SHIFTING FROM DISPOSAL TO SUSTAINABLE RESOURCE BASED STRATEGIES – IMPLEMENTING LOTT'S WASTEWATER RESOURCE MANAGEMENT PLAN

Chris Cleveland*, Karla Fowler**, Bill McCarthy*, and Brian Topolski**

*Brown and Caldwell
606 Columbia Street NW Suite 217
Olympia, Washington 98501

**LOTT Alliance
250 Market St NE Suite 250
Olympia, Washington 98501

ABSTRACT

This paper discusses implementation of the LOTT Wastewater Resource Management Plan (Brown and Caldwell, 1998) from planning through finance and operation of the first capital facilities for recycling the water. In 1995, Brown and Caldwell was selected to assist with the development and implementation of a comprehensive wastewater management plan for north Thurston County in Washington state. The resulting program offers sustainable recycling opportunities integrated with a system-wide discharge capacity strategy. Critical elements for success of the LOTT program were developing facility, financial, AND administrative infrastructure aligned with the system discharge capacity strategy and establishing an environmental documentation and permitting framework to expedite implementation of future facilities.

KEYWORDS

Reclaimed water, infrastructure planning, sustainability, groundwater recharge, finance

INTRODUCTION

The LOTT (Cities of Lacey, Olympia and Tumwater, and Thurston County; a.k.a. Partners) Alliance (LOTT) is a regional wastewater utility serving the 40,000-acre North Thurston Urban Growth Management Area in southwest Washington State, one of the fastest growing regions of Puget Sound. LOTT’s Budd Inlet Wastewater Treatment Plant (Plant) discharges into a marine embayment on Puget Sound and is required to meet a 3 mg/L total inorganic nitrogen (TIN) limit 7 months of the year. The LOTT Wastewater Resource Management Plan (Plan) fundamentally shifted the Pacific Northwest community’s wastewater management program from a disposal based marine discharge to one which relies on water recycling in multiple locations for new discharge capacity as well as effectively respond to new mass-based permit limits and pending total maximum daily loads (TMDLs).

To maximize existing assets and minimize costs, the service area is managed to balance the supply (wastewater generation) and demand (groundwater recharge capacity / reuse) with key diversion points in the wastewater collection system. Under this program LOTT incrementally adds water recycling capacity to match demand with service area growth using satellite reclamation plants (SRPs) and expanding production at the Plant. All reclaimed water produced
by LOTT meets Class A reclaimed water standards (Washington State’s category suitable for human contact) using membrane bioreactors (MBR). The unused Class A water is recharged using surface percolation basins and is available for stream flow mitigation and/or source development.

The Plan focuses on identifying where the water can be most beneficially used, what water quality is required, and what is the best delivery mechanism. The incremental resource-based approach recognizes that there are multiple components to capacity relative to providing regional wastewater service. Highlights of the preferred program include:

- **Using Wastewater as a Resource** – the Plan begins a shift toward using wastewater as a resource, through reclamation and groundwater recharge. Although these methods have been used in dry climates for many years, they are new to the Pacific Northwest.

- **Optimizing Use of Existing Facilities** – The transition to use of wastewater as a resource is aided by optimizing the use of LOTT’s existing facilities. This has allowed LOTT time to develop, test, and gain local experience with reclamation and groundwater recharge facilities. Optimum use also includes aggressive pursuit of reduced per capita wastewater flows, continuing cost-effective removal of inflow and infiltration (I&I), and making full use of the Budd Inlet marine discharge in an environmentally acceptable manner.

- **Focusing on the Environment** – Unlike traditional facilities plans, the Plan adds capacity based on environmental factors instead of pre-selecting a solution then identifying the environmental impacts. Areas are defined for reclamation and recharge based on their environmental suitability for those measures. Only then are specific sites and projects defined.

- **Adding Capacity in Increments** – A unique aspect of the LOTT program is added capacity in small, “bite-sized” increments in an aggressive managed manner to match as closely as practical actual needs for added treatment and conveyance. Adding capacity in small increments also provides the opportunity to take advantage of improving technologies and reduces the risk of over-commitment to any single technical approach.

- **Taking a “Just-in-Time” Approach** – By shortening the time between the need for capacity and facility implementation, there is a better capability to respond to adjustments in growth rates and the actual performance of active flow reduction projects.

- **Structuring a Capacity Management System** – A new method for planning capital investment in facilities integrates and compares information from several sources. The result is a systematic and objective method for tracking where and when treatment, conveyance, and collection system capacity must be available. Decisions to add capacity are triggered by measured conditions.

- **Enabling Alternative Financing** – Adding capacity in small increments opens greater possibilities for equitably balancing the cost impacts of new facilities among existing ratepayers and future development. To the extent practical, this approach favors cash
over debt financing. It seeks to maintain required reserve treatment capacity at the lowest possible cost. It also allows, to the extent practical, the capital cost of new capacity increments to be recovered on a “growth pays for growth” basis, while monthly sewer rates cover system operating costs.

- **Requiring a “Highly Managed” Approach** – An incremental approach requires conditions to be constantly measured, compared and evaluated to ensure capacity needs are met when needed. Capacity assessment, environmental analysis and public information/involvement are continuous activities.

- **Resulting in a “Living” Plan** – The Plan is a continuing work in progress. As conditions change, flow reduction projects proceed, new increments are considered, continuing environmental analysis is conducted, and increments are added. A structured process has been integrated into LOTT’s annual capital improvement plan and budget.

- **Addressing Public Values** – Public values indirectly identify the level of service expectations for LOTT. Under this Plan, these public values were used to refine and screen alternatives and ultimately select the preferred approach. The most important benefits for the selected plan include:

  - *Maximizes the use of existing facilities* by continuing to pursue flow reduction and increased winter discharge in Budd Inlet.
  
  - *Meets current and future demands* with multiple solutions, implemented in small increments over time, based on actual measured conditions.
  
  - Allows a gradual shift toward upland discharge options (through reclamation and groundwater recharge) and potential net *environmental benefits*.
  
  - Enables LOTT to control facilities costs by *maximizing operational flexibility*, relying upon performance-based wastewater flow reduction, minimizing up-front capital expenditures which cuts borrowing expenses, and capitalizing on future technological advances.
  
  - Uses LOTT’s treated *wastewater as a resource*, with recycling opportunities continuously considered.
  
  - Offers continuous opportunities to *provide multiple community benefits*, such as park, green space, and public education opportunities, with resources and facilities located throughout the region.
  
  - Demonstrates LOTT’s responsiveness and commitment to varied public values and opinions expressed throughout a *pro-active and open facilities plan process*.

**STATUS OF THE PROGRAM**

After a four-year planning process, LOTT began to implement the capital facilities to transition from a disposal-based framework. The first reclaimed water facility was commissioned in early...
2005 and the $28-million Hawks Prairie Satellite Facilities began commissioning and startup in June 2006. In accordance with the Plan’s just-in-time approach, annual updates are prepared for the capital program to tailor investments to actual needs. Consequently, LOTT is purchasing property for additional groundwater recharge capacity and in the pre-planning phase for another satellite reclamation facility. After four (4) years of deliberation, interlocal agreements were put in place in 2004 to distribute and allocate reclaimed water resources to the regional partners.

CAPACITY MANAGEMENT

The program emphasizes ongoing wastewater flow reduction, a gradual transition to wastewater recycling through reclamation and groundwater recharge, and making maximum use of existing infrastructure and treatment facilities. Four types of “capacity” are managed including:

- **Discharge Capacity** – refers to distribution and end use of the treated effluent, including the capacity of distribution piping, pump stations, outfalls, recharge basins, etc. These are LOTT-owned facilities.

- **Treatment Capacity** – refers to capacity in a treatment plant that processes raw wastewater to produce treated effluent. Facilities include treatment plants and solids conveyance lines. These are LOTT-owned facilities.

- **Conveyance Capacity** – refers to regional transport or conveyance of collected wastewater to treatment centers. Facilities include the main interceptor gravity sewers, force mains, and pump stations. These are LOTT-owned facilities.

- **Collection Capacity** – refers to the network of sewers that are used to provide retail wastewater service to individual residences, businesses and industry. Facilities include gravity and pressure sewer lines, lift stations, and service laterals; these are Partner-owned facilities.

**Discharge Capacity**

Discharge capacity describes how the treated effluent will be used or disposed within the service area and most importantly defines LOTT’s interaction with its customers. There are two distinct categories of discharge capacity in the LOTT system, the permitted capacity discharged to Budd Inlet and the water recycling, including reclamation and groundwater recharge. Each has fixed capabilities based on seasonal factors and the characteristics of the end use. Another factor that influences discharge capacity is location; Budd Inlet discharge capacity is centrally located, whereas recycling opportunities are distributed through the service area. LOTT is pursuing consumptive recycling opportunities over disposal options for new discharge capacity. However, in both cases, discharge capacity is highly seasonal. The sustainable Budd Inlet discharge capacity is substantially greater in wet weather periods than in dry weather periods; conversely irrigation-based water recycling opportunities are greater in dry weather conditions.

Budd Inlet discharge capacity is defined as the quantity of treated effluent that can be discharged into Budd Inlet without adversely impacting the environment. The allowable amount is defined
in the NPDES permit issued by the Department of Ecology and was based upon the findings contained in the Budd Inlet Scientific Study (Brown and Caldwell / Evans Hamilton, 1997).

Water recycling capacity is defined as the quantity of treated effluent that can be recycled through consumptive uses in a sustainable fashion. Capacity includes the ability of the ground to accept and convey water to the groundwater table, the agronomic application of water to parks and green spaces, and the demand from commercial and industrial enterprises.

Reclaimed Water Uses

Reclaimed water use in the LOTT program is segregated into

- Seasonal irrigation
- Non-seasonal irrigation
- Commercial industrial
- Groundwater recharge

The initial focus of the LOTT program is seasonal irrigation and groundwater recharge. LOTT will continue to explore other options such as streamflow augmentation and habitat restoration as reclaimed water use becomes more established. This ability to adapt to new opportunities is one of the strengths of the LOTT program.

Seasonal Irrigation  Seasonal irrigation includes application of reclaimed water at agronomic rates to public landscapes, parks, golf courses, and agricultural areas. The reclaimed water irrigation demand is highly seasonal in the Pacific Northwest; dry weather irrigation rates can vary from 0.28 to 1.0 inches per day, depending on the vegetation (Washington State Extension Center recommends 1.25 inches per week for residential turf.) During eight months of any year, there may be little or no irrigation demand since incident precipitation meets agronomic requirements. Consequently, seasonal irrigation demands alone cannot be used to sustain wastewater services. However, with over 2,500 acres, large irrigation areas, as summarized in Table 1, can be an instrumental part of the overall discharge capacity strategy.

The first public user of the reclaimed water was Washington State Department of General Administration for irrigation at the State’s Marathon Park. In later phases, they also plan to irrigate Heritage Park and the State Capitol Campus. The Port of Olympia plans to use reclaimed water for irrigation, equipment washdown, boat washing, marine terminal dust suppression, and a constructed pond. The City of Olympia will be irrigating city parks in the downtown area. A reclaimed water “filling station” on the Plant site will allow City tanker trucks to load water for various irrigation, dust suppression, and washing uses.
Table 1. Summary of Potential Large Seasonal Irrigation Demands

<table>
<thead>
<tr>
<th>Area</th>
<th>Potential Seasonal Irrigation User</th>
<th>Average Demand (MGD)</th>
<th>Maximum Demand (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tumwater</td>
<td>Tumwater Valley GC</td>
<td>0.97</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>Airport 9 Hole GC</td>
<td>0.29</td>
<td>0.81</td>
</tr>
<tr>
<td></td>
<td>Tumwater High School</td>
<td>0.15</td>
<td>0.41</td>
</tr>
<tr>
<td>Budd Inlet</td>
<td>Capitol Campus</td>
<td>0.15</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>Capitol Lake / Port of Olympia</td>
<td>0.24</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>Olympia Country Club GC</td>
<td>0.97</td>
<td>2.8</td>
</tr>
<tr>
<td>Chambers Prairie</td>
<td>Capitol City GC</td>
<td>0.61</td>
<td>1.7</td>
</tr>
<tr>
<td></td>
<td>Indian Summer GC</td>
<td>2.2</td>
<td>6.1</td>
</tr>
<tr>
<td></td>
<td>Lacey Regional Park</td>
<td>0.15</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>Country Green Turf Farms</td>
<td>1.2</td>
<td>3.4</td>
</tr>
<tr>
<td>Hawks Prairie</td>
<td>The Two Woods GC 1</td>
<td>1.2</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>The Two Woods GC 2</td>
<td>1.2</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>Thurston County Landfill</td>
<td>0.68</td>
<td>1.9</td>
</tr>
<tr>
<td></td>
<td>Lacey Regional Sports Park</td>
<td>0.15</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td>St Martins College / Ecology</td>
<td>1.4</td>
<td>3.8</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>11.6</strong></td>
<td><strong>32.4</strong></td>
</tr>
</tbody>
</table>

Notes: Average demand based on at 1.25 inches per week and maximum irrigation demand estimated at 0.5 inches per day.

**Groundwater Recharge.** Groundwater recharge in the LOTT program currently focuses on infiltration basins to allow the water to percolate to the groundwater table. At the present time regulatory preferences in Washington make injection systems procedurally and cost prohibitive. Locations suitable for recharge are limited by local hydrogeologic considerations (soil characteristics, proximity to wells, depth to water, etc.). Where conditions are favorable, hydrogeologic investigations suggest five (5) to ten (10)-acre constructed basins will have a discharge capacity of up to 5 MGD. Table 2 summarizes the estimated infiltration basin recharge capacity for different regions in the LOTT service area. Field verification of these values is an ongoing activity and one of LOTT’s most critical efforts (the recharge permit for the Hawks Prairie site can be found at [http://www.lottonline.org/PDF/HawksPrairieRWPermit.pdf](http://www.lottonline.org/PDF/HawksPrairieRWPermit.pdf))
Table 2. Summary of Estimated Groundwater Recharge Capacity

<table>
<thead>
<tr>
<th>Area</th>
<th>Potential Groundwater Recharge Site</th>
<th>Estimated Recharge Capacity (MGD)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
</tr>
<tr>
<td>Tumwater</td>
<td>79th Ave / Old Hwy 99</td>
<td>1.0</td>
<td>5.0</td>
</tr>
<tr>
<td></td>
<td>79th Ave / Deschutes River</td>
<td>0.5</td>
<td>3.0</td>
</tr>
<tr>
<td>Budd Inlet</td>
<td>None</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Chambers Prairie</td>
<td>South of Yelm Hwy / Ruddell Rd</td>
<td>1.0</td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>East of Pattison Lake</td>
<td>2.0</td>
<td>5.0</td>
</tr>
<tr>
<td>Hawks Prairie</td>
<td>East of Marvin Rd between 31st and 48th Ave</td>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>West of Marvin Rd between 28th and 31st Ave</td>
<td>5.0</td>
<td>10.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>14.5</td>
<td>36.0</td>
</tr>
</tbody>
</table>

**Marine Discharge Capacity and NPDES Permit.** The LOTT Budd Inlet Plant discharges to Budd Inlet, an estuarine reach of Puget Sound, and a Class A reclaimed water distribution system. The Budd Inlet discharge capacity is controlled by the National Pollution Discharge Elimination System (NPDES) permit (No. WA-003706) administered by the State Department of Ecology (Ecology). Budd Inlet is identified as a water body seasonally failing to meet federal water quality standards for several different constituents as contained in the 303(d) list. In 2003, Ecology began a formal process to determine the achievable water quality conditions in the watershed and the total maximum daily loading (TMDL) to sustain these conditions. Scheduled to be completed in 2007, the TMDL process will further define the Plant performance and discharge capacity by establishing total pollutant mass emissions for Budd Inlet.

In summer 2004, Ecology proposed guidelines for a new NPDES permit, which became effective on October 1, 2005. Since Budd Inlet is on the 303(d) list, EPA requires the NPDES permit to contain performance-based discharge with interim mass emission limits representing the maximum historical discharges by LOTT into Budd Inlet. A summary of allowable loads are contained in Table 3.
Table 3. NPDES Permit Limits, Budd Inlet Plant

<table>
<thead>
<tr>
<th></th>
<th>Average Monthly</th>
<th>Average Weekly</th>
<th>Max Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Load (lb/d)</td>
<td>Conc. (mg/l)</td>
<td>Load (lb/d)</td>
</tr>
<tr>
<td>Final Permit (subject to TMDL process)</td>
<td>Load (lb/d)</td>
<td>Conc. (mg/l)</td>
<td>Load (lb/d)</td>
</tr>
<tr>
<td>Summer¹ BOD</td>
<td>671</td>
<td>7</td>
<td>1006</td>
</tr>
<tr>
<td>TIN</td>
<td>288</td>
<td>3</td>
<td>--</td>
</tr>
<tr>
<td>Shoulder² BOD</td>
<td>900</td>
<td>8</td>
<td>1350</td>
</tr>
<tr>
<td>TIN</td>
<td>338</td>
<td>3</td>
<td>--</td>
</tr>
<tr>
<td>Winter³ BOD</td>
<td>5640</td>
<td>30</td>
<td>8460</td>
</tr>
<tr>
<td>NH₃-N</td>
<td>--</td>
<td>26</td>
<td>--</td>
</tr>
<tr>
<td>NH₃-N</td>
<td>--</td>
<td>22</td>
<td>--</td>
</tr>
<tr>
<td>Year Round TSS</td>
<td>5265</td>
<td>30</td>
<td>7898</td>
</tr>
<tr>
<td>Fecal Coliform</td>
<td>--</td>
<td>200/100</td>
<td>--</td>
</tr>
<tr>
<td>Total Copper</td>
<td>--</td>
<td>0.006</td>
<td>--</td>
</tr>
<tr>
<td>pH</td>
<td>Daily minimum is equal to or greater than 6, daily maximum equal to or less than 9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1. Summer = June, July, August, September
2. Shoulder = April, May, October
3. Winter = November, December, January, February, March

Treatment Capacity

Treatment capacity is defined as the ability to process wastewater at adequate rates to meet regional discharge capacity demands. From a simple business perspective, if discharge capacity is the consumer market, then treatment capacity represents the production factory. To be affordable to the customer, this new strategy requires locating the resource production nearest the demand and incrementally adding treatment capacity based on actual near term demand. In effect the discharge capacity sets the performance criteria for the treatment capacity. And since we are locating the treatment near uses, LOTT can selectively locate treatment capacity where discharge conditions favor their cost structure and level of treatment; thus saving costs. As a result, or by definition, treatment capacity generates products most closely matching their customer demands and puts the utility in a position of being able to manage the regulatory requirements. Over time LOTT plans to have treatment capacity located in multiple locations throughout the service area.
Treatment capacity in the LOTT system is segregated into the existing Budd Inlet Treatment Plant and capacity provided at satellite reclamation plants. This distinction is important not only because they produce different products but also because satellite reclamation plants will be utilized at 100 percent of their treatment capacity immediately upon commissioning.

Under the Plan, LOTT provides new treatment capacity to satisfy system growth at satellite facilities matched to water recycling opportunities. The system reserve is maintained at the Budd Inlet Plant for public health emergencies and interim system growth. The Department of Ecology as part of the NPDES permit requires that, in addition to meeting the base need, a reserve capacity of approximately 15 percent must be provided to sustain anticipated system growth and protect public health in declared emergencies.

Conveyance Capacity

Conveyance capacity is defined as carrying capacity of the regional wastewater transport system to deliver untreated wastewater to regional and satellite treatment centers. Conveyance capacity varies through the system. LOTT will balance the need for additional conveyance capacity with recycling opportunities and available treatment capacity.

Collection Capacity

Collection capacity is the retail wastewater service and transport to the regional conveyance system. LOTT’s Partner jurisdictions provide and maintain this capacity. Service extensions are coordinated with LOTT to assure that discharges can be satisfied most efficiently and conveyance capacity capital investments are minimized.

A PROGRAM FOR MANAGING CAPACITY

Since LOTT relies on a series of small projects to meet wastewater system capacity requirements as they occur, it is important that every project is complete and functioning "just in time,” and that the program of projects offers a seamless continuity of reliable facilities which carefully controls costs. This means that wastewater facilities planning is continuous and the progression of projects is “highly managed.” This also creates opportunities to make decisions about projects which can respond to circumstances of the time rather than installing a large facility that commits resources to a particular technology or wastewater management strategy resulting in no significant opportunity to change until the next facility is built 20 years hence.

The decisions about new capacity, while still being driven primarily by the need to provide wastewater treatment, can also be environmentally opportunistic and allow multiple benefits from each new wastewater management investment. The time between
when a project is first conceived and when it becomes an operating reality can be managed to both provide certainty of completion and control cost.

This does, however, require an organized approach and timely decision making. It is quite possible to expect situations will come up where two new increments of wastewater treatment capacity will be needed in a few years’ time. To successfully respond to changing capacity needs, this means the program will require several projects to be under various stages of development simultaneously, any one of which can be advanced as needed.

Having several projects in various stages of development simultaneously provides some certainty of capacity availability. Siting and permitting actions occurring before design and construction are the most problematic project elements. Indeed, sites for small plants and their related polishing ponds and recharge basins are essential for new discharge capacity increments. On the other hand, there is no particular advantage in racing to commit financial resources that never result in productive projects. The essence of small increment, “just-in-time” facilities and all their associated benefits is mastery of doing exactly what is useful and necessary and nothing more.

To achieve the best possible outcomes LOTT advances, holds, or eliminates new capacity projects using the best available data on actual conditions, the best predictions of trends, and considerable sound judgment.

The following data and projections are routinely maintained, monitored, and updated:

- Number and spatial distribution of current customers
- Measured flows in existing facilities (discharge, treatment, conveyance and collection)
- Reserve capacity available (discharge, treatment, conveyance and collection)
- Performance of LOTT’s flow reduction programs
- Time to implement the next unit of capacity
- Projected near-term (3-5 year) spatial flows and loadings forecasts

To assist in this planning process modeling tools have been developed that translate population forecasts into flows and loadings and predict facility capacity reserves and shortfalls graphically. LOTT also has a model that predicts the Budd Inlet Treatment Plant performance to determine the reserve treatment capacity.

**Flow and Loading Forecasts – Defining Needed Discharge Capacity**

In the Urban Growth Area (UGA), there is an estimated 21,000 sewered acres. The 2004 and 2025 projected sewered area is shown in Figure 1. It is estimated that roughly 59
percent of the residential population in the Urban Growth Area is currently sewered. The sewering of future growth and existing unsewered populations will have a significant impact on the rate at which LOTT must bring new facilities on-line under the “just-in-time” approach. Predicting what areas will be sewer and when is difficult due to uncertainties in future growth patterns, environmental regulatory enforcement, and political direction. Consequently, LOTT annually reviews development patterns with its Partner jurisdictions to identify where sewers will be extended and discharge capacity will be needed.

**Figure 1. LOTT Service Area, 2004 and Projected Expansion (2025)**

The population and employment forecasts are developed by the Thurston Regional Planning Council (TRPC) based on local zoning policies and state economic forecasting models. This uniform basis links LOTT’s infrastructure development consistent with its Partners. The TRPC population and employment forecasts for the North Thurston UGA indicate a two (2) to four (4) percent annual population and employment increase over the next several years. Maps showing the population density in 2005 and 2025 are shown in Figure 2. Similar figures are generated for employment.

Accurate flow and loading projections are essential to any system capacity assessment. These projections help demonstrate when various elements within the system will reach
their operable limits. Flow and loadings projections are built upon three (3) key elements:

- Analysis of historical flows and loadings recorded at the Plant.
- Projections of population and/or commercial growth within the service area.
- Analysis of environmental factors, such as precipitation, which may contribute to wastewater flow.

Figure 2. LOTT System Population Density, 2005 and 2025 Respectively

The Capacity Assurance Planning Environment (CAPE) developed by Brown and Caldwell combined with “rasterized” GIS data is used to develop the wastewater forecasts. CAPE develops wastewater forecasts using over 40 parameters and summarizes the data over geographic areas (e.g. how much wastewater was generated in the tributary to each SRP, or how much was generated within each jurisdiction?). The resulting wastewater generation profiles by Partner jurisdiction is provided in Table 4.

Table 4. Summary of LOTT Wastewater Generation Rate Profiles by Jurisdiction (gallons per capita day, gpcd)

<table>
<thead>
<tr>
<th>Jurisdiction</th>
<th>Lacey</th>
<th>Olympia</th>
<th>Tumwater</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Flow Rate</td>
<td>64.0</td>
<td>81.0</td>
<td>69.0</td>
<td>39.4</td>
</tr>
</tbody>
</table>

The timing for expansion of the service area within the Urban Growth Area (UGA) is based on local Health Department criteria for maximum density of on-site treatment and local development activities. Employment projections are generated by the State Office of Financial Management (OFM) and submitted to the TRPC for distribution in the County in accordance with local Comprehensive General Plans. Historical flow data plus precipitation records are used to develop flows and loads including average annual, peak
month, and inflow and infiltration (I&I). Projected flows and loadings for the service area are shown in Table 5.

Table 5. Projected Loadings (Annual Average), LOTT System, 2004-2025

<table>
<thead>
<tr>
<th>Year</th>
<th>BOD (lb/day)</th>
<th>TSS (lb/day)</th>
<th>Base Sanitary (MGD)</th>
<th>Average Annual (MGD)</th>
<th>10-Year Peak Mo. (MGD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>21,993</td>
<td>23,709</td>
<td>9.57</td>
<td>12.63</td>
<td>21.71</td>
</tr>
<tr>
<td>2006</td>
<td>22,971</td>
<td>24,761</td>
<td>9.99</td>
<td>13.09</td>
<td>22.25</td>
</tr>
<tr>
<td>2007</td>
<td>23,951</td>
<td>25,815</td>
<td>10.50</td>
<td>13.67</td>
<td>22.94</td>
</tr>
<tr>
<td>2008</td>
<td>25,157</td>
<td>27,112</td>
<td>11.12</td>
<td>14.38</td>
<td>23.76</td>
</tr>
<tr>
<td>2009</td>
<td>26,600</td>
<td>28,663</td>
<td>11.73</td>
<td>15.07</td>
<td>24.58</td>
</tr>
<tr>
<td>2010</td>
<td>28,020</td>
<td>30,189</td>
<td>12.29</td>
<td>15.71</td>
<td>25.34</td>
</tr>
<tr>
<td>2015</td>
<td>33,231</td>
<td>35,792</td>
<td>14.45</td>
<td>18.15</td>
<td>28.19</td>
</tr>
<tr>
<td>2020</td>
<td>39,123</td>
<td>42,131</td>
<td>16.63</td>
<td>20.59</td>
<td>31.04</td>
</tr>
<tr>
<td>2025</td>
<td>42,235</td>
<td>45,484</td>
<td>17.85</td>
<td>21.95</td>
<td>32.60</td>
</tr>
</tbody>
</table>

Determining Level of Service and Need For Capacity Adjustments

A number of factors are affected when facilities approach their available capacity that influences what new facilities are required. These factors include level of service considerations centered on regulatory and physical constraints:

Capacity Thresholds

The Washington Department of Ecology requires treatment plants and mechanical conveyance facilities begin planning and design of new facilities when they reach 85 percent of their maximum rated or permitted condition. LOTT refers to the remaining 15 percent buffer as reserve capacity. In accordance with Ecology guidelines, this rule provides necessary time to plan and construct new facilities before exceeding the capacity of existing facilities and assures public health protection during declared emergencies. To minimize sunk costs, addition of satellite reclamation facilities requires this system reserve capacity to maintained at the Budd Inlet Plant. Since satellite plants will be connected to the Budd Inlet Plant, satellite plants will be designed, rated, and operated at their full capacity as opposed to the firm capacity with the largest unit out of service. This dramatically lowers the capital and maintenance costs for the SRPs by marginalizing differential treatment costs and providing better opportunities for standardization. And since the SRP is operated at its full capacity immediately, sunk costs are minimized.
Environment

Environmental protection has been a significant public value relative to implementation and management of wastewater facilities within the LOTT service area. While there are numerous possible interpretations of “environmental protection”, we have used consistency with adopted environmental regulations, standards and policies to frame this broad issue and help identify the level of service. Environmental considerations can affect capacity through limiting the size or footprint of a constructed facility, limiting the discharge quantity or quality, and/or affecting facility operation. Through strategic development of programmatic and supplemental environmental impact statement documentation, LOTT has built a framework to expedite implementation of new facilities. These documents provide a public record and qualify potential impacts as part of an ongoing compliance program. This documentation was integrated into the original Wastewater Resource Management Plan (Brown and Caldwell, 1998). The documents summarize potential impacts to ground and surface water quality standards, city and/or county sensitive/critical areas ordinance requirements, and state and federal wildlife protection requirements, including the Endangered Species Act. Theses standards become LOTT’s level of service performance measures reported to its stakeholders.

Available Discharge Capacity

The Budd Inlet discharge currently represents the largest component of LOTT’s discharge capacity. This is largely controlled by the NPDES permit. However, the program begins with developing facilities and operating practices around proven ability to beneficially recycle the water (discharge capacity). Over the next 20 years water recycling will represent approximately 50 percent of the discharge capacity during the dry weather periods and approximately 30 percent during average wet weather conditions. Because irrigation uses currently does not offer dependable discharge capacity, new discharge capacity is controlled by groundwater recharge capacity.

Groundwater recharge basins represent the final step in the water recycling process for LOTT. The purpose of the groundwater recharge ponds is to enable the highly treated water to reach the groundwater in a managed and efficient manner. The location, configuration and operation of the basins are instrumental in assuring that the recharge basin can sustain operations during the entire calendar year. The recharge basins provide the key link in sustaining the resource-based approach.
In absence of recharge basins, alternative recycling or disposal methods would be needed. One option would be to provide additional mechanical and physical treatment at satellite reclamation plants to produce near drinking water quality in advance of injection wells for direct groundwater recharge. This would reduce dependence on the horizontal and vertical transmissivity of the vadose zone, upper aquifer water table, and large land areas. Alternately LOTT could pursue alternative disposal options including a marine discharge.

Assessments about the viability of groundwater recharge in Thurston County were conducted in multiple phases during the planning effort. First a programmatic hydrogeologic evaluation using existing and available data was conducted to screen potential recharge sites by quarter section throughout Thurston County. This analysis considered only hydrogeologic characteristics of an area. Hydrogeologic criteria included soil permeability, surface geology, surface slope, surficial unit thickness, and depth to groundwater table. This analysis suggested approximately 180 square miles in 32 different areas inside Thurston County may be suitable for groundwater recharge using surface infiltration basins. However, many of these sites are located several miles outside the service area, substantially developed, or in other environmentally sensitive areas. Consequently, site-specific assessments were conducted to further prioritize potential sites.

To quantify the discharge capacity of potential recharge sites, physical tests were conducted and 3D numerical models prepared to determine the impacts and define the likely maximum, sustainable continuous application rate at the site. These tools are also used to determine the water quality impacts. As illustrated on Figure 3, the tools were used to generate information to illustrate the steady state mounding height, determine the direction of travel, and estimate dilution / recovery factors for the applied water with background conditions (depth to groundwater is approximately 80 feet). Once proven recharge capacity has been determined, these sites become the basis for siting and configuring the remaining infrastructure.

In order to sustain groundwater recharge options into the future, LOTT must continuously look for opportunities to acquire land that is suitable for percolation and recharge. In absence of suitable land, LOTT will need to consider mechanical methods such as injection wells, which require higher levels of treatment (essentially meeting drinking water standards at the plant). Injection wells can be placed more easily in the service area and require substantially less land (0.25 to 1 acre) but will nearly double the treatment costs. LOTT is currently in the process of identifying an additional 10 MGD groundwater recharge capacity throughout the services area to satisfy its ultimate demands (currently LOTT has approximately 8 MGD secured). By the end of 2007 LOTT plans to be holding all groundwater recharge capacity locations necessary to meet buildout discharge capacity demands.
Treatment Capacity

In the LOTT system, treatment capacity is determined by matching discharge capacity water quality requirements (marine discharge, reclaimed water, etc.) with the demand for service and the wastewater characteristics. The treatment and discharge capacities of Budd Inlet Plant are the pivotal in determining the next steps of infrastructure implementation. Aside from discharge capacity limitations imposed by the NPDES permit, the Budd Inlet Plant is impacted by the loadings into the whole system. Its ability to continue to provide treatment capacity is dependant on understanding the potential capacity limitations, for example:

- The Budd Inlet Master Plan (Brown and Caldwell, 2005) indicated that the secondary clarifiers would become a capacity constraint as early as 2006 if there was no improvement in sludge settleability. Limiting the sludge volume index (SVI) to a maximum of 250ml/l would delay clarifier capacity limitations to 2013.

- Satellite reclamation plants will relieve Plant capacity limitations by removing flow from the system. Increasing the amount of flow treated at satellite plants could delay the Budd Inlet Plant secondary clarifier capacity limitation until 2015, even without any change in SVI.

- Increasing the amount of flow treated at SRPs would also delay a number of other Plant treatment capacity limitations in the process aeration, digester, DAFT, and North Outfall.
To understand and manage the available treatment capacity, comprehensive process modeling and stress testing was conducted. The result is a process simulation tool which can be used to predict the system performance and target treatment capacity improvements to process areas with the greatest benefit. Simulation results are organized by discharge capacity and water quality criteria for the final product. The results are a series of figures demonstrating the effects of changing effluent performance conditions on the Plant treatment capacity. Figure 4 illustrates the capacity restrictions at the Budd Inlet Plant in order to meet a 3 mg/l TIN effluent performance goal during April (a permit limiting month).

**Figure 4. Plant Capacity Curve for April Condition, Effluent TIN = 3 mg/L**

The bold black line represents the Budd Inlet Plant influent flow characteristics over time resulting from implementation of satellite reclamation plants elsewhere in the service area. The colored lines represent the unit process limitations at the Plant. Where the black and colored lines intersect represents a treatment capacity restriction. Separate curves are prepared for different effluent water quality and wastewater characteristics. A combination of these curves representing the anticipated conditions are used to develop a capital program for treatment capacity improvements.

**Determining Conveyance Capacity**

Gravity sewers and interceptors under this strategy are considered to exceed available capacity when either of the following conditions occurs:
• Depth of flow in the sewer during average monthly dry weather conditions exceeds 70 percent of the diameter of the pipe.

• Depth of the flow in the sewer during 10-year peak hour event exceeds a 2-foot surcharge above the crown of the pipe or is within 2 feet of the manhole rim.

Depth lines are considered to exceed capacity when the 10-year peak hour flows exceed 10 feet per second (fps) in the pipeline.

COMBINING CAPACITY AND DEVELOPING INFRASTRUCTURE

Combining these capacity considerations with demands for new service results in an infrastructure implementation plan focused on placing facilities where they have most benefit. Understanding these needs for LOTT results in the following criteria / guidelines for new infrastructure investments:

• Recharge locations should be located in close proximity to treatment facilities when possible.

• Recharge capacity is highly dependent upon local soil conditions.

• Martin Way SRP and Hawks Prairie Recharge Basins can provide up to five (5) MGD of treatment and discharge capacity in the Hawks Prairie region.

• Recharge capacity in the Chambers Prairie area is limited by hydrogeologic conditions. Chambers Prairie SRP treatment capacity is limited to two (2) to three (3) MGD.

• Class A reclaimed water produced at the Budd Inlet Plant will have to be transported several miles for recharge.

The conveyance system then must be arranged to support these facilities. If done so in advance, sunk costs in large sewer lines can be avoided and sewage flows can be concentrated in locations to facilitate a SRP. In the LOTT Wastewater Resource Management Plan (Brown and Caldwell, 1998), several locations were identified in the collection system for diverting flows to SRPs. These locations are referred to as diversion points. Flow and loading forecasts are then developed for the diversion points and used to schedule the implementation of new treatment and discharge capacity “just in time.” An example of one potential diversion strategy to serve LOTT’s southeast service area is shown in Figure 5. As these strategies are developed they are evaluated to determine total life-cycle cost, environmental and social costs and compared against level of service goals prior to implementation.
INFRASTRUCTURE OPERATING STRATEGY

Cost effectively implementing a capital plan requires an integrated operating strategy. This maximizes the use of existing assets and takes advantage of best practices to lower operating and life-cycle costs. Key elements of LOTT’s strategy include:

- Emphasis on automation and less emphasis on new staff
- Develop highly skilled staff (multiple technical capabilities)
- Remote operation of SRPs from central control at the Budd Inlet Plant
• Contracting non-core activities
• Treat peak wet-weather flow using a marine discharge

The following briefly describes the operations and maintenance activities for the Martin Way SRP, and the Hawks Prairie Wetland Ponds (Ponds) and Recharge Basins (Basins) and how they are integrated with the Budd Inlet Plant.

**Satellite Reclamation Plant**

Most of the SRP operations will be automated with remote process control from the Budd Inlet Plant. There are no permanent staff located onsite. However, there are onsite activities required including periodic operations and routine maintenance. Table 6 contains the operations staffing plan for each satellite reclamation plant. These activities will be accomplished using a crew (minimum two (2) persons) originating from the Budd Inlet Plant. Operational upsets and routine maintenance requiring shut down of part of the SRP are handled by diverting the unavailable treatment capacity to the Budd Inlet Plant (this capability is built into the SRP influent pump station).

**Table 6: Typical 5 MGD Satellite Reclamation Plant Staffing Plan**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
<th>Staffing ¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grit/screenings removal</td>
<td>Daily</td>
<td>0.250</td>
</tr>
<tr>
<td>Aeration blower</td>
<td>Monthly</td>
<td>0.012</td>
</tr>
<tr>
<td>Pumps</td>
<td>Monthly</td>
<td>0.050</td>
</tr>
<tr>
<td>Membrane Bioreactor</td>
<td>Bi-weekly</td>
<td>0.185</td>
</tr>
<tr>
<td>Other mechanical maintenance</td>
<td>Monthly</td>
<td>0.012</td>
</tr>
<tr>
<td>Water quality sampling</td>
<td>Daily</td>
<td>0.088</td>
</tr>
<tr>
<td>Instrumentation maintenance</td>
<td>Monthly</td>
<td>0.046</td>
</tr>
<tr>
<td>Process control, on site</td>
<td>Daily</td>
<td>0.250</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>0.893</td>
</tr>
</tbody>
</table>

Notes: Staffing is in FTEs – Full Time Equivalents

**Wetland Polishing Ponds**

The Ponds, along with the Recharge Basins, require less process control and more landscape maintenance and public access control. There are no permanent staff onsite at these locations. Regular operations and maintenance visits are conducted to ensure a “maintained facility identity” is confirmed to the public. Managing public access requires a daily presence by a staff member of LOTT, parks department, or other agency. Landscape maintenance is conducted seasonally through contractual arrangement with other civic entities or departments.
Water quality sampling occurs on a weekly basis and shared with the Recharge Basins. The staffing plan for the Ponds is shown in Table 7. FTEs shown for water quality sampling do not include analytical testing.

Table 7: Wetland Ponds Staffing Plan

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
<th>Staffing $^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow control (inlet and outlet)</td>
<td>Monthly</td>
<td>0.023</td>
</tr>
<tr>
<td>Flow control</td>
<td>Semi-annually</td>
<td>0.008</td>
</tr>
<tr>
<td>Emergency response</td>
<td>By incident</td>
<td>(0.004)$^2$</td>
</tr>
<tr>
<td>Automated valves</td>
<td>Annually</td>
<td>0.004</td>
</tr>
<tr>
<td>Plant harvesting, debris removal and wildlife habitat</td>
<td>Annually</td>
<td>0.115</td>
</tr>
<tr>
<td>Landscape maintenance</td>
<td>Monthly</td>
<td>0.050</td>
</tr>
<tr>
<td>Public access management and security</td>
<td>Daily</td>
<td>0.188$^3$</td>
</tr>
<tr>
<td>Water quality sampling</td>
<td>Weekly</td>
<td>0.050</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>0.438</strong></td>
</tr>
</tbody>
</table>

Notes:
1. Staffing is in FTEs – Full Time Equivalents
2. Included with public access management and security.
3. Includes incident response.

Recharge Basins

Similar to the wetland ponds, the Recharge Basins require more earthwork, grounds keeping and landscaping than mechanical maintenance. Basins require periodic cleaning and restoration based on measured recharge performance and to control plant growth on a quarterly basis. Cleaning of a basin will be accomplished with earth working equipment assisted by manual labor on an infrequent (two (2) to five (5) year cycle). Activities are accomplished in conjunction with similar needs at the Ponds. The staffing plan for the Recharge Basins is shown in Table 8.
Table 8: Recharge Basins Staffing Plan

<table>
<thead>
<tr>
<th>Activity</th>
<th>Frequency</th>
<th>Staffing$^1$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet control</td>
<td>Weekly</td>
<td>0.025</td>
</tr>
<tr>
<td>Distribution pipe and valve</td>
<td>Monthly</td>
<td>0.025</td>
</tr>
<tr>
<td>Basin cleaning and permeable base restoration</td>
<td>Quarterly</td>
<td>0.160</td>
</tr>
<tr>
<td>Site security</td>
<td>Daily</td>
<td>(0.100)$^2$</td>
</tr>
<tr>
<td>Landscape maintenance</td>
<td>Monthly</td>
<td>(0.025)$^3$</td>
</tr>
<tr>
<td>Water quality monitoring, sampling</td>
<td>Weekly</td>
<td>0.100$^7$</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>0.260</td>
</tr>
</tbody>
</table>

Notes:
1. Staffing is given in FTEs – Full Time Equivalents
2. One person, one half hour per day, included with Wetland Ponds security.
3. One person, four hours per month, included with Wetland Ponds landscape maintenance.

CONSISTENT FINANACIAL PERFORMANCE

The test for a sustainable infrastructure program is the financial performance. Do demands for additional rates and fees fluctuate? Can the utility maintain and replace assets to sustain service? In LOTT’s case, rates are forecast to remain at $25.50/month/ equivalent residential unit (ERU) and connection fees to average $3,650/ ERU for the 20-year horizon. Since the public infrastructure program was aligned with community values, rates and fees remain fixed even though significant changes in the discharge and treatment capacity infrastructure requirements have occurred.

The LOTT asset management program recognizes capital investments for infrastructure offer financial return over a 10 to 20 year period as opposed to two (2) to five (5) years for most private businesses. This requires careful consideration of level of service when developing a financial plan for an adaptable recycling-based program. In LOTT’s case, this was developed by aligning the necessary improvements with the requests for new capacity. As a result, LOTT will demonstrate consistent financial performance over the next twenty years as demonstrated in Figure 6. With exception of a four (4) year window from 2011 to 2015, when their debt position is marginal, LOTT will be in a favorable financial position and able to create reserves for repair and replacement and/or adapt to new conditions without adjusting rates and fees.
CREATING A FRAMEWORK FOR RESOURCE DISTRIBUTION AND USE – BUILDING ADMINISTRATIVE CAPACITY

Only one (1) year after LOTT began its Plan, the State of Washington published draft guidelines for the production and use of reclaimed water (Ecology, 1997). Consequently there were many undefined elements regarding establishing a reclaimed water utility these include:

- Ambiguity regarding state water right law and reclaimed water use
- Impact of reclaimed water distribution on local potable water utilities
- State regulatory reporting and oversight
- Regional allocation of the resource
- Financial commitment of LOTT and its partner jurisdictions

Consequently, prior to commissioning reclaimed water capital facilities, LOTT realized it needed to initiate efforts to establish a policy framework to manage and administer the resource…build Administrative Infrastructure. After discussions with the partner jurisdictions, LOTT identified over 40 different policy issues that needed to be resolved.
in advance of distributing reclaimed water. These are summarized into the following categories:

- Utility interactions - Maintenance requirements and authority between wastewater and potable water utilities
- Resource equity – Defining ownership and rights; how much reclaimed water does each partner get and when?
- Regulatory due diligence - Define the reporting requirements and who is responsible for providing the information. Determine who has responsibility for enforcement actions.
- Community consistency - Describe how to uniformly represent the resource within the regional community. Developing uniform partner jurisdiction ordinances
- Financial - Costs for wholesale and retail recipients and receipt of operating revenues. Who pays for what capital facilities? …Value to LOTT v. value to Partners
- Application – Developing installation and monitoring standards and identifying an incentives program to expand use.

As a wastewater utility, LOTT is not a water purveyor. Instead, the three (3) Partner cities – Lacey, Olympia, and Tumwater – will play that role. LOTT’s solution included establishment of a task force, development of agreements, coordinated regional communications, and internal orientation and training to put the appropriate Administrative Infrastructure in place and enable Plan implementation. This multi-jurisdictional effort required several years to complete and was perhaps the most underestimated level effort in the program.

The inter-agency Reclaimed Water Policies Task Force has addressed most of these policy issues. Most were resolved through a series of interlocal, distribution, supply, and end user agreements reclaimed water generated by LOTT. The agreements strive to offer a regional resource approach while preserving each jurisdiction’s operating autonomy.

A distribution methodology has been defined to assure that each of the partner jurisdictions will have reasonably equitable access to reclaimed water over time, so they have the assurances they need to begin planning purple pipe infrastructure. Working with the Reclaimed Water Policies Task Force, LOTT has developed a regional Public Information, Education and Marketing Program. The program logo – featuring a blue water drop – emphasizes the message that the product is water. (It’s no longer wastewater.) The logo also includes one of two program themes – “The Right Water for the Right Use.”
RESULTS

By incrementally adding system capacity, LOTT saved over $40 million in total program costs as compared to securing another marine discharge. In addition LOTT is creating multiple community benefits including additional water resources, affordable sewer rates and maximizing the use of existing facilities. The integrated process of continually managing the available capacity to public values has allowed LOTT to adapt to changing conditions without financial repercussions. Rates and connection fees ($25.50/mo and a 20-yr average of $3,650/residential equivalent, respectively) continue to project constant for the next 20-years even though the facilities being implemented have changed. Consequently, LOTT is perceived and provides a higher level of service (better treatment, higher level of environmental protection, and more community benefits) to its customers at a lower cost. In addition, LOTT is able to assert more control of its capital implementation program.

Figure 7 – LOTT Hawks Prairie Satellite Reclamation Facilities

(From top left clockwise: SRP from Martin Way, Information kiosk at wetland pond, aerial view of 41-acre wetland pond and recharge site, and SRP from neighboring property)
CONCLUSION

Sustainable water recycling programs can be cost effective sustainable solutions provided they are integrated into the overall capacity needs for the system – they must provide discharge capacity benefits year round. To truly be a sustainable water reclamation program, the planning must be comprehensive. The plan must anticipate not only the physical utility infrastructure, but also the policy framework, implementation process, environmental documentation, financial position and level of service performance goals (public values). When solutions are integrated into an overall system capacity solution, the utility has the ability to adapt incrementally to changes in social and environmental conditions, and discharge restrictions such as TMDLs, and demands for additional water resources. Further, the time frame to implement cost effective flexible systems will be dependent upon the ability to create the regulatory, physical, and administrative infrastructure. Consequently, the end solution for each system will be inherently unique however; the approach to reach a solution will be similar.

Following a resource-based ‘just-in-time’ program has enabled LOTT’s rates and connection fees to allow growth to pay for growth while affording rates, currently well below the state average, to remain constant for 20 years. However, this takes a commitment to establishing a structured management program with regular monitoring and evaluation. Consequently value-based planning and resource based strategies results in a sustainable program utilizing operational and business best practices:

- Achieves elected official and public support
- Maximizes use of available discharge capacity
- Incremental capital program provides for better cost equity and targets capital improvements to best meet needs
- Recycling supports community ethic and water resource development (supply and mitigation)
- Collectively managing assets to achieve an overall system goal can result in higher environmental protection with lower up front costs
- Continual planning maximizes adaptability and avoids sunk costs
- Simple was all used up

ACKNOWLEDGEMENTS

The author acknowledges the contributions of citizens of Thurston County and their participation in public involvement opportunities and countless workshops offering suggestions to identify community needs and ultimately create a foundation for elected official support for the program.
REFERENCES


LOTT Alliance, (2005) *General Interlocal Agreement Between The LOTT Wastewater Alliance, Thurston County And The Cities Of Lacey, Olympia And Tumwater For Distribution And Use Of Reclaimed Water*