BROWN AND CALDWELL

Technical Memorandum Working Draft

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Prepared for: King County Wastewater Treatment Division, Washington

Project Title: Preliminary Analysis of Reclaimed Water Options in the Green River Valley

Project No: 130433-016

Technical Memorandum

Subject: Green River Valley Reclaimed Water Study – Working Draft

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To: Mark Buscher, King County Senior Program Manager

From: Matt Maring, Brown and Caldwell Project Manager

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1. EXECUTIVE SUMMARY

This section summarizes a preliminary analysis of reclaimed water options for the Green River Valley. It provides general background into the analysis, preliminary analysis findings, and discussion of the basis for those findings along with a summary of subsequent document sections.

1.1 Background

This technical memorandum (tech memo) provides a broad overview, preliminary assessment, and planning analysis of reclaimed water supply options for the Green River Valley. King County, and the Cities of Auburn, Covington, Kent, Renton, and Tukwila, identified a desire to initiate this overview and analysis of options for treating and distributing reclaimed water to the Green River Valley communities, as a means to enhance and extend available water supplies. Figure 1-1 shows the locations of the communities that comprise the study area for this preliminary review. The Cities and County have identified three preliminary reclaimed water supply scenarios for producing and delivering reclaimed water to potential uses within the study area.

This tech memo provides a broad overview of three reclaimed water supply scenarios and preliminary estimates of the capital and operating costs associated with each scenario. In addition, this tech memo summarizes issues associated with reclaimed water supply and identifies information that will be required to determine the viability of each scenario, economically and otherwise. The following three reclaimed water supply and distribution scenarios were selected for analysis by King County and the study area Cities:

- Scenario 1: Distribution of reclaimed water produced from reclaimed water treatment facilities to be developed and sited at the existing King County South Treatment Plant (South Plant) and supplied from existing plant secondary treated wastewater effluent
- Scenario 2: Distribution of reclaimed water treated and produced from satellite polishing plants located around the Green River Valley and supplied from secondary treated wastewater effluent piped from the South Treatment Plant.
- Scenario 3: Distribution of reclaimed water treated and produced at satellite treatment plants located around the Green River Valley and supplied from local raw wastewater conveyance system flows at each plant location.

The scenarios are developed relative to initial assumptions made by King County and representatives from the study area Cities regarding total reclaimed water supply and capacity needs within the study area:

- Year 2016: 15 mgd (million gallons per day) total potential reclaimed water use
- Year 2020: 35 mgd total potential reclaimed water use
- Year 2030: 50 mgd total potential reclaimed water use

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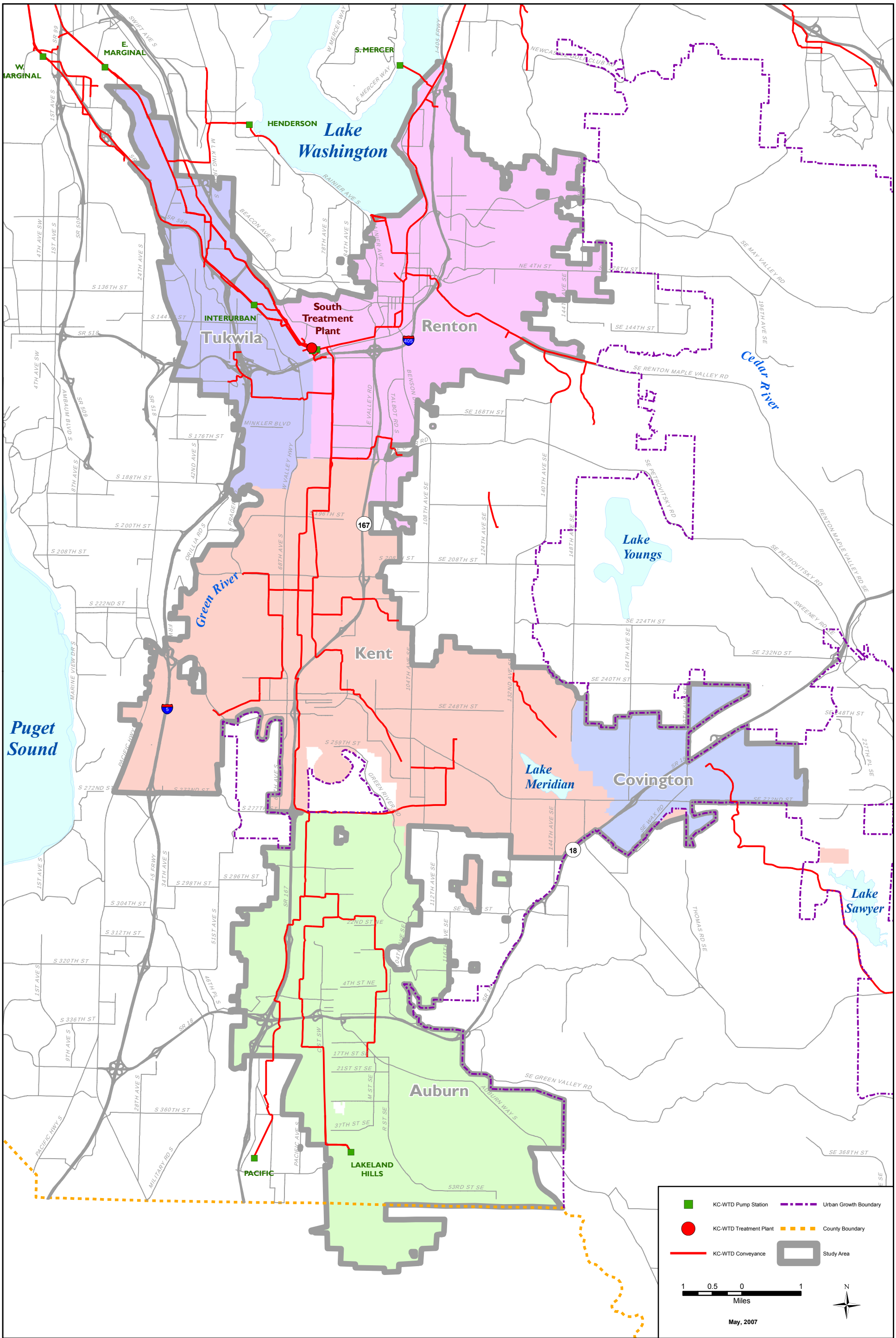

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Green River Valley Reclaimed Water Study Area

Figure 1-1. Green River Valley Reclaimed Water Study Area

As part of this analysis, preliminary estimates for each reclaimed water supply scenario are developed as follows:

- Estimates of how much reclaimed water might be made available based on wastewater flow measurements and forecasts.
- Estimates of the types and quantities of potential reclaimed water demands within the study area based on existing land uses and currently available information.
- Estimates of relative capital, operating, and capacity specific costs for each reclaimed water supply and distribution scenario.

The results of these analyses and estimates are then used to compare and contrast scenarios, identify relative advantages and limitations, and develop preliminary findings.

1.2 Preliminary Findings

Preliminary findings and conclusions regarding the reclaimed water supply and distribution scenarios assessed in this tech memo are presented in the following sections to include estimated costs, economics of scale, peaking capacity and operational efficiency considerations, and ability to support anticipated reclaimed water demands. Of the three scenarios assessed, Scenario 1 appears to be the most cost effective overall and offers the greatest flexibility to support varied reclaimed water demand, distribution, and supply needs.

Preliminary Cost Estimates and Economies of Scale

Figure 1-2 summarizes preliminary annual unit cost estimates (per gallon of reclaimed water supply) relative to system capacity for each of the three reclaimed water scenarios assessed. Scenario 1, producing reclaimed water from treated secondary wastewater effluent at the South Treatment Plant and piping that water to specific points of use throughout the study area, appears the least expensive of the three scenarios studied, followed by Scenarios 2 and 3. This is appears to be largely due to the greater economies of scale likely in providing reclaimed water treatment at a single, larger, centralized facility, rather than through multiple smaller satellite facilities distributed around the study area.

Additional cost efficiency may also be possible where reclaimed water system implementation can be structured to fulfill other future capacity needs as well. Although not specifically assessed as part of this analysis, reclaimed water treatment under Scenario 1, for example, could be structured to utilize membrane bioreactor (MBR) treatment processes to simultaneously provide both secondary wastewater treatment and Class A reclaimed water treatment of South Plant primary wastewater effluent. Such a treatment approach could provide the added benefit of effectively expanding South Plant secondary wastewater treatment capacity through the addition of a full MBR secondary wastewater treatment/reclaimed water treatment train. Thus reclaimed water treatment costs could be considered to be somewhat offset by costs that might otherwise need to be incurred at South Plant in the future to expand secondary wastewater treatment capacity. A South Plant MBR treatment approach might thus fulfill both future secondary treatment capacity expansion and reclaimed water needs.

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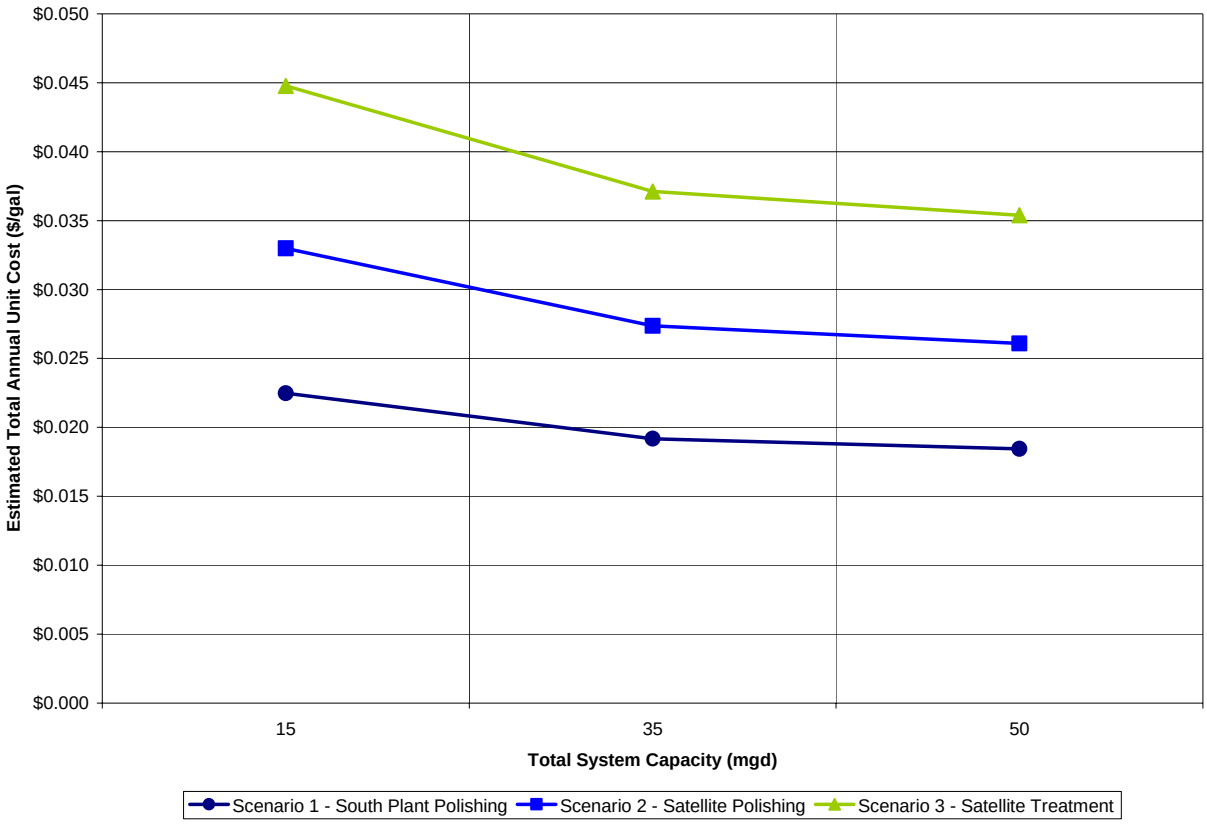
Figure 1-2. Preliminary Reclaimed Water Annual Unit Cost Comparison



Peaking Capacity and Operational Cost Efficiency

As shown in Figure 1-2, preliminary cost estimates suggest the following ranges of annual unit costs in dollars per gallon of reclaimed water produced:

- Scenario I: $0.018 to $0.022 (July 2007 dollars)
- Scenario II: $0.026 to $0.033 (July 2007 dollars)
- Scenario III: $0.035 to $0.045 (July 2007 dollars)

It should be noted however that reclaimed water peaking capacity and operations can have a significant impact on unit reclaimed water costs and efficiencies in terms of cost per gallon. As with potable water infrastructure, reclaimed water facilities are generally sized to satisfy anticipated peak demands such that capital implementation costs are largely determined by the peak supply capacity required. While many elements of O&M cost vary with use, certain O&M cost elements are fixed and determined largely by peak system supply capacity as well.

If reclaimed water facilities are sized to accommodate large peaks in demand, but are only operated seasonally and lie partially or completely dormant for significant portions of the year, as might be the case in support of irrigation use, annual implementation costs per gallon of water produced will be much higher than for reclaimed water uses that support more consistent year round operations. The more reclaimed water systems can be designed and implemented to operate at or near peak capacity on a continuous basis, the more efficient such systems become in terms of annual cost per gallon of reclaimed water produced. Similarly, the

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closer average reclaimed water use is maintained to peak reclaimed water use, the more cost efficient reclaimed water systems can become.

The annual unit cost estimates presented in dollars per gallon of reclaimed water produced assume that reclaimed water is produced largely for irrigation use during only 5 months out of the year. Significant reductions in annual unit costs may be possible if reclaimed water operations and use can be extended for longer periods or continuously year round, and if variations and peaks in reclaimed water use can be minimized such that peak system capacity can be more closely aligned with average reclaimed water usage rates.

For example, preliminary estimates indicate that for continuous year round reclaimed water production averaging 80 percent of peak system capacity, annual unit costs in dollars per gallon of reclaimed water produced could be as low as:

- Scenario I: $0.0035 to $0.0043 (July 2007 dollars)
- Scenario II: $0.0051 to $0.0064 (July 2007 dollars)
- Scenario III: $0.0075 to $0.0095 (July 2007 dollars)

This demonstrates the potential for more continuous and less variable year round reclaimed water operations to support annual unit cost reductions to approximately one fifth of the costs associated with reclaimed water production and use for more highly variable seasonal irrigation use. While irrigation tends to be a seasonal and highly variable use, reclaimed water uses that may offer the potential for more continuous and less variable year round demand would most likely generally include:

- Industrial Processes
- Groundwater Recharge

Given the sensitivity of reclaimed water annual unit costs to demand variability and operations patterns, additional analyses of potential reclaimed water use beyond potential irrigation uses should likely be explored, with an emphasis on identifying potential uses that are not highly variable or seasonal in nature.

Reclaimed Water Use and Demand Potential

Estimates indicate that potential study area reclaimed water irrigation use could range from an average of approximately 8 mgd for the irrigation months from May through September, to as much as 12.5 and 25 mgd on a peak month and maximum day demand basis respectively. Other potential study area demands for reclaimed water may include upwards of 18 mgd for groundwater recharge, and significant additional potential industrial process demands as well. This range of potential estimated demand correlates fairly closely with the assumed study area schedule of total potential reclaimed water use ranging from 15 mgd by 2016 to 50 mgd by 2030. Given the cost variability associated with seasonal reclaimed water use as compared with more continuous year round use, the potential for more continuous reclaimed water use for industrial processes or groundwater recharge should likely be further evaluated.

Reclaimed Water Supply Flexibility

Wastewater flows within the study area form the basis of the locally available reclaimed water supply resource. In terms of supporting potential reclaimed water demands, Scenarios 1 and 2 offer the most flexibility and the least limitations for providing reclaimed water supply throughout the study area regardless of the potential for non-uniform demand distributions and areas with large local reclaimed water needs. Under Scenarios 1 and 2, reclaimed water supply becomes effectively limited only by regional wastewater flow volumes and reclaimed water treatment and distribution capacity. Scenario 3, producing reclaimed water from raw wastewater at satellite treatment plants distributed throughout the study area, appears to be the most limited

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in terms of flexibility to support areas where large local reclaimed water demands may exceed locally available wastewater flows and reclaimed water supply resources.

Scenarios 1 and 2 present a regional approach to reclaimed water supply and thus provide implementation flexibility to provide desired levels of reclaimed water service anywhere in the study area. By comparison Scenario 3 provides a more local approach, where the local reclaimed water supply capacities of satellite treatment plants are effectively constrained by locally available wastewater flows as the reclaimed water supply resource. So long as local demands and potential uses of reclaimed water do not exceed the locally available wastewater flows, this is not an issue. However, where large localized reclaimed water demands exceed the reclaimed water supply available from local wastewater flows, this may become a significant limitation under Scenario 3. Indeed, according to preliminary estimates of potential reclaimed water demand, there appears to be a reasonable possibility that areas may exist within the study area where localized reclaimed water demand could exceed locally available reclaimed water supply capabilities in terms of local wastewater flow resources.

While the estimates of potential reclaimed water demand developed herein are strictly preliminary in nature and demonstrate a need for better and more detailed data regarding the actual potential for reclaimed water demand within the study area, they do illustrate that both the quantity and distribution of potential demands needs to be carefully assessed relative to available wastewater flows and reclaimed water supply resources to ensure that local demands can be supported by the available wastewater resource flows.

Potable Water Utility Revenue Considerations

Reclaimed water use often offsets and reduces potable water use as reclaimed water is implemented for supply needs that have been historically met through potable water supplies. Such reductions in potable water use can result in decreased utility revenues that can serve as a disincentive to reclaimed water implementation for certain communities and utilities. This can be especially significant for use during the summer irrigation months when potable water use, usage fees/rates, and associated utility revenues typically peak. As such, reclaimed water systems are often most viable in areas where existing potable water supplies have become limited, additional new or expanded potable water supplies are expensive relative to reclaimed water options, or other local and regional drivers create economic incentives for reclaimed water implementation.

1.3 Basis for Findings

The findings described herein are based on a review of current requirements and regulations, application of a variety of available analysis tools, and numerous assumptions and estimates, as detailed in the following sections of this tech memo. In addition to presenting estimates and assessments to support and develop the preliminary capacity and cost values summarized in Figure 1-2, this tech memo identifies information related to reclaimed water production and distribution in general, and specifically within the Green River Valley study area, as needed to make preliminary determinations regarding the relative viability of each reclaimed water supply/distribution scenario. While the analyses and information contained herein are intended to follow the best available information at this time, the estimates and assessments contained in this tech memo are strictly preliminary in nature and can likely benefit from further refinement and development as reclaimed water options for the Green River Valley are further reviewed and considered.

This tech memo contains seven sections in addition to this executive summary, as follows:

- Section 2 provides an introduction to this memorandum by summarizing the purpose of this study and the available background information concerning the study area.
- Section 3 summarizes the information available and key assumptions made in the preparation of the tech memo, and for the development and preliminary analysis of reclaimed water supply scenarios. Section 3 also identifies some of the specific implementation issues associated with reclaimed water production and

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use that could impact implementation of reclaimed water supplies, including related regulations and requirements.

- Section 4 focuses on potential reclaimed water supplies and presents estimates of existing and forecasted future wastewater flows as a resource for reclaimed water supply.
- Section 5 looks at the demand side of the reclaimed water equation by estimating some of the potential reclaimed water demands that may exist within the study area, to include variations and seasonal effects.
- Section 6 identifies performance and design considerations and assumptions for reclaimed water supply to the study area, including regulatory requirements, possible changes in the regulatory climate, and current trends in reclaimed water production and use around Washington State.
- Section 7 presents preliminary summaries and analyses of each of the identified reclaimed water supply scenarios relative to the information and assumptions presented in the previous sections. Facilities and processes required for producing and distributing reclaimed water under each scenario are summarized, and estimated capital and operating costs for producing and distributing reclaimed water are presented.
- Section 8 provides preliminary findings and a summary and comparison of the reclaimed water supply scenarios developed and detailed in Section 7, along with discussions of the relative limitations and flexibility available for each scenario. Additional data needs for further refinement and analyses of reclaimed water supply scenarios are also presented.

2. INTRODUCTION

This section provides an introduction to this tech memo, including summaries of its purpose, key related questions to be addressed, and a description and background information on the geography of the associated study area, including related mapping.

2.1 Purpose

This tech memo provides a broad overview and preliminary analysis of reclaimed water supply options in the Green River Valley, to include areas within the Cities of Auburn, Covington, Kent, Renton, and Tukwila. The focus is to provide a preliminary assessment to:

- Identify relevant and available information
- Identify areas where additional information or better information may be needed
- Screen available information to identify issues, considerations, limitations, and potential flaws
- Identify technical, policy, level of service, and other issues relevant to feasibility and further future analyses of identified and potential reclaimed water production and delivery scenarios
- Identify appropriate approaches, methodologies, rationale, procedures, and considerations pertinent to further future analyses of scenarios
- Screen scenarios and draw conclusions where possible, and identify areas and considerations where further future analysis will be necessary

2.2 Key Questions

This tech memo strives to define and answer the following key questions regarding potential Green River Valley reclaimed water supply options:

1. What treatment processes and equipment are necessary to produce and deliver Class A reclaimed water according to the following scenarios:
   - Scenario 1: Distribution of reclaimed water produced from reclaimed water treatment facilities to be developed and sited at the existing King County South Treatment Plant (South Plant) and supplied from existing plant secondary treated wastewater effluent
   - Scenario 2: Distribution of reclaimed water treated and produced from satellite polishing plants located around the Green River Valley and supplied from secondary treated wastewater effluent piped from the South Treatment Plant.
   - Scenario 3: Distribution of reclaimed water treated and produced at satellite treatment plants located around the Green River Valley and supplied from local raw wastewater conveyance system flows at each plant location.
2. How much reclaimed water might be made available through each production/delivery scenario?
3. What can be estimated about the relative capital and operating costs for each production/delivery scenario?
4. What appears to be the most feasible approach to producing and delivering reclaimed water in the Green River Valley based on preliminary estimated costs, capacities, demands, and operational issues?

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2.3 Study Area

The Green River Valley reclaimed water study area encompasses approximately 55,000 acres and includes the Cities of Auburn, Covington, Kent, Renton, and Tukwila, as well as a few small localized unincorporated, as shown previously in Figure 1-1. Within the study area, local jurisdictions and agencies provide local collection and conveyance of wastewater to the regional King County wastewater conveyance network which routes flows to the King County South Treatment Plant (South Plant), located in Renton. South Plant provides treatment of wastewater flows to secondary effluent standards, and also currently includes a small 1.26 million gallon per day (mgd) reclaimed water treatment facility that further treats plant secondary effluent to support reclaimed water irrigation and use on onsite and within areas or Renton and Tukwila.

As shown in Figure 2-1, much of the study area lies along the Green River Valley floor, where ground surface elevations typically range from 15 to 30 ft above sea level in Renton and Tukwila, 20 to 50 ft above sea level in Kent, rising to the 50 to 70 ft above sea level range in Auburn, with higher elevations rising to 400 ft above sea level and higher up the slopes of the valley walls to the east and west in Kent, east into Covington, and south in Auburn.

A composite aerial photograph image of the study area depicting development densities and surface features is included as Figure 2-2. Study area population distributions and present land use are depicted in Figures 2-3 and 2-4 respectively. As shown in the figures, the lower elevations of the Green River Valley floor show a preponderance of concentrated commercial and industrial land use as well as some multi-family residential areas, with greater concentrations of single family residential areas and higher resident populations up the slopes of the valley walls to the east, west, and south. Land use for the study area breaks down approximately as follows:

- Less than 1 percent Agricultural
- 19 percent Commercial
- 10 percent Industrial
- 3 percent Institutional and Community
- 7 percent Multi-Family Residential
- 4 percent Parks and Open Space
- 42 percent Single Family Residential
- 15 percent Public Right of Way

The year 2000 census population estimate for the study area totals approximately 207,000 residents. King County population as a whole grew by approximately 11 percent between 1994 and 2004, and is currently forecasted to increase further by approximately 15 percent by 2022 (*King County, 2004*). Given the growth rates anticipated for the County as a whole, population growth within the study area can be anticipated to be significant as well.

The potential for growth within the study area is reflected in King County wastewater flow volume forecasts for the area as well, which suggest an approximately 15 to 30 percent increase in estimated average dry weather flows from 2006 levels through 2016, and a further increase from 2016 through 2030 of approximately 20 to 30 percent.

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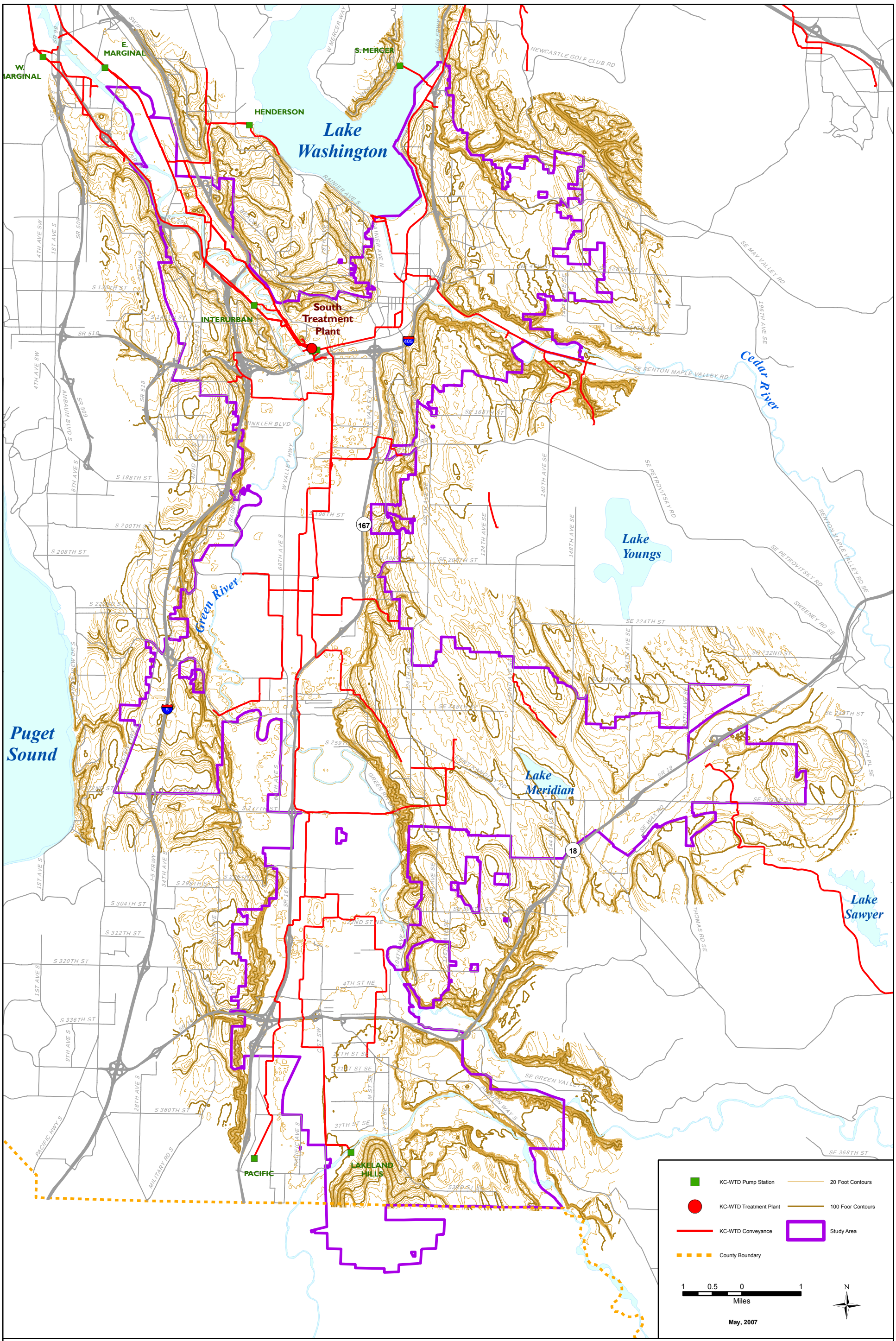

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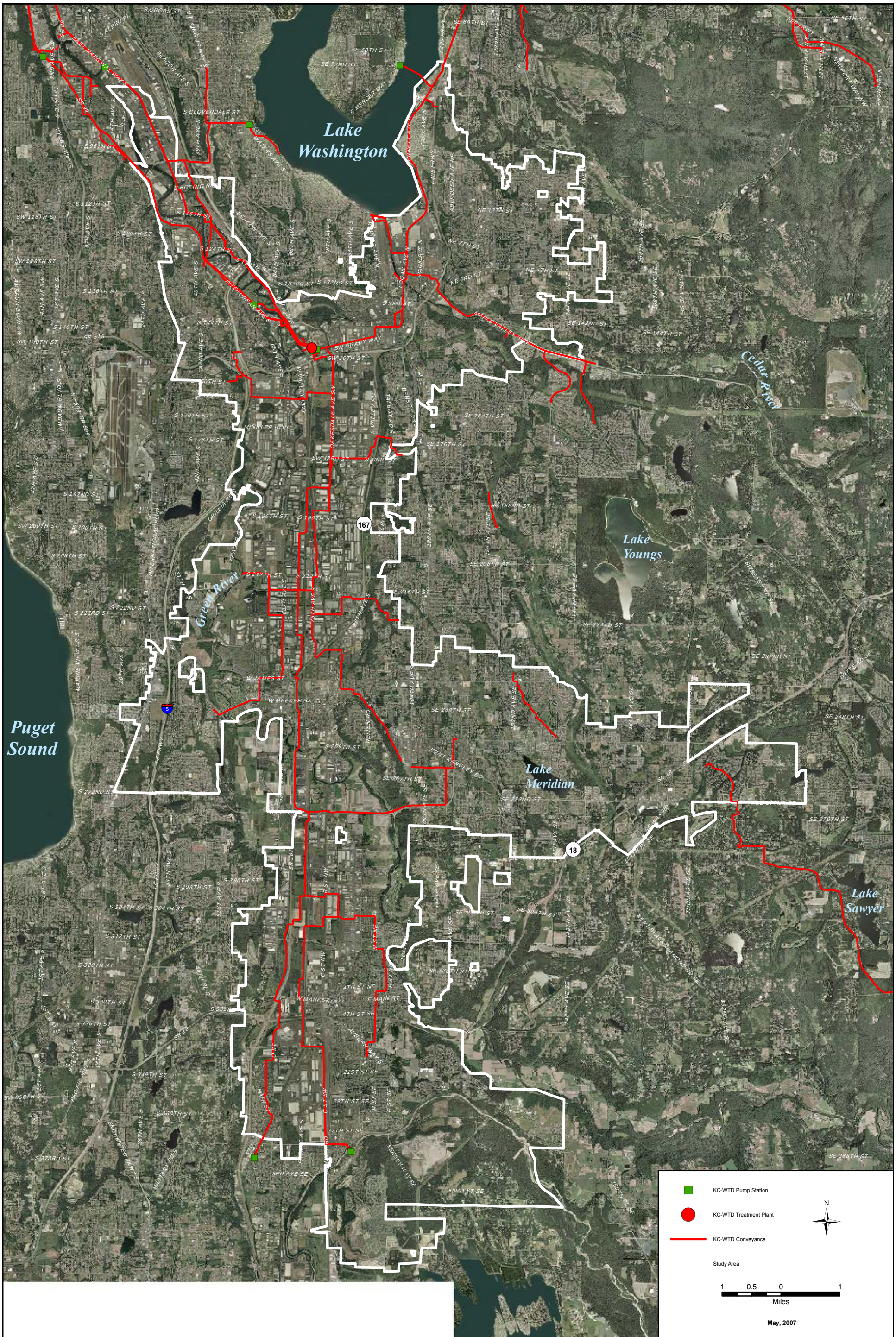
Green River Valley Reclaimed Water Study Area Detail

Figure 2-1. Green River Valley Reclaimed Water Study Area Detail



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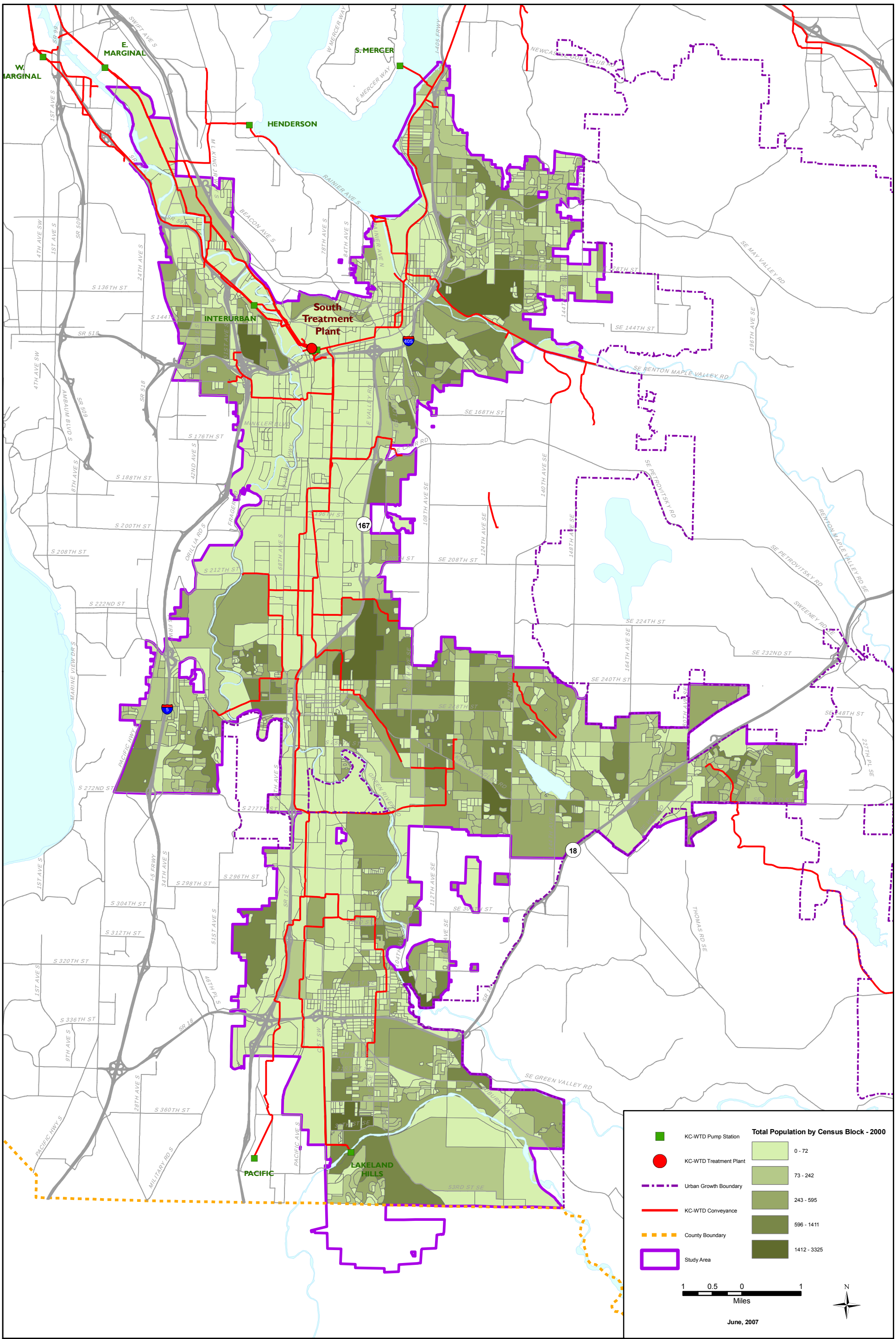
Green River Valley Reclaimed Water Study Area

Figure 2-2. Green River Valley Reclaimed Water Study Area Aerial Photograph



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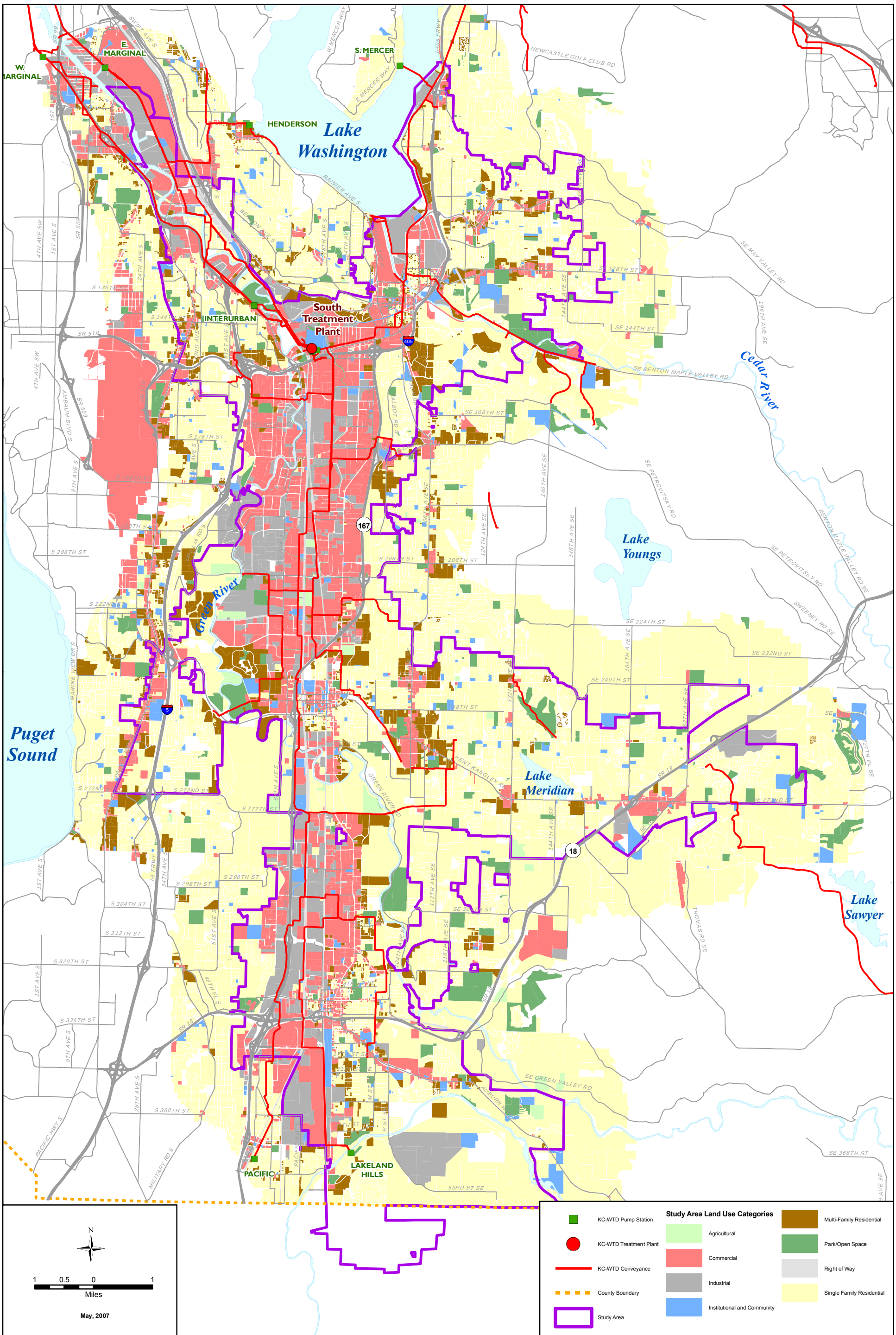
Green River Valley Reclaimed Water Study Area Population Distribution

Figure 2-3. Green River Valley Reclaimed Water Study Area Population Distribution



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Shaun O'Neil 20070523

Green River Valley Reclaimed Water Study Area Present Land Use

Figure 2-4. Green River Valley Reclaimed Water Study Area Land Use

3. SUMMARY OF ASSUMPTIONS AND DATA GAPS

This section summarizes the key assumptions and information sources that form the basis for the assessments and analyses presented in this tech memo and include Washington State reclaimed water standards and typical industry practice. Areas where additional information is likely needed to further refine and develop reclaimed water analyses are identified, and discussion regarding other related issues and considerations regarding reclaimed water use and system implementation is included.

3.1 Key Assumptions, Information Sources, and Additional Information Needs

In order to provide preliminary assessment and analyses of reclaimed water options in the Green River Valley, a number of assumptions and information sources are employed. Table 3-1 summarizes key assumptions, requirements, information sources, and additional information needs related to potential types of reclaimed water use within the study area. Assumed performance and design criteria and levels of service utilized to facilitate the analysis of Green River Valley reclaimed water supply scenarios are summarized in Table 3-2, along with associated information sources and additional information needs. These tables summarize the basis for analyses of Green River Valley reclaimed water supply scenarios, and identify areas where additional information might be sought to further refine, develop, and assess these scenarios in the future. Definitions for key terms in the table are also included in each subsequent tech memo section.

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Table 3-1. Potential Reclaimed Water Use - Key Assumptions, Requirements, Information Sources, and Additional Information Needs

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Reclaimed Water Requirements for Potential Types of Use			
Irrigation			
- Agricultural NonFood Crops	- Requires Class C, D, or better reclaimed water depending on specific crops types	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
- Agricultural Food Crops	- Requires Class A, B, D, or better reclaimed water depending on specific crop types	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
- Landscaping - Cemeteries, Commercial, Golf Course, Office Parks, Parks, Street Right of Way, Schools, and Wildlife Areas	- Requires Class A or better reclaimed water for open access areas, Class C or better reclaimed water for restricted access areas	WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Other			
- Street Cleaning	- Requires Class A, C, or better reclaimed water depending on street cleaning use	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
- Dust Control	- Requires Class C or better reclaimed water	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Industrial			
- Cement/Concrete	- Requires Class C or better reclaimed water	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
- Gravel Washing	- Requires Class C or better reclaimed water	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
- Boiler Feed	- Requires Class C or better reclaimed water	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
- Cooling Water	- Requires Class A, C, or better reclaimed water depending on type of cooling	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
- Process Water	- Requires Class A or better reclaimed water for human exposure areas, Class C or better reclaimed water for nonhuman exposure areas	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements

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Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Reclaimed Water Requirements for Potential Types of Use			
Streamflow Augmentation	- Requires reclaimed water compliance with Federal Water Pollution Control Act, Chapter 90.48 RCW - Incorporation in area/utility planning	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Wetlands Enhancement	- Requires Class A, B, C, D, or better reclaimed water depending on wetland types - Limits on hydraulic loading, water levels, reclaimed water quality and contaminant loading rates apply - Biological, ground water protection, and environmental benefit criteria apply - Ongoing monitoring is required	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Groundwater Recharge			
- Infiltration/Surface Percolation	- Requires secondary wastewater treatment nitrogen removal and Class A or better reclaimed water along with an Ecology delegated wastewater pre-treatment program or waste discharge permits for all applicable discharges - Incorporation in area/utility planning required	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
- Potable Groundwater Aquifer Injection/Direct Recharge	- All known, available, and reasonable methods of contaminant prevention, control, and treatment required, including Class A and Reverse Osmosis treatment, - Water quality to be consistent with Table 1 Chapter 173-200 WAC (excluding nitrate) and Chapter 246-290 maximum contaminant levels and goals with turbidity, nitrogen, TOC, limited to 0.1 NTU, 10 mg/L as N, and 1.0 mg/L respectively - Aquifer withdrawals to be consistent with Chapters 173-136 and 173-150 WAC - Incorporation in area/utility planning required - Ecology delegated wastewater pre-treatment program or waste discharge permits for all applicable discharges required - 12 months underground retention required prior to withdrawal for drinking water supply with withdrawal points at least 2000 ft away from injection points - Groundwater monitoring well sampling and monitoring program required - Pilot plant treatment study required	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
- NonPotable Groundwater Aquifer Injection/ASR/Direct Recharge	- All known, available, and reasonable methods of contaminant prevention, control, and treatment required, including Class A treatment with BOD and TSS limited to 5.0 mg/L - Aquifer withdrawals to be consistent with Chapters 173-136 and 173-150 WAC - Incorporation in area/utility planning required - Ecology delegated wastewater pre-treatment program or waste discharge permits for all applicable discharges required - Groundwater monitoring well sampling and monitoring program required	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Potential Green River Valley Study Area Reclaimed Water Uses			
Irrigation	- Potential irrigation use and locations estimated for study area agricultural, commercial, industrial, institutional and community, and park/open space parcels larger than 1 acre in size, and for Right of Ways, based on GIS land use information, GIS pervious/impervious areas data, and assumptions regarding irrigation application rates, implementation, and water use trending based on available data	- USGS Scientific Investigations Report 2004-5015, Estimated Domestic, Irrigation, and Industrial Water Use in Washington, 2000	- Information regarding potential irrigation use, timing, volumes, and locations
Industrial	- Potential industrial uses and locations unknown - Some study area jurisdictions have expressed potential interest		- Information regarding potential industrial use, timing, volumes, and locations
Streamflow Augmentation	- Potential use and augmentation locations unknown - Some study area jurisdictions have expressed potential interest		- Information regarding potential streamflow augmentation use, timing, volumes, and locations
Wetlands Enhancement	- Potential use and enhancement locations unknown - Some study area jurisdictions have expressed potential interest		- Information regarding potential wetlands enhancement use, timing, volumes, and locations
Groundwater Recharge	- Potential use and recharge locations and methods unknown - Some study area jurisdictions utilizing groundwater resources for water supply may have interest - Study area jurisdictions have expressed interest in potentially upwards of 18 mgd reclaimed water supply for groundwater recharge		- Information regarding potential groundwater use, timing, volumes, locations, and recharge methods
Other (such as street cleaning and dust control)	- Potential uses and locations unknown - Some study area jurisdictions may have interest in reclaimed water use for street cleaning and/or dust control - Street cleaning and/or dust control use unlikely to be significant relative to overall reclaimed water use potential		
Total Potential Reclaimed Water Use and Timing	- 2016: 15 mgd maximum day demand - 2020: 35 mgd maximum day demand - 2030: 50 mgd maximum day demand	- Preliminary study area jurisdiction and King County estimates	- Information regarding potential use, timing, volumes, and locations

Table 3-2. Performance and Design Criteria and Levels of Service - Key Assumptions, Requirements, Information Sources, and Additional Information Needs

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Reclaimed Water Demand Variability	- Consistent with typical demand curve patterns according to anticipated study area usage, demands, and patterns - Monthly irrigation demand variability estimated from regional monthly water demand estimates relative to annual base demands - Irrigation maximum day demand (MDD) estimated as twice the peak month irrigation average daily demand (ADD) - Irrigation peak hourly demand (PHD) estimated as twice to three times irrigation MDD	- Typical Industry Practice - Regional monthly water demand estimates - WSDOH Water System Design Manual, August 2001	- Anticipated future reclaimed water requirements - Jurisdictional metered customer water use analyses and trending to further estimate and quantify potential reclaimed water demand variability in each category of potential use
Typical Irrigation Application Rates	- Consistent with established and representative agronomic rates	- USGS Scientific Investigations Report 2004-5015, Estimated Domestic, Irrigation, and Industrial Water Use in Washington, 2000	- Information regarding potential irrigation use, timing, volumes, and locations
Wastewater Conveyance			
Available Wastewater Flows	- King County metered wastewater flow estimates and forecasts	- King County	- Information regarding conveyance system infrastructure - Flow estimates and forecasts for additional locations to further refine future reclaimed water resource and use assessments
Minimum flows and system flushing requirements	- Maintain minimum flows and adequate flushing velocities at least 2 ft/s at sufficient frequencies to mobilize solids and limit accumulation	- Typical Industry Practice	
Measures and requirements to ensure odor control	- Maintain minimum flows and adequate flushing velocities at least 2 ft/s at sufficient frequencies to mobilize solids and limit accumulation	- Typical Industry Practice	

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Reclaimed Water Standards			
Water Quality	- Class A water quality to provide reclaimed water that is at all times an oxidized, coagulated, filtered, and disinfected wastewater to include daily water quality compliance sampling, monitoring, and reporting	- Supports broadest range of use under WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Disinfection treatment dosing and contact time requirements	- 1.0 mg/L minimum chlorine residual following a 30 minute minimum chlorine contact time or better as required to meet WSDOH pathogen reduction requirements	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Minimum disinfection residual	- 0.5 mg/L minimum chlorine residual for conveyance and distribution to points of use	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Minimum service pressure	- 20 psi minimum pressures for delivery for use	- Pressures may be increased through pumping by end users on site if needed	
Maximum service pressure	- 120 psi maximum pressure practical given typical pressure ratings and factors of safety for pipes, fittings, and appurtenances and for consistency with typical potable water main operations	- Pressures may be reduced by end users on site if needed	
Maximum service interruptions and reliability	- Reclaimed water supply considered interruptible/nonessential due to potable water supply redundancy - Adequate provisions for redundant potable water supply to be provided where needed with appropriate cross connection control measures	- Common Industry Practice	
Continuous or seasonal service	- Continuous or seasonal based on uses and demand	- Typical Industry Practice	- Information regarding potential use, timing, volumes, and locations - Jurisdictional metered customer water use analyses and trending to further estimate and quantify potential reclaimed water demand variability in each category of potential use

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Reclaimed Water Treatment			
Microfiltration membrane treatment	- Not addressed under WSDOH/WSDOE Water Reclamation and Reuse Standards - WSDOH/WSDOE adoption of California standards for membrane treatment to show equivalency to filtration steps for Class A reclaimed water	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997 - WSDOE Frequently Asked Questions about Reclaimed Water Use, 05-10-012, January 2005	- Anticipated future reclaimed water requirements
Secondary wastewater effluent polishing treatment processes	- Provide a Class A oxidized, coagulated, filtered, disinfected wastewater, with an Ecology delegated wastewater pre-treatment program or waste discharge permits for all applicable discharges - South Plant membrane bio reactor (MBR) treatment of primary wastewater effluent, to include screening, aeration, MBR, disinfection, storage, and reclaimed water pumping to local distribution systems - Satellite or South Plant membrane filtration treatment of secondary wastewater effluent, to include screening, membrane filtration, disinfection, storage, and reclaimed water pumping to local distribution systems	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997 - WSDOE Frequently Asked Questions about Reclaimed Water Use, 05-10-012, January 2005	- Anticipated future reclaimed water requirements
Satellite treatment processes	- Provide a Class A oxidized, coagulated, filtered, disinfected wastewater, with an Ecology delegated wastewater pre-treatment program or waste discharge permits for all applicable discharges - MBR treatment of raw wastewater influent from King County conveyance system, to include influent pumping, screening, grit removal, aeration, MBR, disinfection, storage, and reclaimed water pumping to local distribution systems	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997 - WSDOE Frequently Asked Questions about Reclaimed Water Use, 05-10-012, January 2005	- Anticipated future reclaimed water requirements
Capacity	- Sufficient to support anticipated MDD	- Typical Industry Practice	
Reclaimed water facility aesthetics	- Architectural and landscaping treatments to screen and blend facilities into local settings and aesthetics	- Typical Industry Practice	
Odor control measures	- Fully enclosed treatment facilities with active odor control measures	- Typical Industry Practice	
Waste stream management and solids handling	- Return waste flows to wastewater conveyance/process - Waste stream flows from reclaimed water treatment processes contain 1 to 2 percent solids or less	- Typical Industry Practice	
Alternative disposal of any untreated wastewater	- Wastewater storage and/or means for alternative disposal of untreated or partially treated waste water required	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Facility automation and staffing	- Qualified operations personnel sufficient to achieve required levels of treatment at all times per Chapter 173-230 WAC	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Facility personnel/operations areas	- As required to support anticipated staffing and operations	- Typical Industry Practice	
Facility siting	- Commercial and Industrial Areas	- Typical Industry Practice	- Potential facility siting alternatives

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Transmission and Distribution Pumping	- As required by uses, topography, service pressures, and hydraulics sufficient to support anticipated peak demands	- Typical Industry Practice	
Transmission and Distribution Piping			
Diameters	- As required by uses, topography, service pressures, and hydraulics sufficient to support anticipated peak demands	- Typical Industry Practice	
Maximum pipeline flow velocities	- Generally 6 to 8 ft/s	- Typical Industry Practice	
Alignment	- Public right of way, - Private easements only as required	- Typical Industry Practice	
Pipe looping	- As hydraulically appropriate and feasible but generally not required for interruptible systems	- Typical Industry Practice	
Depth of cover	- Typical potable water main depth of cover, 3' to 4' minimum	- Typical Industry Practice	
Valve locations and frequency	- Typical potable water main locations and frequency	- Typical Industry Practice	
Flushing station locations and frequency	- Typical potable water main locations and frequency	- Typical Industry Practice	
Potable water pipe separation requirements	- 10' Horizontal - Reclaimed water pipes to pass 1.5' under potable water pipes at crossings	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Setbacks	- 50' to 500' setback required between potable water supply wells and Class A reclaimed water facilities, infrastructure, and use areas depending on type	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Potable water cross connection control devices	- Reduced pressure principal back flow prevention devices or approved air gap separations required	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Materials	- Typical potable water main piping, including Ductile Iron or PVC, with purple reclaimed water color coding and labeling	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Standards	- AWWA, ANSI water main standards	- Typical Industry Practice	
Storage			
Untreated/Partially Treated Wastewater Storage where No Approved Alternative Wastewater Disposal System Exists	- Emergency storage or alternate permitted discharge locations required for use during reclamation system upset or failure conditions - Wet weather conditions storage required for the duration of a 10-year storm or at least 3 times that portion of the average daily flow for which no alternative disposal system is permitted	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Treated Reclaimed Water Storage			
- Operational	- As hydraulically needed to support suction supply and cycling for reclaimed water supply pumping	- Typical Industry Practice	
- Peaking	- Reclaimed water transmission and distribution piping and pumping systems sized to support anticipated MDD - Demands exceeding MDD provided through system and/or customer provided treated reclaimed water storage - Peaking storage volume estimated as the difference between PHD and MDD for a total daily duration of 3 hours, which generally equates to a volume equal to 0.25 MDD	- Typical Industry Practice - WSDOH Water System Design Manual, August 2001	
- Emergency/Standby	- None given potable water supply redundancy	- Typical Industry Practice	

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Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Agency Reclaimed Water Responsibility			
Local Agencies	- Where reclaimed water production and uses are identified as under the direct control of a local jurisdiction, the local jurisdiction shall maintain control and responsibility for all facilities and activities inherent to reclaimed water use to ensure that the local jurisdiction's portion of the system operates as intended and in compliance with all State requirements	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements - Desired local, county, and regional responsibilities and agreements
King County	- Where reclaimed water production and uses are identified as under the direct control of the County, the County shall maintain control and responsibility for all facilities and activities inherent to reclaimed water use to ensure that the County's portion of the system operates as intended and in compliance with all State requirements	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements - Desired local, county, and regional responsibilities and agreements

3.2 Implementation Issues and Considerations

Beyond the basic reclaimed water system considerations, there are a number of other implementation issues and considerations that can be critical. These include:

- Public concerns and acceptance
- Potable water utility revenue offsets and supply limitations
- Regulatory requirements
- Coordination, cooperation, and agreements between reclaimed water agencies and customers/users

The following section briefly describes each of these implementation considerations.

Public Concerns and Acceptance

The significance of public concerns related to reclaimed water will likely impact decisions regarding the scale and type of reclaimed water system that may eventually be implemented. Significant public concerns persist nationally and within Washington State despite increasing implementation of reclaimed water systems and cautious positions and precautions taken in terms of reclaimed water legislation, standards, rules, and requirements. Public involvement, outreach, education, and buy-in are typically critical considerations for reclaimed water implementation given typical public concerns regarding inadvertent public exposure and water quality contaminants and constituents of concern which may be as yet unknown/unidentified and potentially not effectively removed in reclaimed water treatment.

Potable Water Utility Revenue Offsets and Supply Limitations

Reclaimed water use typically offsets and reduces potable water use as reclaimed water is implemented for supply needs that have been historically met through potable water supplies. Such reductions in potable water use can result in decreased utility revenues that can serve as a disincentive to reclaimed water implementation for certain communities and utilities. This can be especially significant for use during the summer irrigation months when potable water use, usage fees/rates, and associated utility revenues typically peak. As such, reclaimed water systems are often most viable in areas where existing potable water supplies have become limited, additional new or expanded potable water supplies are expensive relative to reclaimed

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water options, or other local and regional drivers create economic incentives for reclaimed water implementation.

Regulatory Requirements

The September 1997 Water Reclamation and Reuse Standards prepared jointly by the Washington State Department of Health (WSDOH) and the Washington State Department of Ecology (WSDOE) are due to be updated and replaced with more formal WSDOE reclaimed water rules by December 31, 2010. Reclaimed water planning must thus take into consideration not only the existing 1997 Standards, but also the anticipated requirements of the forthcoming WSDOE rules, which will likely include updated requirements for membrane treatment.

Coordination, Cooperation, and Agreements between Reclaimed Water Agencies and Customers/Users

As detailed in the WSDOH/WSDOE Water Reclamation and Reuse Standards, close coordination, cooperation, and formal agreements are required for reclaimed water systems that involve or affect multiple agencies. All associated roles and responsibilities must be clearly identified and defined in formal agreements prior to implementing reclaimed water systems. Given the multiple agencies and interests typically involved in reclaimed water systems, such processes can take significant amounts of time and require careful consideration.

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4. WASTEWATER FLOWS

This section provides estimates of available current and forecasted wastewater flows within the study area. These estimates form the basis of the locally available reclaimed water supply resource. The flow estimates are used in subsequent sections to estimate and characterize locally available reclaimed water supply resources at different locations within the study area.

4.1 Wastewater Flow Estimates and Forecasts

King County has developed preliminary wastewater flow estimates and forecasts for specific study area conveyance system metering locations for the years 2006/2007, 2016, and 2030. The study area metering locations for which the flow estimates and forecasts have been provided are located at:

- Boundary Blvd and O Street in Auburn
- 44th Street NW in Auburn
- 11326 SE 272nd Place in Kent
- 1301 SW 16th Street in Renton

Figures 4-1 and 4-2 present current dry and wet weather wastewater flow estimates respectively, to include maximum, minimum, and daily average flows. Figures 4-3 and 4-4 present dry and wet weather wastewater flow forecasts for the study area through 2030. These wastewater flows can generally be viewed as the available reclaimed water supply resource for the Green River Valley. Additional wastewater flows are conveyed to South Plant through Tukwila from areas northwest and through Renton from areas northeast. Expected ranges of dry and wet weather wastewater flows showing anticipated trending over time for each flow metering location and for total South Plant wastewater flows are presented graphically in Figures 4-5 through 4-9. Expected dry weather wastewater flow trends are presented in terms of current and forecasted minimum, average, and maximum flows. Current and forecasted average wet weather wastewater flows are also shown, along with recent data for maximum and minimum wet weather flow values.

In terms of wastewater use for reclaimed water supply, summer dry weather wastewater flows can be viewed as a limiting supply constraint due to the fact that water use, both in terms of potable and potential reclaimed water demand, typically peak during the summer months as well. As such, dry weather wastewater flows form the basis of the available reclaimed water supply resource for the various areas within the study area.

Based on the dry weather average wastewater flow metering data and forecasts provided, Table 4-1 presents rough estimates of the average dry weather wastewater flows that may be available around the study area for reclaimed water supply. Available flows for areas around Auburn were roughly estimated as those represented for the 44th Street NW and 11326 SE 272nd Place flow metering locations. Available flows for areas around Kent and Covington were roughly estimated according to the difference between Auburn area flows and those represented for the 1301 SW 16th Street flow metering location. Available flows for areas around Renton and Tukwila were roughly estimated according to the difference between Auburn and Kent area flows and those represented for South Plant.

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Table 4-1. Local Average Dry Weather Wastewater Flows Available for Reclaimed Water Supply

Area	Estimated Locally Available Reclaimed Water Supply (mgd)[1]		
	2006	2016	2030
Auburn Area	10	13	17
Kent Area	12	13	15
Renton/Tukwila Area	42	60	72
Total	65	86	104

Notes:

1. Estimated from King County flow metering location data and forecasts

4.2 Growth and Infiltration/Inflow Effects

The King County wastewater flow estimates include allowances for both growth and water conservation. Growth tends to proportionately increase water use and corresponding wastewater flows, while water conservation efforts can reduce user specific water usage rates and corresponding wastewater flows.

As shown in the Figures 4-5 through 4-9, the King County flow forecasts generally indicate an upward trend of increasing flow over time reflecting anticipated growth and development within the study area, with some initial downward trending related to expected increases in water conservation. Some of the wet weather flow forecasts show a decreasing near term trend due the fact that current flow data for 2006 reflect a wetter than average wet weather season, whereas future wet weather flow forecasts are reflect an average wet weather season projection. Including allowances for estimated growth and water conservation effects, the study area wastewater flow volume forecasts suggest an approximately 15 to 30 percent increase in estimated average dry weather flows from 2006 levels through 2016, and a further increase from 2016 through 2030 of approximately 20 to 30 percent.

Both wet and dry weather wastewater flows can also be influenced by groundwater infiltration and surface inflows to wastewater conveyance systems. Thus while growth and infiltration/inflow (I/I) tend to increase wastewater flows, conservation efforts and efforts to control I/I can stabilize and even reduce system flows.

Due to the effects of infiltration and inflow on wastewater conveyance systems, wet weather flows will typically exceed dry weather flows by as little as 10 percent to as much as 50 percent or more. Allowances for the effects of growth and anticipated conservation on existing and anticipated future wastewater flows have been included in the King County flow estimates and forecasts. Potential effects of efforts to reduce I/I, which could tend to have some impact on wet weather flows but likely little if any impact on dry weather flows, are not included in the wastewater flow volume forecasts.

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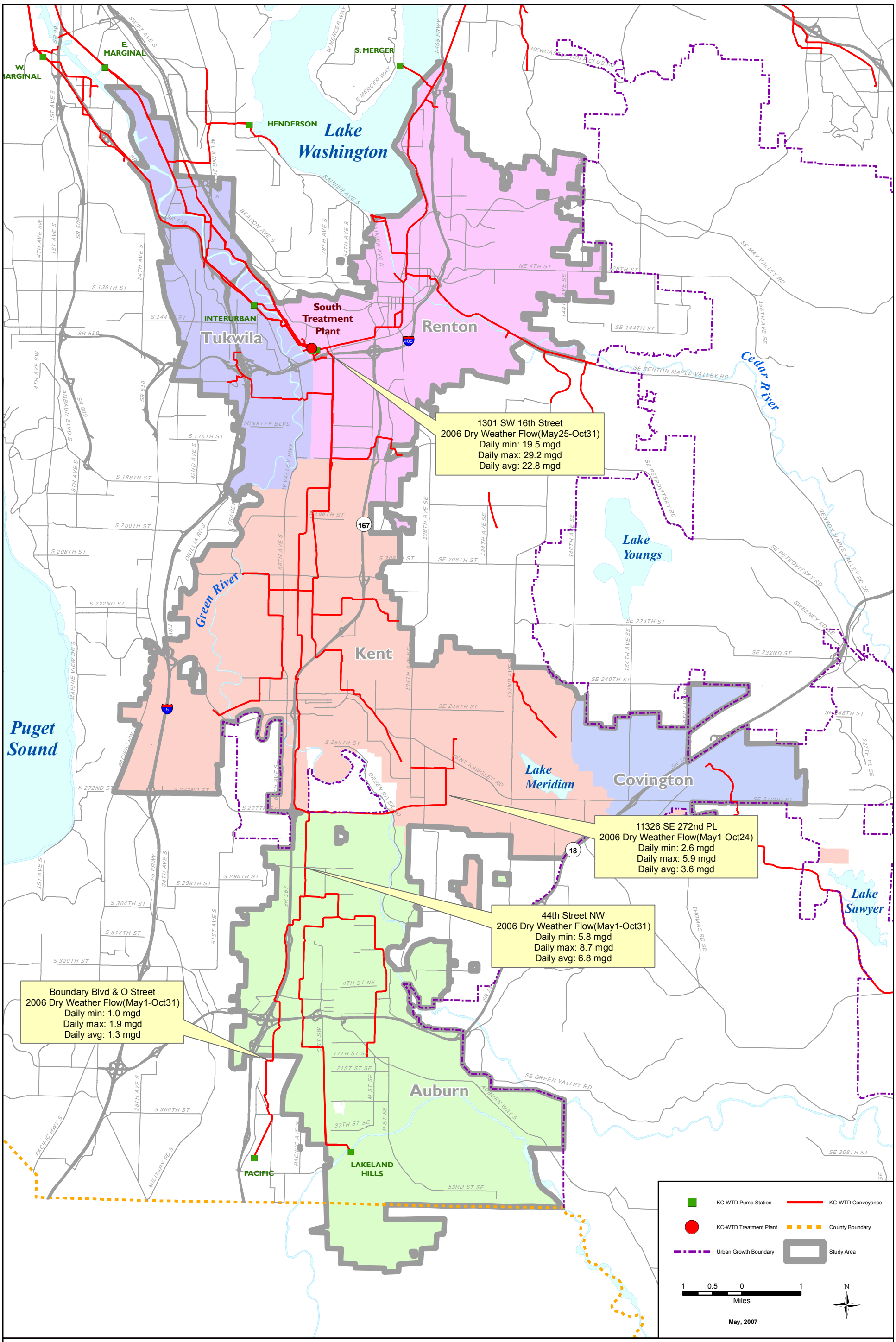

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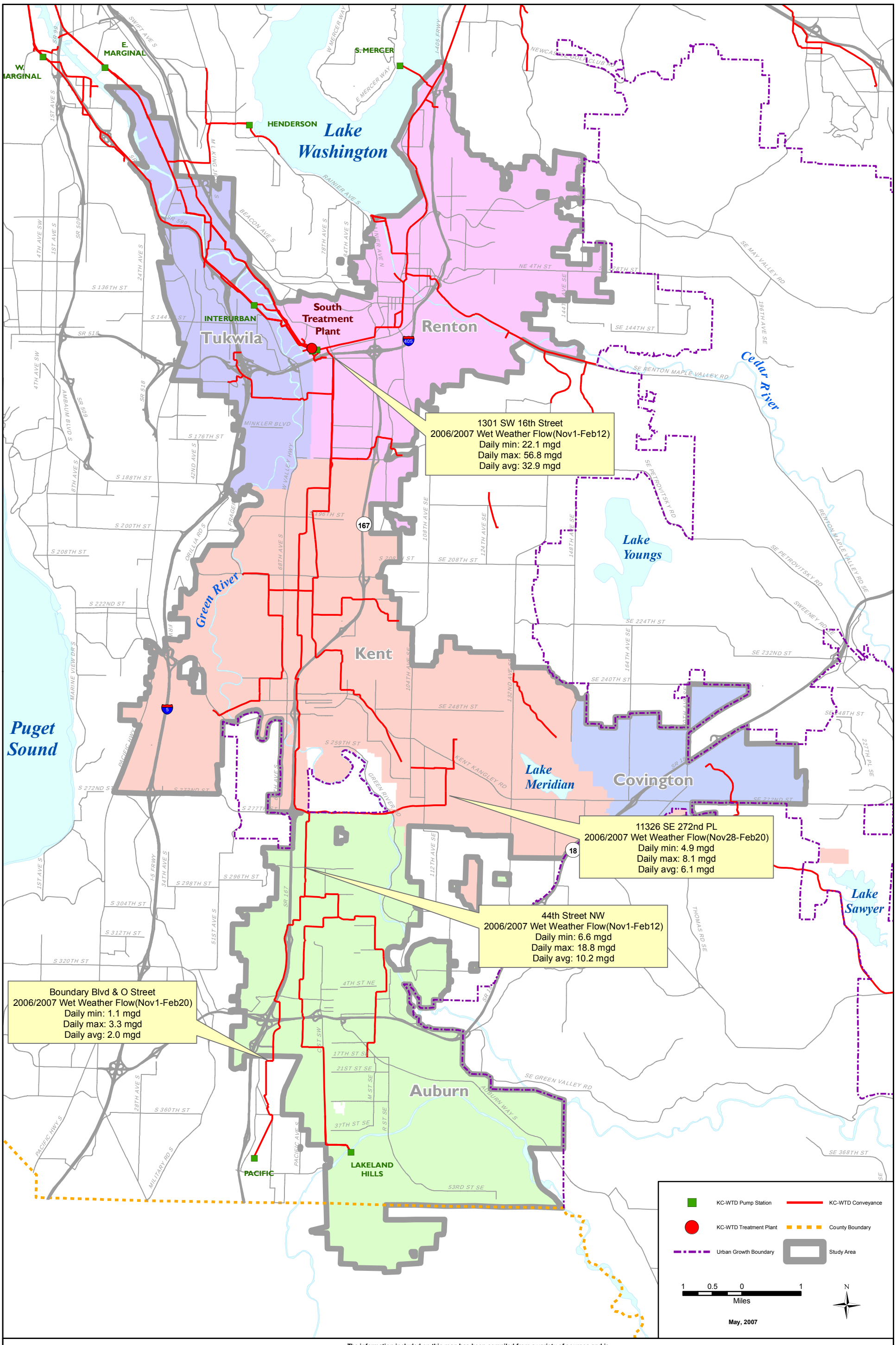
File Name: //dnrp1/projects/wtd/projects/waterreuse/projects/studyarea_flow_dry.mxd
Shaun O'Neil 20070514

Green River Valley
Reclaimed Water
Daily Dry Weather Flows
Based on 2006 Metered Flows

Figure 4-1. Green River Valley Daily Dry Weather Wastewater Flows



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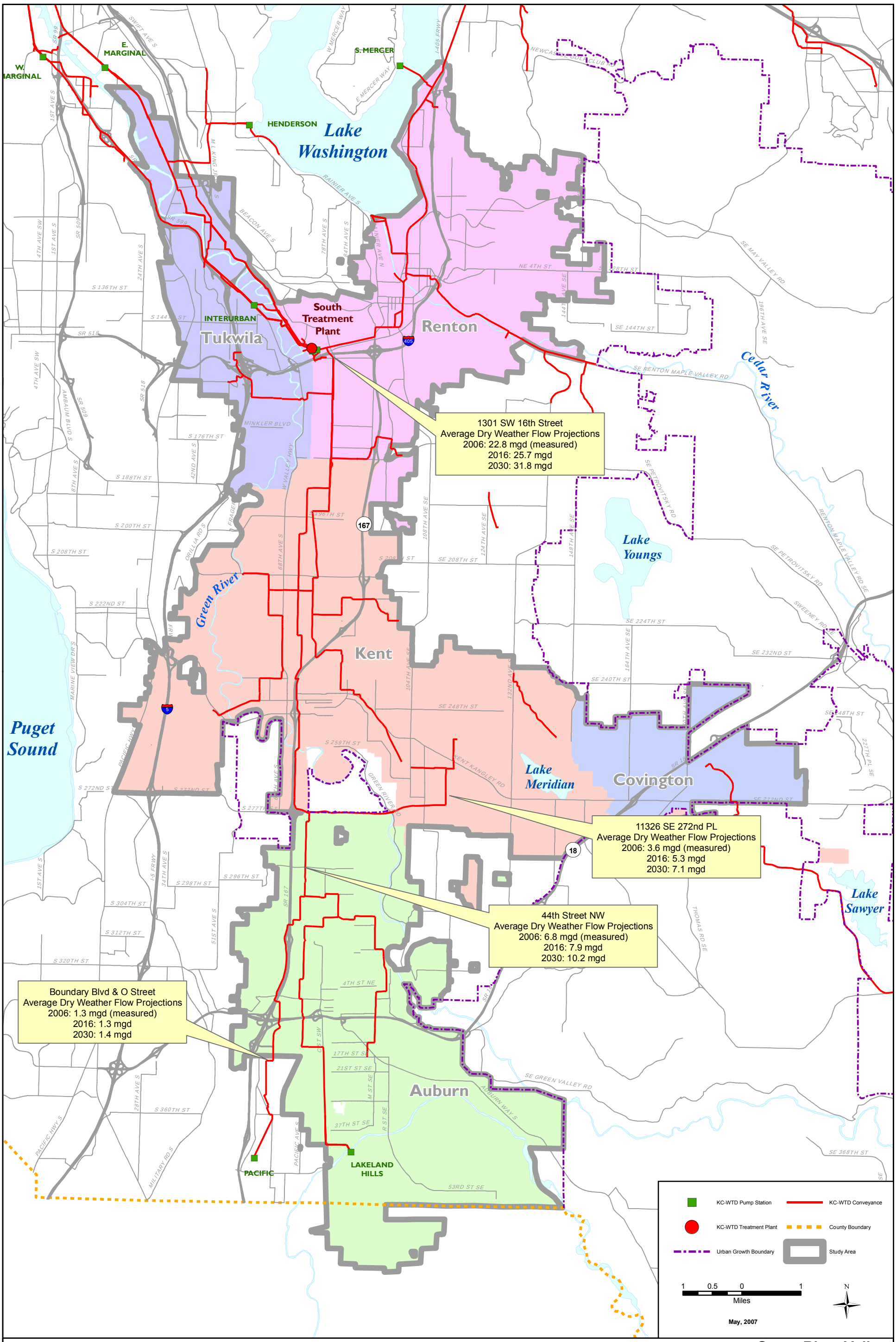
Green River Valley Reclaimed Water Daily Wet Weather Flows
Based on 2006/2007 Metered Flows

Figure 4-2. Green River Valley Daily Wet Weather Wastewater Flows



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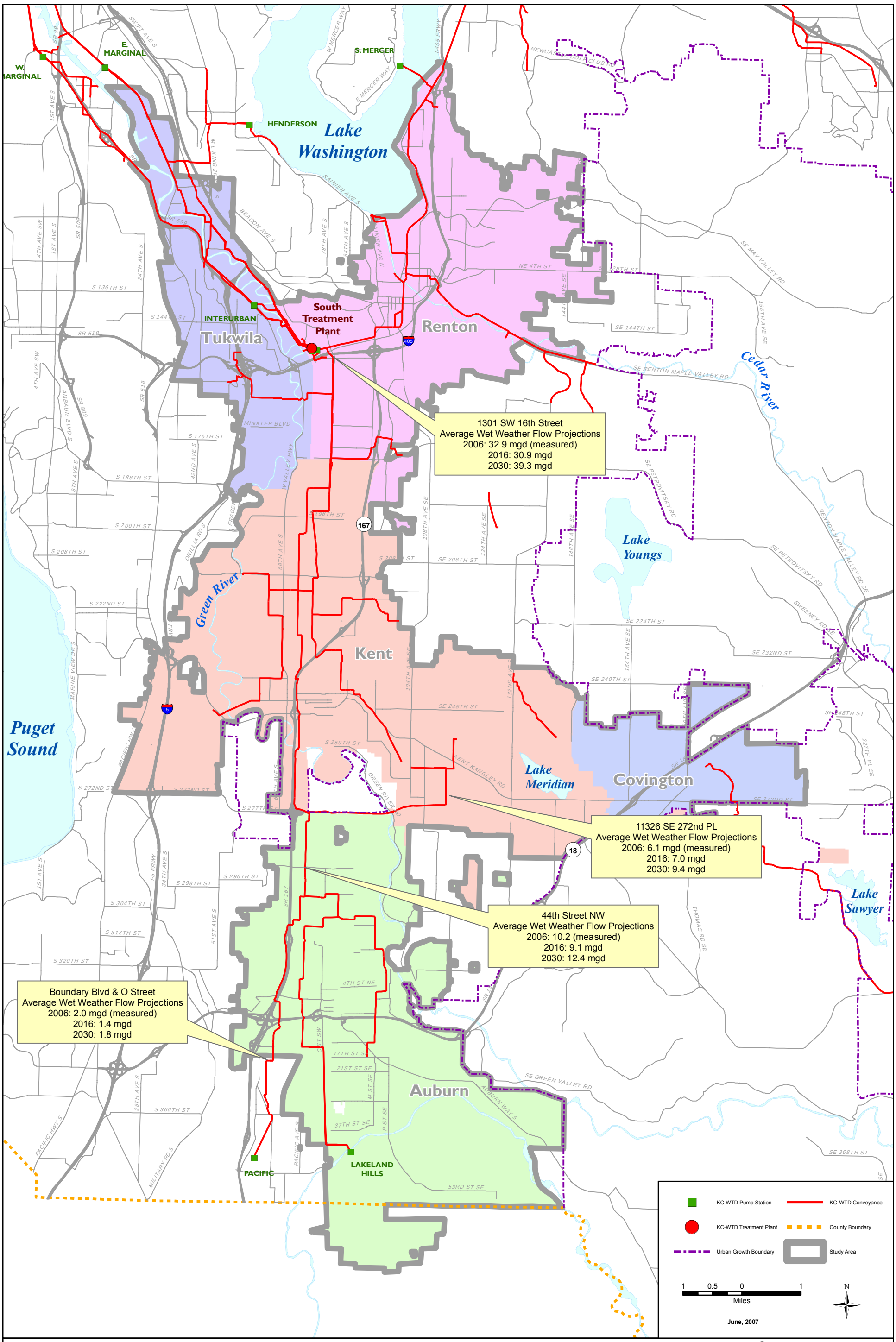
Green River Valley Reclaimed Water Daily Dry Weather Flows and Forecasts
2006 Measured Flows with 2016 and 2030 Forecasts

Figure 4-3. Green River Valley Daily Dry Weather Wastewater Flows and Forecasts



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File Name: //dnrp1/projects/wtd/projects/waterreuse/projects/studyarea_flow_future_wet.mxd
Shaun O'Neil 20070608

Green River Valley Reclaimed Water
Daily Wet Weather Flows and Forecasts
2006 Measured Flows with 2016 and 2030 Forecasts

Figure 4-4. Green River Valley Daily Wet Weather Wastewater Flows and Forecasts

Figure 4-5. Boundary Blvd and O Street, 2006 Wastewater Flows and Forecast

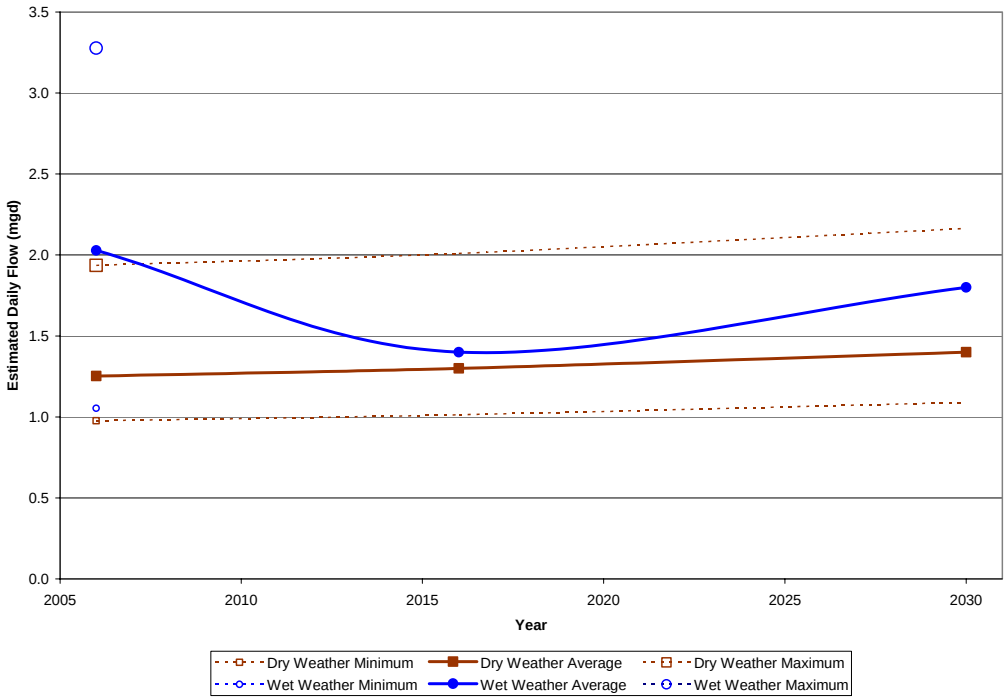


Figure 4-6. 44th Street NW, 2006 Wastewater Flows and Forecast

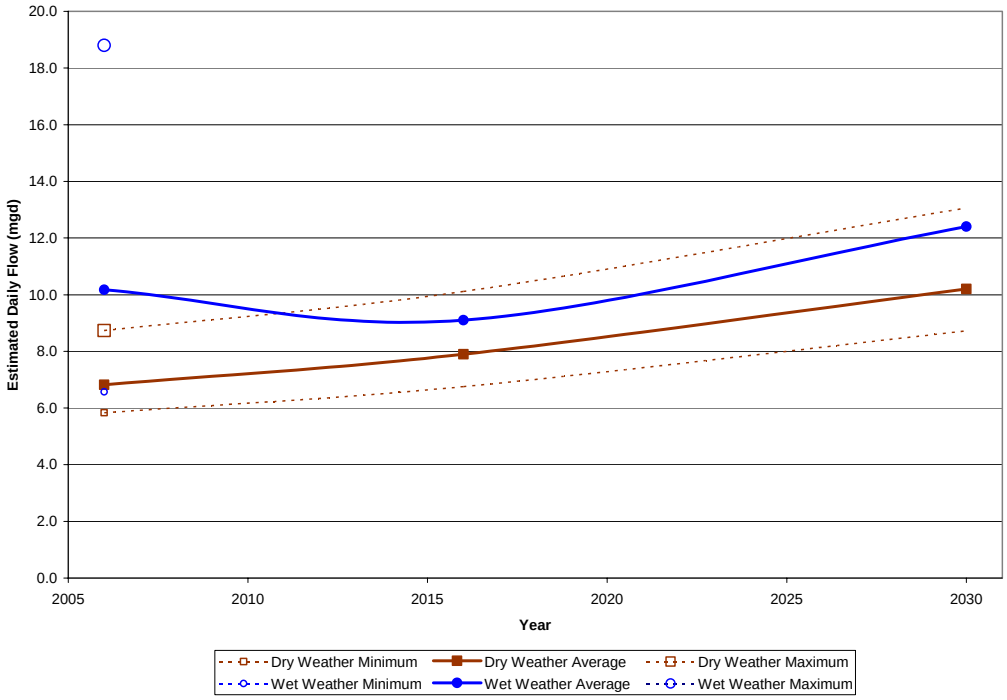


Figure 4-7. 11326 SE 272nd Place, 2006 Wastewater Flows and Forecast

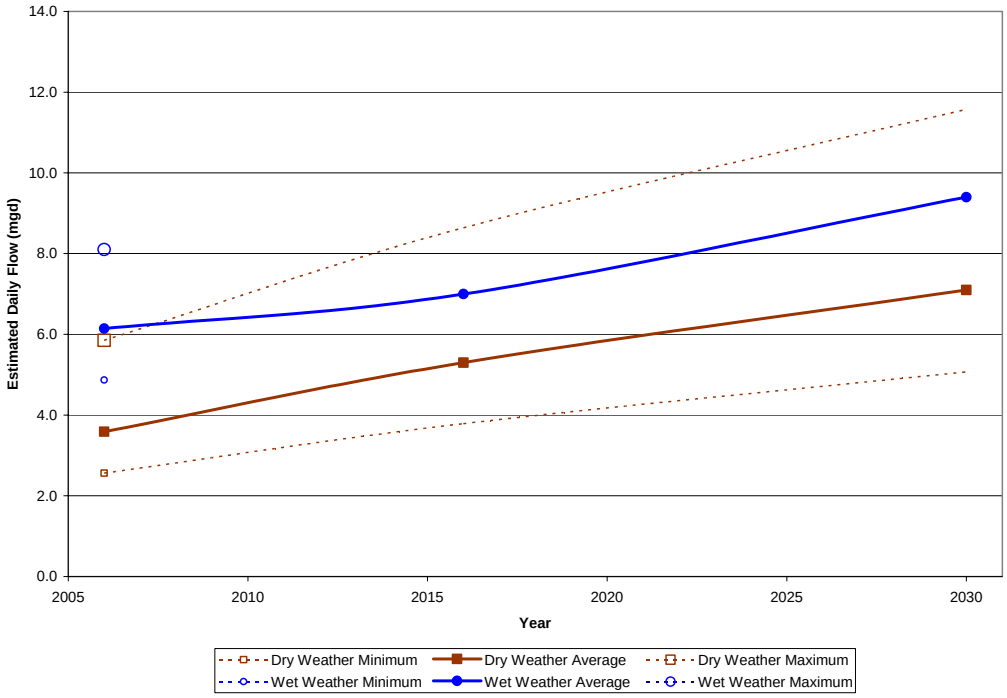


Figure 4-8. 1301 SW 16th Street, 2006 Wastewater Flows and Forecast

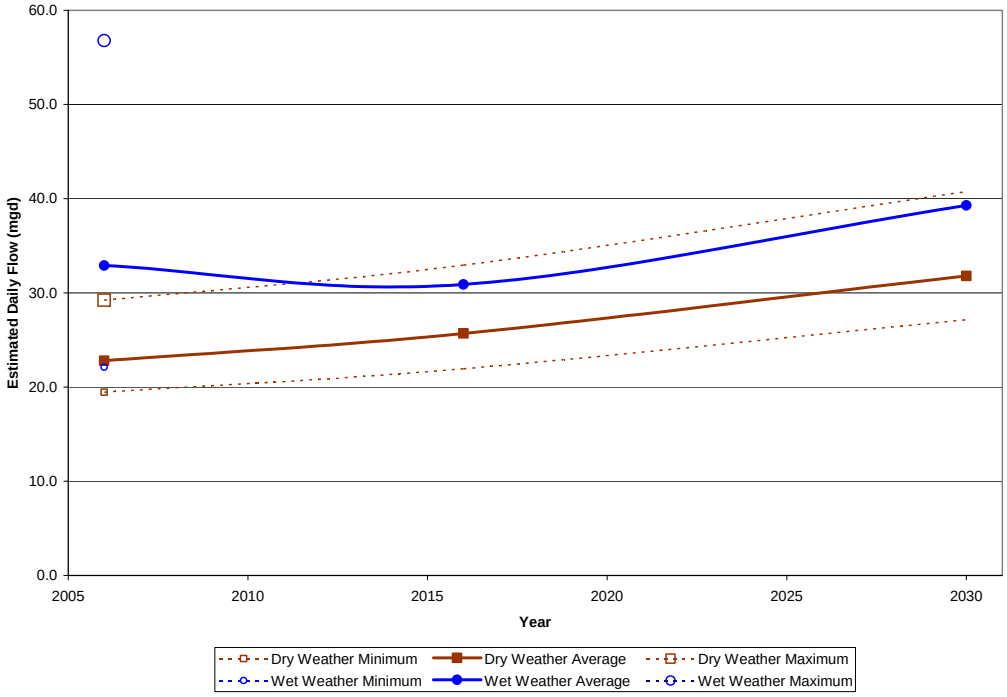
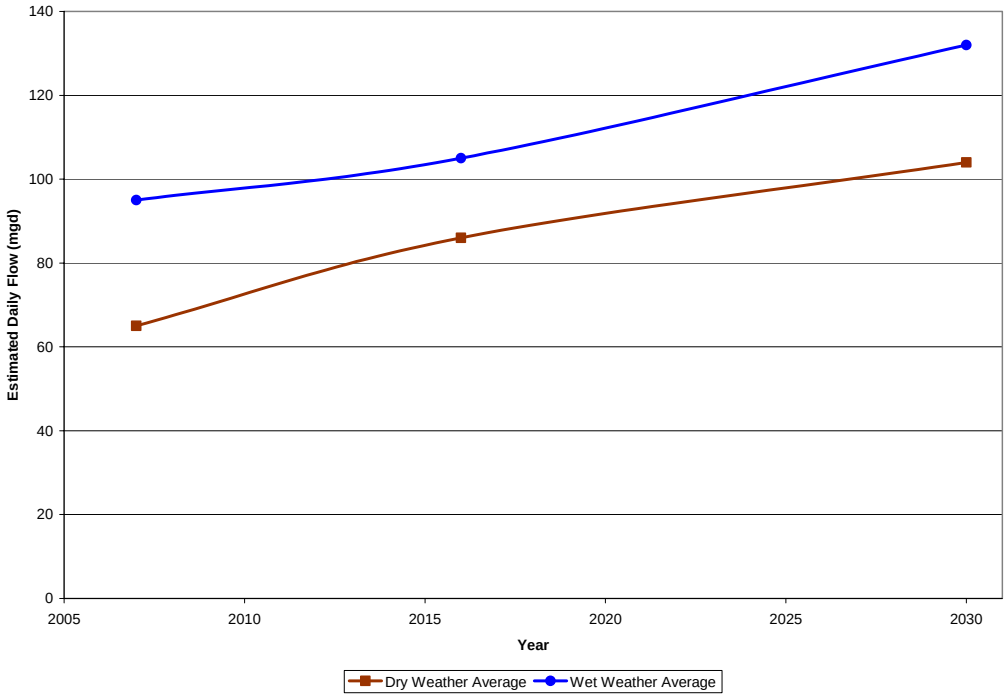


Figure 4-9. South Plant, 2007 Wastewater Flows and Forecast



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5. POTENTIAL RECLAIMED WATER DEMANDS

This section provides an overview of potential reclaimed water uses within the study area to include preliminary rough estimates of potential use for irrigation and possible groundwater recharge. Potential reclaimed water demands and demand pattern variability are estimated for locations around the study area as the basis for reclaimed water scenario analyses presented in subsequent sections.

5.1 Types of Potential Uses

Potential types of reclaimed water uses identified within the study area are summarized in Table 5-1 to include:

- Irrigation – Typically seasonal use only
    - Agricultural
    - Commercial including businesses and offices
    - Industrial
    - Institutional and Community
    - Park/Open Space including golf courses and forest, rural, urban reserve, and conservation areas
    - Right of Way
- Industrial Process – Seasonal to sustained year round uses
- Streamflow Augmentation – Typically seasonal use
- Wetlands Enhancement – Typically seasonal use, some potential for more sustained use in constructed wetlands
- Groundwater Recharge – Seasonal to sustained year round uses
- Other – Minor seasonal uses
    - Street Cleaning
    - Dust Control

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Table 5-1. Potential Reclaimed Water Use Summary

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Potential Green River Valley Study Area Reclaimed Water Uses			
Irrigation	- Potential irrigation use and locations estimated for study area agricultural, commercial, industrial, institutional and community, and park/open space parcels larger than 1 acre in size, and for Right of Ways, based on GIS land use information, GIS pervious/impervious areas data, and assumptions regarding irrigation application rates, implementation, and water use trending based on available data	- USGS Scientific Investigations Report 2004-5015, Estimated Domestic, Irrigation, and Industrial Water Use in Washington, 2000	- Information regarding potential irrigation use, timing, volumes, and locations
Industrial	- Potential industrial uses and locations unknown - Some study area jurisdictions have expressed potential interest		- Information regarding potential industrial use, timing, volumes, and locations
Streamflow Augmentation	- Potential use and augmentation locations unknown - Some study area jurisdictions have expressed potential interest		- Information regarding potential streamflow augmentation use, timing, volumes, and locations
Wetlands Enhancement	- Potential use and enhancement locations unknown - Some study area jurisdictions have expressed potential interest		- Information regarding potential wetlands enhancement use, timing, volumes, and locations
Groundwater Recharge	- Potential use and recharge locations and methods unknown - Some study area jurisdictions utilizing groundwater resources for water supply may have interest - Study area jurisdictions have expressed interest in potentially upwards of 18 mgd reclaimed water supply for groundwater recharge		- Information regarding potential groundwater use, timing, volumes, locations, and recharge methods
Other (such as street cleaning and dust control)	- Potential uses and locations unknown - Some study area jurisdictions may have interest in reclaimed water use for street cleaning and/or dust control - Street cleaning and/or dust control use unlikely to be significant relative to overall reclaimed water use potential		
Total Potential Reclaimed Water Use and Timing	- 2016: 15 mgd maximum day demand - 2020: 35 mgd maximum day demand - 2030: 50 mgd maximum day demand	- Preliminary study area jurisdiction and King County estimates	- Information regarding potential use, timing, volumes, and locations

5.2 Demands and Variations

As summarized in Table 5-1 preliminary discussions between King County and representatives from the study area Cities established the following rough initial estimates of total potential reclaimed water demand within the study area:

- Year 2016: 15 mgd total potential reclaimed water maximum day demand (MDD) use
- Year 2020: 35 mgd total potential reclaimed water use (MDD)
- Year 2030: 50 mgd total potential reclaimed water use (MDD)

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These assumed potential use estimates fall well within the range of the total South Plant wastewater flows available as a reclaimed water supply resource as indicated previously in Figure 4-9. This demonstrates that in terms of wastewater flows available within the study area, the potential for reclaimed water supply exceeds the assumed study area reclaimed water demand.

Potential Use Areas

In order to validate these reclaimed water demand assumptions on an order of magnitude basis, and further estimate how reclaimed water demands might be distributed within the study area, an evaluation of current land use and the potential for reclaimed water irrigation use was developed. Potential reclaimed water use locations for the study area were identified based on land use to include the following areas as presented in Figure 5-1:

- Agricultural parcels 1 acre in size or larger
- Commercial parcels 1 acre in size or larger
- Industrial parcels 1 acre in size or larger
- Institutional and Community parcels 1 acre in size or larger
- Park/Open Space parcels 1 acre in size or larger
- Right of Way
- Potential Groundwater Recharge Areas

These are areas where potential for reclaimed water irrigation and/or other uses may exist. As shown in Figure 5-1, these potential reclaimed water use locations are largely clustered within the Cities of Auburn, Kent, Renton, and Tukwila along the floor of the Green River Valley and in lower elevation areas of the Cedar River Valley in Renton adjacent to Lake Washington, with some more dispersed areas of potential use identified in the higher elevation areas above the valley floor, including a number of Covington golf courses, parks, and commercial and industrial sites. Although potential agricultural, institutional and community, park/open space areas are represented, the identified potential reclaimed water uses areas are dominated by commercial, industrial, and right of way land uses, as illustrated in Figure 5-1.

Also identified in Figure 5-1 are critical aquifer recharge areas identified for unincorporated areas of King County generally external to the jurisdictions that form the study area. While these areas, as identified by King County, have not been mapped for incorporated areas within the study area, they are suggestive of locations where recharge of groundwater aquifers via reclaimed water surface infiltration may be effective to supplement aquifer supplies.

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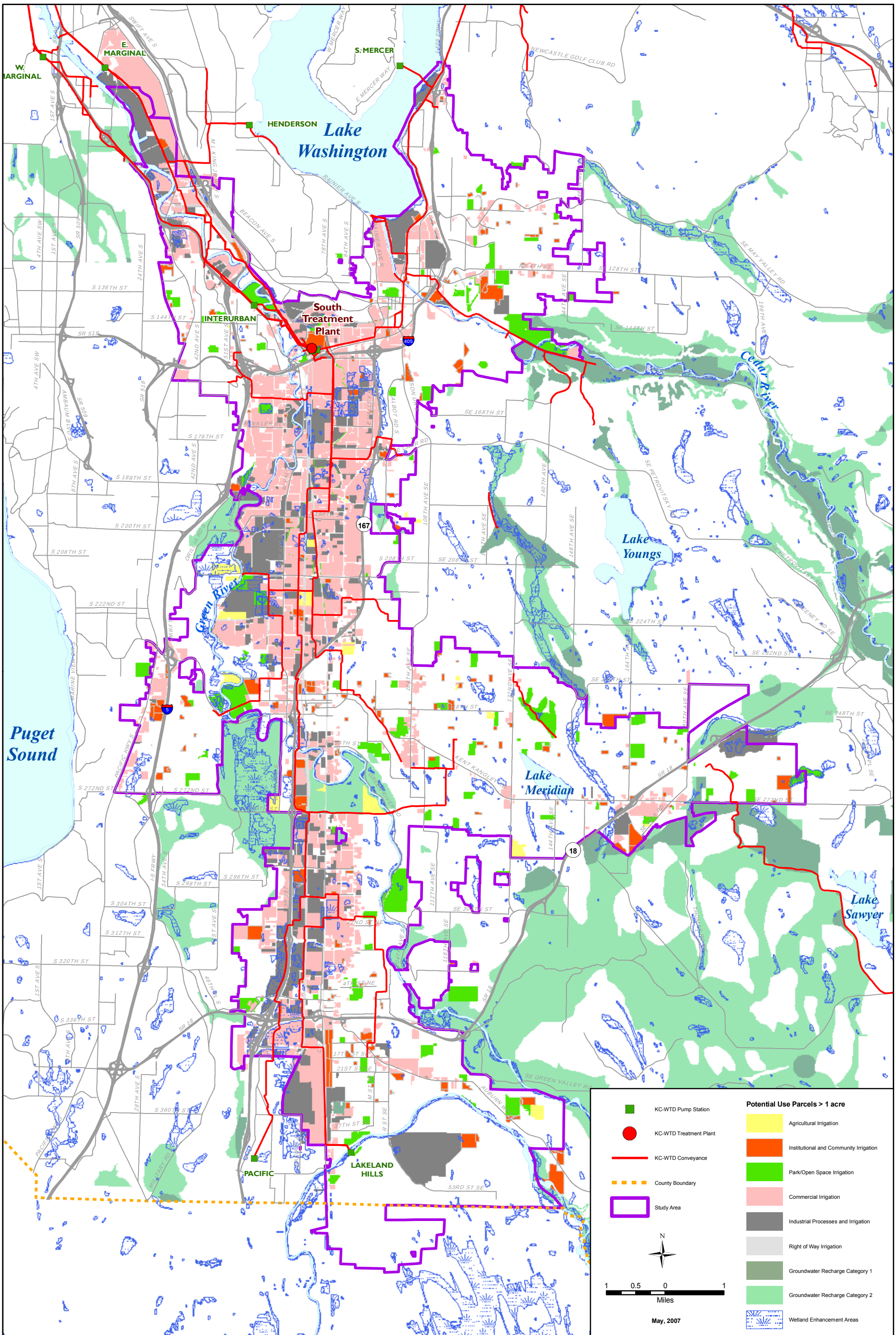

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

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Shaun O'Neil 20070608

Green River Valley Reclaimed Water Study Area Potenial Use Parcels Larger Than One Acre

Figure 5-1. Green River Valley Potential Reclaimed Water Use Parcels

Table 5-2 presents a breakdown of the potential reclaimed water use areas identified in Figure 5-1 detailing estimated land use areas for each category of potential use, and a breakdown of these areas among the jurisdictions that comprise the study area. As shown in Table 5-2, these potential reclaimed water use areas are distributed among the study area jurisdictions approximately proportional to the total acreage of each.

Table 5-2. Potential Reclaimed Water Use Areas and Acreage

Land Use Catetories and Potential Irrigation Uses	Potential Use Parcels (acres)[1]	Jurisdictional Areas (acres)[1]					
		Auburn	Covington	Kent	Renton	Tukwila	Unincorporated
Agricultural (parcels 1 acre or larger)	400	30	5	300	0	0	65
Commercial (parcels 1 acre or larger)	8,500	2,100	160	3,050	1,760	1,410	20
Industrial (parcels 1 acre or larger)	4,760	1,860	190	1,270	830	600	10
Institutional and Community (parcels 1 acre or larger)	1,390	360	150	380	370	110	20
Park/Open Space (parcels 1 acre or larger)	2,040	470	180	710	470	210	0
Right of Way	7,500	1,550	500	2,380	1,870	1,160	40
Potential Use Total	24,590	6,370	1,185	8,090	5,300	3,490	155
Percent of Total Potential Use Acreage	100%	26%	5%	33%	22%	14%	1%
Total Study Area	55,000	15,000	3,760	18,200	11,400	5,850	790
Percent of Total Study Area Acreage	100%	27%	7%	33%	21%	11%	1%

Notes:
1. King County GIS land use estimates

Potential Irrigation Use

As noted in Table 5-1, potential reclaimed water use for irrigation of areas noted in Figure 5-1 and Table 5-2 can be roughly estimated according to available study area data on land use and impervious/pervious areas based on data and assumptions regarding irrigation water use and rates. Total annual water use for agricultural and golf course irrigation in King and Pierce Counties total approximately 1.1 and 1.3 ft per acre per year respectively for agricultural applications, and 1.1 and 1.4 ft per acre per year for golf courses (*USGS, 2000*). Given this reported range of irrigation use, an equivalent representative annual irrigation application of 1.2 ft per acre per year, or approximately 14.5 inches per irrigated acre, was assumed to estimate potential study area irrigation use.

In order to assess factors related to potential reclaimed water demand variations and peaking, Figure 5-2 presents representative regional water use patterns for the greater Seattle metropolitan area in terms of average monthly water use relative to overall average annual use. These water use patterns, developed from Seattle Public Utilities regional water supply data, provide a general characterization of regional water use patterns, as might be considered approximately typical within the study area. As shown Figure 5-2, monthly water use base flows remain relatively constant at around 85 percent of the annual average daily demand (ADD) from November through April. During May, June, July, August, and September, higher average monthly water use are evident, with a monthly ADD peak in July and August at approximately 140 percent of annual ADD, driven largely by summertime irrigation use. Water system maximum day demands (MDD) can generally be expected to peak even higher at approximately twice annual ADD (*WSDOH, 2001*). Ratios between water uses and demands can thus generally be estimated as follows:

- Non Irrigation Period Base Flow Water Use, approximately 85 percent of annual ADD (Figure 5-2)
- Total Peak Monthly Average Water Use, approximately 140 percent of annual ADD (Figure 5-2)
- Peak Monthly Average Irrigation Use, approximately 55 percent of ADD = (140 percent ADD – 85 percent ADD)
- MDD, approximately 200 percent of ADD (WSDOH Water System Design Manual and representative regional water use data)
- MDD Irrigation Use, approximately 115 percent of ADD = (200 percent ADD – 85 percent ADD)

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- MDD Irrigation Use, approximately 200 percent of Peak Monthly Average Irrigation Use (115 percent ADD/55 percent ADD)

Figure 5-2. Regional Average Monthly Water Use Patterns

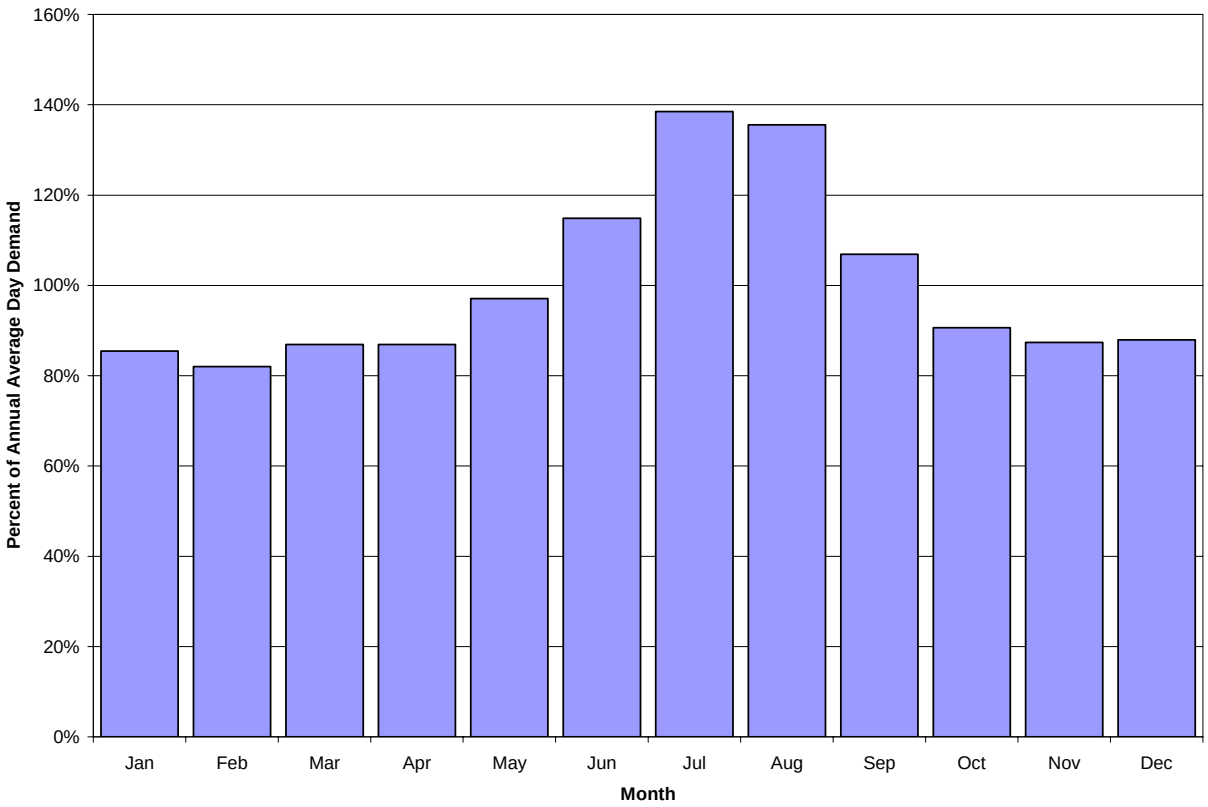

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Table 5-3 presents estimated and assumed irrigation factors and rates for the study area based on estimates of study area pervious and impervious surface areas, and estimated monthly and annual irrigation application rates in inches per month or year consistent with the monthly water use patterns presented in Figure 5-2. Irrigated areas are estimated according to the ratio of impervious to pervious areas for each land use category, based on assumptions regarding the portion of pervious areas that may be irrigated.

Table 5-3. Reclaimed Water Irrigation Factors and Rates

Potential Irrigation Uses	Impervious Surface[1]	Pervious Surface[1]	Pervious Irrigation[2]	Irrigation Area[3]	Annual Irrigation (in/yr)[4]	Assumed Summer Irrigation Pattern (in/month)[5]				
						May	June	July	Aug	Sept
Agricultural	25%	75%	50%	37.5%	14.5	1.0	3.0	4.5	4.0	2.0
Commercial	70%	30%	50%	15.0%	14.5	1.0	3.0	4.5	4.0	2.0
Industrial	45%	55%	50%	27.5%	14.5	1.0	3.0	4.5	4.0	2.0
Institutional and Community	45%	55%	50%	27.5%	14.5	1.0	3.0	4.5	4.0	2.0
Park/Open Space	30%	70%	50%	35.0%	14.5	1.0	3.0	4.5	4.0	2.0
Right of Way	50%	50%	10%	5.0%	14.5	1.0	3.0	4.5	4.0	2.0

Notes:

1. King County GIS estimates
2. Assumed percentage of pervious areas subject to irrigation
3. Estimated from percent pervious surface and percent pervious irrigation estimates
4. Estimated according to average King and Pierce County Washington agricultural and golf course irrigation rates *(USGS, 2004)*
5. Estimated from annual irrigation rates consistent with regional average monthly water use patterns

Potential reclaimed water irrigation use for the study area is estimated in Table 5-4, and is based on the information presented in Tables 5-2 and 5-3. Irrigable areas are estimated for each potential use category according to the total acreages listed in Table 5-2 and the irrigation areas listed for each category in Table 5-3. Irrigation areas are estimated from the estimated irrigable areas according to assumptions regarding the extent to which irrigation may actually be implemented for each potential use category. Potential annual and monthly reclaimed water irrigation usage rates in millions of gallons per day (mgd) are then estimated for identified irrigation areas according to irrigation application rates in terms of inches of irrigation per unit area as noted in Table 5-3. Potential MDD irrigation use is similarly estimated at approximately twice peak monthly irrigation ADD according to the ratios estimated previously. Potential reclaimed water irrigation use for the study area is summarized for each use category based on overall study area land use data, and for each jurisdiction within the study area based on corresponding jurisdictional land use data, according to the potential use parcels identified in Figure 5-1 and Table 5-2.

Table 5-4. Potential Reclaimed Water Irrigation Use

Potential Use	Estimated Irrigable Area (acres)[1]	Parcel Implementation[2]	Estimated Irrigation Area (acres)[3]	Potential Annual Use (mg)[4]	Potential Monthly ADD Use (mgd)[5]						Potential MDD Use (mgd)[6]	Percent of Total	Potential MDD Use Density (gpd/acre)[7]
					May	June	July	Aug	Sept	Average			
Agricultural (parcels 1 acre or larger)	150	90%	140	60	0.1	0.4	0.6	0.5	0.3	0.4	1.1	4%	2,760
Commercial (parcels 1 acre or larger)	1,280	90%	1,150	450	1.0	3.1	4.5	4.0	2.1	2.9	9.1	36%	1,070
Industrial (parcels 1 acre or larger)	1,310	90%	1,180	460	1.0	3.2	4.7	4.1	2.1	3.0	9.3	37%	1,950
Institutional and Community (parcels 1 acre or larger)	380	50%	190	70	0.2	0.5	0.7	0.7	0.3	0.5	1.5	6%	1,080
Park/Open Space (parcels 1 acre or larger)	710	50%	360	140	0.3	1.0	1.4	1.3	0.7	0.9	2.8	11%	1,390
Right of Way	380	40%	150	60	0.1	0.4	0.6	0.5	0.3	0.4	1.2	5%	160
Total	**4,210**	**75%**	**3,170**	**1,240**	**2.8**	**8.6**	**12.5**	**11.1**	**5.7**	**8.1**	**25.0**	**100%**	**1,020**
Auburn Subtotal	1,180	78%	920	360	0.8	2.5	3.6	3.2	1.7	2.4	7.2	29%	1,130
Covington Subtotal	210	62%	130	50	0.1	0.4	0.5	0.5	0.2	0.3	1.0	4%	880
Kent Subtotal	1,390	76%	1,050	410	0.9	2.9	4.1	3.7	1.9	2.7	8.3	33%	1,020
Renton Subtotal	850	72%	610	240	0.5	1.7	2.4	2.1	1.1	1.6	4.8	19%	910
Tukwila Subtotal	540	76%	410	160	0.4	1.1	1.6	1.5	0.7	1.1	3.3	13%	940
Unincorporated Subtotal	40	75%	30	10	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1%	1,560

Notes:
1. Estimated from potential use parcel acreage and percent irrigation area estimates
2. Assumed percentage of parcel acreage implementing reclaimed water irrigation'
3. Estimated from irrigable area and parcel implementation estimates
4, Estimated from irrigation area and annual irrigation rate estimates
5. Estimated from irrigation area and monthly irrigation rate estimates
6. Estimated as twice peak monthly ADD irrigation use
7. Estimate from potential MDD use and potential use parcel acreage estimates

Reclaimed water for irrigation is likely to form a significant percentage of overall reclaimed water demand for the study area. As noted in Table 5-4, total potential reclaimed water irrigation use for the study area, estimated according to land use and likely irrigation rates, is estimated as follows:

- Approximately 1.2 billion gallons on an annual volume basis
- Approximately 8 mgd ADD for the irrigation months from May through September
- Approximately 12.5 mgd peak month ADD
- Approximately 25 mgd on a peak MDD basis.
- Average ADD for the May through September irrigations months
    - Approximately 65 percent of peak month ADD
    - Approximately 32 percent of MDD

Between the study area jurisdictions, approximately 29, 4, 33, 20, 13, and 1 percent of the total potential reclaimed water irrigation use is estimated for Auburn, Covington, Kent, Renton, Tukwila, and unincorporated areas respectively. This indicates that the distribution of potential reclaimed water irrigation use can be expected to be roughly proportional to the study area jurisdiction acreages as a percent of total study area as indicated in Table 5-2.

Potential Supplies and Demands

The range of potential reclaimed water irrigation use estimates corresponds fairly well on an order of magnitude basis with the assumed study area schedule of total potential reclaimed water demands, given that the approximately 25 mgd MDD potential irrigation demand value does not consider the potential for additional reclaimed water needs related to industrial process, streamflow augmentation, wetland enhancement, and groundwater recharge uses. Beyond the potential reclaimed water irrigation use estimates, information has not yet been compiled as would be necessary to estimate other types of potential use, except to note that study area jurisdictions have expressed interest in upward of 18 mgd in reclaimed water use for groundwater recharge, streamflow augmentation, and wetlands enhancement. Industrial processes may also present significant opportunities for reclaimed water use within the study area, but information regarding such potential uses has not been complied at this time, and potential use estimates have not been completed.

Comparisons between estimated available local wastewater flow resources for reclaimed water supply, and estimates of potential local area reclaimed water demands are presented in Figures 5-3, 5-4, and 5-5 for areas around Auburn, Covington and Kent, and Renton and Tukwila respectively. These figures allow estimates of local wastewater flow reclaimed water supply resources to be evaluated alongside estimated potential local reclaimed water demands. The figures present estimated available local wastewater flow resources for reclaimed water supply and potential local reclaimed water demand estimates in terms of:

- Available local area average dry weather wastewater flow estimates as summarized in Table 4-1
- Available local area average wet weather wastewater flow estimates
- Potential local area reclaimed water irrigation use MDD estimates as summarized in Table 5-4
- Identified estimates of potential local area reclaimed water use for groundwater recharge
- Assumed potential local area reclaimed water MDD demand estimates proportioned consistent with distributions of estimated potential reclaimed water irrigation use listed in Table 5-4 with timing and total demands according to the following assumed total reclaimed water schedule as identified in Table 5-1:
    - 2016: 15 mgd total
    - 2020: 35 mgd total
    - 2030: 50 mgd total

Figure 5-3. Auburn Area Available Wastewater Flow Supply and Reclaimed Water Demands

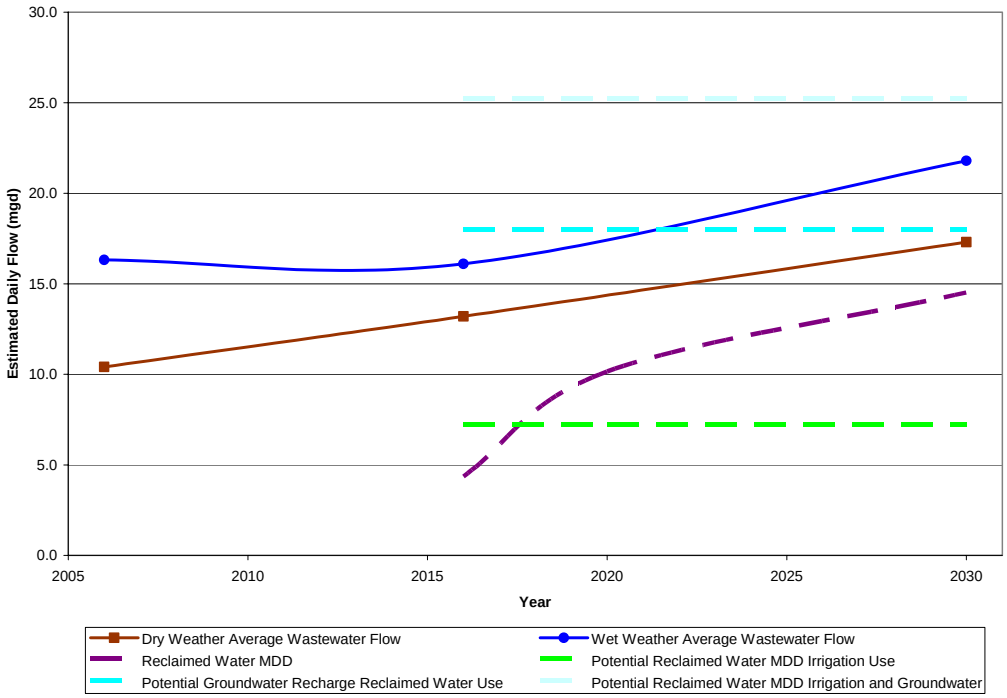


Figure 5-4. Covington/Kent Area Available Wastewater Flow Supply and Reclaimed Water Demands

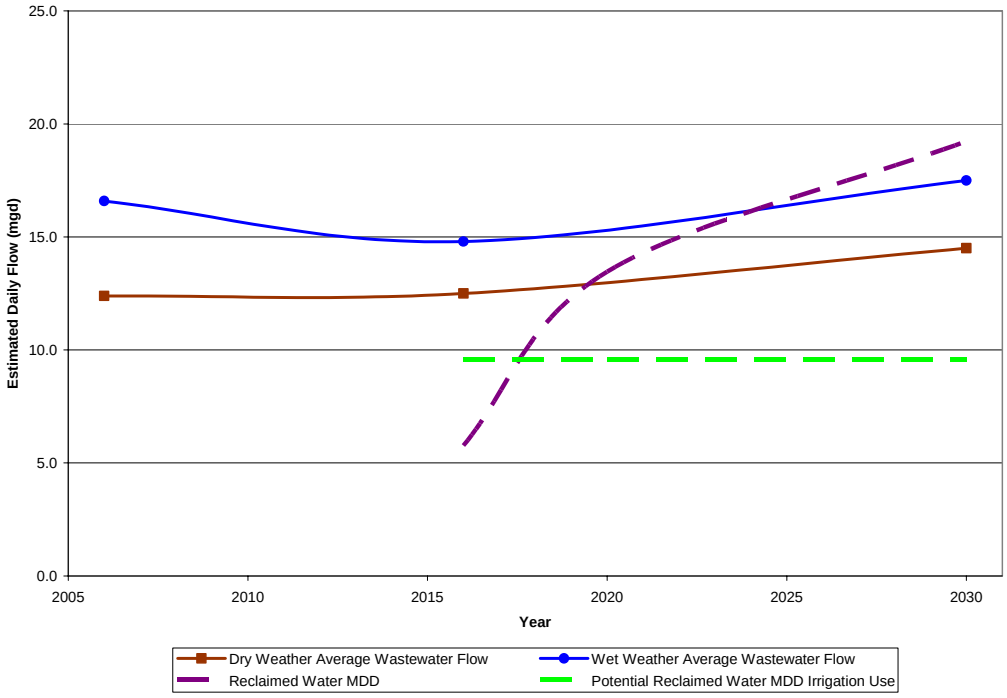
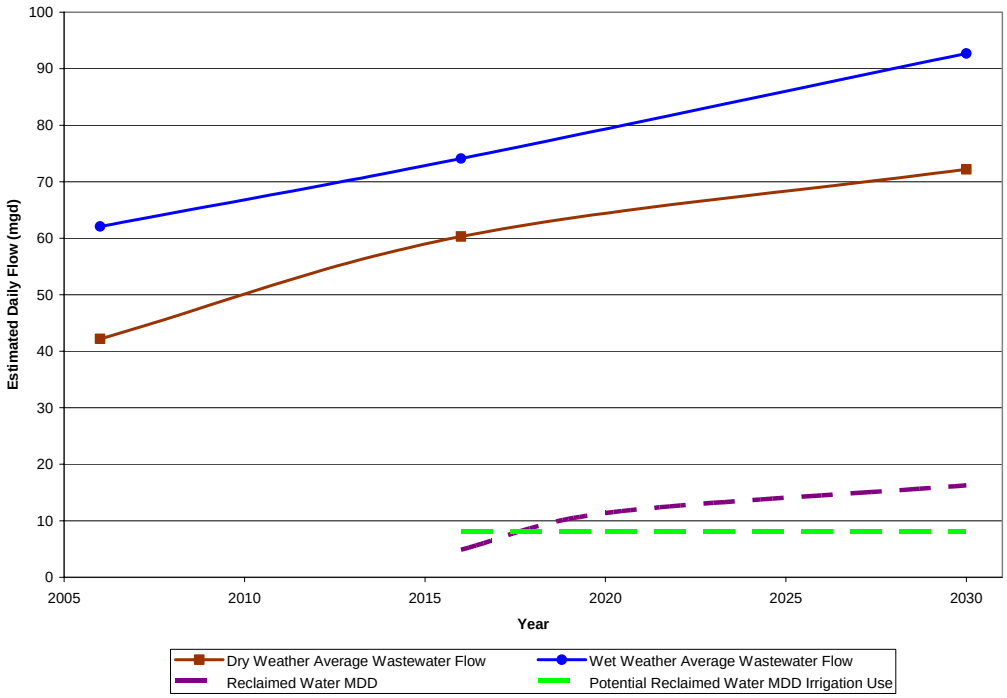


Figure 5-5. Renton/Tukwila Area Available Wastewater Flow Supply and Reclaimed Water Demands



As illustrated in the figures, for each identified local area the estimated local wastewater flow resource for reclaimed water supply exceeds current local area estimates of potential reclaimed water irrigation use as presented in Table 5-4. However, as shown for the Auburn area in Figure 5-3, preliminary estimates of potential reclaimed water use for groundwater recharge demonstrate that large local demands for reclaimed water can potentially exceed locally available wastewater flow resources for reclaimed water supply. Similarly for the Covington and Kent areas as shown in Figure 5-4, potential local reclaimed water demands according to the assumed schedule of total reclaimed water demand may exceed the locally available wastewater flow resource for reclaimed water supply as well.

6. PERFORMANCE AND DESIGN CONSIDERATIONS

This section provides an overview of supply and treatment regulations and requirements for reclaimed water supply, along with assumptions regarding typical performance, design, and level of service criteria for reclaimed water systems and infrastructure. Also included is a brief summary of reclaimed water use within the state of Washington. The requirements and criteria presented in this section establish a common basis for assessing and comparing reclaimed water supply scenarios in subsequent sections

6.1 Regulations and Guidance

The WSDOH and WSDOE published Water Reclamation and Reuse Standards for Washington State in September 1997. The standards define four classes of reclaimed water, from Class A to Class D, as summarized and defined along with other key terms from the standards in Table 6-1. Treatment and quality requirements for different classifications of reclaimed water use under the standards are summarized in Table 6-2. Table 6-3 details various setback and separation requirements under the standards that limit the proximity of reclaimed water use and infrastructure relative to other utilities and surface features. Reclaimed water monitoring requirements are detailed in Table 6-4. The requirements listed under these standards form the basis for many of the assumptions and criteria utilized in assessing Green River Valley reclaimed water scenarios, as detailed herein.

Engrossed Substitute House Bill 2884

In March 2006, Engrossed Substitute House Bill (ESHB) 2884 was passed. ESHB 2884 requires Ecology to adopt new reclaimed water rules by December 31, 2010. The bill is meant to address the fact that the 1997 standards are outdated and do not reflect recent developments in wastewater treatment technologies. The new rules are to address all aspects of reclaimed water use and shall be developed with consultation from an advisory committee. The advisory committee shall consist of "a broad range of interested individuals representing the various stakeholders that utilize or are potentially impacted by the use of reclaimed water; the advisory committee must also contain individuals with technical expertise and knowledge of new advancements in technology." In addition, the bill shifts regulatory responsibility for reclaimed water to Ecology, although the Department of Health may still have a regulatory role after the new rules are adopted.

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Table 6-1. Summary of Reclaimed Water Quality and Treatment Definitions

Term	Water Treatment and Quality Requirements	Key Parameters				
		Oxidized	Coagulated	Filtered	Disinfected	Water Quality Limits
Oxidized Wastewater (Secondary Wastewater Effluent)	Wastewater in which organic matter has been stabilized such that the biochemical oxygen demand (BOD) does not exceed 30 mg/L and the total suspended solids (TSS) do not exceed 30 mg/L, is nonputrescible, and contains dissolved oxygen.	Yes	No	No	No	30 mg/L BOD 30 mg/L TSS >0 mg/L DO
Coagulated Wastewater	An oxidized wastewater in which colloidal and finely divided suspended matter have been destabilized and agglomerated prior to filtration by the addition of chemicals or by an equally effective method.	Yes	Yes	No	No	
Filtered Wastewater	An oxidized, coagulated wastewater which has been passed through natural undisturbed soils or filter media, such as sand or anthracite, so that the turbidity as determined by an approved laboratory method does not exceed an average operating turbidity of 2 nephelometric turbidity units (NTU), determined monthly, and does not exceed 5 NTU at any time.	Yes	Yes	Yes	No	2 NTU turbidity average 5 NTU turbidity maximum
Disinfected Wastewater	Wastewater in which pathogenic organisms have been destroyed by chemical, physical or biological means.	No	No	No	Yes	
Reclaimed Water	Effluent derived in any part from sewage from a wastewater treatment system that has been adequately and reliably treated, so that as a result of that treatment, it is suitable for a beneficial use or a controlled use that would not otherwise occur and is no longer considered wastewater.	Yes	Varies	Varies	Yes	Varies
Class D Reclaimed Water	"Class D Reclaimed Water" means reclaimed water that, at a minimum, is at all times an oxidized, disinfected wastewater. The wastewater shall be considered adequately disinfected if the median number of total coliform organisms in the wastewater after disinfection does not exceed 240 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed.	Yes	No	No	Yes	240 per 100 mL total coliform 7-day median
Class C Reclaimed Water	"Class C Reclaimed Water" means reclaimed water that, at a minimum, is at all times an oxidized, disinfected wastewater. The wastewater shall be considered adequately disinfected if the median number of total coliform organisms in the wastewater after disinfection does not exceed 23 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed, and the number of total coliform organisms does not exceed 240 per 100 milliliters in any sample.	Yes	No	No	Yes	23 per 100 mL total coliform 7-day median 240 per 100 mL total coliform individual sample
Class B Reclaimed Water	"Class B Reclaimed Water" means reclaimed water that, at a minimum, is at all times an oxidized, disinfected wastewater. The wastewater shall be considered adequately disinfected if the median number of total coliform organisms in the wastewater after disinfection does not exceed 2.2 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed, and the number of total coliform organisms does not exceed 23 per 100 milliliters in any sample.	Yes	No	No	Yes	2.2 per 100 mL total coliform 7-day median 23 per 100 mL total coliform individual sample
Class A Reclaimed Water	"Class A Reclaimed Water" means reclaimed water that, at a minimum, is at all times an oxidized, coagulated, filtered, disinfected wastewater. The wastewater shall be considered adequately disinfected if the median number of total coliform organisms in the wastewater after disinfection does not exceed 2.2 per 100 milliliters, as determined from the bacteriological results of the last 7 days for which analyses have been completed, and the number of total coliform organisms does not exceed 23 per 100 milliliters in any sample.	Yes	Yes	Yes	Yes	2.2 per 100 mL total coliform 7-day median 23 per 100 mL total coliform individual sample

Notes:

1. Adapted from the WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997

Table 6-2. Summary of Treatment and Quality Requirements for Reclaimed Water Use

Use	Type of Reclaimed Water Allowed			
	Class A	Class B	Class C	Class D
Irrigation of Nonfood Crops				
Trees and Fodder, Fiber, and Seed Crops	Yes	Yes	Yes	Yes
Sod, Ornamental Plants for Commercial Use, and Pasture to Which Milking Cows or Goats Have Access	Yes	Yes	Yes	No
Irrigation of Food Crops				
Spray Irrigation				
All Food Crops	Yes	No	No	No
Food Crops Which Undergo Physical or Chemical Processing Sufficient to Destroy All Pathogenic Agents	Yes	Yes	Yes	Yes
Surface Irrigation				
Food Crops Where There is No Reclaimed Water Contact With Edible Portion of Crop	Yes	Yes	No	No
Root Crops	Yes	No	No	No
Orchards and Vineyards	Yes	Yes	Yes	Yes
Food Crops Which Undergo Physical or Chemical Processing Sufficient to Destroy All Pathogenic Agents	Yes	Yes	Yes	Yes
Landscape Irrigation				
Restricted Access Areas (e.g., Cemeteries and Freeway Landscapes)	Yes	Yes	Yes	No
Open Access Areas (e.g., Golf Courses, Parks, Playgrounds, Schoolyards, and Residential Landscapes)	Yes	No	No	No
Impoundments				
Landscape Impoundments	Yes	Yes	Yes	No
Restricted Recreational Impoundments	Yes	Yes	No	No
Nonrestricted Recreational Impoundments	Yes	No	No	No
Fish Hatchery Basins	Yes	Yes	No	No
Decorative Fountains	Yes	No	No	No
Flushing of Sanitary Sewers	Yes	Yes	Yes	Yes
Street Cleaning				
Street Sweeping, Brush Dampening	Yes	Yes	Yes	No
Street Washing, Spray	Yes	No	No	No
Washing of Corporation Yards, Lots, and Sidewalks	Yes	Yes	No	No
Dust Control (Dampening Unpaved Roads and Other Surfaces)	Yes	Yes	Yes	No
Dampening of Soil for Compaction (at Construction Sites, Landfills, etc.)	Yes	Yes	Yes	No
Water Jetting for Consolidation of Backfill around Pipelines				
Pipelines for Reclaimed Water, Sewage, Storm Drainage, and Gas, and Conduits for Electricity	Yes	Yes	Yes	No
Fire Fighting and Protection				
Dumping from Aircraft	Yes	Yes	Yes	No
Hydrants or Sprinkler Systems in Buildings	Yes	No	No	No
Toilet and Urinal Flushing	Yes	No	No	No
Ship Ballast	Yes	Yes	Yes	No
Washing Aggregate and Making Concrete	Yes	Yes	Yes	No
Industrial Boiler Feed	Yes	Yes	Yes	No
Industrial Cooling				
Aerosols or Other Mist not Created	Yes	Yes	Yes	No
Aerosols or Other Mist Created (e.g., Use in Cooling Towers, Forced Air Evaporation, or Spraying)	Yes	No	No	No
Industrial Process				
Without Exposure of Workers	Yes	Yes	Yes	No
With Exposure of Workers	Yes	No	No	No
Streamflow Augmentation	Complying with Federal Water Pollution Control Act, Chapter 90.48 RCW			
Wetlands Enhancement				
Discharge to constructed beneficial use wetlands	Yes	Yes	No	No
Discharge to natural wetlands	Yes	Yes	Yes	Yes
Human non-contact restricted access	Yes	Yes	Yes	No
Fisheries or human non-contact recreation	Yes	Yes	No	No
Human Contact	Yes	No	No	No
Surface Percolation Groundwater Recharge	With Nitrogen Removal	No	No	No
Direct Recharge into Nonpotable Ground Water Aquifers	BOD ≤ 5 mg/L TSS ≤ 5 mg/L	No	No	No
Direct Recharge into Potable Ground Water Aquifers	Reverse Osmosis Treatment required in addition to Oxidation, Coagulation, Filtration, and Disinfection, Total Coliform ≤ 1/100 mL 7-day median, ≤ 5/100 mL each daily sample, Primary and secondary contaminant, radionuclide, and carcinogen limits per Table 1 Chapter 173-200 WAC (except nitrate) and other drinking water MCLs, Turbidity ≤ 0.1 NTU, Total nitrogen ≤ 10 mg/L (as N), TOC ≤ 1.0 mg/L	No	No	No

Notes:

1. Adapted from the WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997

Table 6-3. Summary of Reclaimed Water Setback Distance Requirements Relative to Other Utilities and Surface Features

Conditions	Setback Distance (Feet) By Type of Reclaimed Water			
	Class A	Class B	Class C	Class D
Minimum Distance between any reclaimed water pipeline and potable water supply well.	50	100	100	300
Where reclaimed water is used for spray or surface irrigation, minimum distance between the area subject to irrigation, and any potable water supply well.	50	100	100	300
Where reclaimed water is used for spray irrigation, minimum distance between the area subject to irrigation and areas accessible to the public and the use area property line.	0	50	50	100
Where reclaimed water is used for an impoundment that is not lined or sealed to prevent measurable seepage, minimum distance between the perimeter of the impoundment and any potable water supply well.	500	500	500	n/a
Where reclaimed water is used for an impoundment that is lined or sealed to prevent measurable seepage, minimum distance between the perimeter of the impoundment and any potable water supply well.	100	100	100	n/a
Where reclaimed water is used for a storage pond that is not lined or sealed to prevent measurable seepage, minimum distance between the perimeter of the pond and any potable water supply well.	500	500	500	1,000
Where reclaimed water is used for a storage pond that is lined or sealed to prevent measurable seepage, minimum distance between the perimeter of the pond and any potable water supply well.	100	100	100	200

Notes:

1. Adapted from the WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997

Table 6-4. Summary of Reclaimed Water Quality Monitoring Requirements

Parameter	Sample Type & Frequency	Compliance Requirements
General Reuse		
Biochemical Oxygen Demand	24-hour composite, collected at least weekly	Shall not exceed 30 mg/L determined monthly, based on the arithmetic mean of all samples collected during the month.
Total Suspended Solids	24-hour composite, collected at least weekly (sampling may be reduced for those projects generating Class A reclaimed water on a case by case basis by Health and Ecology.)	Shall not exceed 30 mg/L determined monthly, based on the arithmetic mean of all samples collected during the month.
Total Coliforms	Grab, collected at least daily	Compliance determined daily, based on the median value determined from the bacteriological results of the last 7 days for which analyses have been completed.
Turbidity	Continuous recording turbidmeter	Filtered wastewater shall not exceed an average operating turbidity of 2 NTU, determined monthly, and shall not exceed 5 NTU at any time
Dissolved Oxygen	Grab, collected at least daily	Shall contain dissolved oxygen
Wetlands Enhancement		
Biochemical Oxygen Demand	24-hour composite, collected at least weekly	Shall not exceed 20 mg/L on an average annual basis
Total Suspended Solids	24-hour composite, collected at least daily	Shall not exceed 20 mg/L on an average annual basis
Total Coliforms	Grab, collected at least daily	Compliance determined daily, based on the median value determined from the bacteriological results of the last 7 days for which analyses have been completed.
Kjeldahl Nitrogen	24-hour composite, collected weekly	Shall not exceed 3 mgTKN-N/L on an average annual basis
Total Ammonia-Nitrogen	24-hour composite, collected weekly	Shall not exceed Washington chronic standards for freshwater or as specified in Article 3 (4)
Total Phosphorus	24-hour composite, collected weekly	Shall not exceed 1 mg P/L on an average annual basis
Metals: Arsenic, Cadmium, Copper, Lead, Mercury, Zinc	24-hour composite, collected at least weekly	Shall not exceed Washington surface water quality standards, or as specified in Article 3 (5)
Flow Rate	Continuous Recording	2 to 5 cm/day, depending on wetland category & type
Water Level Elevation	Continuous Recording	Increase not greater than 10 cm above average pre-augmentation water level elevation
Biological: Vegetation cover, plant diversity, macroinvertebrate biomass, amphibian species, fish biomass & species, bird density & species, threatened/endangered density & species	Once/year during 1st, 2nd, 4th, 6th, 8th, & 10th growing seasons	No more than 25% reduction in parameter measurements over wetland, or 50% reduction at any one location within wetlands.
Direct Aquifer Recharge		
Oxidized Wastewater:		
BOD	24-hour composite, collected at least weekly	≤ 30 mg/L average determined monthly, based on arithmetic mean of all samples collected during the month
TSS	24-hour composite, collected at least daily	≤ 30 mg/L average determined monthly, based on arithmetic mean of all samples collected during the month
Dissolved oxygen	Grab, collected at least daily	Shall contain dissolved oxygen
Filtered Wastewater:		
Turbidity	Continuous recording turbidmeter	≤ 2 NTU average determined monthly; 5 NTU maximum
Reclaimed Water:		
BOD	24-hour composite, collected at least daily	≤ 5mg/L average determined daily, based on arithmetic mean of all daily samples collected during the last 7 days of operation
TSS	24-hour composite, collected at least daily	≤ 5mg/L average determined daily, based on arithmetic mean of all daily samples collected during the last 7 days of operation
Total coliforms	Grab, collected at least daily	1/100 mL median value determined daily based on bacteriological results of at least 7 days for which analyses have been completed; 5/100 mL maximum
TOC	24-hour composite, collected at least daily	≤ 1.0 mg/L average determined daily, based on arithmetic mean of all samples collected during the last 30 days of operation
Primary contaminants (except total coliforms and nitrate), secondary contaminants, radionuclides, and carcinogens listed in chapter 173-200 WAC	Grab or 24-hour composite, collected at least quarterly	Compliance with limits listed in Table 1 in chapter 173-200 WAC determined annually, based on arithmetic mean of all samples collected during the previous 12 months
Total Nitrogen	Grab or 24-hour composite, collected at least weekly	≤ 10 mg/L (as N) average determined annually, based on arithmetic mean of all samples collected during previous 12 months
Potable Ground Water from Monitoring Wells:		
TOC	Grab, collected at least quarterly	No limit specified in these standards
Primary contaminants, secondary contaminants, radionuclides, and carcinogens listed in chapter 173-200 WAC	Grab, collected at least quarterly	No limit specified in these standards
Nonpotable Ground Water from Monitoring Wells:		
Case-by-case determination	Case-by-case determination	Case-by-case determination

Notes:
1. Adapted from the WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997

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Reclaimed Water Use in Washington State

According to a Department of Ecology 2005 study, seventeen reclaimed water treatment facilities had been constructed or upgraded to operate under the state's reclaimed water standards by the end of 2004. Drivers for these projects include:

- Elimination or decrease in wastewater discharges for environmental purposes
- Additional water supplies including drought resistant supplies
- Growth and water demand increases
- Increasing focus on water conservation
- Nonpotable water supply for irrigation
- Need for development of new wastewater facilities
- Rising costs, challenges, and issues for traditional development of new or additional potable water supplies

As water demands increase, reclaimed water may be evaluated as an option to decrease potable water usage since development of new surface water and groundwater sources is becoming more lengthy, costly and uncertain, given the multiple demands being made on a finite resource. Stringent environmental, regulatory and legal requirements are involved in establishing water rights and developing new potable water supply facilities. Moreover, Ecology requires that water suppliers demonstrate that water conservation efforts have been duly considered, developed, and implemented prior to the granting of additional water rights.

6.2 Level of Service, Performance, and Design Criteria Assumptions and Requirements

Assumptions regarding reclaimed water system levels of service, treatment processes, and infrastructure and materials requirements established for the purpose of assessing Green River Valley reclaimed water scenarios are as summarized in Table 6-5. The assumptions are based on Washington state requirements and typical industry practice. These assumptions form the basis of the scenario analyses and comparisons presented in subsequent sections.

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Table 6-5. Performance and Design Criteria and Levels of Service Summary

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Reclaimed Water Demand Variability	- Consistent with typical demand curve patterns according to anticipated study area usage, demands, and patterns - Monthly irrigation demand variability estimated from regional monthly water demand estimates relative to annual base demands - Irrigation maximum day demand (MDD) estimated as twice the peak month irrigation average daily demand (ADD) - Irrigation peak hourly demand (PHD) estimated as twice to three times irrigation MDD	- Typical Industry Practice - Regional monthly water demand estimates - WSDOH Water System Design Manual, August 2001	- Anticipated future reclaimed water requirements - Jurisdictional metered customer water use analyses and trending to further estimate and quantify potential reclaimed water demand variability in each category of potential use
Typical Irrigation Application Rates	- Consistent with established and representative agronomic rates	- USGS Scientific Investigations Report 2004-5015, Estimated Domestic, Irrigation, and Industrial Water Use in Washington, 2000	- Information regarding potential irrigation use, timing, volumes, and locations
Wastewater Conveyance			
Available Wastewater Flows	- King County metered wastewater flow estimates and forecasts	- King County	- Information regarding conveyance system infrastructure - Flow estimates and forecasts for additional locations to further refine future reclaimed water resource and use assessments
Minimum flows and system flushing requirements	- Maintain minimum flows and adequate flushing velocities at least 2 ft/s at sufficient frequencies to mobilize solids and limit accumulation	- Typical Industry Practice	
Measures and requirements to ensure odor control	- Maintain minimum flows and adequate flushing velocities at least 2 ft/s at sufficient frequencies to mobilize solids and limit accumulation	- Typical Industry Practice	

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Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Reclaimed Water Standards			
Water Quality	- Class A water quality to provide reclaimed water that is at all times an oxidized, coagulated, filtered, and disinfected wastewater to include daily water quality compliance sampling, monitoring, and reporting	- Supports broadest range of use under WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Disinfection treatment dosing and contact time requirements	- 1.0 mg/L minimum chlorine residual following a 30 minute minimum chlorine contact time or better as required to meet WSDOH pathogen reduction requirements	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Minimum disinfection residual	- 0.5 mg/L minimum chlorine residual for conveyance and distribution to points of use	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Minimum service pressure	- 20 psi minimum pressures for delivery for use	- Pressures may be increased through pumping by end users on site if needed	
Maximum service pressure	- 120 psi maximum pressure practical given typical pressure ratings and factors of safety for pipes, fittings, and appurtenances and for consistency with typical potable water main operations	- Pressures may be reduced by end users on site if needed	
Maximum service interruptions and reliability	- Reclaimed water supply considered interruptible/nonessential due to potable water supply redundancy - Adequate provisions for redundant potable water supply to be provided where needed with appropriate cross connection control measures	- Common Industry Practice	
Continuous or seasonal service	- Continuous or seasonal based on uses and demand	- Typical Industry Practice	- Information regarding potential use, timing, volumes, and locations - Jurisdictional metered customer water use analyses and trending to further estimate and quantify potential reclaimed water demand variability in each category of potential use

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Reclaimed Water Treatment			
Microfiltration membrane treatment	- Not addressed under WSDOH/WSDOE Water Reclamation and Reuse Standards - WSDOH/WSDOE adoption of California standards for membrane treatment to show equivalency to filtration steps for Class A reclaimed water	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997 - WSDOE Frequently Asked Questions about Reclaimed Water Use, 05-10-012, January 2005	- Anticipated future reclaimed water requirements
Secondary wastewater effluent polishing treatment processes	- Provide a Class A oxidized, coagulated, filtered, disinfected wastewater, with an Ecology delegated wastewater pre-treatment program or waste discharge permits for all applicable discharges - South Plant membrane bio reactor (MBR) treatment of primary wastewater effluent, to include screening, aeration, MBR, disinfection, storage, and reclaimed water pumping to local distribution systems - Satellite or South Plant membrane filtration treatment of secondary wastewater effluent, to include screening, membrane filtration, disinfection, storage, and reclaimed water pumping to local distribution systems	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997 - WSDOE Frequently Asked Questions about Reclaimed Water Use, 05-10-012, January 2005	- Anticipated future reclaimed water requirements
Satellite treatment processes	- Provide a Class A oxidized, coagulated, filtered, disinfected wastewater, with an Ecology delegated wastewater pre-treatment program or waste discharge permits for all applicable discharges - MBR treatment of raw wastewater influent from King County conveyance system, to include influent pumping, screening, grit removal, aeration, MBR, disinfection, storage, and reclaimed water pumping to local distribution systems	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997 - WSDOE Frequently Asked Questions about Reclaimed Water Use, 05-10-012, January 2005	- Anticipated future reclaimed water requirements
Capacity	- Sufficient to support anticipated MDD	- Typical Industry Practice	
Reclaimed water facility aesthetics	- Architectural and landscaping treatments to screen and blend facilities into local settings and aesthetics	- Typical Industry Practice	
Odor control measures	- Fully enclosed treatment facilities with active odor control measures	- Typical Industry Practice	
Waste stream management and solids handling	- Return waste flows to wastewater conveyance/process - Waste stream flows from reclaimed water treatment processes contain 1 to 2 percent solids or less	- Typical Industry Practice	
Alternative disposal of any untreated wastewater	- Wastewater storage and/or means for alternative disposal of untreated or partially treated waste water required	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Facility automation and staffing	- Qualified operations personnel sufficient to achieve required levels of treatment at all times per Chapter 173-230 WAC	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Facility personnel/operations areas	- As required to support anticipated staffing and operations	- Typical Industry Practice	
Facility siting	- Commercial and Industrial Areas	- Typical Industry Practice	- Potential facility siting alternatives

Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Transmission and Distribution Pumping	- As required by uses, topography, service pressures, and hydraulics sufficient to support anticipated peak demands	- Typical Industry Practice	
Transmission and Distribution Piping			
Diameters	- As required by uses, topography, service pressures, and hydraulics sufficient to support anticipated peak demands	- Typical Industry Practice	
Maximum pipeline flow velocities	- Generally 6 to 8 ft/s	- Typical Industry Practice	
Alignment	- Public right of way, - Private easements only as required	- Typical Industry Practice	
Pipe looping	- As hydraulically appropriate and feasible but generally not required for interruptible systems	- Typical Industry Practice	
Depth of cover	- Typical potable water main depth of cover, 3' to 4' minimum	- Typical Industry Practice	
Valve locations and frequency	- Typical potable water main locations and frequency	- Typical Industry Practice	
Flushing station locations and frequency	- Typical potable water main locations and frequency	- Typical Industry Practice	
Potable water pipe separation requirements	- 10' Horizontal - Reclaimed water pipes to pass 1.5' under potable water pipes at crossings	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Setbacks	- 50' to 500' setback required between potable water supply wells and Class A reclaimed water facilities, infrastructure, and use areas depending on type	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Potable water cross connection control devices	- Reduced pressure principal back flow prevention devices or approved air gap separations required	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Materials	- Typical potable water main piping, including Ductile Iron or PVC, with purple reclaimed water color coding and labeling	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Standards	- AWWA, ANSI water main standards	- Typical Industry Practice	
Storage			
Untreated/Partially Treated Wastewater Storage where No Approved Alternative Wastewater Disposal System Exists	- Emergency storage or alternate permitted discharge locations required for use during reclamation system upset or failure conditions - Wet weather conditions storage required for the duration of a 10-year storm or at least 3 times that portion of the average daily flow for which no alternative disposal system is permitted	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements
Treated Reclaimed Water Storage			
- Operational	- As hydraulically needed to support suction supply and cycling for reclaimed water supply pumping	- Typical Industry Practice	
- Peaking	- Reclaimed water transmission and distribution piping and pumping systems sized to support anticipated MDD - Demands exceeding MDD provided through system and/or customer provided treated reclaimed water storage - Peaking storage volume estimated as the difference between PHD and MDD for a total daily duration of 3 hours, which generally equates to a volume equal to 0.25 MDD	- Typical Industry Practice - WSDOH Water System Design Manual, August 2001	
- Emergency/Standby	- None given potable water supply redundancy	- Typical Industry Practice	

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Parameter	Available Information and Assumptions	Information Sources and Notes	Additional Information Needs
Agency Reclaimed Water Responsibility			
Local Agencies	- Where reclaimed water production and uses are identified as under the direct control of a local jurisdiction, the local jurisdiction shall maintain control and responsibility for all facilities and activities inherent to reclaimed water use to ensure that the local jurisdiction's portion of the system operates as intended and in compliance with all State requirements	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements - Desired local, county, and regional responsibilities and agreements
King County	- Where reclaimed water production and uses are identified as under the direct control of the County, the County shall maintain control and responsibility for all facilities and activities inherent to reclaimed water use to ensure that the County's portion of the system operates as intended and in compliance with all State requirements	- WSDOH/WSDOE Water Reclamation and Reuse Standards, September 1997	- Anticipated future reclaimed water requirements - Desired local, county, and regional responsibilities and agreements

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7. SCENARIO ANALYSIS

This section provides details of three potential scenarios for reclaimed water production and distribution and an analysis of each in terms of their ability to provide reclaimed water for the study area. Illustrative schematics and detailed cost estimate summaries, along with relevant assumptions and methodologies, are provided for each scenario. This section forms the basis of the preliminary findings and scenario comparisons presented subsequently in Section 8.

7.1 Overview

Three scenarios for producing and delivering reclaimed water service to the Green River Valley, as identified by King County and representatives from the study area Cities, are presented, considered, assessed, and analyzed in this section. These include:

- Scenario 1: South Treatment Plant Reclaimed Water Backbone - Distribution of reclaimed water produced from reclaimed water treatment facilities to be developed and sited at the existing King County South Treatment Plant (South Plant) and supplied from existing plant secondary treated wastewater effluent
- Scenario 2: Satellite Reclaimed Water Polishing Plants - Distribution of reclaimed water treated and produced from satellite polishing plants located around the Green River Valley and supplied from secondary treated wastewater effluent piped from the South Treatment Plant.
- Scenario 3: Satellite Reclaimed Water Treatment Plants - Distribution of reclaimed water treated and produced at satellite treatment plants located around the Green River Valley and supplied from local raw wastewater conveyance system flows at each plant location.

The scenarios are developed and assessed in the following sections relative to initial assumptions made by King County and representatives from the study area Cities regarding total reclaimed water supply and capacity needs and timing within the study area:

- Year 2016: 15 mgd total potential reclaimed water use (MDD)
- Year 2020: 35 mgd total potential reclaimed water use (MDD)
- Year 2030: 50 mgd total potential reclaimed water use (MDD)

This range of values correlates fairly closely with the approximately 25 mgd total potential MDD reclaimed water irrigation use estimate developed in Section 5 and summarized in Table 5-4, given the fact that additional potential reclaimed water use estimates for industrial processes, streamflow augmentation, wetlands enhancement, and groundwater recharge have not been specifically developed. For the purposes of these analyses, the distribution of reclaimed water uses for each assumed demand level is assumed to vary proportionately among the study area jurisdictions proportionate to the estimated distribution of potential reclaimed water irrigation use.

7.2 Cost Estimating Methodologies

Uniform phasing assumptions and cost estimating methodology are applied in analyzing the three scenarios, with cost and capacity estimates presented for each scenario as follows:

- Capital and operations and maintenance (O&M) cost estimates for reclaimed water treatment scenarios are developed consistent with the King County Reclaimed Water Cost Model assuming membrane treatment to Class A reclaimed water standards. Given the fact that the cost model reports estimates in

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terms of June 2005 dollars, both capital and O&M cost model estimates were updated to July 2007 dollars according to an annual escalation rate of 10 percent per year.

- Costs for satellite treatment plant siting were estimated based on estimated site requirements of 0.5 acres per mgd of treatment capacity at an assumed cost of $25 per site square ft plus an additional 30 percent allowance for contingency.
- Cost estimates for regional and local reclaimed water distribution, to include associated storage consistent with criteria identified in Table 6-5, are estimated based on a preliminary hydraulic assessment of the sizes and locations of reclaimed water piping necessary to provide service for groupings of identified potential use parcels and available streets and piping utility corridors consistent with Figure 5-1. Given potential reclaimed water use estimates and densities, a preliminary and simplified hydraulic analysis developed consistent with the assumptions and criteria listed in Table 6-5 indicates that on the order of 4 miles of 12 inch diameter reclaimed water local distribution piping might be required for each mgd of MDD reclaimed water use and capacity. Hydraulic analyses similarly indicate that scenarios requiring regional distribution piping to convey reclaimed water volumes regionally through the study area could require 8 or more miles of 30 inch diameter regional reclaimed water distribution piping. Reclaimed water distribution storage needs were estimated consistent with Table 6-5 assumptions and criteria based on a volume equivalent to 0.25 MDD in order to provide peaking storage to support peak hourly demands at levels that may exceed average MDD. Capital costs for these elements are based on estimated unit costs of $300 per lineal ft of 12 inch diameter reclaimed water pipe, $650 per lineal ft or 30 inch diameter reclaimed water pipe, and $3 per gallon of reclaimed water distribution storage.
- All capital cost estimates include estimates for all construction costs with additional allowances for design, construction management, and contingency of approximately 10 percent, 5 percent, and 30 percent respectively.
- Present value cost estimates are calculated as the sum of estimated capital and O&M costs based on a 6 percent discount rate and 40 year term and timeframe.
- Estimated annual debt service for funding of estimated capital costs are similarly estimated based on a 6 percent discount rate and 40 year term. Total annual costs are estimated as the sum of estimated annual debt service and O&M costs.
- Annual unit costs for each scenario are calculated from total estimated annual costs according to estimates of total annual reclaimed water production and delivery based on the average estimated potential reclaimed water use indicated in Table 5-4 for the five month summer irrigation period. Annual unit costs are then estimated consistent with the estimated production volumes in terms of dollars per gallon of reclaimed water produced.
- All costs are estimated and presented in terms of July 2007 dollars.

The following sections describe each scenario and include schematics, cost estimates, and discussion regarding limitations and considerations.

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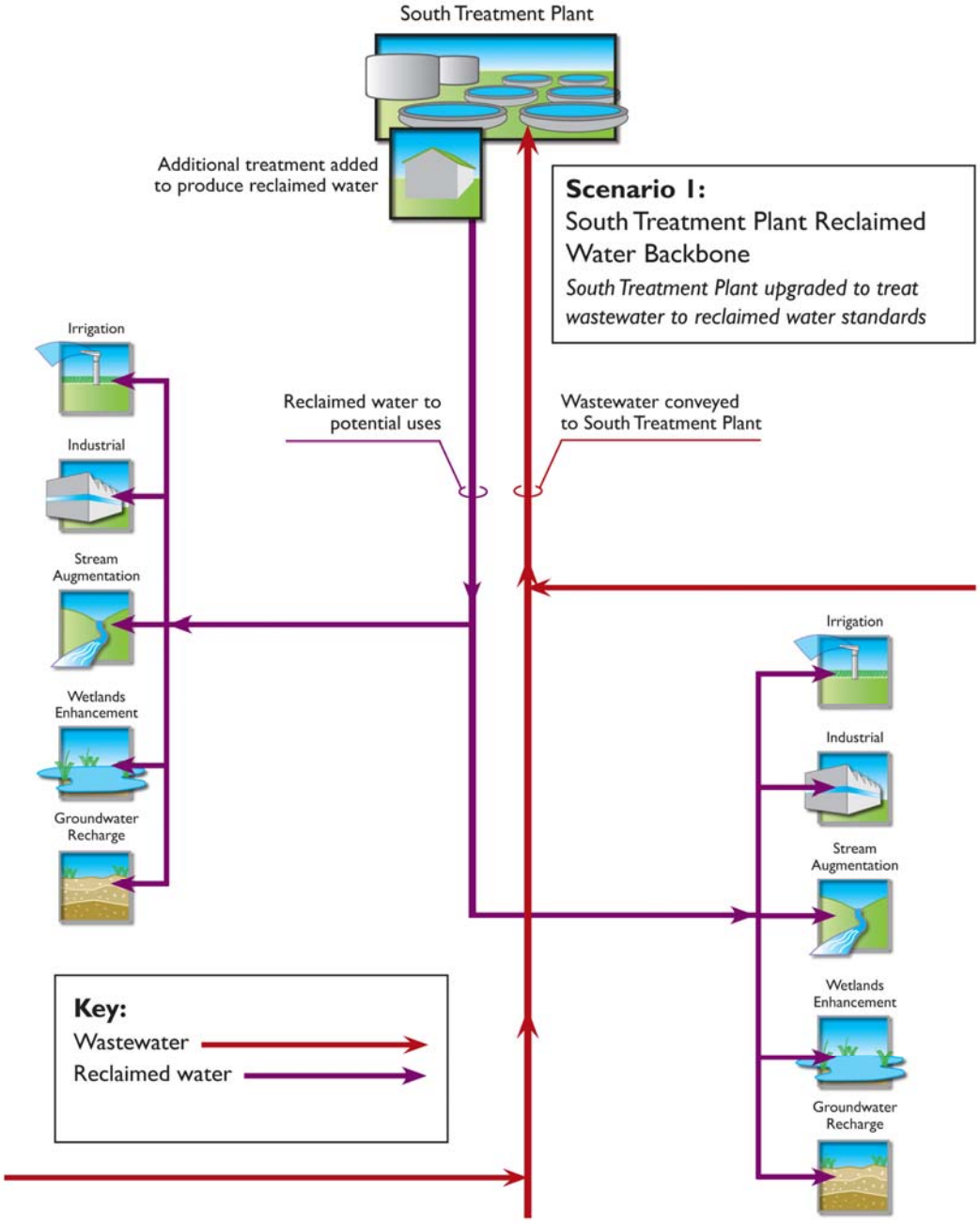
7.3 Scenario 1: South Treatment Plant Reclaimed Water Backbone

This reclaimed water scenario involves treating wastewater to reclaimed water standards via facilities to be developed at South Plant, and distributing reclaimed water to the study area for local use via a regional piping distribution system, as illustrated in Figure 7-1.

Figure 7-1. Scenario 1 Reclaimed Water System



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Scenario 1 includes the following key elements and processes to produce and distribute reclaimed water as indicated in Figures 7-1 and 7-2:

- South Plant Reclaimed Water processes treat secondary wastewater effluent via membrane filtration to achieve Class A reclaimed water standards, process elements include:
    - Screening
    - Membrane filtration
    - Disinfection
    - Storage
    - Reclaimed water pumping
- Regional and local piping and storage to distribute reclaimed water from South Plant to potential study area uses

As illustrated in Figure 7-2, reclaimed water treatment under this scenario is provided at South Plant by drawing off treated secondary wastewater effluent following the existing biological treatment processes. Supply to the reclaimed water polishing treatment process undergoes fine screening followed by membrane filtration and disinfection to meet Class A reclaimed water standards.

A second treatment option, though not specifically detailed as part of this analysis, could involve drawing off treated primary effluent wastewater downstream of the existing primary clarification process and applying membrane bioreactor (MBR) treatment processes to simultaneously achieve both secondary wastewater treatment and Class A reclaimed water treatment of South Plant primary wastewater effluent. This treatment approach provides the added benefit of effectively expanding South Plant secondary wastewater treatment capacity through the addition of a full MBR secondary wastewater treatment/reclaimed water treatment train. Thus treatment costs could be considered to be somewhat offset by costs that might otherwise be incurred at South Plant to expand secondary wastewater treatment capacity. Thus a South Plant MBR treatment approach could fulfill both future secondary treatment capacity expansion and reclaimed water needs.

Under either treatment approach, reclaimed water is then distributed from South Plant to potential study area uses via pumping and regional and local distribution piping and storage as illustrated in Figure 7-1. Waste flows from the reclaimed water treatment processes are returned to the South Plant wastewater treatment system for processing and disposal.

Although South Plant currently includes a small 1.26 mgd Class A reclaimed water treatment system using sand filters, this scenario is based on membrane treatment given the potential for membranes to provide higher levels of treatment, improved performance, improved removal efficiencies, and simplified operations relative to the older sand filtration treatment technologies.

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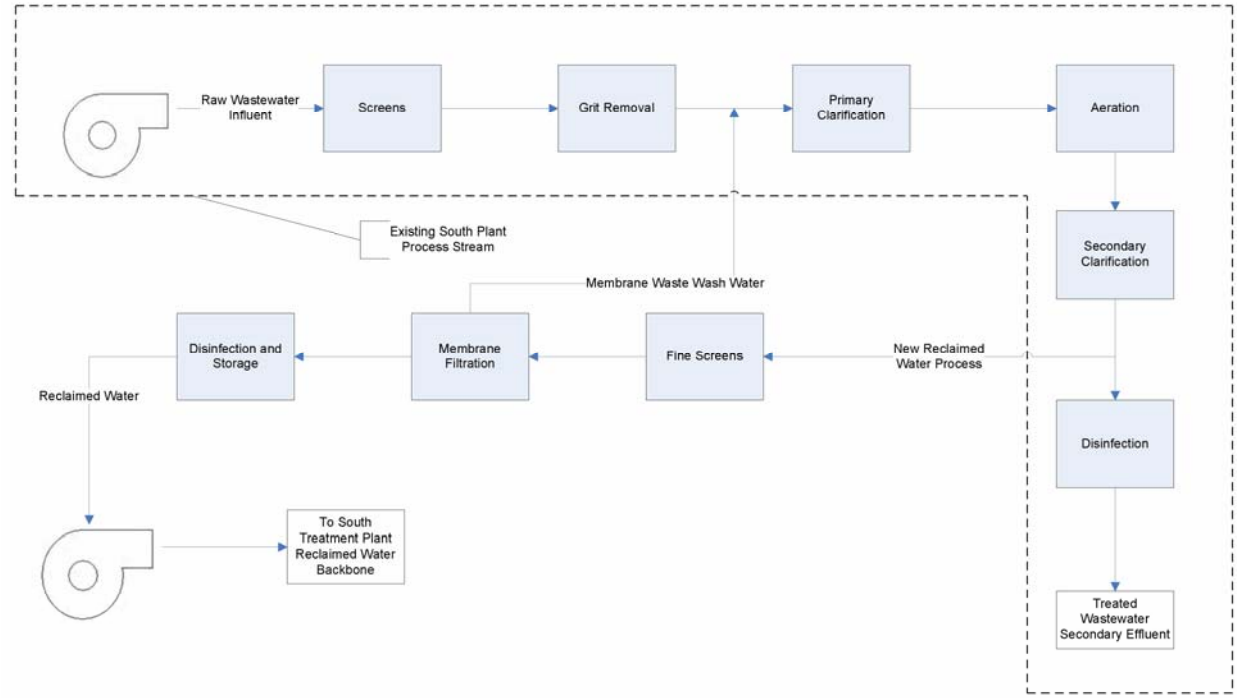
Figure 7-2. Scenario 1: South Plant Reclaimed Water Polishing Process



Given estimated wastewater flows available for reclaimed water supply at South Plant as summarized in Figure 4-9, and the ability of regional and local reclaimed water piping and storage facilities to be implemented to provide desired levels of reclaimed water service anywhere in the study area, this scenario can be implemented to deliver large amounts of reclaimed water, effectively limited only by South Plant flow volumes and the reclaimed water treatment and distribution capacity of the system. A preliminary review of current facilities and infrastructure at the South Plant site relative to estimated footprint and space requirements for the proposed reclaimed water treatment facilities, as needed to supply assumed study area reclaimed water demands through 2030 and beyond, indicates that there appears to be adequate room on site north of existing secondary wastewater treatment process areas.

Although reclaimed water facilities to be located at South Plant would likely have to be regionally owned and operated, regional and local distribution piping and storage systems needed to then deliver reclaimed water to the study area could be either regionally or locally owned and operated by either public or private entities as desired.

Preliminary estimated initial capital, O&M, present value, debt service, annual, and capacity specific costs for this scenario are summarized in Table 7-1 consistent with the cost estimating methodologies and assumptions presented previously and previously detailed assumptions regarding required reclaimed water system capacities and timing.

Table 7-1. Scenario 1 Preliminary Cost Estimate (Millions)

Scenario	Year	Total System Capacity (mgd)[1]	Treatment Location[1]	Treatment Capacity (mgd)[2]	Estimated Capital Costs					Estimated Annual O&M Costs[7]	Estimated Present Value Cost[8]	Estimated Annual Debt Service Cost[9]	Estimated Annual Cost[10]	Annual Irrigation Volume Estimate (mg)[11]	Annual Unit Cost ($/mg)[12]
					Treatment[3]	Treatment Siting[4]	Regional Distribution[5]	Local Distribution[6]	Total						
1 - South Treatment Plant Secondary Wastewater Effluent Polishing with Reclaimed Water Backbone Distribution															
	2016	15	South Plant	15	$85		$27	$106	$218	$2.2	$252	$15	$17	744	$0.022
Subtotal				**15**	**$85**		**$27**	**$106**	**$218**	**$2.2**	**$252**	**$15**	**$17**	**744**	**$0.022**
	2020	35	South Plant	35	$76			$142	$217	$2.2	$250	$14	$17	1,737	$0.019
Subtotal				**35**	**$160**		**$27**	**$248**	**$436**	**$4.4**	**$501**	**$29**	**$33**	**1,737**	**$0.019**
	2030	50	South Plant	50	$57			$106	$163	$1.6	$187	$11	$12	2,481	$0.018
Total				**50**	**$217**		**$27**	**$354**	**$599**	**$6.0**	**$689**	**$40**	**$46**	**2,481**	**$0.018**

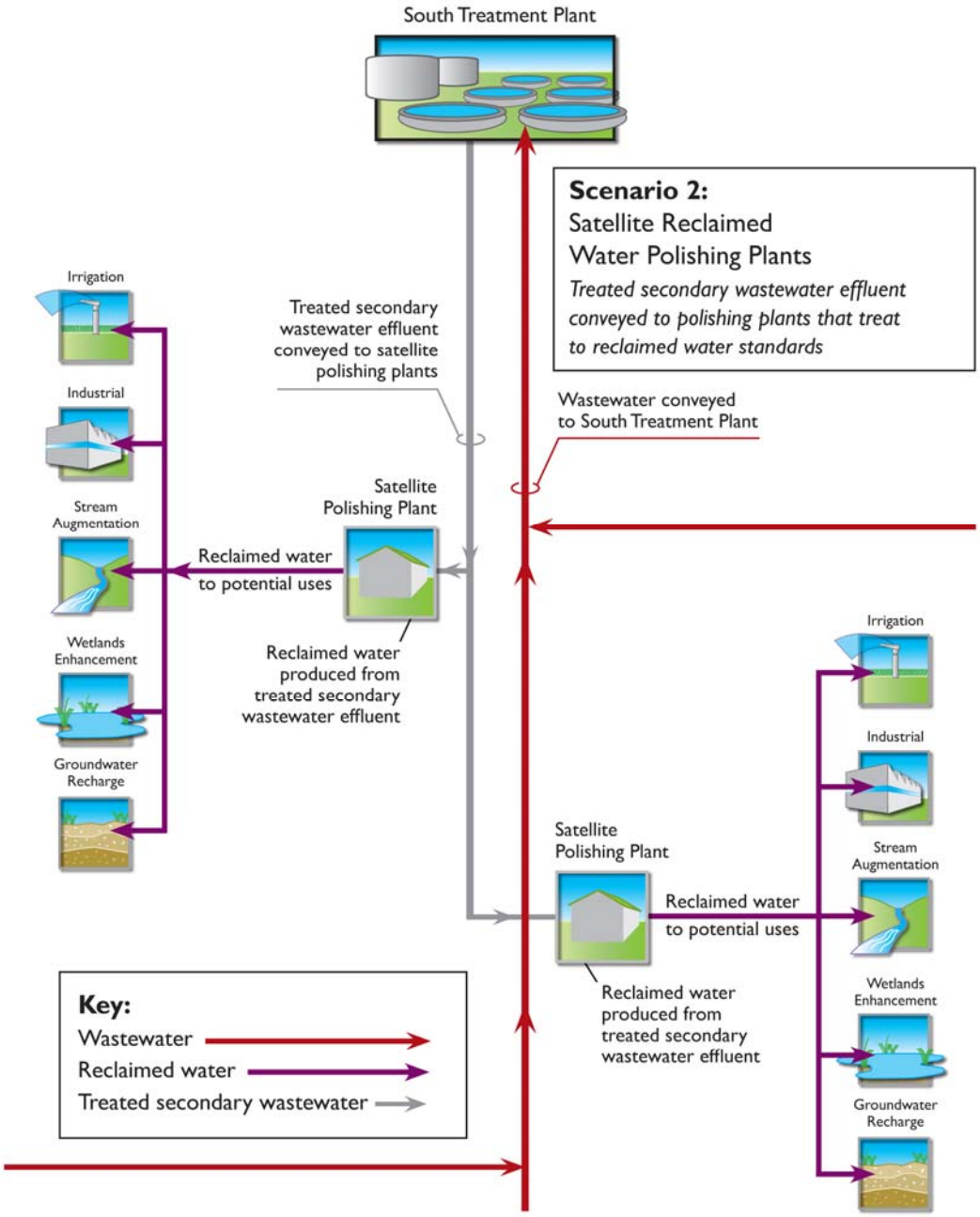
Notes:

1. Assumed for illustrative purposes to assess potential differences between some possible reclaimed water production and delivery scenarios
2. Local flow distributions assumed according to estimated proportionality of potential reclaimed water irrigation use
3. Estimated from King County Reclaimed Water Treatment Plant Cost Model to include construction costs, and 10, 5, and 30 percent allowances for design, construction management, and contingency respectively, cost estimates adjusted from June 2005 to July 2007 dollar basis using an annual escalation rate of 10 percent
4. Satellite plant siting requirements estimated at 0.5 acres per mgd plant capacity and $25 per site square ft plus a 30 percent contingency allowance
5. Estimated from preliminary hydraulic analysis to include approximately 8 miles of 30 inch diameter regional piping at $650 per lineal ft including construction costs and 10, 5, and 30 percent allowances for design, construction management, and contingency respectively
6. Estimated from preliminary hydraulic analysis to include approximately 4 miles of 12 inch diameter local distribution piping per mgd reclaimed water supply capacity at $300 per lineal ft, 0.25 gallons of reclaimed water system storage per mgd of reclaimed water supply capacity at $3 per gallon, including construction costs and 10, 5, and 30 percent allowances for design, construction management, and contingency
7. Estimated from King County Reclaimed Water Treatment Plant Cost Model including operations, maintenance, energy, and chemical costs, cost estimates adjusted from June 2005 to July 2007 dollar basis using an annual escalation rate of 10 percent
8. Estimated as the sum of total capital costs and annual O&M costs according to a 6 percent discount rate and 40 year term
9. Estimated from total capital costs according to a 6 percent discount rate and a 40 year term
10. Estimated as the sum of annual debt service and annual O&M costs
11. Estimated total annual volume of reclaimed water produced according to potential reclaimed water irrigation use estimates
12. Estimated from annual costs and total annual volume of reclaimed water produced assuming production according to potential reclaimed water irrigation use estimates
13. All costs are estimated in terms of July 2007 dollars

7.4 Scenario 2: Satellite Reclaimed Water Polishing Plants

This reclaimed water scenario involves distributing secondary wastewater effluent from South Plant to the study area through a regional piping system, and treating that water to reclaimed water standards for local use via satellite polishing plants located around the study area, as illustrated in Figure 7-3.

Figure 7-3. Scenario 2 Reclaimed Water System



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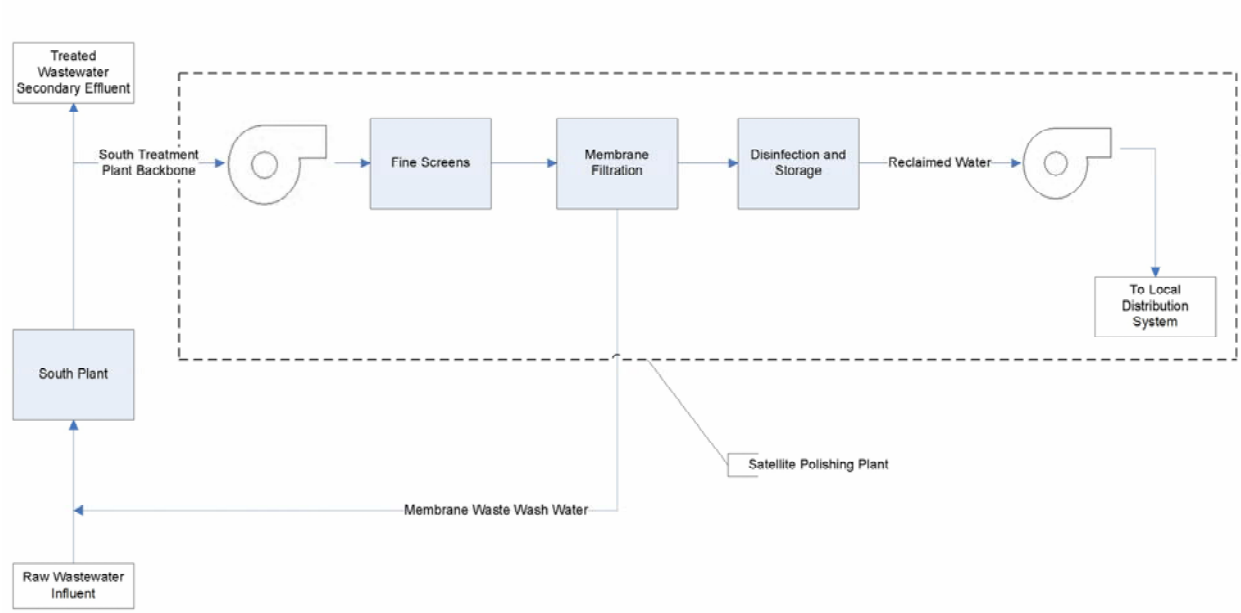
Scenario 2 includes the following key elements and processes to produce and distribute reclaimed water as indicated in Figures 7-3 and 7-4:

- Regional piping to convey secondary wastewater effluent from the South Plant to Satellite Reclaimed Water Polishing Plants within the study area
- Satellite Reclaimed Water Polishing Plants treat secondary wastewater effluent via membrane filtration to achieve Class A reclaimed water standards, process elements include:
    - Screening
    - Membrane filtration
    - Disinfection
    - Storage
    - Reclaimed water pumping
- Local piping and storage to distribute reclaimed water from Satellite Reclaimed Water Polishing Plants to potential study area uses

As illustrated in Figure 7-4, reclaimed water treatment under this scenario is provided by Satellite Reclaimed Water Polishing Plants located around the study area supplied with secondary wastewater effluent piped from South Plant. Following the existing South Plant biological treatment processes, secondary effluent is drawn off as needed to support reclaimed water uses and delivered to satellite locations within the study area for treatment. The reclaimed water polishing treatment process includes fine screening followed by membrane filtration and disinfection to meet Class A reclaimed water standards. Reclaimed water is then distributed to potential study area uses via pumping and regional and local distribution piping and storage as illustrated in Figure 7-3. Waste flows from the reclaimed water polishing treatment process are returned to the wastewater conveyance system for disposal to South Plant.

Figure 7-4. Scenario 2: Satellite Reclaimed Water Polishing Process



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Given estimated wastewater flows available for reclaimed water supply at South Plant as summarized in Figure 4-9, and the ability of satellite reclaimed water polishing plants, associated regional and local piping, and storage facilities to be implemented to provide desired levels of reclaimed water service anywhere in the study area, this scenario can be implemented to deliver large amounts of reclaimed water as needed to supply assumed study area reclaimed water demands through 2030 and beyond, effectively limited only by South Plant flow volumes and the reclaimed water treatment and distribution capacity of the system.

A preliminary review of satellite reclaimed water polishing facility footprints relative to production capacity indicates that approximately 0.5 site acres would likely be required per mgd of reclaimed water capacity. For the purposes of this analysis, four satellite polishing plants are assumed in order to produce reclaimed water for assumed and estimated potential reclaimed water demands in the Auburn, Covington, Kent, and Renton/Tukwila areas. Such satellite polishing plants, the regional secondary wastewater effluent piping needed to support them, and local distribution piping and storage systems needed to then deliver reclaimed water to the study area could be either regionally or locally owned and operated by either public or private entities as desired.

Preliminary estimated initial capital, O&M, present value, debt service, annual, and capacity specific costs for this scenario are summarized in Table 7-2 consistent with the cost estimating methodologies and assumptions presented previously and previously detailed assumptions regarding required reclaimed water system capacities and timing.

Table 7-2. Scenario 2 Preliminary Cost Estimate (Millions)

Scenario	Year	Total System Capacity (mgd)[1]	Treatment Location[1]	Treatment Capacity (mgd)[2]	Estimated Capital Costs					Estimated Annual O&M Costs[7]	Estimated Present Value Cost[8]	Estimated Annual Debt Service Cost[9]	Estimated Annual Cost[10]	Annual Irrigation Volume Estimate (mg)[11]	Annual Unit Cost ($/mg)[12]
					Treatment[3]	Treatment Siting[4]	Regional Distribution[5]	Local Distribution[6]	Total						
2 - Satellite Polishing Plants with South Plant Secondary Effluent Backbone and Local Reclaimed Water Distribution															
	2016	15	Auburn	4.4	$41	$10	$8	$31	$90	$1.0	$105	$6	$7	216	$0.032
			Covington	0.6	$14	$1	$1	$4	$21	$0.3	$25	$1	$2	31	$0.054
			Kent	5.1	$47	$12	$9	$36	$105	$1.1	$122	$7	$8	255	$0.032
			Renton/Tukwila	4.9	$45	$12	$9	$35	$100	$1.1	$117	$7	$8	242	$0.032
Subtotal				**15**	**$148**	**$35**	**$27**	**$106**	**$317**	**$3.5**	**$369**	**$21**	**$25**	**744**	**$0.033**
	2020	35	Auburn	10.2	$43			$41	$84	$1.1	$100	$6	$7	504	$0.027
			Covington	1.5	$6			$6	$12	$0.2	$14	$1	$1	73	$0.036
			Kent	12.0	$50			$49	$99	$1.3	$118	$7	$8	595	$0.027
			Renton/Tukwila	11.4	$48			$46	$94	$1.2	$112	$6	$7	565	$0.027
Subtotal				**35**	**$295**	**$35**	**$27**	**$248**	**$606**	**$7.2**	**$715**	**$40**	**$48**	**1,737**	**$0.027**
	2030	50	Auburn	14.5	$32			$31	$63	$0.8	$75	$4	$5	720	$0.026
			Covington	2.1	$5			$4	$9	$0.1	$11	$1	$1	104	$0.032
			Kent	17.1	$38			$36	$74	$1.0	$89	$5	$6	850	$0.026
			Renton/Tukwila	16.3	$36			$35	$71	$0.9	$84	$5	$6	807	$0.026
Total				**50**	**$406**	**$35**	**$27**	**$354**	**$823**	**$10.0**	**$974**	**$55**	**$65**	**2,481**	**$0.026**

Notes:

1. Assumed for illustrative purposes to assess potential differences between some possible reclaimed water production and delivery scenarios
2. Local flow distributions assumed according to estimated proportionality of potential reclaimed water irrigation use
3. Estimated from King County Reclaimed Water Treatment Plant Cost Model to include construction costs, and 10, 5, and 30 percent allowances for design, construction management, and contingency respectively, cost estimates adjusted from June 2005 to July 2007 dollar basis using an annual escalation rate of 10 percent
4. Satellite plant siting requirements estimated at 0.5 acres per mgd plant capacity and $25 per site square ft plus a 30 percent contingency allowance
5. Estimated from preliminary hydraulic analysis to include approximately 8 miles of 30 inch diameter regional piping at $650 per lineal ft including construction costs and 10, 5, and 30 percent allowances for design, construction management, and contingency respectively
6. Estimated from preliminary hydraulic analysis to include approximately 4 miles of 12 inch diameter local distribution piping per mgd reclaimed water supply capacity at $300 per lineal ft, 0.25 gallons of reclaimed water system storage per mgd of reclaimed water supply capacity at $3 per gallon, including construction costs and 10, 5, and 30 percent allowances for design, construction management, and contingency
7. Estimated from King County Reclaimed Water Treatment Plant Cost Model including operations, maintenance, energy, and chemical costs, cost estimates adjusted from June 2005 to July 2007 dollar basis using an annual escalation rate of 10 percent
8. Estimated as the sum of total capital costs and annual O&M costs according to a 6 percent discount rate and 40 year term
9. Estimated from total capital costs according to a 6 percent discount rate and a 40 year term
10. Estimated as the sum of annual debt service and annual O&M costs
11. Estimated total annual volume of reclaimed water produced according to potential reclaimed water irrigation use estimates
12. Estimated from annual costs and total annual volume of reclaimed water produced assuming production according to potential reclaimed water irrigation use estimates
13. All costs are estimated in terms of July 2007 dollars

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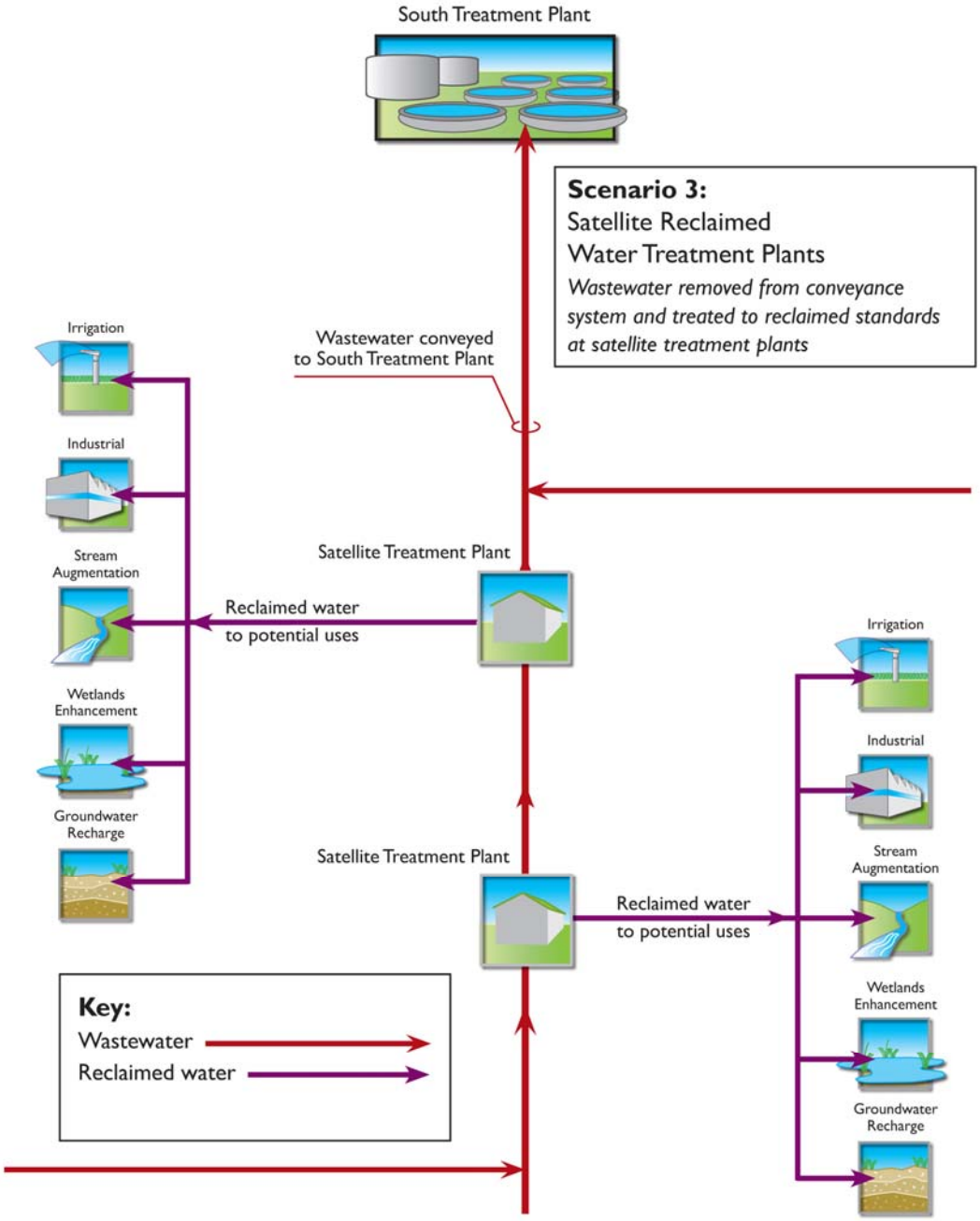
7.5 Scenario 3: Satellite Reclaimed Water Treatment Plants

This reclaimed water scenario involves treating wastewater from the King County conveyance system to reclaimed water standards for local use via satellite treatment plants located around the study area, as illustrated in Figure 7-5.

Figure 7-5. Scenario 3 Reclaimed Water System



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Scenario 3 includes the following key elements and processes to produce and distribute reclaimed water as indicated in Figures 7-5 and 7-6:

- Satellite Reclaimed Water Treatment Plants treat raw wastewater influent from King County conveyance system via membrane bioreactor (MBR) process to achieve Class A reclaimed water standards, process elements include:
    - Influent pumping
    - Screening
    - Grit Removal
    - Aeration
    - MBR
    - Disinfection
    - Storage
    - Reclaimed water pumping
- Local piping and storage to distribute reclaimed water from Satellite Reclaimed Water Treatment Plants to potential study area uses

As illustrated in Figure 7-6, reclaimed water treatment under this scenario is provided by Satellite Reclaimed Water Treatment Plants located around the study area supplied with raw wastewater sourced directly from existing wastewater conveyance systems. Raw wastewater is drawn off locally for treatment at satellite plant locations as needed to support local reclaimed water uses. The reclaimed water treatment process includes screening followed by grit removal, and aeration and membrane bioreactor (MBR) treatment followed by disinfection to meet Class A reclaimed water standards. Reclaimed water is then distributed to potential local study area uses via pumping and local distribution piping and storage as illustrated in Figure 7-5. Waste flows from the reclaimed water treatment process are returned to the wastewater conveyance system for disposal to South Plant. With the satellite treatment plants drawing wastewater directly out of the regional conveyance system for reclaimed water supply, satellite treatment plant reclaimed water production would also need to be limited such that flows sufficient to mobilize process waste products and solids are maintained in the conveyance system.

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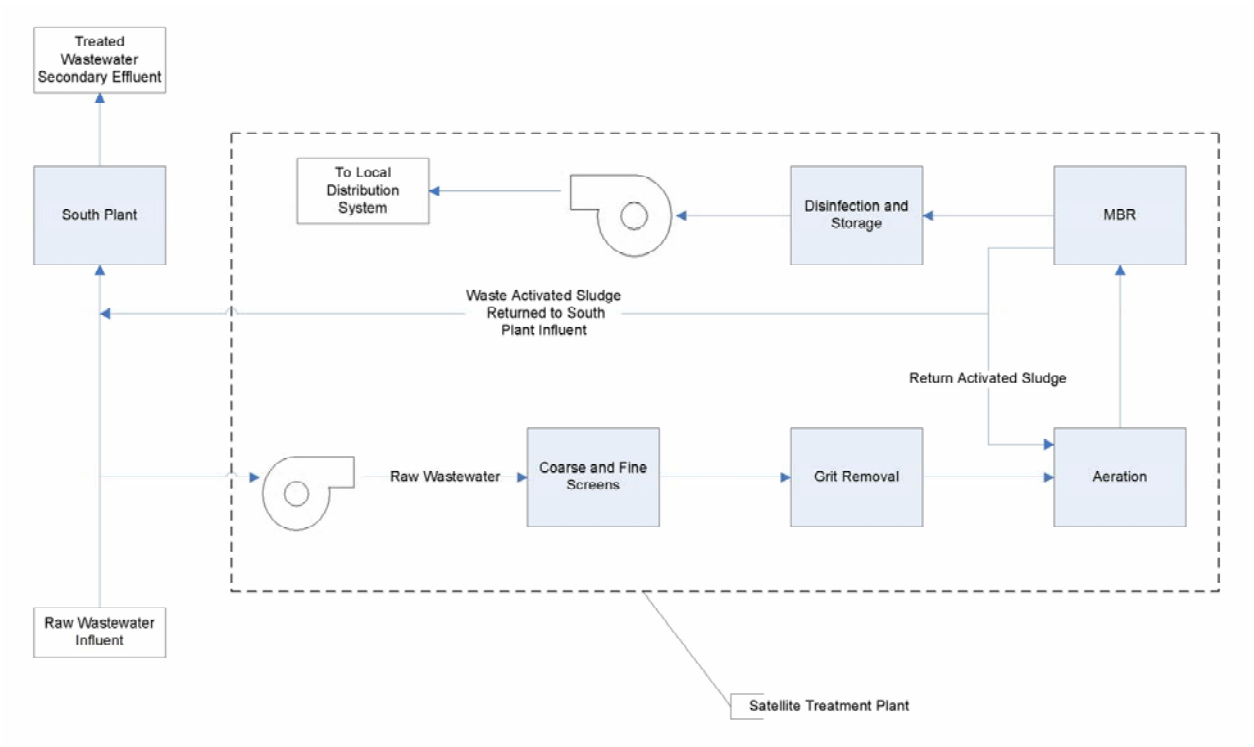
Figure 7-6. Scenario 3: Satellite Reclaimed Water Treatment Process



Satellite reclaimed water treatment plant supply capacities are effectively limited by the upstream raw wastewater conveyance flows at each satellite plant location. Thus, while wastewater flow and potential reclaimed water use estimates appear to suggest that reclaimed water uses might generally be distributed proportionate to area wastewater conveyance flows, large reclaimed water uses in specific isolated locations could potentially exceed locally available wastewater conveyance flows, and thus be more difficult to support under Scenario 3 than other considered reclaimed water scenarios. This potential limitation of the satellite treatment plant approach is illustrated in Figures 5-3, 5-4, and 5-5, which demonstrate that for certain local areas, potential local reclaimed water use and demands could exceed the locally available wastewater flow resources for reclaimed water supply. Thus, detailed and careful review and assessments of local potential reclaimed water demands are critical if satellite treatment approaches are to be effectively realized such that use is not artificially or inappropriately constrained by locally isolated wastewater flow supply limitations.

A preliminary review of satellite reclaimed water treatment facility footprints relative to production capacity indicates that approximately 0.5 site acres would likely be required per mgd of reclaimed water capacity. For the purposes of this analysis, four satellite treatment plants are assumed in order to produce reclaimed water for assumed and estimated potential reclaimed water demands in the Auburn, Covington, Kent, and Renton/Tukwila areas. Such satellite treatment plants and local distribution piping and storage systems needed to then deliver reclaimed water to the local study areas could be either regionally or locally owned and operated by either public or private entities as desired.

Preliminary estimated initial capital, O&M, present value, debt service, annual, and capacity specific costs for this scenario are summarized in Table 7-3 consistent with the cost estimating methodologies and assumptions presented previously and previously detailed assumptions regarding required reclaimed water system capacities and timing.

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Table 7-3. Scenario 3 Preliminary Cost Estimate (Millions)

Scenario	Year	Total System Capacity (mgd)[1]	Treatment Location[1]	Treatment Capacity (mgd)[2]	Estimated Capital Costs					Estimated Annual O&M Costs[7]	Estimated Present Value Cost[8]	Estimated Annual Debt Service Cost[9]	Estimated Annual Cost[10]	Annual Irrigation Volume Estimate (mg)[11]	Annual Unit Cost ($/mg)[12]
					Treatment[3]	Treatment Siting[4]	Regional Distribution[5]	Local Distribution[6]	Total						
3 - Satellite Treatment Plants with Local Reclaimed Water Distribution															
	2016	15	Auburn	4.4	$66	$10		$31	$107	$2.3	$141	$7	$9	216	$0.043
			Covington	0.6	$25	$1		$4	$31	$0.9	$45	$2	$3	31	$0.096
			Kent	5.1	$74	$12		$36	$123	$2.6	$161	$8	$11	255	$0.042
			Renton/Tukwila	4.9	$71	$12		$35	$117	$2.5	$154	$8	$10	242	$0.042
Subtotal				**15**	**$236**	**$35**	**$0**	**$106**	**$378**	**$8.2**	**$501**	**$25**	**$33**	**744**	**$0.045**
	2020	35	Auburn	10.2	$63			$41	$104	$2.1	$136	$7	$9	504	$0.037
			Covington	1.5	$9			$6	$15	$0.3	$20	$1	$1	73	$0.059
			Kent	12.0	$74			$49	$122	$2.5	$160	$8	$11	595	$0.036
			Renton/Tukwila	11.4	$70			$46	$116	$2.4	$152	$8	$10	565	$0.036
Subtotal				**35**	**$452**	**$35**	**$0**	**$248**	**$735**	**$15.6**	**$970**	**$49**	**$64**	**1,737**	**$0.037**
	2030	50	Auburn	14.5	$47			$31	$78	$1.6	$102	$5	$7	720	$0.035
			Covington	2.1	$7			$4	$11	$0.2	$15	$1	$1	104	$0.051
			Kent	17.1	$55			$36	$92	$1.9	$120	$6	$8	850	$0.035
			Renton/Tukwila	16.3	$53			$35	$87	$1.8	$114	$6	$8	807	$0.035
Total				**50**	**$614**	**$35**	**$0**	**$354**	**$1,003**	**$21.1**	**$1,321**	**$67**	**$88**	**2,481**	**$0.035**

Notes:

1. Assumed for illustrative purposes to assess potential differences between some possible reclaimed water production and delivery scenarios
2. Local flow distributions assumed according to estimated proportionality of potential reclaimed water irrigation use
3. Estimated from King County Reclaimed Water Treatment Plant Cost Model to include construction costs, and 10, 5, and 30 percent allowances for design, construction management, and contingency respectively, cost estimates adjusted from June 2005 to July 2007 dollar basis using an annual escalation rate of 10 percent
4. Satellite plant siting requirements estimated at 0.5 acres per mgd plant capacity and $25 per site square ft plus a 30 percent contingency allowance
5. Estimated from preliminary hydraulic analysis to include approximately 8 miles of 30 inch diameter regional piping at $650 per lineal ft including construction costs and 10, 5, and 30 percent allowances for design, construction management, and contingency respectively
6. Estimated from preliminary hydraulic analysis to include approximately 4 miles of 12 inch diameter local distribution piping per mgd reclaimed water supply capacity at $300 per lineal ft, 0.25 gallons of reclaimed water system storage per mgd of reclaimed water supply capacity at $3 per gallon, including construction costs and 10, 5, and 30 percent allowances for design, construction management, and contingency
7. Estimated from King County Reclaimed Water Treatment Plant Cost Model including operations, maintenance, energy, and chemical costs, cost estimates adjusted from June 2005 to July 2007 dollar basis using an annual escalation rate of 10 percent
8. Estimated as the sum of total capital costs and annual O&M costs according to a 6 percent discount rate and 40 year term
9. Estimated from total capital costs according to a 6 percent discount rate and a 40 year term
10. Estimated as the sum of annual debt service and annual O&M costs
11. Estimated total annual volume of reclaimed water produced according to potential reclaimed water irrigation use estimates
12. Estimated from annual costs and total annual volume of reclaimed water produced assuming production according to potential reclaimed water irrigation use estimates
13. All costs are estimated in terms of July 2007 dollars

8. PRELIMINARY FINDINGS

This section summarizes preliminary findings and comparisons of the reclaimed water production and distribution scenarios described in Section 7 and developed according to the information, assumptions, and criteria developed in Sections 3 through 6. Key areas are also identified where additional data and information will likely be needed to facilitate and refine further analysis of reclaimed water options for the Green River Valley study area.

8.1 Scenario Comparisons and Feasibility

Three scenarios for producing and delivering reclaimed water service to the Green River Valley, as identified by King County and representatives from the study area Cities, are presented, considered, assessed, and analyzed in Section 7. These include:

- Scenario 1: South Treatment Plant Reclaimed Water Backbone - Distribution of reclaimed water produced from reclaimed water treatment facilities to be developed and sited at the existing King County South Treatment Plant (South Plant) and supplied from existing plant secondary treated wastewater effluent
- Scenario 2: Satellite Reclaimed Water Polishing Plants - Distribution of reclaimed water treated and produced from satellite polishing plants located around the Green River Valley and supplied from secondary treated wastewater effluent piped from the South Treatment Plant.
- Scenario 3: Satellite Reclaimed Water Treatment Plants - Distribution of reclaimed water treated and produced at satellite treatment plants located around the Green River Valley and supplied from local raw wastewater conveyance system flows at each plant location.

The scenarios are developed relative to initial assumptions made by King County and representatives from the study area Cities regarding total reclaimed water supply and capacity needs and timing within the study area:

- Year 2016: 15 mgd total potential reclaimed water use (MDD)
- Year 2020: 35 mgd total potential reclaimed water use (MDD)
- Year 2030: 50 mgd total potential reclaimed water use (MDD)

Cost Estimates

Table 8-1 presents a comparative summary of the preliminary cost estimates developed for each of the three scenarios in Section 7. Included are preliminary estimates of initial capital, O&M, present value, debt service, annual, and capacity specific costs, to include appropriate allowances for design, construction, construction management, and planning level contingency. The methodologies and assumptions underlying the cost estimates are summarized in Section 7.

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Table 8-1. Preliminary Reclaimed Water Cost Estimate Summary and Comparison (Millions)

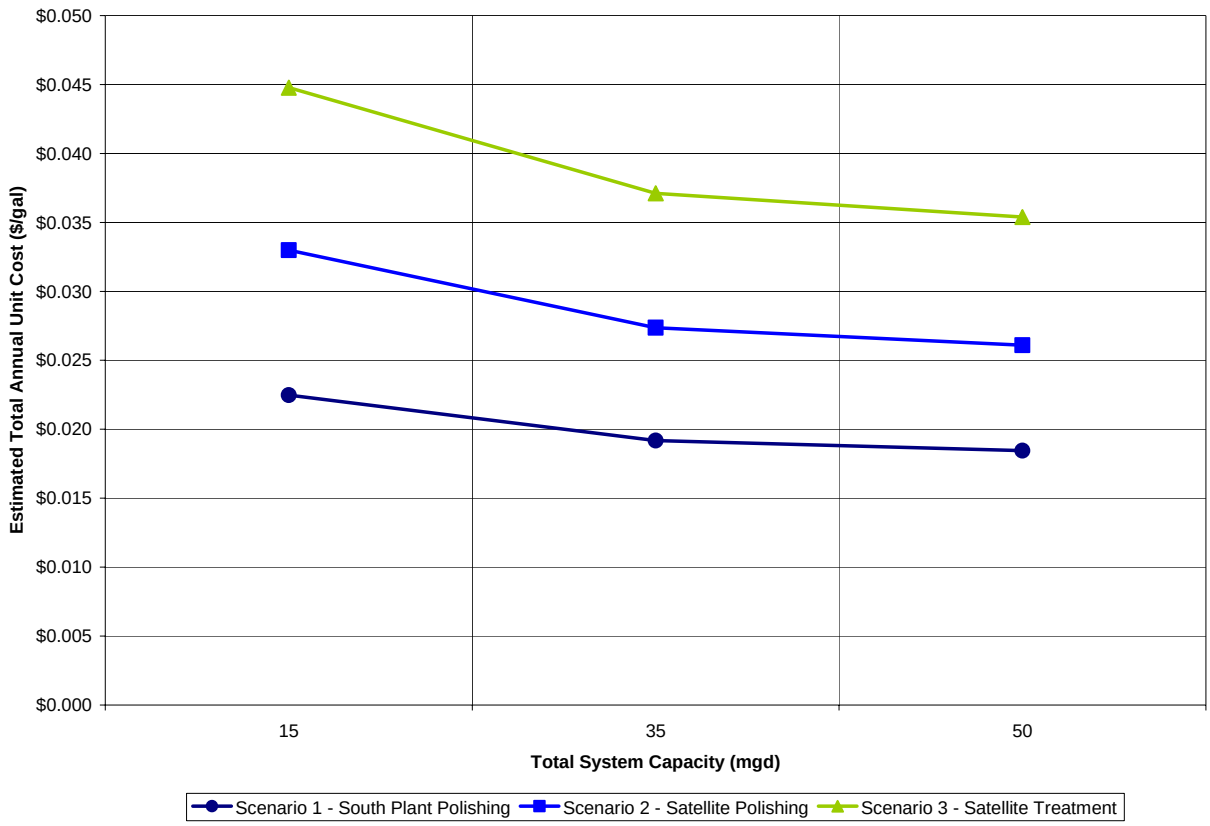
Scenario	Year	Total System Capacity (mgd)	Estimated Capital Costs					Estimated Annual O&M Costs	Estimated Present Value Cost	Estimated Annual Debt Service Cost	Estimated Annual Cost	Annual Irrigation Volume Estimate (mg)	Annual Unit Cost ($/mg)
			Treatment	Treatment Siting	Regional Distribution	Local Distribution	Total						
1 - South Treatment Plant Secondary Wastewater Effluent Polishing with Reclaimed Water Backbone Distribution													
	2016	15	$85		$27	$106	$218	$2.2	$252	$15	$17	744	$0.022
	2020	35	$160		$27	$248	$436	$4.4	$501	$29	$33	1,737	$0.019
	2030	50	$217		$27	$354	$599	$6.0	$689	$40	$46	2,481	$0.018
2 - Satellite Polishing Plants with South Plant Secondary Effluent Backbone and Local Reclaimed Water Distribution													
	2016	15	$148	$35	$27	$106	$317	$3.5	$369	$21	$25	744	$0.033
	2020	35	$295	$35	$27	$248	$606	$7.2	$715	$40	$48	1,737	$0.027
	2030	50	$406	$35	$27	$354	$823	$10.0	$974	$55	$65	2,481	$0.026
3 - Satellite Treatment Plants with Local Reclaimed Water Distribution													
	2016	15	$236	$35		$106	$378	$8.2	$501	$25	$33	744	$0.045
	2020	35	$452	$35		$248	$735	$15.6	$970	$49	$64	1,737	$0.037
	2030	50	$614	$35		$354	$1,003	$21.1	$1,321	$67	$88	2,481	$0.035

As detailed in Table 8-1, preliminary cost estimates indicate that of the three reclaimed water scenarios considered, Scenario 1 appears to be the most cost effective means for producing and supplying reclaimed water for the Green River Valley study area in terms of total estimated treatment system capital costs, total estimated capital cost, and estimated annual O&M costs, which translate into the lowest overall estimates of present value, annual debt service, total estimated annual, and unit annual cost per gallon of reclaimed water supplied. Estimated regional distribution piping capital cost estimates can be expected to be roughly equivalent for Scenarios 1 and 2, and estimated local reclaimed water distribution costs are the same for all three scenarios.

Estimated reclaimed water treatment costs are generally lower for Scenario 1 due to the economies of scale involved in implementing reclaimed water treatment via a single, larger, centralized facility rather than through multiple smaller distributed satellite plants. However, on an incremental development and implementation basis, it may still be more practical to implement reclaimed water via smaller distributed satellite plants despite the potential higher overall unit costs and lower overall economy of scale as compared to a larger centralized facility.

Consistent with the range of unit annual debt service and O&M costs estimated for each scenario, Figure 8-1 presents a comparison of estimated scenario costs based on total system reclaimed water capacity, assuming 15 mgd, 35 mgd, and 50 mgd supply capacities in 2016, 2020, and 2030 respectively.

Figure 8-1. Preliminary Reclaimed Water Annual Debt Service and O&M Unit Cost Comparison



The cost estimates suggest the following ranges of annual unit costs in dollars per gallon of reclaimed water produced:

- Scenario I: $0.018 to $0.022 (July 2007 dollars)
- Scenario II: $0.026 to $0.033 (July 2007 dollars)
- Scenario III: $0.035 to $0.045 (July 2007 dollars)

It should be noted however that reclaimed water peaking capacity and operations can have a significant impact on unit reclaimed water costs and efficiencies in terms of cost per gallon. As with potable water infrastructure, reclaimed water facilities are generally sized to satisfy anticipated peak demands such that capital implementation costs are largely determined by the peak supply capacity required. While many elements of O&M cost vary with use, certain O&M cost elements are fixed and determined largely by peak system supply capacity as well.

Thus if reclaimed water facilities are sized to accommodate large peaks in demand, are only operated seasonally, and lie partially or completely dormant for significant portions of the year, as might be the case in support of irrigation use, annual implementation costs per gallon of water produced will be much higher than for reclaimed water uses that support more consistent year round operations. The more reclaimed water systems can be designed and implemented to operate at or near peak capacity on a continuous basis, the more efficient such systems become in terms of annual cost per gallon of reclaimed water produced. Similarly, the

closer average reclaimed water use is maintained to peak reclaimed water use, the more cost efficient reclaimed water systems can become.

The annual unit cost estimates presented in dollars per gallon of reclaimed water produced assume that reclaimed water is produced largely for irrigation use during only 5 months out of the year, according to information presented in Section 5. Significant reductions in annual unit costs may be possible if reclaimed water operations and use can be extended for longer periods or continuously year round, and if variations and peaks in reclaimed water use can be minimized such that peak system capacity can be more closely aligned with average reclaimed water usage rates.

For example, preliminary estimates indicate that for continuous year round reclaimed water production averaging 80 percent of peak system capacity, annual unit costs in dollars per gallon of reclaimed water produced could be as low as:

- Scenario I: $0.0035 to $0.0043 (July 2007 dollars)
- Scenario II: $0.0051 to $0.0064 (July 2007 dollars)
- Scenario III: $0.0075 to $0.0095 (July 2007 dollars)

This demonstrates the potential for more continuous and less variable year round reclaimed water operations to support annual unit cost reductions to approximately one fifth of the costs associated with reclaimed water production and use for more highly variable seasonal irrigation use. While irrigation tends to be a seasonal and highly variable use, reclaimed water uses that may offer the potential for more continuous and less variable year round demand would most likely generally include:

- Industrial Processes
- Groundwater Recharge

Given the cost variability associated with seasonal reclaimed water use as compared with more continuous year round use, the potential for more continuous reclaimed water use for industrial processes or groundwater recharge should likely be further evaluated.

Additional cost efficiency may also be possible where reclaimed water system implementation can be structured to fulfill other future capacity needs as well. Although not specifically assessed as part of this analysis, reclaimed water treatment under Scenario 1, for example, could be structured to utilize membrane bioreactor (MBR) treatment processes to simultaneously provide both secondary wastewater treatment and Class A reclaimed water treatment of South Plant primary wastewater effluent. Such a treatment approach could provide the added benefit of effectively expanding South Plant secondary wastewater treatment capacity through the addition of a full MBR secondary wastewater treatment/reclaimed water treatment train. Thus reclaimed water treatment costs could be considered to be somewhat offset by costs that might otherwise need to be incurred at South Plant in the future to expand secondary wastewater treatment capacity. A South Plant MBR treatment approach might thus fulfill both future secondary treatment capacity expansion and reclaimed water needs.

Scenario Supply and Demand Limitations

Scenarios 1 and 2 present a more regional focus to reclaimed water supply, compared to a more local approach under Scenario 3. Given their more regional approach, Scenarios 1 and 2 can be implemented to provide desired levels of reclaimed water service anywhere in the study area. Under Scenario 3, the local reclaimed water supply capacities of satellite treatment plants become more locally limited and are effectively constrained by locally available wastewater flows as the reclaimed water supply resource. So long as local demands and potential uses of reclaimed water do not exceed the locally available wastewater flows, this is

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not an issue. However, where large localized reclaimed water demands exceed the reclaimed water supply available from local wastewater flows, this may become a significant limitation under Scenario 3.

While wastewater flow and potential reclaimed water use estimates appear to suggest that reclaimed water uses might generally be distributed proportionate to area wastewater conveyance flows, large reclaimed water uses in specific isolated locations could potentially exceed locally available wastewater conveyance flows, and are thus more difficult to support under Scenario 3. This potential limitation of Scenario 3 is illustrated in Figures 8-2 and 8-3, which demonstrate that for certain local areas, potential local reclaimed water use and demands could exceed the locally available wastewater flow resources for reclaimed water supply. Thus, detailed and careful review and assessments of local potential reclaimed water demands are critical if Scenario 3 approaches are to be effectively realized such that reclaimed water use is not artificially or inappropriately constrained by local wastewater flow supply limitations.

Figure 8-2. Auburn Area Available Wastewater Flow Supply and Reclaimed Water Demands

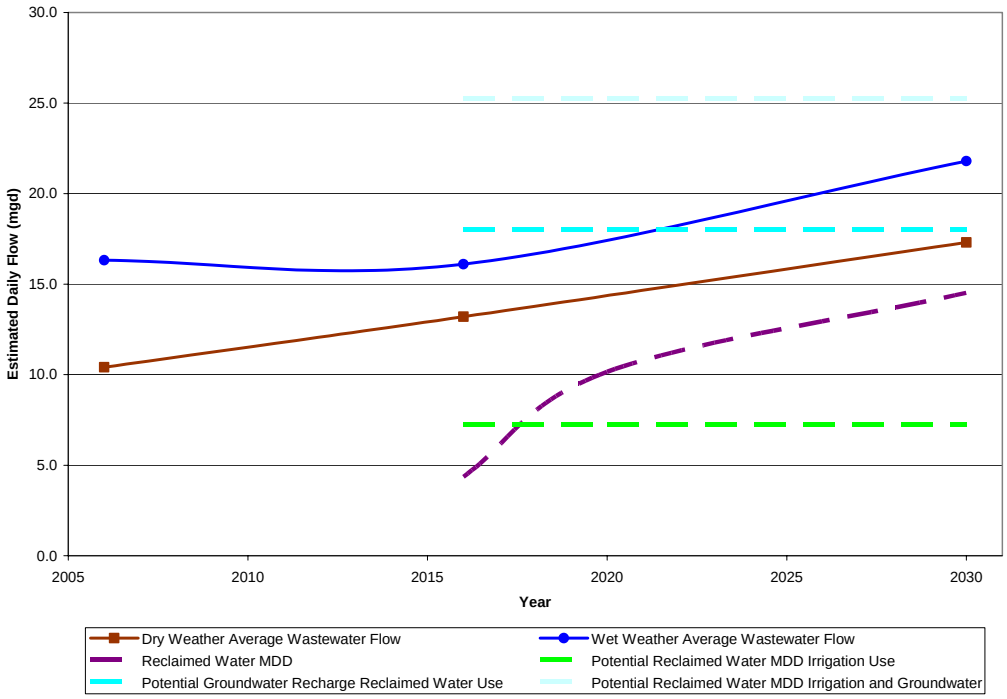
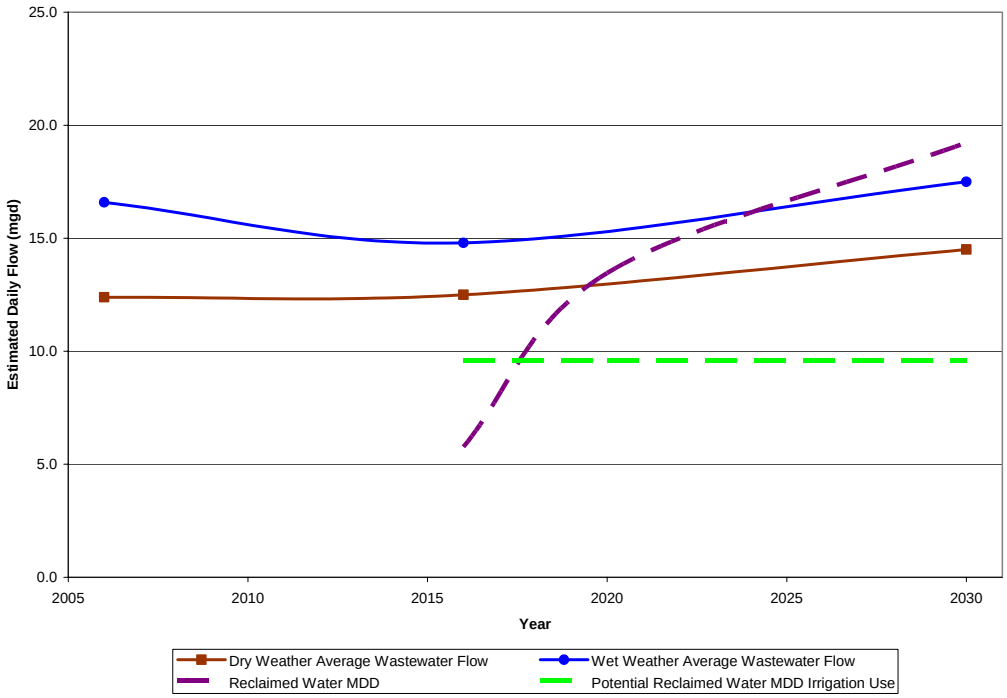


Figure 8-3. Covington/Kent Area Available Wastewater Flow Supply and Reclaimed Water Demands



Although additional data and information regarding potential study area reclaimed water use and distributions are needed to thoroughly assess such considerations, the potential for local wastewater supply to be limiting under Scenario 3 is clearly indicated in Figures 8-2 and 8-3. While estimates of potential reclaimed water demand estimates relative to the available wastewater supply are strictly preliminary in nature and demonstrate a need for better and more detailed data regarding the actual potential for reclaimed water demand within the study area, they do illustrate that both the quantity and distribution of potential demands needs to be carefully assessed relative to available wastewater flows and reclaimed water supply resources to ensure that local demands can be supported by the available wastewater resource flows.

In contrast under Scenarios 1 and 2, where reclaimed water supplies are supported directly by available South Plant flows, reclaimed water supply and distribution around the study area is much less locally limited. Given estimated wastewater flows available for reclaimed water supply at South Plant as summarized in Figure 4-9, the ability of Scenarios 1 and 2 to be implemented to provide desired levels of reclaimed water service via a regional piping system allows for delivery of large amounts of reclaimed water as needed to supply assumed local study area reclaimed water demands through 2030 and beyond, effectively limited only by South Plant flow volumes and the reclaimed water treatment and distribution capacity of the system.

8.2 Analysis Limitations and Additional Data Needs

Additional data needs are summarized in Table 3-1, and generally include the need to validate assumptions and refine information as analyses are further developed and refined in the future. One area where significant additional data is likely needed beyond the available information and assumptions utilized for this analysis is potential reclaimed water demands. In order to refine and further develop accurate assessments for reclaimed water supply options, the locations, volumes and quantities, and hourly, daily, monthly, and seasonal variability of potential reclaimed water demands will need to be carefully quantified and detailed.

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Additional information regarding potential reclaimed water demand is especially important given the fact that reclaimed water system cost efficiency depends directly not only on the locations of reclaimed water uses and the peak system supply capacity required, but also on the manner in which reclaimed water use varies and is maintained on an hourly, daily, weekly, monthly, and seasonal basis. Given the sensitivity of reclaimed water annual unit costs to demand variability and operations patterns, additional analyses of potential reclaimed water use beyond potential irrigation uses should likely be explored, with an emphasis on identifying potential uses that are not highly variable or seasonal in nature. As future trends in wastewater flows and available reclaimed water supply resources develop, reclaimed water supply limitations relative to potential demands will also need to continue to be identified accordingly.

Where reclaimed water use is likely to supplant former potable water usage, pertinent data regarding potential reclaimed water use and trends can likely be compiled and summarized from existing potable water metering records, and will be critical to accurately assess and refine reclaimed water options for the study area. Other potential reclaimed water uses should be carefully estimated and investigated according to identified needs and associated considerations.

Plans for reclaimed water supply should also be coordinated with anticipated future requirements. WSDOE is expected to develop and adopt updated reclaimed water requirements by 2010. As elements and details of these future requirements becomes more clear, plans for reclaimed water will need to be adjusted, developed, and refined accordingly.

It should also be noted that for groundwater recharge using reclaimed water, the current WSDOE/WSDOH Water Reclamation and Reuse Standards currently indicate a requirement for higher levels of reclaimed water treatment beyond Class A reclaimed water standards, ranging from requirements for nitrogen removal for groundwater recharge via surface percolation and infiltration, to reverse osmosis treatment for direct injection into groundwater aquifers. While the potential for reclaimed water use for groundwater recharge is noted for the study area, the analyses, estimates, and assessments contained in this tech memo are based on treatment to Class A reclaimed water standards only and do not directly address any additional treatment requirements that may be required for groundwater recharge. Nitrogen removal for reclaimed water use can likely be efficiently accommodated under any of the three reclaimed water supply scenarios considered herein, and could be provided either as part of South Plant treatment or as part of MBR processes. Reverse osmosis treatment of reclaimed water for direct injection recharge of groundwater aquifers would require additional membrane treatment beyond that directly considered in this tech memo and the associated reclaimed water supply scenarios.

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REFERENCES

King County. King County Comprehensive Plan. 2004.

Washington State Department of Health (WSDOH)/Washington State Department of Ecology (WSDOE). "Water Reclamation and Reuse Standards." September 1997.

USGS. "Estimated Domestic, Irrigation, and Industrial Water Use in Washington, 2000." Scientific Investigations Report 2004-5015. 2004.

Washington State Department of Health (WSDOH). Water System Designs Manual. August, 2001.

Washington State Department of Ecology (WSDOE). "Frequently Asked Questions about Reclaimed Water Use, 05-10-012." January, 2005.

Washington State Department of Ecology (WSDOE). "Case Studies in Reclaimed Water Use, 05-10-013." June 2005

King County. "Generic Reclaimed Water Cost Model.xls". Carollo Engineers.