PROPOSED MOTION 2005-0057

ATTACHMENTS 4-6
AUGUST 24, 2005 STAFF REPORT

Ord Sec: 116	3000	Wastewater Treatment CIP

P3 Proviso:
Of this appropriation, $500,000 shall not be expended or encumbered until the council approves by motion a report unifying Brightwater program reporting and cost monitoring formats and including a Brightwater program baseline budget. The report should be submitted by the executive to the council by January 24, 2005.
□The proposed Brightwater project reporting requirements shall, at a minimum, include the following:
□(1) A format for the Brightwater project monthly management reports in accordance with executive policies and procedures (CON 7-9-1 (AEP)) section 6.8.
□(2) A format modeled after formats currently in use for existing large capital improvement projects such as the Harborview bond program and the courthouse seismic project (i.e. distribution list, executive summary, project descriptions, overall budget summary, critical issues, budget summary tables, schedule, current activities and a look ahead summary).
□(3) A budget reporting format, appropriate to the scale of the Brightwater program, to be used as a consistent template for all Brightwater sub-projects and facilitate budget summary roll ups (example, Harborview bond program UW C-100 budget form 08/01/03).
□(4) A proposed Brightwater program baseline budget based on the proposed budget reporting format and the October 2004 predesign estimate. The baseline budget approved by the council shall serve as a performance measurement planning tool for the Brightwater program.
□The original and 16 copies of the report must be filed with the clerk of the council, who will retain the original and will forward copies to each councilmember and to the lead staff for the budget and fiscal management committee and the lead staff of the regional water quality committee or their successors.

Ord Sec: 116	3000	Wastewater Treatment CIP

P2 Proviso:
Of this appropriation, $500,000 shall not be expended or encumbered until the wastewater treatment division hires a consultant to provide independent oversight and monitoring of the treatment plant, conveyance facilities and marine outfall elements of the Brightwater project.
□(1)□The consultant shall have the following minimum qualifications:
□a. Nationally recognized expertise on major public capital improvement projects with a constructed value of $200 million or more;
□b. Experience with wastewater treatment facilities of similar scope and scale to the Brightwater project;
□c. Capacity and expertise to quickly and professionally review project scope, schedule and budget phase submittals;
□d. Expertise in construction management and/or program management; and
□e. Preference should be given to a consultant with a local office.
□(2) The work program for the consultant shall require the consultant at a minimum to provide to the executive, the council and the Brightwater project representatives the following:
□a. An overview of the Brightwater project including an initial review of scope, schedule, budget and distribution of budget categories compared to other projects of similar scope and scale or industry standards. The overview shall identify any project elements that are inconsistent or out of balance with industry standards or other comparable projects and shall include recommendations, if any, for improvements to the Brightwater project;
□b. A review of the scope, schedule and budget for all major Brightwater project phase submittals including the 30%, 60%, 90% and 100% design submittals;
□c. Written reports on the status of all design phase submittals reviewed by the consultant;
□d. Additional analysis or studies as may be requested by the wastewater treatment division or the council, including, but not limited to, monthly reports on the bidding and construction phases of the project; and
□e. Quarterly presentations on the status of the Brightwater project to the budget and fiscal management committee or the regional water quality committee or their successor committees. The frequency of these presentations may be decreased to less than quarterly at the discretion of the chair of the budget and fiscal management committee or the chair of the regional water quality committee, respectively, or their successor committees.
□(3) To the extent feasible, the consultant procurement process should be timed or phased to facilitate review of the Brightwater Treatment Plan 60% design submittal, currently scheduled for January 2005.
□The original and 16 copies of all oversight monitoring consultant reports must be filed with the clerk of the council, who will retain the original and will forward copies to each councilmember and to the lead staff for the budget and fiscal management committee and the lead staff of the regional water quality committee or their successors.

ATTACHMENT 5

June 14, 2005

RECEIVED
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CLERK
KING COUNTY COUNCIL

The Honorable Ron Sims
King County Executive
701 Fifth Avenue, Suite 3210
Seattle, WA 98104

The Honorable Larry Phillips
Chair, Metropolitan King County Council
516 Third Avenue, Room 1200
Seattle, Washington 98104

Subject: **Brightwater Project Overview Report**

Dear Executive Sims and Chairman Phillips:

Enclosed are an original and 16 copies of the Brightwater Project Overview Report (POR) which was prepared in response to the requirements of King County Ordinance 15083 dated November 22, 2004. Proviso P2(2)(a) of Ordinance 15083 requires that the consultant provide "an overview of the Brightwater project including an initial review of the scope, schedule, budget, and distribution of budget categories compared with other projects of similar scope and scale or industry standards. The overview shall identify any project elements that are inconsistent or out of balance with industry standards or other comparable projects and shall include recommendations, if any, for improvements to the Brightwater project."

The projects used in this comparison were:

Jones Island Wastewater Treatment/Cross Town Conveyance Project: This project, located in Milwaukee Wisconsin, included a 330 mgd conventional secondary (activated sludge) treatment plant and 6.2 miles of conveyance tunnel terminating in a 120 mgd pump station.

Deer Island Wastewater Treatment Improvements Project: This project, located in Boston Massachusetts, included a 350 average mgd conventional secondary (oxygen-activated sludge) wastewater treatment plant and 9.5 miles of conveyance tunnel and marine diffuser.

We look forward to presenting the conclusions of the report to the Budget and Finance Committee. If you have any questions or need further documentation, please do not hesitate to contact me at (206) 695-4470 or Bob Bingham at (206) 695-4504.

Sincerely,

R. W. BECK, INC.

Bob Bingham for

Russell J. Stepp
Project Manager

Enclosures

c: Peggy Dorothy, King County Council Staff
Christie True, Brightwater Program Manger
Pete Letourneau, Brightwater Program Staff

Brightwater Program Overview Report

King County

June 2005

R·W·BECK in association with

CRA INTERNATIONAL

PTM Consulting LLC

Brightwater Program Overview Report

King County

June 2005

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Project Manager

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c: Peggy Dorothy, King County Council Staff
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Brightwater Program Overview Report

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APPENDIX A BRIGHTWATER PROGRAM OVERSIGHT REPORT CONSULTANT TEAM QUALIFICATIONS **67**

R. W. Beck, Inc. is providing Oversight Services for King County's Brightwater Project. This document presents an opinion based on review of materials for process intent only, and is not intended to determine the adequacy or completeness of work products of the County, or any other party providing services for this Project, including its consultants, subconsultants, contractors or subcontractors.

This document is solely for information and assistance to the King County Council in performing their oversight of the Brightwater Project and should not be relied upon by the County for any other purpose or by any third party for any purpose.

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EXECUTIVE SUMMARY

Introduction and Scope of Oversight Report Review

The Brightwater Program Oversight Consultant Team, consisting of R. W. Beck, Inc. (R. W. Beck) in association with CRA International and PTM Consulting LLC, conducted an independent review of certain elements of the Brightwater Program's budget, schedules, and overall management. In general, we conducted a high-level management review that was focused on documents and procedures related to the design phase. We also relied on information gained in limited interviews of Brightwater managers and staff. While our review focused on design phase information, we have also made some recommendations related to overall management that have implications for the construction phase. In assessing how well the Brightwater Program is managed compared to "industry standards," we relied on the experience of our team where published standards were not available. We also considered how well Brightwater compared to a hypothetical, ideally managed project.

A portion of our review involved comparing Brightwater to selected comparable projects and industry standards. The selected comparable projects were:

- **Jones Island Wastewater Treatment/Cross Town Conveyance Project – Milwaukee Metropolitan Sewerage District (MMSD):** The project included a 330 mgd conventional secondary (activated sludge) treatment plant and 6.2 miles of conveyance tunnel terminating in a 120 mgd pump station.
- **Deer Island Wastewater Treatment Improvements Project – Massachusetts Water Resources Authority (MWRA):** The project included a 350 average mgd conventional secondary (oxygen-activated sludge) wastewater treatment plant and 9.5 miles of deep, hard rock conveyance tunnel and marine diffuser.

These two comparable projects were selected because they both involved: implementation of major capital improvements over a long period of time; development of a wastewater treatment plant and significant tunneling; and public agency ownership with reliance on the private sector for many aspects of implementation. However, some key differences relative to Brightwater should also be noted. For example, the comparable projects were larger than Brightwater, they

involved conventional treatment rather than membrane bioreactor treatment, they involved hard rock rather than soft rock tunneling, and they involved retrofitting certain existing unit processes and facilities.

In addition, the two comparable projects were delivered using conventional public works bidding. In contrast, Brightwater will be delivered using a mix of contracting methods including traditional public works bidding for the tunnels and influent pump station, General Contractor/Construction Manager (GC/CM) for the Treatment Plant, and Design-Build for the marine outfall.

It is important to note that our review was focused on a "snapshot" in time, and that work on Brightwater continued to progress while our review was being conducted. For example, our budget review included a management-level review of 30% design cost estimates.

Summary of Key Findings and Recommendations

Overall, we find that the Brightwater Program has implemented or plans to implement programs, policies, and practices that are consistent with the attributes of a well managed, major capital improvement program. For example, the Brightwater Program has instituted thorough QA/QC requirements and practices; has implemented value engineering, constructability, and specialized peer reviews; is assessing and considering risks in its management decisions; and is aware of the importance of schedule integration for the Treatment Plant and Conveyance Projects. There is also a strong commitment to cost control and management among the Program Managers.

Key conclusions and recommendations, based on our review, include:

COST

Modifications to the baseline budget ($2004) are not warranted at this time. The overall budget presented to the County Council is likely somewhat low (on the order of 5%–6%) based on our review of contingency levels, which, in our opinion, are on the low end of industry expectations. However, this is somewhat counter balanced by certain Allied Costs (professional services and staff labor) for the Treatment Plant, which are on the higher end of industry expectations and may reflect some redundancy in roles between the contracted Construction Management firm and the GC/CM. Given the overall level of uncertainty at the 30% design stage, we do not recommend modifying the budget at this time. Further, the proposed budget is having the intended management effect: Brightwater Program Managers and staff clearly feel pressure to make project changes in order to remain within the desired budget.

However, there are several factors that we believe could tend to drive up estimated construction costs as the design develops and during construction. For example, the construction cost estimates – the basis for much of the proposed budget – relied to a large extent on allowances. (Based on information provided by URS, about 56% the overall $259.4 million construction estimate for the Treatment Plant and about 46% of the overall $511.9 million construction estimate for Conveyance are based on allowances.) In addition, the design of certain elements (i.e., the marine outfall) had not progressed beyond the planning stage at the time the 30% estimate was completed, and some geotechnical information was not available at that time. Also, the County conducted an extensive value engineering review of the 30% estimate; the potential of future value engineering savings may, therefore, be more limited.

There are several project risks, such as encountering large boulders during tunneling, which have not been explicitly budgeted for. Because such circumstances would truly be unforeseen, we do not believe it is prudent to assume they would occur in establishing the budget. Nonetheless, should these conditions actually be encountered during construction, Brightwater would likely need to request supplemental funding.

There are several unique technical and management elements of the Project that, taken together, may also affect Project costs and schedule. These include:

- The fact that the Treatment Plant will involve the largest application of membrane bioreactor (MBR) treatment in the United States;
- The requirement for 99.9% odor reduction at the Treatment Plant fence line;
- The fact that extremely high hydrostatic pressures in certain reaches of the Central Conveyance Tunnel will necessitate use of tunnel boring machine (TBM) technology that has never been used before in the United States; and
- The use of several new contracting methods and provisions.

MANAGEMENT

Changes should be made to establish a collaborative "partnering" relationship between the Treatment Plant designer (CH2M Hill) and the GC/CM contractor. The lump sum design contract for the Treatment Plant with CH2M Hill coupled with the decision to have the responsibility for cost estimating rest solely with URS and Hoffman may have had the unintended effect of creating conflicting interests between the designer and GC/CM. While Hoffman's preconstruction services contract includes provisions for design reviews, we believe the Treatment Plant Project would benefit from a collaborative design review process where the GC/CM and designer review the design documents together and can enter into a dialogue about design intent and construction related issues. We believe this is an important step to take in

order to reduce the potential for disputes during construction over what is (or is reasonably inferable to be) in scope. We believe it is critical to address these issues now, so that a "partnering" type of relationship exists between Hoffman and CH2M Hill going into construction. Specific changes that Brightwater should consider include:

- Assuring that a detailed side-by-side review of design drawings and specifications is conducted by Hoffman collaboratively with CH2M Hill; and
- Once a final Treatment Plant construction budget is established (after the 60% design review changes) and if design modifications are required to reduce construction costs, amending CH2M Hill's design contract to include a "design to construction budget" requirement.

The Construction Services GC/CM Contract (to be negotiated), should include specific requirements to address competition during bidding of subcontract packages. Under GC/CM contracting, especially in a tight market for construction services, subcontractors may be reluctant to bid against the GC/CM, who can self-perform up to 30% of the work and who has knowledge and insight into the project that they don't have. This concern may also extend to against other subcontractors that have long-term relationships with the GC/CM. Provisions to address these competitiveness issues could include:

- Providing for a thorough County review of the GC/CM's subcontract packaging plan;
- Requiring a minimum of three bids on subcontract packages or to rebid them;
- Requiring that the County oversee the bidding process for any contract packages that the GC/CM would like to self-perform; and
- Specific outreach activities to subcontractors to acquaint them with the GC/CM bidding process.

In the selection process for contracted Construction Management services for the Treatment Plant, Brightwater should focus on two elements:

- Augment in-house staff capabilities.
- Set a clear mandate that the contract CM services are intended to facilitate and not impede the performance of the GC/CM and Design team.

Significant Construction Management responsibility is typically given to the GC/CM contractor. For example, construction cost management, inspections, and administration of construction-related paperwork are largely the responsibility of the GC/CM, while responsibility for changes to the GC/CM contract typically rests with the owner. Brightwater has elected to deliver the Treatment Plant with a GC/CM contractor, but also plans to hire a contracted Construction Management firm. We

recommend that Brightwater develop a staffing matrix of roles and responsibilities to avoid overlap of tasks, duties, and responsibilities between the CM, GC/CM, Owner, and Design team, and to avoid superfluous positions as well as an unclear decision making process. Special attention should be given so that the CM does not become an intermediate layer between the Owner and GC/CM decision-makers. Essentially, the CM should provide support to Brightwater own CM staff and not be in the line of decision-making.

Brightwater Program Managers should aggressively proceed with their development and analysis of an Integrated Treatment Plant and Conveyance Schedule. Once construction starts, schedule delay poses one of the greatest risks to meeting the Brightwater Project budget. Specifically, the per-day costs of tunneling delay will be significant. In addition, a significant delay in tunneling could also delay startup and testing of the Treatment Plant and potentially put equipment and process guaranties at risk. In developing the Integrated Schedule, care should be taken not to unnecessarily accelerate the planned design and bidding schedule, resulting in unneeded risks and costs.

Brightwater should build on its current risk assessment/risk management activities. There may be value in conducting a probabilistic risk assessment related to Conveyance costs and Treatment Plant costs and schedules. (Such an assessment is underway for the Conveyance schedule.) Specific workaround strategies in the event that unforeseen conditions are encountered (especially for tunneling) should be identified; and role-playing exercises to determine how effectively they can be implemented could be employed.

Brightwater should consider "delegating down" significant construction change order approval authority to expedite decision-making during construction. Once construction starts, the need to have all change orders approved by the overall Program Manager could delay work and drive up costs.

INTRODUCTION

Purpose and Objectives

The Brightwater Program Oversight Consultant Team, consisting of R. W. Beck, Inc. (R. W. Beck) in association with CRA International and PTM Consulting LLC, conducted an independent review of certain elements of the Brightwater Program, including the reasonableness of the proposed overall budget, the reasonableness of the manner in which the budget was allocated, the proposed frequency and format/level of detail of status reporting, and the reasonableness and management of project schedules. Both the Brightwater Treatment Plant and Brightwater Conveyance Projects were reviewed.

Our review also encompassed issues related to the overall management of Brightwater, such as project organization and staffing, project communication, QA/QC procedures, value engineering, constructability reviews, contracting methods, and risk management.

In general, we conducted a high-level management review that was focused on documents and procedures related to the design phase. We also relied on information gained in limited interviews of Brightwater managers and staff. Where we believed it was warranted, we conducted more detailed review on selected project elements and documents. While our review focused on design phase information, we have also made some recommendations related to the overall management of the project that have implications for the construction phase.

COMPARABLE PROJECTS/INDUSTRY STANDARDS

A portion of our review involved comparing Brightwater to selected comparable projects and industry standards. The selected comparable projects were:

1. **Jones Island Wastewater Treatment/Cross Town Conveyance Project - Milwaukee Metropolitan Sewerage District (MMSD):** The project included a 330 mgd conventional secondary (activated sludge) treatment plant and 6.2 miles of conveyance tunnel terminating in a 120 mgd pump station. (This project was part of MMSD's larger Water Pollution Abatement Program, which also included side sewer development and other improvements. These additional elements were not considered in our review.) Construction was completed in January 1996. Project development (design and construction) required 234 months (approximately 20 years) to complete.

2. **Deer Island Wastewater Treatment Improvements Project – Massachusetts Water Resources Authority (MWRA):** The project included a 350 average mgd conventional secondary (oxygen-activated sludge) wastewater treatment plant and 9.5 miles of deep, hard rock conveyance tunnel that discharges treated effluent into the deep waters of Massachusetts Bay through a series of 55 diffusers spaced along the last 1.5 miles of the tunnel. Construction of the entire facility was completed in September 2000. Project development (design and construction) required 148 months (approximately 12 years) to complete.

These two comparable projects were selected because they are similar to Brightwater in several ways:

- They both involved implementation of major capital improvements over a long period of time.
- They both involved development of a wastewater treatment plant and significant tunneling.
- They were both publicly owned and developed projects that relied heavily on the private sector to implement because they required additional resources beyond their agencies' respective staffing capacity.

Some key differences relative to Brightwater should also be noted:

- The two comparable projects involved larger capacity, conventional secondary treatment relative to the 36 average mgd Brightwater Treatment Plant, which will utilize membrane bioreactor (MBR) secondary treatment.
- The two comparable projects primarily involved hard rock tunneling rather than tunneling in glacial till.
- The Jones Island Project involved retrofitting many existing unit processes in addition to adding new ones. The Deer Island Project included demolition of existing facilities and retrofit of pump stations and limited retrofits of other facilities.
- The two comparable projects were delivered using conventional public works bidding. In contrast, Brightwater will be delivered using a mix of contracting methods including traditional public works bidding for the tunnels and influent pump station, General Contractor/Construction Manager (GC/CM) for the Treatment Plant, and Design-Build for the marine outfall.
- The two comparable projects were implemented under court compliance orders.

- Logistical requirements for the two comparable projects' treatment plants were somewhat more complicated than for Brightwater since both were located on sites with limited access.

We also considered information from other projects using GC/CM contracting in the Puget Sound region.

In assessing how well the Brightwater Project's budget, schedule, and management elements compared to "industry standards," we relied on the experience of our team where published standards were not available. Short summaries of team member experience are included in Appendix A to this report. We also considered how well Brightwater compared to a hypothetical, ideally managed project.

Status of Brightwater

Brightwater is an advanced wastewater treatment and conveyance project that will be located in Snohomish and King Counties. The Brightwater Treatment Plant will be designed for an average wet weather flow of 36 mgd and peak hourly flows up to 130 mgd. The Treatment Plant will also be expandable to accommodate an average wet weather flow of 54 mgd and peak hourly flows up to 170 mgd. The Treatment Plant will include the following processes:

- Preliminary treatment including screening and grit removal;
- Primary treatment using primary clarifiers;
- Secondary treatment using MBR technology;
- Split-flow treatment during high flows, wherein a certain portion of the flow will be split off, will receive advanced chemical primary treatment, and will then be recombined with flows that have received MBR treatment;
- Disinfection with sodium hypochlorite;
- Class A reclaimed water production (initially 10 mgd) suitable for non-potable industrial processes as well as irrigation of food and non-food crops and open access areas such as parks, with a major emphasis on marketing most or all of the production from the facility; and
- Biosolids production including anaerobic digestion and dewatering, which, similar to reclaimed water, will also be marketed.

In addition, the Treatment Plant will include extensive odor control measures (covered process areas, three-stage chemical scrubbing, and final treatment with activated carbon) in order to achieve a performance commitment of 99.9% odor removal at the Treatment Plant fence line.

The Brightwater Conveyance System will be comprised of pipelines built inside of underground tunnels as well as five staging areas (portals).

Specific conveyance elements include:

- The East Tunnel, extending from the Treatment Plant Site west to Portal 41. (The East Tunnel will contain both influent and effluent pipelines.)
- The North Creek Influent Pump Station (IPS) located at Portal 41.
- The Central Tunnel, extending from Portal 41, west through Portal 44, and farther west to Portal 5. (Between Portals 41 and 44, the Central Tunnel will contain influent and effluent pipelines. Between Portal 44 and Portal 5, the Central Tunnel will contain a single effluent pipe.)
- The West Tunnel, extending from Portal 5 westward to Portal 19. (The West Tunnel will contain a single effluent pipe.)
- A marine outfall extending westward from Portal 19 and including 5,200 feet of near-shore and offshore 60-inch pipeline and 500 feet of diffuser.
- Various flow control structures and support facilities.

Table 1 illustrates the status of Treatment Plant and Conveyance design during the time this Program Oversight Report (POR) was being prepared (mid-March through mid-May, 2005).

Table 1
Brightwater Project Status of Design Efforts as of POR Preparation
(Mid-March through Mid-May, 2005)

Element	Status	Notes
Treatment Plant (Excluding Mitigation)		
30% Design	Complete	
Final 30% Design Cost Estimate Prepared by URS	Complete	Final 30% Design Cost Estimate incorporates certain value engineering recommendations
60% Design	Complete	Modifications may be made based on internal reviews and additional value engineering
Initial 60% Design Cost Estimate Prepared by URS	Under internal County review	Not available at time of POR development
Initial 60% Design Cost Estimate Prepared by GC/CM (Hoffman Construction)	Under internal County review	Not available at time of POR development

Table 1
Brightwater Project Status of Design Efforts as of POR Preparation
(Mid-March through Mid-May, 2005)

Element	Status	Notes
90% Design	In progress	Not available at time of POR development
Conveyance		
30% Design (All Tunnel Segments Excluding Outfall)	Complete	Outfall design has not progressed beyond Final Environmental Impact Statement stage since it will be delivered as a Design-Build project
East Tunnel – 60% Design	Complete	60% design estimates are not being prepared for conveyance
East Tunnel – 90% Design	Complete	
East Tunnel – 90% Cost Estimate	In progress	
Central Tunnel – 60% Design	In progress	60% design estimates are not being prepared for conveyance
West Tunnel – 60% Design	In progress	60% design estimates are not being prepared for conveyance

It is important to note that our review was focused on a "snapshot" in time, and that work on the Brightwater Project continued to progress while our review was being conducted. Figures 1a and 1b illustrate the anticipated timing of future documents that will provide additional information related to anticipated Project construction costs.

BRIGHTWATER TREATMENT PLANT
TIMING OF CONSTRUCTION COST INFORMATION

R·W BECK

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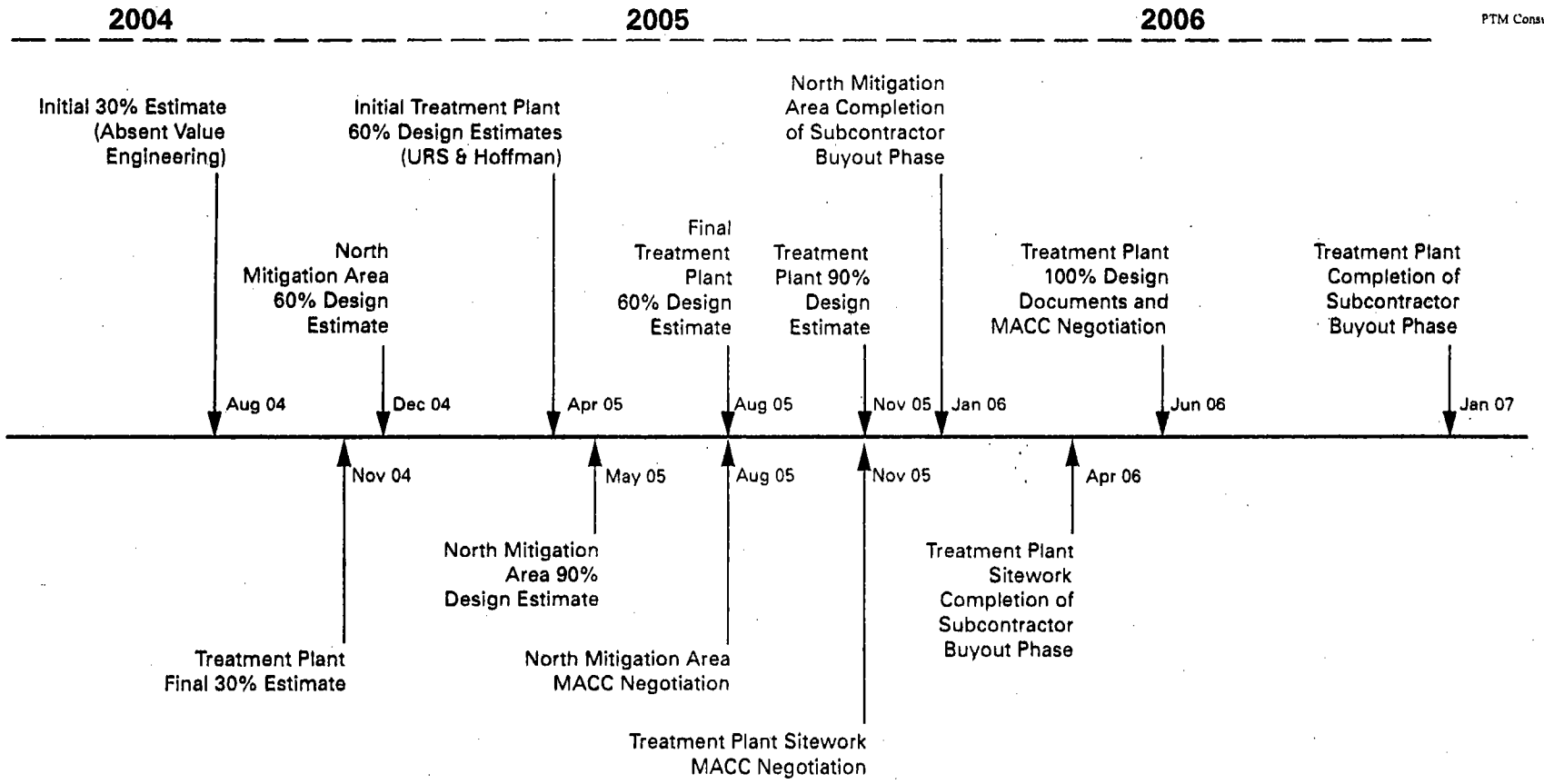

Notes: 1. **Orange** signifies information reviewed for oversight report.

Brightwater Oversight Report

Figure 1a
Brightwater Treatment Plant
Timing of Construction Cost Information

BRIGHTWATER CONVEYANCE
TIMING OF CONSTRUCTION COST INFORMATION

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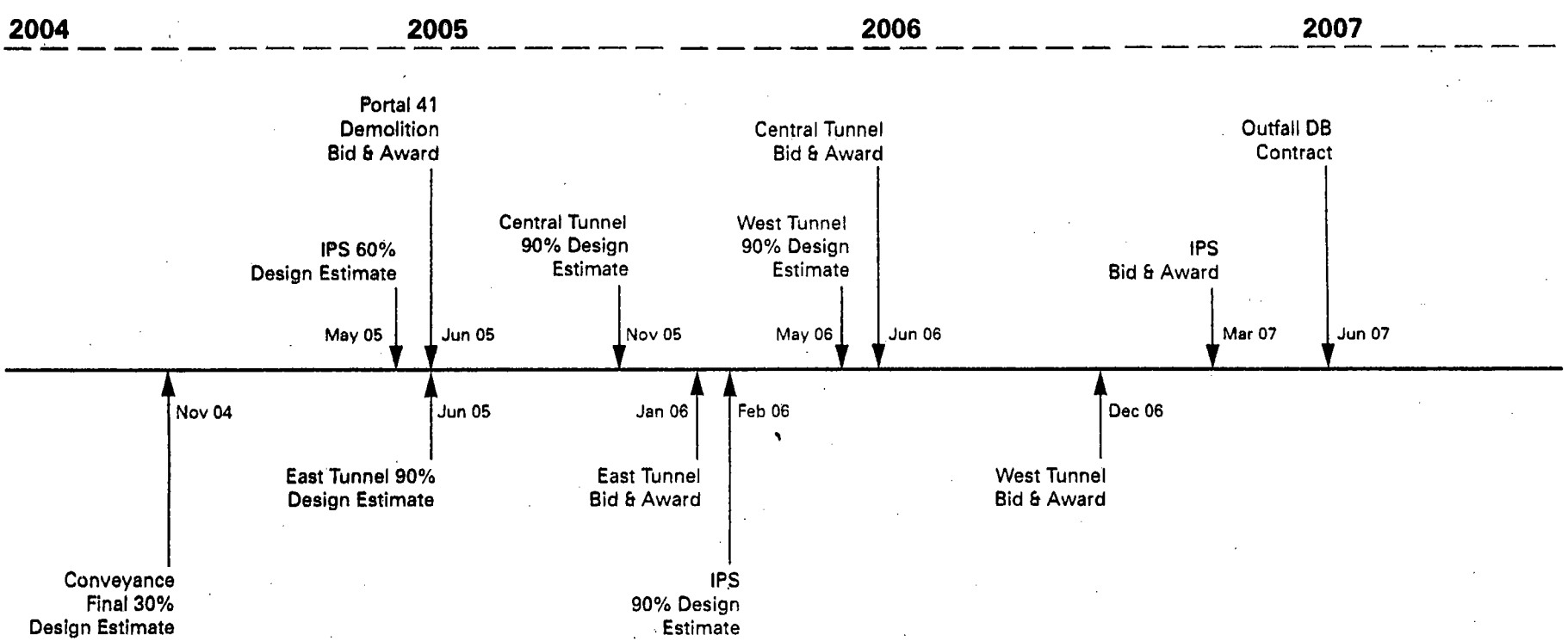
PTM Consulting LLC



Notes:
1. **Orange** signifies information reviewed for oversight report.
2. Some cost information will also result from IPS equipment procurement in June 2008.

Brightwater Oversight Report

Figure 1b
Brightwater Conveyance
Timing of Construction Cost Information

PROGRAM MANAGEMENT ISSUES

Overall Comparison with "Attributes of Well Managed Project"

Table 2 summarizes management aspects of the overall the Brightwater Program relative to a hypothetical, ideally managed major capital improvement project. We categorized aspects of the Brightwater Program as follows:

- Conforms to this practice.
- Generally conforms to this practice – minor improvements may be warranted.
- Partially conforms to this practice – more significant actions or improvements may be warranted.
- Does not conform to this practice.

Overall, we find that the Brightwater Program has implemented or plans to implement many of the programs, policies, and practices that are consistent with the attributes of a well managed, major capital improvement program. Areas of concern include:

- Potential for duplication and unneeded management layers associated with having both a GC/CM and contracted Construction Management firm (given the scope included in the RFP) for the Treatment Plant;
- Change order authority and timely decision making during construction; and
- Need for predetermined workaround strategies associated with major project risks, especially low probability but high consequence risks.

Additional details of our assessment of Brightwater program management issues follow Table 2.

Table 2
Attributes of a Well Managed Project

General Category	Management Practices	Findings
Decision Making and Accountability	Program and project organization formalized and broadly communicated	▪ Brightwater generally conforms to this practice, but lines of reporting and decision making not clearly delineated especially with respect to matrixed staff.
	Roles and responsibilities well defined and broadly communicated	▪ Brightwater generally conforms to this practice; certain roles and responsibilities are well defined and have written descriptions.
	Accountability "chain" well understood and enforced. Who has decision making authority is well established and understood	▪ Brightwater generally conforms to this practice; accountability of Treatment Plant and Conveyance Program Managers, as well as ultimate responsibility of overall Program Manager, are well understood. ▪ Some clarification of designer vs. CM staff accountability during construction may be warranted. For the Treatment Plant, contracted Construction Manager vs. GC/CM responsibilities appear duplicative in some areas.
	Project structure avoids unneeded layers of management and oversight	▪ Brightwater generally conforms to this practice; however, we have concerns related to the contracted Construction Manager for the Treatment Plant given the GC/CM mode of delivery.
	Processes are planned or in place to allow timely decision making during construction	▪ Brightwater partially conforms to this practice. Construction change order authority currently rests with overall Program Manager who can authorize changes provided they do not exceed annual Council-approved budget. However, overall Program Manager is two levels above the staff Construction Management on the organization chart and has responsibilities beyond Brightwater Program. Consider "delegating down" some change authority to Treatment Plant and Conveyance Program Managers and to Construction Management staff.
Communication	Project policies and priorities are well communicated to staff and contractors	▪ Brightwater generally conforms to this practice. Treatment Plant has published project success factors (Document #27, October 2004).
	Formal process exists for communicating changes to staff and contractors	▪ Brightwater partially conforms to this practice. Draft Communications Plan (Document #20, undated) which includes directions related to scope, schedule, and budget changes, has been developed but has gaps and may not be widely distributed (see further discussion of draft plan, below).
	Opportunities exist to informally communicate potential problems to program/project managers	▪ Brightwater generally conforms to this practice; Brightwater technical staff have ample opportunity for informal communication with their consultant staff counterparts. ▪ Emphasis on adherence to budget could create a "no bad news" atmosphere that could stifle informal communication of potential problems.

Table 2
Attributes of a Well Managed Project

General Category	Management Practices	Findings
	Overall communication plan includes internal as well as external (i.e., public communication, issues, and media management) communication	▪ Brightwater partially conforms to this practice. Overall program has draft written Communications Plan for final design phase covering internal (King County) and external (Consultant and Contractor) communications and conflict resolution (Document #20, undated). It is unclear if this has been widely distributed. This document requires updating to complete the following items: External communication guidelines for community communications External communication guidelines for other consultants and contractors External communication guidelines for conflict resolution
	Cost communication to elected officials ▪ Baseline cost estimates ▪ Communication of changes/ deviations	▪ Brightwater is implementing steps that will conform to this practice. A draft standardized Brightwater Monthly Project Report has been developed and generally meets this objective. Budget and schedule changes/deviations for that month are addressed and issues potentially affecting budget or schedule are identified; however, no quantification of the potential impact of identified issues is given.
Quality Assurance/ Quality Control	QA/QC required of all design contractors and budgeted/tracked as a separate cost item	▪ Brightwater generally conforms to this practice.
	Independent QA audit/verification of designers' QA/QC program implementation	▪ Brightwater conforms to this practice.
Scope and Cost Management	Cost-tracking systems in place and consistently applied across contracts	▪ Brightwater conforms to this practice.
	Baseline costs/assumptions/work breakdown structure established	▪ Brightwater conforms to this practice.
	Design contracts include requirements for early notification of owner of: ▪ Events/decisions likely leading to a change in design phase costs and alternative courses of action to mitigate ▪ Events/decisions potentially affecting construction costs and scope and alternative course of action to mitigate	▪ Brightwater generally conforms to this practice.

Table 2
Attributes of a Well Managed Project

General Category	Management Practices	Findings
	Baseline schedules with milestones established	▪ Brightwater conforms to this practice.
Schedule Management	Program in place for regular evaluation of proposed changes and their effects on schedules, especially with respect to milestones	▪ Brightwater conforms to this practice.
	Mitigation measures identified to avoid slippage of milestones	▪ Brightwater has initiated steps to address this practice.
	Schedules updated regularly and communicated to staff and consultants	▪ Brightwater conforms to this practice.
	Program in place for identifying and managing potential risks before they occur, especially for risks borne by the owner	▪ Brightwater conforms to this practice.
Risk and Contingency Management	Risk management considers both probability of an event occurring and magnitude of consequences	▪ Brightwater partially conforms to this practice. Probabilities and consequences are both considered in risk assessment but more attention could be focused on low probability/ high consequence events, and on developing workaround plans.
	Contingency management includes making other project/program changes as needed to make sure entire project is delivered at or below budget	▪ Brightwater conforms to this practice. Extensive efforts are placed on value engineering and modifying project scope to meet budget targets.
		▪

Project Organization, Staffing, and Decision Making

BRIGHTWATER

The overall Brightwater Program is organized into two distinct but coordinated projects: Brightwater Treatment Plant and Brightwater Conveyance. All Brightwater costs are allocated to one or the other of these two projects.

Two separate organization charts (termed "design resource charts") have been developed for each project (see Figures 2a and 2b). As shown in these charts, the Treatment Plant Project and Conveyance Project are each directed by Program Managers who have overall responsibility for the technical, cost, and schedule aspects of their respective programs. The manager of the Major Capital Improvements Section of the Wastewater Treatment Division also serves as overall Program Manager and has overall approval authority for contingency budgets and policy-related issues. The overall Program Manager also has signature authority over all construction change orders and payments.

As illustrated in the organization charts, the Treatment Plant and Conveyance Projects rely on both project staff and matrixed staff resources. Brightwater project staff and matrixed staff are each assigned to a project office in order to facilitate communications.

The Treatment Plant and Conveyance organization charts do not specifically reflect the lines of decision making authority for the Program, and the reporting relationships of matrixed staff to project staff are also not clearly identified in the charts. In interviews, Brightwater staff (Loland, Letourneau) indicated that the Treatment Plant and Conveyance Program Managers had final decision making authority over technical aspects of their programs and over scopes, schedules, and program costs, provided they did not exceed the baseline budgets and schedules established as part of the 30% design process. Supervisors of matrixed staff are not involved in project-level decision making unless the issue would affect policies of their respective groups or departments.

Brightwater staff (Loland, Letourneau) reported that they generally believed staffing levels to be adequate. The Brightwater Program is the major, and often the only, responsibility of matrixed staff, so conflicts over staff resources have not been a major issue. The major staff vacancy at this time is the staff Construction Manager for the Treatment Plant. This position will be advertised in June 2005. This is a critical position especially due to the limited experience of staff with the construction of large, non-conveyance projects. (See the discussion later in this report under "Contracting and Project Delivery" related to Brightwater's plans to hire a contracted Construction Management firm.)

During workshop interviews, Brightwater Treatment Plant and Conveyance Program Managers (Hummel, Sreibers) indicated that the plan is for the current organizational structure to generally continue through construction. The organization charts currently show staff design project managers and staff Construction Managers at the same level of the organization, reporting directly to the Treatment Plant and Conveyance Program Managers. During construction,

technical project management responsibility will remain with the design project managers, but responsibility for construction administration, inspections, and paperwork will be with the Construction Managers.

COMPARABLE PROJECTS

Organization charts for the Jones Island/Cross Town Conveyance and Deer Island Projects are shown in Figures 3 and 4, respectively.

Key differences between the Brightwater organization and the comparable project organizations include:

- Unlike Brightwater, the Jones Island/Cross Town Conveyance and Deer Island Projects were not completely divided into separate Treatment Plant and Conveyance programs. Instead, some program costs and functions remained at the overall program level.
- Both the Jones Island/Cross Town Conveyance and Deer Island Projects were governed by appointed boards with some elected official representation. The projects were the major focus of these appointed boards. (For example, the MWRA Board met 20 times per year to address project changes.)
- The Jones Island/Cross Town Conveyance Project organization included an outside Program Manager (CH2M Hill), which had overall responsibility for the planning, design, construction administration, and startup. Agency staff had responsibility for providing broad oversight and review, resolving conflicts, and documenting of decisions.

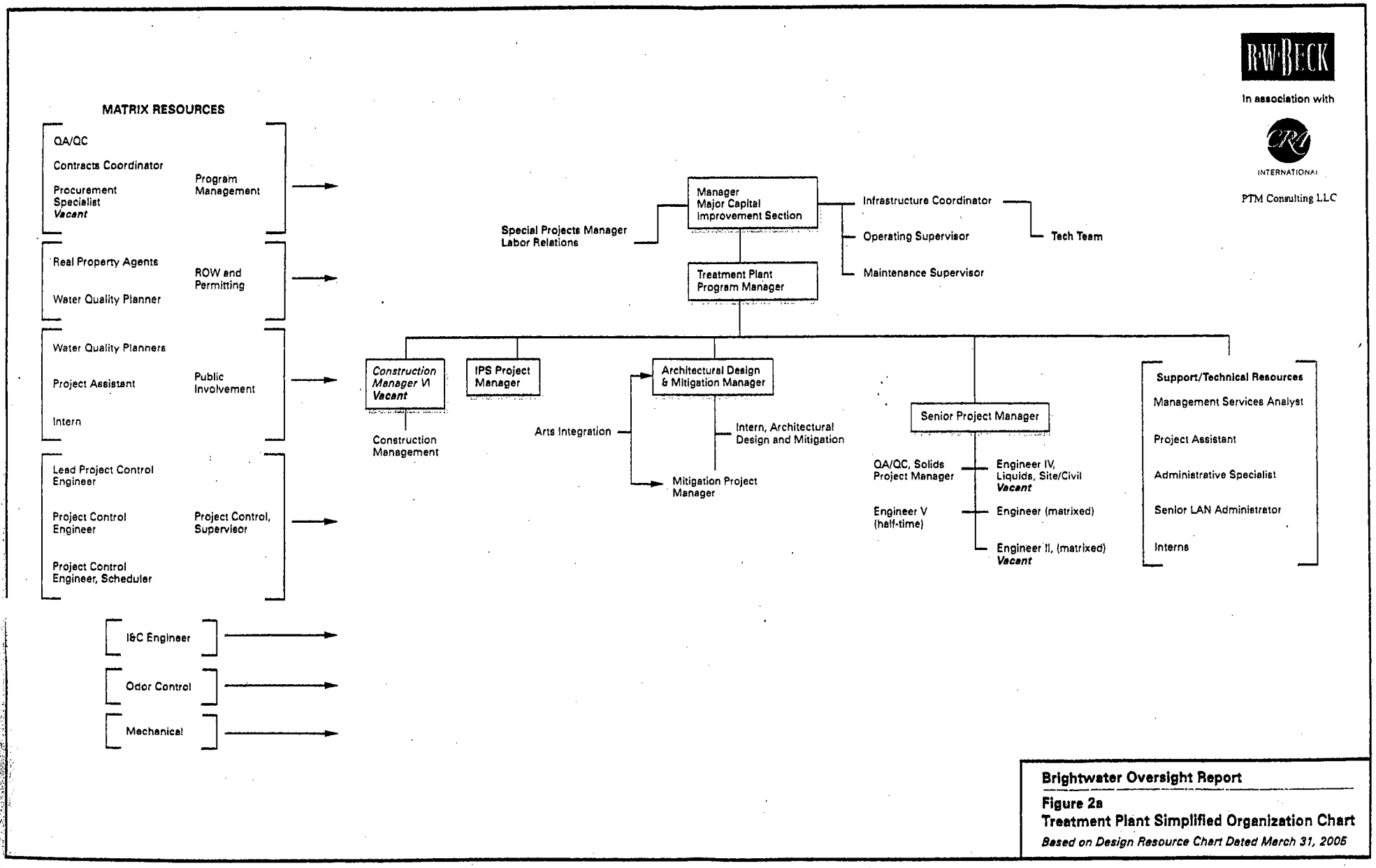


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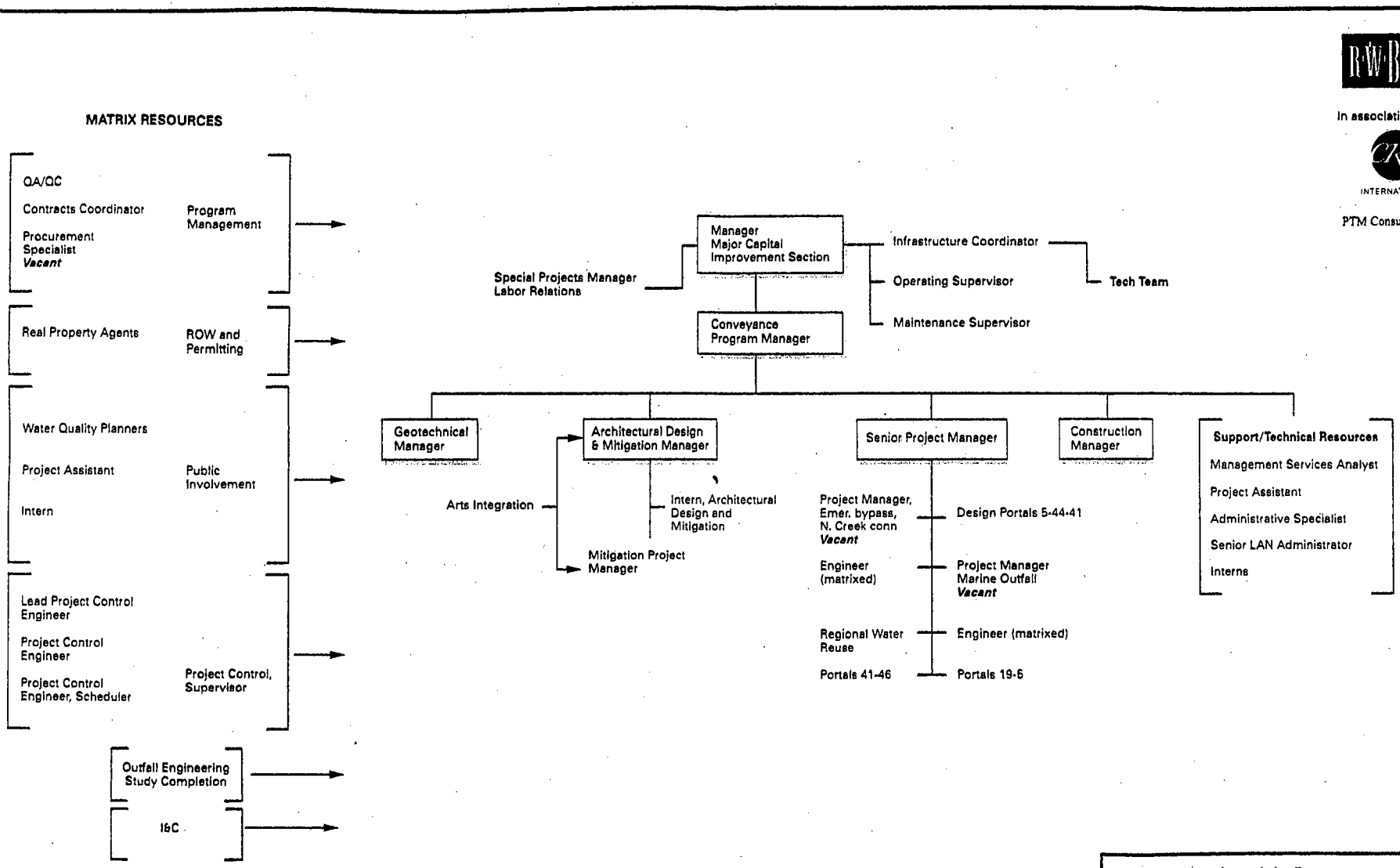
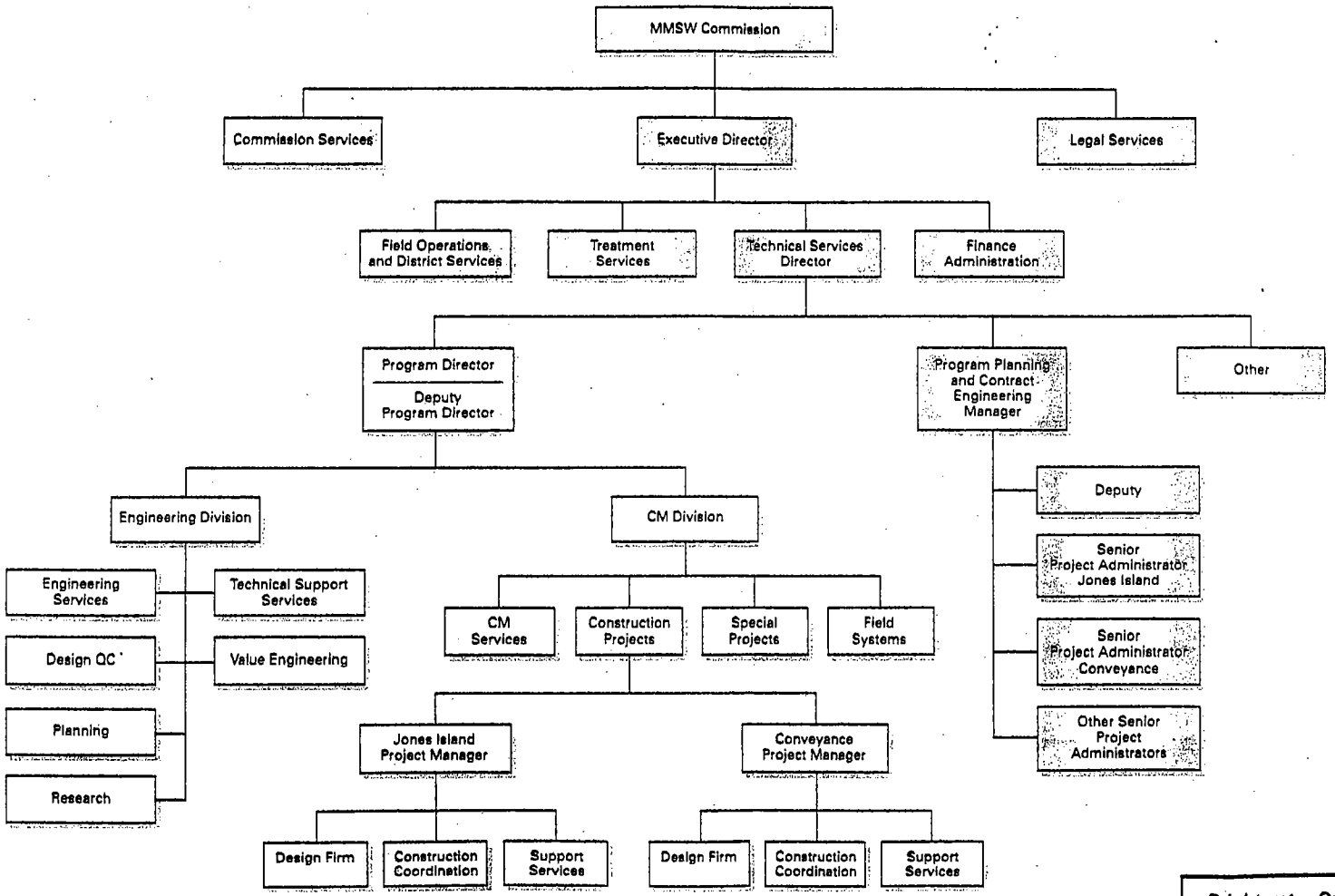
Figure 2a
Treatment Plant Simplified Organization Chart
Based on Design Resource Chart Dated March 31, 2006



Brightwater Oversight Report

Figure 2b
Conveyance Simplified Organization Chart
Based on Design Resource Chart Dated March 31, 2005



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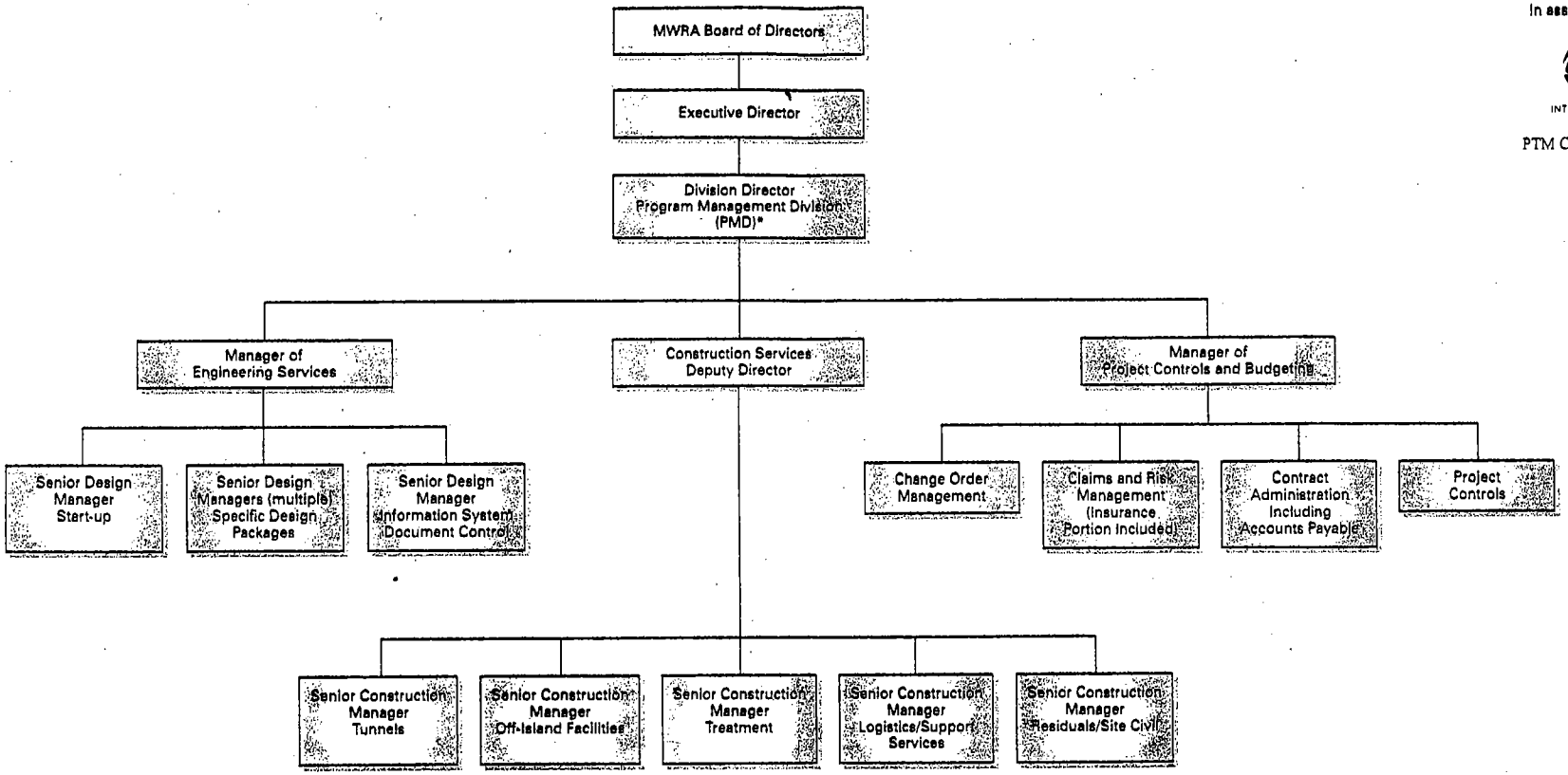
Brightwater Oversight Report

Figure 3
Jones Island/Cross Town Conveyance Project Organization Chart



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* Dedicated Division to Oversee Delivery of Deer Island Project

Brightwater Oversight Report

Figure 4
Massachusetts Water Resource Authority,
Deer Island Wastewater Treatment Project
Organization Chart

The following paragraphs list key success factors and other lessons learned from these comparable projects:

Jones Island/Cross Town Conveyance

- **Key Success Factor:** The contracted Program Manager and the Agency each appointed a specific individual to be responsible for major aspects of the project. Each had defined roles and responsibilities, but they worked in partnership.

- **Key Success Factor:** The contracted Program Manager and the Agency had the capability, resources, and organizational structure that allowed project changes during construction (i.e., design issues and unforeseen conditions) to be addressed quickly, resulting in a significant reduction in claims and disputes. A key aspect was a single point of Agency contact (Resident Contracting Officer) in the field who had delegated authority to approve contract changes of a cumulative value of $400,000 or 10% of the contract bid price, whichever was less. (It should be noted, however, that there were a large number of construction contracts for the Jones Island/Cross Town Conveyance Project [see Table 4, below], and the value of typical construction contracts was smaller than is expected for the Brightwater Program [i.e., Jones Island Project construction contracts typically averaged between $15 and $20 million.]) The Agency also had direct access to cost estimators and schedulers who were able to oversee and check the work of the Program Manager (Zimmerman, Jankowski - MMSD).

- **Lesson Learned:** While both the contracted Program Manager and the Agency attempted to each have a single professional responsible from planning through construction, they found it difficult to find the required range of skills and experience in single individuals. Therefore, the lead professionals were changed when the project transitioned to construction. The lead design managers remained involved through construction, however (Zimmerman).

Deer Island

- **Key Success Factor:** The MWRA was able to hire very experienced staff in key roles because it was able to offer substantially higher compensation to these "limited duration" employees. While this occasionally caused some tension with permanent staff, the MWRA believes this was key to the successful implementation of its project, especially during construction.

- **Key Success Factor:** Maintaining a positive management team to assist, facilitate, and ensure construction contractor compliance resulted in relatively smooth performance during construction. Maintaining involvement by the lead design engineer (consulting firm) with the contracted Construction Manager streamlined many field decisions for the contractors.

- **Key Success Factor:** The MWRA Board delegated construction change authority to the Executive Director via a "delegated authority allowance." The level of change authority

ranged from $250,000 to $400,000, depending on the contract value. If the allowance was expended, the Executive Director could request additional funds from the MWRA Board. In certain circumstances, such as difficult tunneling work, the Board elected to provide greater levels of delegated change authority. The Board was available for emergency sessions in order to support the demands of the project.

- **Lesson Learned:** Any change request over $10,000 required an independent confirmatory Fair Cost Estimate review, which was performed by the contracted Construction Program Manager (ICF Kaiser/Stone & Webster). While the Fair Cost Estimate process ensured reasonable prices for changed work, particularly since the project was highly visible and was subject to several layers of public agency oversight, the necessity to prepare an estimate for requests in excess of $10,000 slowed the change resolution process and at times resulted in expending project management resources in excess of the value of the change request. The process would have been more effective if the limit had been set substantially higher than $10,000.

Contracting and Project Delivery

BRIGHTWATER

The number and form of major engineering and construction contracts for the Brightwater Program are briefly described in Table 3.

Table 3
Brightwater Project Principal Design and Construction Contracts

Contract Type	Firm	Contract Type/Key Contract Provisions
Conveyance		
Lead Designer – Conveyance	MWH/Jacobs Joint Venture	▪ Cost plus fixed fee with not-to-exceed maximum ▪ Scope does not include engineer's cost estimates, which are provided by independent cost estimator (URS)
Designer – Pump Station	Brown & Caldwell under subcontract to CH2M Hill	▪ Design included as part of Treatment Plant[1] ▪ Lump sum ▪ Scope does not include engineer's cost estimates, which are provided by independent cost estimator (URS)
Construction Manager	Jacobs Civil	▪ Cost plus fixed fee with not-to-exceed maximum ▪ Does not include outfall inspection
Tunneling Construction (3 principal contracts)	First contract scheduled for bid July 2005	▪ Traditional public works bidding
Pump Station Construction	Scheduled for bid March 2007	▪ Traditional public works bidding

Table 3
Brightwater Project Principal Design and Construction Contracts

Contract Type	Firm	Contract Type/Key Contract Provisions
Marine Outfall Design and Construction	RFP scheduled to be issued in July 2006	▪ Design-Build project delivery
Geotechnical Services	CDM	▪ Cost plus fixed fee with not-to-exceed maximum
Treatment Plant		
Lead Designer	CH2M Hill	▪ Lump sum contract for design ▪ Cost plus fixed fee with not-to-exceed maximum for ancillary services ▪ Scope does not include engineer's cost estimates, which are provided by independent cost estimator (URS)
Construction – Treatment Plant and Mitigation	Hoffman Construction	▪ General Contractor/Construction Manager project delivery ▪ This is a two-phase contract with Hoffman currently under contract to provide preconstruction services. Preconstruction services contract is cost plus fixed fee ▪ MACC will be negotiated at 90% design
Additional Estimating Support Task Force	CH2M Hill Constructors	▪ Recently added scope to provide additional cost information from constructor perspective
Construction Management Services Firm	RFP issued in May 2005	▪ Staff augmentation ▪ Review 90% cost estimate ▪ Assist in MACC negotiations ▪ Assist in constructability review ▪ Assist in construction planning ▪ Participate in partnering sessions

Note:
1. Influent Pump Station design is now part of the Conveyance Project but was originally part of the Treatment Plant Project because the original location for the pump station was on the Treatment Plant Site. As the design has progressed the location shifted off of the Treatment Plant Site; however, design responsibility remained with CH2M Hill.

Conveyance Contracting. Several issues should be noted with respect to contracting for the Conveyance Project:

- The current plan is to have the IPS foundation work bundled with the East Tunnel contract due to site constraints. However, ongoing constructability review is evaluating the most advantageous division of construction work between the IPS and East Tunnel construction contracts.

- Brightwater Conveyance has elected to segment the tunnel work into three contract packages (West Tunnel, Central Tunnel, and East Tunnel), and to bid the segments at 6-month intervals at a minimum. The intent is to foster more competition and allow for resolution of bid protests, if any.

- Brightwater Conveyance has elected to take or is exploring several measures to both reduce the risk dollars included in contractor bids and reduce the actual risks associated with tunneling. These measures include, for example:
  - Having all geotechnical work conducted by a single lead geotechnical firm (CDM);
  - Including a Geotechnical Baseline Report and a differing site conditions change clause as part of the tunnel construction contracts;
  - Requiring tunnel boring machine (TBM) inspection stops in the East Tunnel every 500 feet due to the risks of mining in abrasive soils;
  - Requiring TBM air locks to access muck chambers and the TBM head where tunnel groundwater pressures are expected to be high;
  - Requiring all TBM data collection to be provided in real time in order to accurately evaluate the performance of the TBM;
  - Specifying maximum leakage rates and minimum aquifer separation distances from Class A water supplies;
  - Specifying the acceptable types and required capabilities of TBMs for each tunnel segment based on expected geotechnical conditions, including requirements for use of a slurry TBM for the Central Tunnel Contract where there are areas of extremely high (up to 7 bars) groundwater pressures. (This type of TBM is currently being used in Portland, Oregon, but does not have other historical use in the United States);
  - Creating a website for potential contractors that provides information helpful to joint venture formation; and
  - Including an escalation clause for specific commodities to limit bidders' exposure to escalation risk.
- Brightwater Conveyance has taken a number of other measures to foster market interest in the tunneling contracts and to assure quality contractors. These measures include, for example:
  - Holding meetings with national and international tunneling contractors to inform them about the project and obtain input;
  - Requiring that the selected tunneling contractors self-perform a minimum of 60% of the work in order to ensure that the general contractor will have the appropriate tunneling expertise; and
  - Requiring that qualifications information, demonstrating a past history on work of similar scope and complexity, be submitted by the low bidder within 3 days of bid opening.

Contract and Project Delivery Innovations. Brightwater managers have also elected to implement a number of innovative contract provisions and project delivery methods for certain elements of the project. These contract provisions and delivery methods offer certain advantages over traditional approaches. However, in some circumstances, these contracting provisions may have unintended consequences that run counter to the long-term interests of the Brightwater Program. For example:

- **Independent Cost Estimating.** Independent construction cost estimates have been developed by URS. (In the case of the Treatment Plant, 60% and 90% estimates are also being developed by Hoffman Construction.) These independent estimates are being developed *instead of* rather than in addition to estimates developed by the lead design firms. Brightwater staff (Loland, Letourneau) report that the aim of the decision to develop independent estimates was partly to assure that the estimates were developed from a contractor's point of view. Nonetheless, this approach may distance the designers from the cost ramifications of their design choices.

  It is also important to note that the independent estimates are not started until a design milestone has been reached (i.e., 30% design) and that the design process is continuing while the independent estimates are being developed. Trend cost estimates are used in between full design milestone cost updates at 60% and 90% to get an idea of potentially significant cost changes.

- **Fixed-Price Provisions of the Treatment Plant Engineering Contract.** Provided that adequate provisions are included to assure adequate QA/QC by the designer, this contracting method provides incentives for the design work to proceed rapidly and efficiently. However, it provides little to no incentive for the designer to slow down the design effort to consider changes or to revise the design concept to cut construction costs. While the fixed-price contract with CH2M Hill includes general language stating that the design should result in a "cost effective" plant, there are no "design to construction budget" requirements.

- **GC/CM Contract for the Treatment Plant.** GC/CM contracting is an alternative to Design-Bid-Build contracting that provides the owner with the ability to select a qualified Construction Manager while receiving the benefits of competitive pricing for direct cost components of work. GC/CM contracting reduces some of the problems inherent in "low bid" contractor selection.

  Typically, GC/CM contracting is done in two phases. In the first, preconstruction phase, the GC/CM provides preconstruction services, typically including cost estimating, constructability reviews, design input, and detailed construction schedule development. The preconstruction services contract with Hoffman includes design and constructability reviews and input into the design process. We believe it would be valuable for Hoffman and CH2M Hill to participate in a collaborative review process to ensure that Hoffman has a detailed understanding of the design intent, especially since, in practice, a typical

area of dispute with the GC/CM during construction is over what is in or can "reasonably be inferred to be in" scope.

Near the end of the first phase, the GC/CM and owner negotiate a Maximum Allowable Construction Cost (MACC) as well as overhead, profit, provisions for use of contingency, and provisions for any incentives or sharing of any cost savings. (Brightwater has elected to negotiate the MACC at 90% design.) The preconstruction services contract with Hoffman includes a task to develop an Incentives Plan. Hoffman's preconstruction services contract also includes a draft form of the construction contract, which includes provisions for return of the unused portion of funds in the buyout contingency to the County via a deductive change order without markup or assessment of the GC/CM's fee.

During construction, the GC/CM acts as the General Contractor and competitively bids out work packages. The GC/CM may self-perform up to 30% of the work (RCW 39.10) but to do so must participate in the competitive bidding process. However, the extent to which the requirements to bid out work packages actually results in competition may vary for a variety of reasons. In addition to acting as the General Contractor, the GC/CM is typically responsible for providing much of the Construction Management and oversight typically provided by the owner.

Contracted Construction Management Firms. Brightwater Conveyance has negotiated a contract for a Construction Manager with Jacobs Civil. For the Treatment Plant, Brightwater is planning on hiring a separate Construction Management firm in addition to the GC/CM. An RFP has been issued for the Treatment Plant Construction Management firm. The RFP includes a discussion of the role of County staff, the lead design firm, the GC/CM, and the contracted Construction Manager during construction. However, in our opinion, the potential remains for overlapping responsibility, unclear lines of decision making, and unnecessary duplication of effort.

New General Conditions. Brightwater Project construction contracts will incorporate new Standard General Conditions currently under development by King County. Brightwater staff reported that they have not yet been provided a draft of the Standard General Conditions for review, but expect to have such a draft by the end of June 2005. Brightwater staff also stated that the revised Standard General Conditions will not affect, to any significant degree, the ongoing work in preparing technical specifications and drawing bid documents (Locke).

In addition to the Standard General Conditions, Brightwater Project staff expect that the Brightwater construction contracts will also include:

- Provisions for a dispute resolution board;
- An owner-controlled insurance program;
- A project labor agreement; and
- Escalation provisions for cement, steel, pipe, and possibly other commodities.

COMPARABLE PROJECTS

On the Jones Island/Cross Town Conveyance Project, all design work was under the direction of the contracted program manager (CH2M Hill); both the program management contract and design contracts were on a cost plus fixed fee basis.

For Deer Island, the MWRA retained a lead design engineer (Metcalf & Eddy), which was principally responsible for the design of the facility and interrelationships with other independently retained specialty engineering firms. The lead design engineer's contract was on a cost plus fixed fee basis. The MWRA also contracted an outside Construction Program Manager (ICF Kaiser/Stone & Webster), which was hired to serve as an agent on behalf of the MWRA. The contracted Construction Manager's contract was on a cost plus fixed fee basis. The Construction Manager also had the opportunity to earn an incentive to its minimum fee. Although the Construction Manager maintained field control during the course of construction, the lead designer participated on a regular basis during construction.

The Jones Island and Deer Island Projects used conventional public works contracting (Design-Bid-Build), and did not use alternative project delivery methods. These projects also had a substantially greater number of prime construction contracts than Brightwater, as shown in Table 4.

Table 4
Brightwater and Comparable Projects – Number of Construction Contract Packages

	Brightwater	Jones Island	Deer Island
Treatment	2 (treatment and mitigation)	89 including equipment pre-purchases	49 (several contracts are subsequent [e.g., phase II] contracts of a main contract)
Conveyance	5 principal construction contracts (Conveyance East, IPS, Conveyance Central, Conveyance West, Outfall) Plus other minor contracts	15 (3 tunnel and 1 odor control, 5 shafts, 1 emergency overflow structure, 1 pump station, 1 solids handling facility, 4 equipment)	6 (2 principal construction contracts, 1 diffuser contract, 2 tunnel muck processing contracts, and 1 startup contract)

The following paragraphs list key success factors and other lessons learned from these comparable projects. In addition to considering contracting issues on the Jones Island/Cross Town Conveyance Project and Deer Island Project, we also considered experience with other GC/CM projects in the Puget Sound region.

Jones Island/Cross Town Conveyance

- **Key Success Factor:** Specifying the capabilities of the TBM, rather than leaving it up to the tunneling construction contractor, was critical and ensured that capabilities for advanced grouting, water control, boulder removal, and subsidence control were in place.

(Brightwater Conveyance is planning on specifying the TBM requirements and capabilities) (Mauer - MMSD).

- **Key Success Factor:** Extra effort in planning for contractor work areas and interfaces on-site at Jones Island, where there were 89 contractors, paid off in few conflicts between contractors and only one claim (Zimmerman).

Deer Island

- **Key Success Factor:** The MWRA was able to efficiently furnish certain services (temporary facilities, site cleanup and trash collection, site access, and worker transport), which helped contractors focus on the major elements of work. This was effective for Deer Island because of the relatively large number of contracts and the constraints of an island location.

- **Lesson Learned:** Expected TBM advance rates for the construction of the marine outfall tunnel were not achieved because the contractor encountered problems with water infiltration and "hard" rock. This resulted in disputes with the contractor. This situation would have been mitigated if very clear and specific protocols for measuring and/or determining varying site conditions had been included in the construction contracts and Geotechnical Baseline Reports.

- **Lesson Learned:** The tunnel contracts did not include provisions for pre-approved costs for TBM and associated equipment downtime or for implementing specific intervention plans. MWRA representatives believe these types of provisions would have been beneficial.

Other GC/CM Projects

Based on experience with some recent GC/CM projects in the Puget Sound region, it appears that subcontractor bid packages at times may not be generating as much interest in the marketplace as anticipated. This could be due to a number of factors including: 1) the state of the current construction market in the Puget Sound area; 2) the suitability of bid packages for subcontractors in the area; and 3) the nature of highly specialized items in some bid packages. This may also be due in part to lack of familiarity with the GC/CM process by the subcontractor community.

Schedule Status and Management

BRIGHTWATER

Baseline design/construction schedules have been developed for both the Treatment Plant and Conveyance Projects. These show major milestones during design. Construction activities are shown at a fairly high level. Overall, these can be described as Level 1 schedules showing the interrelationship between the major components of work and the anticipated start and finish

date. (In contrast, a Level 3 schedule would be at the level of detail typically developed by a contractor to manage actual construction work.)

Schedule development is the responsibility of the design project managers working under the Treatment Plant and Conveyance Program Managers, who are ultimately responsible for compliance with the baseline schedules. Project Controls staff provide support by maintaining critical path schedule data and consulting with Program Managers and design project managers.

Progress toward achieving the baseline schedules is updated monthly. To date, Brightwater staff report that major design milestones have been met (Letourneau).

The following issues should be noted with respect to Brightwater schedules:

- The Conveyance construction schedule is based on 50-foot-per-day tunnel production during times when active mining is occurring (i.e., downtimes for inspection and maintenance have been accounted for separately). We believe this is a reasonable assumption for most of the tunnel. Nonetheless, it should be noted that various unforeseen conditions could result in a lower production rate, especially in those portions of the Central Tunnel where high water pressures will be encountered.

- Brightwater staff (Locke, Sreibers) report that the Conveyance Project is conducting a probabilistic assessment of the likelihood of meeting the conveyance construction schedule. Initial findings indicate that the baseline schedule is very aggressive; however, it includes fairly conservative assumptions about the number of shifts worked. Additional analysis is needed to determine the cost tradeoffs between additional shift work and revising the program schedule.

- While the Treatment Plant and Conveyance can largely be treated as independent projects, integration at key points in the design and construction process is critical. The clearest example is the need for raw wastewater to be delivered (i.e., completion of certain tunnel segments and the influent pump station) when the Treatment Plant achieves substantial completion so that various unit processes and systems (i.e., MBRs and odor control) can be tested and accepted. Delays in the ability to deliver wastewater to the Treatment Plant could have serious impacts on the warranties for these systems.

- Brightwater staff report that they are in the process of developing more detailed Integrated Schedules showing the key interfaces between the Treatment Plant and Conveyance Projects. In addition, lists have been developed that identify inter-contract coordination issues between the Treatment Plant and various Conveyance construction contract packages.

COMPARABLE PROJECTS

Schedule related issues for the two comparable projects are summarized below:

Jones Island/Cross Town Conveyance

Baseline schedules were established during court-ordered deliberations (prior to facility plan development). These schedules were updated annually based on actual scheduled activities and the availability of funds. Design-phase scheduling was the responsibility of the contracted Program Management Office, which was required by its contract with the Agency to deliver designs and construction specifications to meet the milestones established in the court schedule.

Design-phase scheduling was reviewed on a monthly basis by a joint team of managers from the Program Management Office and the Agency. Schedule issues were tracked and workaround plans were developed and monitored for effectiveness. Nonetheless, the project did not remain on schedule throughout design. There were three major reasons for the schedule delays: 1) the unit process to treat and manage biosolids changed at the 30% design stage; 2) property acquisition from Milwaukee County took two years to resolve; and 3) about four years into implementation, the entire Water Pollution Abatement Program was rescheduled to ensure that a specific tax levy was not exceeded during the life of the program. Together, these added about eight years to the schedule.

Deer Island

In 1985, as a result of violations of the 1972 Federal Clean Water Act, the Deer Island Project was subject to a court-mandated schedule. A more detailed baseline schedule for the achievement of program milestones was included in the 1988 Secondary Treatment Facilities Plan.

The Construction Program Manager developed a detailed program-wide schedule incorporating both the completion of various design packages and construction phases. This effort was useful in incorporating constructability elements into the contract packages prior to bid. The project remained on schedule throughout design. However, the project did not achieve several court-mandated milestones due to delays in the construction of the effluent marine outfall tunnel.

Key success factors and other lessons learned from the two comparable projects with respect to scheduling and schedule management include:

Jones Island/Cross Town Conveyance

- **Key Success Factor:** An Issues Management approach, coupled with adequate design resources and commitments to rapid resolution of issues, helped many aspects of the project meet the scheduled design and construction milestones (after the major program schedule change to address tax levy issues) (Zimmerman).

- **Lesson Learned:** The costs of program rescheduling were greater than anticipated at the time rescheduling of the overall Water Pollution Control Abatement Program occurred because commodity and labor cost escalation proved to be higher than anticipated (Zimmerman).

Deer Island

- **Key Success Factor:** The detailed program schedule provided two benefits:
  - It allowed the design packages to be prepared with the appropriate review times.
  - It allowed anticipated bid dates to be publicized early in order to secure strong competition.
- **Lesson Learned:** Tight schedules between contract packages, which were mandated by the court, increased project costs. If it had been possible, the project would have benefited from longer lead times between bid packages.
- **Lesson Learned:** During construction, the MWRA did not render decisions on delay-related impacts in a timely manner. The MWRA encouraged construction contractors to proceed with the work, with the MWRA's determination for schedule extension reserved until schedule recovery options were explored. Occasionally, the contract time expired, resulting in the inability of the MWRA to make progress payments. As a result, the MWRA was forced to grant time extensions in order allow progress payments to be made. This in effect waived liquidated damages opportunities and resulted in claims from contractors for constructive acceleration.

QA/QC Including Peer Review, Constructability Reviews, and Value Engineering

BRIGHTWATER

Brightwater has implemented a multilayered QA/QC program consisting of:

- **Standards and Consistency.** The Wastewater Treatment Division has established engineering standards (guide specs) to help ensure that high quality designs are provided for all projects. Conforming to these guide spec requirements is a requirement in the Brightwater Treatment Plant and Conveyance design contracts.
- **Brightwater Staff Reviews.** These reviews are occurring at the 30%, 60%, and 90% design phases and include input from operations and maintenance staff in addition to Brightwater staff.
- **Designers' QA/QC Programs.** Both the Treatment Plant and Conveyance Projects require that their design consultants have formal QA/QC programs. For example, the Conveyance Project designer had a 1-month QC review prior to submitting the 30% design. Implementation of these QA/QC programs can be audited. For example, the Brightwater Treatment Plant designer's QC program was audited at the designer's office by Brightwater Treatment Plant Project staff. The audit identified several areas in which improvements were required.

- **Peer Review and Review by Technical Advisory Panels – Treatment Plant.** For example, in June 2005, the Treatment Plant Project is having an Independent Odor Panel review and evaluate the proposed odor control systems and comment on the advisability of establishing an odor control reserve fund. A technology selection panel also provided input on the selection of MBRs (Letourneau).

- **Peer Review and Review by Technical Advisory Panels – Conveyance.** The Conveyance Project has instituted a Tunnel Review Board and recently had the design of the East Tunnel, Portal 41, and the Influent Pump Station undergo an independent peer review.

- **Constructability Review – Treatment Plant.** A constructability review is included in the scope of the GC/CM's preconstruction services contract. The constructability review is occurring between 60% and 90% design. In addition, a meeting was held involving County staff, CH2M Hill, URS, and Hoffman to identify potential construction changes/suggestions. These are currently being evaluated and priced by URS and Hoffman.

- **Constructability Review – Conveyance.** An independent constructability review was conducted of the East Tunnel, Portal 41, and the Influent Pump Station. This review resulted in recommendations for changes to work packaging in order to minimize site constraints. These recommendations are currently under consideration by Brightwater staff.

- **Value Engineering – Treatment Plant.** Treatment Plant value engineering efforts have occurred following the Final Environmental Impact Statement (FEIS) cost estimates and initial 30% design estimates, and are now occurring as part of the review of initial 60% design estimates. Major changes to the Treatment Plant design concept that resulted from the value engineering efforts at the FEIS and 30% design stages include:

  - The facility layout was compressed from the original "campus style" layout, reducing the need for access roadways and landscaping and resulting in a more efficient facility to operate.

  - The size of the MBR treatment system was reduced.

  - Peak flow treatment using a ballasted sedimentation process was changed to an advanced chemical primary process. (Pilot testing has confirmed that this concept will work but Facility Plan approval has not yet been obtained from the Washington State Department of Ecology.)

  As part of the initial 60% design estimate review, both the design consultant and Brightwater staff have been tasked to identify potential scope reduction items.

- **Value Engineering – Conveyance.** Conveyance value engineering also occurred following the FEIS and 30% cost estimates. (60% estimates are not being developed for Conveyance. Instead, cost trends associated with design changes are being tracked.)

Major changes to the Conveyance design concept that resulted from the value engineering efforts at the FEIS and 30% design stages include:

- The IPS was relocated to Portal 41, which also reduced the tunnel depth from about 300 feet at the pump station to about 80 feet at the pump station.
- The safety relief overflow to Lake Washington was eliminated.
- Tunnel segments from Swamp Creek to Portal 44 were eliminated.

COMPARABLE PROJECTS

QA/QC and related program requirements for the Jones Island and Deer Island Projects are summarized below:

Jones Island/Cross Town Conveyance

- **Standards and Consistency.** The contracted Program Manager developed standardized specifications and plan sheet formats to reduce bidding errors.
- **Designers' QA/QC.** QA/QC plans were required of design consultants. The contracted Program Manager provided overall QA for each design deliverable. Pilot testing was required for all major unit processes.
- **Staff Reviews.** 30% and 60% designs were reviewed by Agency staff.
- **Constructability Reviews.** The contracted Program Manager required an independent constructability review by outside construction professionals.
- **Peer Review and Review by Technical Advisory Panels.** The Agency established an independent Tunnel Review Board.
- **Value Engineering.** The contracted Program Manager required that all projects with budgets greater than $5 million had a value engineering review.

Deer Island

- **Designers' QA/QC:** Each design firm involved was responsible for following a written QC plan, which they were responsible for developing.
- **Staff Reviews.** The MWRA's senior design managers were responsible for quality assurance. QA reviews were conducted on both regular and spot-check basis and evaluated whether: 1) the correct standards were being utilized; 2) design checks were in place; and 3) QC documentation was completed.
- **Constructability Review.** ICF Kaiser/Stone & Webster provided constructability reviews during design development.

- **Value Engineering.** An early pilot plant constructed on-site assisted in determining that one train of secondary treatment clarifiers and correspondingly a set of egg-shaped digesters did not need to be constructed at that time. The MWRA implemented approximately 20% of the value engineering recommendations presented, which saved about $240 million.

Risk and Change Management

BRIGHTWATER

The Treatment Plant and Conveyance Projects keep formal issues/decision logs to track design and risk issues as they arise. In addition, a formal risk assessment has been conducted for Brightwater. This assessment was most recently updated in March 2005.

In addition to this risk assessment, the Conveyance Project is conducting a probabilistic assessment of the likelihood of meeting its baseline schedule; similar assessments of the Conveyance budget and of the Treatment Plant budget and schedule have not been conducted.

Based on this risk assessment and input from County staff, it should be noted that:

- The change from peak flow treatment using a proprietary ballasted sedimentation process to a non-proprietary advanced primary treatment process also results in the loss of a performance guarantee for the process. However, the technology for the proposed advanced primary treatment is well established, and we believe the savings are being achieved without a substantial increase in Treatment Plant performance risk;
- Property acquisition does not appear to be a significant risk factor at this time;
- Building code and siting issues with Snohomish County could both directly and indirectly affect project costs by adding additional project requirements and by delaying the project schedule;
- High groundwater pressures are expected in certain portions of the Central Tunnel, where a TBM with very limited use in the United States will be used;
- Unforeseen conditions in the tunnels, such as large boulders, are not incorporated into the cost estimates and could be a significant risk factor; and
- Schedule delays once construction begins, a significant risk factor, especially for the Conveyance Program where the per-day costs of tunneling delay will be very high, and where Conveyance construction delay might have impacts on the Treatment Plant.

COMPARABLE PROJECTS

Risk and change management practices for the two comparable projects are described below.

Jones Island/Cross Town Conveyance

The Agency did not have a formal risk management program. However, senior management from the Agency and the contracted Program Manager met on a monthly basis to monitor performance against approved budgets and schedules. Detailed lists of issues and recommended mitigative actions were maintained and reviewed at these monthly meetings to ensure issue resolution.

During the Design phase of the project, the contracted Program Manager required a detailed project delivery analysis (PDA) and a constructability review. The contracted Program Manager's engineering division was directly involved in these efforts and used them to identify threats and opportunities that required either project- or program-level action. These efforts led to the development of program-wide concepts such as: "Differing Site Conditions Procedures," "Property Subsidence Mitigation Program," "Consultant Review Committee," and "Executive Director Appeal," which reduced the potential for claims, lawsuits, and negative public opinion (Former Executive Director of MMSD).

Deer Island

Outside of insurance-related issues, the Deer Island Project did not incorporate a formal risk management assessment for risks that could affect project costs or schedule (for example, unforeseen subsurface conditions along tunnel routes). However, risk assessments and response protocols were developed for life safety issues, such as tunnel evacuation, confined spaces, and coordination with emergency response agencies.

Key Performance Indicators

BRIGHTWATER

King County's Wastewater Treatment Division has division-wide goals of being the best public wastewater provider by 2005 and being competitive with private providers by 2010. A measurement technique called a Balanced Scorecard has been developed, which measures performance in four areas: People Management, Key Internal Processes, Financial Performance, and Customer Focus. The Balanced Scorecard for 2005 incorporates key performance indicators across the four areas. Those that will be helpful in tracking performance of the Brightwater Program are summarized in Table 5.

Table 5
Key Balanced Scorecard Performance Indicators

Balanced Scorecard	Area of Performance	Measured Performance Indicator
People Management	Safety	▪ Lost time accidents do not exceed WTD standard ▪ Employee satisfaction with workplace safety measured by survey
Key Internal Processes	Project Performance	▪ Project Approvals: regulatory and tribal approvals obtained no later than milestones established in baseline schedules ▪ Schedule performance: project milestones achieved in accordance with baseline project schedules
Financial Performance	Cash Flow	▪ Annual accomplishment rate meets or exceeds 85%
	Claims/Change Orders	▪ Less than 10% of constructed value
	Allied Costs	▪ Targets not yet in place
	Bid Estimates	▪ 100% of bids within 10% of engineer's estimate
	Conformance to Budget	▪ Target is 100%
Customer Focus	Neighbors and Stakeholder Satisfaction	▪ Public and community involvement plans in place concurrent with project activities

COMPARABLE PROJECTS

Key performance indicators that were monitored for the comparable projects are described below.

Jones Island/Cross Town Conveyance

The Agency tracked and measured four key performance indicators:

- Progress toward meeting the court-ordered schedule;
- Meeting NPDES permit requirements during construction;
- Ensuring the project was capturing all possible state and federal grants; and
- Ensuring the project's cash flow requirements did not exceed the approved tax levy stated in the approved financing plan.

Deer Island

The performance metrics tracked and measured by the MWRA included:

- Progress toward meeting court-ordered milestones;

- Progress toward meeting design package release dates for bids; and
- Progress completion on construction packages.

The MWRA provided an incentive fee arrangement for the Construction Management firm but did not provide fee incentives for the majority of the design firms. Additionally, no formal or systematic salary incentives were provided to MWRA staff.

In addition, the MWRA created a "Yellow Notebook" to track and monitor performance across the various departments within the MWRA. The metrics included operational performance, construction performance, management performance, and a variety of other human resource indicators (e.g., sick leave, attrition).

Project Reporting Frequency and Format

BRIGHTWATER

Brightwater has developed a draft monthly report to Council. The monthly report is divided into three sections: Project Summary, Conveyance, and Treatment Plant. Important components of each section of the monthly report are as follows:

- Monthly highlights and current activities.
- Project issues and exceptions that look ahead and show upcoming activities.
- Schedules that show target dates and progress to date for project activities.
- A Cost Summary that shows baseline cost, annual expenditures, and budget; and lifetime expenditures and budget.
- Cash flow that shows planned vs. actual expenditures for current year and project lifetime. (This information can correlate schedule adherence through expenditure rates.)
- Staff labor showing project lifetime use for a variety of staff categories.
- Miscellaneous and labor costs.
- Inflation trends.
- A detailed cost report for the Treatment Plant and Conveyance Projects.

COMPARABLE PROJECTS

Jones Island/Cross Town Conveyance

The contracted Program Manager supported monthly reporting to the Board by the Executive Director. The Executive Director's report focused on the status of the overall program (not individual projects) and conformance to the overall cost and schedule plan. Upcoming issues

requiring Board review and approval were also highlighted. When major problems were encountered that had the potential to receive wide media coverage, the Board was immediately informed by special written communication (i.e., tunnel cave-in with worker fatality) and special Commission briefings were held (Former Executive Director of MMSD).

Deer Island

The MWRA Board, which was dedicated to water/wastewater utility issues, met 20 times per year to review staff summaries (typically less than 10 pages), which included performance and change management issues, and the review and status of the delegated authority granted to the Executive Director.

Basis for Overall Budget Proposal

The budget proposal submitted to the County Council (February 2005) was largely based on the 30% design cost estimate prepared by URS (November 2004) and on detailed Allied Cost estimates prepared by the Brightwater Program. To arrive at the final 30% design cost estimate, a number of cost savings ideas and value engineering proposals were evaluated. While the Brightwater estimate developed by URS and the Brightwater proposal presented to the Council (without inflation) both totaled $1.48 billion, the totals were arrived at in a somewhat different manner. Table 6 illustrates where the differences are between the Brightwater Program budget proposal and the URS 30% estimate.

Our review of the 30% estimate focused on information contained in the February 2005 budget memo to the County Council as well as on the URS estimates (November 2004), which generally provided budget and cost information at a summary level.

30% Construction Costs

Table 7 summarizes the final 30% design, estimated construction costs developed by URS. These incorporated contract cost savings and value engineering ideas approved by the Brightwater Program. These estimates do not include sales tax, contingencies, construction mitigation, or Allied Costs. Cost information is summarized by facility. URS estimates were stated as being +20% to –15% accuracy. This is generally in line with guidelines published by the American Association of Cost Engineers, which state that at 30%–40% design, estimates are expected to have an accuracy of +20% to –10%. URS estimates were also based on 25.2% assumed markups for contractor overheads and profits. We believe these are generally in line with industry expectations.

Table 7 also sets forth information provided by URS on the degree to which each line item estimate was based on allowances rather than on drawings, quantity takeoffs, and unit costs. Allowances were used at the 30% design phase where detailed information had not been developed.

Table 6
Construction Cost Comparison

	URS 30% Estimate ($millions)	King County Budget Proposal ($millions)
TREATMENT PLANT		
Construction	$259.4	$259.5
Construction Mitigation		$28.4
Contingency	$51.9	$26.1
Subtotal 1	**$311.3**	**$314.0**
Sales Tax	$21.8	$21.8
Other		
Subtotal 2	**$333.1**	**$335.8**
Allied Costs	$89.1	$125.2
Engineering		$73.4
Permitting and Other Agency Support		$23.3
Miscellaneous Services		$4.5
Staff Labor		$24.0
Land, ROW		$101.4
Arts Allowance	$4.3	
Subtotal 3	**$426.5**	**$562.4**
Project Contingency		$25.9
Credit		($10.0)
Total Treatment	**$426.5**	**$578.3**
CONVEYANCE		
Construction	$511.9	$511.5
Construction Mitigation		$4.2
Contingency	$128.0	$51.1
Subtotal 1	**$639.9**	**$566.8**
Sales Tax	$57.0	$50.4
Other		
Subtotal 2	**$696.9**	**$617.2**
Allied Costs	$172.8	$192.6
Engineering		$138.3
Permitting and Other Agency Support		$21.1
Miscellaneous Services		$4.6
Staff Labor		$28.6
Land, ROW		$20.8
Arts Allowance	$0.1	
Subtotal 3	**$869.8**	**$830.6**
Project Contingency		$74.2
Credit		
Total Conveyance	**$869.8**	**$904.8**
Total Construction Cost	**$1,296.3**	**$1,483.1**
Land, ROW	$98.9	
Mitigation	$88.0	
Program Total (2004 Dollars)	**$1,483.2**	**$1,483.1**

Table 7
Use of Allowances
Including URS 30% Design Construction Cost Estimates

		30% Design Estimate (from URS) (2004$ in millions)	Estimate of Allowances in 30% Estimate (from URS)	$ from Allowances ($millions)	% of Total From Allowances
TREATMENT PLANT Construction Costs	**Process Units**				
	1. Headworks and Truck Loadout Building	$12.5	50%	$6.2	
	2. Grit Removal	$9.9	50%	$5.0	
	3. Primary Clarification	$14.5	45%	$6.5	
	4. Ballasted Sedimentation	$0.0	45%	$0.0	
	5. Sedimentation Support Building	$2.3	45%	$1.0	
	6. Fine Screen	$3.9	50%	$1.9	
	7. Aeration Basin	$33.8	50%	$16.9	
	8. MBR	$47.0	55%	$25.8	
	9. Solids Building	$23.2	43%	$10.0	
	10. Digester Complex (Building and Digesters)	$20.6	60%	$12.3	
	11. Water Reuse Disinfection / Reclaimed Water Building	$0.0	60%	$0.0	
	12. Blending Box/Disinfection	$0.1	20%	$0.0	
	13. Odor Control	$32.1	50%	$16.1	
	14. Chemical Building	$1.8	40%	$0.7	
	15. Storage/StockPot Reuse	$3.7	100%	$3.7	
	16. Energy Recovery (Cogen)/Emergency Power	$12.6	70%	$8.8	
	17. Electrical Substation	$0.0		$0.0	
	18. Gallery / Influent Flow Vault	$5.6	30%	$1.7	
	19. General VE Items	($1.3)	100%	-$1.3	
	Process Units Subtotal	$222.3		$115.5	
	Site Prep				
	20. Base Hazardous Material Removal	$0.4	100%	$0.4	
	21. Site Demolition and Prep (Includes Dewatering)	$3.8	50%	$1.9	
	22. Mass Site Excavation	$8.6	100%	$8.6	
	23. Base Backfill	$9.2	100%	$9.2	
	24. Retaining Walls & Slope Stabilization	$0.0	45%	$0.0	
	25. Permit Stormwater Management	$1.6	40%	$0.6	
	26. Site Improvements, Underdrains, Yard Piping	$3.8	60%	$2.3	
	27. Yard Piping	$8.5	70%	$5.9	
	Site Prep Subtotal	$35.9		$29.0	
	Buildings				
	28. Administration/Maintenance Building	$0.5	85%	$0.4	
	29. Administration/Maintenance Building FF&E	$0.8	100%	$0.8	
	Buildings Subtotal	$1.3		$1.2	
	Treatment Plant Construction Costs Total	$259.4		$145.7	56%
CONVEYANCE Construction Packages	**EAST CONTRACT - Combined Tunnel (Portal 41 to 46)**				
	Portal 41	$8.9	40%	$3.6	
	IPS Shaft	$12.8	40%	$5.1	
	Portal 46	$3.2	50%	$1.6	
	TBM (41 to 46)	$7.5	100%	$7.5	
	Tunneling and Initial Liner Second Pass Liner/Pipes	$84.0	40%	$33.6	
	Portal 46 Below Grade Facilities	$1.0	50%	$0.5	
	Microtunnel			$0.0	
	North Creek Microtunnel North Creek Connector Facilities	$10.3	50%	$5.2	
	East Contract Subtotal	$127.7		$57.0	
	CENTRAL CONTRACT **Influent Effluent Tunnel (Portal 44I to 41, Portal 44E to 41, Portal 44E to 5)**				
	Portal 44I	$3.3	30%	$1.0	
	TBM (44I to 41)	$6.6	100%	$6.6	
	Tunneling and Initial Liner (44I to 41)	$35.7	40%	$14.3	
	Second Pass Liner (44I to 41)	$19.0	40%	$7.6	
	Portal 44I Below Grade Facilities	$0.6	50%	$0.3	
	Portal 44E	$3.6	40%	$1.4	
	TBM (44E to 41)	$2.8	100%	$2.8	
	Tunneling and Initial Liner (44E to 41)	$35.1	40%	$14.1	
	Second Pass Liner (44E to 41)	$15.0	40%	$6.0	
	Portal 5	$6.6	40%	$2.6	
	TBM (44E to 5)	$7.4	100%	$7.4	
	Tunneling and Initial Liner (44E to 5)	$59.4	40%	$23.8	
	Second Pass Liner (44E to5)	$15.7	40%	$6.3	
	Portal 5 Above & Below Grade Facilities and Final Site Work	$2.1	50%	$1.1	
	Portal 44E Below Grade Facilities	$0.4	50%	$0.2	
	Portal 44 Area Above Grade Facilities and Final Site Work	$3.1	50%	$1.5	
	Microtunnel				
	Swamp Creek Cut-&-Cover/Microtunnel	$10.2	50%	$5.1	
	Central Contract Subtotal	$226.7		$102.0	
	WEST CONTRACT - Effluent Tunnel (Portal 19 to 5)				
	Portal 19	$3.1	50%	$1.6	
	TBM (19 to 5)	$7.4	100%	$7.4	
	Tunneling and Initial Liner (19 to 5)	$65.6	40%	$26.2	
	Second Pass Liner (19 to 5)	$1.6	40%	$0.6	
	Portal 19 Above & Below Grade Facilities, and Final Site Work	$6.6	50%	$3.3	
	West Contract Subtotal	$84.3		$39.1	
	INFLUENT PUMP STATION CONTRACT - IPS (Portal 41)				
	Influent Structure	$2.8	60%	$1.7	
	Influent Pump Station & Final Site Work	$31.8	50%	$15.9	
	Odor Control Facility	$4.6	50%	$2.3	
	Primary Power	$3.6	50%	$1.8	
	Secondary Power	$6.4	50%	$3.2	
	Influent Pump Station Contract Subtotal	$49.2		$24.9	
	Misc. Hydraulic Controls	$0.3	100%	$0.3	
	Utility Relocations at Portals	$3.5	100%	$3.5	
	Marine Outfall	$20.2	50%	$10.1	
	Conveyance Construction Costs Total	$511.9		$237.0	46%
	Total Construction	$771.4		$382.7	50%

Based on our review of this cost information and supporting information describing the scope of the project at the time the estimates were developed, the following should be noted:

- About 56% of the overall $259.4 million construction estimate for the Treatment Plant and about 46% of the overall $511.9 million estimate for Conveyance were based on allowances.
- Of the estimated Treatment Plant construction cost, 85.7% is associated with process units; 13.8% is associated with site preparation; and about 0.5% is associated with buildings.
- Two of the 19 process unit line items for the Treatment Plant (MBRs and odor control) account for nearly 35% of the $222.3 million process unit estimate.
- While the overall design was estimated to be 30% complete based on standards established by the County, the design of certain elements (i.e., the marine outfall) had not progressed beyond the planning stage.
- Certain subsurface information that could affect construction costs was not available at the time the 30% design estimates were developed. For example, the seismic fault at the Treatment Plant site had not been evaluated at the time. For the Conveyance Program, phase 1 borings (every 500 feet) were available but supplemental phase 2 borings were not.

USE OF CONTINGENCIES

As shown in Table 6, the total contingency dollars in the proposed Brightwater budget and in the URS 30% estimates were essentially equal for the Treatment Plant, while the contingency for Conveyance was slightly lower in the proposed Brightwater budget relative to the URS 30% estimate. These contingencies were also allocated in different ways, as illustrated below in Table 8.

Table 8
Contingencies Comparison

Type of Contingency	Brightwater Budget ($millions)	URS 30% Estimate ($millions)	Project Oversight Team Estimate ($millions)	Standards Information
Treatment Plant				
Contingency at Start of Construction	$26.1	Included in Overall Project	$32.4 based on 10% of construction estimated at final design	▪ MWRA standard was 10% of construction estimate
Overall Project	$25.9	$51.9	$64.9 based on 25% of construction estimated at 30% design	▪ MWRA contingency standards were 25% at 20%–30% design; 20% at 60% design; and 10% at 90% design
Total	**$52.0**	**$51.9**	**$97.3**	
Conveyance				
Contingency at Start of Construction	$51.1	Included in overall project	$88.3 based on 15% of construction estimated at final design	▪ MWRA standard was 15% of construction estimate for tunneling
Overall Project	$74.2	$128	$76.8 based on 15% of construction estimated at 30% design	▪ MWRA contingency standards were 25% at 20%–30% design; 20% at 60% design; and 10% at 90% design ▪ Expect fewer changes with tunneling design development since design is less complex
Total	**$125.3**	**$128**	**$165.1**	
GRAND TOTAL	**$177.3**	**$179.9**	**$262.4**	**Difference between current contingencies and Project Oversight Team contingency estimate is about 5%–6% of overall Program Budget**

Table 8 also shows guidelines for contingency levels recommended by the MWRA and the contingency levels that our team would have recommended using.

Table 9 summarizes baseline budget and budget allocation information for the Brightwater, Jones Island/Cross Town Conveyance, and Deer Island Projects both in terms of total dollars and relative percentages of total construction contracts cost and of the Total Budget. Table 9 also shows cost breakdowns between the Treatment Plant and Conveyance aspects of Brightwater and the Jones Island/Cross Town Conveyance Project.

Table 9 shows total contingencies as a percent of construction contracts for the Brightwater Program and for the two comparable projects at the time baseline budgets were established. Baseline budgets were based on 30% design for the Jones Island/Cross Town Conveyance Project and on Facility Plan estimates (5%-10% Design) for the Deer Island Project. Contingencies (as a percent of construction contracts) for Brightwater Conveyance are roughly comparable to the contingencies used for the conveyance aspects of the Jones Island/Cross Town Conveyance Project (i.e., about 25%). However, the Brightwater Treatment Plant contingencies (20% of construction contracts) are substantially lower than those used for Jones Island and those recommended by our team. (It should be noted that the contingency for the Deer Island Project baseline budget was substantially higher than both Brightwater and Jones Island; however, because the Deer Island baseline budget was established at the Facility Planning stage (5%-10% design), it is not directly comparable to Brightwater.)

Overall, it is our opinion that the assumed contingencies for Brightwater, especially for the Treatment Plant, are on the low end of industry expectations, in part due to the level of allowances upon which the 30% URS construction estimates were based.

ALLIED COSTS

Our team also reviewed certain Allied Costs included in the proposed Brightwater budget, specifically "engineering and professional services" and program staff costs, in light of information from the comparable projects and industry standards. We did not review "permit fees and other agency costs," "rights of way and land acquisition," or "miscellaneous" Allied Costs because, in our opinion, these are likely to be very location- and project-specific.

Limited "industry standards" information is available with respect to staffing and engineering/professional services costs. The American Society of Civil Engineers has published a "Guide for the Engagement of Engineering Services" (ASCE Manual 45). The latest revised edition is 1996. The editions up to 1988 presented curves which represented median compensation for basic engineering services expressed as a percentage of net construction cost for projects with above-average complexity. The curves showed percentages ranging from 5.6 % to 11.6% depending on project size.

The MMSD conducted a nationwide survey of engineering costs for treatment plant and conveyance projects in 1982. Based on the survey, the MMSD used the following ranges during negotiation for design services and construction management/engineering services during construction:

- Treatment plant designs, depending on size and complexity: 6% to 12%
- Conveyance designs, depending on size: 4% to 10%
- Construction Management/Engineering Services During Construction, depending on complexity: 10% to 15%

MMSD also used guidelines of 3% to 5% for overall program management and 2% to 6% for staff support. Thus, overall professional services and staff costs were expected to range from

21% to 38% for treatment plants and from 19% to 36% for conveyance projects, depending on size and complexity.

Because the comparable projects were structured differently than Brightwater (i.e., Jones Island had a contracted overall Program Manager), we added professional services and staffing costs together to obtain an estimate of the overall non-construction labor (with some minimal expenses) required to support design, construction, and program management efforts. As shown in Table 9, estimated engineering plus staff labor is higher for Brightwater overall (as a percent of construction contracts and as a percent of adjusted budget) compared to the Jones Island/Cross Town Conveyance and Deer Island Projects. However, estimated engineering plus staff labor is generally comparable for the conveyance aspects of the Jones Island/Cross Town Conveyance and Brightwater Conveyance projects. Brightwater Treatment Plant professional services and staff labor were higher than for Jones Island (37.5% vs. 27.8% of construction contracts). This may, in part, reflect some of the redundancy between GC/CM services and contracted Construction Management services for the Treatment Plant.

BRIGHTWATER CONSTRUCTION COST ESTIMATE REVIEW PROCEDURES

Significant review is underway with respect to the Treatment Plant 60% design and 60% cost estimates prepared independently by URS and Hoffman. As reported by Brightwater staff, specific review activities include:

- Reconciling quantities and unit prices used by URS and Hoffman;
- Reviewing and reconciling differences in project scope and other assumptions on which cost estimates are based;
- Preparing a list of possible cost savings measures which could be implemented; and
- Having CH2M Hill's Design-Build division do a third estimate as if they were a contractor proposing on the project, including areas where pricing includes significant risk dollars. This will assist in identifying potential ways to reduce the construction cost.

FACTORS AFFECTING FUTURE CONSTRUCTION COST ESTIMATES

- **Ongoing Design Development.** Brightwater Treatment Plant staff report that significant design changes continued to be made between 30% and 60% design. For comparison purposes, the Jones Island Project changed the unit process for biosolids after the 30% designs were complete. This change had significant cost and schedule impacts.
- **Inflation and Market Trends.** Between the 30% and 60% design estimates, escalation in the costs of certain construction materials, specifically concrete and steel, have been leveling off. However, escalating fuel prices have the potential to affect the cost of construction materials, process equipment manufacturing costs, and operation of construction equipment more broadly.

There are also some indications that the Puget Sound construction market is active. Uncertainty about future commodity prices and subcontractor packaging can significantly affect the number of subcontractors interested in bidding specific packages.

Table 9
Comparison of Overall Program Costs – Baseline Budgets

Cost Category	Brightwater Project – 30 % Design			Jones Island/Cross Town Conveyance Project – 30% Design			Deer Island Project – Facility Plan (5-10% Design)		
	$M (2004)	% Constr.	% Budget	$M (1981)	% Constr.	% Budget	$M (1988)	% Constr.	% Budget
COMPARISON OF PROGRAM COSTS AT 30% DESIGN									
Construction									
Construction Contracts	$ 771.0	100.0%	52.0%	$ 331.6	100.0%	58.8%	$ 2,329.4	100.0%	56.5%
Mitigation	$ 32.6	4.2%	2.2%	$ -	0.0%	0.0%	$ 37.0	1.6%	0.9%
Construction Contingency	$ 77.2	10.0%	5.2%	$ 58.5	17.6%	10.4%	$ 232.9	10.0%	5.7%
Sales Tax	$ 72.2	9.4%	4.9%	$ 17.3	5.2%	3.1%	$ -	0.0%	0.0%
Other	$ 0.2	0.0%	0.0%	$ -	0.0%	0.0%	$ -	0.0%	0.0%
Subtotal Construction Cost	$ 953.2	123.6%	64.3%	$ 407.4	122.9%	72.2%	$ 2,599.3	111.6%	63.1%
"Allied or Soft Costs"									
Engr & Prf Services	$ 211.7	27.5%	14.3%	$ 85.6	25.8%	15.2%	$ 370.8	15.9%	9.0%
Permit Fees and Other Agencies	$ 44.5	5.8%	3.0%	$ 3.0	0.9%	0.5%	$ -	0.0%	0.0%
ROWs and Land	$ 122.2	15.8%	8.2%	$ 3.7	1.1%	0.7%	$ 84.4	3.6%	2.0%
Miscellaneous	$ 9.1	1.2%	0.6%	$ 10.5	3.2%	1.9%	$ 189.2	8.1%	4.6%
Staff Labor	$ 52.6	6.8%	3.5%	$ 8.7	2.6%	1.5%	$ 34.0	91.9%	0.8%
Subtotal Allied Costs	$ 440.1	57.1%	29.7%	$ 111.5	33.6%	19.8%	$ 678.4	29.1%	16.5%
Subtotal Professional Services and Staff Labor	$ 264.3	34.3%	21.6%	$ 94.3	28.4%	17.5%	$ 404.8	17.4%	10.1%
Project Total	$ 1,393.3		93.9%	$ 518.9		92.0%	$ 3,277.7		79.5%
Project Contingency	$ 100.1	13.0%	6.7%	$ 45.4	13.7%	8.0%	$ 844.1	36.2%	20.5%
Other Credits or Charges	$ (10.0)	-1.3%	-0.7%	$ -	0.0%	0.0%	$ -	0.0%	0.0%
Total Budget	$ 1,483.4	192.4%	100.0%	$ 564.3	170.2%	100.0%	$ 4,121.8	176.9%	100.0%
Adjusted Budget	$ 1,221.9			$ 540.3			$ 4,000.4		
Total Contingency % of Construction Contracts	23.0%			31.3%			46.2%		
Total Contingency % of Budget	12.0%			18.4%			26.1%		
Total Contingency % of Adjusted Budget	14.5%			19.2%			26.9%		
Professional Services and Staff Labor % of Construction Contracts	34.3%			28.4%			17.4%		
Professional Services and Staff Labor % of Budget	17.8%			16.7%			9.8%		
Professional Services and Staff Labor % of Adjusted Budget	21.6%			17.5%			10.1%		
COMPARISON OF CONVEYANCE COSTS AT 30% DESIGN									
Construction									
Construction Contracts	$ 511.5	100.0%	56.5%	$ 82.2	100.0%	59.9%	$ 610.2	100.0%	58.2%
Construction Mitigation	$ 4.2	0.8%	0.5%	$ -	0.0%	0.0%	$ -	0.0%	0.0%
Construction Contingency	$ 51.1	10.0%	5.6%	$ 14.5	17.6%	10.6%	$ 61.0	10.0%	5.8%
Sales Tax	$ 50.4	9.9%	5.6%	$ 4.8	5.8%	3.5%	$ -	0.0%	0.0%
Other	$ 0.1	0.0%	0.0%	$ -	0.0%	0.0%	$ -	0.0%	0.0%
Subtotal Construction Cost	$ 617.3	120.7%	68.2%	$ 101.5	123.5%	74.0%	$ 671.2	110.0%	64.1%
"Allied or Soft Costs"									
Engr & Prf Services	$ 138.3	27.0%	15.3%	$ 23.2	28.2%	16.9%	$ 97.1	15.9%	9.3%
Permit Fees and Other Agencies	$ 21.1	4.1%	2.3%	$ 0.5	0.6%	0.4%	$ -	0.0%	0.0%
ROWs and Land	$ 20.8	4.1%	2.3%	$ 0.7	0.9%	0.5%	$ -	0.0%	0.0%
Miscellaneous	$ 4.5	0.9%	0.5%	$ 3.0	3.6%	2.2%	$ 49.6	8.1%	4.7%
Staff Labor	$ 28.6	5.6%	3.2%	$ 1.7	2.1%	1.2%	$ 8.9	1.5%	0.8%
Subtotal Allied Costs	$ 213.3	41.7%	23.6%	$ 29.1	35.4%	21.2%	$ 155.6	25.5%	14.8%
Subtotal Professional Services and Staff Labor	$ 166.9	32.6%	20.6%	$ 24.9	30.3%	19.0%	$ 106.0	17.4%	10.1%
Conveyance Total	$ 830.6		91.8%	$ 130.6		95.2%	$ 826.8		78.9%
Project Contingency	$ 74.2	14.5%	8.2%	$ 6.5	7.9%	4.8%	$ 221.1	36.2%	21.1%
Other Credits or Charges	$ -	0.0%	0.0%	$ -	0.0%	0.0%	$ -	0.0%	0.0%
Total Conveyance Budget	$ 904.8	176.9%	100.0%	$ 137.1	166.8%	100.0%	$ 1,047.9	171.7%	100.0%
Adjusted Conveyance Budget	$ 808.3			$ 131.1			$ 1,047.9		
Total Contingency % of Construction Contracts	24.5%			25.6%			46.2%		
Total Contingency % of Budget	13.8%			15.3%			26.9%		
Total Contingency % of Adjusted Budget	15.5%			16.0%			26.9%		
Professional Services and Staff Labor % of Construction Contracts	32.6%			30.3%			17.4%		
Professional Services and Staff Labor % of Budget	18.4%			18.2%			10.1%		
Professional Services and Staff Labor % of Adjusted Budget	20.6%			19.0%			10.1%		
COMPARISON OF TREATMENT PLANT COSTS AT 30% DESIGN									
Construction									
Construction Contracts	$ 259.5	100.0%	44.9%	$ 249.4	100.0%	58.4%	$ 1,719.2	100.0%	55.9%
Construction Mitigation	$ 28.4	10.9%	4.9%	$ -	0.0%	0.0%	$ 37.0	2.2%	1.2%
Construction Contingency	$ 26.1	10.1%	4.5%	$ 44.0	17.6%	10.3%	$ 171.9	10.0%	5.6%
Sales Tax	$ 21.8	8.4%	3.8%	$ 12.5	5.0%	2.9%	$ -	0.0%	0.0%
Other	$ 0.1	0.0%	0.0%	$ -	0.0%	0.0%	$ -	0.0%	0.0%
Subtotal Construction Cost	$ 335.9	129.4%	58.1%	$ 305.9	122.7%	71.6%	$ 1,928.1	112.2%	62.7%
"Allied or Soft Costs"									
Engr & Prf Services	$ 73.4	28.3%	12.7%	$ 62.4	25.0%	14.6%	$ 273.7	15.9%	8.9%
Permit Fees and Other Agencies	$ 23.4	9.0%	4.0%	$ 2.5	1.0%	0.6%	$ -	0.0%	0.0%
ROWs and Land	$ 101.4	39.1%	17.5%	$ 3.0	1.2%	0.7%	$ 84.4	4.9%	2.7%
Miscellaneous	$ 4.5	1.7%	0.8%	$ 7.5	3.0%	1.8%	$ 139.6	8.1%	4.5%
Staff Labor	$ 24.0	9.2%	4.1%	$ 7.0	2.8%	1.6%	$ 25.1	1.5%	0.8%
Subtotal Allied Costs	$ 226.7	87.4%	39.2%	$ 82.4	33.0%	19.3%	$ 522.8	30.4%	17.0%
Subtotal Professional Services and Staff Labor	$ 97.4	37.5%	23.6%	$ 69.4	27.8%	17.0%	$ 298.3	17.4%	10.1%
Treatment Plant Total	$ 562.6		97.3%	$ 388.3		90.9%	$ 2,450.9		79.7%
Project Contingency	$ 25.9	10.0%	4.5%	$ 38.8	15.6%	9.1%	$ 623.0	36.2%	20.3%
Other Credits or Charges	$ (10.0)	-3.9%	-1.7%	$ -	0.0%	0.0%	$ -	0.0%	0.0%
Treatment Plant Total Budget	$ 578.5	222.9%	100.0%	$ 427.1	171.3%	100.0%	$ 3,073.9	178.8%	100.0%
Adjusted Budget	$ 413.5			$ 409.1			$ 2,952.5		
Total Contingency % of Construction Contracts	20.0%			33.2%			46.2%		
Total Contingency % of Budget	9.0%			19.4%			25.9%		
Total Contingency % of Adjusted Budget	12.6%			20.2%			26.9%		
Professional Services and Staff Labor % of Construction Contracts	37.5%			27.8%			17.4%		
Professional Services and Staff Labor % of Budget	16.8%			16.2%			9.7%		
Professional Services and Staff Labor % of Adjusted Budget	23.6%			17.0%			10.1%		

Note:

1. Adjusted Budget = Total Budget – Mitigation – Sales Tax – Permit Fees – ROW and Land – Other Credits and Charges
2. Breakdown between conveyance and treatment plant Allied Costs for Deer Island was pro-rated based on overall program cost percentages.

CONCLUSIONS AND RECOMMENDATIONS

Key Conclusions and Recommendations

BUDGET AND COST

- **Modifications to the overall baseline budget ($2004) are not warranted at this time.** The overall budget presented to the County Council is likely somewhat low (on the order of 5%–6%) based on our review of contingency levels, which, in our opinion, are on the low end of industry expectations. However, this is somewhat counter balanced by certain Allied Costs (professional services and staff labor) for the Treatment Plant, which are on the high end of industry expectations and may reflect some redundancy in roles between the contracted Construction Management firm and the GC/CM. Given the overall level of uncertainty at the 30% design stage, we do not recommend modifying the budget at this time. Further, the proposed budget is having the intended management effect: Brightwater Program Managers and staff clearly feel pressure to make project changes in order to remain within the desired budget.

- **There are several factors that we believe could tend to drive up elements of the budgeted costs as the design develops and during construction.** These are:

    - The 30% design estimates, which are the basis for the proposed budget, relied to a large extent on allowances.

    - Although the overall design was estimated to be 30% complete based on standards established by the County, the design of certain elements (i.e., the marine outfall) had not progressed beyond the planning stage.

    - The County conducted an extensive value engineering review of the 30% estimate and chose to implement many of the cost savings recommendations. The savings potential of future value engineering may, therefore, be limited.

    - There are several project risks that have not been explicitly budgeted for (these include excavation of large rocks or boulders, premium labor rates, and shortages of local area construction materials). Should these conditions actually be encountered during construction, the Brightwater Project would likely need to request supplemental funding. (For

example, on Deer Island, a 15% construction contingency was carried on four of the five tunnel segments. This was adequate for routine changes but not for major unexpected events.)

- **There are several unique technical and management elements of the Project that, taken together, may also affect Project costs and schedule.** These include:
  - The fact that the Treatment Plant will involve the largest application of MBR treatment in the United States;
  - The requirement for 99.9% odor reduction at the Treatment Plant fence line;
  - The fact that extremely high hydrostatic pressures in certain reaches of the Central Conveyance Tunnel will necessitate use of TBM technology that has never been used before in the United States; and
  - The use of several new contracting methods and provisions such as a lump sum design contract for the Treatment Plant, a GC/CM contract for Treatment Plant construction, and a Design-Build contract for the marine outfall;

MANAGEMENT

- **Changes should be made to establish a collaborative "partnering" relationship between the Treatment Plant designer (CH2M Hill) and the GC/CM contractor.** The lump sum design contract for the Treatment Plant with CH2M Hill coupled with the decision to have the responsibility for cost estimating rest solely with URS and Hoffman may have the unintended effect of creating conflicting interests between the designer and GC/CM contractor. While Hoffman's preconstruction services contract includes provisions design review, we believe the Treatment Plant Project would benefit from a collaborative design review process where the designer and GC/CM review the design documents together and can enter into a dialogue about design intent and construction related issues. We believe this is an important step to take in order to reduce the potential for disputes to arise during construction over what is (or is reasonably inferable to be) in scope. This is, based on our experience, the most common dispute that occurs during GC/CM construction contract implementation. We believe it is critical to address these issues now, so that a "partnering" type of relationship exists between Hoffman and CH2M Hill going into construction. Specific changes that Brightwater should consider include:
  - Assuring, by amending CH2M Hill's design contract if necessary, that a detailed side-by-side review of design drawings and specifications is conducted by Hoffman together with CH2M Hill; and

- Once a final Treatment Plant construction budget is established (after the 60% design review changes) and if design modifications are required to reduce construction costs, amending CH2M Hill's design contract to include a "design to construction budget" requirement.

- **The Construction Services GC/CM Contract (to be negotiated) should include specific requirements to address competition during bidding of subcontract packages.** Under GC/CM contracting, especially in a tight market for construction services, subcontractors may be reluctant to bid against the GC/CM, who has knowledge and insight into the project that they don't have, or against other subcontractors that have long-term relationships with the GC/CM. Provisions to address these competitiveness issues could include:

  - Providing for a thorough review of GC/CM's subcontract packaging plan. The subcontract packaging plan and strategy are an important step in helping to ensure competitive bids. Packages need to be divided into the right size and type of work so that they will be attractive to prospective bidders.

  - Requiring Hoffman to receive a minimum of three bids on subcontract packages or to rebid them.

  - Requiring that the County oversee the bidding process for any contract packages that the GC/CM would like to self-perform.

  - Specific outreach activities to subcontractors to acquaint them with the GC/CM bidding process.

- **In the selection process for contracted Construction Management services for the Treatment Plant, Brightwater should focus on two elements:**

  - Augment in-house staff capabilities.

  - Set a clear mandate that the contract CM services are intended to facilitate and not impede the performance of the GC/CM and Design team.

  Significant Construction Management responsibility is typically given to the GC/CM contractor. For example, construction cost management, inspections, and administration of construction-related paperwork are largely the responsibility of the GC/CM, while responsibility for changes to the GC/CM contract typically rests with the Owner. Brightwater has elected to deliver the Treatment Plant with a GC/CM contractor, but also plans to hire a contracted Construction Management firm. We recommend that Brightwater develop a staffing matrix of roles and responsibilities to avoid overlap of tasks, duties,

and responsibilities between the CM, GC/CM, Owner, and Design team, and to avoid superfluous positions as well as an unclear decision-making process. Special attention should be given so that the CM does not become an intermediate layer between the Owner and GC/CM decision-makers. Essentially, the CM should provide support to Brightwater's own CM staff and not be in the line of decision-making.

- **Brightwater Program Managers should aggressively proceed with their development and analysis of an Integrated Treatment Plant and Conveyance Schedule.** Once construction starts, schedule delay poses one of the greatest risks to meeting the Brightwater Project budget. Specifically, the per-day costs of tunneling delay will be significant. In addition, should a significant delay occur in constructing certain portions of the Conveyance System, it could also delay startup and testing of the Treatment Plant and potentially put equipment and process guaranties at risk. Another area in which schedule integration will be critical is the design and permitting of the outfall. Brightwater has elected to deliver this element using Design-Build, which will allow the contractor more flexibility in determining marine construction methods. However, diffuser design will need to help achieve NPDES permit requirements, will require complex marine dispersion modeling, and will need to consider the expected Treatment Plant performance.

- **In developing the Integrated Schedule, care should be taken not to unnecessarily accelerate the planned design and bidding schedule, resulting in unneeded risks and costs.** The intent of the Integrated Schedule would be to arrive at the best balance between the potential costs of design delay and the potential costs of encountering design problems during construction. Adequate design effort should be expended so design changes during construction are minimized. As stated above, we believe developing a "partnering" relationship between the Treatment Plant designer and GC/CM contractor is essential to project success. This should occur even if it means some delay of the design effort.

- **Brightwater should build on its current risk assessment/risk management activities.** There may be value in conducting a probabilistic risk assessment related to Conveyance costs and Treatment Plant costs and schedules (such an assessment is underway for the Conveyance schedule). Specific workaround strategies in the event that unforeseen conditions are encountered (especially for tunneling) should be identified; and role-playing exercises to determine how effectively they can be implemented could be employed.

- **Brightwater should consider "delegating down" significant construction change order approval authority to expedite decision-making during construction.** Once construction starts, the need to have all change orders

approved by the overall Program Manager could delay work and drive up costs.

Other Recommendations

- Brightwater may want to consider tracking bidding information for major public works projects in the Puget Sound region prior to the buyout phase for the Treatment Plant.
- In developing construction contracts, especially for tunneling and the Influent Pump Station, Brightwater may want to include a flowchart for changed conditions that illustrates implementation of the review and decision process.
- Brightwater may want to consider adding a safety incentive program for construction contractors and subcontractors to the General Conditions.
- Brightwater may want to also track total staff labor using the project cash flow format in its monthly report to Council.

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APPENDIX A
BRIGHTWATER PROGRAM OVERSIGHT REPORT CONSULTANT TEAM QUALIFICATIONS

Russ Stepp, R. W. Beck, Inc.

Russ Stepp has over 30 years experience providing oversight on a broad range of large, complex utility projects. He recently led the Independent Engineering review of the San Francisco Public Utility Commission's (PUC) $3.6 billion Capital Improvement Program (CIP). Mr. Stepp also recently completed an assignment as technical advisor for the Freeport Regional Water Supply Program, a $750 million project being jointly developed by the East Bay Municipal Utility District and Sacramento County.

Bob Bingham, R. W. Beck, Inc.

Mr. Bingham has 30 years experience advising agencies and utilities, particularly in the area of facility and program development. He has advised clients on alternative delivery for more than 15 projects with a capital value in excess of $2 billion. His recent experience includes advising King County's Wastewater Treatment Division on its "productivity initiative".

Pat Tangora, R. W. Beck, Inc.

Pat Tangora has over 20 years experience advising clients on the development of major, complex water, wastewater, and solid waste projects. Her recent experience includes advising the City of Tacoma on its Design-Build procurement of a major expansion and upgrade to its Central Wastewater Treatment Plant. She also advised the City of Seattle on their Design-Build-Operate procurements of the new Tolt and Cedar water treatment plants and participated in R. W. Beck's Independent Engineering review of the San Francisco PUC's $3.6 billion Capital Improvement Program.

Ed Wetzel, R. W. Beck, Inc.

Dr. Wetzel has 25 years of experience working with the wastewater and water clients on technical and management aspects of larger treatment projects. His experience includes wastewater reuse and wastewater treatment plant design, performance evaluation, water treatment process studies, water quality investigations, privatization studies, utility acquisitions, rate and connection fee studies, and bond reports. He is

contributing author to the Water Environment Federation's Manual of Practice No. 8, *Design of Municipal Wastewater Treatment Plants.*

Phil Helmes, CRA International

Phil Helmes has 29 years of experience and participated in a number of high-profile public sector projects on behalf of the owner in project development, project oversight, budget, schedule, and claims review and analysis. He served as construction manager for several projects exceeding $200 million. His recent experience includes project oversight/reviews, strategy development, and dispute resolution analysis on projects including the $14.6 billion Boston Central Artery/Tunnel and the $3.8 billion Massachusetts Water Resources Authority's Deer Island Sewage Treatment Project.

Patrick Marchese, PTM Consulting LLC

With 41 years of experience, Pat Marchese has served in the top executive positions with managerial and leadership responsibility for operating large multi-disciplined organizations and large complex public works projects. He served as Executive Director of the Milwaukee Metropolitan Sewerage District, which has responsibility to convey, store, and treat wastewater and to provide flood protection for a 420 square mile service area. He was responsible for implementing MMSD's $2.3 billion wastewater treatment program.

June 29, 2005

Mr. David Layton
Senior CIP Analyst
Budget & Fiscal Management
King County Courthouse
516 Third Avenue, Room 1200
Seattle, Washington 98104-3272

Subject: **Brightwater Project**

Dear David:

During our recent meeting regarding the Project Oversight Report (POR) you raised two issues:

1) Should the project budget of $1.48 Billion (in 2004 dollars) also be expressed in escalated dollars?

2) Does the overall budget show a reasonable balance between major cost categories and is the total budget estimate "OK"?

While the POR addresses certain aspects of these issues, we believe some additional information may be helpful. The following provides this information:

1) Expressing Project Budget in Escalated Dollars

We believe it would be useful to have a line item budget showing project costs in escalated dollars.

The Brightwater total project budget is $1.48 billion in 2004 dollars (no escalation). To address the issue of inflation, DNR staff has also provided the estimated total cost under two scenarios, 3% and 5% annual escalation applied uniformly to all costs. Using this approach may cause confusion in the future because:

- Expressing total cost in 2004 dollars and tracking costs on this basis creates a discrepancy between actual costs and the stated project budget.
- Project components can vary substantially in terms of how the are affected by inflation. This is due to several factors. First, future costs of various project elements will escalate at different rates (eg. construction vs. staff labor costs). In addition, some costs, such as property acquisition, may already be fixed, while others that occur later in the project, would experience up to six years of escalation.
- If detailed assumptions regarding escalation are not clearly identified, it may be difficult to track how well the project is adhering to the original budget estimate.

2) Overall Budget

In response to your second question, we are of the opinion that the project budget is low by approximately 5%. We base this on our review which identified several areas where there were inconsistencies within the project cost estimate and/or cases where the Brightwater Project budget values differed from the peer projects we evaluated. These included:

1) The project contingency for the treatment plant appears low when compared to industry standards and the peer projects.

2) Allied costs for the treatment plant appear on the high end of the range we have seen on other projects. This is in part due to the current assumption related to the level of effort needed to provide construction management services for the treatment plant.

3) Cost estimates prepared at the completion of 30% design include a relatively high proportion of allowances.

I hope this information addresses your questions. If you would like to discuss this matter further, or require additional information, please contact me at 206-695-4470 or Bob Bingham at 206-695-4504.

Sincerely,

R. W. BECK, INC.

Bob Bingham for

Russell J. Stepp
Project Manager

RJS/ato/rhm
c: Pete Letourneau