70.4			
4532	2750-W-003	2750-W-004	48-in Dia HDPE	492	10	15	15	70.3	68.2	70.3	68.2			
1342	2750-W-004	2750-W-005	48-in Dia RC	47	10	15	15	68.2	68.0	68.2	68.0			
2516	2750-W-005	2750-W-023	48-in Dia RC	49	10	15	15	68.0	67.5	68.0	67.5			
10060	2750-W-023	2750-W-017	54-in Dia RC	262	10	16	16	67.3	66.5	67.3	66.5			
10056	2750-W-017	2750-W-018	54-in Dia RC	307	10	16	16	66.5	65.9	66.5	65.9			
10055	2750-W-018	2750-W-019	54-in Dia RC	262	10	17	17	65.9	65.8	65.9	65.8			
10054	2750-W-019	2750-W-020	54-in Dia RC	113	10	17	17	65.8	65.8	65.8	65.8			
6005	2750-W-020	2750-W-021	54-in Dia RC	349	10	18	18	65.8	65.7	65.8	65.7			
4528	2750-W-012	2750-W-013	42-in Dia RC	449	50	99	138	63.9	48.8	64.4	49.2			
2504	2750-W-013	2750-W-014	42-in Dia RC	349	50	99	138	48.4	27.6	48.8	27.8			
10047	2750-W-014	2750-W-015	48-in Dia RC	336	50	99	138	27.6	15.4	27.8	17.6			
2499	2750-W-015	2750-W-016	60-in Dia RC	385	50	99	138	14.9	13.9	17.6	16.1			
2499-RD	2750-W-015	2750-W-016	Roadway	385	50	0	0	13.9	13.9	16.1	16.1			

*** The pipe was designed for a 10-year event and is not planned for improvements for failing to pass the 50-yr event.**

1. A flooding problem was identified if the model showed flow entering the roadway.
In some cases the water just ponded on the roadway and recorded flow rates in the roadway were zero. These were still considered to be flooding problems.

2. No improvements are proposed for this pipe segment as the problem was resolved as a result of a proposed CIP at another location.

3. Deficiencies were not identified in the model for this pipe segment however improvements made to this pipe segment were necessary to alleviate flooding problems upstream.

4. This segment was also deficient for the 25-yr event. However, this table only includes reporting for the 10-yr and 50-yr events as those are the design criteria that are applied to the pipes in Gresham.

5. Flow in this pipe was not shown to exceed capacity for the 10-yr storm until CIPs were applied in other locations. Backwater from downstream conditions caused flow to come out of this pipe during the 10-yr storm.

Synopsis of Section 4 - For the sumped area, identification of capacity issues was based on field observations and recent infiltration tests conducted by the City. Capacity issues were not identified in this area. The dry wells were also evaluated with respect to nine physical criteria outlined in the Underground Injection Control (UIC) requirements[1]. In general, the West Gresham dry wells met all nine of the UIC physical criteria.

4.1 EVALUATION OF DRY WELLS

The dry wells were evaluated to: determine their capacity for handling runoff without flooding, and their ability to meet the physical requirements outlined in the UIC regulations. The results of both of these evaluations are described below.

4.1.1 Capacity of the Dry Wells to Handle Runoff

The ability of dry wells to dispose of stormwater runoff without flooding depends on the infiltration capacity of the receiving subsurface materials. Data were reviewed from dry well infiltration tests for 23 dry wells conducted by the City of Gresham during 2000. The dry wells were filled with water, and the time to infiltrate a portion of the water was recorded. It should be noted that the infiltration rates do not represent the hydraulic conductivity of the soils, since the water is dispersed throughout the perforated sections of (and any gravel packing surrounding) the dry wells.

The results indicated an average infiltration rate of approximately 29 gallons per minute (gpm), ranging from 9 to 91 gpm. Percolation tests are required for the development of any future dry wells in the City of Gresham's Public Works standards.

Based on field observations, existing dry wells have been operating adequately in terms of draining runoff for flood control.

Based on the flood events inventory map provided by the City, the following flooding problems were observed during the November 1996 and October 1997 storms in the areas that drain to dry wells:

November 1996 Storm:

- 172nd and Couch – Failed dry well.
- 17105 Ash – Failed dry well – however, this dry well is in private ownership.
- 18557 Davis – Flooding was related to a grading problem as the driveway is lower than the street and runoff was draining to the driveway rather than the dry well.
- 2103 190th Street – Waste had been dumped into the dry well. This was a water quality problem, not a flooding problem.

[1] Underground injection control (UIC) is a federal program under the Safe Drinking Water Act. Injection of fluids (including stormwater runoff) below ground, particularly to underground sources of drinking water is strictly regulated. The intent of the program is to protect groundwater aquifers, primarily used for drinking water, from contamination. All groundwater aquifers in Oregon are considered suitable as drinking water.

- 20 196th Street – Flooding was related to a grading problem as the driveway is lower than the street and runoff was draining to the driveway rather than the dry well.
- 19125 Holliday – Oil and debris was clogging catch basins in this area.
- 2610 191st Street – Flooding occurred in this cul-de-sac due to plugged catch basins.

October 1997 Storm:

- Intersection of 190th and Division – Flooding occurred in this area due to plugged catch basins.

As described, most of the problems were related to plugging of catch basins upstream of dry wells. In all of these cases, debris was removed and the problems were resolved. Only one of the City of Gresham dry wells was listed as failing. This was the dry well at 172nd and Couch. This dry well has since been maintained to address the problem and is now reported to be in working order.

4.1.2 Compliance with UIC Criteria

The UIC rules require an evaluation of stormwater dry wells with respect to nine physical criteria. These criteria are as follows:

1. No other waste, including agricultural drainage, industrial waste, or sanitary waste, is mixed with stormwater.
2. Site development, design, construction, and management have minimized stormwater runoff.
3. No other method of disposal, including construction or use of surface discharging storm sewers or surface infiltration designs is appropriate.
4. No domestic drinking water wells are present within 500 feet.
5. The well is not located within the 2-year time-of-travel zone as defined by the Oregon Health Division or closer than 500 feet to a public water supply well, whichever is more protective.
6. No soil or groundwater contamination is present that will be impacted by the construction or use of a stormwater injection system.
7. The injection system does not exceed a depth of 100 feet and does not discharge directly into groundwater or below the seasonal high groundwater level.
8. A confinement barrier or a natural or engineered filtration medium is present between the base of the injection system and the highest seasonal groundwater level and prevents contaminants from reaching groundwater.
9. The injection system is designed and operated in a manner that protects groundwater from accidentally or illicitly disposed wastes or contaminants, and can be temporarily blocked to prevent drainage into the injection system in the event of an accident or spill.

West Gresham dry wells were compared to nine criteria from the UIC rules.

The results of evaluating the West Gresham dry wells with respect to these nine criteria are as follows:

1. Documentation that no other waste, including agricultural drainage, industrial waste, or sanitary waste, is mixed with stormwater.

There are no agricultural activities in the dry well drainage areas so there is no agricultural drainage.

The area is fully served by a sanitary sewer and all sanitary waste is routed to the sewer (see Figure 7).

With respect to the potential for industrial waste to mix with stormwater, Figure 4 includes the dry well locations and provides the general zoning designations for the study area. Using Metro Regional Land Information System (RLIS) data for general zoning classifications, wells were located by zone. The 373 West Gresham dry wells are located by general zoning classification as follows:

- 301 dry wells in residential zones (81%)
- 65 dry wells in commercial zones (17%)
- 7 dry wells in industrial zones (2%)

Only 3 wells have the potential for not meeting criterion #1. The City will work with the adjacent industrial land owners.

The major industries in the City of Gresham - such as Boeing, Boyd Coffee Company, and LSI Logic, Inc. - are primarily located in the industrial area adjacent to the Columbia Slough and away from the concentration of dry wells to the south. However, there are 7 dry wells located in an industrial zoned area of West Gresham. These are located along SE 190th Ave. just south of Yamhill St. For the most part, the dry wells drain the road only, and are not receiving runoff from parking lots or other parts of the adjacent industrial facilities where stormwater could mix with industrial wastes. Potential exceptions include the dry well adjacent to the GCR Truck Tire Center (3149W009), and the dry wells adjacent to the Oregon Asphalt Plant (3149W005 and 3149W007). The City will contact the landowners and discuss alternatives for prevention of stormwater runoff from leaving private property at these two sites. A summary of these dry wells and adjacent drainage patterns is provided in Table 4-1 below.

Table 4-1
Summary of Dry Wells in Industrial Zones

190th Avenue Dry Well ID	Drainage from Adjacent Property to the West	Drainage from Adjacent Property to the East
3149W009*	Property Owner to the west is A-Z Auto Wrecking. A-Z Auto Wrecking has a driveway/parking lot that provides access from 190th Avenue. There is an on-site private dry well that provides stormwater disposal for this driveway/parking lot. The portion of the property that contains wrecked cars slopes to the west (away from 190th) so drainage from this portion of the property cannot reach 190th Avenue. Therefore, this dry well does not appear to receive runoff from the private property located west of 190th Avenue.	GCR Truck Tire Center Inc. occupies the property to the east of 190th Avenue. This property has an approximate slope of 1% towards 190th. Upon initial investigation, it was unclear whether hazardous materials exist on this site. The potential exists for construction of a minor berm at the property line to prevent runoff from leaving the site if upon further investigation this is warranted. Runoff from this private property could flow to the catch basin located along the east curb of 190th Avenue. The City will contact the landowner and discuss alternatives for prevention of stormwater runoff from leaving this site.
3149W005 & 3149W007	Property to west of 190th slopes to the west and stormwater runoff does not contribute flow to these dry wells on 190th.	Oregon Asphalt Plant (OAP) property is located to the east of 190th. This property contains a fuel storage tank (possibly diesel fuel) that could drain to dry well 3149W007 if a malfunction occurred. Containment could be provided by constructing a containment facility at the tank or by grading the site to provide a berm at the property line to prevent spills etc. from leaving the site. The topography is very flat so prevention if necessary (based on additional survey) would be easily obtained. The remainder of the OAP property is lower in elevation than the street and does not present a hazard. The City will contact the landowner and discuss alternatives for prevention of stormwater runoff from leaving this site.
3149W001, 3149W003, 3249W043, 3249W045, 3250F001	Multnomah County owns the property on the west side of 190th Avenue. The topography on the west side of the street is lower than the street which is constructed to City standards with sidewalks and curbs. Stormwater runoff is to these dry wells is entirely from the street.	Multnomah County owns the property on the east side of 190th Avenue. The topography on the east side of the street is lower than the street which is constructed to City standards with sidewalks and curbs. Stormwater runoff is to these dry wells is entirely from the street.

*This dry well is actually located in a residential zoned area just adjacent to the industrial zone and was therefore included in this table.

2. Site development, design, construction, and management have minimized stormwater runoff.

The purpose of this criterion is to prevent runoff at its source, thereby minimizing the amount of runoff discharging to dry wells. The City of Gresham Development Code states in Section A5.205 that the City's drainage management practices should emphasize natural groundwater infiltration recharge (where supported by soil analysis) and natural drainage ways. This Code was adopted in 1999. Incentives to minimize stormwater runoff are also built into the City's stormwater user fees (monthly fees) and the City's system development charges (SDCs)

All West Gresham dry wells meet Criterion #2.

because both of these fees are calculated from the amount of impervious surface.

3. Documentation that no other method of stormwater disposal, including construction or use of surface discharging storm sewers or surface infiltration designs is appropriate.

The City of Gresham originally built dry wells in this area because they are much cheaper to construct than large pipe networks, because the infiltration rates in this area are such that dry wells efficiently handle the disposal of runoff, and because, at the time, there was no regulatory distinction between surface and subsurface discharges of stormwater runoff. A surface discharging system would be possible for the dry well area, however, it would be much less appropriate than dry wells for the following reasons:

- Rerouting runoff to the Columbia Slough or Johnson Creek presents surface water quality issues of concern:
  A summary of stormwater quality issues is presented in Section 5.0 of this document. In general, the constituents of concern in the runoff vary depending on whether you are focused on protecting the aquatic life of receiving waters or whether you are focused on protecting groundwater as a source of drinking water. The stormwater constituents of concern in surface discharges include E.coli, copper, lead, zinc, TSS, and total phosphorus. Although not analyzed directly, temperature and increased runoff volumes are also likely to be of concern with respect to the protection of aquatic life in the Columbia Slough and Johnson Creek. The stormwater constituents of concern in groundwater discharges include E.coli, arsenic, chromium, lead, and sediments. Additional intermittent and unexpected discharges associated with spills and illicit discharges could be of concern to either surface water or groundwater depending upon the nature and volume of the discharge. If runoff from the dry well areas was rerouted to the Columbia Slough or Johnson Creek through pipes, significant concerns would arise with respect to the TMDLs that have been established for the Slough and the pending TMDLs for Johnson Creek. Significant concerns would also arise with respect to the Lower Columbia Steelhead and Chinook which have been listed as threatened species under the Endangered Species Act. Although BMPs could be implemented to address some of the water quality concerns, it would be very difficult if not impossible to address concerns related to increased runoff volumes and elevated summer storm runoff temperatures.

  Due to TMDL and ESA issues in the Columbia Slough and Johnson Creek, no other method of stormwater disposal is appropriate.

- There is no evidence that the existing system has unacceptably polluted groundwater:
  If runoff from currently sumped areas remains sumped, water quality concerns are expected to be more limited. It is estimated that there is a significant depth of geologic materials between the bottom of the dry wells and the top of the seasonal high groundwater. The evaluation that was conducted *(Evaluation and Comparison of Subsurface versus Surface Discharge of Stormwater Runoff*, URS, November, 2001) showed that a large portion of these geologic materials is expected to provide either attenuation or retardation of the constituents of concern. Therefore, it appears that decommissioning of the West Gresham dry wells would not be practical or appropriate with respect to water quality benefits.

- Public funds would be wasted on an unjustified replacement:
  Constructing a surface discharging pipe network to dispose of runoff from the dry well area would be infeasible from a cost perspective as a rough estimate showed the cost to be approximately $50 million.

There are two qualifiers that should be noted regarding the above conclusion. The first is the fact that spills and illicit discharges pose a concern that cannot be predicted or quantified. Therefore, a management plan for the existing dry well area should ensure the highest level of protection with respect to a spill prevention and response plan. In addition, any new sumps constructed for this area should include spill protection devices as appropriate. The second qualifier relates to the fact that in order to evaluate the geologic materials of the West Gresham area, a fair amount of interpolation was made between widely spaced data points over a large geographic area. Supplemental field data collection, such as exploratory borings would reduce any uncertainty associated with the conclusions.

4. No domestic drinking water wells are present within 500 feet.

All West Gresham dry wells meet Criterion #4.

The Oregon Water Resources Department tracks the installation and abandonment of all wells, including wells used for monitoring, industrial water use, and domestic drinking water[2]. The domestic wells within or near the study area are shown on Figure 8. Eleven domestic wells are registered within the study area. Only two of the eleven identified domestic wells had City dry wells within 500 feet. Upon further investigation, both of these domestic wells (well log #2956 and #1418) were found to be abandoned. Additional domestic wells were located within the land survey sections covered by the study area. However, due to insufficient address information provided on the well logs, the wells or well owners were not locatable.

5. The injection system is not located within the 2-year time-of-travel zone as defined by the Oregon Health Division or closer than 500 feet to a public water supply well, whichever is more protective.

All West Gresham dry wells meet Criterion #5.

The Oregon Health Division and the Portland Water Bureau were contacted to identify public water systems within the study area. The only public water supply wells that could conceivably be affected by Gresham's dry wells are the wells in Portland's Columbia South Shore Wellfield and an additional public well that serves a church just south of the study area boundary. The 10-year time of travel areas for the Columbia South Shore Wellfield cross the study area north of I-84, as shown on Figure 8. The source of this boundary is the Oregon Department of Health. The Portland Water Bureau is currently evaluating the status of this boundary. The two-year TOT boundary will be substantially smaller, and located

[2] In this report, wells will be identified by the boring log number registered with WRD. These numbers use the format MULT (for Multnomah County) followed by a four- or five-digit number.

north of the 10-year TOT boundary (PWB, 2001). No existing dry wells are located within the currently established 10-year TOT-based wellhead protection area boundary for the Columbia South Shore Wellfield. In addition, no existing dry wells in the West Gresham Study Area are located within the 2-year time-of-travel zone or within 500 feet of the church well located to the south of the study area.

6. No soil or groundwater contamination is present that will be impacted by the construction or use of a stormwater injection system.

The Department of Environmental Quality (DEQ) Environmental Cleanup Site Information (ECSI) database was queried for contaminated sites within the area serviced by dry wells. Within the study area, there are seven sites with "further investigation required" identified within the ECSI database[3] and eight sites with a "no further action" status. The properties are shown on Figure 9. Only one property requiring further investigation was located within 500 feet of an existing dry well. The contamination at ECSI #2009 is in the soil, and is described in the ECSI database as unlikely to impact groundwater. It is unlikely that continued injection of stormwater will impact soil contamination at ECSI #2009, because soil contamination is not present at typical injection depths. No groundwater contamination has been identified at ECSI #2009. The site has been listed as low priority by DEQ.

All West Gresham dry wells meet Criterion #6. However, new development of underground stormwater injection systems will need to include consideration of existing LUST site locations.

The DEQ Leaking Underground Storage Tank (LUST) database was also queried for sites with active investigations into LUSTs. Nine sites were identified within the study area. The locatable sites are shown on Figure 9. None of the dry wells were located within the identified tax lots. All LUST sites within 500 feet of City dry wells are heating oil tanks. Contamination from LUST releases is generally limited to the shallow soil immediately surrounding the LUST. It is unlikely that stormwater discharge from dry wells will impact shallow soil contamination. However, future dry wells should not be sited on the tax lots listed below and shown on Figure 9.

- 1N3E28CC -00702 (site address – 1832 NE 201st Ave.)
- 1N3E30D -00302 (site address – 2281 NE 181st Ave.)
- 1N3E29DD -00400 (site address – 1840 NE 201st Ave.)
- 1N3E32BD -04200 (site address - 18835 NE Holladay St.)
- 1N3E32BD -05300 (site address – 19010 NE Holladay St.)
- 1S3E06AD -06800 (site address – 17940 SE Main St.)
- 1S3E06DA -09800 (site address – 17900 SE Mill Ct.)
- 1S3E07DA -00100 (site address – 3505 SE 182nd Ave.)

[3] Nine additional properties within the study area were identified in the ECSI database, but had attained a No Further Action (NFA) status. An NFA determination may be made by DEQ even if residual levels of contamination in the soil or groundwater are present. NFA status does not preclude the possibility of additional investigation or remediation.

- 1S3E08BB -03900 (site address (18310 SE Division St.)

7. The injection system does not exceed a depth of 100 feet and does not discharge directly into groundwater or below the seasonal high groundwater level.

Based on USGS data and a targeted geophysical investigation, all West Gresham dry wells are expected to meet Criterion #7.

No dry wells exceed a depth of 100 feet. Groundwater contours were constructed from published data and used to determine whether any dry wells extend below typical groundwater levels. It is assumed that dry wells extending below groundwater levels permit direct discharge of stormwater to the groundwater. The Unconsolidated Sediments (US) and Troutdale Gravel Aquifer (TGA) hydrostratigraphic units that underlie the study area are both unconfined water-bearing units. The geological boundary between the two units is generally well defined; however, the two units show similar responses to rainfall events and are therefore interpreted to comprise an unconfined water table (i.e., aquifer). Precipitation constitutes the majority of the recharge to the US/TGA aquifer system. The hydraulic conductivity of the TGA unit ranges between 10 and 100 feet per day (USGS, 1996). The materials identified on the boring logs and depths are characteristic of the TGA and US units. A more detailed description of hydrostratigraphy is provided under Criterion 8 below.

Groundwater elevations for wells completed in the US or TGA were collected by the USGS. Historical well hydrographs indicated that the seasonal water table within the Portland Basin is highest during April, followed by March and May (USGS, 1996). The most recent published synoptic round of water level measurements corresponding to the seasonal high groundwater level was conducted during two weeks in April 1988; however, the extent of these data points was not adequate for mapping the water table in the entire study area. In order to obtain more data points, the time interval for data was expanded to include March and May of 1988. As mentioned above, the majority of the recharge to the groundwater in the US/TGA aquifer is from precipitation. Precipitation data from 1988 were compared to data from the 20-year period from 1980 through 2000 to determine if water levels were representative of typical conditions. Precipitation in 1988 was approximately 85% of the average for the 20-year period (OCS, 2001). Based on review of longer-term water level data that were available from a few wells, the water table could potentially be up to several feet higher in a typical year.

The data in the vicinity of the study area were plotted and contoured using ARC software (a GIS software package from Environmental Systems Research Institute commonly known as ESRI). The results of the contouring are shown on Figure 10. The data show that groundwater elevations in the combined US and TGA units range from approximately 0 feet above msl in the northern portion to approximately 350 feet above msl in the southern portion of the study area[4]. The groundwater flows generally north and discharges to the Columbia Slough.

[4] The contouring used points at the northeastern and southwestern ends of the study area. As such, local, small-scale variations in groundwater elevations (including perched water) are not represented on Figure 8.

Based on the plotted spring 1998 groundwater level contours, it looked as if 5 dry wells may potentially inject stormwater below the water table and the water table may be within 10 feet of the base of 11 additional dry wells. These dry wells are identified in Table 4-2. The calculation of the proximity of the base of the dry wells to the groundwater is based upon areal projections of groundwater elevations known at widely spaced locations. The groundwater elevations between the measurement points may vary significantly.

Table 4-2
Summary of Dry Wells with Highest Potential to Penetrate High Groundwater

DRY WELL ID	DEPTH (feet)	Proximity to Groundwater[a] (feet)	STATUS[b]
3348W043	20	-4.780	Below Groundwater Surface
3348W007	20	-2.725	Below Groundwater Surface
3348W021	20	-1.582	Below Groundwater Surface
3348W009	20	-1.396	Below Groundwater Surface
3348W011	20	-0.377	Below Groundwater Surface
3348W027	20	0.539	Within 10 ft. of Groundwater Surface
3348W025	20	1.407	Within 10 ft. of Groundwater Surface
3348W013	20	1.556	Within 10 ft. of Groundwater Surface
3348W031	20	3.588	Within 10 ft. of Groundwater Surface
3348W029	20	4.425	Within 10 ft. of Groundwater Surface
3348W005	20	4.629	Within 10 ft. of Groundwater Surface
3348W019	20	5.024	Within 10 ft. of Groundwater Surface
3348W033	20	7.543	Within 10 ft. of Groundwater Surface
3348W023	20	7.804	Within 10 ft. of Groundwater Surface
3349W021	20	8.416	Within 10 ft. of Groundwater Surface
3349W023	20	9.311	Within 10 ft. of Groundwater Surface

a. Elevation difference between the base of the dry well and the computed groundwater surface elevation in feet.
b. Status of the base of the dry well. The dry well could potentially discharge directly into seasonal high groundwater if the well level is below the seasonal high groundwater surface level or within the range of the typical groundwater level fluctuation (i.e., within 10 feet).

In late May, 2002, geophysical testing was conducted to confirm the location of the high groundwater table in this area of potential concern. Specifically, with respect to the west Gresham area, testing was conducted at the following three locations:

Centennial Highschool – 3505 SE 182nd
Centennial Middle School – 17650 SE Brooklyn
Portland Adventist Elementary School – 3990 NW 1st

The results showed high groundwater depths of approximately 48 to 65 feet below the ground surface. Widely scattered small perched aquifers were also observed at shallower depths. Groundwater monitoring results from an existing USGS well located at 133rd and Holgate were checked to estimate the date of occurrence of the seasonal high groundwater for 2001/2002. The results showed the seasonal high groundwater level occurring on April 24th, 2002. Water levels

from late May (when the above geophysical testing was conducted) were only approximately 1 foot lower than the seasonal high groundwater. This would put the seasonal high groundwater depths at the sampling sites to be approximately 47 to 64 feet below the ground surface. These results indicate that the dry wells in this area do not discharge directly to groundwater or below the seasonal high groundwater table.

8. A confinement barrier or a natural or engineered filtration medium is present between the base of the injection system and the highest seasonal groundwater level and prevents contaminants from reaching groundwater.

Under the previous criterion, it was established that the dry wells in the study area do not penetrate the seasonal high groundwater table. The issue under this criterion is whether an adequate filter medium exists between the well bottoms and the seasonal high groundwater table. A sufficiently thick unsaturated zone with contaminant attenuation properties could meet the requirements for a "natural…filtration medium…between the base of the injection system and the highest seasonal groundwater table that prevents contaminants from reaching groundwater" [OAR 340-044-0018 (3)(a)(H)]. A schematic illustrating the relative positions of surface soils, and the unconsolidated sediments (US) and the Troutdale Gravel Aquifer (TGA) hydrostratigraphic units (referred to under criteria 7 above) is included as Figure 11.

In general, soils[5] and subsoils in the study area are limited in depth to the first three to five feet (USDA, 1977). Stormwater is discharged to unconsolidated sediments in the subsurface through dry wells that are 20 – 28 feet deep. Therefore, the surficial geology (i.e., the subsurface) was the focus of the geotechnical review and is described here.

The sediments range in depth from 0 to 200 feet thick within the study area (USGS, 1993). Within the study area, these sediments are characterized as heterogeneous sands, silts and clays. These sediments, along with the TGA, comprise the majority of the shallow (up to about 200 feet below ground surface) geology in the study area (USGS, 1996).

The Troutdale Formation is the most extensive sedimentary unit in the basin. It is stratigraphically complex, but can be characterized by the following hydrostratigraphic units, from top to bottom:

- Troutdale Gravel Aquifer (TGA), a complex of poorly to moderately cemented gravels, Boring lavas, buried clayey soils developed on the gravels and lavas, and weathered windblown clays and silts.
- Confining Unit 1, consisting of medium to fine-grained sands (some of them glassy due to their volcanic origin), silt, and clay. This unit has reduced vertical permeability that results in confinement of groundwater in the underlying unit.

[5] The term "soils" refers to unconsolidated materials on the present land surface developed from the recent weathering of Quaternary alluvial units. Weathered materials in the upper portions of the TGA are considered part of the TGA.

- Troutdale Sandstone Aquifer (TSA) [6], consisting of coarse sandstone and cement gravels with small beds of fine to medium sand and silt. Some drinking water wells in the CSSW draw water from the TSA.
- Confining Unit 2, lithologically similar to Confining Unit 1.
- Troutdale sand and gravel aquifer, which appear to represent sediments deposited by an ancestral Columbia River.

Sediments below the TGA are fully saturated and therefore were not evaluated as a natural filtration medium for purposes of the UIC rule. The upper elevation of the TGA ranges from 0 to approximately 500 feet msl within the study area. The upper elevation of the TGA was estimated based upon information provided by the USGS. In many areas, the top is weathered to a thick, silty clay, which in upland areas may be as much as 100 feet thick (USGS, 1996). The weathered layer, where it exists, could represent a significant attenuation zone for dry wells that penetrate the TGA. However, the weathered layer may not be laterally continuous. Figure 12 shows where dry well depths may penetrate the TGA.

Two general regions were defined in the study area for the purpose of describing the surficial geological materials into which the dry wells discharge stormwater. Region 1 includes the southern portion of the study area, and is defined by the locations of existing dry wells that potentially penetrate the TGA. Region 2 is defined by the remaining dry wells that are not expected to penetrate the TGA[7]. The two regions are shown on Figure 13. The 62 borings that could be specifically located and that described geological materials between the base of the dry wells and 100 feet below ground surface are shown on Figure 13**.**

Generally, the near-surface materials in the two regions are similar, and consist of a heterogeneous mix of clay, silt, sand, cobbles, and boulders. Weathered sandstone, siltstone and basalt, as well as cemented gravel and claystone, were also described in the boring logs. Clay layers ranged from 4 feet to over 50 feet thick. Sequences of clay and cemented gravel layers were locally identified in layers up to 98 feet thick.

Clay, claystone and cemented gravels are a substantial component of the subsurface materials in the study area. On the basis of the attenuation mechanisms presumed to occur in the study area, clay, claystone, or cemented gravel would best fulfill the requirement for a natural filtration medium, as identified in the UIC rules. Silt or silty material could also fill the role of a natural filtration medium; however, clay or cemented gravel materials provide better attenuation capabilities than silty materials. Therefore, to provide a conservative estimate of available treatment we evaluated only the composite thickness of clay, claystone, and cemented gravels in the uppermost 100 ft. of the subsurface as a “treatment zone.”

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[6] A confined aquifer is overlain or confined by a low-permeability geological layer (a confining unit) such that the pore water pressure is not in equilibrium with the atmosphere. The US/TGA aquifer represents an unconfined aquifer, where the pore water pressure is in equilibrium with the atmosphere. The underlying TSA is a confined aquifer.

[7] Based upon the analysis of GIS layers provided by the USGS. Dry wells that do not penetrate the TGA discharge to the Unconsolidated Sediments unit.

Region 1

Logs for 13 borings were reviewed for Region 1. Clay or cemented gravel layers within 100 feet below ground surface were identified in most of the borings. Figure 13 shows the thickness of the most fine-grained or low-porosity materials (i.e., clay, claystone or cemented gravels) identified in the boring logs that were mappable for Region 1.

Region 2

Logs for 49 borings were reviewed for Region 2. Significant clay or cemented gravel layers within 100 feet below ground surface were identified in most of the borings. Figure 13 shows the thickness of the most fine-grained or low-porosity materials (i.e., clay, claystone or cemented gravels) identified in the boring logs that were mappable for Region 2.

The variability in the thickness of the "treatment zone" shown on Figure 13 indicates the highly heterogeneous nature of the surficial geological materials in the study area and vicinity. Zones of potential treatment by attenuation or filtration were identified in 73 of the 87 boring logs reviewed.

Table 4-3 identifies the borings and thickness of potential material treatment. The potential treatment zone in the study area ranged in thickness from 2 feet to 100 feet. The average thickness of the treatment zone in the study area is about 56 feet. Based upon this average thickness, and the high frequency of observations of clay, silt, claystone, or cemented gravel in all of the borings, the subsurface geological materials in the study area meet the criteria for a natural filtration medium.

Where present, the clays, silts, and claystones are specifically well suited to provide geochemical attenuation of the dissolved constituents of concern (i.e., heavy metals and phosphorus) in the injected stormwater. While data are not sufficient to develop a quantitative analysis of mass-loading and attenuation at each dry well, qualitative arguments can be made that strongly suggest that the generally thick (i.e., greater than 10 feet thick) unsaturated zone in the study area provides a suitable long-term reservoir for these constituents. For example, metals such as copper, zinc, and lead are held strongly on the cation exchange sites of clays. Copper, zinc, and phosphorus are, in fact, best sequestered in the deeper geological materials below the base of dry wells rather than in surface aquatic systems. Lead is among the least soluble of metals, so the concentration of dissolved lead in injected stormwater is expected to be very low. In this manner, these compounds are no longer bioavailable in aquatic ecosystems. Arsenic is most mobile under high pH conditions that are not found in northwestern Oregon and it would therefore be sequestered in the unsaturated zone. The measured low concentrations of stormwater constituents should be adequately attenuated over the long term in the geologic materials below the dry wells.

All West Gresham dry wells are expected to meet Criterion #8.

Table 4-3
Thickness of Potential Treatment Material

Log ID (MULT-)	Attenuation Material Within 100' [a]	Thickness[b]
2143	cemented sand and gravel	100
2969	cemented gravel	100
2968	gravel and clay	100
2754	small sand and gravel with cemented gravel and brown clay	100
4978	silt, silty gravel, siltstone	100
2932	clay/cemented gravel	98
2946	clay/cemented gravel	98
2155	clay/cemented gravel	98
2156	clay cemented gravel and boulders	98
2144	cemented gravel	97
2157	clay, silt, cemented gravel	97
2927	clay/cemented gravel	97
2936	clay/cemented gravel/sandy clay	97
2150	cemented gravel and clay	96
2934	clay/cemented gravel/sandy clay	95
2162	clay and cemented gravel	94
2943	clay/cemented gravel	94
3432	Basalt	92
1429	clay and cemented gravel	92
2158	clay and cemented gravel	92
2164	clay and cemented gravel	90
2160	clay and cemented gravel	87
2963	cemented gravel	81
1428	gravel with clay	77
2159	clay and cemented gravel	77
2941	clay/cemented gravel/sandy clay	76
2959	cemented gravel	73
1434	clay, cemented gravel	73
2930	clay/cemented gravel	72
1430	silt and clay, cemented gravel	69
2953	clay/cemented gravel	69
2954	gravel w/sandy clay	65
54008	siltstone, sandstone	65
2940	clay/cemented gravel	60
2951	cemented gravel and clay	60
2147	clay/cemented gravel	59
1415	sandy clay and gravel	58
1421	clay/cemented gravel	58
2944	clay/cemented gravel/sandy clay	56
55822	silt, sandstone	52
1431	sand and clay	49
1417	brown clay and gravel	48
1425	clay and cemented gravel	48
50899	cemented gravels	46
1422	clay, gravel and clay	46
3379	Sandstone	42

Log ID (MULT-)	Attenuation Material Within 100' [a]	Thickness[b]
5149	Sandstone	42
149	silt sand, silt	40
54155	silty clay	39
2957	cemented gravel	37
2935	clay/cemented gravel	36
2149	clay/cemented gravel	36
2151	clay and sandy clay	36
55549	Clay	35
50036	silty clay, silt	34
1407	gravel and clay	33
52475	clay, silt, siltstone	32
1414	brown clay w/gravel large cobbles	31
50016	dense sand	31
55030	Siltstone	29
512	clay and gravel	21
3219	glacial till	21
50999	weathered sandstone	20
4995	silty gravel	17
60574	Sandstone	15
4371	sandy silt with clay and gravel	15
2956	gravel and clay	13
55821	silt, siltstone	11
62806	clay and gravel	10
4963	Silt	10
3218	glacial till	9
1433	cemented gravel	7
58221	Silts	6
4964	Silt	5
3018	clayey silt	4.5
63886	Claystone	2

Number of Borings	Average Thickness
76	56.2

[a] Potential attenuation material within 100' of groundwater surface.
[b] Thickness of potential attenuation material (feet).

9. Demonstrate that the injection system is designed and operated in a manner that protects groundwater from accidentally or illicitly disposed wastes or contaminants, and can be temporarily blocked to prevent drainage into the injection system in the event of an accident or spill.

All West Gresham dry wells meet Criterion #9.

The City of Gresham protects groundwater from accidental and illicit discharges of wastes and contaminants through a spill response system. Spills are responded to either by the City of Gresham Stormwater Division staff or by the Region 3 Hazardous Materials Response Team (Haz Mat 3),

operated by the City of Gresham firefighters from Engine Company 73 (Lofgren, 2001). These responders maintain a selection of spill response materials on-site at their facilities and in their response vehicles to prevent contaminants from entering the stormwater system. These materials include absorbent booms, kitty litter, oil absorbent diapers, filter bags, fabric inserts for catchbasins, and catchbasin protectors/overlays. If wastes or contaminants have already entered the stormwater system before the responders arrive, additional measures are taken to remove the pollutants from the system including pumping or vacuuming the affected portions of the system.

The City is normally notified of an accidental or illicit disposal of wastes or contaminants through phone calls from citizens or city employees. Calls are normally received by the Department of Environmental Services during the day, the Public Works supervisor on-call after hours, or the 9-1-1 emergency dispatch. Haz Mat 3 will respond within 5 minutes to any incident within the Gresham City limits when activated by a 9-1-1 emergency dispatch operator. If Stormwater Division staff respond to the call, the response time ranges from 5 to 30 minutes (Dose, 2001).

Summary of West Gresham Dry Wells that Do Not Satisfy UIC Criteria #1 through #9 Above.

With respect to evaluation of West Gresham dry wells in comparison to the nine UIC physical criteria, in general, all criteria were met. Table 4-4 provides a summary of the results of this comparison.

Table 4-4
Summary Comparison of Dry Wells with UIC Criteria

Criterion	Compliance With Criterion	Comment
1- No other waste is mixed with stormwater.	Yes	The City will contact two industrial landowners in the study area to discuss alternatives for prevention of stormwater runoff from leaving private property at these two sites.
2 – Site development has minimized runoff.	Yes	
3 – No other method of disposal is appropriate.	Yes	
4 – No drinking wells within 500 feet.	Yes	
5 – Not within 2-year time-of-travel or 500 feet of a water supply well.	Yes	

Criterion	Compliance With Criterion	Comment
6- No impact to soil or groundwater contamination.	Yes	The City will require any new development to investigate and verify that any contamination resulting from the identified LUST cannot contaminate stormwater reaching new drywells.
7- Does not exceed 100 feet in depth and does not discharge directly to groundwater.	Yes	
8 – A filtration medium is present.	Yes	
9 – Protective of accidental or illicit spills or discharges.	Yes	

Synopsis of Section 5 – The purpose of this section is to identify the water quality problems that should be addressed in both the piped systems and the dry well systems of the WGSA. To identify these problems, stormwater quality data were evaluated for Gresham. The data were then compared to surface water quality standards for the protection of aquatic life (these apply to the piped system discharging to the Columbia Slough) and to groundwater quality standards for the protection of drinking water (these apply to the dry wells discharging to the subsurface).

Parameters of concern with respect to surface water include bacteria, heavy metals, oil & grease, sediments, nutrients and temperature. Parameters of concern with respect to groundwater as a potential drinking water source include bacteria and heavy metals. In addition to the ubiquitous problems associated with stormwater runoff, spills and illicit discharges also pose a threat to both surface and groundwaters although these are less predictable.

As urbanization occurs, adverse impacts to the health of receiving waters result from changes in the quality and quantity of stormwater runoff. Stormwater runoff is defined as surface water runoff that drains from the land into storm sewer pipes, open channels, rivers, and wetlands. Historically, stormwater management has primarily focused on drainage and flood control. While urban area flooding problems have been successfully addressed, other negative impacts associated with the quality of stormwater runoff have become a concern. The purpose of this section is to identify the water quality problems that should be addressed in both the piped systems and the dry well systems of the WGSA. To identify these problems, stormwater quality data and the potential for spills and illicit discharges were evaluated for the study area.

5.1 STORMWATER QUALITY

Since 1993, the City of Gresham has collected and analyzed samples of stormwater runoff from 4 sampling stations in Gresham. These sampling events represent analysis of a total of 48 samples from 4 sampling stations. Table 5-1 provides the results from that sampling including a description of the problem pollutants which were found, typical sources of the pollutants, specific results from Gresham with respect to surface water standards for the protection of aquatic life, and specific results from Gresham with respect to drinking water standards.

To further evaluate the characteristics of urban runoff and the effects of land use, the Oregon Association of Clean Water Agencies funded a study in 1996. A report titled “Analysis of Oregon Urban Runoff Water Quality Monitoring Data Collected from 1990 to 1996” was generated based on a series of statistical analyses of the stormwater monitoring data collected by the Oregon Municipal Stormwater NPDES applicants and permitted agencies in the Willamette Valley. The report indicates that stormwater pollutant concentrations from different land uses are statistically different from each other. In general, among different land uses, industrial land use showed the highest pollutant concentrations, followed by transportation, commercial and residential. Open space (i.e., undeveloped) land use represented lowest pollutant concentrations. (Note: These are the general results. Results sometimes varied depending upon the specific pollutant.)

The existing stormwater management system in West Gresham consists of storm drains connected to dry wells which drain to the ground, and pipes which drain to the Columbia Slough. Section 303(d) of the federal Clean Water Act requires states to develop a list of waterbodies that do not meet water quality standards and thus require additional pollutant controls. These waters are referred to as "water quality limited" and must be identified on the State "303(d) list" which is updated biennially. Water quality limited waterbodies require the application of Total Maximum Daily Load (TMDL) strategies for bringing the waterbody back into compliance with water quality standards. The Columbia Slough is currently listed on the 303(d) list. A TMDL has been developed for the Columbia Slough. Pollutants that are listed in the Columbia Slough TMDL include temperature, dissolved oxygen (DO), pH, nutrients (total phosphorus, and dissolved ortho-phosphate), bacteria (E. coli), toxics (total and dissolved lead), and organic compounds (PCBs, DDT/DDE, TCDD, and dieldrin).

Although water quality in the Columbia Slough is affected in a complex manner by various sources such as combined sewer overflows, groundwater, industrial runoff, and conventional National Permit Discharge Elimination System (NPDES) point sources, stormwater discharges are also considered to be a contributing source of water quality deterioration in the Slough. The Gresham stormwater monitoring results summarized in Table 5-1 show that the results for E. coli and total phosphorus frequently exceeded the Department of Environmental Quality (DEQ) water quality standards and guidance. Heavy metals were also commonly present in stormwater collected in Gresham. Among the twenty-one samples collected at four sampling stations in the City of Gresham, dissolved lead was detected in thirty percent of the samples and the DEQ water quality standard for lead was exceeded in one sample. Testing for DDT, DDE, dieldrin and PCBs in samples collected from Gresham stations was not performed. However, stormwater samples collected by the City of Portland and other jurisdictions indicate that stormwater can potentially be a source of these organic compounds. Although dissolved oxygen was not analyzed in stormwater samples collected from Gresham, the oxygen demand of pollutants in stormwater was measured by the 5-day biochemical oxygen demand (BOD5) and chemical oxygen demand. There is not a specific standard in place for BOD5, but the TMDL for the Columbia Slough established a background level of 2.5 mg/L. The BOD5 results for Gresham indicated that most of the samples collected (approximately seventy percent) had higher BOD5 concentrations than the background BOD5 concentration defined for the Columbia Slough. Although not monitored, it is likely that high volumes of stormwater runoff from hot paved surfaces and rooftops during summer months may also increase the water temperature in receiving waters.

Stormwater discharges are a contributing source of water quality degradation in the Columbia Slough.

5.2 SPILLS AND ILLICIT DISCHARGES

The above text describes the general more predictable nature of stormwater quality in Gresham. In addition to these water quality issues, unpredictable intermittent spills and illicit discharges can also impact water quality. The following discussion provides a summary of Gresham's recent history with respect to spills or illicit discharges to the storm drainage system.

Since September 1997, the Department of Environmental Services at the City of Gresham has maintained a history of accidental or illicit discharges into the stormwater system. Over the past four years there have been 12 reported accidental or illicit discharges into the stormwater system in West Gresham that were responded to by Stormwater Division staff. Two reported discharges occurred each year from 1997 through 2000, and four discharges occurred in 2001.

Over the past four years there have been 12 reported accidental or illicit discharges into the stormwater system in West Gresham.

The nature of these discharges included oil (5), construction erosion control (1), paint (1), PCBs (1), wash runoff (1), restaurant greases (2), and sewer cross-connection (1). The majority of the discharges consisted of small quantities of pollutants entering a single catchbasin. Stormwater Division staff responded to these discharges. The Region 3 Hazardous Materials Response Team responded to the three most serious discharges, two of which were the result of auto accidents (oil and PCBs) and one of which was the result of a ruptured heating oil storage tank at a residential property (oil).

The auto accident related oil spill consisted of approximately 40 gallons of oil spilling onto the street, of which 1-1/2 gallons may have entered the stormwater system. The auto accident PCBs spill was the result of a car crashing into a power transformer. An unknown quantity of PCBs entered a catchbasin and sump as a result of the crash. Within two days of the crash Pacific Gas and Electric (PGE) performed a clean up to meet DEQ standards. The ruptured heating oil storage tank resulted in the release of 50 to 200 gallons of oil to the ground. Before the spill was cleaned up, the Stormwater Division determined that the spill was not threatening the stormwater system.

5.3 SUMMARY OF PROBLEM STORMWATER POLLUTANTS

In summary, identified problem stormwater pollutants in West Gresham with respect to surface water discharges include:

- Pathogenic Microorganisms (bacteria)
- Heavy Metals (copper, lead, zinc)
- Oil and Grease
- Sediments
- Nutrients
- Temperature

Identified problem stormwater pollutants in West Gresham with respect to the protection of drinking water include:

- Pathogenic Microorganisms (bacteria)
- Heavy Metals (arsenic, chromium, lead)

Table 5-1 Typical Problem Pollutants in Stormwater

Pollutant	Description	Major Sources	Surface Water Quality Standards for the Protection of Aquatic Live		Groundwater Quality Standards for the Protection of Drinking Water[8]
			Gresham's Results	Potential Problems	
Bacteria	- E. Coli - Enterococcus, - Fecal coliform, and - Fecal streptococcus	- Animal Wastes (droppings from wild/domestic animals), - Human Wastes (leaking sanitary sewer pipes, and seepage from septic tanks).	**E. Coli results from more than 70% of samples significantly exceeded the DEQ water quality standard for the protection of aquatic life.**	These are commonly used indicators of human pathogens. Water contact may cause eye and skin irritations and gastro-intestinal diseases if swallowed.	E. Coli results from all 28 samples exceeded the Oregon DEQ Interim Standards for Maximum Measurable Levels of Contaminants in Groundwater.
Heavy Metals	Antimony Arsenic Beryllium Cadmium Chromium Copper Lead Mercury Nickel Selenium Silver Thallium Zinc	- Vehicles (combustion of fossil fuels, improper disposal of car batteries, wear/tear of tires and brake pads), - Metal Corrosion, - Pigments for Paints, - Solder, - Fungicides, - Pesticides, - Wood Preservatives	Chromium, copper, lead, nickel, and zinc were typically present in samples. **Dissolved copper and zinc in stormwater samples frequently (i.e., more than 70%) exceeded DEQ standards for the protection of aquatic life. The DEQ standard for dissolved lead was exceeded once in twenty-one samples.**	Heavy metals are toxic to freshwater aquatic ecosystems. These metals are considered to be the most significant toxic substances which are commonly found in urban stormwater runoff.	The DEQ groundwater standard for total arsenic was exceeded three times in twenty-six samples. The standards for chromium and lead were exceeded once in forty-four samples. The standards for cadmium and mercury were not exceeded in the samples collected.
Oil & Grease	A broad group of pollutants including: - Animal fats, and - Petroleum products.	- Food Wastes (animal and vegetable fats from garbage), - Petroleum Products (gas, engine oil, lubricants, etc.).	**One of forty-four samples (i.e., 2%) had a concentration which exceeded discharge limitations specified for industrial stormwater discharges (i.e., > 10 mg/L).**	These compounds can coat the surface of the water limiting oxygen exchange, clog fish gills, and cling to waterfowl feathers. When ingested these compounds can be toxic to birds, animals and other aquatic life.	No specific standard has been set up for oil and grease by DEQ.
Total suspended Solids	Sediments in the water are considered to be pollutants when they exceed natural concentrations and negatively affect water quality and/or beneficial uses of the water.	- Erosion from increased stream flows, - Construction site runoff, - Landscaping activities, - Agricultural activities, - Logging, - All other activities where the ground surface is disturbed.	**Excess levels were measured at all stations. The mean TSS concentration from all sampling stations in Gresham were about 45% higher than the mean TSS concentration from an open space (i.e., undeveloped) sampling in the City of Portland. Ten out of forty-four samples had a TSS concentration higher than 100 mg/L.**	Sediments cause increased turbidity, reduced prey capture for sight feeding predators, clogging of gills/filters of fish and aquatic insects, and blocked light which limits food production available for fish. Sediments also accumulate in stream bottoms which reduces the capacity of the stream (and hence increases the potential for flooding) and covers stream bottom habitats. Sediment also acts as a carrier of toxic pollutants such as metals and organics.	No specific standard has been set up for TSS for drinking water. The DEQ standard for turbidity is 1 TU. Sampling for turbidity was not conducted.

[8] Per OAR 340-40.

Table 5-1 Typical Problem Pollutants in Stormwater

Pollutant	Description	Major Sources	Surface Water Quality Standards for the Protection of Aquatic Live		Groundwater Quality Standards for the Protection of Drinking Water[8]
			Gresham's Results	Potential Problems	
Nutrients	- Nitrate - Ammonia - Kjeldahl Nitrogen - Phosphorus - Orthophosphate	- Landscaping activities, - Yard debris, - Human wastes (leaks from septic tanks and sanitary sewers), - Animal wastes, - Vehicle exhausts, - Agricultural activities, - Detergents (car washing), - Food Processing	**The DEQ guidance value of 0.1 mg/L for total phosphorus was exceeded in more than 90% of the samples collected.**	Excess levels of nutrients can lead to eutrophication in downstream receiving waters. Problems include surface algal scums, odors, reduced oxygen levels, and dense mats of algae. In addition to water quality problems, these effects have a negative impact to the aesthetic quality of water bodies.	The nitrate-N results from all 44 samples were lower than the DEQ's permanent standard of 10mg/L for maximum measurable level of nitrate-N in groundwater.
Organics	There are many organic compounds, however, the synthetic organics are of most concern and include pollutants from: - Fuels - Solvents - Pesticides - Herbicides.	- Illegal dumping, - Illicit connections, - Spills, - Leaks from drums and storage tanks, - Landscaping activities - Agricultural activities.	Sampling for these compounds was limited. **Phenols were detected in one of the twenty-four samples collected and four volatile organic compounds were detected in twelve samples collected. The VOCs detected were 2-butanone, toluene, tetrachloroethene and 1,1,1-trichloroethane. All the VOCs were detected once in twelve samples, except for 1,1,1-trichloroethane, which was detected twice in twelve samples.**	Most synthetic organics are highly toxic to aquatic life at very low concentrations, and many are carcinogenic (cancer causing) or suspected carcinogens. Although not detected in Gresham, diazinon has been identified in many recent studies as one of the significant causes of toxicity in stormwater.	Two of twelve samples tested for VOCs had 1,1,1-trichloroethane detected. None of the results from the two samples exceeded the DEQ standard for drinking water.
Litter and other Floatable Debris	- Plastics, - Paper products, - Yard debris, - Tires, - Metal, - Glass.	- Littering, - Dumping, - Spills.	Sampling for litter and floatables was not conducted, however, problems associated with litter and debris have been observed in Gresham.	These pollutants degrade the aesthetic quality of water bodies. In addition, they contribute pollutants as they decompose, and they can reduce the capacity of the water body. Excess yard debris contributes to high levels of nutrients and it reduces oxygen levels as it decomposes.	No specific standard has been set up for litter for drinking water by DEQ

Synopsis of Section 6 – This section describes the potential capital improvement project alternatives that were proposed for addressing the flooding and water quality issues identified in the previous sections. A total of seven capital improvement projects were proposed to address flooding problems in the piped system and eight potential water quality capital improvement projects were proposed for the piped area. Capital improvement projects were not proposed for the sumped area due to the lack of identified capacity issues and due to the water quality treatment that is already provided by the significant natural filtration medium that is expected to exist between the base of the dry wells and the top of the seasonal high groundwater.

Sections 3.0, 4.0, and 5.0 of this report provide a summary of the flood control and water quality management issues of concern. This section describes the management alternatives that were selected to address those issues. Section 6.1 provides a summary of selected flood control alternatives and Section 6.2 provides a summary of selected water quality alternatives. Under each of these sections, selected alternatives are provided for both the piped system and the sumped system in the West Gresham Study Area.

6.1 FLOOD CONTROL MANAGEMENT ALTERNATIVES

6.1.1 Piped System

As described in Section 3.0, flooding problems were identified when modeled flows went onto roadway surfaces. In developing capital improvement projects (CIPs) to address flooding issues, the following design criteria were applied:

- The water surface elevation in manholes must be at least 2 feet below the road surface.
- Roughness coefficients (n values) for all new pipes was 0.013.
- All pipe inverts were maintained at their original elevations. In other words, regrading of pipe systems was not conducted due to unknowns regarding feasibility.
- Pipes that drain sub-basins with areas greater than 250 acres or pipes on the major arterials identified by the City were required to pass the 50-year design event. All other pipes were required to pass the 10-year event.

Detention ponds, pipe replacements, and dry wells were considered as options for addressing capacity deficiencies. However, due to space limitations for detention ponds and capacity limitations with respect to dry wells, resulting capital improvement projects were all made up of pipe replacements. Table 6-1 shows a list of pipes that need to be upgraded in order for the system to meet the above criteria. Each potential capital improvement project listed below addresses one or more flooding problems identified in the model results. These potential capital improvement projects are illustrated on Figures 6a through 6e. A capital improvement project fact sheet is also provided for each of the capital improvement

Due to space limitations for detention ponds, and capacity limitations with respect to new dry wells, proposed capital projects consist solely of pipe replacements.

projects in Appendix E. The capital improvement project fact sheets provide a location map and more details regarding each project (e.g., estimated costs, drainage area, etc.). The unit costs that were used to develop capital improvement project cost estimates are provided in Appendix F.

For the flood control capital improvement projects, the fact sheets also include an estimate of the percentage of the project costs that could be funded through system development charges (SDCs). The method used to develop SDC funding estimates is provided in Appendix G.

Table 6-1
Proposed Pipe Improvements to Address Flooding Issues

Structure ID Where Problem is Expected	When Problem is Expected	Capital Improvement Project ID	Capital Improvement Project Description	Comments
2644	50-Yr	**WGFC-1** – South 162nd Ave. Pipe Replacements	Replace pipe segment with larger pipe to address expected problem.	
4511	50-Yr	**WGFC-2** – North 162nd Ave. Pipe Replacements	Replace three pipe segments with larger pipes to address problems expected in one pipe segment.	Drainage is from Portland (51%) in addition to Gresham (49%).
10029 10028 2688 2660 2638 5549 2624 2619 2620	50-Yr 50-Yr 50-Yr 10-Yr 10-Yr 50-Yr 50-Yr 50-Yr 50-Yr	**WGFC-3A** – South 181st Ave. Pipe Replacements (50-Year Improvement)	Replace ten pipe segments with larger pipes to address problems expected in nine segments.	The capital improvement projects #3A and #3B have been developed as mutually exclusive depending on whether 10-year or 50-year protection is desired.
2660 2638	10-Yr 10-Yr	**WGFC-3B –** South 181st Ave. Pipe Replacements (10-Year Improvement)	Replace seven pipe segments with larger pipes to address problems expected in two segments.	The capital improvement projects #3A and #3B have been developed as mutually exclusive depending on whether 10-year or 50-year protection is desired.
5545 10030 4522 297 5939 10032	50-Yr 50-Yr 50-Yr 50-Yr 50-Yr 50-Yr	**WGFC-4** – North 181st Ave. Pipe Replacements	Replace six pipe segments with larger pipes to address problems expected in six segments.	

Structure ID Where Problem is Expected	When Problem is Expected	Capital Improvement Project ID	Capital Improvement Project Description	Comments
2634 10061 4594 2636 10062 723	10-Yr 10-Yr 10-Yr 50-Yr 50-Yr 50-Yr	**WGFC-5 –** Barr Rd./Halsey St. Pipe Replacements	Replace seven pipe segments with larger pipes to address problems expected in six segments.	Sumps were considered as an option for resolving flooding problems. Using an average sump capacity of 30 gallons per minute, approximately 1220 sumps would be needed. Therefore, this option was considered to be infeasible.
2614 775 4570	50-Yr 50-Yr 50-Yr	**WGFC-6 –** East of 194th Ave. Cul-de-sac Pipe Replacements	Replace one pipe segments with larger pipes to address problems expected in three segments.	

6.1.2 Sumped System

This area was not modeled. Information was collected and reviewed regarding any history of observed flooding problems in this area. Eight problems were identified. All of the problems were due to maintenance related issues with the dry wells.

In addition, the evaluation conducted with respect to UIC criteria (see Section 4.1.2) revealed 16 dry wells that may potentially discharge directly to groundwater or to within 10 feet of the groundwater table. These wells are all located in a residential area just west of 182nd and south of Division. As the evaluation of the high groundwater table was based on interpolating between widely distributed points a field investigation was conducted in late May, 2002. As described in Section 4.0 under criterion 7, the results showed seasonal high groundwater depths of approximately 47 to 64 feet below the ground surface. Widely scattered small perched aquifers were also observed at shallower depths (approximately 10 to 20 feet).

Flood control capital projects are not deemed to be necessary in the sumped

Although some perched aquifers exist, existing flooding problems have not been observed and future development is expected to be very minimal in this area. Therefore no capital improvement projects are proposed to address capacity issues associated with existing or future development in the sumped system. For the development of any future dry wells, percolation tests are required in the City of Gresham's Public Works standards. These percolation tests should reveal any potential problems associated with perched systems.

6.2 WATER QUALITY MANAGEMENT ALTERNATIVES

6.2.1 Piped System

Identifying potential capital improvement projects to address water quality concerns is very different from identifying capital improvement projects to address flooding issues. With respect to flooding, specific capacity deficiencies are identified through modeling and capital improvement projects are proposed to address those deficiencies. With respect to water quality, pollutant discharges associated with urban runoff are present throughout the study area. Therefore, with the exception of any specifically observed water quality problems, the focus of developing potential capital improvement project alternatives for water quality was on identifying opportunity areas for the siting of surface water quality capital improvement projects. This included looking for areas with the following characteristics: 1) sufficient space was available for a surface water quality facility, 2) space was available that was publicly owned, and 3) the location drained a large and densely developed high source area. Regional pond-type facilities were desired over underground structural facilities due to difficulties in maintaining the more effective proprietary structural devices and due to the fact that other objectives (i.e., natural resources, aesthetics, education, and potentially some flood control) can be met through the use of surface facilities. However, underground facilities were considered as an option if space was limited for surface facilities. In addition, as temperature is a water quality issue in the Slough, pond-type facilities will need to be designed accordingly.

Ten potential opportunity sites were initially identified for the siting of surface water quality facilities.

An aerial map, the vacant lands map, and the pipe system layout were reviewed to find opportunities for regional facilities. Ten potential opportunity sites were noted and are listed in Table 6-2. These ten potential opportunity sites are also shown on Figures 6a through 6e. The City then reviewed these sites in terms of their existing status with respect to ownership and development. Two opportunities were screened from the list based on this review. For the remaining sites, the model was used to size regional projects in terms of the number of acre-feet of storage that would be required. The XP-SWMM model developed for future conditions (percent impervious for developed conditions) was used to size surface water quality facilities. The City's water quality design storm of 1.2 inches was used to size the facilities.

Table 6-2
Potential Water Quality Facilities

Potential Project ID	Potential Project Location	Status in Terms of Development	Drainage Area Served	Storage Needed
162nd Avenue System				
WGWQ-1A	Downstream end of the 162nd Ave. piped system.	Further investigation is needed with respect to partnering with the City of Portland.	528 Acres	25.3 Acre-Feet
WGWQ-1B	Northeast corner of the 162nd Ave., I-84 intersection.	Further investigation is needed with respect to partnering with the City of Portland.	331 Acres	16.7 Acre-Feet

Potential Project ID	Potential Project Location	Status in Terms of Development	Drainage Area Served	Storage Needed
WGWQ-1C	Southeast corner of 162nd Ave. and NE Thompson St.	Further investigation is needed with respect to partnering with the City of Portland.	127 Acres	4.5 Acre-Feet
West Branch of the 181st Ave. System				
WGWQ-2A	Northwest corner of the 181st Ave., Halsey St. intersection.	Fruit stands currently sit on the site. Development permits are currently inactive.	84 Acres	4.3 Acre-Feet
WGWQ-2B	South side of the I-84 off-ramp at 181st Ave.	A field investigation showed that this site would be very difficult to excavate as it is 15' to 20' above the roadway.	NA	NA
East Branch of the 181st Ave. System				
WGWQ-3A	East of 181st Ave., south of Sandy Blvd.	Development permits have not been obtained.	561 Acres	23.2 Acre-Feet
WGWQ-3B	East of 181st Ave., north of Sandy Blvd.	Owned by AK Media Group. Site has been developed.	NA	NA
Boeing System				
WGWQ-4A	North of Sandy Blvd., west of the wastewater treatment plant on the west side of the Boeing property.	Boeing is the owner. The site is undeveloped.	399 Acres	19.5 Acre-Feet
WGWQ-4B	North of Sandy Blvd., west of the wastewater treatment plant on the Boeing property.	Boeing is the owner. The site is undeveloped.	259 Acres	13.7 Acre-Feet
WGWQ-4C	Northeastern end of the 194th Ave. cul-de-sac, south of I-84.	HDDI, LLC is owner. All development permits have expired.	102 Acres	3.2 Acre-Feet

Some of the potential sites in the above table are mutually exclusive, others are not. In summary:

- WGWQ-1A would also include the drainage areas for WGWQ-1B and WGWQ – 1C
- WGWQ-1B would also include the drainage area for WGWQ-1C
- WGWQ-3A would also include the drainage area for WGWQ-2A
- WGWQ-4B would also include the drainage area for WGWQ-4C

6.2.2 Sumped System

In preparing the December UIC submittal for DEQ, the dry wells were reviewed with respect to a list of criteria (Section 3.2). In the West Gresham study area, only three dry wells were questioned in terms of meeting criteria. These included the 3 dry wells potentially draining industrial facilities along 190th Street. The City will contact the adjacent landowners and discuss alternatives for prevention of stormwater runoff from leaving the private property at these sites.

Water quality capital projects were not proposed for the sumped area due to the fact that the subsurface is expected to provide an effective filtration medium.

With respect to other dry wells in the study area, water quality capital improvement projects are not proposed. This is due to the fact that the subsurface in the study area provides an effective filtration medium between the base of the dry wells and the highest seasonal groundwater level.

DEQ is also very interested in source control programs in the dry well areas. The City already implements source control programs for their NPDES program. These source control programs (BMPs) are implemented City-wide and include:

- Structural and Non-Structural Controls for Residential/Commercial Areas
- Controls for Illicit Discharges and Improper Waste Disposal
- Controls for Industrial Facilities
- Construction Site Controls
- System Planning Controls

The Oregon Association of Clean Water Agencies (ACWA) is currently preparing a best management practices (BMP) manual for underground stormwater injection systems. The purpose of the manual is to compile the best available information regarding management practices for municipal stormwater injection systems including:

- Upstream BMPs for source control.
- Upstream BMPs for pre-treatment.
- Upstream BMPs for spill prevention and response.
- Maintenance activities.
- Design guidance for new stormwater injection systems.
- Decommissioning.
- Record-keeping and reporting.
- Employee/public education.

ACWA will be working to obtain DEQ approval of the manual so it can be used by jurisdictions as support for developing the UIC rule-required management plans for municipal stormwater injection systems. The City of Gresham is participating in the development of this manual. Depending on the outcome of the manual, this West Gresham stormwater master plan may need to be reviewed and potentially modified with respect to water quality management alternatives for the sumped system. Potential modifications could include revising existing source control practices for areas upstream of sumps, revising spill prevention and response practices, and/or revising design guidance for the development of any new stormwater injection systems.

Synopsis of Section 7 - As described in Section 6.0 a total of fourteen potential capital improvement projects were developed for consideration. Seven of the capital improvement projects address pipe capacity issues and eight of the capital improvement projects address water quality issues. Guiding principals were developed to select and rank projects on a qualitative basis. Using these guiding principals, water quality and flood control projects were first ranked separately. Then the projects were combined and ranked as a whole. Four water quality projects and six flood control projects were selected and ranked for implementation. As significant flooding problems were not predicted and have not been observed in the study area, water quality projects were ranked as higher priority than flood control projects.

As described in Section 6.0 a total of fourteen potential capital improvement projects were developed for consideration. Seven of these capital improvement projects address pipe capacity issues and eight of the capital improvement projects address water quality issues. Once the potential projects were identified, the next step was to select and rank projects for implementation. There are several methods that are typically used for selecting and ranking capital improvement projects. Some include numerical scoring systems to rank the capital improvement projects based on specific characteristics such as drainage area served, cost, imminence of the problem, etc. These scoring methods can be simple or complicated. More complicated methods include weighting factors to prioritize the relative importance of each score. For example, depending on priorities, the score for imminence of the problem may be weighted more heavily than drainage area served. Other methods are more qualitative and based on the development of some guiding principles. The method selected can often depend on the number of potential capital improvement projects. For example, if the number of projects is very high, quantitative scoring methods may be the simplest to use.

Guiding principles were developed to qualitatively select and rank projects.

For this West Gresham project, the number of potential projects that need to be evaluated is relatively small. Therefore, it was easiest to develop guiding principles and to select and rank projects on a qualitative basis. The rationale used to select and rank projects is described below according to the following steps:

1. Selection and ranking of the eight water quality projects (section 7.1).
2. Selection and ranking of the seven flood control projects (section 7.2).
3. Combining and ranking of the selected water quality and flood control projects (section 7.3).

7.1 SELECTION AND RANKING OF WATER QUALITY PROJECTS

The first step in the selection and ranking of water quality projects was to prepare Table 7-1 summarizing some of the general characteristics of the projects.

Table 7-1
Information to Assist in Selecting and Prioritizing
Water Quality Capital Improvement Projects

CIP ID	Drainage Area Served (acres)	Storage Required (acre-feet)	Estimated Const. Costs	Estimated Acquisition Costs	Percent of Drainage from Future Development	Would Eliminate the Need for the Following CIPs
*WGWQ-1A	528	25.3	$2,096,800	$1,836,780	16%	1B and 1C
WGWQ-1B	331	16.7	$1,384,000	$1,212,420	2%	1C
WGWQ-1C	127	4.5	$373,000	$326,700	1%	
WGWQ-2A	84	4.3	$356,500	$312,180	37%	
*WGWQ-3A	561	23.2	$1,922,780	$1,684,320	29%	2A
*WGWQ-4A	399	19.5	$1,616,200	$1,415,700	20%	
*WGWQ-4B	259	13.7	$1,135,400	$994,620	25%	4C
WGWQ-4C	102	3.2	$265,200	$232,320	33%	

*These projects (1A, 3A, 4A, and 4B) would eliminate the need for all of the other projects (1B, 1C, 2A, and 4C) due to the overlap of drainage areas treated.

The first item noted was that the projects are not all mutually exclusive. The piped systems in the West Gresham Study Area generally flow from south to north and a capital improvement project is proposed at the most downstream end of four of these systems. Some of the drainage areas for the projects overlap. Construction of four specific capital improvement projects would eliminate the need for the remaining capital improvement projects due to the overlapping coverage of drainage areas. For example, if WGWQ-1A is constructed, it would include treatment of the drainage areas that are covered by projects WGWQ-1B and WGWQ-1C, therefore eliminating the need for these projects. Therefore, it made the most sense to select the four capital improvement projects providing the most total coverage in terms of drainage area treated. The four capital improvement projects included WGWQ-1A, 3A, 4A, and 4B.

Four water quality capital projects were selected and ranked for implementation.

The next step was to rank these four capital improvement projects for implementation. Capital improvement project WGWQ-4B was considered to be the highest priority as the City is currently working with the owner of this site and acquisition costs are likely to be less than those estimated above due to these negotiations. WGWQ-4A was considered to be next in priority as this site has the same owner as WGWQ-4A and the City is also discussing the possibility of acquiring this site as well. As capital improvement project WGWQ-1A has a drainage area that is approximately 51% City of Portland, this project would require negotiations, coordination and potential funding from the City of Portland. As this adds complications to the project, it was ranked as last of the four selected water quality capital improvement projects. In summary, four water quality capital improvement projects were selected for implementation and these projects are ranked as follows:

1. WGWQ-4B: East Boeing Site north of Sandy Blvd.
2. WGWQ-4A: West Boeing Site north of Sandy Blvd.

3. WGWQ-3A: NE 181st and Sandy Blvd. Water Quality Facility
4. WGWQ-1A: NE 162nd Ave. Water Quality Facility

Fact sheets for projects that were screened from the list are still included in this master plan as back-up projects in the event that any of the above four projects are determined to be infeasible during the design phase.

7.2 SELECTION AND RANKING OF FLOOD CONTROL PROJECTS

The first step in the selection and ranking of flood control projects was to prepare a Table 7-2 summarizing some of the general characteristics of the projects.

Table 7-2
Information to Assist in Prioritizing Flood Control Capital Improvement Projects

CIP ID	Drainage Area Served (acres)	Linear Footage of Pipes Needing Replacement	Estimated Cost	SDC Funding Potential	Portion of Problem Associated with 10-Yr Reqs.	Portion of Problem Associated with 50-Yr Reqs.	Significance of Problem
WGFC-1	19.5	399	$80,100	0%	0%	100%	Low
WGFC-2	528	482	$433,900	100%	0%	100%	Med-High
*WGFC-3A	205	2921	$1,040,100	36%	30%	70%	Med-High
*WGFC-3B	188	1956	$593,600	0%	100%		Med-High
WGFC-4	561	1958	$1,044,300	100%		100%	Med-High
WGFC-5	207	2678	$1,247,500	5%	60%	40%	High
WGFC-6	71	228	$54,900	0%	100%		Low

* These projects reflect two different alternatives for addressing the same area. One would address capacity deficiencies identified under both the 10-Yr and 50-Yr storms (3A) and the other would only address the 10-Yr capacity deficiencies (3B).

Six flood control projects were selected and ranked for implementation.

In discussions related to the ranking of flood control capital improvement projects, three issues surfaced as guiding principles. These included the following: 1) address problems that are expected to occur in the busiest arterials (i.e., those flooding problems that would affect the most traffic); 2) address problems in order of the significance of the flooding (i.e., how much water is expected to get into the streets); and 3) address problems that include 100% City of Gresham drainage prior to addressing problems that also include City of Portland drainage as these projects will require negotiations, coordination and potential additional funding from the City of Portland. Based on these guiding principals, the flood control capital improvement projects were ranked in the following priority order based on the rationale that is provided.

1. **WGFC-3A: South 181st Ave. Pipe Replacements**
   Rationale: This project was selected as highest priority due to the significance of the flooding predicted and due to the relatively high traffic volume on this section of 181st when compared to traffic volumes in other areas where capacity deficiencies were identified.
2. **WGFC-5: Barr Road/Halsey Street Pipe Replacements**
   Rationale: This project was considered to be similar to project WGFC-4 in terms of the traffic volume that would be affected. However, the significance of the flooding predicted was greater for this project that it was for WGFC-4.
3. **WGFC-4: North 181st Ave. Pipe Replacements**
   Rationale: This project was considered to be similar to the above project (WGFC-5) in terms of traffic volume affected. However, the significance of the flooding predicted was not as great for this project (i.e., the depth of water in the roadway was less).
4. **WGFC-2: North 162nd Ave. Pipe Replacements**
   Rationale: This project was ranked below the above two projects due to the fact that a significant portion of the drainage area (i.e., approximately 51%) for this project is located in the City of Portland. This project was ranked above the following two projects because it addresses capacity deficiencies that would affect a fairly busy arterial.
5. **WGFC-6: East of 194th Ave. Cul-de-sac Pipe Replacements**
   Rationale: This project was ranked as second to last due to the fact that the deficient pipe is located along the back lot line of properties along the 194th Ave. cul-de-sac and it is not expected to result in property damage. In addition, the significance of the flooding predicted was relatively low when compared to the other deficiencies identified.
6. **WGFC-1: South 162nd Ave. Pipe Replacements**
   Rationale: This project was ranked last due to the fact that a significant portion of the drainage area (i.e., approximately 82%) for this project is located in the City of Portland. In addition, the significance of the flooding predicted was relatively low when compared to the other deficiencies identified.

It should be noted that capital improvement project WGFC-3B was screened from the list of projects. The reason for developing this capital improvement project was to determine whether addressing flooding problems for the 10-year storm would significantly reduce the cost of this project. As the cost difference is estimated to be approximately $446,500 (or 43% of project 3A), and the design criteria that applies to several of these pipe segments is a 50-year storm, a decision was made to retain capital improvement project WGFC-3A and to provide protection for the 50-year storm.

7.3 RANKING OF COMBINED WATER QUALITY AND FLOOD CONTROL PROJECTS

Due to lack of observed flooding problems, water quality capital projects were considered to be higher priority than flood control capital

Once the projects were separately ranked for flood control and water quality, the selected projects were combined and ranked. Discussions centered around the model results that generated the list of

flood control capital improvement projects. Based on the lack of observed flooding problems in the study area, for recent significant storms such as the one that occurred in November, 1996 (see page 3-3), a decision was made to rank all of the water quality projects as higher priority than the flood control projects. Water quality is a known problem in the area, and due to the fact that properties will need to be acquired for water quality projects, opportunities could potentially be lost if they are placed lower on the list.

As a result of the above discussions, the final capital improvement project list for the West Gresham Study Area in order of priority ranking is as follows (see Figure 14 for selected capital improvement project locations):

1. WGWQ-4B: East Boeing Site north of Sandy Blvd.
2. WGWQ-4A: West Boeing Site north of Sandy Blvd.
3. WGWQ-3A: North 181st and Sandy Blvd. Water Quality Facility
4. WGWQ-1A: North 162nd Ave. Water Quality Facility
5. WGFC-3A: South 181st Ave. Pipe Replacements
6. WGFC-5: Barr Road/Halsey Street Pipe Replacements
7. WGFC-4: North 181st Ave. Pipe Replacements
8. WGFC-2: North 162nd Ave. Pipe Replacements
9. WGFC-6: East of 194th Ave. Cul-de-sac Pipe Replacements
10. WGFC-1: South 162nd Ave. Pipe Replacements

This ranking should be re-evaluated on a regular basis based on City priorities. Another issue that was discussed is the potential to use some of the water quality project locations to also address flood control. For example, when designing capital improvement project WGWQ-3A, the potential for also alleviating some of the capacity deficiencies associated with WGFC-4 or coordinating construction with WGFC-4 should be considered. If cost efficiencies are noted, this could potentially elevate one of the flood control projects in the ranking.

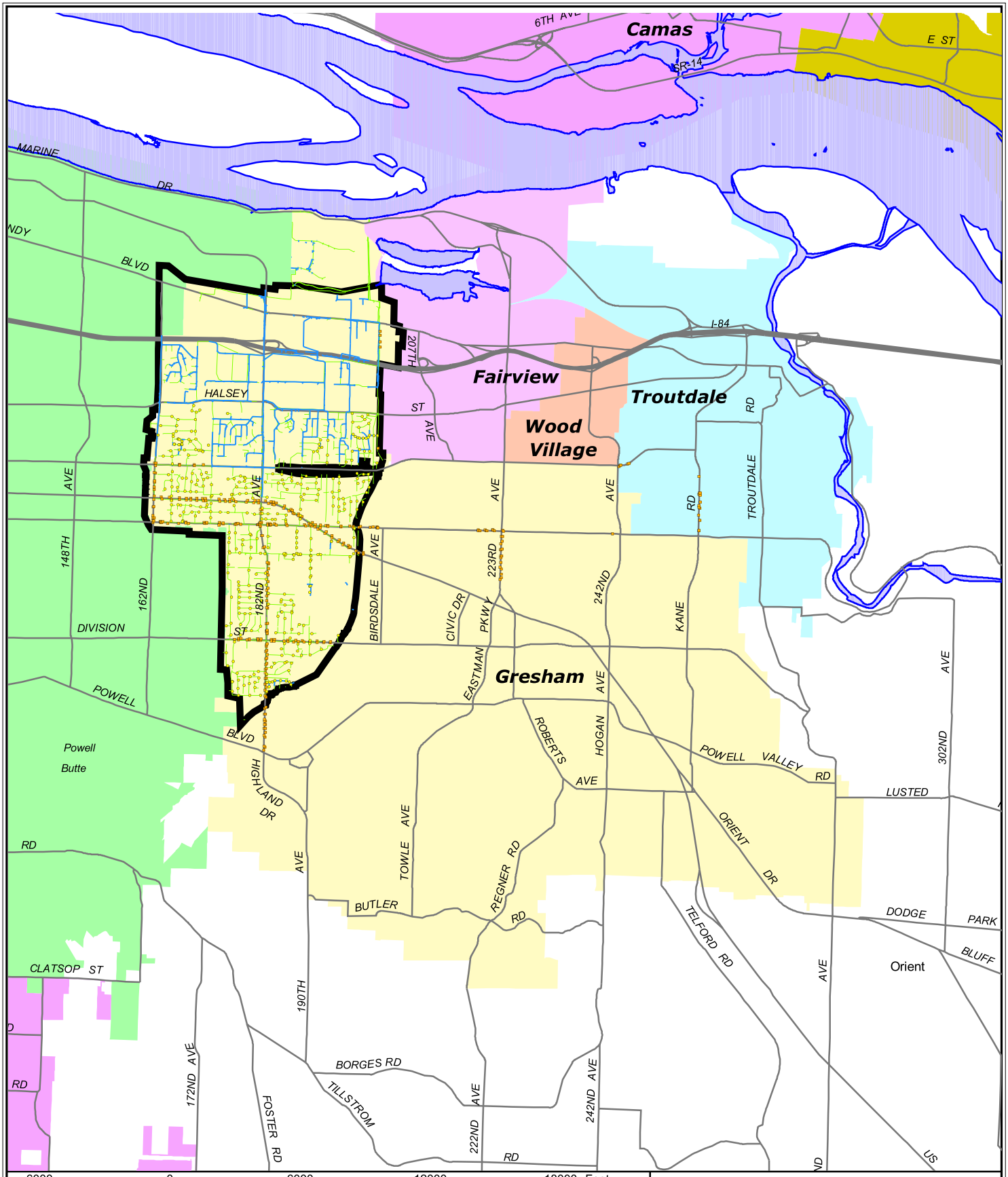
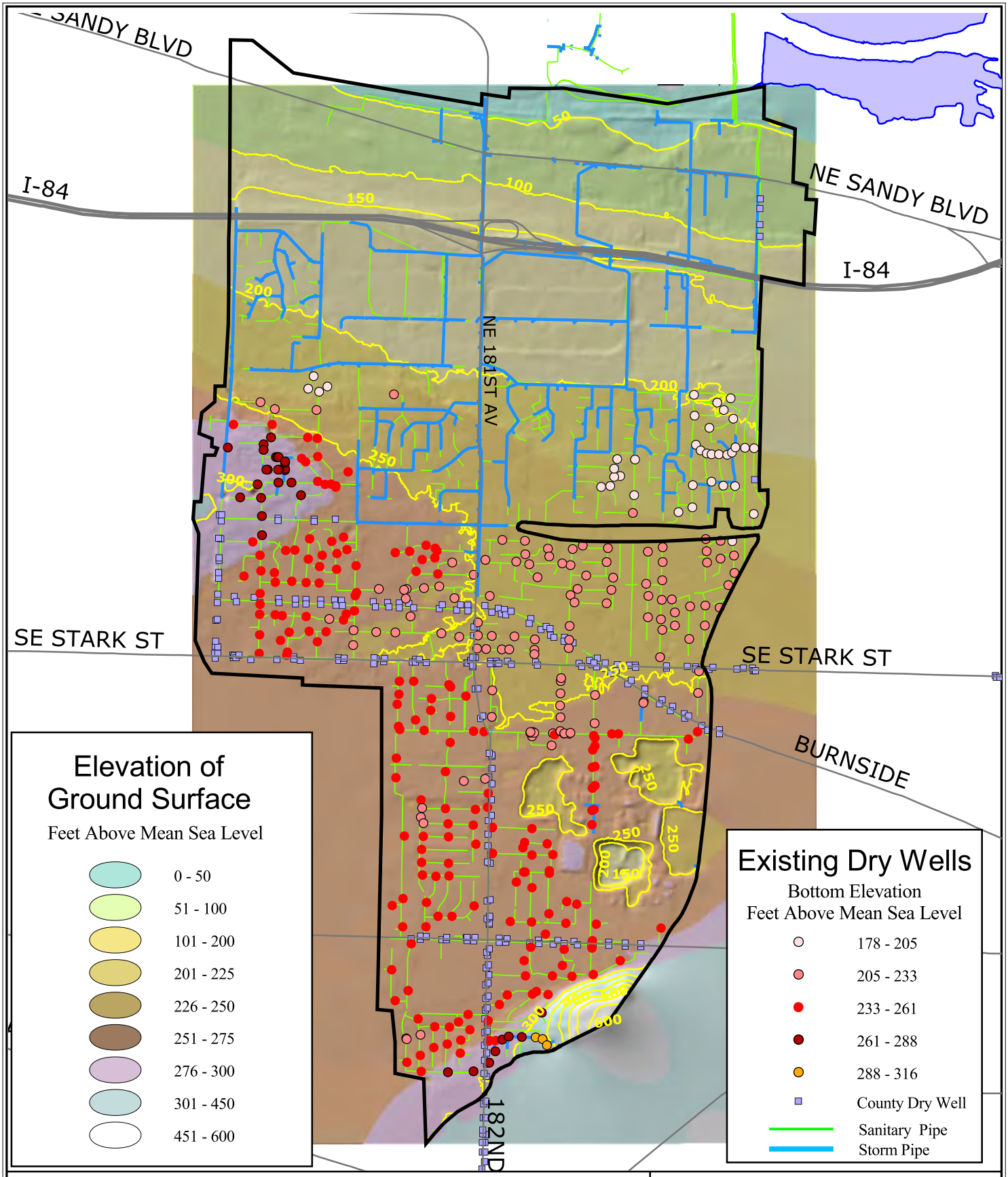


Figure 1

Vicinity Map

West Gresham Stormwater Master Plan

52-00170002.00



2500 0 2500 5000 7500 Feet

N

WGSA Boundary

Freeways

Major Streets

URS

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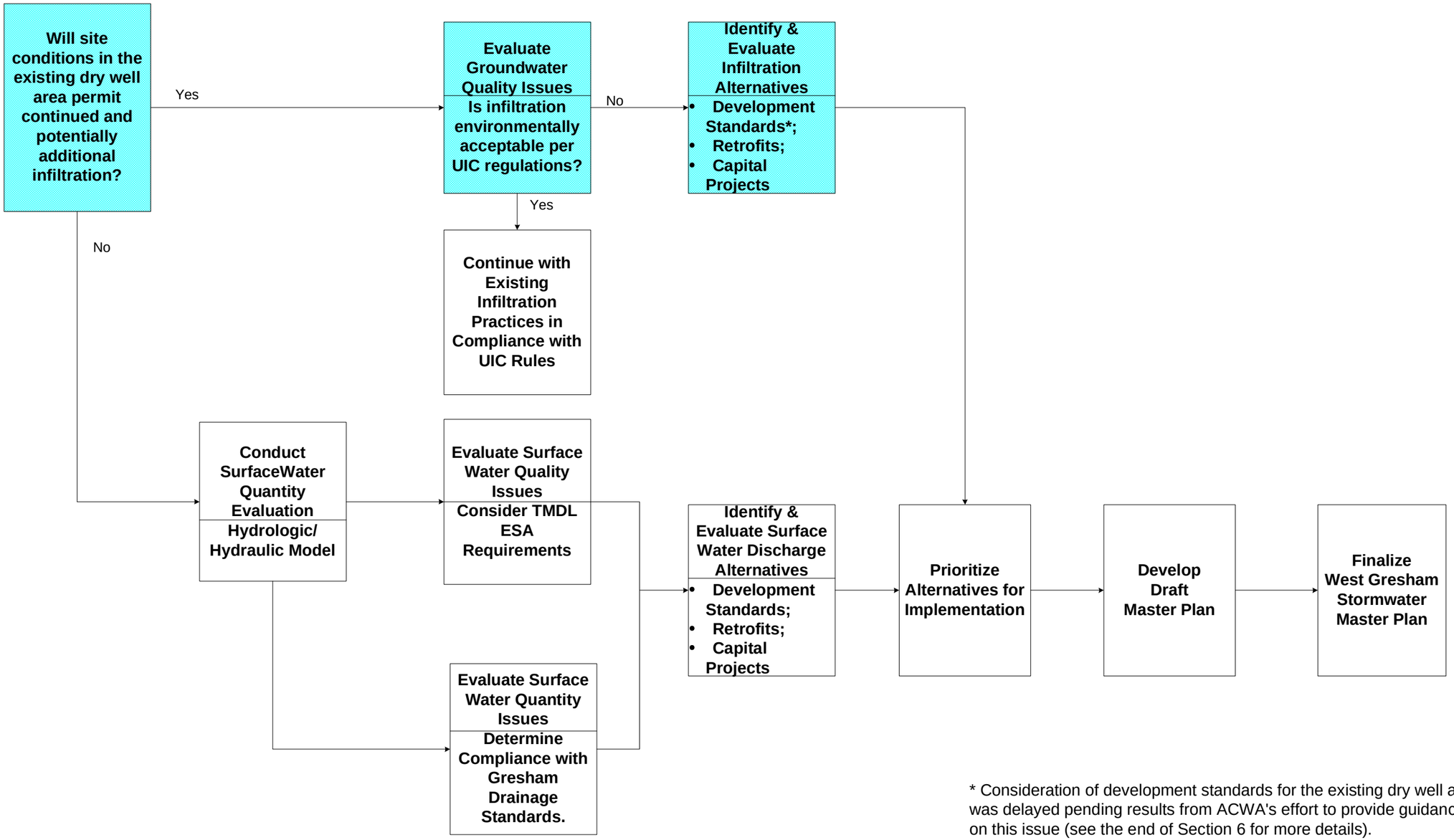
Figure 2

WGSA and Dry Well Locations

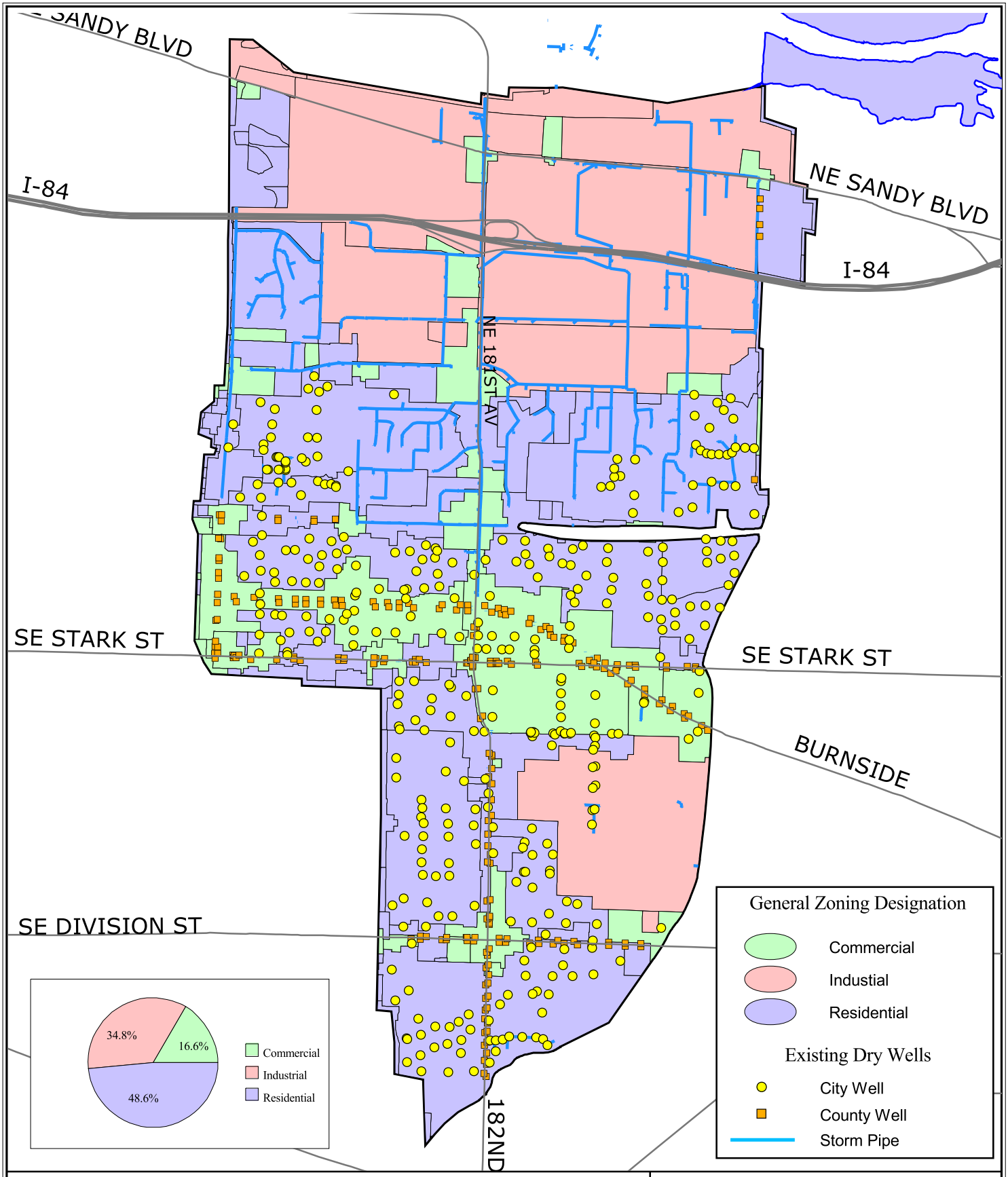
West Gresham Stormwater Master Plan

52-00170002.00

Figure 3
West Gresham Stormwater Master Plan
Project Approach



* Consideration of development standards for the existing dry well area was delayed pending results from ACWA's effort to provide guidance on this issue (see the end of Section 6 for more details).



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N

WGSA Boundary

Freeways

Major Streets

URS

Print Date: June 2002 k:\w_gresham\apr\june02_figs.apr

Figure 4

General Zoning Designation

West Gresham Stormwater Master Plan

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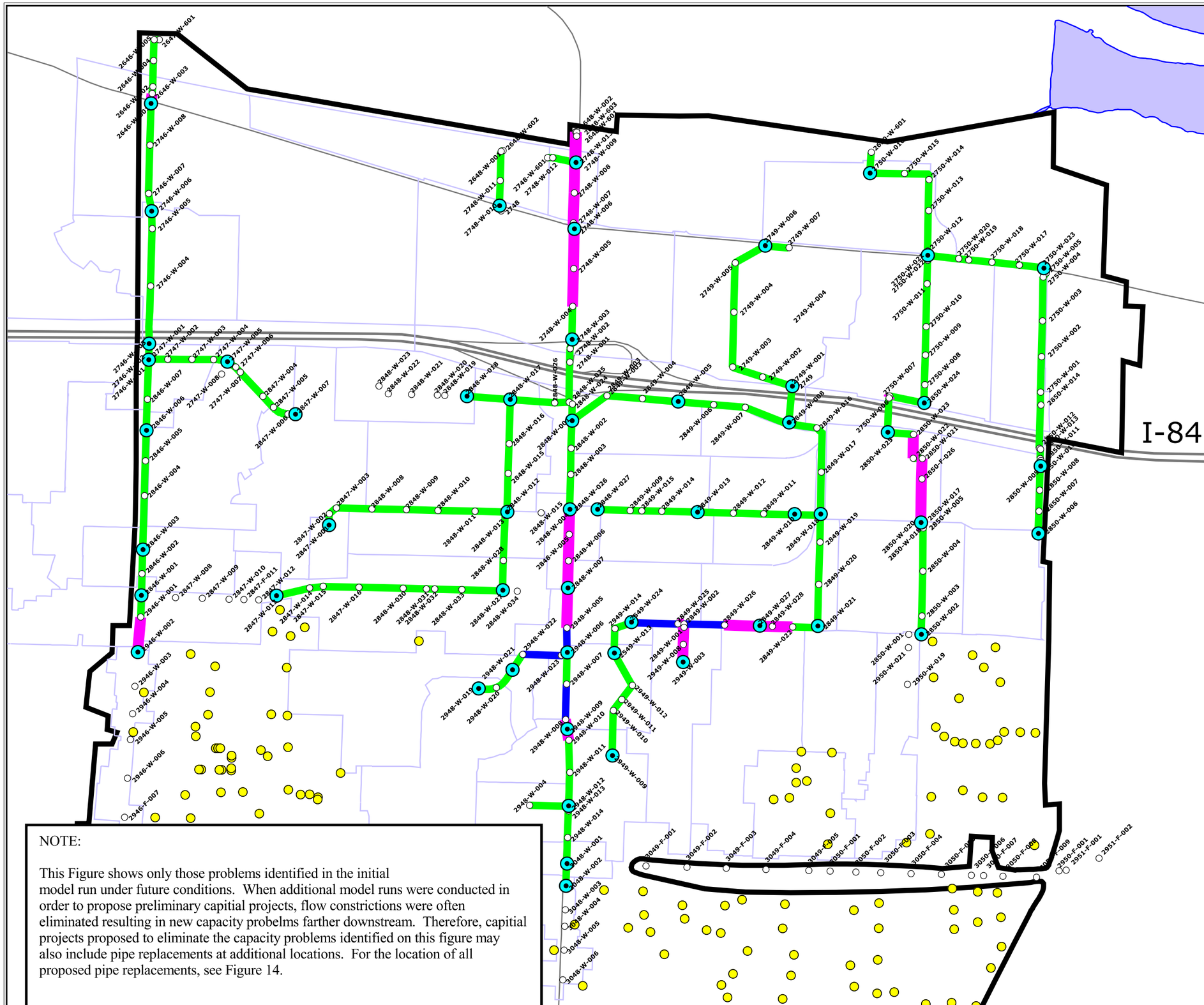
West Gresham Stormwater Master Plan



Map Features

- Node with ID
- Modeled Input Nodes
- City Drywells

Modeled Pipes

- No Predicted Problems
- Problem Predicted for 10-Year Storm
- Problem Predicted for 50-Year Storm
- Subbasin Boundary
- Freeways
- Major Streets

N

900 0 900 Feet

NOTE:

This Figure shows only those problems identified in the initial model run under future conditions. When additional model runs were conducted in order to propose preliminary capitial projects, flow constrictions were often eliminated resulting in new capacity probelms farther downstream. Therefore, capitial projects proposed to eliminate the capacity problems identified on this figure may also include pipe replacements at additional locations. For the location of all proposed pipe replacements, see Figure 14.

Figure 5

Model-Predicted Flooding Problems

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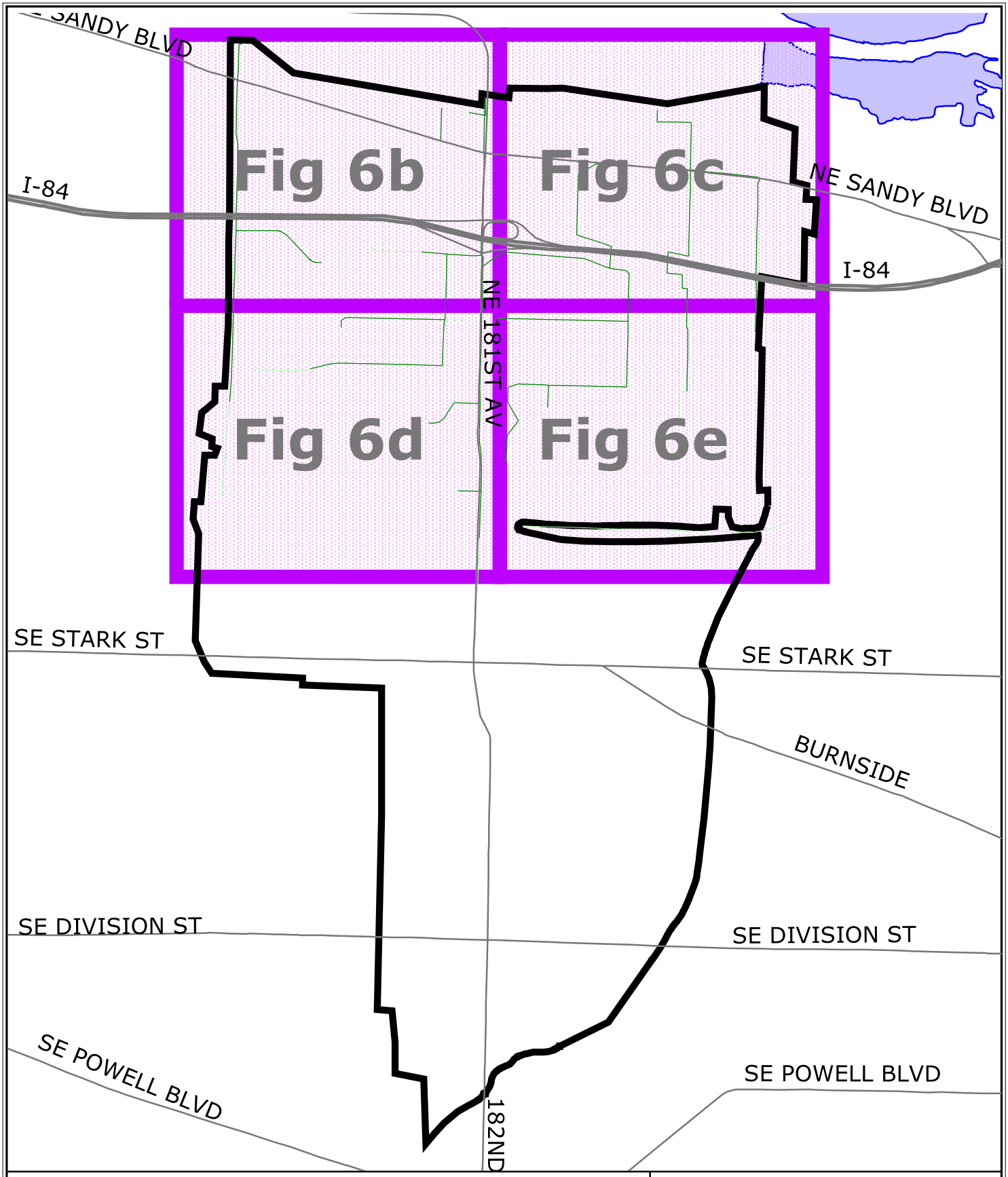

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N

WGSA Boundary

Freeways

Major Streets

URS

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Figure 6a

Page Index

West Gresham Stormwater Master Plan

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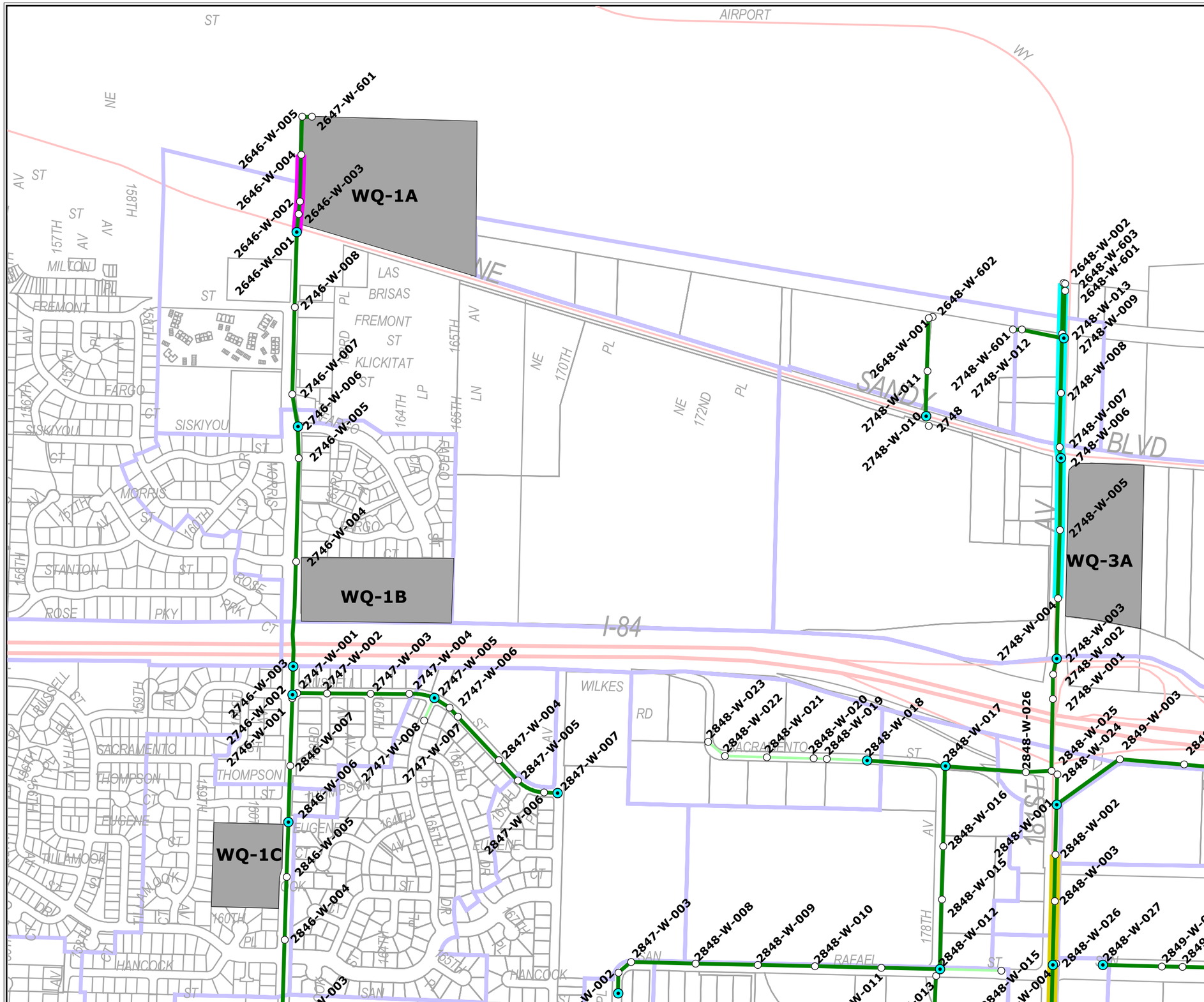
West Gresham Stormwater Master Plan



Map Features

- Node Numbers
- Modeled Input Nodes
- City Drywells
- Modeled Pipes
- Non-modeled Pipes
- CIP WGFC-1
- CIP WGFC-2
- CIP WGFC-3
- CIP WGFC-4
- CIP WGFC-5
- CIP WGFC-6
- Subbasin Boundary
- Water Quality Pond
- Tax Lots
- Freeways
- Major Streets

N

500 0 500 Feet

Figure 6b
Modeled Pipe System and Subbasins and Potential Project Alternatives

URS

Print Date: March 2005
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West Gresham Stormwater Master Plan

Map Features

- Node Numbers
- Modeled Input Nodes
- City Drywells
- Modeled Pipes
- Non-modeled Pipes
- CIP WGFC-1
- CIP WGFC-2
- CIP WGFC-3
- CIP WGFC-4
- CIP WGFC-5
- CIP WGFC-6
- Subbasin Boundary
- Water Quality Pond
- Tax Lots
- Freeways
- Major Streets

N

500 0 500 Feet

Figure 6c
Modeled Pipe System and Subbasins and Potential Project Alternatives

URS

Print Date: March 2005
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West Gresham Stormwater Master Plan

Map Features

- Node Numbers
- Modeled Input Nodes
- City Drywells
- Modeled Pipes
- Non-modeled Pipes
- CIP WGFC-1
- CIP WGFC-2
- CIP WGFC-3
- CIP WGFC-4
- CIP WGFC-5
- CIP WGFC-6
- Subbasin Boundary
- Water Quality Pond
- Tax Lots
- Freeways
- Major Streets

N

500 0 500 Feet

Figure 6d
Modeled Pipe System and Subbasins and Potential Project Alternatives

URS

Print Date: March 2005
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West Gresham Stormwater Master Plan

Map Features

- Node Numbers
- Modeled Input Nodes
- City Drywells
- Modeled Pipes
- Non-modeled Pipes
- CIP WGFC-1
- CIP WGFC-2
- CIP WGFC-3
- CIP WGFC-4
- CIP WGFC-5
- CIP WGFC-6
- Subbasin Boundary
- Water Quality Pond
- Tax Lots
- Freeways
- Major Streets

N

500 0 500 Feet

Figure 6e
Modeled Pipe System and Subbasins and Potential Project Alternatives

URS

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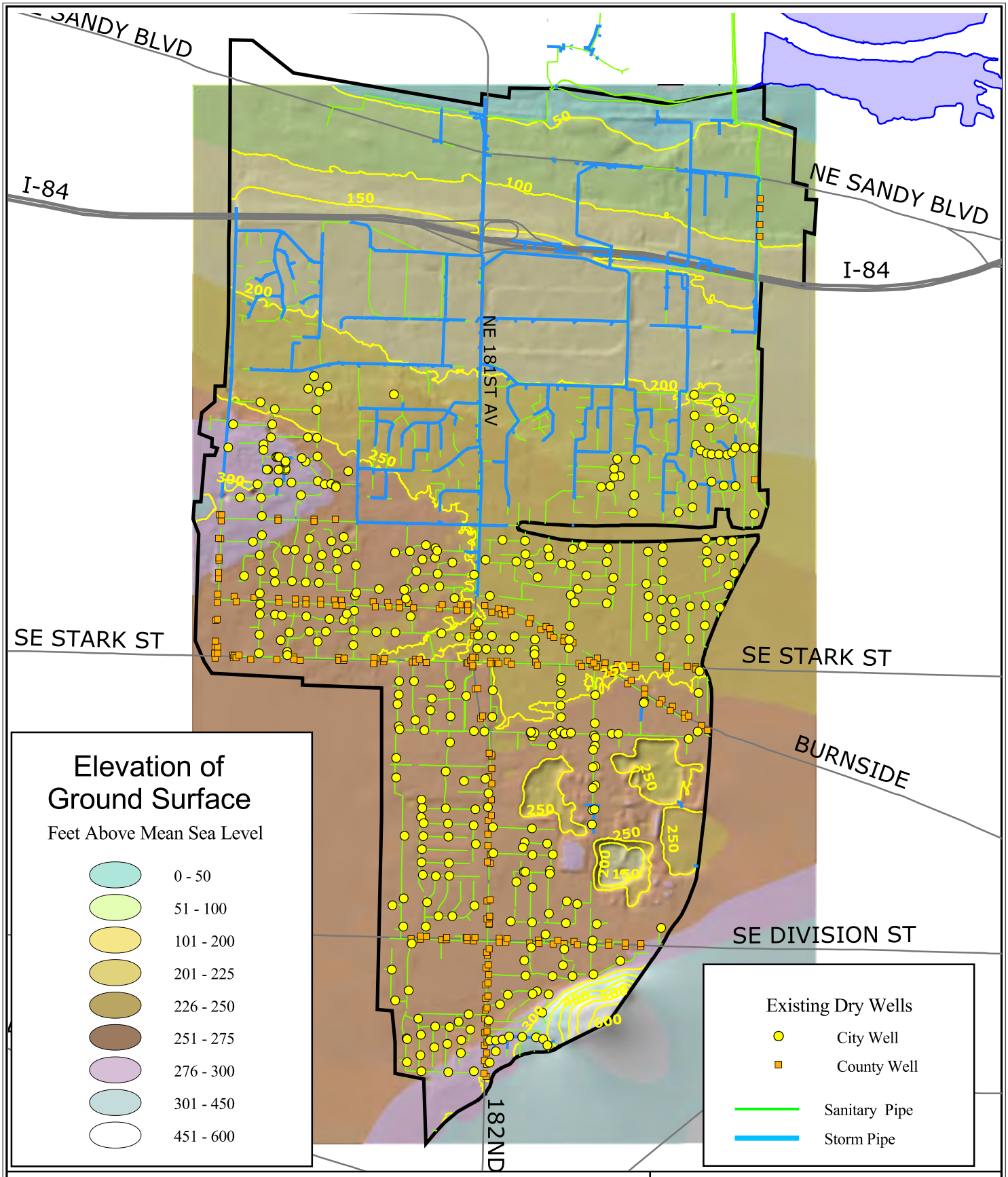

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WGSA Boundary

Freeways

Major Streets

URS

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Figure 7
Surface Elevation and Sanitary System with Dry Well Locations
West Gresham Stormwater Master Plan

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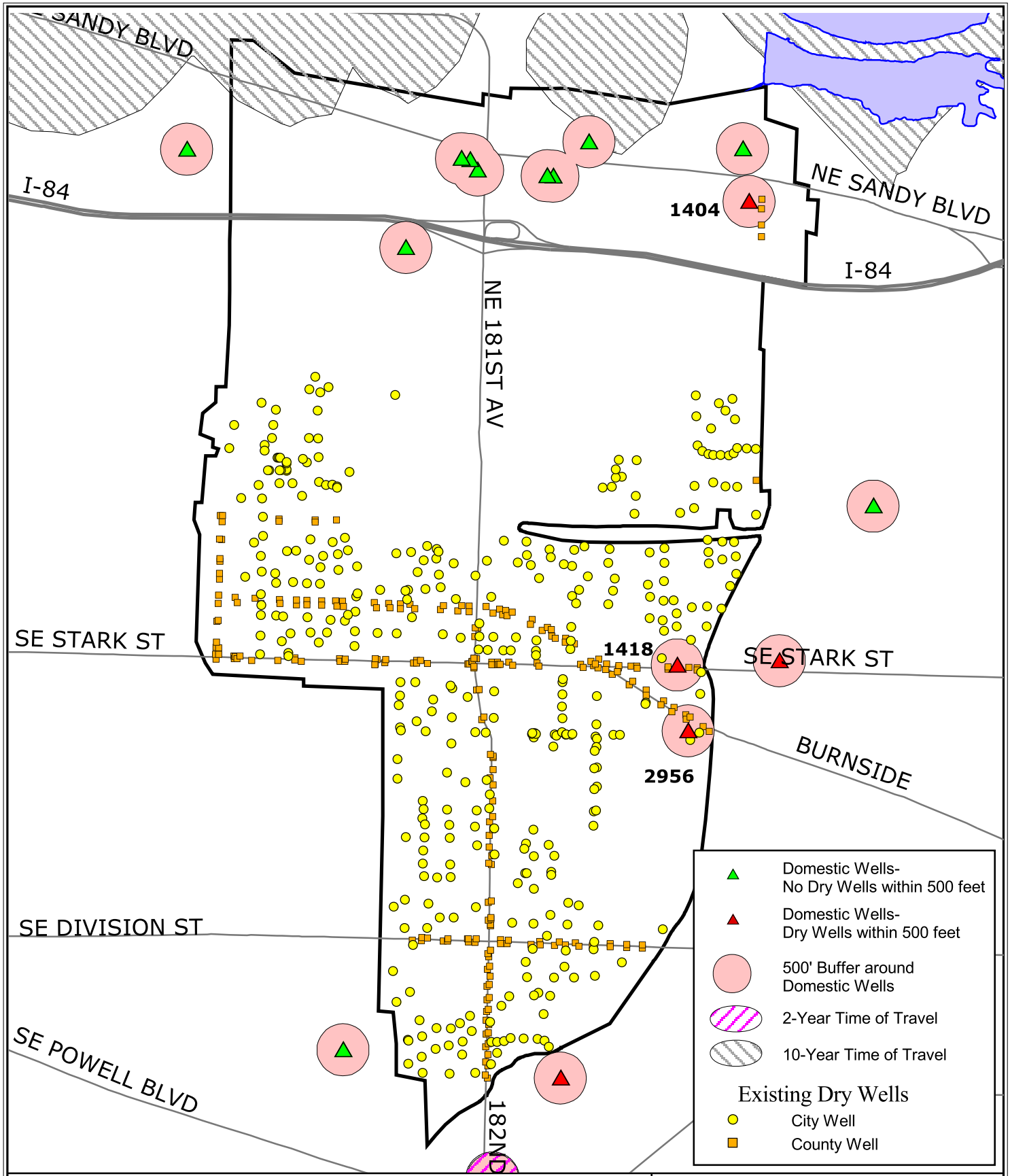

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N

WGSA Boundary

Freeways

Major Streets

URS

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Figure 8

Domestic Wells
and Public Water Supply

West Gresham Stormwater
Master Plan

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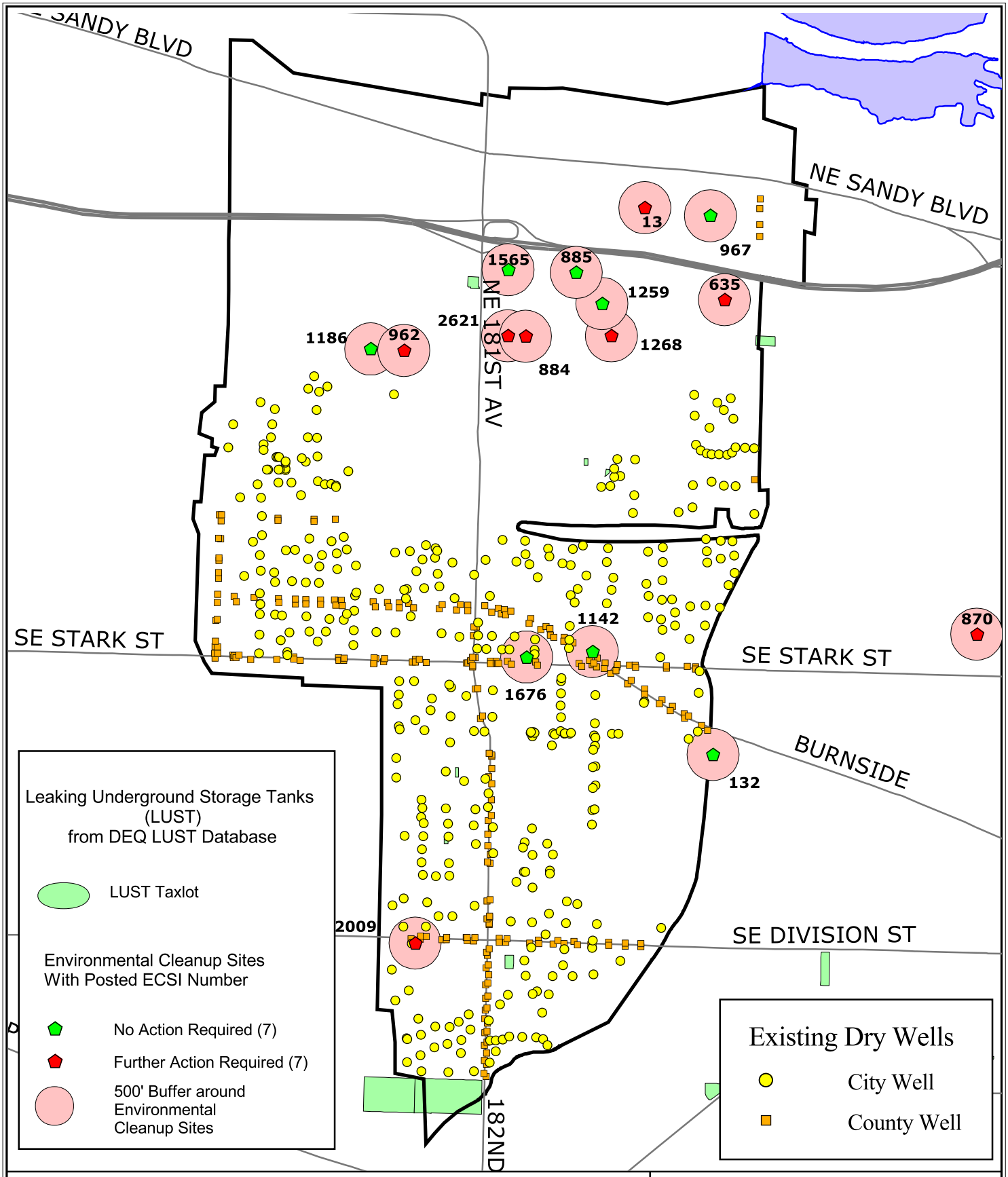

2500 0 2500 5000 7500 Feet

N

WGSA Boundary

Freeways

Major Streets

URS

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Figure 9

Contaminated Sites

West Gresham Stormwater
Master Plan

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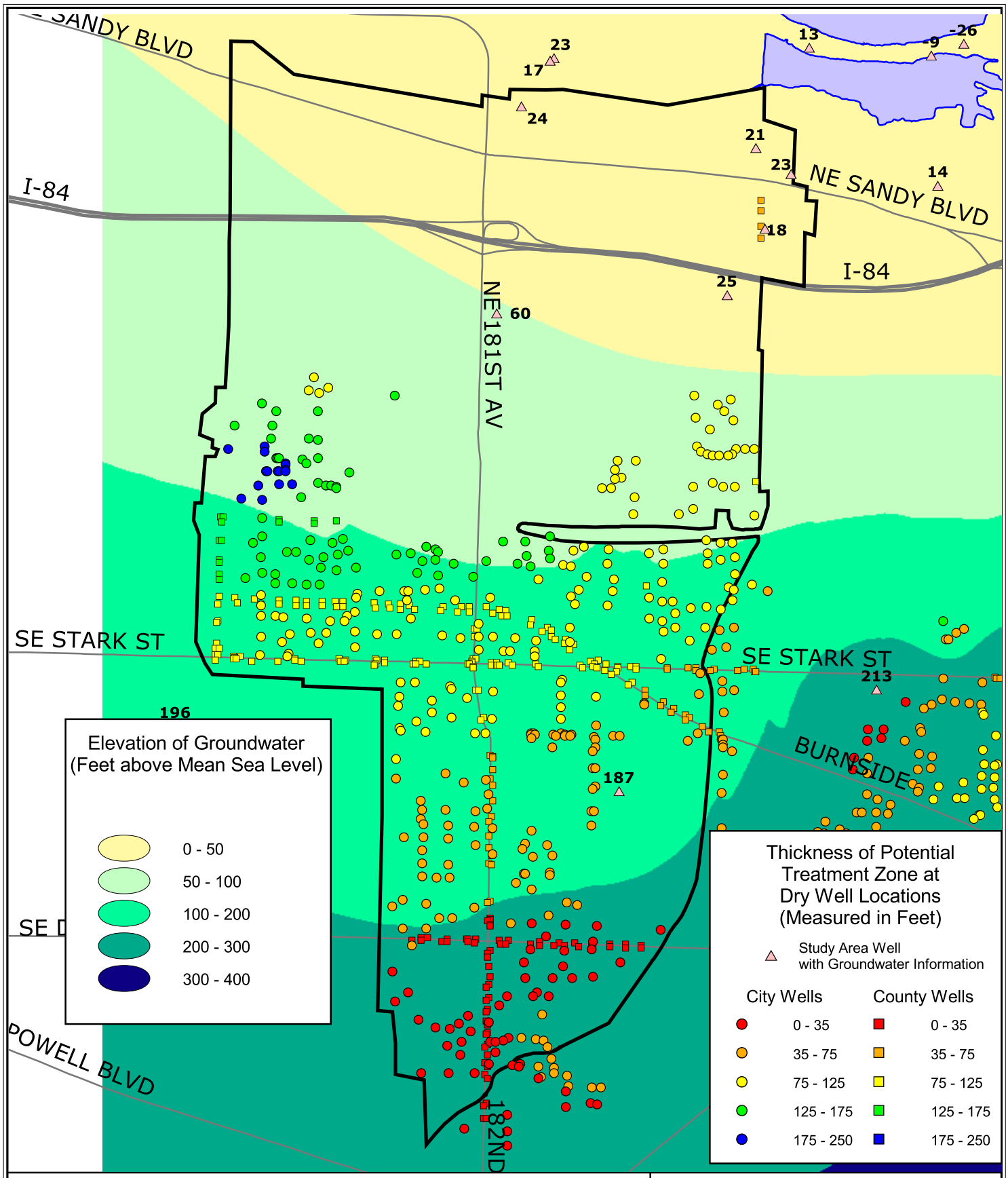

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N

WGSA Boundary

Freeways

Major Streets

URS

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Figure 10

Elevation of Groundwater
(Spring 1988)

West Gresham Stormwater
Master Plan

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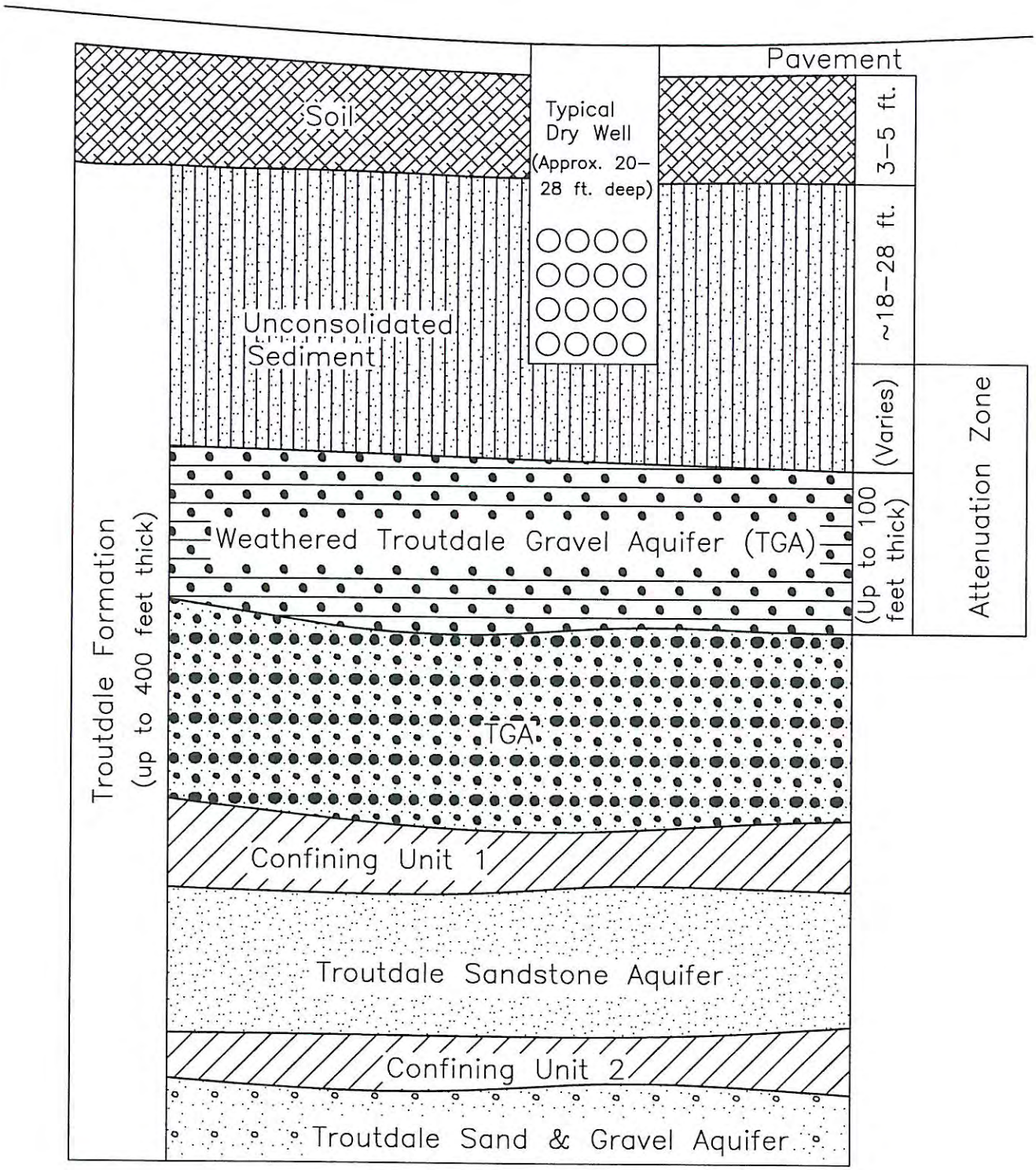
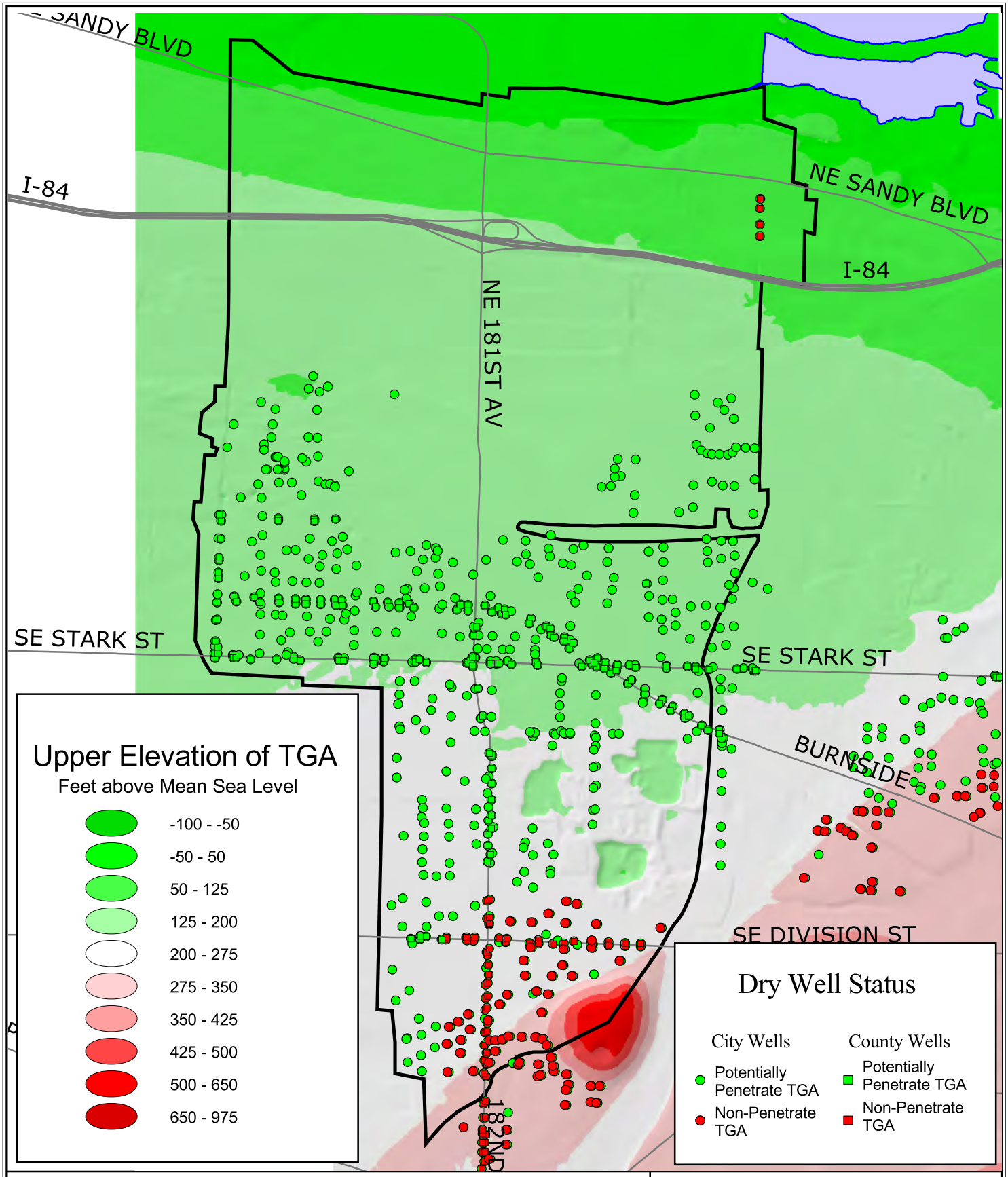


NOT TO SCALE

URS	TITLE: Typical Cross–Section Dry Well and Attenuation Zone Gresham, OR	DWN: jgdp	DES.:	PROJECT NO.: 52–00170002.00
		CHKD:	APPD:	FIGURE NO.: 11
		DATE: 6/25/02	REV.: 0	



2500 0 2500 5000 7500 Feet

N

WGSA Boundary

Freeways

Major Streets

URS

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Figure 12

Elevation of Troutdale Gravel Aquifer

West Gresham Stormwater Master Plan

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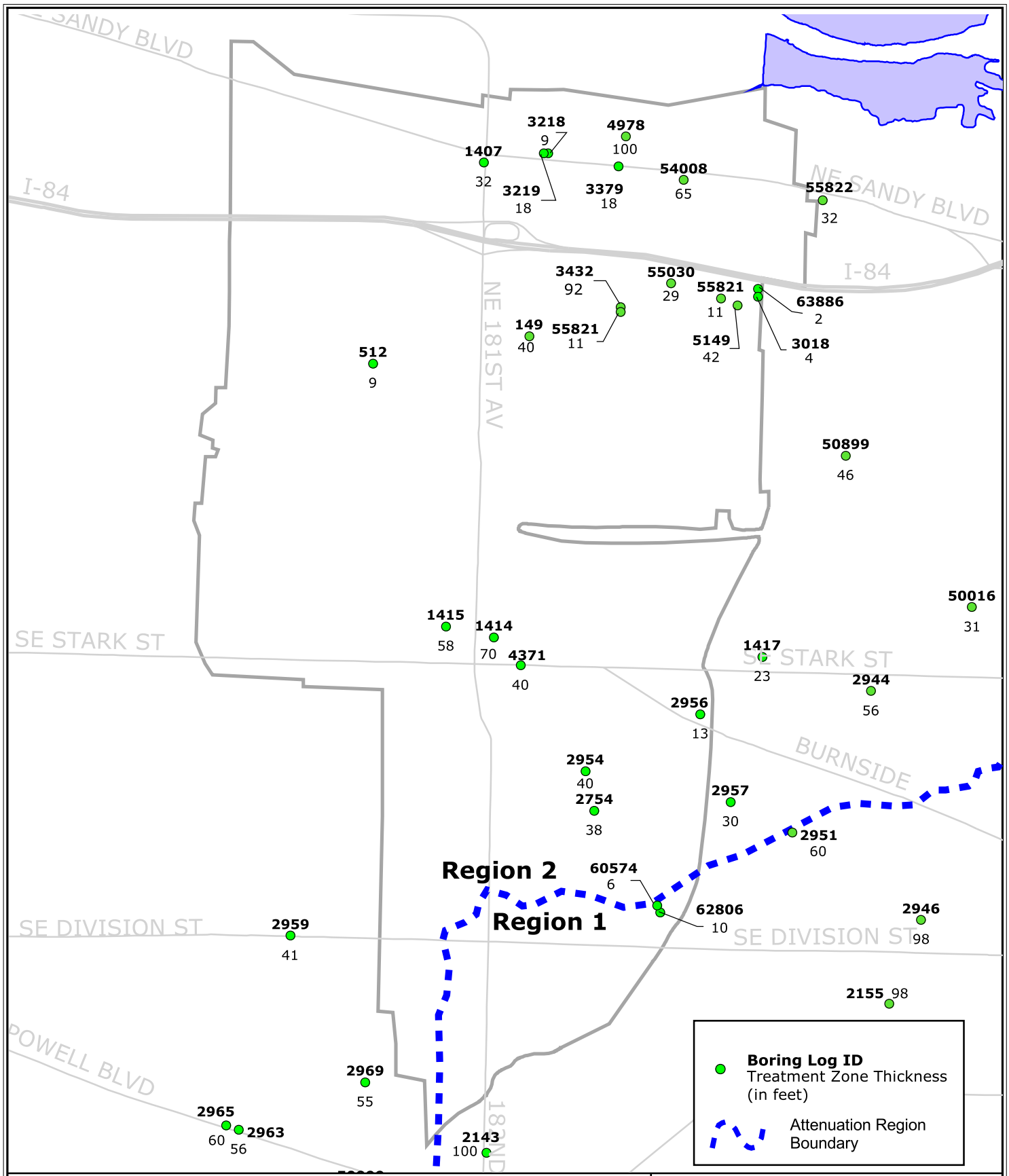

Figure 13

Thickness of Potential Treatment Zone Observed in Boring Logs (in feet)

West Gresham Stormwater Master Plan

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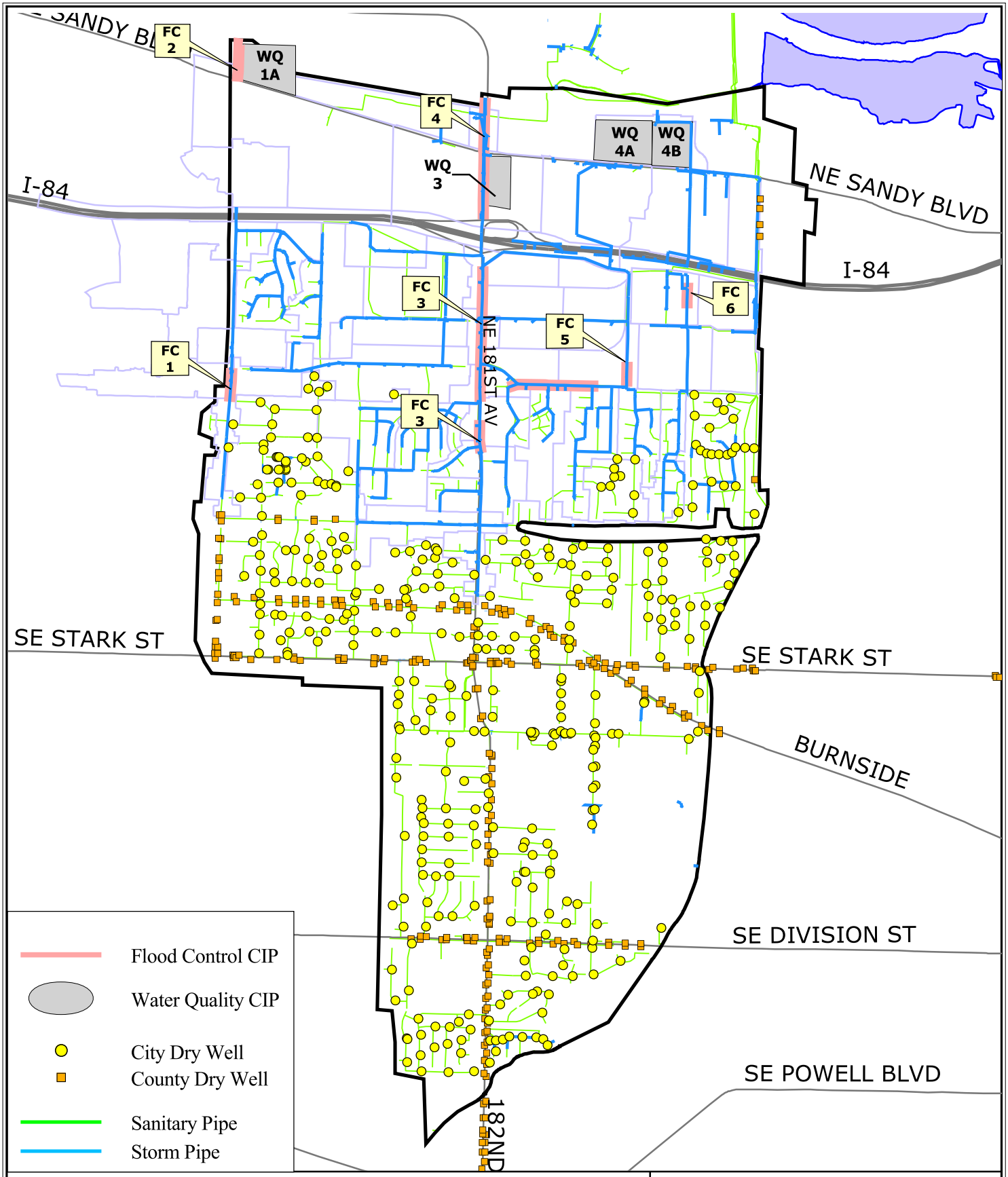

2500 0 2500 5000 7500 Feet

N

Basin Boundary

WGSA Boundary

Freeways

Major Streets

URS

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Figure 14

Selected Capital Project Alternatives

West Gresham Stormwater Master Plan

52-00170002.00

To evaluate the capacity of the existing piped system to adequately convey storm water runoff, a computer model was developed to simulate the hydrologic/hydraulic conditions of the public storm drainage system. The storm system was evaluated under both existing and expected future land use conditions. The XP-SWMM model was selected to conduct these analyses. In order to develop the hydrologic and hydraulic computer model of the existing storm pipe system, a number of input parameters were needed to develop the RUNOFF (hydrology) and EXTRAN (hydraulics) blocks of XP-SWMM. The information in this Appendix describes the required input parameters and specifies methods for developing the data. The necessary model input parameters are listed below in the following three categories:

- Meteorological (e.g., rainfall, evaporation)
- Subbasin Hydrologic Data (e.g., area, impervious percentage, infiltration parameters)
- Storm Drainage System Hydraulic Data (e.g., pipe size, material, length and invert elevations)

A description of the method or literature reference used to determine the value for each parameter is also provided.

METEOROLOGICAL DATA

Design Storms and Precipitation Data

Based on the design standards specified in the 2001 City of Gresham Public Works Design Standards Manual, major drainage system elements shall meet the following conveyance capacity requirements:

- For laterals (collectors) draining less than 250 acres: 10-year 24-hour design storm.
- For trunks draining greater than 250 acres: 50-year 24-hour design storm.
- For arterial streets and the drainage system in or under arterial streets: 50-year 24-hour design storm.

Since there is no rain gage located within the study area, the 10, 50 and 100-year design storm volumes were based on the Rainfall Intensity Duration Curve contained in the City's Public Works Design Standards Manual. Storm volumes for different return periods are listed as follows:

- 10-year 24-hour design storm: volume = 3.6 inches; maximum intensity = 0.61 inches/hr
- 50-year 24-hour design storm: volume = 4.3 inches; maximum intensity = 0.73 inches/hr
- 100-year 24-hour design storm: volume = 5.0 inches; maximum intensity = 0.85 inches/hr

The design storm distribution is based on the 24-hour SCS Type 1-A distribution that applies to the Pacific Northwest.

Evaporation
Evaporation data is estimated based on the monthly evapo-transpiration data provided by the Oregon State Agricultural Extension for the Willamette Valley. The monthly evapotranspiration rates for wet season are as follows:

- January = 0.71 inches
- February = 1.13 inches
- March = 1.54 inches
- November = 0.47 inches
- December = 0.71 inches

Since most large storm events are likely to occur in the wet season, the synthetic design storms were assumed to take place in the month of January.

SUBBASIN HYDROLOGIC DATA

The West Gresham study area was subdivided into smaller subbasins for modeling purposes. The subbasin boundaries were delineated based on the topographic map and the locations of the existing drainage system. The subbasin boundaries were then digitized into the GIS. Many of the subbasin hydrologic data described in this section of the Appendix were developed through the use of GIS.

Input Parameters
In order for the RUNOFF block of XP-SWMM to generate a stormwater runoff hydrograph from each subbasin, the following parameters were specified for each subbasin:

- Subbasin name or number.
- Area of subbasin (acres).
- Width of subbasin (feet).
- Hydraulically connected impervious percentage (percent).
- Average ground slope (dimensionless, ft/ft).
- Manning's roughness coefficient for impervious areas.
- Manning's roughness coefficient for pervious areas.
- Depression storage for impervious areas (inches of water over subbasin).
- Depression storage for pervious areas (inches of water over subbasin).
- Green-Ampt soil infiltration parameters: average capillary suction (inches), saturated hydraulic conductivity (inches/hour), and initial moisture deficit (volume air/volume voids).

For each of these parameters, a discussion is presented below describing the methods that were used to generate the values used in XP-SWMM. For many of these parameters, the GIS was used to generate area-weighted average values for each subbasin.

Subbasin Name
The subbasin name was assigned to each subbasin using the manhole ID for the manhole location where the subbasin hydrograph enters the system. The manhole IDs were obtained from the City's GIS.

Subbasin Area
The subbasin areas were generated using GIS to calculate areas within the subbasin boundaries.

Subbasin Width
Subbasin width is defined as the physical width of overland flow. The subbasin width was determined from the basin map using one of two different methods, depending on the location of the subbasin within the drainage system:

- For the furthest upstream subbasin on each drainage system, the subbasin width was estimated using the area of the subbasin divided by the average maximum distance from the subbasin boundary to the inlet point to the drainage system.
- For the remaining subbasins, the subbasin width was obtained using the area of the subbasin divided by the average maximum distance from the subbasin boundary to the main flow path of the drainage system.

Subbasin Effective Impervious Percentage
Effective impervious percentage is the portion of the mapped impervious area within a subbasin that is directly connected to the drainage collection system. For example, curb-and-gutter streets are directly connected to the drainage collection system and represent "effective impervious area". However, a sidewalk that is separated from the street by a vegetated strip is not considered directly connected since the runoff has the opportunity to infiltrate. The amount of impervious area in a subbasin differs depending on its land use. Two sets of the mapped impervious percentages (existing and future land use conditions) were estimated for each subbasin. Estimates of mapped impervious area for existing conditions were determined based on land use data obtained from the City.

The future buildout land use conditions were based on the zoning map. The following table was used to develop the area weighted impervious percentages for each subbasin:

Zoning Code	Land Use Designation	Estimated Percentage of Impervious Area
AGF	Agriculture, forest, farm lands, timber	2%
RUR	Rural residential, rural commercial, rural industrial	30%
SFR	Single (low density) residential	35%
MFR	Village residential and medium density residential	60%
COM	Commercial	85%
POS	Parks and open Spaces	2%
IND	Light industrial	75%

These area-weighted mapped impervious percentages for each subbasin were then adjusted based on the following equation developed by Sutherland (1995) to obtain the effective impervious percentages:

$$\text{Effective Imp. \%} = 0.4 * (\text{Mapped Imp. \%})^{1.2}$$

The above equation applies to basins where the local drainage collector system for the urban areas within the basin is predominately sewered with curbs and gutters; the residential rooftops are directly connected to the drainage system, and there are no infiltration facilities (e.g., dry wells) in the basin.

Subbasin Slope (units = dimensionless, ft/ft)
The subbasin slope is the average slope along the pathway of overland flow to the inlet of the drainage system. The subbasin slope was developed based on the digital topographic data contained in the GIS.

Manning's Roughness Coefficient for Impervious Areas (dimensionless)
Manning's roughness coefficient provides a measure of friction resistance to flow across a surface or channel. The Manning's roughness for impervious surfaces is based on values presented in the SWMM User's Manual. Based on the assumption that most, if not all, of the impervious surfaces are asphalt or concrete, the Manning's roughness coefficient for impervious areas was set equal to 0.014.

Manning's Roughness Coefficient for Pervious Areas (dimensionless)
Using the aerial photography maps for the study area, the average roughness coefficient value for the pervious areas within each subbasin was estimated based on the cover types and Manning's roughness coefficients listed in the following table:

Cover Type	Manning's n
lawn or turf grass in urbanized areas	0.45
pasture or cropland	0.20
Dense shrubs and/or forest	0.40

Depression Storage for Impervious Areas (units = inches)
The depression storage is the volume of depression in the land surface that must be filled prior to the occurrence of runoff. Depression storage was set equal to 0.05 inches for all impervious areas based on typical values recommended by the SWMM User's Manual.

Depression Storage for Pervious Areas (units = inches)
The depression storage for pervious areas was based on USDA soil texture classification. Since the predominant soil type in the study area is silt loam, the depression storage was set equal to 0.15 inches (typical for loam). This depression storage was estimated based on values recommended by the SWMM User's Manual.

Green-Ampt Infiltration Parameters (units vary)

The Green-Ampt infiltration method was used to estimate the infiltration losses associated with pervious areas. The Green-Ampt infiltration calculation requires estimation of three infiltration parameters: average capillary suction (inches), saturated hydraulic conductivity (inches per hour), and initial moisture deficit (dimensionless ratio). The values for each of these three infiltration parameters were based on the soil types found in the West Gresham study area. The locations and specific information on the soils present in the study area are available in GIS from the Metro and the Natural Resources Conservation Service. Approximately 22 different soil series are present in the study area. The 22 soil series were combined into 4 groups based on their USDA soil texture classification (e.g., sand, loam, silty clay, etc.). The soil texture groups present in the study area, their corresponding SCS soil map numbers, and the values for the Green-Ampt infiltration parameters, which have been estimated from literature values presented by Rawls, et. al. (1983), are summarized in the following table:

USDA Soil Texture Class	SCS Soil Numbers in West Gresham study area	Avg. Capillary Suction (in)	Saturated Hydraulic Conductivity (in/hr)	Initial Moisture Deficit
Silt Loam	1A, 2A, 29A, 29B, 29E, 29C, 30A, 40, 57	6.6	0.5	0.49
Loam	25B, 25C, 36A, 36B, 36C, 37A, 37B, 37C, 38A, 51C, 54B	3.5	0.3	0.43
Sandy Loam	6B	4.3	0.9	0.41
Silty Clay Loam	46	10.7	0.08	0.43

Based on the values presented in the above table, the area-weighted values for each subbasin for the three infiltration parameters were generated using GIS.

STORM DRAINAGE SYSTEM HYDRAULIC DATA

Input Parameters

The primary purpose of the modeling was to conduct a hydraulic analysis of the storm drainage system. The evaluation of the storm drainage system included a hydraulic analysis of the major roadway crossings and open channels that convey stormwater discharges. The following parameters were required in the EXTRAN block of SWMM for the open channels and culverts:

- Segment name.
- Upstream node number.
- Downstream node number.
- Length of segment, graphical and measured (feet).
- Invert elevation at upstream node (feet).
- Ground surface elevation at upstream node (feet).
- Invert elevation at downstream node (feet).
- Ground elevation at downstream node (feet).

- Roadway crossing shape, size and material.
- Typical channel cross section.

Conduit Name or Number, Upstream Node Number, and Downstream Node Number
Segment name and upstream and downstream node numbers were obtained from the City.

Conduit Shape
Unless otherwise noted, each pipe segment was assumed to be circular.

Pipe Diameter
The diameter for each pipe segment, in inches, was provided by the City.

Length of Pipe Section
The length of each pipe segment was provided by the City. Where available, the measured lengths were used. If the measured length was not available, the graphical length was used.

Invert Elevations at Upstream and Downstream Nodes
The upstream and downstream invert elevations for each pipe segment were provided by the City.

Ground Surface Elevation at Upstream and Downstream Nodes
The ground surface elevation at each node or manhole location was necessary to accurately simulate possible surcharging of the sewer system. The elevation of the rim of each manhole was provided by the City and was used as the ground surface elevation.

Pipe Material
In order to assign a Manning's roughness coefficient for each pipe segment, the pipe material must be specified. The City provided information on pipe material and the roughness coefficient was then assigned by URS.

There were two open channel segments in the XP-SWMM model. The length for the open channel segments was measured from the study area aerial photo. The geometry of the open channels was assumed to be trapezoidal. The size of the channels and vegetation in the channels was determined based on observations from a field visit.

APPENDIX B
MAJOR HYDROLOGIC INPUT DATA FOR THE WEST GRESHAM STORM DRAINAGE SYSTEM

Subbasin Name	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Calibrated Subbasin Width** (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
		Existing Land Use		Future Land Use									Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
		Mapped	Calibrated*	Mapped	Calibrated*				Impervious	Pervious	Impervious	Pervious			
2549-W-013	20.6	51.5	36.3	63.0	46.1	0.036	1414	1061	0.014	0.450	0.05	0.15	4.03	0.54	0.53
2549-W-024	28.8	73.1	55.1	77.5	59.2	0.030	1194	896	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2646-W-001	153.5	26.1	16.0	56.4	40.4	0.048	1942	1457	0.014	0.200	0.05	0.15	4.07	0.48	0.35
2746-W-002	81.9	75.5	57.4	75.5	57.4	0.028	855	641	0.014	0.450	0.05	0.15	4.17	0.51	0.48
2746-W-003	21.6	80.0	61.5	80.0	61.5	0.004	3848	2886	0.014	0.450	0.05	0.15	4.17	0.51	0.48
2746-W-006	43.5	80.0	61.5	80.0	61.5	0.066	1991	1493	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2747-W-005	51.1	47.9	33.3	47.9	33.3	0.021	874	656	0.014	0.450	0.05	0.15	4.16	0.51	0.48
2748-W-003	57.2	80.0	61.5	80.0	61.5	0.006	10178	7634	0.014	0.450	0.05	0.15	4.18	0.51	0.49
2748-W-006	99.4	31.0	19.7	75.5	57.4	0.049	2825	2119	0.014	0.370	0.05	0.15	3.90	0.48	0.30
2748-W-010	42.1	43.3	29.4	76.0	57.8	0.053	438	329	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2748-W-013	9.8	40.7	27.4	77.6	59.2	0.065	200	150	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2749-W-001	7.3	78.6	60.2	79.9	61.4	0.005	1306	980	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2749-W-006	69.7	50.1	35.0	75.3	57.2	0.050	2194	1646	0.014	0.450	0.05	0.15	3.93	0.48	0.32
2750-W-016	44.1	11.0	5.7	75.6	57.4	0.086	1323	992	0.014	0.200	0.05	0.15	3.90	0.48	0.30
2750-W-021	65.2	68.5	51.1	75.2	57.1	0.048	1476	1107	0.014	0.450	0.05	0.15	4.03	0.49	0.39
2750-W-023	25.7	13.3	7.1	75.4	57.3	0.042	2007	1505	0.014	0.200	0.05	0.15	4.05	0.50	0.40
2846-W-001	38.6	79.8	61.3	79.8	61.3	0.059	708	531	0.014	0.450	0.05	0.15	4.12	0.50	0.44
2846-W-003	26.7	67.3	50.0	67.3	50.0	0.018	1746	1310	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2846-W-006	41.7	79.1	60.7	79.1	60.7	0.022	1706	1280	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2847-W-001	7.3	53.4	37.8	68.8	51.3	0.022	405	304	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2847-W-007	49.9	58.4	42.2	63.3	46.5	0.020	903	677	0.014	0.450	0.05	0.15	4.18	0.51	0.49
2847-W-013	23.2	34.6	22.5	73.5	55.6	0.036	559	419	0.014	0.450	0.05	0.15	4.14	0.50	0.53
2848-W-001	10.2	73.5	55.6	79.1	60.7	0.044	1593	1195	0.014	0.450	0.05	0.15	4.00	0.49	0.37
2848-W-004	7.6	63.9	47.0	81.2	62.6	0.023	1243	932	0.014	0.450	0.05	0.15	4.17	0.51	0.48
2848-W-007	6.8	83.5	64.7	83.5	64.7	0.025	796	597	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2848-W-012	26.3	71.3	53.5	75.4	57.3	0.026	1821	1366	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2848-W-017	53.8	75.5	57.3	77.2	58.9	0.021	2274	1706	0.014	0.450	0.05	0.15	4.18	0.51	0.49
2848-W-018	27.7	72.3	54.5	75.4	57.3	0.013	808	606	0.014	0.450	0.05	0.15	4.14	0.50	0.46
2848-W-027	61.2	52.4	37.0	68.0	50.6	0.036	3789	2842	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2848-W027a	4.4	56.6	40.6	76.1	57.9	0.028	242	182	0.014	0.450	0.05	0.15	4.13	0.50	0.45
2849-W-005	18.7	2.5	1.0	75.0	56.9	0.015	1280	960	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2849-W-008	13.0	75.0	56.9	75.0	56.9	0.015	1299	974	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2849-W-010	31.4	61.4	44.8	75.9	57.7	0.028	2232	1674	0.014	0.450	0.05	0.15	4.11	0.50	0.44
2849-W-013	38.5	68.6	51.2	75.8	57.7	0.031	3311	2483	0.014	0.450	0.05	0.15	4.05	0.50	0.40
2849-W-018	9.3	57.9	41.7	77.5	59.2	0.056	1781	1336	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2849-W-021	28.5	46.4	32.0	49.7	34.7	0.015	512	384	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2849-W-027	71.3	52.5	37.1	55.5	39.7	0.023	1031	773	0.014	0.450	0.05	0.15	4.19	0.51	0.49
2850-W-002	30.5	45.5	31.2	46.5	32.1	0.014	425	319	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2850-W-006	24.0	34.6	22.5	70.2	52.6	0.029	559	419	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2850-W-009	24.1	52.8	37.4	75.3	57.1	0.035	956	717	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2850-W-020	40.4	31.3	19.9	76.7	58.4	0.035	965	724	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2850-W-024	18.5	79.8	61.3	80.0	61.5	0.091	543	407	0.014	0.450	0.05	0.15	3.90	0.48	0.30

*** Calibrated impervious area is 80% of effective impervious area. Effective impervious area is based in the following equation Effective Imp. % = 0.4* (Mapped Imp. %)$^{1/2}$**
*** * Calibrated subbasin width is 75% of subbasin width**

APPENDIX B
MAJOR HYDROLOGIC INPUT DATA FOR THE WEST GRESHAM STORM DRAINAGE SYSTEM

Subbasin Name	Subbasin Area (acres)	Impervious Area (%)				Average Subbasin Slope (ft/ft)	Subbasin Width (ft)	Calibrated Subbasin Width** (ft)	Overland Flow Roughness Coefficient		Depression Storage (inch)		Green-Ampt Infiltration Parameters		
		Existing Land Use		Future Land Use									Average Capillary Suction (in)	Initial Moisture Deficit (ft/ft)	Saturated Hydraulic Conductivity (inch/hour)
		Mapped	Calibrated*	Mapped	Calibrated*				Impervious	Pervious	Impervious	Pervious			
2850-W-025	30.8	59.3	42.9	75.3	57.2	0.028	1091	818	0.014	0.450	0.05	0.15	3.90	0.48	0.30
2946-W-002	19.5	58.1	41.9	67.2	49.9	0.054	2500	1875	0.014	0.450	0.05	0.15	4.15	0.51	0.47
2948-W-006	5.3	62.4	45.6	67.6	50.2	0.036	727	545	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2948-W-009	12.2	52.9	37.5	63.9	46.9	0.020	431	323	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2948-W-012	15.7	68.7	51.3	69.4	51.9	0.019	741	556	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2948-W-019	42.3	35.5	23.2	53.2	37.7	0.022	667	500	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2948-W-021	51.0	43.5	29.6	44.0	30.0	0.034	740	555	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2949-W-003	34.2	44.8	30.7	55.0	39.2	0.019	749	562	0.014	0.450	0.05	0.15	4.20	0.51	0.50
2949-W-009	23.3	57.2	41.1	69.8	52.2	0.015	813	610	0.014	0.450	0.05	0.15	4.20	0.51	0.50
3048-W-001	37.8	51.7	36.4	70.8	53.1	0.016	481	361	0.014	0.450	0.05	0.15	4.20	0.51	0.50
3048-W-002	16.4	62.4	45.6	81.3	62.7	0.010	571	428	0.014	0.450	0.05	0.15	4.20	0.51	0.50

*** Calibrated impervious area is 80% of effective impervious area. Effective impervious area is based in the following equation Effective Imp. % = 0.4* (Mapped Imp. %)$^{1.2}$**
*** * Calibrated subbasin width is 75% of subbasin width**

APPENDIX C

HYDRAULIC PERFORMANCE OF THE WEST GRESHAM STORM DRAINAGE SYSTEM UNDER EXISTING LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
2644	2946-W-002	2946-W-001	12-in Dia CONC	399	50	7	10	11	11	11	250.6	218.4	251.3	219.0	251.5	219.2	258.1	219.4	258.3	219.4	258.3	219.6	258.3	227.5
2644-RD	2946-W-002	2946-W-001	Roadway	399	50	0	0	0	1	4	258.3	227.5	218.8	218.8	218.9	218.9	219.0	219.0	258.3	227.5	258.3	227.5	258.3	227.5
2633	2946-W-001	2846-W-001	15-in Dia CONC	241	50	7	10	11	11	14	218.1	207.3	218.8	208.0	218.9	208.1	219.0	208.2	219.0	208.3	219.6	208.5	227.5	217.8
10039	2846-W-001	2846-W-002	36-in Dia CONC	244	50	24	32	36	38	46	206.3	203.8	207.7	205.1	208.0	205.3	208.2	205.4	208.3	205.4	208.5	205.9	217.8	216.0
4586	2846-W-002	2846-W-003	36-in Dia CONC	270	50	24	31	36	38	45	203.8	200.4	205.1	202.5	205.3	202.9	205.4	203.2	205.4	203.3	205.9	204.3	216.0	211.5
2596	2846-W-003	2846-W-004	42-in Dia RC	608	50	35	45	51	55	64	200.4	197.4	202.5	198.8	202.9	199.1	203.2	199.2	203.3	199.3	204.3	199.4	211.5	210.5
4572	2846-W-004	2846-W-005	36-in Dia RC	390	50	35	45	51	56	65	197.4	189.6	198.8	190.9	199.1	191.1	199.2	191.3	199.3	191.4	199.4	192.3	210.5	198.8
737	2846-W-005	2846-W-006	36-in Dia RC	340	50	34	45	51	56	64	189.6	182.8	190.9	184.8	191.1	185.3	191.3	186.2	191.4	187.3	192.3	189.1	198.8	191.0
4556	2846-W-006	2846-W-007	36-in Dia RC	350	50	52	69	78	83	97	182.8	176.2	184.8	177.7	185.3	178.0	186.2	178.1	187.3	178.2	189.1	178.5	191.0	185.5
4556-RD	2846-W-006	2846-W-007	Roadway	350	50	0	0	0	0	0	191.0	185.5	177.7	177.7	178.0	178.0	178.1	178.1	178.2	178.2	178.5	178.5	191.0	185.5
2564	2846-W-007	2746-W-001	36-in Dia RC	418	50	52	69	78	83	97	176.2	164.5	177.7	166.0	178.0	166.3	178.1	166.4	178.2	166.5	178.5	166.8	185.5	173.8
2526	2746-W-001	2746-W-002	48-in Dia RC	22	50	52	69	78	83	97	163.7	162.8	165.2	164.9	165.6	165.3	165.8	165.6	166.0	165.8	166.5	166.3	173.8	173.1
2562	2847-W-007	2847-W-006	30-in Dia CONC	81	10	14	19	22	23	28	170.0	169.6	171.3	170.9	171.6	171.2	171.8	171.4	171.9	171.5	172.3	171.8	182.9	181.7
4549	2847-W-006	2847-W-005	30-in Dia CONC	188	10	14	19	22	23	28	169.6	168.7	170.9	170.0	171.2	170.2	171.4	170.4	171.5	170.5	171.8	170.8	181.7	180.7
2555	2847-W-005	2847-W-004	30-in Dia CONC	172	10	14	19	22	23	28	168.7	167.8	170.0	169.1	170.2	169.3	170.4	169.4	170.5	169.4	170.8	169.7	180.7	179.8
5644	2847-W-004	2747-W-007	36-in Dia CONC	371	10	14	19	22	23	27	167.6	166.5	169.0	167.8	169.2	168.1	169.4	168.3	169.4	168.4	169.7	168.7	179.8	177.9
4534	2747-W-007	2747-W-006	36-in Dia CONC	78	10	14	19	22	23	27	166.5	166.3	167.8	167.5	168.1	167.8	168.3	168.0	168.4	168.1	168.7	168.5	177.9	177.6
10040	2747-W-006	2747-W-005	48-in Dia CONC	105	10	14	19	22	23	27	165.7	165.5	167.5	167.4	167.8	167.7	168.0	167.9	168.1	168.0	168.5	168.4	177.6	178.1
4533	2747-W-005	2747-W-004	48-in Dia CONC	154	10	25	33	39	41	49	165.5	165.2	167.4	167.0	167.7	167.3	167.9	167.5	168.0	167.7	168.4	168.0	178.1	178.9
2524	2747-W-004	2747-W-003	48-in Dia CONC	240	10	25	33	38	41	48	165.2	164.7	167.0	166.5	167.3	166.9	167.5	167.1	167.7	167.2	168.0	167.6	178.9	178.5
2523	2747-W-003	2747-W-002	48-in Dia CONC	270	10	25	33	38	41	48	164.7	164.1	166.5	166.0	166.9	166.3	167.1	166.5	167.2	166.6	167.6	167.1	178.5	177.0
5642	2747-W-002	2747-W-001	48-in Dia CONC	186	10	25	33	38	41	48	164.1	163.8	166.0	165.7	166.3	166.0	166.5	166.2	166.6	166.3	167.1	166.8	177.0	172.5
5641	2747-W-001	2746-W-002	36-in Dia CONC	31	10	25	33	38	41	49	163.8	163.7	165.7	165.3	166.0	165.6	166.2	165.7	166.3	165.8	166.8	166.3	172.5	173.1
5641-RD	2746-W-002	2747-W-001	Roadway	31	10	0	0	0	0	0	173.1	172.5	165.7	165.7	166.0	166.0	166.2	166.2	166.3	166.3	166.8	166.8	172.5	173.1
6025	2746-W-002	2746-W-003	48-in Dia RC	200	50	102	135	155	166	194	162.8	154.8	164.9	156.5	165.3	156.8	165.6	157.0	165.8	157.1	166.3	157.3	173.1	166.0
764	2746-W-003	2746-W-004	48-in Dia RC	622	50	111	147	169	180	213	154.6	128.6	156.4	130.4	156.7	130.7	156.8	131.0	156.9	131.1	157.2	131.5	166.0	141.0
763	2746-W-004	2746-W-005	42-in Dia RC	644	50	111	147	168	180	212	128.6	87.9	130.4	89.6	130.7	89.9	131.0	90.1	131.1	90.2	131.5	90.5	141.0	103.0
763-RD	2746-W-004	2746-W-005	Roadway	644	50	0	0	0	0	0	141.0	103.0	89.5	89.5	89.9	89.9	90.1	90.1	90.2	90.2	90.5	90.5	141.0	103.0
2505	2746-W-005	2746-W-006	42-in Dia RC	196	50	111	147	168	180	212	87.8	74.7	89.5	76.3	89.9	76.6	90.1	76.8	90.2	76.9	90.5	77.2	103.0	94.0
762	2746-W-006	2746-W-007	72-in Dia RC	202	50	130	172	195	207	248	73.9	68.6	76.0	70.5	76.3	70.9	76.5	71.1	76.6	71.2	76.9	71.5	94.0	85.0
4518	2746-W-007	2746-W-008	54-in Dia RC	541	50	130	171	195	207	247	68.4	53.4	70.5	55.9	70.9	56.2	71.1	56.4	71.2	56.5	71.5	57.1	85.0	70.0
2490	2746-W-008	2646-W-001	72-in Dia RC	466	50	130	171	195	207	252	54.0	44.3	55.9	48.4	56.2	50.3	56.4	51.5	56.5	52.2	57.1	53.1	70.0	53.0
2490-RD	2746-W-008	2646-W-001	Roadway	466	50	0	0	0	0	0	70.0	53.0	48.4	48.4	50.3	50.3	51.5	51.5	52.2	52.2	53.1	53.1	71.0	54.0
4511	2646-W-001	2646-W-002	54-in Dia RC	114	50	147	193	223	239	307	44.3	42.6	48.4	44.4	50.3	44.8	51.5	45.0	52.2	45.1	53.1	49.0	53.0	51.0
4511-RD	2646-W-001	2646-W-002	Roadway	114	50	0	0	0	0	14	53.0	51.0	44.4	44.4	44.8	44.8	45.0	45.0	45.1	45.1	53.1	51.1	53.0	51.0
2486	2646-W-002	2646-W-003	54-in Dia RC	77	50	147	193	227	243	307	42.6	37.7	44.4	39.6	44.8	39.9	45.0	40.3	45.1	40.6	49.1	46.7	51.0	46.8
2486-RD	2646-W-002	2646-W-003	Roadway	77	50	0	0	0	0	0	51.0	46.8	39.6	39.6	39.9	39.9	40.3	40.3	40.6	40.6	46.7	46.7	51.0	46.8
4509	2646-W-003	2646-W-004	48-in Dia RC	291	50	147	193	225	239	290	37.7	21.1	39.6	24.7	39.9	25.8	40.3	26.7	40.6	27.2	46.8	29.5	46.8	31.0
4509-RD	2646-W-003	2646-W-004	Roadway	291	50	0	0	0	0	0	46.8	31.0	24.7	24.7	25.8	25.8	26.7	26.7	27.2	27.2	46.8	31.0	46.8	31.0
760	2646-W-004	2646-W-005	72-in Dia RC	241	50	147	193	222	237	292	21.1	19.4	24.7	24.1	25.8	25.0	26.7	25.6	27.2	25.9	29.5	27.1	31.0	28.5
760-RD	2646-W-004	2646-W-005	Roadway	241	50	0	0	0	0	0	31.0	28.5	24.1	24.1	25.0	25.0	25.6	25.6	25.9	25.9	27.1	27.1	31.0	28.5
5913	2646-W-005	2647-W-601	72-in Dia RC	61	50	147	193	222	237	293	19.4	19.0	24.1	21.9	25.0	22.4	25.6	22.7	25.9	22.9	27.1	23.5	28.5	25.5
5551	3048-W-002	3048-W-001	21-in Dia CONC	250	50	5	7	8	9	10	236.4	235.2	237.3	236.0	238.8	238.4	242.5	241.8	243.8	243.0	247.5	246.3	249.0	248.0
5551-RD	3048-W-002	3048-W-001	Roadway	250	50	0	0	0	0	0	249.0	248.0	236.0	236.0	238.4	238.4	241.8	241.8	243.0	243.0	246.3	246.3	249.0	248.0
2730	3048-W-001	2948-W-014	27-in Dia CONC	300	50	14	17	21	23	27	234.7	233.2	236.0	234.5	238.4	237.3	241.8	240.1	243.0	241.1	246.3	243.7	248.0	244.5
2730-RD	3048-W-001	2948-W-014	Roadway	300	50	0	0	0	0	0	248.0	244.5	234.5	234.5	237.3	237.3	240.1	240.1	241.1	241.1	243.7	243.7	248.0	244.5

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
2723	2948-W-014	2948-W-013	27-in Dia CONC	300	50	14	17	21	23	27	233.2	231.7	234.5	233.8	237.3	236.2	240.1	238.5	241.1	239.3	243.7	241.0	244.5	241.0
2723-RD	2948-W-014	2948-W-013	Roadway	300	50	0	0	0	0	0	244.5	241.0	233.8	233.8	236.2	236.2	238.5	238.5	239.3	239.3	241.0	241.0	244.5	241.0
10029	2948-W-013	2948-W-012	27-in Dia CONC	53	50	13	17	21	23	26	231.7	231.4	233.8	233.7	236.2	236.0	238.5	238.1	239.3	238.9	241.0	240.5	241.0	240.5
10029-RD	2948-W-013	2948-W-012	Roadway	53	50	0	0	0	0	0	241.0	240.5	233.7	233.7	236.0	236.0	238.1	238.1	238.9	238.9	241.0	240.5	241.0	240.5
2706	2948-W-012	2948-W-011	27-in Dia CONC	377	50	19	25	31	33	37	231.4	229.5	233.7	230.7	236.0	233.1	238.1	233.8	238.9	233.8	240.5	234.0	240.5	236.5
2706-RD	2948-W-012	2948-W-011	Roadway	377	50	0	0	0	0	0	240.5	236.5	230.7	230.7	233.1	233.1	233.8	233.8	233.8	233.8	240.5	236.5	240.5	236.5
2687	2948-W-011	2948-W-010	36-in Dia CONC	363	50	20	24	31	33	37	229.5	225.7	230.7	229.9	233.1	232.5	233.8	232.6	233.8	232.6	234.0	232.7	236.5	232.5
2687-RD	2948-W-011	2948-W-010	Roadway	363	50	0	0	0	0	0	236.5	232.5	229.9	229.9	232.5	232.5	232.6	232.6	232.6	232.6	232.7	232.7	237.5	233.5
10028	2948-W-010	2948-W-009	27-in Dia CONC	122	50	23	25	26	26	26	225.7	223.2	229.9	229.6	232.5	231.6	232.6	231.8	232.6	232.0	232.7	232.1	232.5	232.0
10028-RD	2948-W-010	2948-W-009	Roadway	122	50	0	0	4	7	16	232.5	232.0	229.6	229.6	232.5	232.0	232.6	232.1	232.6	232.1	232.7	232.2	232.5	232.0
2688	2948-W-009	2948-W-008	27-in Dia CONC	111	50	25	28	30	32	33	224.0	223.2	229.7	229.8	231.6	230.5	231.8	230.5	232.0	230.6	232.1	230.6	232.0	230.5
2688-RD	2948-W-009	2948-W-008	Roadway	111	50	0	0	0	0	8	232.0	230.5	229.8	229.8	230.5	230.5	230.5	230.5	230.6	230.6	232.1	230.6	232.0	230.5
2660	2948-W-008	2948-W-007	27-in Dia CONC	398	50	24	30	29	29	34	223.2	218.9	229.8	219.7	230.5	219.7	230.5	219.7	230.6	219.7	230.6	219.9	230.5	225.8
2660-RD	2948-W-008	2948-W-007	Roadway	398	50	0	2	2	3	7	230.5	225.8	219.7	219.7	230.5	225.8	230.5	225.8	230.6	225.8	230.6	225.8	230.5	225.8
5550	2948-W-007	2948-W-006	27-in Dia CONC	350	50	34	35	35	34	41	218.9	195.6	219.7	202.4	219.7	204.5	219.7	204.6	219.7	204.6	219.9	204.7	225.8	204.5
5550-RD	2948-W-007	2948-W-006	Roadway	350	50	0	0	0	0	0	225.8	204.5	202.4	202.4	204.5	204.5	204.6	204.6	204.6	204.6	204.7	204.7	226.8	205.5
5675	2948-W-019	2948-W-020	24-in Dia CONC	201	10	7	10	11	12	14	218.8	217.8	219.9	218.8	220.1	219.0	220.2	219.1	220.2	219.2	223.5	222.6	228.5	230.3
5675-RD	2948-W-020	2948-W-019	Roadway	201	10	0	0	0	0	0	230.3	228.5	219.9	219.9	220.1	220.1	220.2	220.2	220.2	220.2	223.5	223.5	228.5	230.3
2658	2948-W-020	2948-W-021	24-in Dia CONC	270	10	7	10	11	12	14	217.8	216.2	218.8	217.1	219.0	217.3	219.1	217.4	219.2	218.2	222.6	221.3	230.3	227.5
2657	2948-W-021	2948-W-022	24-in Dia CONC	208	10	18	25	28	28	35	209.9	204.6	210.9	205.7	213.7	211.1	217.4	213.9	218.2	214.5	221.3	215.5	227.5	215.5
2645	2948-W-022	2948-W-023	24-in Dia CONC	442	10	19	25	28	28	30	204.3	198.6	205.7	201.5	211.1	205.6	213.9	206.1	214.5	206.2	215.5	206.3	215.5	206.3
2645-RD	2948-W-022	2948-W-023	Roadway	442	10	0	0	0	0	4	215.5	206.3	201.5	201.5	205.6	205.6	206.1	206.1	206.2	206.2	215.5	206.3	215.5	206.3
4597	2948-W-023	2948-W-006	24-in Dia CONC	73	10	26	27	27	29	29	198.5	197.5	201.5	202.4	205.6	204.5	206.1	204.6	206.2	204.6	206.3	204.7	206.3	204.5
4597-RD	2948-W-023	2948-W-006	Roadway	73	10	0	0	0	0	4	206.3	204.5	202.4	202.4	204.5	204.5	204.6	204.6	204.6	204.6	206.3	204.7	206.3	204.5
2638	2948-W-006	2948-W-005	30-in Dia CONC	280	50	42	47	47	47	47	195.3	193.6	202.4	198.2	204.5	200.3	204.6	201.2	204.6	201.2	204.7	201.3	204.5	201.0
2638-RD	2948-W-006	2948-W-005	Roadway	280	50	0	2	13	18	33	204.5	201.0	198.2	198.2	204.5	201.0	204.6	201.2	204.6	201.2	204.7	201.3	204.5	201.0
5549	2948-W-005	2848-W-007	30-in Dia CONC	445	50	38	47	48	48	48	193.6	190.8	198.2	192.9	200.3	193.2	201.2	195.9	201.2	197.8	201.3	199.1	201.0	199.0
5549-RD	2948-W-005	2848-W-007	Roadway	445	50	0	0	11	22	47	201.0	199.0	192.2	192.2	193.2	193.2	201.2	199.1	201.2	199.2	201.3	199.3	201.0	199.0
2624	2848-W-007	2848-W-006	30-in Dia RC	305	50	42	51	54	57	58	190.5	184.5	192.2	186.1	193.2	188.1	195.9	189.7	197.8	191.0	199.1	192.2	199.0	192.0
2624-RD	2848-W-007	2848-W-006	Roadway	305	50	0	0	0	0	19	199.0	192.0	186.1	186.1	188.1	188.1	189.7	189.7	191.0	191.0	199.1	192.2	199.0	192.0
2619	2848-W-006	2848-W-005	30-in Dia RC	295	50	41	50	54	57	59	184.5	178.4	186.1	180.4	188.1	182.9	189.7	183.7	191.0	184.3	192.2	186.9	192.0	186.8
2619-RD	2848-W-006	2848-W-005	Roadway	295	50	0	0	0	0	24	192.0	186.8	180.4	180.4	182.9	182.9	183.7	183.7	184.3	184.3	192.2	186.9	192.0	186.8
2620	2848-W-005	2848-W-004	36-in Dia CONC	279	50	40	50	54	57	70	177.9	176.5	180.4	179.3	182.9	181.0	183.7	181.5	184.3	181.9	186.9	183.8	186.8	184.0
2620-RD	2848-W-005	2848-W-004	Roadway	279	50	0	0	0	0	9	186.8	184.0	179.3	179.3	181.0	181.0	181.5	181.5	181.9	181.9	186.9	184.1	186.8	184.0
5548	2848-W-004	2848-W-003	36-in Dia CONC	396	50	42	52	56	59	78	176.5	174.5	179.3	175.9	181.0	176.1	181.5	176.2	181.9	176.2	183.8	176.9	184.0	186.0
5548-RD	2848-W-003	2848-W-004	Roadway	396	50	0	0	0	0	0	186.0	184.0	179.3	179.3	181.0	181.0	181.5	181.5	181.9	181.9	183.8	183.8	184.0	186.0
2591	2848-W-003	2848-W-002	36-in Dia CONC	290	50	42	52	56	59	77	174.5	167.2	175.9	169.1	176.1	169.4	176.2	169.6	176.2	169.7	176.9	172.0	186.0	178.0
2582	2848-W-002	2848-W-001	36-in Dia CONC	310	50	42	52	56	59	77	167.2	163.6	169.1	165.0	169.4	165.2	169.6	165.3	169.7	165.3	172.0	165.6	178.0	176.5
2582-RD	2848-W-002	2848-W-001	Roadway	33	50	0	0	0	0	0	178.0	176.5	165.0	165.0	165.2	165.2	165.3	165.3	165.3	165.3	165.6	165.6	178.0	176.5
4553	2848-W-001	2848-W-024	36-in Dia RC	187	50	46	55	60	62	77	163.6	158.1	165.0	159.4	165.2	159.6	165.3	159.7	165.3	159.7	165.6	160.0	176.5	169.5
299	2848-W-024	2848-W-025	36-in Dia RC	42	50	46	55	60	62	77	157.6	155.9	159.1	157.1	159.3	157.3	159.4	157.3	159.5	157.4	159.8	158.5	169.5	170.0
2628	2847-W-013	2847-W-014	36-in Dia CONC	381	50	4	6	6	7	8	199.9	197.7	200.5	198.5	200.6	198.6	200.7	198.7	200.7	198.7	200.7	198.8	212.4	208.3
4593	2847-W-014	2847-W-015	36-in Dia CONC	125	50	4	6	6	7	8	197.7	197.4	198.5	198.0	198.6	198.1	198.7	198.2	198.7	198.2	198.8	198.3	208.3	206.3
2623	2847-W-015	2847-W-016	36-in Dia CONC	408	50	4	6	6	7	8	197.4	195.2	198.0	195.8	198.1	195.9	198.2	196.0	198.2	196.0	198.3	196.1	206.3	206.7
5639	2847-W-016	2848-W-030	42-in Dia CONC	497	50	4	6	6	7	8	195.2	193.1	195.8	193.9	195.9	194.1	196.0	194.1	196.0	194.2	196.1	194.3	206.7	206.0
10087	2848-W-030	2848-W-031	42-in Dia CONC	258	50	4	5	6	7	8	193.1	192.8	193.9	193.5	194.1	193.6	194.1	193.7	194.2	193.7	194.3	193.8	206.0	204.0
10088	2848-W-031	2848-W-032	42-in Dia CONC	98	50	4	5	6	7	8	192.8	192.6	193.5	193.1	193.6	193.2	193.7	193.2	193.7	193.2	193.8	193.3	204.0	203.1
10089	2848-W-032	2848-W-033	42-in Dia CONC	302	50	4	5	6	7	8	192.6	190.0	193.1	190.5	193.2	190.6	193.2	190.6	193.2	190.6	193.3	190.7	203.1	199.7
10090	2848-W-033	2848-W-027	42-in Dia CONC	466	50	4	5	6	7	8	190.0	186.0	190.5	186.8	190.6	186.9	190.6	187.0	190.6	187.0	190.7	187.2	199.7	199.0
6221	2848-W-027	2848-W-028	42-in Dia CONC	344	10	23	29	34	36	42	185.8	179.3	186.8	180.3	186.9	180.5	187.0	180.6	187.0	180.6	187.2	180.8	199.0	191.0

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
10052	2848-W-028	2848-W-013	42-in Dia CONC	465	10	22	29	33	36	42	179.3	173.3	180.3	174.4	180.5	174.7	180.6	174.8	180.6	174.9	180.8	175.1	191.0	184.8
4591	2848-W-013	2848-W-012	42-in Dia RC	47	10	22	29	33	35	42	173.0	172.7	174.4	174.0	174.7	174.2	174.8	174.3	174.9	174.4	175.1	174.6	184.8	184.3
5652	2847-W-001	2847-W-002	24-in Dia RC	129	10	2	3	3	4	4	189.0	185.7	189.3	186.1	189.4	186.1	189.4	186.2	189.4	186.2	189.5	186.2	195.2	191.8
4580	2847-W-002	2847-W-003	24-in Dia RC	101	10	2	3	3	4	4	185.7	183.1	186.1	183.6	186.1	183.7	186.2	183.7	186.2	183.7	186.2	183.8	191.8	189.3
2600	2847-W-003	2848-W-008	24-in Dia RC	404	10	2	3	3	4	4	183.1	179.5	183.6	180.0	183.7	180.1	183.7	180.1	183.7	180.1	183.8	180.2	189.3	185.8
2603	2848-W-008	2848-W-009	24-in Dia RC	382	10	2	3	3	4	4	179.5	177.3	180.0	177.8	180.1	177.9	180.1	177.9	180.1	177.9	180.2	178.0	185.8	186.5
2604	2848-W-009	2848-W-010	30-in Dia RC	355	10	2	3	3	4	4	176.9	174.8	177.4	175.3	177.4	175.3	177.5	175.4	177.5	175.4	177.6	175.4	186.5	183.9
2604-RD	2848-W-009	2848-W-010	Roadway	355	10	0	0	0	0	0	186.5	183.9	175.2	175.2	175.2	175.2	175.3	175.3	175.3	175.3	175.3	175.3	186.5	183.9
4577	2848-W-010	2848-W-011	36-in Dia RC	413	10	2	3	3	4	4	174.7	173.0	175.2	173.5	175.2	173.5	175.3	173.6	175.3	173.6	175.3	173.7	183.9	186.2
4577-RD	2848-W-011	2848-W-010	Roadway	413	10	0	0	0	0	0	186.2	183.9	175.2	175.2	175.2	175.2	175.3	175.3	175.3	175.3	175.3	175.3	183.9	186.2
2605	2848-W-011	2848-W-012	36-in Dia RC	364	10	2	3	3	3	4	173.0	171.9	173.5	172.7	173.5	173.0	173.6	173.2	173.6	173.3	173.7	173.6	186.2	184.3
2605-RD	2848-W-011	2848-W-012	Roadway	364	10	0	0	0	0	0	186.2	184.3	172.7	172.7	173.0	173.0	173.2	173.2	173.3	173.3	173.6	173.6	186.2	184.3
2606	2848-W-012	2848-W-015	48-in Dia RC	433	10	35	46	53	56	66	170.9	168.0	172.7	169.6	173.0	169.9	173.2	170.0	173.3	170.1	173.6	170.3	184.3	180.5
4578	2848-W-015	2848-W-016	48-in Dia RC	331	10	35	46	53	56	66	168.0	166.0	169.6	167.6	169.9	167.8	170.0	168.0	170.1	168.0	170.3	168.3	180.5	176.9
2578	2848-W-016	2848-W-017	54-in Dia RC	502	10	35	46	53	56	66	165.9	162.7	167.4	164.9	167.6	165.3	167.8	165.6	167.8	165.8	168.0	166.3	176.9	179.5
2578-RD	2848-W-017	2848-W-016	Roadway	502	10	0	0	0	0	0	179.5	176.9	167.4	167.4	167.6	167.6	167.8	167.8	167.8	167.8	168.0	168.0	176.9	179.5
4561	2848-W-018	2848-W-017	36-in Dia RC	485	10	10	13	15	17	20	165.8	163.7	166.8	164.9	167.0	165.3	167.1	165.6	167.1	165.8	167.3	166.3	179.6	179.5
2547	2848-W-017	2848-W-026	54-in Dia CONC	495	10	67	88	101	107	127	162.6	158.1	164.9	160.0	165.3	160.3	165.6	160.5	165.8	160.5	166.3	160.8	179.5	179.0
4545	2848-W-026	2848-W-025	54-in Dia CONC	161	10	67	88	101	108	127	158.1	156.1	160.0	157.9	160.3	158.2	160.5	158.3	160.5	158.4	160.8	158.7	179.0	170.0
2550	2848-W-025	2748-W-001	42-in Dia RC	445	50	112	141	161	169	192	153.1	124.6	154.7	126.6	155.0	127.1	155.2	127.5	155.2	127.8	158.5	137.3	170.0	138.5
4543	2748-W-001	2748-W-002	48-in Dia CONC	152	50	112	141	161	168	192	124.1	120.5	126.6	123.0	127.1	123.4	127.5	123.7	127.8	123.8	137.3	132.7	138.5	134.3
4543-RD	2748-W-001	2748-W-002	Roadway	152	50	0	0	0	0	0	138.5	134.3	123.0	123.0	123.4	123.4	123.7	123.7	123.8	123.8	132.7	132.7	138.5	134.3
298	2748-W-002	2748-W-003	48-in Dia CONC	100	50	112	141	161	168	192	120.5	118.1	123.0	120.1	123.4	120.4	123.7	120.7	123.8	121.1	132.7	129.9	134.3	135.0
298-RD	2748-W-002	2748-W-003	Roadway	100	50	0	0	0	0	0	134.3	135.0	123.0	123.0	123.4	123.4	123.7	123.7	123.8	123.8	132.7	132.7	134.3	135.0
4530	2748-W-003	2748-W-004	42-in Dia CONC	375	50	135	172	197	207	236	118.1	97.6	120.1	99.7	120.4	100.3	120.7	101.3	121.1	102.5	129.9	105.6	135.0	105.5
4530-RD	2748-W-003	2748-W-004	Roadway	375	50	0	0	0	0	0	135.0	105.5	99.7	99.7	100.3	100.3	101.3	101.3	102.5	102.5	105.6	105.6	135.0	105.5
5545	2748-W-004	2748-W-005	48-in Dia CONC	425	50	135	172	196	208	226	97.1	86.9	99.7	89.3	100.3	89.8	101.3	90.2	102.5	90.4	105.6	93.1	105.5	96.0
5545-RD	2748-W-004	2748-W-005	Roadway	425	50	0	0	0	0	14	105.5	96.0	89.3	89.3	89.8	89.8	90.2	90.2	90.4	90.4	105.6	96.1	105.5	96.0
10030	2748-W-005	2748-W-006	48-in Dia CONC	446	50	135	172	196	207	224	86.9	76.2	89.3	78.5	89.8	78.9	90.2	79.2	90.4	79.3	93.1	80.4	96.0	84.5
10030-RD	2748-W-005	2748-W-006	Roadway	446	50	0	0	0	0	0	96.0	84.5	78.5	78.5	78.9	78.9	79.2	79.2	79.3	79.3	80.4	80.4	96.0	84.5
4522	2748-W-006	2748-W-007	48-in Dia CONC	68	50	148	190	215	227	251	76.2	73.2	78.5	75.3	78.9	75.7	79.2	75.9	79.3	76.0	80.4	77.8	84.5	82.3
4522-RD	2748-W-006	2748-W-007	Roadway	68	50	0	0	0	0	0	84.5	82.3	75.1	75.1	75.4	75.4	75.7	75.7	75.9	75.9	77.8	77.8	84.5	82.3
297	2748-W-007	2748-W-008	48-in Dia CONC	337	50	148	190	215	228	247	73.0	58.5	75.1	60.7	75.4	61.2	75.7	61.3	75.9	61.3	77.8	66.6	82.3	68.5
297-RD	2748-W-007	2748-W-008	Roadway	337	50	0	0	0	0	0	82.3	68.5	60.7	60.7	61.2	61.2	61.3	61.3	61.3	61.3	66.6	66.6	82.3	68.5
5939	2748-W-008	2748-W-009	42-in Dia CONC	368	50	148	189	217	229	243	58.5	34.6	60.7	36.3	61.2	36.6	61.3	37.2	61.3	37.6	66.6	41.4	68.5	42.5
5939-RD	2748-W-008	2748-W-009	Roadway	368	50	0	0	0	0	0	68.5	42.5	36.3	36.3	36.6	36.6	37.2	37.2	37.6	37.6	41.4	41.4	68.5	42.5
10032	2748-W-009	2648-W-601	42-in Dia CONC	314	50	148	189	216	227	242	34.6	4.8	36.3	8.5	36.6	9.0	37.2	9.4	37.6	9.6	41.4	9.8	42.5	14.0
10032-RD	2748-W-009	2648-W-601	Roadway	314	50	0	0	0	0	0	42.5	14.0	8.5	8.5	9.0	9.0	9.4	9.4	9.6	9.6	9.8	9.8	43.5	15.0
5544	2748-W-010	2748-W-011	30-in Dia HDPE	280	10	9	12	14	15	17	70.0	58.8	70.6	59.4	70.6	59.4	70.7	59.5	70.7	59.5	70.8	59.6	77.9	67.0
10041	2748-W-011	2648-W-001	30-in Dia HDPE	325	10	9	12	14	14	17	58.7	40.6	59.2	41.4	59.2	41.5	59.3	41.6	59.3	41.7	59.4	41.8	67.0	47.7
5944	2648-W-001	2648-W-602	30-in Dia HDPE	25	10	9	12	14	14	17	40.5	40.2	41.4	40.9	41.5	41.1	41.6	41.2	41.7	41.2	41.8	41.4	47.7	47.0
L186	2648-W-602	2748-W-601	Natural	505	10	9	12	13	14	17	40.2	33.6	40.9	34.2	41.1	34.3	41.2	34.4	41.2	34.4	41.4	34.5	47.0	41.0
5946	2748-W-601	2748-W-012	36-in Dia HDPE	55	10	9	11	13	14	17	33.6	32.7	34.2	33.3	34.3	33.4	34.4	33.5	34.4	33.5	34.5	33.6	41.0	39.8
4515	2748-W-012	2748-W-013	36-in Dia HDPE	266	10	9	11	13	14	17	32.6	28.8	33.2	29.5	33.3	29.6	33.4	29.6	33.4	29.6	33.5	29.7	39.8	45.9
296	2748-W-013	2648-W-002	36-in Dia HDPE	294	50	10	14	16	17	20	28.7	14.4	29.2	15.0	29.3	15.0	29.4	15.1	29.4	15.1	29.5	15.2	45.9	24.9
5940	2648-W-002	2648-W-603	48-in Dia CONC	45	50	10	14	16	17	20	8.3	7.5	9.2	8.2	9.4	8.3	9.5	8.3	9.6	8.3	9.7	8.4	24.9	17.5
2671	2949-W-009	2949-W-010	24-in Dia CONC	512	10	9	9	11	11	13	222.7	220.1	223.9	221.2	223.9	221.2	224.0	221.3	224.1	221.3	224.3	221.5	230.0	229.0
2668	2949-W-010	2949-W-011	24-in Dia CONC	154	10	9	9	11	11	13	220.1	202.5	220.6	203.3	220.6	203.3	220.6	203.3	220.6	203.4	220.7	203.7	229.0	215.0
5684	2949-W-011	2949-W-012	24-in Dia CONC	198	10	9	9	11	11	14	202.5	198.6	203.3	199.7	203.3	199.8	203.3	200.7	203.4	201.5	203.7	202.9	215.0	206.3
2662	2949-W-012	2549-W-013	30-in Dia CONC	412	10	9	10	11	12	14	198.1	194.8	199.7	199.4	199.8	199.6	200.7	200.4	201.5	201.0	202.9	202.4	206.3	203.5

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
2662-RD	2949-W-012	2549-W-013	Roadway	412	10	0	0	0	0	0	206.3	203.5	199.4	199.4	199.6	199.6	200.4	200.4	201.0	201.0	202.4	202.4	206.3	203.5
924	2549-W-013	2949-W-014	30-in Dia CONC	280	10	20	20	20	21	25	194.8	192.5	199.4	199.0	199.6	199.1	200.4	199.7	201.0	200.2	202.4	201.2	203.5	201.8
924-RD	2549-W-013	2949-W-014	Roadway	280	10	0	0	0	0	0	203.5	201.8	199.0	199.0	199.1	199.1	199.7	199.7	200.2	200.2	201.2	201.2	203.5	201.8
2639	2949-W-014	2549-W-024	24-in Dia CONC	196	50	17	18	19	21	25	192.5	189.0	199.0	198.0	199.1	198.0	199.7	198.0	200.2	198.1	201.2	198.2	201.8	197.5
2639-RD	2949-W-014	2549-W-024	Roadway	196	50	0	0	0	0	0	201.8	197.5	198.0	198.0	198.0	198.0	198.0	198.0	198.1	198.1	198.2	198.2	201.8	197.5
2634	2549-W-024	2849-W-025	27-in Dia RC	521	50	25	25	25	25	25	189.0	187.5	198.0	197.7	198.0	197.7	198.0	198.0	198.1	198.0	198.2	198.2	197.5	197.5
2634-RD	2549-W-024	2849-W-025	Roadway	521	50	15	16	22	25	34	197.5	197.5	198.0	197.7	198.0	197.7	198.0	198.0	198.1	198.0	198.2	198.2	197.5	197.5
10061	2849-W-025	2849-W-002	27-in Dia RC	68	50	25	26	26	26	26	187.5	187.3	197.7	197.6	197.7	197.7	198.0	197.9	198.0	198.0	198.2	198.2	197.5	197.5
10061-RD	2849-W-025	2849-W-002	Roadway	68	50	8	10	16	19	26	197.5	197.5	197.7	197.6	197.7	197.7	198.0	197.9	198.0	198.0	198.2	198.2	197.5	197.5
2647	2949-W-003	2949-W-008	24-in Dia CONC	200	50	10	10	12	13	15	196.4	195.9	198.4	198.0	198.6	198.2	199.1	198.4	199.4	198.6	200.3	199.2	206.5	205.5
2647-RD	2949-W-003	2949-W-008	Roadway	200	10	0	0	0	0	0	206.5	205.5	198.0	198.0	198.2	198.2	198.4	198.4	198.6	198.6	199.2	199.2	206.5	205.5
2637	2949-W-008	2849-W-001	24-in Dia CONC	199	50	9	10	12	13	15	195.7	194.9	198.0	197.6	198.2	197.7	198.4	198.0	198.6	198.1	199.2	198.3	205.5	205.0
2637-RD	2949-W-008	2849-W-001	Roadway	199	50	0	0	0	0	0	206.5	205.9	197.6	197.6	197.7	197.7	198.0	198.0	198.1	198.1	198.3	198.3	205.5	205.0
6249	2849-W-001	2849-W-002	24-in Dia CONC	36	50	13	14	16	16	16	194.7	189.5	197.6	197.6	197.7	197.7	198.0	197.9	198.1	198.0	198.3	198.2	205.0	197.5
6249-RD	2849-W-001	2849-W-002	Roadway	36	50	0	0	0	0	0	205.0	197.5	197.6	197.6	197.7	197.7	197.9	197.9	198.0	198.0	198.2	198.2	206.0	198.5
4594	2849-W-002	2849-W-026	27-in Dia RC	454	50	29	29	30	30	31	187.3	185.9	197.6	195.8	197.7	196.1	197.9	197.3	198.0	197.7	198.2	198.1	197.5	197.5
4594-RD	2849-W-002	2849-W-026	Roadway	454	50	0	1	14	21	32	197.5	197.5	197.6	197.5	197.7	197.5	197.9	197.7	198.0	197.7	198.2	198.1	197.5	197.5
2636	2849-W-026	2849-W-027	33-in Dia RC	379	50	28	29	30	33	34	185.4	184.3	195.8	195.3	196.1	195.7	197.3	196.6	197.7	197.0	198.1	198.0	197.5	197.5
2636-RD	2849-W-026	2849-W-027	Roadway	379	50	0	0	0	4	24	197.5	197.5	195.3	195.3	195.7	195.7	196.6	196.6	197.7	197.6	198.1	198.0	197.5	197.5
10062	2849-W-027	2849-W-028	42-in Dia RC	141	50	45	45	44	44	46	184.3	183.9	195.3	194.9	195.7	195.3	196.6	196.2	197.0	196.7	198.0	197.9	197.5	197.5
10062-RD	2849-W-027	2849-W-028	Roadway	141	50	0	0	0	0	29	197.5	197.5	194.9	194.9	195.3	195.3	196.2	196.2	196.7	196.7	198.0	197.9	197.5	197.5
723	2849-W-028	2849-W-022	42-in Dia RC	233	50	42	42	43	44	46	183.6	182.9	194.9	194.5	195.3	194.9	196.2	195.8	196.7	196.2	197.9	197.7	197.5	197.5
723-RD	2849-W-028	2849-W-022	Roadway	233	50	0	0	0	0	18	197.5	197.5	194.5	194.5	194.9	194.9	195.8	195.8	196.2	196.2	197.9	197.7	197.5	197.5
5638	2849-W-022	2849-W-021	42-in Dia RC	321	50	40	40	43	44	47	182.9	181.9	194.5	193.9	194.9	194.3	195.8	195.2	196.2	195.6	197.7	197.0	197.5	204.0
5638-RD	2849-W-021	2849-W-022	Roadway	321	50	0	0	0	0	0	204.0	197.5	194.5	194.5	194.9	194.9	195.8	195.8	196.2	196.2	197.7	197.7	204.4	204.0
2635	2849-W-021	2849-W-020	27-in Dia RC	472	10	47	48	49	49	50	181.8	173.9	193.9	180.4	194.3	180.6	195.2	181.0	195.6	181.1	197.0	182.2	204.0	196.0
2622	2849-W-020	2849-W-019	27-in Dia RC	475	10	48	48	49	49	50	173.9	165.9	180.4	167.8	180.6	167.8	181.0	167.9	181.1	167.9	182.2	168.3	196.0	182.8
4589	2849-W-019	2849-W-018	27-in Dia RC	309	10	47	48	49	49	50	165.9	157.6	167.8	159.4	167.8	159.4	167.9	159.5	167.9	159.5	168.3	159.6	182.8	180.5
2602	2848-W027a	2849-W-009	30-in Dia RC	360	10	2	2	2	2	3	165.0	163.9	165.5	164.4	165.5	164.4	165.5	164.4	165.5	164.5	165.6	164.5	170.5	171.5
6149	2849-W-009	2849-W-015	30-in Dia RC	132	10	2	2	2	2	3	163.9	163.5	164.4	164.0	164.4	164.0	164.4	164.1	164.5	164.1	164.5	164.1	171.5	171.0
6148	2849-W-015	2849-W-014	30-in Dia RC	227	10	2	2	2	2	3	163.5	162.8	164.0	163.2	164.0	163.2	164.1	163.3	164.1	163.3	164.1	163.6	171.0	170.3
2607	2849-W-014	2849-W-013	36-in Dia RC	400	10	3	3	3	4	5	162.3	161.1	163.0	163.0	163.1	163.0	163.2	163.2	163.3	163.3	163.6	163.5	170.3	172.0
4579	2849-W-013	2849-W-012	36-in Dia RC	400	10	22	23	27	28	33	161.1	159.9	163.0	161.4	163.0	161.4	163.2	161.6	163.3	161.6	163.5	161.8	172.0	170.3
2608	2849-W-012	2849-W-011	42-in Dia RC	340	10	22	23	26	28	33	159.5	158.4	161.1	160.2	161.2	160.2	161.3	160.4	161.4	160.5	161.7	160.8	170.3	171.5
4581	2849-W-011	2849-W-010	42-in Dia RC	345	10	23	23	27	28	34	158.4	157.6	160.2	159.6	160.2	159.7	160.4	159.9	160.5	160.0	160.8	160.3	171.5	170.5
10068	2849-W-010	2849-W-018	42-in Dia RC	269	10	36	37	43	45	53	157.6	156.6	159.6	158.6	159.7	158.6	159.9	158.8	160.0	158.9	160.3	159.2	170.5	180.5
2610	2849-W-018	2849-W-017	48-in Dia RC	465	50	88	89	96	100	109	155.8	151.2	158.6	153.7	158.6	153.7	158.8	153.8	158.9	153.9	159.2	154.1	180.5	169.0
10067	2849-W-017	2849-W-016	48-in Dia RC	620	50	89	90	96	100	109	151.2	145.8	153.7	148.3	153.7	148.4	153.8	148.5	153.9	148.6	154.1	148.8	169.0	165.5
10063	2849-W-016	2849-W-008	48-in Dia RC	312	50	88	90	96	99	109	145.7	142.3	148.3	144.6	148.4	144.6	148.5	144.7	148.6	144.8	148.8	145.0	165.5	164.5
2566	2848-W-001	2849-W-003	24-in Dia RC	482	10	0	0	1	1	4	165.0	159.7	165.0	159.7	165.2	159.9	165.3	160.0	165.3	160.0	165.6	160.3	176.5	166.5
2545	2849-W-003	2849-W-004	24-in Dia CONC	398	10	0	0	1	1	4	159.6	157.7	159.6	157.7	159.9	157.8	159.9	157.9	160.0	158.0	160.3	158.3	166.5	164.5
2549	2849-W-004	2849-W-005	30-in Dia RC	400	10	0	0	1	1	4	157.2	155.1	157.2	155.3	157.3	155.4	157.4	155.4	157.5	155.5	157.8	155.8	164.5	166.0
4542	2849-W-005	2849-W-006	30-in Dia RC	400	10	0	0	1	1	4	155.1	153.2	155.3	153.3	155.4	153.3	155.4	153.4	155.5	153.5	155.8	153.8	166.0	164.5
4542-RD	2849-W-005	2849-W-006	Roadway	400	10	0	0	0	0	0	166.0	164.5	153.0	153.0	153.1	153.1	153.2	153.2	153.2	153.2	153.5	153.5	166.0	164.5
2554	2849-W-006	2849-W-007	33-in Dia RC	355	10	0	0	1	1	4	152.9	151.1	153.0	151.2	153.1	151.3	153.2	151.4	153.2	151.4	153.5	151.7	164.5	165.8
4555	2849-W-007	2849-W-008	33-in Dia RC	500	10	0	0	1	1	4	151.0	143.9	151.1	144.0	151.2	144.1	151.2	144.1	151.3	144.2	151.5	144.4	165.8	164.5
2569	2849-W-008	2749-W-001	48-in Dia RC	406	50	94	97	103	107	118	142.2	119.9	143.7	122.1	143.7	122.2	143.8	122.3	143.8	122.3	143.9	122.5	164.5	129.0
5530	2749-W-001	2749-W-002	48-in Dia CONC	348	50	97	101	108	112	124	119.9	111.5	122.1	113.4	122.2	113.4	122.3	113.5	122.3	113.6	122.5	113.7	129.0	121.0
4536	2749-W-002	2749-W-003	54-in Dia CONC	354	50	97	101	108	112	124	111.0	106.0	113.2	108.0	113.2	108.0	113.3	108.1	113.4	108.2	113.5	108.3	121.0	121.8
4535	2749-W-003	2749-W-004	48-in Dia CONC	585	50	97	101	108	112	124	106.0	89.9	108.0	91.8	108.0	91.8	108.1	91.9	108.2	91.9	108.3	92.1	121.8	101.0

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
10044	2749-W-004	2749-W-005	48-in Dia CONC	586	50	97	101	108	112	124	89.9	72.9	91.8	74.7	91.8	74.7	91.9	74.8	91.9	74.9	92.1	75.0	101.0	85.8
207	2749-W-005	2749-W-006	54-in Dia CONC	386	50	97	101	108	112	124	72.4	67.6	74.6	70.1	74.6	70.3	74.7	70.5	74.8	70.6	74.9	70.8	85.8	76.0
5527	2749-W-006	2749-W-007	54-in Dia CONC	267	50	112	121	133	139	155	67.6	64.4	70.1	67.1	70.3	67.2	70.5	67.4	70.6	67.5	70.8	67.8	76.0	72.5
L191	2749-W-007	2750-W-016	Natural	1300	50	111	120	132	137	185	64.4	7.8	67.1	12.7	67.2	13.2	67.4	13.7	67.5	13.9	67.8	14.8	72.5	18.8
5953	2750-W-016	2650-W-601	78-in Dia RC	234	50	172	200	224	235	279	7.8	6.6	12.7	9.8	13.2	10.1	13.7	10.4	13.9	10.5	14.8	11.0	18.8	15.3
2632	2850-W-002	2850-W-003	21-in Dia CONC	210	10	6	8	10	10	12	187.1	185.4	188.1	186.0	188.3	186.1	188.4	186.2	188.5	186.2	188.7	186.3	197.5	196.0
787	2850-W-003	2850-W-004	21-in Dia CONC	500	10	6	8	10	10	12	185.4	171.4	186.0	172.0	186.1	172.1	186.2	172.2	186.2	172.2	186.3	172.3	196.0	178.5
4588	2850-W-004	2850-W-005	21-in Dia CONC	490	10	6	8	9	10	12	171.4	157.7	172.0	158.3	172.1	158.4	172.2	158.5	172.2	158.5	172.3	158.6	178.5	165.8
2616	2850-W-005	2850-W-018	21-in Dia CONC	60	10	6	12	12	13	13	157.5	149.1	157.9	151.5	157.9	155.6	157.9	155.6	157.9	155.7	157.9	155.7	165.8	155.7
2616-RD	2850-W-005	2850-W-018	Roadway	60	10	0	0	0	0	0	165.8	155.7	151.5	151.5	155.6	155.6	155.6	155.6	155.7	155.7	155.7	155.7	166.8	156.7
2614	2850-W-018	2850-W-020	24-in Dia HDPE	22	10	6	11	11	12	12	149.1	149.0	151.5	151.4	155.6	155.5	155.6	155.6	155.7	155.6	155.7	155.6	155.7	155.5
2614-RD	2850-W-018	2850-W-020	Roadway	22	10	0	0	0	0	0	155.7	155.5	151.4	151.4	155.5	155.5	155.6	155.6	155.6	155.6	155.6	155.6	155.7	155.5
775	2850-W-020	2850-F-026	21-in Dia RC	493	10	12	16	16	16	16	149.0	146.5	151.4	148.0	155.5	150.0	155.6	152.8	155.6	153.1	155.6	153.2	155.5	153.1
775-RD	2850-W-020	2850-F-026	Roadway	33	10	0	0	8	10	14	155.5	153.1	148.0	148.0	155.5	153.1	155.6	153.1	155.6	153.2	155.6	153.2	155.5	153.1
4570	2850-F-026	2850-W-021	21-in Dia RC	228	10	12	16	19	19	19	146.5	144.9	148.0	146.5	150.0	147.4	152.8	149.1	153.1	149.3	153.2	150.8	153.1	153.0
4570-RD	2850-F-026	2850-W-021	Roadway	228	10	0	0	0	0	7	153.1	151.5	146.5	146.5	147.4	147.4	149.1	149.1	153.1	151.5	153.2	151.6	153.1	153.0
1343	2850-W-021	2850-W-022	24-in Dia HDPE	107	10	12	16	19	19	22	144.9	144.4	146.5	145.8	147.4	146.8	149.1	148.0	149.3	148.2	150.8	149.4	153.0	153.0
1343-RD	2850-W-021	2850-W-022	Roadway	107	10	0	0	0	0	0	153.0	153.0	145.8	145.8	146.8	146.8	148.0	148.0	148.2	148.2	149.4	149.4	153.0	153.0
4566	2850-W-022	2850-W-023	24-in Dia HDPE	269	10	12	16	19	19	22	144.3	143.1	145.8	144.9	146.8	145.4	148.0	145.9	148.2	146.0	149.4	146.5	153.0	152.3
2575	2850-W-023	2850-W-025	27-in Dia RC	291	10	12	16	19	19	22	142.8	142.6	144.9	143.8	145.4	144.0	145.9	144.1	146.0	144.2	146.5	144.3	152.3	153.8
10053	2850-W-025	2750-W-006	33-in Dia RC	390	10	21	27	34	36	41	142.1	129.0	143.1	129.9	143.2	130.0	143.4	130.2	143.4	130.2	143.5	130.3	153.8	134.9
2544	2750-W-006	2750-W-007	30-in Dia RC	22	10	21	27	34	36	41	122.0	121.7	123.4	123.0	123.6	123.3	124.0	123.6	124.1	123.7	124.3	123.8	134.9	128.2
5523	2750-W-007	2850-W-024	36-in Dia RC	396	10	21	27	34	36	40	121.6	118.5	122.9	119.7	123.1	120.0	123.3	120.4	123.4	120.8	123.7	121.8	128.2	129.7
5523-RD	2850-W-024	2750-W-007	Roadway	396	10	0	0	0	0	0	129.7	128.2	122.9	122.9	123.1	123.1	123.3	123.3	123.4	123.4	123.7	123.7	129.7	128.2
4548	2850-W-024	2750-W-008	30-in Dia RC	206	10	29	38	47	49	56	118.2	114.4	119.7	115.7	120.0	115.9	120.4	116.2	120.8	116.3	121.8	116.6	129.7	121.0
10045	2750-W-008	2750-W-009	30-in Dia RC	329	10	29	38	47	49	56	114.0	97.6	115.0	98.6	115.2	98.8	115.4	98.9	115.4	98.9	115.5	99.1	121.0	104.2
2521	2750-W-009	2750-W-010	30-in Dia RC	321	10	29	38	47	49	56	97.5	72.7	98.4	73.7	98.5	73.9	98.7	74.1	98.7	74.2	98.8	74.3	104.2	81.0
4531	2750-W-010	2750-W-011	42-in Dia RC	479	10	29	38	46	48	57	72.4	66.4	73.7	67.7	73.9	67.9	74.1	68.0	74.2	68.1	74.3	68.4	81.0	73.7
2517	2750-W-011	2750-W-022	42-in Dia RC	267	10	29	38	46	48	55	66.3	63.5	67.6	65.0	67.8	65.7	68.0	66.2	68.0	66.5	68.4	67.5	73.7	74.0
2517-RD	2750-W-022	2750-W-011	Roadway	267	10	0	0	0	0	0	74.0	73.7	67.6	67.6	67.8	67.8	68.0	68.0	68.0	68.0	68.4	68.4	74.0	73.7
10058	2750-W-022	2750-W-021	42-in Dia RC	55	10	29	38	46	48	55	63.5	62.4	65.0	65.2	65.7	65.7	66.2	66.2	66.5	66.5	67.5	67.2	74.0	74.0
10059	2750-W-021	2750-W-012	42-in Dia RC	50	50	63	81	94	99	115	62.4	62.0	65.2	63.4	65.7	63.7	66.2	63.8	66.5	63.9	67.2	64.1	74.0	73.7
2617	2850-W-006	2850-W-007	36-in Dia HDPE	254	10	4	6	7	7	8	153.7	148.0	154.1	148.4	154.2	148.5	154.2	148.5	154.2	148.5	154.3	148.6	171.7	159.8
4584	2850-W-007	2850-W-008	36-in Dia HDPE	232	10	4	6	7	7	8	147.8	138.1	148.2	138.4	148.2	138.5	148.3	138.5	148.3	138.5	148.3	138.6	159.8	150.6
2595	2850-W-008	2850-W-009	36-in Dia HDPE	269	10	4	6	7	7	8	137.9	121.9	138.2	122.5	138.2	122.6	138.3	122.7	138.3	122.7	138.3	122.8	150.6	132.9
4571	2850-W-009	2850-W-010	36-in Dia HDPE	67	10	12	16	18	19	22	121.8	120.2	122.5	120.9	122.6	121.0	122.7	121.0	122.7	121.0	122.8	121.1	132.9	133.0
2585	2850-W-010	2850-W-011	36-in Dia HDPE	20	10	12	16	18	19	22	120.0	119.2	120.7	119.9	120.9	120.0	120.9	120.0	120.9	120.1	121.0	120.1	133.0	127.6
4567	2850-W-011	2850-W-012	36-in Dia HDPE	107	10	12	16	18	19	22	118.9	112.8	119.5	113.4	119.6	113.5	119.6	113.5	119.6	113.5	119.7	113.6	127.6	118.6
2583	2850-W-012	2850-W-013	36-in Dia HDPE	18	10	12	16	18	19	22	112.6	110.2	113.2	110.7	113.3	110.8	113.4	110.8	113.4	110.8	113.5	110.9	118.6	117.7
4562	2850-W-013	2850-W-014	36-in Dia HDPE	484	10	12	15	18	19	22	108.7	100.7	109.5	101.5	109.6	101.6	109.6	101.7	109.7	101.7	109.8	101.8	117.7	113.5
2551	2850-W-014	2750-W-001	36-in Dia HDPE	143	10	12	15	18	19	22	100.4	94.6	101.1	95.2	101.1	95.3	101.2	95.4	101.2	95.4	101.3	95.5	113.5	108.9
4546	2750-W-001	2750-W-002	36-in Dia HDPE	364	10	12	16	18	19	22	94.4	72.5	95.0	73.1	95.1	73.2	95.1	73.2	95.1	73.3	95.2	73.4	108.9	81.9
2522	2750-W-002	2750-W-003	48-in Dia HDPE	400	10	12	15	18	19	22	72.1	69.5	73.0	70.3	73.2	70.4	73.2	70.5	73.3	70.5	73.4	70.6	81.9	80.5
4532	2750-W-003	2750-W-004	48-in Dia HDPE	492	10	12	15	18	19	22	69.3	66.9	70.2	68.0	70.3	68.2	70.4	68.3	70.4	68.4	70.5	68.5	80.5	80.9
1342	2750-W-004	2750-W-005	48-in Dia RC	47	10	12	15	17	18	22	66.8	66.7	68.0	67.8	68.2	68.0	68.3	68.1	68.4	68.1	68.5	68.3	80.9	81.7
2516	2750-W-005	2750-W-023	48-in Dia RC	49	10	12	15	17	18	22	66.7	66.5	67.8	67.4	68.0	67.5	68.1	67.6	68.1	67.6	68.3	67.7	81.7	82.8
10060	2750-W-023	2750-W-017	54-in Dia RC	262	10	12	16	19	20	23	66.0	65.2	67.1	66.3	67.3	66.5	67.4	66.6	67.4	66.8	67.7	67.4	82.8	79.4
10056	2750-W-017	2750-W-018	54-in Dia RC	307	10	12	16	18	20	23	65.2	64.4	66.3	65.5	66.5	65.9	66.6	66.4	66.8	66.6	67.4	67.3	79.4	76.7
10055	2750-W-018	2750-W-019	54-in Dia RC	262	10	13	17	19	20	24	64.4	63.7	65.5	65.2	65.9	65.8	66.4	66.3	66.6	66.5	67.3	67.3	76.7	74.9
10054	2750-W-019	2750-W-020	54-in Dia RC	113	10	13	17	21	22	25	63.7	63.3	65.2	65.2	65.8	65.8	66.3	66.3	66.5	66.5	67.3	67.2	74.9	74.7

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Exisiting Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Existing Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
6005	2750-W-020	2750-W-021	54-in Dia RC	349	10	13	18	22	23	27	63.3	62.4	65.2	65.2	65.8	65.7	66.3	66.2	66.5	66.5	67.2	67.2	74.7	74.0
4528	2750-W-012	2750-W-013	42-in Dia RC	449	50	63	81	94	99	115	62.0	46.8	63.4	48.3	63.7	48.5	63.8	48.7	63.9	48.8	64.1	48.9	73.7	55.7
2504	2750-W-013	2750-W-014	42-in Dia RC	349	50	63	81	94	99	115	46.8	25.8	48.1	27.1	48.2	27.4	48.4	27.5	48.4	27.6	48.6	27.8	55.7	34.4
10047	2750-W-014	2750-W-015	48-in Dia RC	336	50	63	81	94	99	118	25.7	13.6	27.1	15.0	27.4	15.2	27.5	15.3	27.6	15.4	27.8	15.7	34.4	23.6
2499	2750-W-015	2750-W-016	60-in Dia RC	385	50	63	81	94	99	117	12.8	8.3	14.5	12.7	14.7	13.2	14.9	13.7	14.9	13.9	15.7	14.8	23.6	18.8
2499-RD	2750-W-015	2750-W-016	Roadway	385	50	0	0	0	0	0	23.6	18.8	12.7	12.7	13.2	13.2	13.7	13.7	13.9	13.9	14.8	14.8	23.6	18.8

APPENDIX C

HYDRAULIC PERFORMANCE OF THE WEST GRESHAM STORM DRAINAGE SYSTEM UNDER FUTURE LAND USE CONDITIONS

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
2644	2946-W-002	2946-W-001	12-in Dia CONC	399	50	7	10	11	11	11	250.6	218.4	251.3	219.0	251.5	219.2	258.1	219.4	258.3	219.4	258.3	224.9	258.3	227.5
2644-RD	2946-W-002	2946-W-001	Roadway	399	50	0	0	0	3	6	258.3	227.5	218.8	218.8	218.9	218.9	219.0	219.0	258.3	227.5	258.3	227.5	258.3	227.5
2633	2946-W-001	2846-W-001	15-in Dia CONC	241	50	7	10	11	13	16	218.1	207.3	218.8	208.0	218.9	208.1	219.0	208.2	219.2	208.4	224.9	208.5	227.5	217.8
10039	2846-W-001	2846-W-002	36-in Dia CONC	244	50	24	32	36	41	48	206.3	203.8	207.7	205.1	208.0	205.3	208.2	205.4	208.3	205.5	208.5	206.1	217.8	216.0
4586	2846-W-002	2846-W-003	36-in Dia CONC	270	50	24	31	36	40	47	203.8	200.4	205.1	202.5	205.3	202.9	205.4	203.2	205.5	203.4	206.1	204.6	216.0	211.5
2596	2846-W-003	2846-W-004	42-in Dia RC	608	50	35	45	51	57	66	200.4	197.4	202.5	198.8	202.9	199.1	203.2	199.2	203.4	199.3	204.6	199.4	211.5	210.5
4572	2846-W-004	2846-W-005	36-in Dia RC	390	50	35	45	51	59	66	197.4	189.6	198.8	190.9	199.1	191.1	199.2	191.3	199.3	191.6	199.4	192.8	210.5	198.8
737	2846-W-005	2846-W-006	36-in Dia RC	340	50	34	45	51	58	66	189.6	182.8	190.9	184.8	191.1	185.3	191.3	186.2	191.6	187.6	192.8	189.2	198.8	191.0
4556	2846-W-006	2846-W-007	36-in Dia RC	350	50	52	69	78	86	97	182.8	176.2	184.8	177.7	185.3	178.0	186.2	178.1	187.6	178.3	189.2	178.5	191.0	185.5
4556-RD	2846-W-006	2846-W-007	Roadway	350	50	0	0	0	0	0	191.0	185.5	177.7	177.7	178.0	178.0	178.1	178.1	178.3	178.3	178.5	178.5	191.0	185.5
2564	2846-W-007	2746-W-001	36-in Dia RC	418	50	52	69	78	86	97	176.2	164.5	177.7	166.0	178.0	166.3	178.1	166.4	178.3	166.6	178.5	166.8	185.5	173.8
2526	2746-W-001	2746-W-002	48-in Dia RC	22	50	52	69	78	86	97	163.7	162.8	165.2	164.9	165.6	165.3	165.8	165.6	166.1	165.9	166.5	166.4	173.8	173.1
2562	2847-W-007	2847-W-006	30-in Dia CONC	81	10	14	19	22	25	30	170.0	169.6	171.3	170.9	171.6	171.2	171.8	171.4	172.0	171.6	172.7	172.2	182.9	181.7
4549	2847-W-006	2847-W-005	30-in Dia CONC	188	10	14	19	22	25	30	169.6	168.7	170.9	170.0	171.2	170.2	171.4	170.4	171.6	170.6	172.2	170.9	181.7	180.7
2555	2847-W-005	2847-W-004	30-in Dia CONC	172	10	14	19	22	25	30	168.7	167.8	170.0	169.1	170.2	169.3	170.4	169.4	170.6	169.5	170.9	169.8	180.7	179.8
5644	2847-W-004	2747-W-007	36-in Dia CONC	371	10	14	19	22	25	29	167.6	166.5	169.0	167.8	169.2	168.1	169.4	168.3	169.5	168.5	169.8	168.8	179.8	177.9
4534	2747-W-007	2747-W-006	36-in Dia CONC	78	10	14	19	22	25	29	166.5	166.3	167.8	167.5	168.1	167.8	168.3	168.0	168.5	168.2	168.8	168.6	177.9	177.6
10040	2747-W-006	2747-W-005	48-in Dia CONC	105	10	14	19	22	25	29	165.7	165.5	167.5	167.4	167.8	167.7	168.0	167.9	168.2	168.1	168.6	168.5	177.6	178.1
4533	2747-W-005	2747-W-004	48-in Dia CONC	154	10	25	33	39	43	50	165.5	165.2	167.4	167.0	167.7	167.3	167.9	167.5	168.1	167.7	168.5	168.1	178.1	178.9
2524	2747-W-004	2747-W-003	48-in Dia CONC	240	10	25	33	38	43	50	165.2	164.7	167.0	166.5	167.3	166.9	167.5	167.1	167.7	167.2	168.1	167.7	178.9	178.5
2523	2747-W-003	2747-W-002	48-in Dia CONC	270	10	25	33	38	43	50	164.7	164.1	166.5	166.0	166.9	166.3	167.1	166.5	167.2	166.7	167.7	167.2	178.5	177.0
5642	2747-W-002	2747-W-001	48-in Dia CONC	186	10	25	33	38	43	50	164.1	163.8	166.0	165.7	166.3	166.0	166.5	166.2	166.7	166.3	167.2	166.8	177.0	172.5
5641	2747-W-001	2746-W-002	36-in Dia CONC	31	10	25	33	38	43	50	163.8	163.7	165.7	165.3	166.0	165.6	166.2	165.7	166.3	165.9	166.8	166.4	172.5	173.1
5641-RD	2746-W-002	2747-W-001	Roadway	31	10	0	0	0	0	0	173.1	172.5	165.7	165.7	166.0	166.0	166.2	166.2	166.3	166.3	166.8	166.8	172.5	173.1
6025	2746-W-002	2746-W-003	48-in Dia RC	200	50	102	135	155	170	196	162.8	154.8	164.9	156.5	165.3	156.8	165.6	157.0	165.9	157.1	166.4	157.3	173.1	166.0
764	2746-W-003	2746-W-004	48-in Dia RC	622	50	111	147	169	184	215	154.6	128.6	156.4	130.4	156.7	130.7	156.8	131.0	156.9	131.1	157.2	131.6	166.0	141.0
763	2746-W-004	2746-W-005	42-in Dia RC	644	50	111	147	168	184	214	128.6	87.9	130.4	89.6	130.7	89.9	131.0	90.1	131.1	90.3	131.6	90.6	141.0	103.0
763-RD	2746-W-004	2746-W-005	Roadway	644	50	0	0	0	0	0	141.0	103.0	89.5	89.5	89.9	89.9	90.1	90.1	90.2	90.2	90.5	90.5	141.0	103.0
2505	2746-W-005	2746-W-006	42-in Dia RC	196	50	111	147	168	184	214	87.8	74.7	89.5	76.3	89.9	76.6	90.1	76.8	90.2	76.9	90.5	77.2	103.0	94.0
762	2746-W-006	2746-W-007	72-in Dia RC	202	50	130	172	195	211	250	73.9	68.6	76.0	70.5	76.3	70.9	76.5	71.1	76.6	71.2	76.9	71.5	94.0	85.0
4518	2746-W-007	2746-W-008	54-in Dia RC	541	50	130	171	195	211	249	68.4	53.4	70.5	55.9	70.9	56.2	71.1	56.4	71.2	56.7	71.5	57.2	85.0	70.0
2490	2746-W-008	2646-W-001	72-in Dia RC	466	50	130	171	195	220	249	54.0	44.3	55.9	48.4	56.2	50.3	56.4	51.5	56.7	53.1	57.2	53.3	70.0	53.0
2490-RD	2746-W-008	2646-W-001	Roadway	466	50	0	0	0	0	0	70.0	53.0	48.4	48.4	50.3	50.3	51.5	51.5	53.1	53.1	53.3	53.3	71.0	54.0
4511	2646-W-001	2646-W-002	54-in Dia RC	114	50	147	193	223	307	307	44.3	42.6	48.4	44.4	50.3	44.8	51.5	45.0	53.1	48.8	53.3	49.8	53.0	51.0
4511-RD	2646-W-001	2646-W-002	Roadway	114	50	0	0	0	12	85	53.0	51.0	44.4	44.4	44.8	44.8	45.0	45.0	53.1	51.1	53.3	51.3	53.0	51.0
2486	2646-W-002	2646-W-003	54-in Dia RC	77	50	147	193	227	305	319	42.6	37.7	44.4	39.6	44.8	39.9	45.0	40.3	48.9	46.6	49.8	46.9	51.0	46.8
2486-RD	2646-W-002	2646-W-003	Roadway	77	50	0	0	0	0	0	51.0	46.8	39.6	39.6	39.9	39.9	40.3	40.3	46.6	46.6	46.9	46.9	51.0	46.8
4509	2646-W-003	2646-W-004	48-in Dia RC	291	50	147	193	225	289	296	37.7	21.1	39.6	24.7	39.9	25.8	40.3	26.7	46.6	29.4	46.9	30.2	46.8	31.0
4509-RD	2646-W-003	2646-W-004	Roadway	291	50	0	0	0	0	28	46.8	31.0	24.7	24.7	25.8	25.8	26.7	26.7	29.4	29.4	46.9	31.1	46.8	31.0
760	2646-W-004	2646-W-005	72-in Dia RC	241	50	147	193	222	291	317	21.1	19.4	24.7	24.1	25.8	25.0	26.7	25.6	29.4	27.0	30.2	27.6	31.0	28.5
760-RD	2646-W-004	2646-W-005	Roadway	241	50	0	0	0	0	0	31.0	28.5	24.1	24.1	25.0	25.0	25.6	25.6	27.0	27.0	27.6	27.6	31.0	28.5
5913	2646-W-005	2647-W-601	72-in Dia RC	61	50	147	193	222	292	317.4393	19.4	19.0	24.1	21.9	25.0	22.4	25.6	22.7	27.0	23.5	27.6	23.9	28.5	25.5
5551	3048-W-002	3048-W-001	21-in Dia CONC	250	50	5	7	8	11	12	236.4	235.2	237.3	236.0	238.8	238.4	242.5	241.8	248.7	247.3	249.1	248.0	249.0	248.0
5551-RD	3048-W-002	3048-W-001	Roadway	250	50	0	0	0	0	2	249.0	248.0	236.0	236.0	238.4	238.4	241.8	241.8	247.3	247.3	249.1	248.0	249.0	248.0
2730	3048-W-001	2948-W-014	27-in Dia CONC	300	50	14	17	21	30	32	234.7	233.2	236.0	234.5	238.4	237.3	241.8	240.1	247.3	244.2	248.0	244.5	248.0	244.5
2730-RD	3048-W-001	2948-W-014	Roadway	300	50	0	0	0	0	2	248.0	244.5	234.5	234.5	237.3	237.3	240.1	240.1	244.2	244.2	248.0	244.5	248.0	244.5

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
2723	2948-W-014	2948-W-013	27-in Dia CONC	300	50	14	17	21	30	31	233.2	231.7	234.5	233.8	237.3	236.2	240.1	238.5	244.2	241.0	244.5	241.1	244.5	241.0
2723-RD	2948-W-014	2948-W-013	Roadway	300	50	0	0	0	0	2	244.5	241.0	233.8	233.8	236.2	236.2	238.5	238.5	241.0	241.0	244.5	241.1	244.5	241.0
10029	2948-W-013	2948-W-012	27-in Dia CONC	53	50	13	17	21	30	32	231.7	231.4	233.8	233.7	236.2	236.0	238.5	238.1	241.0	240.5	241.1	240.6	241.0	240.5
10029-RD	2948-W-013	2948-W-012	Roadway	53	50	0	0	0	1	6	241.0	240.5	233.7	233.7	236.0	236.0	238.1	238.1	241.0	240.5	241.1	240.6	241.0	240.5
2706	2948-W-012	2948-W-011	27-in Dia CONC	377	50	19	25	31	37	37	231.4	229.5	233.7	230.7	236.0	233.1	238.1	233.8	240.5	234.0	240.6	234.4	240.5	236.5
2706-RD	2948-W-012	2948-W-011	Roadway	377	50	0	0	0	0	6	240.5	236.5	230.7	230.7	233.1	233.1	233.8	233.8	240.5	236.5	240.6	236.6	240.5	236.5
2687	2948-W-011	2948-W-010	36-in Dia CONC	363	50	20	24	31	37	42	229.5	225.7	230.7	229.9	233.1	232.5	233.8	232.6	234.0	232.7	234.4	232.7	236.5	232.5
2687-RD	2948-W-011	2948-W-010	Roadway	363	50	0	0	0	0	0	236.5	232.5	229.9	229.9	232.5	232.5	232.6	232.6	232.7	232.7	232.7	232.7	237.5	233.5
10028	2948-W-010	2948-W-009	27-in Dia CONC	122	50	23	25	26	26	25	225.7	223.2	229.9	229.6	232.5	231.6	232.6	231.8	232.7	232.1	232.7	232.1	232.5	232.0
10028-RD	2948-W-010	2948-W-009	Roadway	122	50	0	0	4	16	21	232.5	232.0	229.6	229.6	232.5	232.0	232.6	232.1	232.7	232.2	232.7	232.2	232.5	232.0
2688	2948-W-009	2948-W-008	27-in Dia CONC	111	50	25	28	30	33	33	224.0	223.2	229.7	229.8	231.6	230.5	231.8	230.5	232.1	230.6	232.1	230.6	232.0	230.5
2688-RD	2948-W-009	2948-W-008	Roadway	111	50	0	0	0	9	14	232.0	230.5	229.8	229.8	230.5	230.5	230.5	230.5	232.1	230.6	232.1	230.6	232.0	230.5
2660	2948-W-008	2948-W-007	27-in Dia CONC	398	50	24	30	29	34	38	223.2	218.9	229.8	219.7	230.5	219.7	230.5	219.7	230.6	219.9	230.6	220.1	230.5	225.8
2660-RD	2948-W-008	2948-W-007	Roadway	398	50	0	2	2	7	10	230.5	225.8	219.7	219.7	230.5	225.8	230.5	225.8	230.6	225.8	230.6	225.8	230.5	225.8
5550	2948-W-007	2948-W-006	27-in Dia CONC	350	50	34	35	35	42	47	218.9	195.6	219.7	202.4	219.7	204.5	219.7	204.6	219.9	204.7	220.1	204.8	225.8	204.5
5550-RD	2948-W-007	2948-W-006	Roadway	350	50	0	0	0	0	0	225.8	204.5	202.4	202.4	204.5	204.5	204.6	204.6	204.7	204.7	204.8	204.8	226.8	205.5
5675	2948-W-019	2948-W-020	24-in Dia CONC	201	10	7	10	11	18	22	218.8	217.8	219.9	218.8	220.1	219.0	220.2	219.1	224.9	223.5	228.5	226.6	228.5	230.3
5675-RD	2948-W-020	2948-W-019	Roadway	201	10	0	0	0	0	0	230.3	228.5	219.9	219.9	220.1	220.1	220.2	220.2	224.9	224.9	228.5	228.5	228.5	230.3
2658	2948-W-020	2948-W-021	24-in Dia CONC	270	10	7	10	11	18	22	217.8	216.2	218.8	217.1	219.0	217.3	219.1	217.4	223.5	221.5	226.6	223.9	230.3	227.5
2657	2948-W-021	2948-W-022	24-in Dia CONC	208	10	18	25	28	36	42	209.9	204.6	210.9	205.7	213.7	211.1	217.4	213.9	221.5	215.6	223.9	215.6	227.5	215.5
2645	2948-W-022	2948-W-023	24-in Dia CONC	442	10	19	25	28	30	30	204.3	198.6	205.7	201.5	211.1	205.6	213.9	206.1	215.6	206.3	215.6	206.3	215.5	206.3
2645-RD	2948-W-022	2948-W-023	Roadway	442	10	0	0	0	5	12	215.5	206.3	201.5	201.5	205.6	205.6	206.1	206.1	215.6	206.3	215.6	206.3	215.5	206.3
4597	2948-W-023	2948-W-006	24-in Dia CONC	73	10	26	27	27	29	29	198.5	197.5	201.5	202.4	205.6	204.5	206.1	204.6	206.3	204.7	206.3	204.8	206.3	204.5
4597-RD	2948-W-023	2948-W-006	Roadway	73	10	0	0	0	6	13	206.3	204.5	202.4	202.4	204.5	204.5	204.6	204.6	206.3	204.7	206.3	204.8	206.3	204.5
2638	2948-W-006	2948-W-005	30-in Dia CONC	280	50	42	47	47	47	47	195.3	193.6	202.4	198.2	204.5	200.3	204.6	201.2	204.7	201.3	204.8	201.4	204.5	201.0
2638-RD	2948-W-006	2948-W-005	Roadway	280	50	0	2	13	35	48	204.5	201.0	198.2	198.2	204.5	201.0	204.6	201.2	204.7	201.3	204.8	201.4	204.5	201.0
5549	2948-W-005	2848-W-007	30-in Dia CONC	445	50	38	47	48	49	48	193.6	190.8	198.2	192.9	200.3	193.2	201.2	195.9	201.3	199.1	201.4	199.2	201.0	199.0
5549-RD	2948-W-005	2848-W-007	Roadway	445	50	0	0	11	48	62	201.0	199.0	192.2	192.2	193.2	193.2	201.2	199.1	201.3	199.3	201.4	199.4	201.0	199.0
2624	2848-W-007	2848-W-006	30-in Dia RC	305	50	42	51	54	58	58	190.5	184.5	192.2	186.1	193.2	188.1	195.9	189.7	199.1	192.2	199.2	192.2	199.0	192.0
2624-RD	2848-W-007	2848-W-006	Roadway	305	50	0	0	0	20	35	199.0	192.0	186.1	186.1	188.1	188.1	189.7	189.7	199.1	192.2	199.2	192.2	199.0	192.0
2619	2848-W-006	2848-W-005	30-in Dia RC	295	50	41	50	54	59	63	184.5	178.4	186.1	180.4	188.1	182.9	189.7	183.7	192.2	186.9	192.2	187.0	192.0	186.8
2619-RD	2848-W-006	2848-W-005	Roadway	295	50	0	0	0	26	41	192.0	186.8	180.4	180.4	182.9	182.9	183.7	183.7	192.2	186.9	192.2	187.0	192.0	186.8
2620	2848-W-005	2848-W-004	36-in Dia CONC	279	50	40	50	54	70	65	177.9	176.5	180.4	179.3	182.9	181.0	183.7	181.5	186.9	183.8	187.0	184.5	186.8	184.0
2620-RD	2848-W-005	2848-W-004	Roadway	279	50	0	0	0	12	31	186.8	184.0	179.3	179.3	181.0	181.0	181.5	181.5	186.9	184.1	187.0	184.5	186.8	184.0
5548	2848-W-004	2848-W-003	36-in Dia CONC	396	50	42	52	56	80	85	176.5	174.5	179.3	175.9	181.0	176.1	181.5	176.2	183.8	177.1	184.5	177.6	184.0	186.0
5548-RD	2848-W-004	2848-W-003	Roadway	396	50	0	0	0	0	0	184.0	186.0	179.3	179.3	181.0	181.0	181.5	181.5	183.8	183.8	184.5	184.5	184.0	186.0
2591	2848-W-003	2848-W-002	36-in Dia CONC	290	50	42	52	56	80	84	174.5	167.2	175.9	169.1	176.1	169.4	176.2	169.6	177.1	172.3	177.6	172.5	186.0	178.0
2582	2848-W-002	2848-W-001	36-in Dia CONC	310	50	42	52	56	80	84	167.2	163.6	169.1	165.0	169.4	165.2	169.6	165.3	172.3	165.6	172.5	166.0	178.0	176.5
2582-RD	2848-W-002	2848-W-001	Roadway	33	50	0	0	0	0	0	178.0	176.5	165.0	165.0	165.2	165.2	165.3	165.3	165.6	165.6	166.0	166.0	178.0	176.5
4553	2848-W-001	2848-W-024	36-in Dia RC	187	50	46	55	60	79	85	163.6	158.1	165.0	159.4	165.2	159.6	165.3	159.7	165.6	160.0	166.0	163.5	176.5	169.5
299	2848-W-024	2848-W-025	36-in Dia RC	42	50	46	55	60	79	91	157.6	155.9	159.1	157.1	159.3	157.3	159.4	157.3	159.9	157.6	163.5	162.6	169.5	170.0
2628	2847-W-013	2847-W-014	36-in Dia CONC	381	50	4	6	6	15	18	199.9	197.7	200.5	198.5	200.6	198.6	200.7	198.7	201.1	199.2	201.2	199.3	212.4	208.3
4593	2847-W-014	2847-W-015	36-in Dia CONC	125	50	4	6	6	15	18	197.7	197.4	198.5	198.0	198.6	198.1	198.7	198.2	199.2	198.6	199.3	198.7	208.3	206.3
2623	2847-W-015	2847-W-016	36-in Dia CONC	408	50	4	6	6	15	18	197.4	195.2	198.0	195.8	198.1	195.9	198.2	196.0	198.6	196.4	198.7	196.5	206.3	206.7
5639	2847-W-016	2848-W-030	42-in Dia CONC	497	50	4	6	6	15	18	195.2	193.1	195.8	193.9	195.9	194.1	196.0	194.1	196.4	194.7	196.5	194.8	206.7	206.0
10087	2848-W-030	2848-W-031	42-in Dia CONC	258	50	4	5	6	15	17	193.1	192.8	193.9	193.5	194.1	193.6	194.1	193.7	194.7	194.1	194.8	194.2	206.0	204.0
10088	2848-W-031	2848-W-032	42-in Dia CONC	98	50	4	5	6	15	17	192.8	192.6	193.5	193.1	193.6	193.2	193.7	193.2	194.1	193.6	194.2	193.7	204.0	203.1
10089	2848-W-032	2848-W-033	42-in Dia CONC	302	50	4	5	6	15	18	192.6	190.0	193.1	190.5	193.2	190.6	193.2	190.6	193.6	190.9	193.7	191.0	203.1	199.7
10090	2848-W-033	2848-W-027	42-in Dia CONC	466	50	4	5	6	15	17	190.0	186.0	190.5	186.8	190.6	186.9	190.6	187.0	190.9	187.4	191.0	187.6	199.7	199.0
6221	2848-W-027	2848-W-028	42-in Dia CONC	344	10	23	29	34	53	63	185.8	179.3	186.8	180.3	186.9	180.5	187.0	180.6	187.4	181.0	187.6	181.2	199.0	191.0

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
10052	2848-W-028	2848-W-013	42-in Dia CONC	465	10	22	29	33	53	62	179.3	173.3	180.3	174.4	180.5	174.7	180.6	174.8	181.0	175.4	181.2	175.7	191.0	184.8
4591	2848-W-013	2848-W-012	42-in Dia RC	47	10	22	29	33	52	62	173.0	172.7	174.4	174.0	174.7	174.2	174.8	174.3	175.4	174.8	175.7	175.1	184.8	184.3
5652	2847-W-001	2847-W-002	24-in Dia RC	129	10	2	3	3	5	6	189.0	185.7	189.3	186.1	189.4	186.1	189.4	186.2	189.5	186.2	189.6	186.3	195.2	191.8
4580	2847-W-002	2847-W-003	24-in Dia RC	101	10	2	3	3	5	6	185.7	183.1	186.1	183.6	186.1	183.7	186.2	183.7	186.2	183.8	186.3	183.9	191.8	189.3
2600	2847-W-003	2848-W-008	24-in Dia RC	404	10	2	3	3	5	6	183.1	179.5	183.6	180.0	183.7	180.1	183.7	180.1	183.8	180.2	183.9	180.3	189.3	185.8
2603	2848-W-008	2848-W-009	24-in Dia RC	382	10	2	3	3	5	6	179.5	177.3	180.0	177.8	180.1	177.9	180.1	177.9	180.2	178.0	180.3	178.1	185.8	186.5
2604	2848-W-010	2848-W-009	30-in Dia RC	355	10	2	3	3	5	5	174.8	176.9	177.4	175.3	177.4	175.3	177.5	175.4	177.6	175.5	177.7	175.5	186.5	183.9
2604-RD	2848-W-009	2848-W-010	Roadway	355	10	0	0	0	0	0	186.5	183.9	175.2	175.2	175.2	175.2	175.3	175.3	175.4	175.4	175.4	175.4	186.5	183.9
4577	2848-W-011	2848-W-010	36-in Dia RC	413	10	2	3	3	5	5	173.0	174.7	175.2	173.5	175.2	173.5	175.3	173.6	175.4	173.9	175.4	174.3	183.9	186.2
4577-RD	2848-W-011	2848-W-010	Roadway	413	10	0	0	0	0	0	186.2	183.9	175.2	175.2	175.2	175.2	175.3	175.3	175.4	175.4	175.4	175.4	183.9	186.2
2605	2848-W-012	2848-W-011	36-in Dia RC	364	10	2	3	3	6	8	171.9	173.0	173.5	172.7	173.5	173.0	173.6	173.2	173.9	173.8	174.3	174.2	186.2	184.3
2605-RD	2848-W-011	2848-W-012	Roadway	364	10	0	0	0	0	0	186.2	184.3	172.7	172.7	173.0	173.0	173.2	173.2	173.8	173.8	174.2	174.2	186.2	184.3
2606	2848-W-012	2848-W-015	48-in Dia RC	433	10	35	46	53	74	87	170.9	168.0	172.7	169.6	173.0	169.9	173.2	170.0	173.8	170.5	174.2	170.8	184.3	180.5
4578	2848-W-015	2848-W-016	48-in Dia RC	331	10	35	46	53	74	87	168.0	166.0	169.6	167.6	169.9	167.8	170.0	168.0	170.5	168.4	170.8	168.8	180.5	176.9
2578	2848-W-016	2848-W-017	54-in Dia RC	502	10	35	46	53	74	87	165.9	162.7	167.4	164.9	167.6	165.3	167.8	165.6	168.2	166.2	168.5	167.2	176.9	179.5
2578-RD	2848-W-017	2848-W-016	Roadway	502	10	0	0	0	0	0	179.5	176.9	167.4	167.4	167.6	167.6	167.8	167.8	168.2	168.2	168.5	168.5	176.9	179.5
4561	2848-W-018	2848-W-017	36-in Dia RC	485	10	10	13	15	17	20	165.8	163.7	166.8	164.9	167.0	165.3	167.1	165.6	167.2	166.2	167.6	167.2	179.6	179.5
2547	2848-W-017	2848-W-026	54-in Dia CONC	495	10	67	88	101	125	152	162.6	158.1	164.9	160.0	165.3	160.3	165.6	160.5	166.2	160.8	167.2	163.6	179.5	179.0
4545	2848-W-026	2848-W-025	54-in Dia CONC	161	10	67	88	101	125	137	158.1	156.1	160.0	157.9	160.3	158.2	160.5	158.3	160.8	158.6	163.6	162.6	179.0	170.0
2550	2848-W-025	2748-W-001	42-in Dia RC	445	50	112	141	161	190	204	153.1	124.6	154.7	126.6	155.0	127.1	155.2	127.5	156.1	135.8	162.6	138.6	170.0	138.5
4543	2748-W-001	2748-W-002	48-in Dia CONC	152	50	112	141	161	190	207	124.1	120.5	126.6	123.0	127.1	123.4	127.5	123.7	135.8	131.1	138.6	134.4	138.5	134.3
4543-RD	2748-W-001	2748-W-002	Roadway	152	50	0	0	0	0	23	138.5	134.3	123.0	123.0	123.4	123.4	123.7	123.7	131.1	131.1	138.6	134.4	138.5	134.3
298	2748-W-002	2748-W-003	48-in Dia CONC	100	50	112	141	161	190	208	120.5	118.1	123.0	120.1	123.4	120.4	123.7	120.7	131.1	128.3	134.4	131.4	134.3	135.0
298-RD	2748-W-002	2748-W-003	Roadway	100	50	0	0	0	0	0	134.3	135.0	123.0	123.0	123.4	123.4	123.7	123.7	131.1	131.1	134.4	134.4	134.3	135.0
4530	2748-W-003	2748-W-004	42-in Dia CONC	375	50	135	172	197	228	243	118.1	97.6	120.1	99.7	120.4	100.3	120.7	101.3	128.3	105.7	131.4	105.7	135.0	105.5
4530-RD	2748-W-003	2748-W-004	Roadway	375	50	0	0	0	0	0	135.0	105.5	99.7	99.7	100.3	100.3	101.3	101.3	105.7	105.7	105.7	105.7	135.0	105.5
5545	2748-W-004	2748-W-005	48-in Dia CONC	425	50	135	172	196	213	213	97.1	86.9	99.7	89.3	100.3	89.8	101.3	90.2	105.7	96.1	105.7	96.2	105.5	96.0
5545-RD	2748-W-004	2748-W-005	Roadway	425	50	0	0	0	35	57	105.5	96.0	89.3	89.3	89.8	89.8	90.2	90.2	105.7	96.2	105.7	96.2	105.5	96.0
10030	2748-W-005	2748-W-006	48-in Dia CONC	446	50	135	172	196	211	211	86.9	76.2	89.3	78.5	89.8	78.9	90.2	79.2	96.1	84.7	96.2	84.8	96.0	84.5
10030-RD	2748-W-005	2748-W-006	Roadway	446	50	0	0	0	7	30	96.0	84.5	78.5	78.5	78.9	78.9	79.2	79.2	96.1	84.7	96.2	84.8	96.0	84.5
4522	2748-W-006	2748-W-007	48-in Dia CONC	68	50	148	190	215	264	267	76.2	73.2	78.5	75.3	78.9	75.7	79.2	75.9	84.7	82.3	84.8	82.4	84.5	82.3
4522-RD	2748-W-006	2748-W-007	Roadway	68	50	0	0	0	44	84	84.5	82.3	75.1	75.1	75.4	75.4	75.7	75.7	84.7	82.4	84.8	82.5	84.5	82.3
297	2748-W-007	2748-W-008	48-in Dia CONC	337	50	148	190	215	264	265	73.0	58.5	75.1	60.7	75.4	61.2	75.7	61.3	82.3	68.6	82.4	68.7	82.3	68.5
297-RD	2748-W-007	2748-W-008	Roadway	337	50	0	0	0	4	42	82.3	68.5	60.7	60.7	61.2	61.2	61.3	61.3	82.3	68.6	82.4	68.7	82.3	68.5
5939	2748-W-008	2748-W-009	42-in Dia CONC	368	50	148	189	217	246	246	58.5	34.6	60.7	36.3	61.2	36.6	61.3	37.2	68.6	42.6	68.7	42.7	68.5	42.5
5939-RD	2748-W-008	2748-W-009	Roadway	368	50	0	0	0	22	62	68.5	42.5	36.3	36.3	36.6	36.6	37.2	37.2	68.6	42.6	68.7	42.7	68.5	42.5
10032	2748-W-009	2648-W-601	42-in Dia CONC	314	50	148	189	216	246	246	34.6	4.8	36.3	8.5	36.6	9.0	37.2	9.4	42.6	10.3	42.7	11.0	42.5	14.0
10032-RD	2748-W-009	2648-W-601	Roadway	314	50	0	0	0	23	65	42.5	14.0	8.5	8.5	9.0	9.0	9.4	9.4	42.6	14.1	42.7	14.2	43.5	15.0
5544	2748-W-010	2748-W-011	30-in Dia HDPE	280	10	9	12	14	25	29	70.0	58.8	70.6	59.4	70.6	59.4	70.7	59.5	70.9	59.7	71.0	59.8	77.9	67.0
10041	2748-W-011	2648-W-001	30-in Dia HDPE	325	10	9	12	14	25	29	58.7	40.6	59.2	41.4	59.2	41.5	59.3	41.6	59.5	42.2	59.6	42.4	67.0	47.7
5944	2648-W-001	2648-W-602	30-in Dia HDPE	25	10	9	12	14	24	29	40.5	40.2	41.4	40.9	41.5	41.1	41.6	41.2	42.2	41.7	42.4	41.9	47.7	47.0
L186	2648-W-602	2748-W-601	Natural	505	10	9	12	13	24	29	40.2	33.6	40.9	34.2	41.1	34.3	41.2	34.4	41.7	34.7	41.9	34.8	47.0	41.0
5946	2748-W-601	2748-W-012	36-in Dia HDPE	55	10	9	11	13	24	29	33.6	32.7	34.2	33.3	34.3	33.4	34.4	33.5	34.7	33.8	34.8	33.9	41.0	39.8
4515	2748-W-012	2748-W-013	36-in Dia HDPE	266	10	9	11	13	24	29	32.6	28.8	33.2	29.5	33.3	29.6	33.4	29.6	33.7	29.9	33.8	30.0	39.8	45.9
296	2748-W-013	2648-W-002	36-in Dia HDPE	294	50	10	14	16	30	36	28.7	14.4	29.2	15.0	29.3	15.0	29.4	15.1	29.6	15.3	29.8	15.4	45.9	24.9
5940	2648-W-002	2648-W-603	48-in Dia CONC	45	50	10	14	16	30	36	8.3	7.5	9.2	8.2	9.4	8.3	9.5	8.3	10.1	8.6	10.3	8.7	24.9	17.5
2671	2949-W-009	2949-W-010	24-in Dia CONC	512	10	9	9	11	14	16	222.7	220.1	223.9	221.2	223.9	221.2	224.0	221.3	224.3	221.5	224.9	221.6	230.0	229.0
2668	2949-W-010	2949-W-011	24-in Dia CONC	154	10	9	9	11	14	16	220.1	202.5	220.6	203.3	220.6	203.3	220.6	203.3	220.7	203.9	220.7	205.5	229.0	215.0
5684	2949-W-011	2949-W-012	24-in Dia CONC	198	10	9	9	11	14	17	202.5	198.6	203.3	199.7	203.3	199.8	203.3	200.7	203.9	203.1	205.5	204.3	215.0	206.3
2662	2949-W-012	2549-W-013	30-in Dia CONC	412	10	9	10	11	14	17	198.1	194.8	199.7	199.4	199.8	199.6	200.7	200.4	203.1	202.6	204.3	203.5	206.3	203.5

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
2662-RD	2949-W-012	2549-W-013	Roadway	412	10	0	0	0	0	0	206.3	203.5	199.4	199.4	199.6	199.6	200.4	200.4	202.6	202.6	203.5	203.5	206.3	203.5
924	2549-W-013	2949-W-014	30-in Dia CONC	280	10	20	20	20	25	29	194.8	192.5	199.4	199.0	199.6	199.1	200.4	199.7	202.6	201.4	203.5	201.8	203.5	201.8
924-RD	2549-W-013	2949-W-014	Roadway	280	10	0	0	0	0	0	203.5	201.8	199.0	199.0	199.1	199.1	199.7	199.7	201.4	201.4	203.5	201.8	203.5	201.8
2639	2949-W-014	2549-W-024	24-in Dia CONC	196	50	17	18	19	25	27	192.5	189.0	199.0	198.0	199.1	198.0	199.7	198.0	201.4	198.2	201.8	198.4	201.8	197.5
2639-RD	2949-W-014	2549-W-024	Roadway	196	50	0	0	0	0	3	201.8	197.5	198.0	198.0	198.0	198.0	198.0	198.0	198.2	198.2	201.8	198.4	201.8	197.5
2634	2549-W-024	2849-W-025	27-in Dia RC	521	50	25	25	25	25	25	189.0	187.5	198.0	197.7	198.0	197.7	198.0	198.0	198.2	198.2	198.4	198.3	197.5	197.5
2634-RD	2549-W-024	2849-W-025	Roadway	521	50	15	16	22	32	41	197.5	197.5	198.0	197.7	198.0	197.7	198.0	198.0	198.2	198.2	198.4	198.3	197.5	197.5
10061	2849-W-025	2849-W-002	27-in Dia RC	68	50	25	26	26	26	27	187.5	187.3	197.7	197.6	197.7	197.7	198.0	197.9	198.2	198.2	198.3	198.3	197.5	197.5
10061-RD	2849-W-025	2849-W-002	Roadway	68	50	8	10	16	25	35	197.5	197.5	197.7	197.6	197.7	197.7	198.0	197.9	198.2	198.2	198.3	198.3	197.5	197.5
2647	2949-W-003	2949-W-008	24-in Dia CONC	200	50	10	10	12	16	18	196.4	195.9	198.4	198.0	198.6	198.2	199.1	198.4	200.3	199.2	201.7	200.1	206.5	205.5
2647-RD	2949-W-003	2949-W-008	Roadway	200	10	0	0	0	0	0	206.5	205.5	198.0	198.0	198.2	198.2	198.4	198.4	199.2	199.2	200.1	200.1	206.5	205.5
2637	2949-W-008	2849-W-001	24-in Dia CONC	199	50	9	10	12	16	18	195.7	194.9	198.0	197.6	198.2	197.7	198.4	198.0	199.2	198.3	200.1	198.6	205.5	205.0
2637-RD	2949-W-008	2849-W-001	Roadway	199	50	0	0	0	0	0	206.5	205.9	197.6	197.6	197.7	197.7	198.0	198.0	198.3	198.3	198.6	198.6	205.5	205.0
6249	2849-W-001	2849-W-002	24-in Dia CONC	36	50	13	14	16	16	18	194.7	189.5	197.6	197.6	197.7	197.7	198.0	197.9	198.3	198.2	198.6	198.3	205.0	197.5
6249-RD	2849-W-001	2849-W-002	Roadway	36	50	0	0	0	0	0	205.0	197.5	197.6	197.6	197.7	197.7	197.9	197.9	198.2	198.2	198.3	198.3	206.0	198.5
4594	2849-W-002	2849-W-026	27-in Dia RC	454	50	29	29	30	31	31	187.3	185.9	197.6	195.8	197.7	196.1	197.9	197.3	198.2	198.0	198.3	198.3	197.5	197.5
4594-RD	2849-W-002	2849-W-026	Roadway	454	50	0	1	14	31	44	197.5	197.5	197.6	197.5	197.7	197.5	197.9	197.7	198.2	198.0	198.3	198.3	197.5	197.5
2636	2849-W-026	2849-W-027	33-in Dia RC	379	50	28	29	30	35	36	185.4	184.3	195.8	195.3	196.1	195.7	197.3	196.6	198.0	197.9	198.3	198.3	197.5	197.5
2636-RD	2849-W-026	2849-W-027	Roadway	379	50	0	0	0	23	36	197.5	197.5	195.3	195.3	195.7	195.7	196.6	196.6	198.0	197.9	198.3	198.3	197.5	197.5
10062	2849-W-027	2849-W-028	42-in Dia RC	141	50	45	45	44	46	46	184.3	183.9	195.3	194.9	195.7	195.3	196.6	196.2	197.9	197.7	198.3	198.3	197.5	197.5
10062-RD	2849-W-027	2849-W-028	Roadway	141	50	0	0	0	20	45	197.5	197.5	194.9	194.9	195.3	195.3	196.2	196.2	197.9	197.7	198.3	198.3	197.5	197.5
723	2849-W-028	2849-W-022	42-in Dia RC	233	50	42	42	43	46	47	183.6	182.9	194.9	194.5	195.3	194.9	196.2	195.8	197.7	197.3	198.3	198.2	197.5	197.5
723-RD	2849-W-028	2849-W-022	Roadway	233	50	0	0	0	6	35	197.5	197.5	194.5	194.5	194.9	194.9	195.8	195.8	197.7	197.6	198.3	198.2	197.5	197.5
5638	2849-W-022	2849-W-021	42-in Dia RC	321	50	40	40	43	46	47	182.9	181.9	194.5	193.9	194.9	194.3	195.8	195.2	197.3	196.6	198.2	197.5	197.5	204.0
5638-RD	2849-W-021	2849-W-022	Roadway	321	50	0	0	0	0	0	204.0	197.5	194.5	194.5	194.9	194.9	195.8	195.8	197.3	197.3	198.2	198.2	204.4	204.0
2635	2849-W-021	2849-W-020	27-in Dia RC	472	10	47	48	49	50	51	181.8	173.9	193.9	180.4	194.3	180.6	195.2	181.0	196.6	182.1	197.5	182.4	204.0	196.0
2622	2849-W-020	2849-W-019	27-in Dia RC	475	10	48	48	49	50	51	173.9	165.9	180.4	167.8	180.6	167.8	181.0	167.9	182.1	168.3	182.4	168.4	196.0	182.8
4589	2849-W-019	2849-W-018	27-in Dia RC	309	10	47	48	49	50	51	165.9	157.6	167.8	159.4	167.8	159.4	167.9	159.5	168.3	159.6	168.4	159.7	182.8	180.5
2602	2848-W027a	2849-W-009	30-in Dia RC	360	10	2	2	2	3	4	165.0	163.9	165.5	164.4	165.5	164.4	165.5	164.4	165.6	164.6	165.7	164.6	170.5	171.5
6149	2849-W-009	2849-W-015	30-in Dia RC	132	10	2	2	2	3	4	163.9	163.5	164.4	164.0	164.4	164.0	164.4	164.1	164.6	164.2	164.6	164.2	171.5	171.0
6148	2849-W-015	2849-W-014	30-in Dia RC	227	10	2	2	2	3	4	163.5	162.8	164.0	163.2	164.0	163.2	164.1	163.3	164.2	163.5	164.2	163.9	171.0	170.3
2607	2849-W-014	2849-W-013	36-in Dia RC	400	10	3	3	3	5	7	162.3	161.1	163.0	163.0	163.1	163.0	163.2	163.2	163.5	163.5	163.9	163.8	170.3	172.0
4579	2849-W-013	2849-W-012	36-in Dia RC	400	10	22	23	27	32	38	161.1	159.9	163.0	161.4	163.0	161.4	163.2	161.6	163.5	161.7	163.8	162.0	172.0	170.3
2608	2849-W-012	2849-W-011	42-in Dia RC	340	10	22	23	26	32	37	159.5	158.4	161.1	160.2	161.2	160.2	161.3	160.4	161.6	160.8	162.0	161.3	170.3	171.5
4581	2849-W-011	2849-W-010	42-in Dia RC	345	10	23	23	27	32	38	158.4	157.6	160.2	159.6	160.2	159.7	160.4	159.9	160.8	160.3	161.3	160.8	171.5	170.5
10068	2849-W-010	2849-W-018	42-in Dia RC	269	10	36	37	43	53	62	157.6	156.6	159.6	158.6	159.7	158.6	159.9	158.8	160.3	159.2	160.8	159.7	170.5	180.5
2610	2849-W-018	2849-W-017	48-in Dia RC	465	50	88	89	96	110	119	155.8	151.2	158.6	153.7	158.6	153.7	158.8	153.8	159.2	154.1	159.7	154.4	180.5	169.0
10067	2849-W-017	2849-W-016	48-in Dia RC	620	50	89	90	96	110	119	151.2	145.8	153.7	148.3	153.7	148.4	153.8	148.5	154.1	148.8	154.4	149.0	169.0	165.5
10063	2849-W-016	2849-W-008	48-in Dia RC	312	50	88	90	96	110	119	145.7	142.3	148.3	144.6	148.4	144.6	148.5	144.7	148.8	145.0	149.0	145.1	165.5	164.5
2566	2848-W-001	2849-W-003	24-in Dia RC	482	10	0	0	1	4	11	165.0	159.7	165.0	159.7	165.2	159.9	165.3	160.0	165.6	160.4	166.0	160.9	176.5	166.5
2545	2849-W-003	2849-W-004	24-in Dia CONC	398	10	0	0	1	4	11	159.6	157.7	159.6	157.7	159.9	157.8	159.9	157.9	160.4	158.4	160.9	158.8	166.5	164.5
2549	2849-W-004	2849-W-005	30-in Dia RC	400	10	0	0	1	4	10	157.2	155.1	157.2	155.3	157.3	155.4	157.4	155.4	157.8	156.5	158.2	156.8	164.5	166.0
4542	2849-W-005	2849-W-006	30-in Dia RC	400	10	0	0	1	14	20	155.1	153.2	155.3	153.3	155.4	153.3	155.4	153.4	156.5	154.4	156.8	154.7	166.0	164.5
4542-RD	2849-W-005	2849-W-006	Roadway	400	10	0	0	0	0	0	166.0	164.5	153.0	153.0	153.1	153.1	153.2	153.2	154.2	154.2	154.5	154.5	166.0	164.5
2554	2849-W-006	2849-W-007	33-in Dia RC	355	10	0	0	1	14	20	152.9	151.1	153.0	151.2	153.1	151.3	153.2	151.4	154.2	152.3	154.5	152.6	164.5	165.8
4555	2849-W-007	2849-W-008	33-in Dia RC	500	10	0	0	1	14	20	151.0	143.9	151.1	144.0	151.2	144.1	151.2	144.1	151.9	144.8	152.1	145.0	165.8	164.5
2569	2849-W-008	2749-W-001	48-in Dia RC	406	50	94	97	103	132	146	142.2	119.9	143.7	122.1	143.7	122.2	143.8	122.3	144.0	122.7	144.1	122.9	164.5	129.0
5530	2749-W-001	2749-W-002	48-in Dia CONC	348	50	97	101	108	136	151	119.9	111.5	122.1	113.4	122.2	113.4	122.3	113.5	122.7	113.8	122.9	114.0	129.0	121.0
4536	2749-W-002	2749-W-003	54-in Dia CONC	354	50	97	101	108	136	151	111.0	106.0	113.2	108.0	113.2	108.0	113.3	108.1	113.7	108.5	113.9	108.8	121.0	121.8
4535	2749-W-003	2749-W-004	48-in Dia CONC	585	50	97	101	108	136	152	106.0	89.9	108.0	91.8	108.0	91.8	108.1	91.9	108.5	92.2	108.8	92.3	121.8	101.0

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
10044	2749-W-004	2749-W-005	48-in Dia CONC	586	50	97	101	108	136	151	89.9	72.9	91.8	74.7	91.8	74.7	91.9	74.8	92.2	75.1	92.3	75.4	101.0	85.8
207	2749-W-005	2749-W-006	54-in Dia CONC	386	50	97	101	108	136	151	72.4	67.6	74.6	70.1	74.6	70.3	74.7	70.5	75.1	71.3	75.4	71.8	85.8	76.0
5527	2749-W-006	2749-W-007	54-in Dia CONC	267	50	112	121	133	177	201	67.6	64.4	70.1	67.1	70.3	67.2	70.5	67.4	71.3	67.7	71.8	68.3	76.0	72.5
L191	2749-W-007	2750-W-016	Natural	1300	50	111	120	132	182	197	64.4	7.8	67.1	12.7	67.2	13.2	67.4	13.7	67.7	16.1	68.3	17.8	72.5	18.8
5953	2750-W-016	2650-W-601	78-in Dia RC	234	50	172	200	224	334	378	7.8	6.6	12.7	9.8	13.2	10.1	13.7	10.4	16.1	11.5	17.8	12.9	18.8	15.3
2632	2850-W-002	2850-W-003	21-in Dia CONC	210	10	6	8	10	10	12	187.1	185.4	188.1	186.0	188.3	186.1	188.4	186.2	188.5	186.2	188.7	186.3	197.5	196.0
787	2850-W-003	2850-W-004	21-in Dia CONC	500	10	6	8	10	10	12	185.4	171.4	186.0	172.0	186.1	172.1	186.2	172.2	186.2	172.2	186.3	172.3	196.0	178.5
4588	2850-W-004	2850-W-005	21-in Dia CONC	490	10	6	8	9	10	12	171.4	157.7	172.0	158.3	172.1	158.4	172.2	158.5	172.2	158.5	172.3	158.6	178.5	165.8
2616	2850-W-005	2850-W-018	21-in Dia CONC	60	10	6	12	12	10	12	157.5	149.1	157.9	151.5	157.9	155.6	157.9	155.6	157.9	155.8	157.9	155.8	165.8	155.7
2616-RD	2850-W-005	2850-W-018	Roadway	60	10	0	0	0	0	0	165.8	155.7	151.5	151.5	155.6	155.6	155.6	155.6	155.8	155.8	155.8	155.8	166.8	156.7
2614	2850-W-018	2850-W-020	24-in Dia HDPE	22	10	6	11	11	13	13	149.1	149.0	151.5	151.4	155.6	155.5	155.6	155.6	155.8	155.6	155.8	155.6	155.7	155.5
2614-RD	2850-W-018	2850-W-020	Roadway	22	10	0	0	0	2	2	155.7	155.5	151.4	151.4	155.5	155.5	155.6	155.6	155.8	155.6	155.8	155.6	155.7	155.5
775	2850-W-020	2850-F-026	21-in Dia RC	493	10	12	16	16	16	16	149.0	146.5	151.4	148.0	155.5	150.0	155.6	152.8	155.6	153.3	155.6	153.6	155.5	153.1
775-RD	2850-W-020	2850-F-026	Roadway	33	10	0	0	8	27	34	155.5	153.1	148.0	148.0	155.5	153.1	155.6	153.1	155.6	153.3	155.6	153.6	155.5	153.1
4570	2850-F-026	2850-W-021	21-in Dia RC	228	10	12	16	19	20	20	146.5	144.9	148.0	146.5	150.0	147.4	152.8	149.1	153.3	153.1	153.6	153.6	153.1	153.0
4570-RD	2850-F-026	2850-W-021	Roadway	228	10	0	0	0	27	39	153.1	151.5	146.5	146.5	147.4	147.4	149.1	149.1	153.3	153.1	153.6	153.6	153.1	153.0
1343	2850-W-021	2850-W-022	24-in Dia HDPE	107	10	12	16	19	26	26	144.9	144.4	146.5	145.8	147.4	146.8	149.1	148.0	153.1	151.4	153.6	153.5	153.0	153.0
1343-RD	2850-W-021	2850-W-022	Roadway	107	10	0	0	0	2	29	153.0	153.0	145.8	145.8	146.8	146.8	148.0	148.0	153.1	153.0	153.6	153.5	153.0	153.0
4566	2850-W-022	2850-W-023	24-in Dia HDPE	269	10	12	16	19	26	30	144.3	143.1	145.8	144.9	146.8	145.4	148.0	145.9	151.4	147.3	153.5	148.1	153.0	152.3
2575	2850-W-023	2850-W-025	27-in Dia RC	291	10	12	16	19	26	30	142.8	142.6	144.9	143.8	145.4	144.0	145.9	144.1	147.3	144.4	148.1	144.5	152.3	153.8
10053	2850-W-025	2750-W-006	33-in Dia RC	390	10	21	27	34	46	51	142.1	129.0	143.1	129.9	143.2	130.0	143.4	130.2	143.6	130.4	143.7	130.5	153.8	134.9
2544	2750-W-006	2750-W-007	30-in Dia RC	22	10	21	27	34	46	51	122.0	121.7	123.4	123.0	123.6	123.3	124.0	123.6	125.3	124.8	128.7	128.0	134.9	128.2
5523	2750-W-007	2850-W-024	36-in Dia RC	396	10	21	27	34	46	52	121.6	118.5	122.9	119.7	123.1	120.0	123.3	120.4	124.8	122.4	128.0	124.9	128.2	129.7
5523-RD	2850-W-024	2750-W-007	Roadway	396	10	0	0	0	0	0	129.7	128.2	122.9	122.9	123.1	123.1	123.3	123.3	124.8	124.8	128.0	128.0	129.7	128.2
4548	2850-W-024	2750-W-008	30-in Dia RC	206	10	29	38	47	59	68	118.2	114.4	119.7	115.7	120.0	115.9	120.4	116.2	122.4	116.7	124.9	116.9	129.7	121.0
10045	2750-W-008	2750-W-009	30-in Dia RC	329	10	29	38	47	59	68	114.0	97.6	115.0	98.6	115.2	98.8	115.4	98.9	115.6	99.1	115.7	99.3	121.0	104.2
2521	2750-W-009	2750-W-010	30-in Dia RC	321	10	29	38	47	59	68	97.5	72.7	98.4	73.7	98.5	73.9	98.7	74.1	98.8	74.3	99.0	74.5	104.2	81.0
4531	2750-W-010	2750-W-011	42-in Dia RC	479	10	29	38	46	60	67	72.4	66.4	73.7	67.7	73.9	67.9	74.1	68.0	74.3	69.2	74.5	70.7	81.0	73.7
2517	2750-W-011	2750-W-022	42-in Dia RC	267	10	29	38	46	58	66	66.3	63.5	67.6	65.0	67.8	65.7	68.0	66.2	69.2	68.3	70.7	69.3	73.7	74.0
2517-RD	2750-W-022	2750-W-011	Roadway	267	10	0	0	0	0	0	74.0	73.7	67.6	67.6	67.8	67.8	68.0	68.0	69.2	69.2	70.7	70.7	74.0	73.7
10058	2750-W-022	2750-W-021	42-in Dia RC	55	10	29	38	46	58	66	63.5	62.4	65.0	65.2	65.7	65.7	66.2	66.2	68.3	68.1	69.3	69.0	74.0	74.0
10059	2750-W-021	2750-W-012	42-in Dia RC	50	50	63	81	94	138	161	62.4	62.0	65.2	63.4	65.7	63.7	66.2	63.8	68.1	64.4	69.0	64.7	74.0	73.7
2617	2850-W-006	2850-W-007	36-in Dia HDPE	254	10	4	6	7	15	17	153.7	148.0	154.1	148.4	154.2	148.5	154.2	148.5	154.5	148.8	154.5	148.9	171.7	159.8
4584	2850-W-007	2850-W-008	36-in Dia HDPE	232	10	4	6	7	15	17	147.8	138.1	148.2	138.4	148.2	138.5	148.3	138.5	148.5	138.7	148.5	138.8	159.8	150.6
2595	2850-W-008	2850-W-009	36-in Dia HDPE	269	10	4	6	7	15	17	137.9	121.9	138.2	122.5	138.2	122.6	138.3	122.7	138.5	123.0	138.5	123.1	150.6	132.9
4571	2850-W-009	2850-W-010	36-in Dia HDPE	67	10	12	16	18	32	38	121.8	120.2	122.5	120.9	122.6	121.0	122.7	121.0	123.0	121.3	123.1	121.4	132.9	133.0
2585	2850-W-010	2850-W-011	36-in Dia HDPE	20	10	12	16	18	32	38	120.0	119.2	120.7	119.9	120.9	120.0	120.9	120.0	121.2	120.3	121.4	120.4	133.0	127.6
4567	2850-W-011	2850-W-012	36-in Dia HDPE	107	10	12	16	18	32	38	118.9	112.8	119.5	113.4	119.6	113.5	119.6	113.5	119.9	113.7	119.9	113.8	127.6	118.6
2583	2850-W-012	2850-W-013	36-in Dia HDPE	18	10	12	16	18	32	38	112.6	110.2	113.2	110.7	113.3	110.8	113.4	110.8	113.7	111.0	113.8	111.1	118.6	117.7
4562	2850-W-013	2850-W-014	36-in Dia HDPE	484	10	12	15	18	32	38	108.7	100.7	109.5	101.5	109.6	101.6	109.6	101.7	110.0	102.0	110.1	102.1	117.7	113.5
2551	2850-W-014	2750-W-001	36-in Dia HDPE	143	10	12	15	18	32	38	100.4	94.6	101.1	95.2	101.1	95.3	101.2	95.4	101.5	95.6	101.6	95.7	113.5	108.9
4546	2750-W-001	2750-W-002	36-in Dia HDPE	364	10	12	16	18	32	38	94.4	72.5	95.0	73.1	95.1	73.2	95.1	73.2	95.3	73.6	95.4	73.8	108.9	81.9
2522	2750-W-002	2750-W-003	48-in Dia HDPE	400	10	12	15	18	31	37	72.1	69.5	73.0	70.3	73.2	70.4	73.2	70.5	73.6	70.9	73.8	71.0	81.9	80.5
4532	2750-W-003	2750-W-004	48-in Dia HDPE	492	10	12	15	18	31	37	69.3	66.9	70.2	68.0	70.3	68.2	70.4	68.3	70.8	69.2	70.9	70.3	80.5	80.9
1342	2750-W-004	2750-W-005	48-in Dia RC	47	10	12	15	17	30	36	66.8	66.7	68.0	67.8	68.2	68.0	68.3	68.1	69.2	69.0	70.3	70.2	80.9	81.7
2516	2750-W-005	2750-W-023	48-in Dia RC	49	10	12	15	17	30	36	66.7	66.5	67.8	67.4	68.0	67.5	68.1	67.6	69.0	68.9	70.2	70.1	81.7	82.8
10060	2750-W-023	2750-W-017	54-in Dia RC	262	10	12	16	19	45	52	66.0	65.2	67.1	66.3	67.3	66.5	67.4	66.6	68.9	68.7	70.1	69.9	82.8	79.4
10056	2750-W-017	2750-W-018	54-in Dia RC	307	10	12	16	18	44	53	65.2	64.4	66.3	65.5	66.5	65.9	66.6	66.4	68.7	68.5	69.9	69.7	79.4	76.7
10055	2750-W-018	2750-W-019	54-in Dia RC	262	10	13	17	19	45	54	64.4	63.7	65.5	65.2	65.9	65.8	66.4	66.3	68.5	68.4	69.7	69.4	76.7	74.9
10054	2750-W-019	2750-W-020	54-in Dia RC	113	10	13	17	21	45	54	63.7	63.3	65.2	65.2	65.8	65.8	66.3	66.3	68.4	68.3	69.4	69.3	74.9	74.7

Structure ID	Node ID		Structure Size/Type	Structure Length (ft)	Design Storm	Peak Flow (cfs) Future Land Use Conditions					Invert Elevation (ft)		Water Surface Elevation under Future Land Use Conditions (ft)										Ground Elevation (ft)	
													2-Year		10-Year		25-Year		50-Year		100-Year			
	US	DS				2-Year	10-Year	25-Year	50-Year	100-Year	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS	US	DS
6005	2750-W-020	2750-W-021	54-in Dia RC	349	10	13	18	22	45	54	63.3	62.4	65.2	65.2	65.8	65.7	66.3	66.2	68.3	68.1	69.3	69.0	74.7	74.0
4528	2750-W-012	2750-W-013	42-in Dia RC	449	50	63	81	94	138	161	62.0	46.8	63.4	48.3	63.7	48.5	63.8	48.7	64.4	49.2	64.7	49.5	73.7	55.7
2504	2750-W-013	2750-W-014	42-in Dia RC	349	50	63	81	94	138	162	46.8	25.8	48.1	27.1	48.2	27.4	48.4	27.5	48.8	27.8	49.0	28.1	55.7	34.4
10047	2750-W-014	2750-W-015	48-in Dia RC	336	50	63	81	94	138	161	25.7	13.6	27.1	15.0	27.4	15.2	27.5	15.3	27.8	17.6	28.1	19.9	34.4	23.6
2499	2750-W-015	2750-W-016	60-in Dia RC	385	50	63	81	94	138	161	12.8	8.3	14.5	12.7	14.7	13.2	14.9	13.7	17.6	16.1	19.9	17.8	23.6	18.8
2499-RD	2750-W-015	2750-W-016	Roadway	385	50	0	0	0	0	0	23.6	18.8	12.7	12.7	13.2	13.2	13.7	13.7	16.1	16.1	17.8	17.8	23.6	18.8

CITY OF GRESHAM

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Matt Korot
Manager

Mapping Program
Ron Wray
Manager

March 15, 2002

West Gresham Stormwater Master Plan

The City of Gresham is in the process of developing a Stormwater Master Plan for the West Gresham area and we need your help. We are soliciting any comments that you or your neighbors may have regarding drainage problems, such as flooding, erosion, or stormwater quality that you may have observed in your area. These comments are important for a complete and comprehensive study so we may plan accordingly.

This study was initiated in an effort to identify existing stormwater problems, and to develop a management plan to address these problems. It will also help us plan for economic growth in the area, while meeting some very stringent environmental regulations. The study area covers approximately 6 square miles in the West Gresham area. The general boundary is: 202nd on the east, Columbia Slough on the north, Powell Blvd. on the south, and 162nd on the west.

Please fill out the attached green colored questionnaire and return to: City of Gresham, Attn.: Stormwater, 1333 NW Eastman Parkway, Gresham, OR 97030, either by fax (503-661-5927), or by U.S. Mail. If you have any questions, or would prefer to provide information over the phone, please contact Bob Brown at 503-618-2389. We would like you to complete the survey even if you have not observed or experienced any problems. We would like to hear back from you by **Wednesday, March 27**, as your feedback is important. If you would like a copy of the survey results please indicate so on the questionnaire.

Thanks in advance for your support in completing this Master Plan.

Sincerely,

Carrie Pak, P.E.
Stormwater Division Manager

CP:ras

enclosure

Printed on recycled paper

CITY OF GRESHAM
WEST GRESHAM STORMWATER MASTER PLAN

PROBLEM INVENTORY/VERIFICATION Problem I/D No.: _____

Problem Location:

Nearest address, cross streets or landmarks: _____

_____

Type of Drainage:

___ Creek
___ Culvert
___ Inlet/Grate
___ Pipe Discharge
___ Curb/Gutter
___ Roadside Ditch
___ Pond
___ Detention Facility
___ Storm Sewer/Manhole
___ Overland Flows:
  ___ Yard, Field
  ___ Parking Lot
  ___ Steep Slope
___ Other_____

Problem Type (May be more than one):

___ Standing Water – Indicate water depth, if known: _____
___ Low Flow – Indicate water depth, if known: _____
___ Flooding – Indicate water depth, if known: _____
___ Debris/Obstruction
___ Land/Mud Slide
___ Inadequate Capacity
___ Water backing up
___ Oil/Grease
___ Pavement Undermined
___ Erosion
___ Sedimentation/Deposits
___ Inadequate Maintenance
___ Other Pollution _____
Other _____

Specific Problem Description: _____

_____

_____

Possible Cause: _____

_____

_____

Possible Solution: _____

_____

I would like a copy of the survey results: ❒ **Yes** ❒ **No**

Person Describing Problem (Optional):

Name: _____

Address: _____

Telephone Number: _____

Proj # **Name:** **WGFC-1 - South 162nd Avenue Pipe Replacements.**

Description:
Replace pipe segment along 162nd Avenue to the south of Halsey Street. Project elements are as follows:

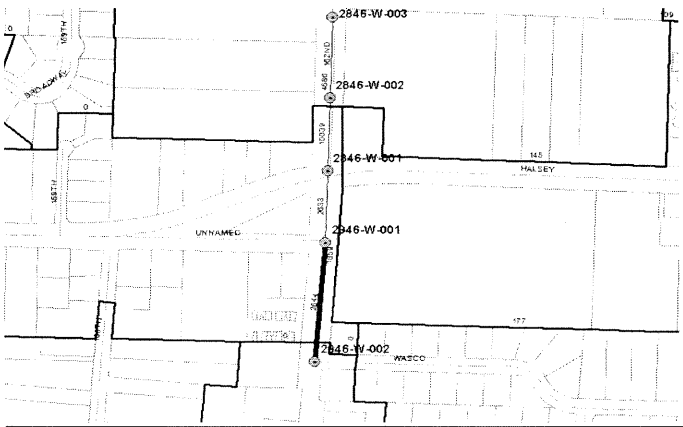
Replace 12" Dia pipe with 15" Dia pipe, 399' Long.

Based on impervious percentages and water surface elevations for existing and future conditions, 0% of the project would be funded by SDCs.

Justification:
This capital project will provide increased capacity to alleviate expected flooding problems on 162nd Ave. just south of Halsey St. at node number 2946-W-002.

Type of Project: Construction of facilities and utilities to correct deficiencies.

Map:



N

FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses							
Design/Constr Admin (30%)	$ 16,700						
Property Acq	$ -						
Construction	$ 55,500						
Other	$ -						
Administration (11%)	$ 7,900	0	0	0	0	0	0
TOTAL Expenses	$ 80,100	0	0	0	0	0	0

Subbasin Properties

Subbasin names: 2946-w-002

Drainage Area Served by Capital Project :	19.5	Acres	U/S Manhole	2946-w-002
% Impervious (Existing) :	52.3		D/S Manhole	2946-w-001
% Impervious (Future) :	62.4			

Project Elelments

Pipe Id	From MH	To MH	Length	Unit	Existing Size	New Size and Cover	Unit Cost*	Total Cost
2644	2946-W-002	2946-W-001	399	Ft	12" - Dia	15" SP (5-10 ft. cover)	$ 139	$ 55,500
						Total Construction Cost		**$ 55,500**

** Unit costs from ENR 5950*

Maintenance Requirements

Not applicable

Costs

Construction	$	55,500
Site Acquisition	$	-
Engineering (30%)	$	16,700
Administration (11%)	$	7,900
Capital Project Implementation Costs	**$**	**80,100**
Annual Maintenance Costs		**N/A**

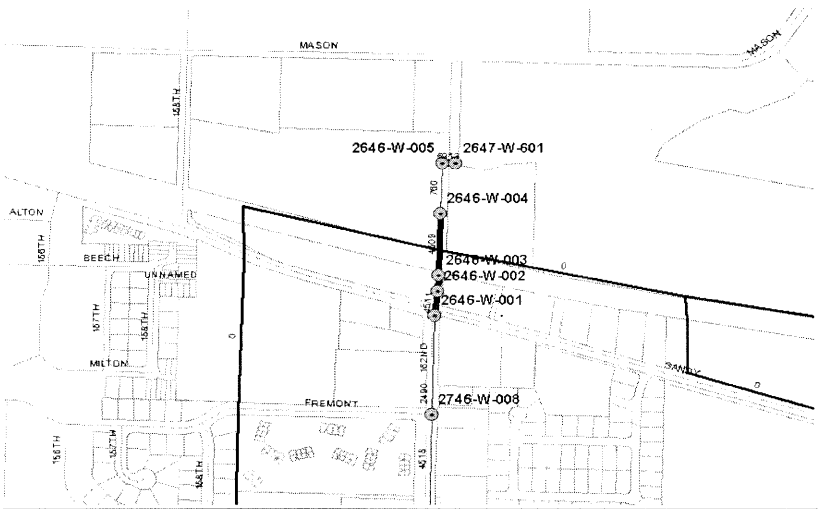
Proj # **Name:** **WGFC-2 - North 162nd Avenue Pipe Replacements** Applicable Criteria

Description:
Replace pipe segments along 162nd Avenue starting just north of Sandy Boulevard. Project elements are as follows:
1) Replace 54" Dia pipe with 72" Dia pipe, 191' Long.
2) Replace 48" Dia pipe with 72" Dia pipe, 291' Long.
Based on impervious percentages and water surface elevations for existing and future conditions, 100% of the project would be funded by SDCs.

Justification:
This capital project will provide increased capacity to alleviate expected flooding problems as a result of future development on 162nd Ave. north of Sandy Blvd.

Type of Project: Construction of facilities and utilities for growth.

Map:



N

FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses							
Design/Constr Admin (30%)	$ 90,200						
Property Acq	$ -						
Construction	$ 300,700						
Other	$ -						
Administration (11%)	$ 43,000	0	0	0	0	0	0
TOTAL Expenses	$ 433,900	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 2946-w-002, 2846-w-001, 2846-w-003, 2846-w-006, 2746-w-002
2747-w-005, 2847-w-007, 2746-w-003, 2746-w-001, 2646-w-001

Drainage Area Served by Capital Project :	528	Acres	U/S Manhole	2646-w-001
% Impervious (Existing) :	52		D/S Manhole	2646-w-004
% Impervious (Future) :	62			

Project Elelments

Pipe Id	From MH	To MH	Length	Unit	Existing Size	New Size and Cover	Unit Cost*	Total Cost
4511	2646-W-001	2646-W-002	114	Ft	54" - Dia	72" SP (2-5 ft. cover)	$ 624	$ 71,100
2486	2646-W-002	2646-W-003	77	Ft	54" - Dia	72" SP (2-5 ft. cover)	$ 624	$ 48,000
4509	2646-W-003	2646-W-004	291	Ft	48" - Dia	72" SP (2-5 ft. cover)	$ 624	$ 181,600
							Total Construction Cost	**$ 300,700**

** Unit costs from ENR 5950*

Maintenance Requirements

Not applicable

Costs

Construction	$	300,700
Site Acquisition	$	-
Engineering (30%)	$	90,200
Administration (11%)	$	43,000
Capital Project Implementation Costs	**$**	**433,900**
Annual Maintenance Costs		**N/A**

Proj # **Name:** **WGFC-3A - South 181st Avenue Pipe Replacements (50 - year Fix)** Justification Criteria

Description:

Replace pipe segments along 181st Avenue starting just south Glisan Street and extending to I-84. Project elements are as follows:

1) Replace 27" Dia pipe with 36" Dia pipe, 631' Long. 2) Replace 30" Dia pipe with 42" Dia pipe, 1325' Long.
3) Replace 36" Dia pipe with 42" Dia pipe, 965' Long.

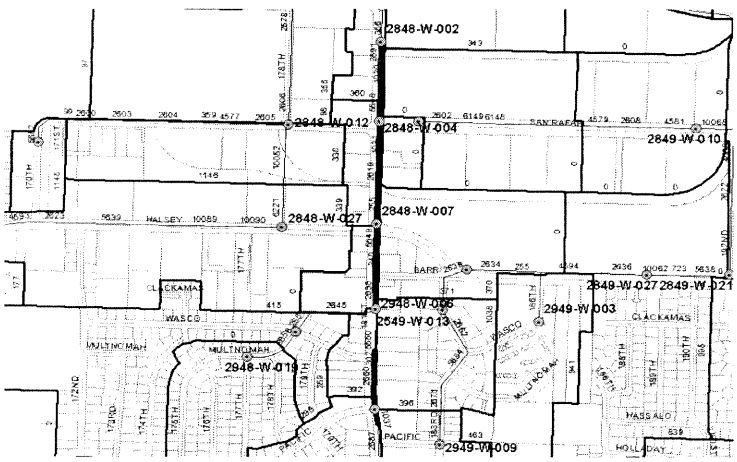
Based on impervious percentages and water surface elevations for existing and future conditions, 36% of the project would be funded by SDCs.

Justification:

This capital project will provide increased capacity to alleviate expected flooding problems on 181st Ave. south of I-84.

Type of Project: Construction of facilities related to growth and to correct deficiencies.

Map:



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses							
Design/Constr Admin (30%)	$ 216,200						
Property Acq	$ -						
Construction	$ 720,800						
Other	$ -						
Administration (11%)	$ 103,100	0	0	0	0	0	0
TOTAL Expenses	$ 1,040,100	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 3048-w-001, 3048-w-002, 2948-w-009, 2948-w-012, 2848-w-001
2948-w-021, 2948-w-019, 2848-w-004, 2848-w-007, 2948-w-006

Drainage Area Served by Capital Project :	205	Acres	U/S Manhole	2948-w-010
% Impervious (Existing) :	46		D/S Manhole	2848-w-002
% Impervious (Future) :	57			

Project Elelments

Pipe Id	From MH	To MH	Length	Unit	Existing Size	New Size and Cover	Unit Cost*	Total Cost
10028	2948-W-010	2948-W-009	122	Ft	27" - Dia	36" SP (5-10 ft. cover)	$ 258	$ 31,500
2688	2948-W-009	2948-W-008	111	Ft	27" - Dia	36" SP (2-5 ft. cover)	$ 202	$ 22,400
2660	2948-W-008	2948-W-007	398	Ft	27" - Dia	36" SP (2-5 ft. cover)	$ 202	$ 80,400
2638	2948-W-006	2948-W-005	280	Ft	30" - Dia	42" SP (2-5 ft. cover)	$ 238	$ 66,600
5549	2948-W-005	2848-W-007	445	Ft	30" - Dia	42" SP (2-5 ft. cover)	$ 238	$ 105,900
2624	2848-W-007	2848-W-006	305	Ft	30" - Dia	42" SP (5-10 ft. cover)	$ 308	$ 93,900
2619	2848-W-006	2848-W-005	295	Ft	30" - Dia	42" SP (2-5 ft. cover)	$ 238	$ 70,200
2620	2848-W-005	2848-W-004	279	Ft	36" - Dia	42" SP (2-5 ft. cover)	$ 238	$ 66,400
5548	2848-W-004	2848-W-003	396	Ft	36" - Dia	42" SP (2-5 ft. cover)	$ 238	$ 94,200
2591	2848-W-003	2848-W-002	290	Ft	36" - Dia	42" SP (5-10 ft. cover)	$ 308	$ 89,300
							Total Construction Cost	**$ 720,800**

** Unit costs from ENR 5950*

Maintenance Requirements

Not applicable

Costs

Construction	$	720,800
Site Acquisition	$	-
Engineering (30%)	$	216,200
Administration (11%)	$	103,100
Capital Project Implementation Costs	**$**	**1,040,100**
Annual Maintenance Costs		**N/A**

Proj # **Name:** **WGFC-3B - South 181st Avenue Pipe Replacements (10-year Fix)**

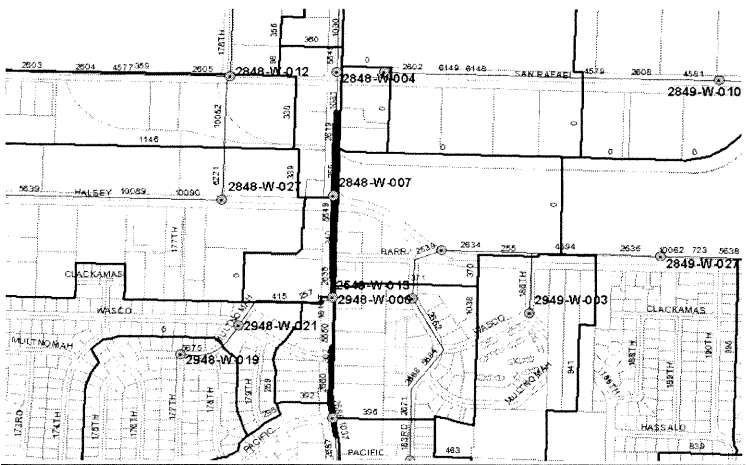
Description:
Replace pipe segments along 181st Avenue starting just south Glisan Street and extending to I-84. Project elements are as follows:

1) Replace 27" Dia pipe with 30" Dia pipe, 631' Long.
2) Replace 30" Dia pipe with 36" Dia pipe, 1325' Long.
Due to the 10-year detention requirement and the fact that this CIP is only addressing 10-year problems, 0% of the project will be funded through SDCs.

Justification:
This capital project will provide increased capacity to alleviate expected flooding problems on 181st Ave. south of I-84.

Type of Project: Construction of facilities and utilities to correct deficiencies

Map:



N

FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses							
Design/Constr Admin (30%)	$ 123,400						
Property Acq	$ -						
Construction	$ 411,400						
Other	$ -						
Administration (11%)	$ 58,800	0	0	0	0	0	0
TOTAL Expenses	$ 593,600	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 3048-w-001, 3048-w-002, 2948-w-009, 2948-w-012, 2948-w-021, 2948-w-019, 2848-w-007, 2948-w-006

Drainage Area Served by Capital Project :	188	Acres	U/S Manhole	2948-w-010
% Impervious (Existing) :	44		D/S Manhole	2848-w-005
% Impervious (Future) :	55			

Project Elelments

Pipe Id	From MH	To MH	Length	Unit	Existing Size	New Size and Cover	Unit Cost*	Total Cost
10028	2948-W-010	2948-W-009	122	Ft	27" - Dia	30" SP (5-10 ft. cover)	$ 241	$ 29,400
2688	2948-W-009	2948-W-008	111	Ft	27" - Dia	30" SP (2-5 ft. cover)	$ 191	$ 21,200
2660	2948-W-008	2948-W-007	398	Ft	27" - Dia	30" SP (2-5 ft. cover)	$ 191	$ 76,000
2638	2948-W-006	2948-W-005	280	Ft	30" - Dia	36" SP (2-5 ft. cover)	$ 202	$ 56,600
5549	2948-W-005	2848-W-007	445	Ft	30" - Dia	36" SP (2-5 ft. cover)	$ 202	$ 89,900
2624	2848-W-007	2848-W-006	305	Ft	30" - Dia	36" SP (5-10 ft. cover)	$ 258	$ 78,700
2619	2848-W-006	2848-W-005	295	Ft	30" - Dia	36" SP (2-5 ft. cover)	$ 202	$ 59,600
							Total Construction Cost	**$ 411,400**

** Unit costs from ENR 5950*

Maintenance Requirements

Not applicable

Costs

Construction	$	411,400
Site Acquisition	$	-
Engineering (30%)	$	123,400
Administration (11%)	$	58,800
Capital Project Implementation Costs	**$**	**593,600**
Annual Maintenance Costs		**N/A**

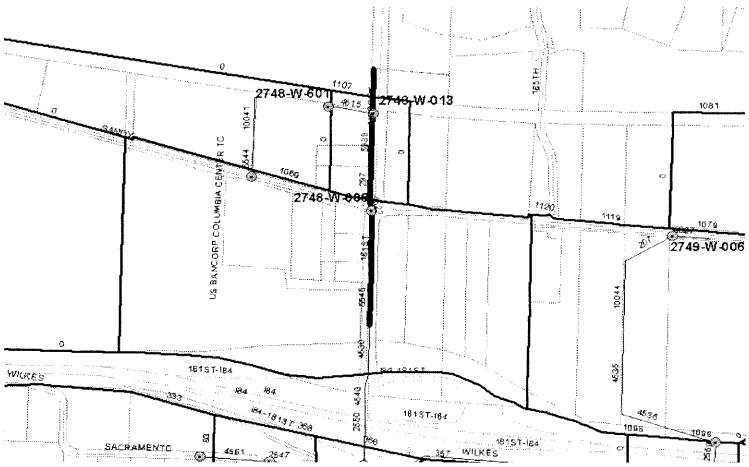
Proj # **Name:** **WGFC-4 - North 181st Avenue Pipe Replacements** Applicable Criteria

Description:
Replace pipe segments along 181st Avenue starting north of I-84 and extending to the outfall of the 181st Avenue pipe system. Project elements are as follows:
1) Replace 48" Dia pipe with 54" Dia pipe, 1276' Long. 2) Replace 42" Dia pipe with 48" Dia pipe, 368' Long.
3) Replace 42" Dia pipe with 60" Dia pipe, 314' Long.
Based on impervious percentages and water surface elevations for existing and future conditions, 100% of the project would be funded by SDCs.

Justification:
This capital project will provide increased capacity to alleviate expected flooding problems on 181st Ave north of I-84.

Type of Project: Construction of facilities related to growth and to correct deficiencies.

Map:



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses							
Design/Constr Admin (30%)	$ 217,100						
Property Acq	$ -						
Construction	$ 723,700						
Other	$ -						
Administration (11%)	$ 103,500	0	0	0	0	0	0
TOTAL Expenses	$ 1,044,300	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 3048-w-001, 3048-w-002, 2948-w-009, 2948-w-012, 2848-w-001
2948-w-021, 2948-w-019, 2848-w-004, 2848-w-006, 2848-w-007, 2948-w-006
2848-w-012, 2847-w-013, 2848-w-018, 2848-w-027, 2848-w-017, 2847-w-001,
2748-w-003, 2848-w-001

Drainage Area Served by Capital Project :	561	Acres	U/S Manhole	2748-w-004
% Impervious (Existing) :	49		D/S Manhole	2648-w-601
% Impervious (Future) :	66			

Project Elelments

Pipe Id	From MH	To MH	Length	Unit	Existing Size	New Size and Cover	Unit Cost*	Total Cost
5545	2748-W-004	2748-W-005	425	Ft	48" - Dia	54" SP (2-5 ft. cover)	$ 375	$ 159,400
10030	2748-W-005	2748-W-006	446	Ft	48" - Dia	54" SP (2-5 ft. cover)	$ 375	$ 167,300
4522	2748-W-006	2748-W-007	68	Ft	48" - Dia	54" SP (2-5 ft. cover)	$ 375	$ 25,500
297	2748-W-007	2748-W-008	337	Ft	48" - Dia	54" SP (2-5 ft. cover)	$ 375	$ 126,400
5939	2748-W-008	2748-W-009	368	Ft	42" - Dia	48" SP (2-5 ft. cover)	$ 282	$ 103,800
10032	2748-W-009	2648-W-601	314	Ft	42" - Dia	60" SP (2-5 ft. cover)	$ 450	$ 141,300
							Total Construction Cost	**$ 723,700**

** Unit costs from ENR 5950*

Maintenance Requirements

Not applicable

Costs

Construction	$	723,700
Site Acquisition	$	-
Engineering (30%)	$	217,100
Administration (11%)	$	103,500
Capital Project Implementation Costs	**$**	**1,044,300**
Annual Maintenance Costs		**N/A**

Proj # **Name:** **WGFC-5 - Barr Road / Halsey Street Pipe Replacements**

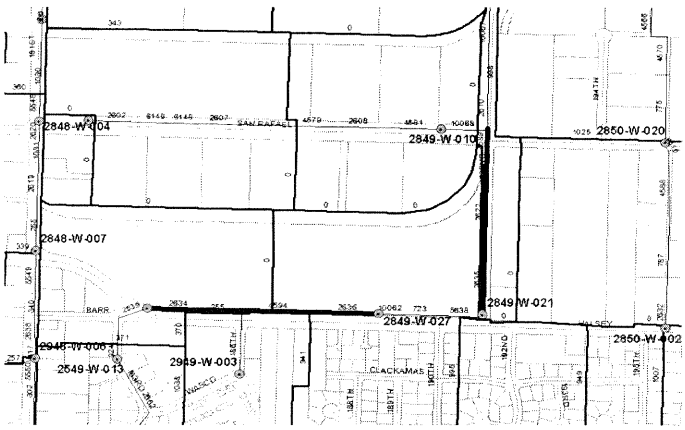
Description:
Replace pipe segments starting at the intersection of Halsey Street and Barr Road and extending to San Rafael St. Project elements are as follows:
1) Replace 27" Dia pipe with 42" Dia pipe, 2299' Long.
2) Replace 33" Dia pipe with 42" Dia pipe, 379' Long.

Based on impervious percentages and water surface elevations for existing and future conditions, 5% of the project would be funded by SDCs.

Justification:
This capital project will provide increased capacity to alleviate expected flooding problems on the 192nd Avenue system.

Type of Project: Construction of facilities related to growth and to correct deficiencies.

Map:



N

FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses							
Design/Constr Admin (30%)	$ 259,400						
Property Acq	$ -						
Construction	$ 864,500						
Other	$ -						
Administration (11%)	$ 123,600	0	0	0	0	0	0
TOTAL Expenses	$ 1,247,500	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 2949-w-009, 2549-w-013, 2549-w-024, 2949-w-003, 2849-w-027, 2849-w-021

Drainage Area Served by Capital Project :	207	Acres	U/S Manhole	2549-w-024
% Impervious (Existing) :	48		D/S Manhole	2849-w-018
% Impervious (Future) :	55			

Project Elelments

Pipe Id	From MH	To MH	Length	Unit	Existing Size	New Size and Cover	Unit Cost*	Total Cost
2634	2549-W-024	2849-W-025	521	Ft	27" - Dia	48" SP (2-5 ft. cover)	$ 282	$ 146,900
10061	2849-W-025	2849-W-002	68	Ft	27" - Dia	48" SP (5-10 ft. cover)	$ 367	$ 25,000
4594	2849-W-002	2849-W-026	454	Ft	27" - Dia	48" SP (5-10 ft. cover)	$ 367	$ 166,600
2636	2849-W-026	2849-W-027	379	Ft	33" - Dia	48" SP (5-10 ft. cover)	$ 367	$ 139,100
2635	2849-W-021	2849-W-020	472	Ft	27" - Dia	42" SP (5-10 ft. cover)	$ 308	$ 145,400
2622	2849-W-020	2849-W-019	475	Ft	27" - Dia	42" SP (5-10 ft. cover)	$ 308	$ 146,300
4589	2849-W-019	2849-W-018	309	Ft	27" - Dia	42" SP (5-10 ft. cover)	$ 308	$ 95,200
							Total Construction Cost	**$ 864,500**

** Unit costs from ENR 5950*

Maintenance Requirements

Not applicable

Costs

Construction	$	864,500
Site Acquisition	$	-
Engineering (30%)	$	259,400
Administration (11%)	$	123,600
Capital Project Implementation Costs	**$**	**1,247,500**
Annual Maintenance Costs		**N/A**

Proj # **Name:** **WGFC-6 - East of 194th Avenue Cul-de-Sac Pipe Replacements**

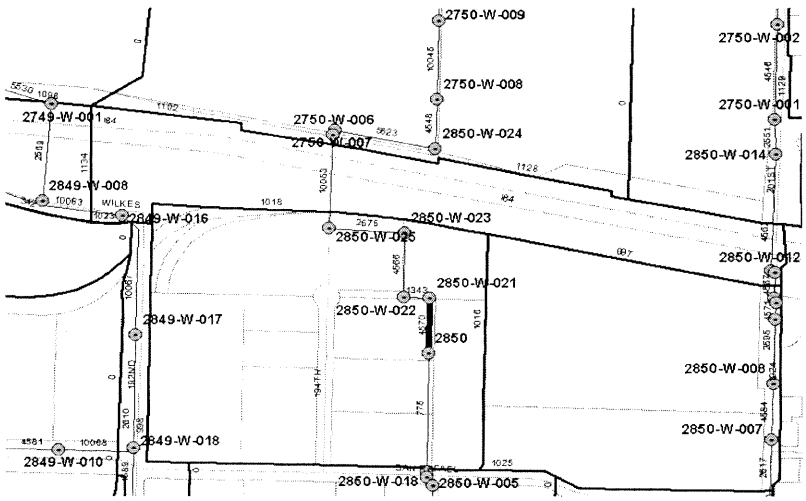
Description:
Replace pipe segments to the east of the 194th Avenue cul-de-sac. Project elements are as follows:
1) Replace 21" Dia pipe with 27" Dia pipe, 228' Long.

Due to the 10-year detention requirement and the fact that this CIP is only addressing 10-year problems, 0% of the project will be funded through SDCs.

Justification:
This capital project will provide increased capacity to alleviate expected flooding problems at the intersection of Halsey St. and Barr St.

Type of Project: Construction of facilities and utilities to correct deficiencies.

Map:



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses							
Design/Constr Admin (30%)	$ 11,400						
Property Acq	$ -						
Construction	$ 38,100						
Other	$ -						
Administration (11%)	$ 5,400	0	0	0	0	0	0
TOTAL Expenses	$ 54,900	0	0	0	0	0	0

Subbasin Properties

Subbasin names 2850-w-002, 2850-w-020

Drainage Area Served by Capital Project :	71	Acres	U/S Manhole	2850-F-026
% Impervious (Existing) :	31		D/S Manhole	2850-w-021
% Impervious (Future) :	59			

Project Elelments

Pipe Id	From MH	To MH	Length	Unit	Existing Size	New Size and Cover	Unit Cost*	Total Cost
4570	2850-F-026	2850-W-021	228	Ft	21" - Dia	27" SP (2-5 ft. cover)	$ 167	$ 38,100
						Total Construction Cost		**$ 38,100**

** Unit costs from ENR 5950*

Maintenance Requirements

Not applicable

Costs

Construction	$	38,100
Site Acquisition	$	-
Engineering (30%)	$	11,400
Administration (11%)	$	5,400
Capital Project Implementation Costs	**$**	**54,900**
Annual Maintenance Costs		**N/A**

Proj # **Name:** **WGWQ-1A - Water Quality Facility at N. 162nd Ave.** Applicable Criteria

Description:

Create a 25.3 - acre-feet water quality facility at the outfall of the 162nd Avenue pipe system north of Sandy Boulevard. Based on impervious percentages for existing and future conditions, 16% of the project would benefit flows associated with future development. This project is located in the Wilkes East neigborhood district.

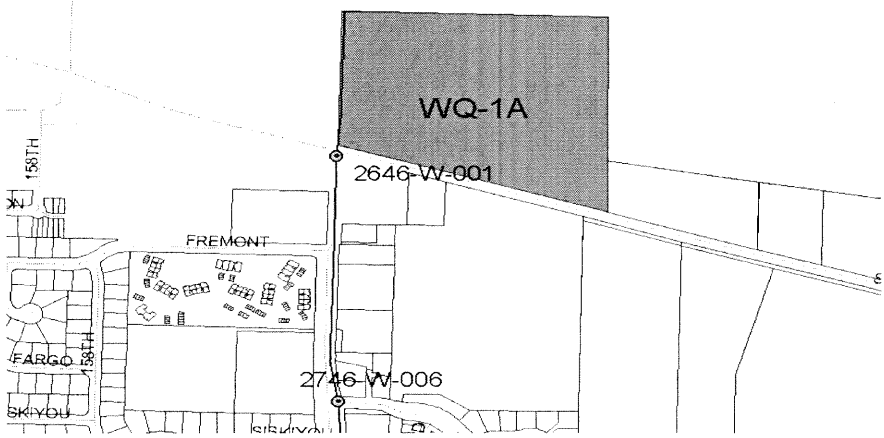
Justification:

This facility would provide water quality treatment for a drainage area of approximately 528 acres. 53% of the drainage area lies in Gresham and 43% lies in Portland.

Type of Project: Construction of facilities related to growth and to correct deficiencies.

Map:

N



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating		0					
Grant		0					
SDC		0					
Bond		0					
Developer		0					
IGA		0					
Other, identify:_____		0					
TOTAL Funding Resources		0	0	0	0	0	0	0

Expenses								
Design/Constr Admin (30%)	$	393,900						
Property Acq	$	1,836,780						
Construction	$	1,313,100						
Other	$	-						
Administration (11%)	$	389,800	0	0	0	0	0	0
TOTAL Expenses	$	3,933,580	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 2946-w-002, 2846-w-001, 2846-w-003, 2846-w-006, 2746-w-002
2747-w-005, 2847-w-007, 2746-w-003, 2746-w-006, 2646-w-001

Drainage Area Served by Capital Project :	528	Acres	U/S Manhole	2946-w-002
% Impervious (Existing) :	51		D/S Manhole	2647-w-601
% Impervious (Future) :	61			

Project Elelments

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	25.3	$ 51,900	$ 1,313,100
Acquisition*	Ft2	183,678	$ 10	$ 1,836,780

* Acquisition costs assume a 6-foot deep facility.

Maintenance Requirements

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	25.3	$1,128	$ 28,500
			Annual Maintenance Cost	**$ 28,500**

Costs

Construction	$ 1,313,100
Site Acquisition	$ 1,836,780
Engineering (30%)	$ 393,900
Administration (11%)	$ 389,800
Capital Project Implementation Costs	**$ 3,933,580**
Annual Maintenance Costs	**$ 28,500**

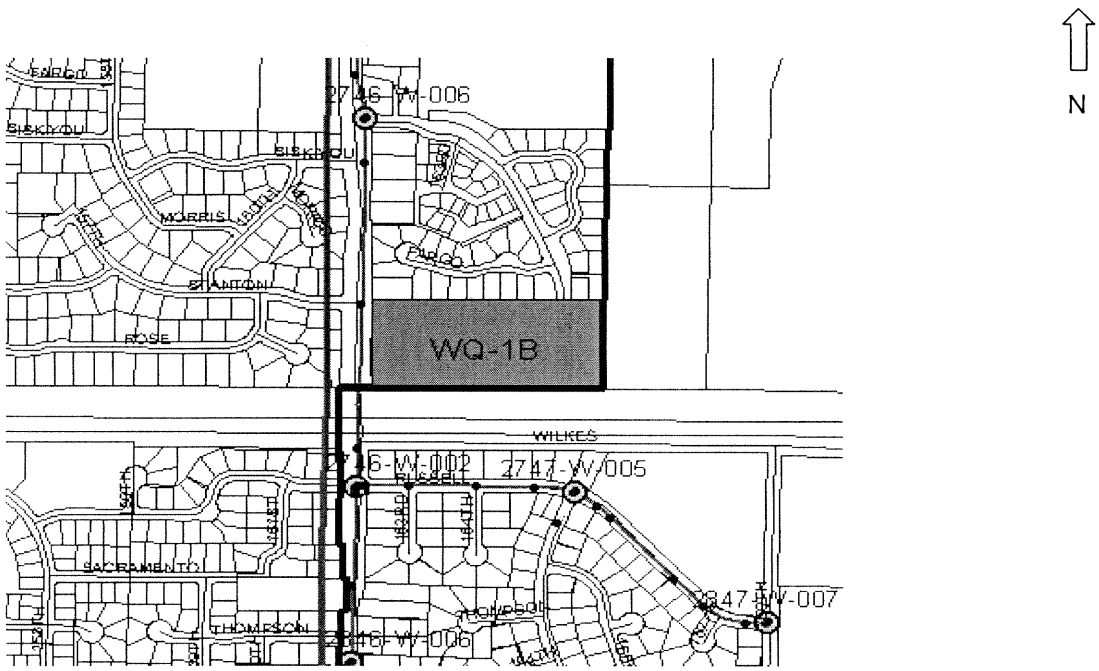
Proj # **Name:** **WGWQ-1B - Water Quality Facility at 162nd & I-84**

Description:
Create a 16.7 - acre-feet water quality facility at the north-eastern corner of the intersection of 162nd Avenue and I-84. Based on impervious percentages for existing and future conditions, 2% of the project would benefit flows associated with future development. This project is located in the Wilkes East neigborhood district.

Justification:
This facility would provide water quality treatment for a drainage area of approximately 309 acres.

Type of Project: Construction of facilities related to growth and to correct deficiencies. 63% of the drainage area lies in Gresham and 37% lies in Portland.

Map:



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses							
Design/Constr Admin (30%)	$ 260,000						
Property Acq	$ 1,212,420						
Construction	$ 866,700						
Other	$ -						
Administration (11%)	$ 257,300	0	0	0	0	0	0
TOTAL Expenses	$ 2,596,420	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 2946-w-002, 2846-w-001, 2846-w-003, 2846-w-006, 2746-w-002
2747-w-005, 2847-w-007

Drainage Area Served by Capital Project :	331	Acres	U/S Manhole	2946-w-002
% Impervious (Existing) :	63		D/S Manhole	2746-w-004
% Impervious (Future) :	64			

Project Elelments

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	16.7	$ 51,900	$ 866,700
Acquisition	Ft2	121,242	$ 10	$ 1,212,420

* Acquisition costs assume a 6-foot deep facility.

Maintenance Requirements

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	16.7	$1,128	$ 18,800
			Annual Maintenance Cost	**$ 18,800**

Costs

Construction	$ 866,700
Site Acquisition	$ 1,212,420
Engineering (30%)	$ 260,000
Administration (11%)	$ 257,300
Capital Project Implementation Costs	**$ 2,596,420**
Annual Maintenance Costs	**$ 18,800**

Proj # **Name:** **WGWQ-1C - Water Quality Facility at 162nd & Thompson**

Description:

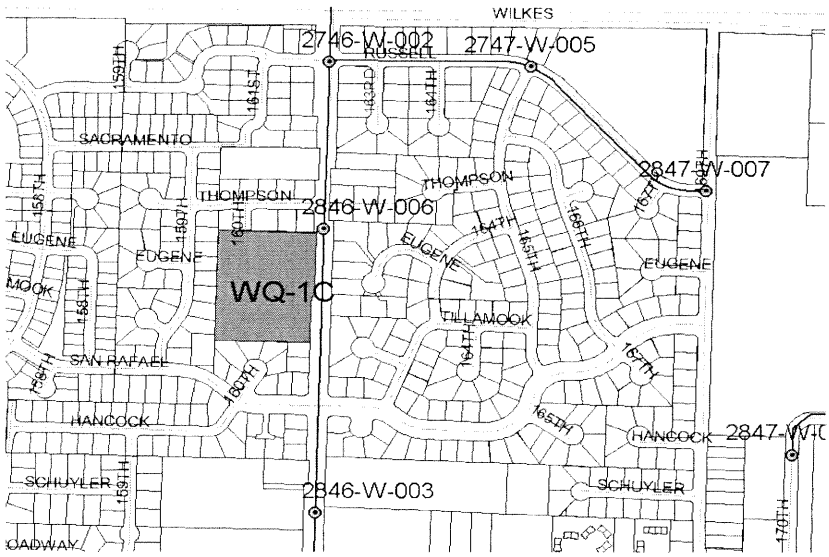
Create a 4.5 - acre-feet water quality facility at the south-eastern corner of the intersection of 162nd Avenue and NE Thompson Street. Based on impervious percentages for existing and future conditions, 1% of the project would benefit flows associated with future development. This project is located in the Wilkes East neigborhood district.

Justification:

This facility would provide water quality treatment for a drainage area of approximately 127 acres.

Type of Project: Construction of facilities related to growth and to correct deficiencies. 19% of the drainage area lies in Gresham and 81% lies in Portland.

Map:



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses								
Design/Constr Admin (30%)	$	70,100						
Property Acq	$	326,700						
Construction	$	233,600						
Other	$	-						
Administration (11%)	$	69,300	0	0	0	0	0	0
TOTAL Expenses	$	699,700	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 2946-w-002, 2846-w-001, 2846-w-003, 2846-w-006

Drainage Area Served by Capital Project :	127	Acres	U/S Manhole	2946-w-002
% Impervious (Existing) :	70		D/S Manhole	2846-w-006
% Impervious (Future) :	71			

Project Elelments

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	4.5	$ 51,900	$ 233,600
Acquisition	Ft2	32,670	$ 10	$ 326,700

* Acquisition costs assume a 6-foot deep facility.

Maintenance Requirements

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	4.5	$1,128	$ 5,100
			Annual Maintenance Cost	**$ 5,100**

Costs

Construction	$ 233,600
Site Acquisition	$ 326,700
Engineering (30%)	$ 70,100
Administration (11%)	$ 69,300
Capital Project Implementation Costs	**$ 699,700**
Annual Maintenance Costs	**$ 5,100**

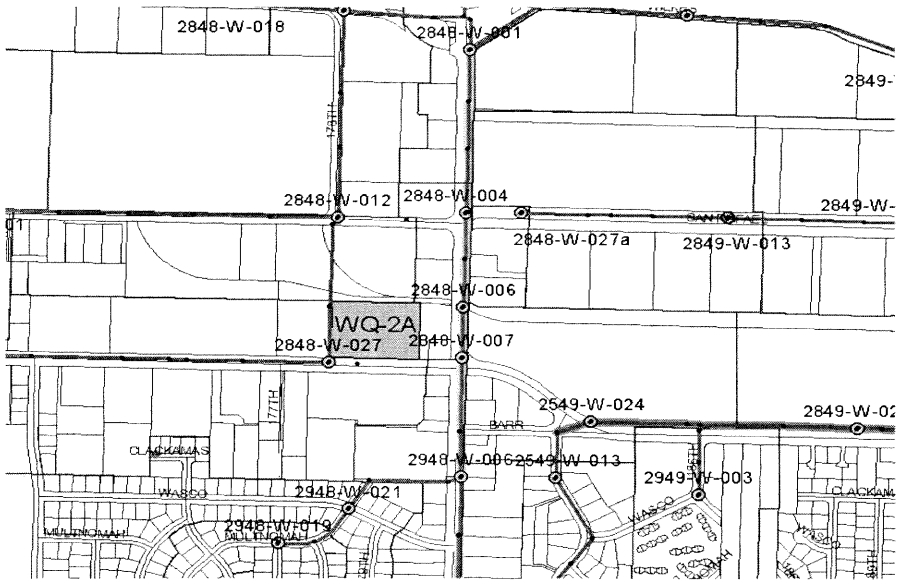
Proj # **Name:** **WGWQ-2A - Water Quality Facility at 181st & Halsey**

Description:
Create a 4.3 - acre-feet water quality facility at the north-western corner of the intersection of 181st Avenue and Halsey Street. Based on impervious percentages for existing and future conditions, 37% of the project would benefit flows associated with future development. This project is located in the Wilkes East neigborhood district.

Justification:
This facility would provide water quality treatment for a drainage area of approximately 84 acres.

Type of Project: Construction of facilities related to growth and to correct deficiencies.

Map:



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses								
Design/Constr Admin (30%)	$	67,000						
Property Acq	$	312,180						
Construction	$	223,200						
Other	$	-						
Administration (11%)	$	66,300	0	0	0	0	0	0
TOTAL Expenses	$	668,680	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 2848-w-027, 2847-w-013

Drainage Area Served by Capital Project :	84	Acres	U/S Manhole	2847-w-013
% Impervious (Existing) :	41		D/S Manhole	2848-w-027
% Impervious (Future) :	65			

Project Elelments

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	4.3	$ 51,900	$ 223,200
Acquisition	Ft2	31,218	$ 10	$ 312,180

* Acquisition costs assume a 6-foot deep facility.

Maintenance Requirements

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	4.3	$1,128	$ 4,900
			Annual Maintenance Cost	**$ 4,900**

Costs

Construction	$ 223,200
Site Acquisition	$ 312,180
Engineering (30%)	$ 67,000
Administration (11%)	$ 66,300
Capital Project Implementation Costs	**$ 668,680**
Annual Maintenance Costs	**$ 4,900**

Proj # **Name:** **WGWQ-3A - Water Quality Facility at N. 181st & Sandy Blvd.** Applicable Criteria

Description:

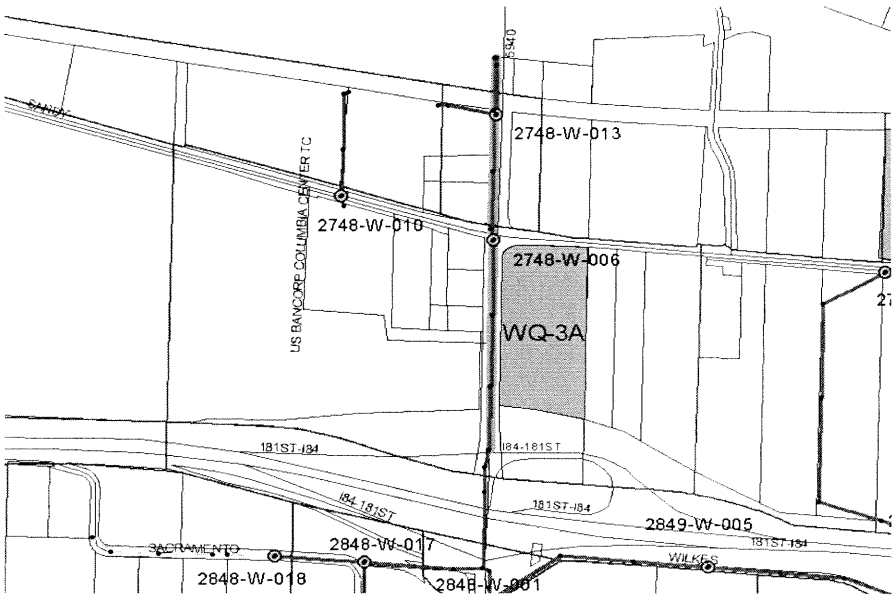
Create a 23.2 - acre-feet water quality facility at the south-eastern corner of the intersection of 181st Avenue and Sandy Boulevard. Based on impervious percentages for existing and future conditions, 29% of the project would benefit flows associated with future developments. This project is located in the North Gresham neigborhood district.

Justification:

This facility would provide water quality treatment for a drainage area of approximately 561 acres.

Type of Project: Construction of facilities related to growth and to correct deficiencies.

Map:



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
*Other, identify:*_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses								
Design/Constr Admin (30%)	$	361,200						
Property Acq	$	1,684,320						
Construction	$	1,204,080						
Other	$	-						
Administration (11%)	$	357,500	0	0	0	0	0	0
TOTAL Expenses	$	3,607,100	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 3048-w-002, 3048-w-001, 2948-w-012, 2948-w-009, 2948-w-006, 2948-w-019, 2948-w-021, 2848-w-007, 2848-w-004, 2848-w-001, 2847-w-013, 2848-w-027, 2847-w-001, 2848-w-012, 2848-w-018, 2848-w-017, 2748-w-003, 2748-w-006

Drainage Area Served by Capital Project :	561	Acres	U/S Manhole	3048-w-002
% Impervious (Existing) :	46		D/S Manhole	2748-w-006
% Impervious (Future) :	65			

Project Elelments

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	23.2	$ 51,900	$ 1,204,080
Acquisition	Ft2	168,432	$ 10	$ 1,684,320

* Acquisition costs assume a 6-foot deep facility.

Maintenance Requirements

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	23.2	$1,128	$ 26,200
			Annual Maintenance Cost	**$ 26,200**

Costs

	Total Cost
Construction	$ 1,204,080
Site Acquisition	$ 1,684,320
Engineering (30%)	$ 361,200
Administration (11%)	$ 357,500
Capital Project Implementation Costs	**$ 3,607,100**
Annual Maintenance Costs	**$ 26,200**

Proj # **Name:** **WGWQ-4A - Water Quality Facility N of Sandy Blvd. & E of 185th**

Description:

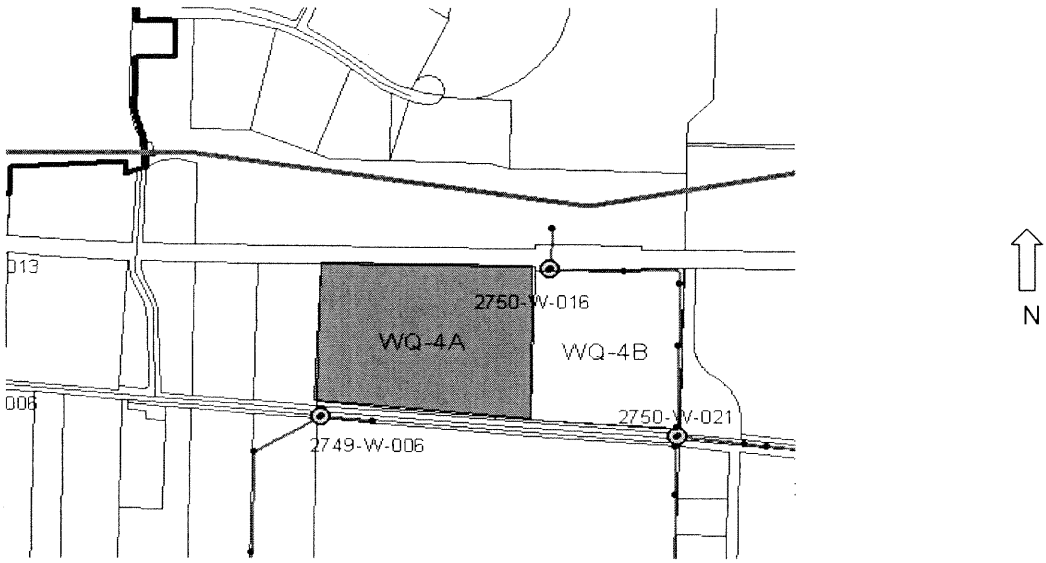
Create an 19.5 - acre-feet water quality facility at the location of the open channel west of the Waste Water Treatment Plant north of Sandy Boulevard. Based on impervious percentages for existing and future conditions, 20% of the project would benefit flows associated with future development. This project is located in the North Gresham neigborhood district.

Justification:

This facility would provide water quality treatment for a drainage area of approximately 399 acres.

Type of Project: Construction of facilities related to growth and to correct deficiencies.

Map:



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses								
Design/Constr Admin (30%)	$	303,600						
Property Acq	$	1,415,700						
Construction	$	1,012,100						
Other	$	-						
Administration (11%)	$	300,500	0	0	0	0	0	0
TOTAL Expenses	$	3,031,900	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 2949-w-009, 2549-w-013, 2549-w-024, 2949-w-003, 2849-w-027, 2849-w-021
2848-w-027a, 2849-w-013, 2849-w-010, 2849-w-018, 2849-w-005
2849-w-008, 2749-w-001, 2749-w-006

Drainage Area Served by Capital Project :	399	Acres	U/S Manhole	2949-w-014
% Impervious (Existing) :	51		D/S Manhole	2749-w-007
% Impervious (Future) :	64			

Project Elelments

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	19.5	$ 51,900	$ 1,012,100
Acquisition	Ft2	141,570	$ 10	$ 1,415,700

* Acquisition costs assume a 6-foot deep facility.

Maintenance Requirements

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	19.5	$1,128	$ 22,000
			Annual Maintenance Cost	**$ 22,000**

Costs

Construction	$ 1,012,100
Site Acquisition	$ 1,415,700
Engineering (30%)	$ 303,600
Administration (11%)	$ 300,500
Capital Project Implementation Costs	**$ 3,031,900**
Annual Maintenance Costs	**$ 22,000**

Proj # **Name:** **WGWQ-4B - Water Quality Facility N of Sandy Blvd. & W of 197th Pl.**

Description:

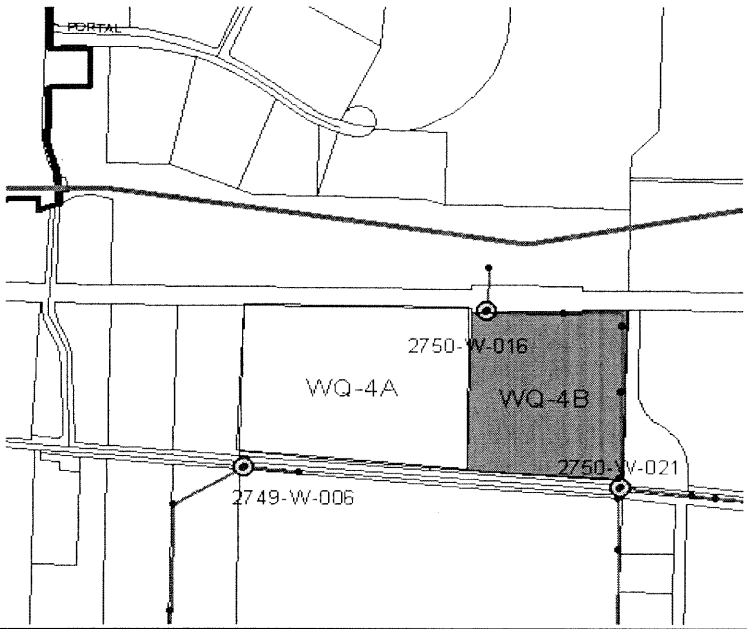
Create a 13.7 - acre-feet water quality facility north of Sandy Boulevard and west of the waste water treatment plant. Based on impervious percentages for existing and future conditions, 25% of the project would benefit flows associated with future development. This project is located in the North Gresham neigborhood district.

Justification:

This facility would provide water quality treatment for a drainage area of approximately 259 acres.

Type of Project: Construction of facilities related to growth and to correct deficiencies.

Map:



N

FUNDED

		TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources								
Operating		0						
Grant		0						
SDC		0						
Bond		0						
Developer		0						
IGA		0						
Other, identify:_____		0						
TOTAL Funding Resources		0	0	0	0	0	0	0
Expenses								
Design/Constr Admin (30%)	$	213,300						
Property Acq	$	994,620						
Construction	$	711,000						
Other	$	-						
Administration (11%)	$	211,100	0	0	0	0	0	0
TOTAL Expenses	$	2,130,020	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 2850-w-002, 2850-w-020, 2850-w-025, 2850-w-024
2750-w-021, 2850-w-006, 2850-w-009, 2750-w-023

Drainage Area Served by Capital Project :	259	Acres	U/S Manhole	2850-w-002
% Impervious (Existing) :	53		D/S Manhole	2750-w-021
% Impervious (Future) :	71			

Project Elelments

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	13.7	$ 51,900	$ 711,000
Acquisition	Ft2	99,462	$ 10	$ 994,620

* Acquisition costs assume a 6-foot deep facility.

Maintenance Requirements

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	13.7	$1,128	$ 15,500
			Annual Maintenance Cost	**$ 15,500**

Costs

Construction	$ 711,000
Site Acquisition	$ 994,620
Engineering (30%)	$ 213,300
Administration (11%)	$ 211,100
Capital Project Implementation Costs	**$ 2,130,020**
Annual Maintenance Costs	**$ 15,500**

Proj # **Name:** **WGWQ-4C - Water Quality Facility at the 194th Ave. Cul-de-sac**

Description:

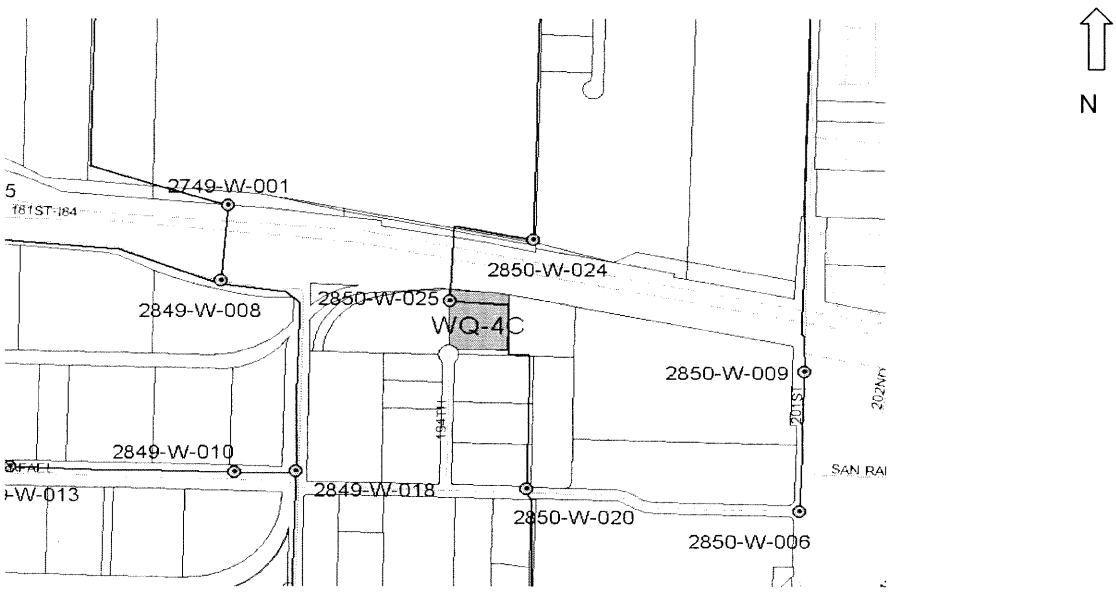
Create a 3.2 - acre-feet water quality facility at the north-eastern corner of the the cul-de-sac at the north end of 194th Avenue south of I-84. Based on impervious percentages for existing and future conditions, 33% of the project would benefit flows associated with future development. This project is located in the North Gresham neigborhood district.

Justification:

This facility would provide water quality treatment for a drainage area of approximately 102 acres.

Type of Project: Construction of facilities related to growth and to correct deficiencies.

Map:



FUNDED

	TOTAL	Estimated 2001-02	2002-03	2003-04	2004-05	2005-06	2006-07
Funding Resources							
Operating	0						
Grant	0						
SDC	0						
Bond	0						
Developer	0						
IGA	0						
Other, identify:_____	0						
TOTAL Funding Resources	0	0	0	0	0	0	0

Expenses								
Design/Constr Admin (30%)	$	49,800						
Property Acq	$	232,320						
Construction	$	166,100						
Other	$	-						
Administration (11%)	$	49,300	0	0	0	0	0	0
TOTAL Expenses	$	497,520	0	0	0	0	0	0

Subbasin Properties

Subbasin names : 2850-w-002, 2850-w-020, 2850-w-025

Drainage Area Served by Capital Project :	102	Acres	U/S Manhole	2850-w-022
% Impervious (Existing) :	44		D/S Manhole	2850-w-025
% Impervious (Future) :	66			

Project Elelments

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	3.2	$ 51,900	$ 166,100
Acquisition	Ft2	23,232	$ 10	$ 232,320

* Acquisition costs assume a 6-foot deep facility.

Maintenance Requirements

Facility	Unit	Size	Unit Cost	Total Cost
Water Quality Facility	Ac-ft	3.2	$1,128	$ 3,600
			Annual Maintenance Cost	**$ 3,600**

Costs

Construction	$ 166,100
Site Acquisition	$ 232,320
Engineering (30%)	$ 49,800
Administration (11%)	$ 49,300
Capital Project Implementation Costs	**$ 497,520**
Annual Maintenance Costs	**$ 3,600**

Note: The unit prices listed in the table below are for new pipe construction cost. For replacement pipe, the unit may be higher. For stormwater pipe replacement, applying a 10-20 percent factor to the new pipe cost is recommended.

New Unit Pipe Cost

Pipe Installation Construction Cost $ / Linear Foot

DIAMETER (INCHES)	DIAMETER (FEET)	DEPTH TO INVERT (FEET) 6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40
6	0.5	$122	$125	$132	$134	$138	$142	$146	$150	$155	$158	$163	$166	$171	$868	$868	$868	$868	$868
8	0.7	$122	$125	$132	$134	$138	$142	$146	$150	$155	$158	$163	$166	$171	$868	$868	$868	$868	$868
10	0.8	$122	$126	$132	$136	$140	$143	$150	$154	$158	$163	$169	$173	$177	$876	$876	$876	$876	$876
12	1.0	$120	$125	$132	$136	$142	$146	$153	$158	$163	$169	$174	$179	$185	$885	$885	$885	$885	$885
15	1.3	$120	$126	$136	$142	$151	$158	$166	$174	$181	$189	$197	$203	$213	$896	$896	$896	$896	$896
18	1.5	$125	$136	$142	$153	$159	$170	$177	$186	$194	$203	$211	$221	$229	$910	$910	$910	$910	$910
21	1.8	$133	$143	$155	$169	$179	$191	$202	$214	$226	$239	$251	$262	$274	$925	$925	$925	$925	$925
24	2.0	$151	$163	$178	$193	$205	$221	$235	$248	$262	$276	$291	$303	$318	$937	$937	$937	$937	$937
27	2.3	$158	$177	$194	$213	$231	$248	$264	$283	$302	$319	$336	$356	$373	$950	$950	$950	$950	$950
30	2.5	$171	$191	$211	$231	$251	$272	$291	$311	$331	$351	$371	$391	$411	$1,179	$1,179	$1,179	$1,179	$1,179
33	2.8	$174	$198	$218	$239	$263	$286	$303	$324	$348	$367	$393	$408	$436	$1,196	$1,196	$1,196	$1,196	$1,196
36	3.0	$179	$202	$225	$246	$270	$292	$314	$336	$359	$381	$404	$428	$450	$1,204	$1,204	$1,204	$1,204	$1,204
42	3.5	$197	$223	$252	$279	$308	$336	$363	$391	$417	$448	$474	$501	$530	$1,232	$1,232	$1,232	$1,232	$1,232
48	4.0	$233	$264	$299	$332	$367	$399	$433	$466	$500	$533	$567	$599	$634	$1,261	$1,261	$1,261	$1,261	$1,261
54	4.5	$298	$336	$375	$412	$450	$489	$526	$565	$602	$639	$678	$716	$753	$1,286	$1,286	$1,286	$1,286	$1,286
60	5.0	$372	$411	$450	$489	$527	$567	$607	$646	$686	$725	$764	$802	$842	$1,311	$1,311	$1,311	$1,311	$1,311
66	5.5	$415	$458	$506	$551	$595	$640	$687	$731	$776	$822	$866	$911	$957	$2,267	$2,267	$2,267	$2,267	$2,267
72	6.0		$547	$598	$650	$700	$751	$804	$853	$905	$954	$1,007	$1,056	$1,108	$2,292	$2,292	$2,292	$2,292	$2,292
78	6.5		$626	$684	$744	$802	$862	$921	$982	$1,040	$1,100	$1,159	$1,218	$1,277	$2,320	$2,320	$2,320	$2,320	$2,320
84	7.0		$763	$824	$885	$947	$1,007	$1,023	$1,131	$1,192	$1,253	$1,317	$1,376	$1,439	$2,346	$2,346	$2,346	$2,346	$2,346
90	7.5					$1,030	$1,125	$1,185	$1,273	$1,361	$1,406	$1,495	$1,555	$1,628	$2,373	$2,373	$2,373	$2,373	$2,373
96	8.0						$1,311	$1,359	$1,450	$1,525	$1,729	$1,691	$1,766	$1,835	$2,401	$2,427	$2,454	$2,481	$2,507
102	8.5						$1,535	$1,625	$1,689	$1,780	$1,872	$1,977	$2,041	$2,067	$2,094	$2,481	$2,507	$2,534	$2,560
108	9.0						$1,707	$1,786	$1,895	$1,973	$2,110	$2,188	$2,268	$2,295	$2,321	$2,534	$2,560	$2,587	$2,613
120	10.0							$2,009	$2,105	$2,202	$2,299	$2,325	$2,352	$2,378	$2,405	$2,587	$2,613	$2,640	$2,667
132	11.0								$2,320	$2,435	$2,493	$2,519	$2,546	$2,572	$2,599	$2,640	$2,667	$2,693	$2,720
144	12.0									$2,665	$2,684	$2,710	$2,737	$2,764	$2,790	$2,817	$2,843	$2,870	$2,896
156	13.0									$2,894	$2,874	$2,900	$2,927	$2,954	$2,980	$2,870	$2,896	$2,923	$2,950
168	14.0										$3,065	$3,092	$3,118	$3,145	$3,171	$2,923	$2,950	$2,976	$3,003

Notes:

1) ENR = 5950. Costs include manhole installation, street restoration and traffic control, costs do not include O&M.
Multiply by 1.45 to determine total capital cost (which includes contingency, engineering, and administrative costs).
Costs also assume trench construction for invert depths less than or equal to 30 feet and tunnel construction for inver depths greater than 30 feet.

2) Cost table source is the Combined Sewer Overflow Program Estimating Standards, May 1995, revised using Brown and Caldwell's BACPAC consturction cost estimating computer model. Revisions resulted in an approximate 23% cost increase from the source table.

Unit Cost Assumptions for Construction and Maintenance of Water Quality Ponds

The water quality capital projects shown in the fact sheets each include water quality ponds. The unit costs used to estimate the construction costs and maintenance costs for water quality ponds were derived as follows:

Backup Unit Construction Costs Per Acre-Foot of Water Quality Pond

Construction Activity/Materials	Unit	Estimated Unit Cost	Estimated Quantity	Estimated Cost
Gravel Access Rd.	Ft^2	$3.80	350	$1,330
Clearing & Grubbing	Acres	$2,000	0.33	$660
General Excavation	Yd^3	$15	1,600	$24,000
Grading	Yd^3	$5	100	$500
Inlet Structure	Each	$3,500	1	$3,500
Outlet Structure	Each	$5,000	1	$5,000
Curb & Gutter	Ft	$12	20	$240
Hydroseed	Acres	$2,000	0.33	$660
Trees & Shrubs	Each	$50	100	$5,000
Riprap	Yd^3	$60	3	$180
Fencing	Ft	$17	600	$10,200
Erosion Control	Acres	$2,000	0.33	$660
Total Estimated Unit Cost Per Acre-Ft for Water Quality Ponds:				**$51,930**

Backup Unit Maintenance Costs Per Five Acre-Foot of Water Quality Pond

Maintenance Activity	Times/ Year	Labor Hours Necessary	Estimated Labor Costs*	Equipment Hours Necessary	Estimated Hourly Equipment Costs	Estimated Equipment Costs
Inspect and Clean Inlet/Outlet	4	4	$640	2	$150	$1,200
Inspect Vegetation	2	1	$80			
Remove Debris/Garbage	4	2	$320			
Maintain Vegetation	4	4	$640	4	$10	$160
Inspect Sediment Loading	2	1	$80			
Remove Sediment	0.5	12	$240	6	$300	$900
Disposal Costs	0.5		$800			
Inspect Slopes	2	1	$80			
Repair Slopes	Ongoing		$500			
Annual Labor Subtotal:			$3,380	Annual Equip. Subtotal:		$2,260
Total Estimated Annual Maintenance $ Per 5 Ac-Ft:			**$5,640**			

*The estimated cost assumes $40/hour for labor.

Appendix G
Methods for Estimating SDCs

For the flood control capital improvement projects (CIPs), the CIP fact sheets include estimates of the percentage of the CIP costs that should be funded through system development charges (SDCs). The purpose of this appendix is to describe the methods that were used to develop the SDC funding estimates. In general there were three types of funding categories as described below:

Category 1 – SDCs = 100% of the CIP Cost

The entire capital improvement project costs were attributed to SDCs when the expected capacity deficiencies were only predicted to occur as a result of projected future development in the drainage area. In other words, when the pipe system was evaluated under existing land use conditions, capacity deficiencies were not identified; when the pipe system was evaluated under future land use conditions, capacity deficiencies were identified.

Category 2 - SDCs = 0% of the CIP Cost

No portion of the capital improvement project costs were attributed to SDCs when the expected capacity deficiencies were not made any worse as a result of projected future development in the drainage area. In other words, the estimated depth of flow in the roadway under existing land use conditions did not increase as a result of future land use conditions.

Category 3 – SDCs = Some portion of the CIP Cost (between 0% and 100%)

Estimating this category of SDCs was more complicated than it was for the above two categories. One complication is the fact that the CIP may be made up of many pipe segments and the contribution from future flows may vary for each pipe segment. In addition, it would be ideal to estimate SDC funding estimates based on the difference between peak flows under existing conditions and peak flows under future conditions. However, to maintain flow continuity in the model, flows in excess of pipe capacities were routed through the streets. Therefore, estimating peak flows would require some more detailed analysis to add the flow in the streets to the flow in the pipes. To get around these complications, another method for estimating SDC funding was developed. The method that was used is outlined in the following steps. It should be noted that this method also has limitations and was used for general estimating purposes.

Step 1 – For each proposed pipe segment replacement in an individual CIP, the depth of flow in the roadway under both existing and future conditions was obtained. For example, for pipe segment 2619 (CIP WGFC-3A) the depth of flow in the roadway under existing land use conditions was 0.15 feet and the depth of flow in the roadway under future land use conditions was 0.2 feet (see Appendix C).

Step 2 – In developing CIPs to address flooding issues, water surface elevations in manholes were kept to at least 2 feet below the road surface. Therefore, 2 feet was added to each of the depths obtained in Step 1. This was done because this 2 feet is a portion of the depth of flow that will need to be addressed by the CIP. Therefore, using the same example that is provided in Step 1 above, the depth of flow needing to be addressed by

CIP WGFC-3A for pipe segment 2619 is 2.15 feet under existing conditions and 2.2 feet under future conditions.

Step 3 – The depth of flow obtained in Step 2 for existing land use conditions was divided by the depth of flow obtained in Step 2 for future land use conditions. Using the example in Step 2, this would be 2.15/2.2 or 0.98. This number was then multiplied by 100 to obtain the estimated percentage of the pipe replacement cost that is attributable to existing development. The remainder of the cost is estimated to be attributable to SDCs. Again using the example from the previous steps, pipe segment 2619 is currently a 30" diameter pipe. The model estimates that replacement with a 42" pipe is necessary. The cost of this pipe replacement is estimated to be $70,200 (see Capital Improvement Project fact sheet for WGFC-3A). Therefore, 98% of this cost or $68,600 was attributed to existing development and 2% of this cost, or $1,600 was attributed to SDCs.

Step 4 – The above steps were conducted for each pipe segment proposed for replacement in a CIP with the exception of those pipes where deficiencies were not identified but improvements were necessary to alleviate problems upstream. For example, steps 1 through 3 were conducted for 14 pipe segment replacements proposed for CIP WGFC-3A (pipes 2591 and 2582 were not included as they are not predicted to be deficient by the model). The SDC costs were then totaled for each of the 14 pipe segment replacements for this CIP. This SDC cost was then divided by the estimated total pipe construction cost for these 14 segments to get an overall SDC funding estimate for the project. For example, for CIP WGFC-3A, the SDC costs for each of the 14 pipes were totaled to equal $263,962. This cost divided by the total estimated pipe construction cost for the 14 segments of $1,070,100 equals 25%.

Step 5 – In order to double check the estimate obtained in Step 4, the SDC funding estimate was compared to the impervious percentages for both existing and future conditions in the drainage area of the capital improvement project. For the example used above (CIP WGFC-3A), the impervious percentage under existing conditions is 46% and the estimated impervious percentage under future conditions is 57%. Taking 46% divided by 57%, it is estimated that approximately 81% of the expected future buildout impervious surface already exists in this drainage area and an additional 19% impervious surface is expected as a result of future buildout. Therefore, you would expect SDC funding estimates to be somewhere in the range of 19% which it was for this example.

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