
Identification of Potential Economic Costs of Production and Use of Reclaimed Water

**Working Draft
November 2009**



King County

Department of
Natural Resources and Parks
Wastewater Treatment Division

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1.0. INTRODUCTION

This report was prepared to support the development of a Reclaimed Water Comprehensive Plan for King County’s Wastewater Treatment Division (WTD). The purpose of the Reclaimed Water Comprehensive Plan is to determine if, how, when, where, and by what funding mechanism over the next 30 years the county’s existing reclaimed water program should expand.

The report synthesizes available information regarding the potential economic costs—both financial and societal—that might arise from producing and using reclaimed water in the county’s reclaimed water planning area (Figure 1). This synthesis is part of the first step in an economic analysis that King County is conducting for the Reclaimed Water Comprehensive Plan. The other part, which identifies the potential benefits of producing and using reclaimed water, is documented in a companion report.¹ The information in both reports is preliminary and will serve as a basis for subsequent steps in the economic analysis.

1.1 Steps in the Economic Analysis

The economic analysis to be conducted for the Reclaimed Water Comprehensive Plan consists of a benefit-cost analysis of different strategies for producing and distributing reclaimed water that could serve identified potential uses throughout the region. To conduct the benefit-cost analysis, the county is using as a general guide an economic framework developed by the WateReuse Foundation.² The economic framework is a tool that can be used to organize, document, and communicate benefit-cost information in a transparent manner so that it can help guide public involvement and policy making.

King County will be adapting the framework to the planning process for the Reclaimed Water Comprehensive Plan.³ The planning process is designed to incorporate involvement of interested parties in each of the anticipated major steps of the economic analysis, described below:

- **Identification of the benefits and costs associated with the production and use of reclaimed water.** This step includes developing a list of all potential benefits and costs that may accrue from production and use of reclaimed water. A broad suite of benefit and cost categories are considered. The benefits and costs are then screened to determine which can be analyzed quantitatively, which should be described only qualitatively, and which are insignificant and can be eliminated from further analysis. This report and the companion report on potential benefits have been prepared to complete this step.
- **Establishing a baseline to define the outcomes associated with the “no action” alternative.** The baseline serves as the “status quo” scenario and defines what conditions would be like without development of the Reclaimed Water Comprehensive Plan. The

¹ King County. 2009. *Identification of Potential Economic Benefits of Production and Use of Reclaimed Water*. Working Draft. http://your.kingcounty.gov/dnrp/library/wastewater/rw/CompPlan/0911_IDEconomicBenefits.pdf.

² Raucher, R., K. Darr, J. Henderson, R. Linsky, J. Rice, B. Sheikh, and C. Wagner. 2006. *An Economic Framework for Evaluating the Benefits and Costs of Water Reuse*. Alexandria, VA: WateReuse Foundation.

³ King County. 2009. Reclaimed Water Comprehensive Plan – Planning Process. http://your.kingcounty.gov/dnrp/library/wastewater/rw/CompPlan/090722_AttachmentA_Motion.pdf.

baseline is not static and does not represent a single point in time; it must define likely conditions through 2040 to reflect the 30-year planning period being considered.

- **Identification of alternatives to reclaimed water that may achieve similar benefits.** In this step, alternatives to the production and use of reclaimed water will be identified. A brief example of an alternative to reclaimed water are new stormwater management practices that could hold water for irrigation or to improve baseflow conditions in a stream basin. An evaluation of the technical feasibility, benefits, and costs of these alternatives could occur during or after the planning process is completed but prior to making project-specific recommendations about expanding any portion of the existing regional reclaimed water system.
- **Assign and estimate values for benefits and costs to comprehensive plan reclaimed water strategies.** Benefits and costs that have been identified will be assigned to reclaimed water strategies. For those that can be quantified, a total value expressed in dollars will be estimated. For those where it is not feasible to express a quantitative value, the benefits and costs will be described qualitatively. The relative importance of each cost will be described in terms of importance and/or value. The importance and/or value will be scored on a qualitative ranking system so that all qualitative costs are compared on the same scale. The WaterReuse Foundation framework suggests a five-point scale, ranging from -2 to +2, where +2 signifies a very high relative benefit, -2 represents a large relative negative cost, and -1 and +1 represent the intermediate outcomes of relatively smaller benefits and costs. A similar scale will be used in the economic analysis done as part of the Reclaimed Water Comprehensive Plan. The county will seek input from interested parties when assigning and estimating values for benefits and costs.
- **Conduct benefit-cost analysis.** The benefits and costs for each reclaimed water strategy will be summarized and discounted to present value at an appropriate discount rate. This summary will include monetized benefits and costs and a limited qualitative assessment of the non-quantified benefits and costs. The benefits and costs of each reclaimed water strategy will be compared to determine if the strategy has a net benefit or cost. Once the net benefit or cost for each individual strategy is completed, all the strategies can be compared to one another and the baseline.
- **Conduct sensitivity analysis.** A sensitivity analysis will be conducted on key variables of benefit and cost estimates to explore and communicate the impact of assumptions, uncertainty, or natural variability.

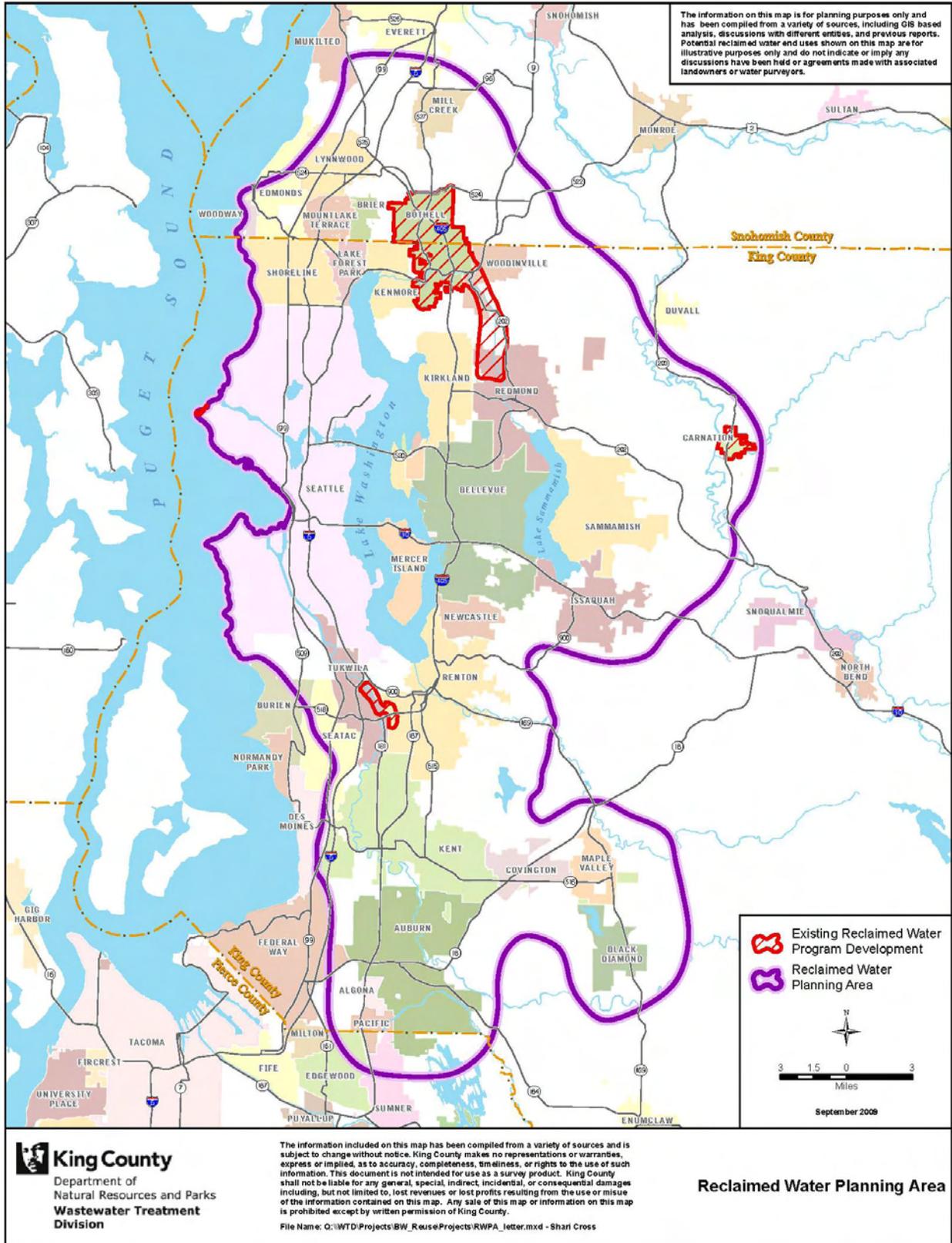


Figure 1. King County Reclaimed Water Planning Area

1.2 Approach to Identifying Potential Costs

The approach to identifying both potential benefits and costs relies on the WateReuse Foundation's economic framework to conduct a "full social cost accounting" of benefits and costs of reclaimed water projects. Full social cost accounting tries to identify and account for all benefits and costs, regardless of who is impacted or whether the impact can be valued through market prices. The framework includes benefits, costs, and risks that are carried internally by water and wastewater agencies or their customers and those carried externally by others such as households, businesses, and special interest groups.

The direct and indirect costs identified in this report can be described as follows:

- Potential direct/internal/financial costs include capital, operation, and maintenance costs .
- Potential indirect/external (societal) costs occur as a side-effect or consequence of implementing reclaimed water strategies. These indirect costs include environmental, recreation, economic and social, and human health costs:
 - Environmental costs include impacts that may occur, such as greenhouse gas emissions associated with increased energy use.
 - Recreation costs include the potential for reduced value of recreational opportunities associated with the possible negative stigma of using recreational areas irrigated with reclaimed water.
 - Economic and social costs include negative impacts associated with increased urban growth as a result of improved water resources.
 - Human health costs include increased risk of contact with reclaimed water.

In most cases, reliable cost estimating information is available to determine the unit cost price of a potential direct cost. Cost estimating methodologies for capital project planning, such as a unit cost per linear foot of piping, can be used. For indirect costs, however, market prices are not available. This does not mean that the value is zero. Instead, it means that the relationship between these potential costs and the economy is not conducive to the establishment of market prices. As a consequence, families and businesses need to express the value they place on these costs through means other than buying and selling in a market, and economists must use techniques other than market analysis to describe the values. This is especially the case for negative environmental externalities, which are an activity's impacts on the environment that negatively affect the economic well-being of people other than those engaged in the activity. For some of these externalities, economists have developed techniques that yield substitutes for market prices as indicators of monetary value. Where they are available, these prices are included in the cost identification process.

The costs identified are based on available information, the WateReuse Foundation framework, and consultations with WTD staff. They represent costs that could possibly occur. Further information about costs that might actually occur will be forthcoming as the steps and tasks necessary to develop the Reclaimed Water Comprehensive Plan are completed.

2.0. POTENTIAL ECONOMIC COSTS

Potential economic costs were identified through the following process:

- Developing an initial list of potential costs based on a template developed by the WateReuse Foundation (Table A-1 in Appendix A)⁴
- Screening and further categorizing the potential costs (Table A-2)
- Describing and assigning unit values for costs for which sufficient quantitative information is available (Table A-3)
- Describing costs for which insufficient information is available to support quantification (Table A-4)

The tables in Appendix A correspond to the templates in the WateReuse Foundation's economic framework.

2.1 Developing an Initial List of Potential Costs

Table A-1 in Appendix A lists all potential economic costs identified to date. The costs are listed in two broad categories: (1) direct costs to water and wastewater utilities and their customers, and (2) indirect costs to society at large or interested parties other than the water or wastewater agencies and their customers. The indirect costs are divided further into four categories: (1) environmental costs, (2) recreation costs (3) economic and social costs, and (4) human health costs.⁵

2.2 Screening and Further Categorizing the Potential Costs

Table A-2 in Appendix A, which follows the WateReuse Foundation's Template 4 – Summary Screening Process, summarizes the results of the screening and categorizing process. The process consisted of two steps:

- Some potential costs were eliminated from further consideration because it appears they are not applicable in the reclaimed water planning area. For example loss of marsh habitat from increased salinity was eliminated because it is unlikely a reduction in the amount of treated wastewater discharged to Puget Sound would result in increased salinity in the Sound.
- The remaining potential costs were separated into two subgroups: (1) those for which there appears to be sufficient information to estimate a cost in monetary terms, and (2) those for which it appears there is sufficient information to support qualitative assessment.

⁴ Raucher et al., 2006.

⁵ Rauscher, et al., 2006, p. 24.

2.3 Describing Potential Costs for Which Sufficient Quantitative Information Is Available

Table A-3 in Appendix A, which follows the WaterReuse Foundation’s Templates 5 and 6 – Detail on Cost Value Derivation, gives information on the potential costs for which it appears there is a cost estimating methodology and sufficient information to describe them in quantitative or monetary terms.⁶ The table is organized as follows:

- The first subheading under each cost describes the cost.
- The second subheading provides a placeholder for inserting the annual quantity of reclaimed water when specific project information becomes available.
- The third subheading shows the unit cost of each potential cost, which has been extracted from the relevant data and literature.
- The fourth subheading describes what the unit cost represents, its source, and important information regarding its quality and applicability.

For most identified costs, the unit cost has not been given in Table A-3. These costs largely depend on project- and site-specific factors. As specific reclaimed water facility strategies are developed, unit costs will be estimated and then multiplied by estimated annual quantities of reclaimed water to produce planning-level estimates of the total potential cost. The accuracy of cost estimates increases and are specified in greater detail as projects become more defined. Costs estimates for projects in planning can have a rough order-of-magnitude estimate in the range of -50 to +100 percent. Table 1 lists tools available for developing unit cost estimates.

Table 1. Tools Available for Estimating Unit Costs

Tool	Description
Tabula cost estimating software for conveyance system (including piping, pumping, and storage) for reclaimed water distribution	Tabula, developed for use by King County WTD staff and consultants, provides conveyance capital cost estimates. It integrates information gathered through analysis of historical and other cost planning curves to provide budgetary planning estimates in a consistent and reproducible manner.
Standardized cost curves for reclaimed water production	Standardized costs curves will be developed based on typical utility capital and operation and maintenance (O&M) costs and industry references and publications. Cost curves will use current facility construction cost metrics and O&M expenses to provide budgetary planning estimates.
<i>Guidelines for Water Reuse (2004)</i>	The U.S. Environmental Protection Agency and the U.S. Agency for International Development have assembled summary and specific case-study information describing some of the costs associated with water reuse systems.

⁶ Raucher et al., 2006, p. 49.

2.4 Describing Potential Costs for Which Insufficient Information Is Available to Support Quantification

Costs for which insufficient information exists or is likely to exist to support reliable quantification are described in qualitative terms. These costs are listed in Table A-4 in Appendix A, which corresponds to the WaterReuse Foundation's Template 7 – Qualitative Costs Description. The costs listed in Table A-4 are not necessarily less or more important than those whose values can be described in quantitative terms. To understand the overall potential economic costs of the production and/or use of reclaimed water, the full set of potential costs described in Tables A-3 and A-4 should be considered.

The first subheading in Table A-4 describes the cost. The second subheading provides a placeholder for the relative importance of the cost, which for most costs will be completed when reclaimed water strategy information becomes available. The relative importance of each cost will be described in terms of importance and/or value. The importance and/or value will be scored on a qualitative ranking system so that all qualitative costs are compared on the same scale.

3.0. REFERENCES

- King County. 2009. *Identification of Potential Economic Benefits of Production and Use of Reclaimed Water*. Working Draft.
http://your.kingcounty.gov/dnrp/library/wastewater/rw/CompPlan/0911_IDEconomicBenefits.pdf.
- King County. 2009. Reclaimed Water Comprehensive Plan – Planning Process.
http://your.kingcounty.gov/dnrp/library/wastewater/rw/CompPlan/090722_AttachmentA_Motion.pdf.
- King County. 2009. Tabula Conveyance System Cost Estimating Software. Version 3. Available at <http://www.kingcounty.gov/environment/wastewater/CSI/Tabula.aspx>.
- Raucher, R., K. Darr, J. Henderson, R. Linsky, J. Rice, B. Sheikh, and C. Wagner. 2006. *An Economic Framework for Evaluating the Benefits and Costs of Water Reuse*. Alexandria, VA: WaterReuse Foundation.
- U.S. Environmental Protection Agency and U.S. Agency for International Development. 2004. *Guidelines for Water Reuse*. EPA/625/R-04/108.

APPENDIX A—COST TABLES

Table A-1. Initial List of Potential Economic Costs of Production and Use of Reclaimed Water

General Notes: *This table identifies potential economic costs that might materialize as a result of developing and implementing reclaimed water strategies to serve potential uses of reclaimed water. It represents the first step in the process. Some of these costs have been deleted from further consideration in later tables, because staff from King County’s Wastewater Treatment Division (WTD) determined they would not be relevant to the particular circumstances that would arise from the development of the Reclaimed Water Comprehensive Plan. These costs are included in this list, however, to document the efforts to consider all potential possibilities. Individual items were identified by applying the economic framework developed by the WateReuse Foundation and consulting with WTD staff.⁷*

Costs (potential expense or increase in costs or expenditures)

Direct costs to an agency or customer

- Capital costs for reclaimed water production
- O&M costs for reclaimed water production
- Capital costs for reclaimed water storage and distribution
- O&M costs for reclaimed water storage and distribution
- Capital costs for customer retrofits and training
- Customer O&M costs
- Loss of potable water sales
- Reclaimed water program administrative costs
- Reductions in anticipated reclaimed water sales revenue
- Increases in groundwater pumping costs
- Reduced customer water supply flexibility

Indirect costs (societal)

Environment

- Environmental impacts of increased energy consumption
- Salinity impacts from landscape irrigation on grass and plants
- Increase in groundwater salinity over time
- Reduced effluent flows into Puget Sound
- Loss of marsh habitat due to increased salinity

Recreation

- Reduced value of recreational opportunities arising from potential stigma of using playing fields, golf courses, and other facilities irrigated with reclaimed water

Human health

- Increased public health risk due to increased contact with reclaimed water

Economic and social

- Increased urban growth as a result of improved water resources (congestion, other negative impacts)
- Reclaimed water production facility location (odor, traffic, visual, aesthetics)
- Inequitable regional access to reclaimed water (resource access/social justice)

⁷ Raucher, R., K. Darr, J. Henderson, R. Linsky, J. Rice, B. Sheikh, and C. Wagner. 2006. *An Economic Framework for Evaluating the Benefits and Costs of Water Reuse*. Alexandria, VA: WateReuse Foundation.

**Table A-2. Potential Economic Costs of Production and Use of Reclaimed Water
(WateReuse Foundation Template 4, Summary Screening Analysis)**

General Notes: *This table identifies potential economic costs that might materialize as a result of developing and implementing reclaimed water strategies to serve potential uses of reclaimed water. Individual items were identified by applying the economic framework developed by the WateReuse Foundation and consulting with WTD staff.⁸*

Key: D = direct; E = environment; R = recreation; H = human health; ES = economic/social.

Potential Cost for Which It Appears There is Sufficient Information to Support Quantitative Cost Estimate	
3.D.1	Capital costs for reclaimed water production
3.D.2	O&M costs for reclaimed water production
3.D.3	Capital costs for reclaimed water storage and distribution
3.D.4	O&M costs for reclaimed water storage and distribution
3.D.5	Capital costs for customer retrofits and training
3.D.6	Customer O&M costs
3.D.7	Loss of potable water sales
3.D.8	Reclaimed water program administrative costs
3.D.9	Reductions in anticipated reclaimed water sales revenue
3.D.10	Increases in groundwater pumping costs
3.D.11	Reduced customer water supply flexibility
Potential Costs for Which It Appears there Is Sufficient Information to Support Qualitative Assessment	
4.E.1	Environmental impacts of increased energy consumption
4.E.2	Salinity impacts from landscape irrigation on grass and plants
4.E.3	Increase in groundwater salinity over time
4.R.1	Reduced value of recreational opportunities arising from potential stigma of using playing fields, golf courses, and other facilities irrigated with reclaimed water
4.H.1	Increased public health risk due to increased contact with reclaimed water
4.ES.1	Increased urban growth as a result of improved water resources (congestion, other negative impacts)
4.ES.2	Reclaimed water production facility location (odor, traffic, visual, aesthetics)
4.ES.3	Inequitable regional access to reclaimed water (resource access/social justice)

⁸ Raucher, R., K. Darr, J. Henderson, R. Linsky, J. Rice, B. Sheikh, and C. Wagner. 2006. *An Economic Framework for Evaluating the Benefits and Costs of Water Reuse*. Alexandria, VA: WateReuse Foundation.

**Table A-3. Potential Economic Costs of Production and Use of Reclaimed Water
that Can Be Described Quantitatively
(WaterReuse Foundation Templates 5 and 6)**

General Notes: *The intent of this table is to provide a broad array of potential costs that may result from implementing reclaimed water strategies to serve potential uses of reclaimed water. The types of costs listed below reflect a "menu" of possible costs, only a subset of which will likely be relevant to any specific application of reclaimed water. In some instances, the list shows alternative ways of describing a particular type or potential cost, reflecting different analytical approaches applied in past studies, but this overlap does not mean that the cost should be double-counted. The unit values listed for each cost represent a starting point for analysis; the actual value will depend on site- and action-specific factors and may be greater or less than the value shown.*

All unit values in 2008 dollars.

Key: D = direct.

Cost: 3.D.1 Capital costs for reclaimed water production

Description Costs to purchase land, equipment, and construct facilities to be used in the production of reclaimed water.

Annual Quantity To be completed when specific project information becomes available.

Unit Cost The typical range is approximately \$3 to \$25 per gallon per day production capacity depending on required treatment approaches and economy of scale.

Comments on Unit Cost This unit value range is based on the following:

- King County. 2006. Generic Reclaimed Water Cost Model (Excel spreadsheet). Developed by Carollo Engineers. Seattle, WA.
- Brown and Caldwell. 2007. *Green River Valley Reclaimed Water Study – Working Draft*. Prepared for King County.

The value range will be reviewed for accuracy as more specific project information, such as location, technologies, and generic facility concepts, becomes available.

Cost: 3.D.2 O&M costs for reclaimed water production

Description Costs for the administration, supervision, operation, maintenance, preservation, and protection of the reclaimed water production facilities. Include expenses normally incurred for such items as routine repairs and alterations of buildings; equipment; care of grounds; operation and maintenance of buildings and other plant facilities; security; earthquake and disaster preparedness; environmental safety; property, liability, and all other insurance relating to property; facility planning and management.

Annual Quantity To be completed when specific project information becomes available.

Unit Cost Unit O&M costs might typically range from \$600 to \$18,000 per million gallons treated depending on required treatment approaches, seasonality of operations, and economy of scale.

Comments on Unit Cost This unit value range is based on the following:

- King County. 2006. Generic Reclaimed Water Cost Model (Excel spreadsheet). Developed by Carollo Engineers. Seattle, WA.
- Brown and Caldwell. 2007. *Green River Valley Reclaimed Water Study – Working*

Draft. Prepared for King County.

The value range will be reviewed for accuracy as more specific project information, such as generic facility concepts including capacity, timing of operation, and treatment technologies, becomes available.

Cost: 3.D.3 Capital costs for reclaimed water storage and distribution	
Description	Costs to purchase land and equipment and to construct facilities to be used in the distribution of reclaimed water.
Annual Quantity	To be completed when specific project information becomes available.
Unit Cost	Cost to be determined when specific project information becomes available.
Comments on Unit Cost	Tabula cost estimating software will be used to prepare cost estimates. Tabula is the King County Wastewater Treatment Division's primary tool for developing water conveyance cost estimates at the planning level. Tabula incorporates a range of unit costs for developing storage and conveyance costs. The conveyance pipe unit costs vary based on parameters such as size, material, construction technique, and property acquisition. Pump station and storage unit costs vary based on parameters such as capacity, pumping requirements, and property acquisition.
Cost: 3.D.4 O&M costs for reclaimed water storage and distribution	
Description	Costs for the administration, supervision, operation, maintenance, preservation, and protection of the reclaimed water distribution facilities. Includes expenses normally incurred for items such as repairs and routine alterations of facilities; equipment; security; earthquake and disaster preparedness; environmental safety; liability and all other insurance relating to property.
Annual Quantity	To be completed when specific project information becomes available.
Unit Cost	Unit costs vary for pipes, pump stations, and storage facilities.
Comments on Unit Cost	Unit costs will be determined based on applying parameters such as O&M staff, materials (spare parts, chemicals), and energy costs. These parameters will be determined during the planning process.
Cost: 3.D.5 Capital costs for customer retrofits and training	
Description	Costs to reclaimed water customer to establish a reclaimed water service at the use site and train individuals in the rules governing reclaimed water use.
Annual Quantity	To be completed when specific project information becomes available.
Unit Cost	Cost to be determined based on options for a specific location.
Comments on Unit Cost	Retrofits and training can include ensuring there is no connection between reclaimed and potable water systems and accommodating changes in salinity, nutrient loads, and other aspects of water quality.
Cost: 3.D.6 Customer O&M costs	
Description	End-user costs for the operation, maintenance, preservation, and protection of reclaimed water for customer service connections.
Annual Quantity	To be completed when specific project information becomes available.
Unit Cost	Cost to be determined based on options for a specific location.

Comments on Unit Cost Expenses include complying with Washington State Reclaimed Water and Reuse Standards such as posting signage that states that reclaimed water is being used, ensuring there is no connection between reclaimed and potable water systems, and taking measures to prevent ponding of reclaimed water.

Cost: 3.D.7 Loss of potable water sales

Description	The net financial effect on a water utility that because of a reduction in the volume of water sold, experiences a reduction in revenue greater than its reduction in capital and operating costs.
Annual Quantity	To be completed when specific project information becomes available.
Unit Cost	Current retail water rate to be determined based on specific project information developed during the planning process.

Comments on Unit Cost

Cost: 3.D.8 Reclaimed water program administrative costs

Description	Costs for general management, oversight, and coordination of the reclaimed water program.
Annual Quantity	To be completed when specific project information becomes available.
Unit Cost	Cost to be determined based on the Reclaimed Water Comprehensive Plan.

Comments on Unit Cost Administrative costs may arise from ensuring there is no connection between reclaimed and potable water systems; managing potential effects that might occur when reclaimed water, with differences in salinity, nutrient loads, and other aspects of water quality, is substituted for water from other sources; and addressing the public’s concerns about using reclaimed water.

Cost: 3.D.9 Reductions in anticipated reclaimed water sales revenue

Description	Anticipated revenues from the sale of reclaimed water may fail to materialize or, once realized, may disappear.
Annual Quantity	To be completed when specific project information becomes available.
Unit Cost	Cost to be determined based on options for specific potential reclaimed water uses and scenarios.

Comments on Unit Cost Several factors may reduce the willingness to pay for reclaimed water below anticipated levels. An economic recession may reduce general willingness to pay for nonessential consumptive uses, a decline in profitability may reduce willingness of a specific business customer to pay, an unusually wet summer may reduce short-term demand from irrigators and other seasonal users.

Cost: 3.D.10 Increases in groundwater pumping costs

Description	Reclaimed water could be used for groundwater recharge. Groundwater pumping costs would increase as the lowest-cost pumping opportunities are exhausted.
Annual Quantity	To be completed when specific project information becomes available.
Unit Cost	Cost to be determined based on specific circumstances.

Comments on Unit Cost Economic theory indicates that, all else being equal, the unit cost of pumping likely would increase as the volume pumped increases.

Cost: 3.D.11 Reduced customer water supply flexibility

Description The potential for a reclaimed water customer to have less flexibility as compared to other water supply options (self-supply and/or a water utility).

Annual Quantity To be completed when specific project information becomes available.

Unit Cost Cost to be determined based on specific circumstances.

Comments on Unit Cost

**Table A-4. Potential Economic Costs of Production and Use of Reclaimed Water
that Can Be Described Qualitatively
(WaterReuse Foundation Template 7, Qualitative Cost Description)**

General Notes: *The intent of this table is to describe potential costs that may arise from implementing reclaimed water strategies to serve potential uses of reclaimed water. Only a subset of these costs likely will be relevant to any specific action. In some instances, the table includes alternative descriptions of a potential cost; these should not be used to double-count the cost.*

Key: E = environment; R = recreation; H = human health; ES = economic/social.

Cost: 4.E.1 Environmental impacts of increased energy consumption

Description Amount of additional energy beyond that already consumed by secondary wastewater treatment that is required to treat water to reclaimed water standards and distribute to end use.

Relative Importance To be completed when reclaimed water strategy information becomes available.

Cost: 4.E.2 Salinity impacts from landscape irrigation on grass and plants

Description All reclaimed waters contain some amount of dissolved mineral salts. The accumulation of salt in the landscape can impact grass and plants. Although salt is integral to the survival of all plant life, too much salt stunts growth and limits crop yields.

Relative Importance In many arid areas of the country, salinity in municipal water supplies and reclaimed water is a serious concern. Elevated levels of salinity can damage crops and soils and corrode infrastructure. The research conducted locally on King County’s reclaimed water applied to turf grass and ornamentals has shown that salinity in the reclaimed water is very low and it does not accumulate in the soils. At these low levels, it does not adversely affect plants or soils.

Cost: 4.E.3 Increase in groundwater salinity over time

Description All reclaimed waters contain some amount of dissolved mineral salts. When reclaimed water is used to artificially recharge a groundwater system, the salinity of groundwater may increase. Salinity limits how water resources can be used.

Relative Importance To be completed when reclaimed water strategy information becomes available.

Cost: 4.R.1 Reduced value of recreational opportunities arising from potential stigma of using playing fields, golf courses, and other facilities irrigated with reclaimed water

Description Some people may see a shift to using reclaimed water rather than untreated (groundwater or surface water) or potable water to irrigate as posing a greater risk of exposure to harmful or noxious materials.

Relative Importance Survey research of the general public found the following negative response percentages to different uses of reclaimed water:

Use	Negative Response (Percent)
Irrigation of Athletic Fields	16
Irrigation of Office Parks and Business Campuses	18
Irrigation of Highway Right-of-way	15
Residential Landscape Irrigation and Maintenance	26
Golf Course Irrigation	11
Irrigation of Agricultural Crops	18
Irrigation of Crops for Direct Human Consumption	70

Vehicle Wash Water	24
Concrete Production	10
Dust Control	18
Stream Augmentation	33
Toilet Flushing	20
Fire Protection	16
Ornamental Ponds/Fountains	44
Street Cleaning	13
Industrial Process Water	22
Wetland Creation	16
Pools/Spas	85
Potable Reuse – Direct	82
Potable Reuse – Indirect	60

Hall, W.L., and A.R. Rubin. 2002. Reclaimed water: A public perception. *WEFTEC 2002. Proceedings of the 75th Annual Conference and Exposition, Chicago, Illinois*. Adapted from U.S. Environmental Protection Agency and U.S. Agency for International Development. 2004. *Guidelines for Water Reuse*. EPA/625/R-04/108.

Cost: 4.H.1 Increased public health risk due to increased contact with reclaimed water

Description Reclaimed water is, in most cases, suitable for human contact. In many locations where reclaimed water is used, human contact is possible. Although rare, any reclaimed water program has the potential for cross-connections as reclaimed water lines are installed near potable water lines.

Relative Importance To be completed when reclaimed water strategy information becomes available.

Cost: 4.ES.1 Increased urban growth as a result of improved water resources (congestion, other negative impacts)

Description Improved water resources may lead to increased urban growth. Urban growth has been associated with undesirable effects such as traffic congestion and overcrowded schools. Other negative impacts associated with urban growth are degraded environmental resources such as surface water and groundwater quality, air quality, landscape aesthetics, and wildlife habitat.

Relative Importance To be completed when reclaimed water strategy information becomes available.

Cost: 4.ES.2 Reclaimed water production facility location (odor, traffic, visual, aesthetics)

Description Construction of reclaimed water facilities requires the purchase and development of land. The operation of reclaimed water facilities requires operating equipment that produces air emissions and increases vehicle traffic associated with operating the facility.

Relative Importance To be completed when reclaimed water strategy information becomes available.

Cost: 4.ES.3 Inequitable regional access to reclaimed water (resource access/social justice)

Description The potential for inequitable access to reclaimed water by people of all races, cultures, incomes, and educational levels.

Relative Importance To be completed when reclaimed water strategy information becomes available.