Cedar Water Treatment Facilities: Project Completion Report

January 25, 2005 briefing to the Utilities and Technology Committee of the Seattle City Council

Lake Youngs with Mt Rainier in Background

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The purpose of the briefing is to provide the following:

1. Refresher level background on the project objectives,
2. Summary of project implementation and specifically the design-build-operate (DBO) contracting approach, and
3. Comparison of the delivered water quality from Cedar and Tolt with new water treatment facilities on both supplies.

Project Objectives

Please refer to Attachment No. 1 for SPU's Water System Map.

The new Cedar Water Treatment Facility is located on the northeast shore of the Lake Youngs Reservoir.

Seattle Public Utilities has implemented treatment improvements on the Cedar supply to achieve three water quality and drinking water regulatory objectives that continue to assure public health protection on that source:

1. Comply with the Agreed Order between SPU and Washington Department of Health (which was resolved on November 1, 2004). This order was in response to the 1992 exceedance of the raw water fecal coliform criteria to remain unfiltered.
2. Improve public health protection against *Cryptosporidium*. There was no regulation for *Cryptosporidium* at the time that the project was being developed but we knew that a regulation would be in force within a few years.
3. Reduce the periodic earthy, musty taste of Cedar water.

Additionally, there was an objective to create more flexibility in regulatory requirements by creation of the "Limited Alternative to Filtration" category in the federal drinking water regulations. Such a change would acknowledgement the exceptional source protection in the Cedar watershed and allow Seattle to treat the source with a non-filtration treatment process, thus saving ratepayers over $100 million.

Finally, there were project objectives for cost effectiveness and low environmental impacts.

In 1999, our estimate of what it would cost to implement the facility using a conventional design-bid-build contracting approach was $115 million and our estimate of what it would cost to operate the facility for 25 years was $49 million, for a total life cycle cost estimate of $164 million. Our goal was to have the facility operational in 2004.

In May 1999, the City Council authorized (Resolution 29938) the use of a design-build-operate (or, DBO) contracting approach for implementation of the Cedar Treatment Facility project.

Project Implementation

In mid-2000, a Request for Proposals was issued for Cedar Water Treatment Facility using the DBO procurement approach. Two proposals were requested -- one using ozone only to meet the project objectives, and one using a combination of ozone and

*Attachment No. 2 provides further information about **UV**.*

Ultraviolet Light (UV) to meet them. Ozone is a strong gaseous disinfectant, very commonly used in the drinking water industry (SPU's Tolt Water Treatment Facility includes ozone treatment). Significant new research had demonstrated that UV is very effective for treatment of *Cryptosporidium* in drinking water without using chemicals and at lower cost.

*See Attachment No. 3 for discussion of the transition to operations and **key capacity and water quality criteria** information.*

Upon completion of a successful – and very competitive – procurement process, SPU signed a contract on April 30, 2001 with CH2M Hill for the permitting, design, construction, and operation of the new treatment facility. Construction in and near Lake Youngs began in summer of 2002 and progressed until late Spring 2004 when the active transition to the new facilities began.

The contract executed in 2001 consisted of about $78 million for the capital component of the project, and about $31 million for 25 years of operations. (The contract can be terminated at the end of 15 years of operations, but the City will have the option to extend for two additional five-year periods at the same contract terms.) When other costs such as SPU oversight (including consultant assistance) and costs for the Lake Youngs Substation are added, our savings for use of the DBO approach is estimated to be approximately $45 million on a life-cycle basis. In other terms, we implemented the project for about 27% less than conventional contracting and City operations would have cost.

- *See Attachment No. 4 for a table of **project costs** and cost savings summary for Tolt and Cedar DBO Projects.*
- *See Attachment No. 5 for more about **design-build-operate** and why Seattle decided to use it, including where did the cost savings come from, and a brief discussion of risk allocation.*
- *And finally, see Attachment No. 6 for a discussion of the **sustainability** aspects of the facility.*

Before and After Water Quality Comparisons

Filtration was needed on the Tolt supply to remove material in the water – **turbidity** that creates a reliability problem on that supply and **organics** which, when combined with chlorine, creates a disinfection byproduct compliance problem. The configuration of the Cedar system, which includes a large transmission reservoir (Lake Youngs), makes it much easier to maintain low turbidities on that supply. And the organics level on the Cedar is much lower than the Tolt. Filtration (at much higher capital and O&M cost) is not needed now on the Cedar. The combination of ozone and UV will meet all current and anticipated water quality and regulatory objectives on this supply.

Attachment No. 7 summarizes the differences in raw water quality between the Tolt and Cedar surface water supplies that led to different treatment strategies. This attachment also indicates the water quality and regulatory issues for each of these supplies and how the implemented water treatment has resolved the issue.

*Attachment No. 8 shows the most visible aspect of the improvement of Cedar water quality – **taste and odor**.*

Please see Attachment No. 9 for photographs of the completed facility.

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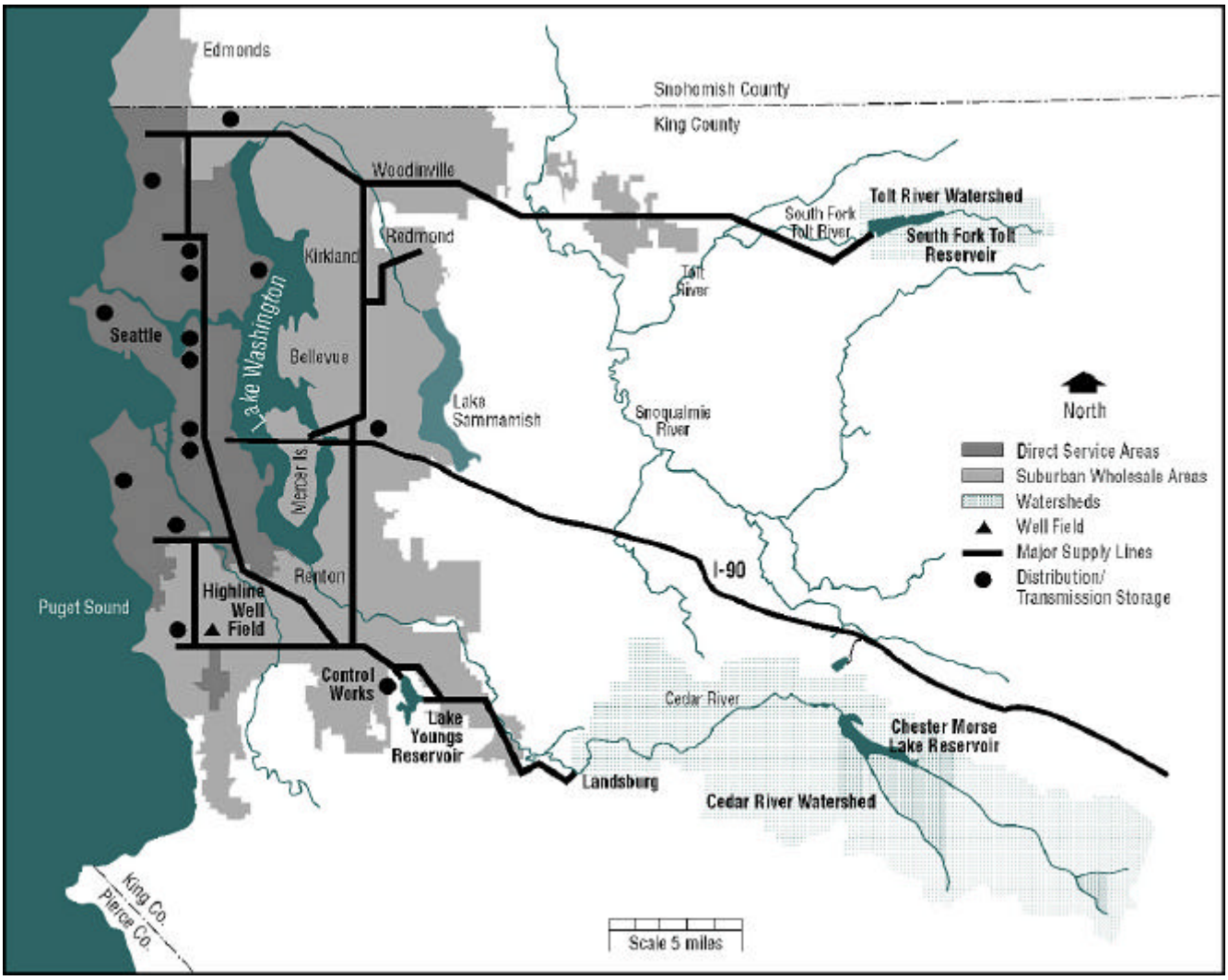
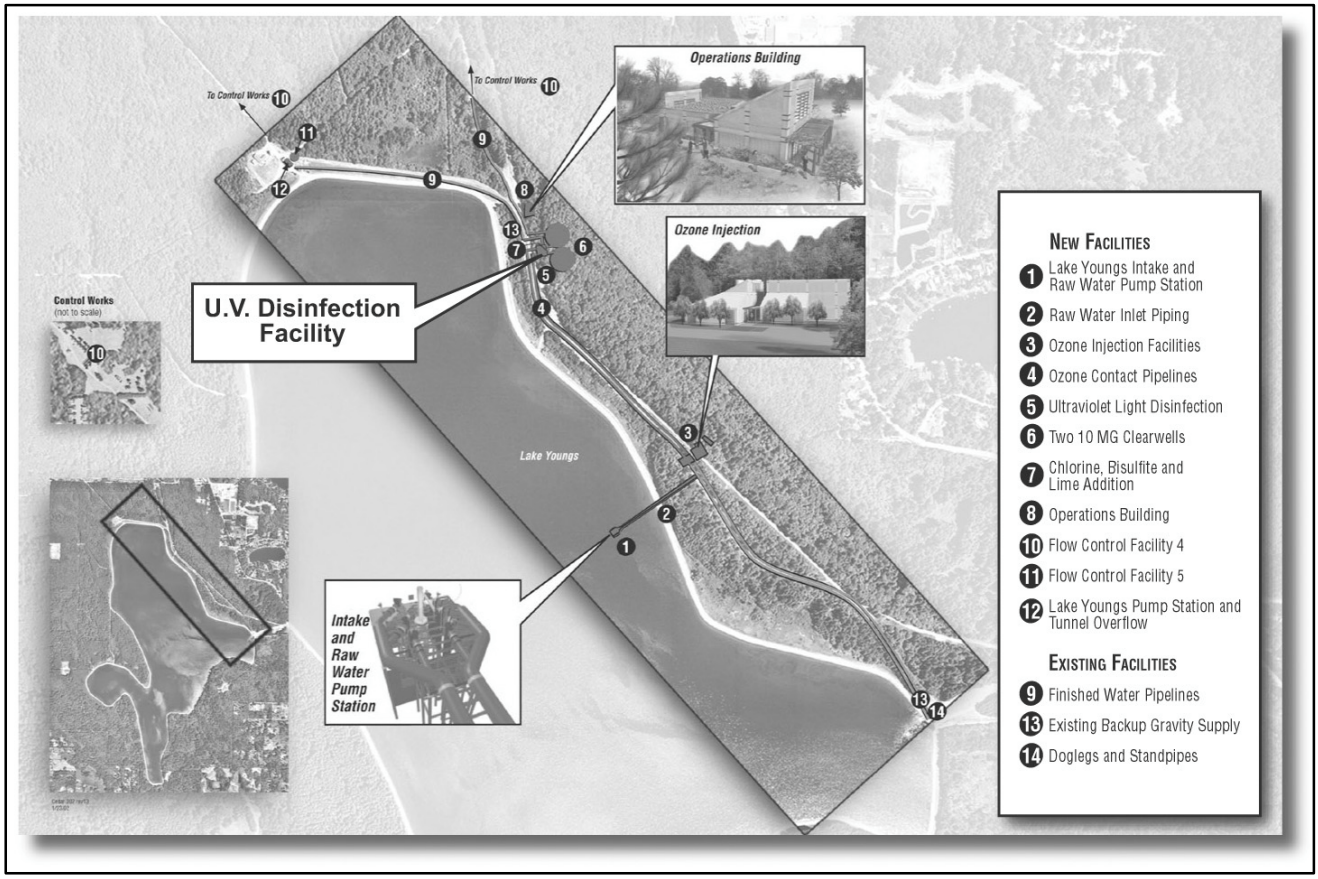
Attachment 1
SPU Water System Map




To Control Works 10
To Control Works 10
Operations Building
Ozone Injection
U.V. Disinfection Facility
Control Works
(not to scale)
Lake Youngs
Intake and Raw Water Pump Station
New Facilities
1 Lake Youngs Intake and Raw Water Pump Station
2 Raw Water Inlet Piping
3 Ozone Injection Facilities
4 Ozone Contact Pipelines
5 Ultraviolet Light Disinfection
6 Two 10 MG Clearwells
7 Chlorine, Bisulfite and Lime Addition
8 Operations Building
10 Flow Control Facility 4
11 Flow Control Facility 5
12 Lake Youngs Pump Station and Tunnel Overflow
Existing Facilities
9 Finished Water Pipelines
13 Existing Backup Gravity Supply
14 Doglegs and Standpipes

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Attachment 2
What is UV Treatment?

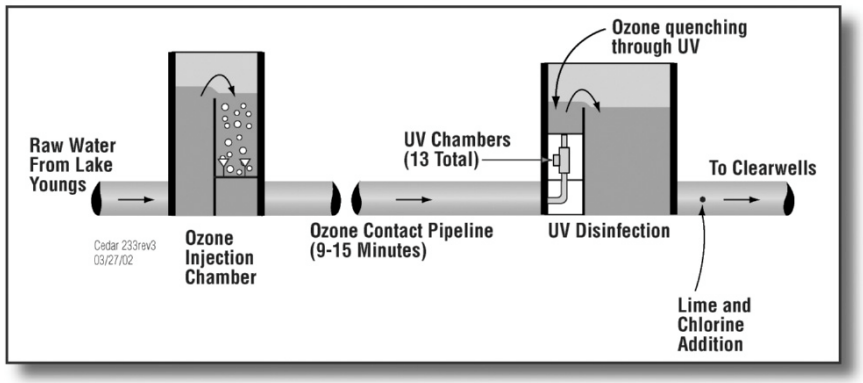
What is UV? UV stands for ultraviolet, and in this case ultraviolet light used for disinfecting drinking water. UV light occurs naturally as part of sunlight, but can also be produced using commercial lamps. The range of ultraviolet light wavelengths that are considered germicidal (germ killing) is 200 to 300 nanometers.

How does UV work? At germicidal wavelengths, UV is absorbed by a microorganisms's genetic material (DNA) causing molecules to form new bonds. Once the DNA is altered, the microorganism is unable to replicate.

Where has UV been used before? In 1999, there were about 1000 public water systems in the US currently using UV (there are more now). Most of these systems are small, non-community ground water systems. It has been used more extensively in over 500 large and small wastewater treatment plants up to 225 MGD, although wastewater treatment goals are clearly not the same as those in drinking water. There are many small systems using UV in Europe (1,500), with roughly 50 systems ranging in size up to 40 MGD; however, only 3 plants have design flows between 50 and 80 MGD. The Cedar Treatment Facility is currently the largest UV drinking water treatment facility in the world.

What are the benefits of using UV for the Cedar system? There are numerous benefits to using UV for the Cedar system:

- The water quality characteristics of the Cedar supply make UV a very effective alternative for primary disinfection. UV has been shown to be effective for many chlorine resistant pathogens, including *Cryptosporidium* and *Giardia*, and has no demonstrated low temperature constraints as compared to ozone and other chemical disinfectants.
- Compared to ozone only, an ozone/UV combination costs less to construct and operate. There are no chemicals to purchase for UV treatment, and the size of facility needed is smaller (than for an ozone-only facility).
- For the Cedar system, UV is used in conjunction with ozone, providing a multi-barrier treatment system able to inactivate bacteria, viruses, protozoa, and other pathogens.
- UV does not appear to lead to distribution system bacteria regrowth issues, which may be a concern – although manageable – with ozone only.
- There are currently no known disinfection by-products formed by UV treatment.



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Attachment 3
Transition to Operations and
Key Operations Phase Capacity and Water Quality Criteria

Transition to Operations Phase

The time between the first water flowing through a new plant facility and the final plant acceptance was called the Transition to Operations or Transition Phase. During this period there were three key objectives:

1. Continue to delivery high quality water to Cedar customers.
2. Support the Company in its efforts to test the new facilities and at the end of the transition phase to conduct a 14-day Acceptance Test.
3. Accept the new facility and begin operations phase payments only after the new facilities have successfully passed the rigorous 14 day Acceptance Test.

The Transition Phase began in March of 2004 and continued through mid August 2005. During this period, all three objectives were met. Although SPU was receiving partial benefits from the new facilities in June, we did not begin operations phase payments to OMI, the contract operator, until August 26, a day after the successful completion of the 14-day Acceptance Test.

Key Operations Phase Capacity and Water Quality Criteria

Design Feature	Requirement
Plant Capacity	180 MGD, expandable to 275 MGD.
Redundancy and Reliability Features	• The plant has two 90 MGD treatment 'trains'. • There are two pipelines (v. one previously) that can deliver treated water from the plant. • All pumping and water treatment facilities have emergency standby power.
Microbial Protection	≥ 99.9 % Removal of *Cryptosporidium* ≥ 99.99% Removal of *Giardia* ≥ 99.999% Removal of Virus
Corrosion Control	The pH (a measure of corrosivity) must be maintained within a strict performance range.
Taste & Odor Reduction	The Flavor Rating Assessment of the water must be ≤ 3: "I am sure that I could accept this water as my everyday drinking water."

SPU has the ability to monitor plant performance in real time through a SCADA (Supervisory Control and Data Acquisition) connection to the new facility.

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Attachment 4 – Project costs and cost savings for Tolt and Cedar DBO Projects

SPU's Estimate for Conventional Contracting[1]

	Tolt Treatment	Cedar Treatment
Capital	$115 m	$115 m
Operations (25 yrs)	$56 m	$49 m
Total	**$171 m**	**$164 m**

Actual DBO Contracting Approach Cost

	Tolt Treatment	Cedar Treatment
DBO Contract -- Capital Phase[2]	$65 m	$78.4 m
Other Capital Phase Costs[3]	$10.5 m	$6.1 m
Additional Costs (unanticipated at time of DBO contract execution)[4]	$2.0 m	$.5 m
Lake Youngs Substation[5]		$4.3m[5]
Remaining to completion		.3 m
Total Capital	**$77.5 m**	**$87 m**
Operations (25 yrs)[6]	$36 m	$31 m
SPU Ops Phase Oversight Costs	$1.3 m	$1.3 m
Total	**$115 m**	**$119 m**
	Approximately $56 m (33%) life cycle savings	**Approximately $45 m (27%) life cycle savings**

(Note: The Tolt cost was about $646,000 per MGD of constructed facility and the Cedar cost was about $483,000 per constructed MGD of facility)

Total savings for the two projects:
Capital: $66 m (29%) savings
Ops: $35 m (34%) savings
Total: $101 m (30%) savings

[1] Cost estimates & conventional vs. DBO comparisons are as of the time contracting approaches were evaluated for each project (following preliminary engineering for Tolt and following planning for Cedar). Therefore, total project costs as shown in Summit are different than the numbers on this table – they include "sunk" costs as of that date and interest payments. Cost estimates for the Tolt project were generated in two different ways – 1) using standard estimating techniques employed at the time of preliminary engineering completion, and 2) use of an additional method wherein an independent consultant employed an EPA technique that examined completed project costs for similar treatment facility projects. Cost estimates for the Cedar project were generated using standard estimating techniques employed at the time of completion of planning phase documents.

[2] Capital phase DBO costs include all costs (other than SPU review) and risks associated (as allocated in the Service Agreements) with associated with project management, permitting, mitigation, community outreach, design, construction, and construction inspection.

[3] SPU costs included procurement process management, contract negotiations, honorarium payments, insurance, contract oversight, permit document review and agency coordination, design review, misc SPU crew work, on-site coordination with SPU crews, and interconnection for the Tolt to the nearby transmission system.

[4] Unanticipated capital costs for Tolt included archaeological findings. Unanticipated capital costs for Cedar included various fiber optic cable installations, various improvements to portions of the nearby transmission system, and various security services.

[5] $2.4 million of the capital costs for the Lake Youngs Substation will be reimbursed by PSE in 2007.

[6] Operations costs are estimates because some associated costs are pass-through to SPU (for example, power and chemical costs), and because actual costs will vary due to cost index variations and depending on the amount of water treated at the facilities.

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Attachment 5
More about design-build-operate and why Seattle decided to use it

Design-Build-Operate (DBO) is a non-traditional approach to project implementation wherein proposers compete for a contract that includes design, construction, and long term facility operation. SPU believes that by allowing a DBO contractor to customize the construction of the facility to fit the treatment methods developed, the contractor will maximize efficiency, resulting in lower construction and operation costs, and improved reliability.

This approach to public agency contracting is available to the City due to Washington State legislation enacted in 1994 (RCW Ch. 39.10) and subsequently extended, which authorizes entities such as the City of Seattle to use alternative public works contracting procedures in certain situations.

Design-build-operate was determined to be the approach that would most likely lead to project success for SPU's Tolt Treatment Facility and Cedar Treatment Facility projects for the following reasons:

Improved schedule	It is expected that the period of time required for project implementation using a DBO approach is less than with the use of a conventional design-bid-build approach.
Transfer risk	The DBO approach allows the City to avoid certain risks over which it has little ability to control and a poor track record of managing.
Synergy (better outcome)	Synergism is created when teams of designers, constructors, and operators are forced to work together toward a common goal of high quality and efficient facility development (in a competitive environment). That is, the ultimate outcome is more likely tailored to the City's specifically defined treated water quality and supply objectives than with the use of a conventional design-bid-build project approach.
Positive experience on Tolt	Seattle Public Utilities design-build-operate experience, based on the Tolt Treatment Facilities project proved that the DBO approach provides a successful tool for meeting operational and financial objectives.
Cost and schedule certainty	Upon execution of a DBO contract, the owner has greater certainty of implementation cost and schedule than would be available at a comparable time using a conventional design-bid-build procurement approach.
Life cycle cost analysis	Upon evaluation of proposals, the City can consider firm life cycle costs (i.e., including all fixed operational costs, as well as maintenance, and equipment renewal and replacement costs).

Market availability	The vendor community is poised to take advantage of DBO procurement opportunities. That is, there are firms and teams of firms currently structured to provide the range of necessary disciplines needed for implementation of design-build-operate projects.
Reduced cost	The life cycle cost of a facility being implemented with a DBO approach is likely be lower than the estimates that are based on the use of a conventional design-bid-build procurement approach. The Tolt DBO produced considerable cost savings over the estimated cost of implementing the project using a conventional design-bid-build-City operations approach.

Three key aspects of a "project philosophy" formed the foundation for development of the procurement process.

- that the City describes its needs in terms of performance requirements and standards, and then let vendors propose solutions for how to achieve these requirements;
- that technological innovation be encouraged within the range of proven technology, and competition be used to achieve *both* technical innovation and lower cost; and
- that risk be allocated between the City and the vendor in a manner which minimizes overall project costs (i.e., assign the risk to the party best able to manage it).

WHERE DO THE COST SAVINGS COME FROM?

The City of Seattle expected efficiencies and cost savings from utilizing a DBO approach for the Cedar Facilities for the following reasons:

1. A close working relationship between the designer and constructor, leading to:
   - a more economical design,
   - application of cost-saving construction techniques,
   - elimination of owner mediation to resolve disputes between the designer and constructor, and
   - purchase of critical components able to start prior to final design completion.
2. Various operational efficiencies, such as
   - highly automated facilities,
   - bulk purchasing of supplies and material, and
   - introduction of new technology by large operating firm, thereby driving down long-term operating costs.
3. Incentives for the contractor to design and build a reliable and "operator-friendly" facility since the DBO contractor also assumes responsibility for operating and maintaining the plant and for meeting performance guarantees under a long-term Service Agreement.

4. Competitive market savings due to:
   - continued keen international market interest in bringing the DBO approach to the American water industry, and
   - qualified competitors wanting to establish a long-term market niche.
5. Ability during solicitation and negotiation process to clarify and refine expectations and contract terms.
6. Simplifies business relationship with public agencies.

RISK ALLOCATION

Risk allocation for a DBO project is somewhat different than for a conventional design-bid-build approach. Following is a listing of typical risks assessed to parties in implementing large capital projects, with discussion of the specific allocation for the Cedar DBO project.

Site acquisition	City	The facility was constructed on property already owned by the City.
SEPA	City	The city had conducted the SEPA process. The Company was required to build the project in a manner consistent with or less than the impacts described in the Final EIS, and was required to conduct mitigation measures in a manner consistent or greater than those described in the Final EIS.
Permitting	Company	The company proposed a permitting approach that the city reviewed, and upon contract execution had the responsibility for applying for and obtaining the permits.
Schedule	Company	The company proposed a project implementation schedule and upon contract execution was obligated to complete the project within the time frames defined in the contract.
Design-build (constructability)	Company	The company had the risk of ensuring that the design was constructable, and to the extent that there were problems in construction, they were obligated to perform within the same cost and schedule parameters.
Design-operate (operability)	Company	The company had the responsibility to ensure that the facility is operated in a manner described in their proposal, and if the operators find problems or difficulties in operations, the company will be responsible for correcting them.

Build-operate (sub-standard construction)	Company	If during the operations phase of the contract sub-standard construction is determined to have occurred, then the company must correct problems associated with this.
Technology	Company	The competitive procurement process encouraged teams to be innovative, but they retain the responsibility to ensure that technology functions as expected.
Treated water quality	Company	The company is obligated to produce treated water meeting the city's performance specifications. Liquidated damages will be imposed if treated water quality falls below these standards.
Raw water quality	City	The city maintains the obligation to provide raw water quality that meets parameters provided in the contract.
Change in law		
• change in code	City	The company is obligated to obtain permits, however, if permit requirements change between the time the contract is executed and the time the company submits permit applications, then the city will compensate for impacts.
• change in regulations	City	If drinking water regulations change to become more stringent than the defined Service Agreement performance specifications, then the city and company must negotiate changes necessary for the city to continue to meet regulatory requirements.
• patents	City/Company	The company must obtain licenses associated with the project, with the exception of patents related to UV technology.
Financing	City	The city has financed the project through issuance of bonds.
Unanticipated site conditions		
• subsurface conditions	Company	If subsurface conditions create problems for construction (e.g., groundwater or other geotechnical conditions), then the company still has the responsibility to implement the project within the cost and schedule parameters.

• Archaeology	City	If cultural resources are located on site, such a situation is defined as an Uncontrollable Circumstance and the company must mitigate impacts, but the city is obligated to compensate the company for impacts.
• hazardous materials	City	If pre-existing hazardous materials are found on site, such a situation is defined as an Uncontrollable Circumstance, and the company must mitigate impacts, but the city is obligated to compensate the company for impacts.
Weather	Company	The company is obligated to implement the project within the cost and schedule parameters defined in the contract. That is, there will be no "rain days", or contract extensions for bad weather.
Strikes	City/Company	National strikes are Uncontrollable Circumstances (thus, the city will compensate for impacts). However, in the case of a local strike, the company is obligated to implement the project within the cost and schedule parameters defined in the contract.
Termination for Convenience		
• if during Development Period		Generally, subject to Cost Substantiation, the City would have reimbursed the Company for its actual direct costs incurred.
• if during Construction Period		$3,000,000 payment to the Company if the City had exercised termination for convenience during the Construction Period
• if during Operations Period		$500,000 payment to the Company, reduced by 1/180 for each month which has elapsed during the operations period (with an additional $500,000 if the termination occurs during the first year of the Operations Period.)
Renewal and Replacement and Maintenance	Company	The company was required to describe their renewal and replacement and maintenance programs in the proposal, and is obligated to perform in a manner consistent with these, and if additional costs or efforts are required, then, generally, the company is obligated to correct deficiencies.
Power costs	City	Electricity is treated as a "pass-through" item in the service fee, and thus the city has the risk of increasing power costs.

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Attachment 6
How has Sustainability been Incorporated?

CH2M HILL's approach to the Cedar Treatment Facility project was based on "least impact" to the Lake Youngs Reservation and the environment. Wherever possible, CH has sought to avoid impacts, especially to wetlands. Impact avoidance leads to permitting certainty and implementation risk avoidance. CH2M HILL's design and environmental protection strategy minimized all impacts to wetlands and buffers on the Lake Youngs Reservation and avoided or reduced all other environmental impacts. CH mitigated the minor wetland and buffer impacts by completing a restoration project at Lake Youngs for a previously impacted wetland that included a "planting and education" day for a Boy Scout troop and through replacement buffer set-asides.

The City of Seattle has adapted the US Green Building Council's Leadership in Energy and Environmental Design (LEED) Green Building program. LEED is a voluntary, consensus-based, market-driven green building rating system, which is based on existing, proven technology and evaluates environmental performance from a "whole building" perspective. LEED is a self-certifying system designed for rating new and existing commercial, institutional, and multi-family residential buildings. It contains prerequisites and credits in five categories: Sustainable Sites, Energy and Atmosphere, Water Efficiency, Materials and Resources, and Indoor Environmental Quality. The City of Seattle Green Building Team has prepared a "Seattle Supplement" to LEED. This supplement provides additional information relevant to the Seattle regional area, and provides resource listings.
The Cedar Treatment Facility will meet Seattle policy of achieving a Silver rating, and may achieve the next highest rating, Gold.

- Silver rating required
- $50,000 incentive payment for obtaining gold rating

Sustainability features include:

- Reduced site disturbance, including 40-foot protection zones around buildings
- Stormwater management
- Innovative wastewater management, including use of waterless urinals, and other water reduction features
- Minimum energy requirements through passive ventilation, use of natural light
- Energy efficient appliances and building systems
- Light pollution reduction
- Water efficient landscaping
- Recycling during construction
- Some building re-use
- Use of local/regional materials
- Use of recycled/rapidly renewable materials
- Use of certified wood

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Attachment 7
A Comparison of Tolt and Cedar Water Quality Issues and Treatment Strategies

The following table summarizes the differences in raw water quality between the Tolt and Cedar surface water supplies that led to different treatment strategies. The shaded boxes indicate the water quality and regulatory issues for each of these supplies and how the implemented water treatment has resolved the issue is in **BOLD**.

Source Water Quality and Treatment Strategies Summary

	Tolt	Cedar
System Reliability	Periodic high turbidity required that the supply be taken out of service. **Filtration has resolved this issue.**	Landsburg diversion controls turbidity, and Lake Youngs provides a storage buffer.
Surface Water Treatment Rule (SWTR) Compliance for *Giardia*		1992 unfiltered system criteria exceedance led to an Agreed Order. **O3 has resolved this order.**
Future Enhanced SWTR for *Cryptosporidium*	**Filtration & O3**	**Ultraviolet (UV) Light Disinfection**
Disinfection By-Product Rule (THM/HAAs in ppb) • Phase I (80/60) • Phase 2 (40/30??)	Existing:(75/75) • **Filtration** • Flexibility in new Tolt WTP to address this future reg.	Existing: (30/30) • Likely not a problem but flexibility in the plant design to respond to this, if needed.
Lead & Copper Rule Compliance	**Corrosion treatment was optimized** after the plant was brought on-line. 2003-4 residential monitoring resulted in the Nov 2004 resolution of the Lead and Copper Bilateral Compliance Agreement with WDOH.	
Taste & Odor		**O3** has addressed T&O at the Lake Youngs outlet.

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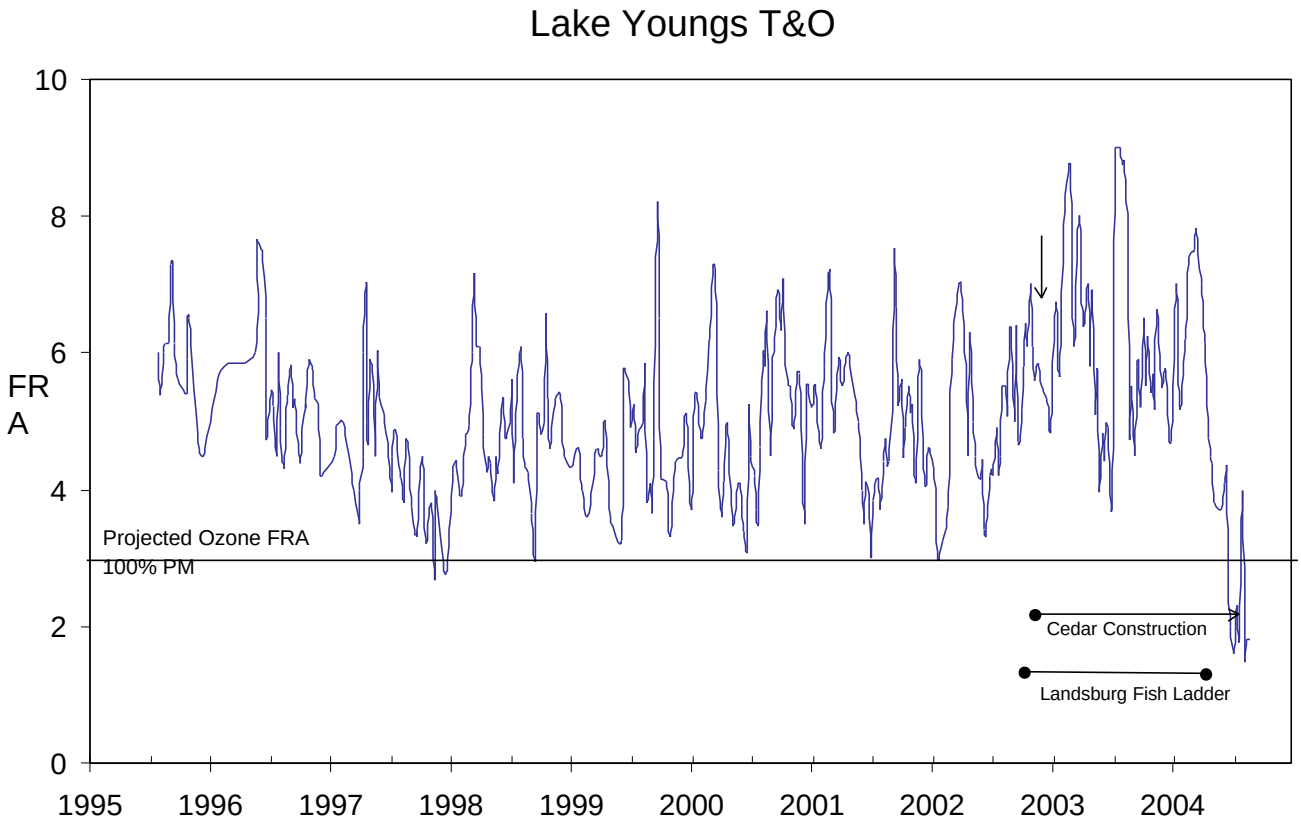
Attachment 8
The most visible aspect of the improvement of Cedar water quality – taste and odor



Flavor Rating Assessment Scale:

1. I would be very happy to accept this water as my everyday drinking water.
2. I would be happy to accept this water as my everyday drinking water.
3. I am sure that I could accept this water as my everyday drinking water.
4. I could accept this water as my everyday drinking water.
5. Maybe I could accept this water as my everyday drinking water.
6. I don't think I could accept this water as my everyday drinking water.
7. I could not accept this water as my everyday drinking water.
8. I could never drink this water.
9. I can't stand this water in my mouth and I could never drink it.

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Attachment 9
Photographs of Completed Facility

Operations Building

Ozone Building

Intake Structure in Lake Youngs

Treated Water Tanks

Ultraviolet Treatment

Project Team