Deschutes Estuary Feasibility Study, Phase 3

Engineering Design and Cost Estimates

FINAL REPORT

Prepared for:

**Washington Department of
Fish and Wildlife**

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Executive Summary

The objective of the Deschutes Estuary Feasibility Study (DEFS) is to evaluate the possibility of restoring the Deschutes River estuary to tidal flow as an alternative to the continued management actions necessary to maintain Capitol Lake in its current condition. An important input to this feasibility study is an analysis of the engineering feasibility and likely cost of the three restoration alternatives under consideration. The three alternatives are:

- Alternative A: a 500-foot opening width at the current Fifth Avenue dam, with necessary modifications to existing infrastructure. This alternative leaves the existing Fourth Avenue bridge in place and leads to restoration of full tidal hydrology with minimum effects on current land use and infrastructure.
- Alternative B: Alternative A plus an increased opening width at the BNSF railroad crossing, which is located at the division between the North and Middle basins of Capitol Lake. Current bridge span is 200 feet and increasing this span is thought to improve tidal circulation and reduce hydraulic stress (e.g. scour) at this crossing.
- Alternative D: Alternative A plus a split basin design that divides the North basin, along a north-south line, into a reflecting pool to the east and a free flowing estuary to the west. This alternative recognizes the value of a reflecting pool for the state capitol while at the same time reconnecting the Deschutes River with Budd Inlet.

Alternative C – Alternative B plus an increased opening width to Percival Cove – was considered earlier in the Deschutes Estuary Feasibility Study. Alternative C was rejected because hydrodynamic modeling showed it did not give a significant change in conditions within Percival Cove.

A preliminary-level design and cost estimate of each of the three proposed restoration alternatives has been prepared. The conclusions of the engineering analysis are as follows.

- No fatal flaws have been identified that would rule out any of the restoration alternatives as completely infeasible from an engineering point of view.
- It is recommended that, for any of the alternatives, the main channel of the restored estuary be dredged before the establishment of tidal flow, and that the dredged materials used to provide intertidal habitat along Deschutes Parkway. In addition to the habitat benefits, this would decrease the quantity of navigation dredging required at the marinas along Percival Landing and at the Port of Olympia in the years immediately following reintroduction of tidal flow into the estuary.
- It is recommended that the reflecting pool, in Alternative D, be a saltwater pool with muted tidal flow. This would allow natural flushing of the pool and the maintenance of adequate water quality. If a freshwater pool were to be maintained, an artificial recirculation system and the use of reclaimed water in significant quantities would be necessary.
- Construction for all alternatives could be achieved within three to four years, under the assumption that only the chinook salmon and bull trout windows for in-water work are observed.

Preliminary-level cost estimates for each alternative are given on the following page. The costs are provided in a three-point estimate format. The point of a three-point estimate is to capture the range of likely costs – including a minimum (most optimistic), either the average or the most likely, and maximum (pessimistic but excluding very remote eventualities). Approximately one-half of the variability in project costs is associated with initial dredging of the basin and placement of the dredged materials along Deschutes Parkway to provide intertidal habitat. A greater quantity of initial dredging, associated with higher initial costs, would most likely lead to lower costs in later years associated with dredging the marinas along Percival Landing and at the Port of Olympia.

Both the raw construction costs – an estimate of the total contractor's bid – and the total project costs, which include "soft" costs such as engineering, permitting, and right of way acquisition, are given.

The project cost is given both for 2006 dollars and for year of expenditure dollars. The year of expenditure dollars are inflated to a construction start date of 2012 with 3.5% annual inflation rate in the intervening years. The rate of 3.5% is based on the average inflation rate experienced for construction projects between 1990 and 2005. Year of expenditure costs can change dramatically depending on the construction start date and the rate of inflation for heavy construction. As a worst-case example, if the construction start date is deferred to 2020 and inflation between 2006 and 2020 is estimated at 6%, the year of expenditure costs would be almost double those shown here.

	Low Cost (x 1,000,000)	**Avge. Cost (x 1,000,000)**	**High Cost (x 1,000,000)**
Alternative A			
Construction Cost (2006 dollars)	$46.3	$53.3	$61.0
Total Project Cost (2006 dollars)	$65.9	$76.1	$87.2
Project Cost, Inflated to 2012 Start at 3.5%/year	$82.5	$95.2	$109.1
Alternative B			
Construction Cost (2006 dollars)	$55.9	$63.3	$71.6
Total Project Cost (2006 dollars)	$79.6	$90.3	$102.3
Project Cost, Inflated to 2012 Start at 3.5%/year	$99.6	$112.9	$127.9
Alternative D			
Construction Cost (2006 dollars)	$65.9	$74.5	$84.1
Total Project Cost (2006 dollars)	$93.8	$106.2	$120.0
Project Cost, Inflated to 2012 Start at 3.5%/year	$117.3	$132.8	$150.1

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1. Introduction

1.1 Background

Capitol Lake and its surroundings form the hub of Olympia. The Lake's construction in 1951 fulfilled the 1911 vision of architects White and Wilder by providing a reflecting pool for the State Capitol Building. Recreational uses of the lake include open-water activities such as boating, canoeing, and fishing (salmon, trout, and bass) as well as upland uses based around shoreline parks and their trail connections – walking, jogging, bicycling, and bird-watching. Salmon runs at the fish ladder provide fish-watching, a typical Pacific Northwestern activity.

At the same time, Capitol Lake is increasingly unsustainable in its current configuration. Sediment from the Deschutes River and Percival Creek is filling in the lake; environmental concerns mean that ongoing dredging of the lake is increasingly difficult and expensive. The lake is on the state list of impaired waterbodies for fecal coliform bacteria and total phosphorus. The noxious weeds purple loosestrife and eurasian milfoil are invading the lake. Capitol Dam is a significant barrier to the Deschutes River's salmon runs; it restricts upstream salmon passage and increases mortality as fish are delayed and vulnerable to predation. Passage of juvenile fish and other fish species is likely reduced or prevented as well.

These challenges led to the inclusion of an estuary feasibility study as a key Management Objective in the 2002 Capitol Lake Adaptive Management Plan (CLAMP). The objective of the Deschutes Estuary Feasibility Study (DEFS) is to evaluate the possibility of a restored estuary as an alternative to the continued management actions necessary to maintain a lake in this setting. The Deschutes Estuary Feasibility Study process contains a number of study tasks grouped together into four phases:

Phase 1:

- Conceptual Model of Estuarine Process and Community Values
- Bathymetric Survey
- Hydraulic and Sediment Transport Analysis and Modeling – Phase 1

Phase 2:

- Reference Estuary Survey (Earth Design Consultants, 2006)
- Biological Conditions Report (Earth Design Consultants, 2006)
- Hydraulic and Sediment Transport Analysis and Modeling – Phase 2 (USGS, 2006)
- Independent Technical Review
- Community Review

Phase 3:

- Engineering Design and Preliminary Cost Estimates (this document)
- Net Benefit Analysis (in preparation)
- Independent Technical Review
- Community Review

Phase 4:

- Report Development
- Community Review

1.2 Scope

This document is the Final Report for the Deschutes Estuary Feasibility Study (DEFS), Phase 3: Engineering Design and Preliminary Cost Estimates. The Engineering Design and Preliminary Cost Estimates Task includes the following scope:

- Collect and Review Data
- Analyze the Three Alternatives for Completeness and Against Restoration Criteria
- Assess Affected Infrastructure and Constraints
- Develop Designs and Engineering Cost Estimates
- Prepare Report and Presentation
- Management and QA/QC

1.3 Restoration Alternatives

The DEFS is analyzing three alternatives:

- Alternative A: a 500-foot opening width at the current Fifth Avenue dam, with necessary modifications to existing infrastructure. This alternative leaves the existing Fourth Avenue bridge in place and leads to restoration of full tidal hydrology with minimum effects on current land use and infrastructure.
- Alternative B: Alternative A plus an increased opening width at the BNSF railroad crossing, which is located at the division between the North and Middle basins of Capitol Lake. Current bridge span is 200 feet and increasing this span is thought to improve tidal circulation and reduce hydraulic stress (e.g. scour) at this crossing.
- Alternative D: Alternative A plus a split basin design that divides the North basin, along a north-south line, into a reflecting pool to the east and a free flowing estuary to the west. This alternative recognizes the value of a reflecting pool for the state capitol while at the same time reconnecting the Deschutes River with Budd Inlet.

Alternative C – Alternative B plus an increased opening width to Percival Cove – was considered earlier in the Deschutes Estuary Feasibility Study. Alternative C was rejected because hydrodynamic modeling showed it did not give a significant change in conditions within Percival Cove.

Exhibits 1 through 4, after the main text of this document, illustrate the existing condition of Capitol Lake and the main infrastructure changes required to realize each alternative. Exhibits 5 through 8, which will be discussed in more detail in the following sections, illustrate specifics of the major infrastructure modifications.

2. Estuarine Hydrodynamics

2.1 Introduction

The purpose of this section is to summarize the estuarine hydrodynamics and sediment transport anticipated in the restored Deschutes Estuary, with emphasis on those aspects of the hydrodynamics that will affect the infrastructure surrounding Capitol Lake. The engineering response to these hydrodynamics is discussed in Section 3.

2.2 Daily Tidal Fluctuations

The most immediate and obvious effect of restoring Capitol Lake to tidal flow will be the replacement of a stable water level within the lake by a water level that fluctuates tidally, driven by the tides in Budd Inlet. These tides are mixed semidiurnal, meaning that there are two unequal low and high tides each day. The tidal datums for Olympia, Budd Inlet are presented in Table 1 (NOAA 2006). This report gives all elevation values relative to the NGVD29 datum, which is close to mean sea level.

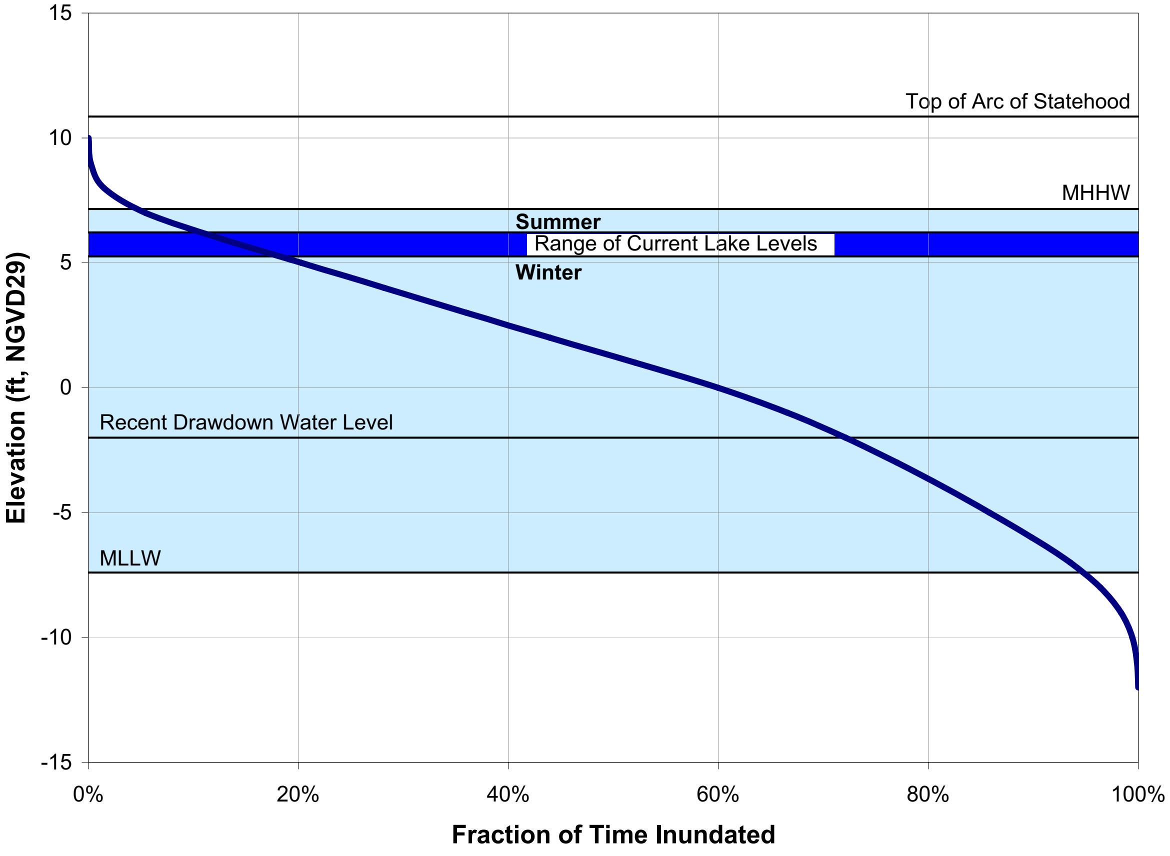
Table 1: Tidal Datums for Budd Inlet (1983-2001 epoch)

Datum Plane	Feet, MLLW	Feet, NGVD29
Highest Observed Tide (12/15/1977)	17.94	10.54
Mean Higher High Water (MHHW)	14.56	7.16
Mean High Water (MHW)	13.55	6.15
Mean Tide Level (MTL)	8.31	0.91
National Geodetic Vertical Datum of 1929 (NGVD29)	7.40	0.00
Mean Low Water (MLW)	3.07	-4.33
Mean Lower Low Water (MLLW)	0.00	-7.40
Lowest Observed Tide (1/2/1977)	-4.33	-11.73

The tidal fluctuations in Budd Inlet will drive similar tidal fluctuations within the restored Deschutes Estuary. Hydrodynamic modeling (USGS 2006) showed that the water levels within the restored estuary will be controlled by the tides, responding very little to river flows except during major flooding events. Figure 1 shows inundation curves for the restored estuary (i.e., the fraction of time that different elevations are inundated) based on the tidal fluctuations within Budd Inlet.

At high tide (e.g., MHHW) the entire lake basin will be inundated, with water levels slightly higher than they are now: current lake management targets an elevation of 6.22 feet NGVD 29 during the summer and 5.26 feet NGVD during the winter (URS Group and Dewberry 2003). At low tide, based on the current bathymetry, flow within the South Basin and the southern part of the Middle Basin will be confined to the main channel. In contrast, much of the North Basin, particularly its eastern half (near Heritage Park), will remain inundated throughout the tidal cycle – more than one-half of the North Basin has a bottom elevation of -8 to -10 feet NGVD 29 (see the contours in Exhibit 1). The inundation frequency in the North Basin in particular will change as the bathymetry of the restored estuary evolves, as described in Section 2.3.

Figure 1: Inundation Curves within Restored Estuary



An indication of the visual characteristics of the estuary during low tide can be obtained from photographs taken during summer drawdowns of the lake. The lowest elevations during drawdown have ranged from about -7 to about -3 feet NGVD29. The photograph on this page, with the water level at about -2 feet NGVD29, shows that the reflection of the Capitol building can be observed even at these relatively low water levels – suggesting that the Capitol will be reflected at least 75% of the time after the restoration of tidal flow. Photographs on the following page suggest the visual characteristics of other parts of the restored estuary during low tide.

Reflection during Drawdown (Water level -2 ft NGVD29)

North Basin and 4th/5th Avenue Bridge during Drawdown

South Basin and I-5 Bridge during Drawdown

2.3 Sediment Transport

USGS (2006) examined sediment transport in the restored estuary in detail. Uncertainty as to the erodibility of the sediment in Capitol Lake led to a relatively wide range in the prediction as to the overall rate of erosion and deposition in the lake and Budd Inlet. However, the general pattern of bathymetric change is clear, and it has been shown that the differences between the three restoration alternatives is minor.

Under all restoration alternatives, the main channel of a restored estuary will erode by up to six feet in the first three years of tidal influence, with most of the change occurring in the first year. Much of the erosion occurs in the main channel of the South and Middle Basins, with deposition occurring on either side of the main channel in the North Basin. The estuary approaches an equilibrium condition after about three years.

The marinas along Percival Landing and the Port of Olympia's navigation channel in the south of Budd Inlet will trap most of the sediment that is exported from the estuary. After the first three years, between 160,000 and 370,000 cubic yards are expected to deposit in that area for Alternatives A and B, while between 220,000 and 470,000 cubic yards are expected for Alternative D. More sediment is exported to Budd Inlet under Alternative D because the sediment is not deposited in the east part of the North Basin under that alternative – the reflecting pool is effectively isolated from the tidally transported sediment. Long-term – over the course of a decade – the rate of sediment transport into the marinas and the port is expected to drop to about 43,000 cubic yards annually for Alternatives A and B, and about 60,000 cubic yards annually for Alternative D.

Sediments deposited in the port and marina area must be dredged from those areas for navigation purposes. In order to decrease the quantity of dredging needed – at least in the short term – this study suggests dredging Capitol Lake before tidal flow is established. The dredged materials could be used to provide intertidal habitat along Deschutes Parkway, similar to the use of dredged materials in the creation of the Heritage Park Mitigation Wetland (Washington State General Administration 1997). More details of this proposal are given in Section 3.5.

2.4 Flooding

The highest observed tide at Olympia, Budd Inlet, occurred on December 15, 1977. This high tide, combined with high river flows, caused Capitol Lake to reach flood heights. Field observations indicated that the lake level in the North Basin was about 0.4 feet higher than the observed high tide (URS and Dewberry 2003). A simulation of the same tide and river flow conditions for the restored estuary (USGS 2006) predicted peak water levels about 0.2 feet higher than the observed high tide in the North Basin – a slight, but not truly significant, improvement compared to the observed lake flooding.

To investigate the likely worst-case flood condition, USGS also simulated the 1977 high tide conditions combined with the 100-year river discharge. The predicted peak water level in the restored estuary was 11.1 feet NGVD29 in the North Basin. For comparison, URS and Dewberry 2003 predicted a 100-year lake flood level of 11.5 feet NGVD 29 (existing conditions).

For all flood conditions studied by USGS 2006, peak water levels in the Middle and South Basin were slightly higher than in the North Basin – for example, the 1977 high tide conditions combined with the 100-year river discharge gives a predicted peak water level of 11.6 feet at the I-5 Bridge. Previous studies did not address the Middle and South Basins.

The USGS studies of the restored estuary do not meet the standards of a FEMA-approved floodplain study such as the URS and Dewberry studies of the existing lake. The City of Olympia may require a FEMA-approved floodplain study as part of the permitting requirements for the proposed restoration project. However, it can be concluded that flooding in the restored estuary will be similar to current (managed lake) conditions at worst. A decided advantage of the restored estuary is that flood management will no longer depend on the correct functioning of a mechanical system – flooding under current conditions can be considerably exacerbated if the tide gate controls should fail.

Under 100-year flood conditions, the Heritage Park bulkhead (crown elevation +10.86 feet NGVD29) will be overtopped, and portions of Marathon Park and the trail system at Tumwater Historical Park will be inundated. The gravel parking lot at the General Administration Powerhouse (immediately south of the railroad bridge on the east side of the Middle Basin) will also be inundated, although the building itself (which was constructed before Capitol Lake was impounded, with a finish floor elevation of 13.83 feet) will not.

Since the flooding of these areas will not be exacerbated by the restoration, additional flood protection is not included in the cost estimates provided here. However, it may be desirable to consider further flood protection for these areas, whatever the final decision as to the future management of Capitol Lake.

General Administration Powerhouse

2.5 Salinity

Vegetation in the vicinity of the restored estuary will be affected by the introduction of salt water into the basin as well as by tidal fluctuations in water level. The USGS 2006 study investigated near-bed salinity for the different restoration scenarios. The simulations predicted a steady salinity gradient, increasing from freshwater at the base of the falls at the south end of the South Basin up to 20 ppt or more in the North Basin. The predicted salinity was similar for all three alternatives.

Table 2: Predicted Near-Bed Salinity in the Restored Estuary

Location	Average Annual Near-Bed Salinity (ppt)	Dry-Season Near-Bed Salinity (ppt)
South Basin	0 – 3	0 – 5
Middle Basin	5 – 15	5 – 20
North Basin	15 – 20	20 – 25
Budd Inlet	28	28

The introduction of brackish water will cause the die-off of some existing freshwater vegetation, followed by natural recruitment of transitional and salt-tolerant vegetation. This report suggests that, for the most part, this change in vegetation be managed adaptively by monitoring the succession of vegetation types. The removal of invasive plants and planting of desirable plants would be performed as necessary. Some mechanical removal of dying vegetation may be necessary to maintain water quality.

2.6 Slope Stability

Slope stability along Deschutes Parkway, which runs along the western shoreline of the North and Middle Basins, could be adversely affected by the introduction of tidal fluctuations (AGI Technologies 2000; Entranco 2000). Much of the embankment will be regularly wetted and dried. Under rapid drawdown, the excess pore pressures within a slope can substantially reduce slope stability, and can in an extreme case cause a deep-seated slope failure. AGI Technologies recommended alternatives such as the construction of toe drainage, slope retaining structures, regraded slopes, geogrid-reinforced embankment fill slopes, and/or other measures. The present study suggests the addition of a rock buttress to weigh down the soft slope, combined with the use of dredged materials over the rock buttress to provide intertidal habitat. Details of the proposed slope stability improvements are given in Section 3.5.

In contrast to the west shoreline, which was extensively investigated after the Nisqually Earthquake, little geotechnical information is available for the east shoreline of Capitol Lake, in the Middle and South Basins. This area is characterized by bluffs that are likely to be relatively dense and less prone to instability. In contrast to the filled area underlying Deschutes Parkway, these areas are natural formations that were present for many years prior to the impoundment of Capitol Lake. It is possible that some isolated areas may experience downslope movement during rapid water drawdown. The currently available geotechnical information does not allow the stability of the bluffs, particularly towards the south where there are homes relatively close to the bluff edge, to be fully assessed. Additional geotechnical investigations would be needed as part of the further design process for the restoration of tidal flow into the Deschutes Estuary.

2.7 Scour

The restoration of tidal flow into the Deschutes Estuary will increase the quantity of water flowing through the narrow bridge openings (Fourth/Fifth Avenue Bridges, the Railroad Bridge, and the I-5 Bridge). A full scour analysis for the existing and new bridges, as well as for the toe of the reflecting pool barrier in Alternative D, was outside the scope of the present study. A full scour analysis would be a necessary part of the final design of the proposed restoration.

Two sources were used to estimate the extent of bridge scour and to design and develop cost estimates for scour protection and/or foundation modification at each bridge. USGS (2006) provided estimates of the long-term erosion anticipated at each bridge as a result of the restoration of tidal flow, together with peak velocity estimates for each bridge. Entranco (2000) provided estimates for the peak flood-induced scour at each bridge. The peak velocity estimates provided by USGS were generally consistent with those provided by Entranco.

Based on these references, best-case and worst-case scour estimates were made for each bridge and for each contribution to the total scour, assuming no new scour protection. The different scour contributions are as follows:

- Long-Term Erosion: The drop in the bed elevation that occurs as the overall bathymetry in the vicinity of the bridge adjusts to a new equilibrium in the years after the restoration of tidal flow.
- Contraction Scour: Loss of material from the bed across all or most of the channel width, resulting in the contraction of the flow area between under the bridge and the corresponding flow acceleration.
- Pier Scour: Loss of material around the piers caused by the acceleration of flow and by flow vortices caused as the water flows around the obstruction.

Table 3: Bridge Scour Estimates

Bridge	Long-Term Erosion	Contraction Scour	Pier Scour	Total Scour
Fourth Avenue Bridge (existing)	5 feet	0-5 feet	5-20 feet	10-30 feet
Fifth Avenue Bridge (new)	5-10 feet	0-5 feet	5-20 feet	10-35 feet
Railroad Bridge (existing – Alts A&D)	5-10 feet	5-10 feet	10-30 feet	20-50 feet
Railroad Bridge (new – Alt B)	0-5 feet	0	5-20 feet	5-25 feet
I-5 Bridge (existing)	0-5 feet	0-5 feet	5-20 feet	5-30 feet

Scour at the base of the reflecting pool barrier is estimated at approximately 5-15 feet.

These estimates were used in the design of the new bridges and to evaluate the degree of retrofit scour prediction needed for existing bridges.

3. Engineering Evaluation of Project Elements

3.1 Introduction

The purpose of this section is to discuss some of the significant engineering issues, construction methods, and other decisions made during the development of the preliminary designs and cost estimates shown here. More detailed assumptions are given in the appendices.

3.2 New Fifth Avenue Bridge

The main element common to all alternatives is a new Fifth Avenue Bridge with a 500-foot span to allow free tidal flow. Exhibit 5 illustrates a possible bridge and roadway alignment, elevation, and section.

The proposed roadway alignment has been discussed with the Public Works department at the City of Olympia, and is consistent with previous studies of the corridor (City of Olympia 1995). Specific issues and assumptions related to the proposed alignment include the following.

Utility Lines at Dam

- Major utility lines (including potable water and sanitary sewer) cross over the dam. These utility lines would be temporarily relocated to the Fourth Avenue Bridge during construction, and would return to the Fifth Avenue Bridge after construction.
- The new bridge provides four lanes of traffic, with bicycle and pedestrian lanes on each side.
- The railroad track that currently runs along the west side of Deschutes Parkway and Budd Inlet in the vicinity of the bridge is anticipated to be abandoned. The proposed layout will support Deschutes Parkway and 5th Avenue west of the bridge on fill, which is less costly than a continuation of the elevated bridge structure (which was used in the Fourth Avenue Bridge).
- The City has plans to construct a pedestrian trail along the abandoned railroad corridor. The pedestrian trail will pass along the east side of Deschutes Parkway and under the new bridge – similar to the pedestrian walkway that currently exists under I-5.
- A separate pedestrian trail will pass over the bridge to downtown Olympia. Exhibit 5 illustrates a possible stairway to allow pedestrian access from the bridge to the new pedestrian trail along Budd Inlet.
- The main traffic flow over the new bridge is anticipated to be between downtown Olympia and the roundabout. A T-junction between Deschutes Parkway and 5th Avenue allows for northbound traffic to turn left onto 5th Avenue (which is not currently legal), as well as for westbound traffic on 5th Avenue to continue west towards the roundabout, or to turn left onto Deschutes Parkway. Traffic signals at this intersection are not recommended, since they could cause a backup from the T-junction to the roundabout. However, alternative configurations (such as a dedicated left turn pocket on 5th Avenue) are possible, and would be investigated, in coordination with a detailed traffic flow study, if this design were taken further.

Structurally, a standard WSDOT precast, prestressed concrete girder bridge is proposed. This is a relatively low-cost and well-understood bridge type, illustrated in Figure 2.

Figure 2: Precast Concrete Girder Bridge

It is not anticipated that this bridge would be as sculptural as the recently constructed Fourth Avenue Bridge (see Figure 3), which was designed to replicate the historical bridge at that location. Nevertheless, there are opportunities for aesthetic elements. Railings and light standards could be selected to complement or match the Fourth Avenue Bridge.

Figure 3: Recently Constructed Fourth Avenue Bridge

The bridge is supported on drilled shafts. The shafts are installed sufficiently deep that scour protection is not required for each column – riprap scour protection is provided only at the bridge abutments. In contrast, the existing riprap scour protection at the recently constructed Fourth Avenue Bridge will need to be enhanced to allow for the tidal currents that will occur after the entrance to Capitol Lake is opened. This will not involve a much greater quantity of rock than is already present; however, the rock size will be increased.

The recently constructed Fourth Avenue Bridge will be affected in one other way. One of the bridge piers, directly east of the railroad track, stands on land at about MHHW. If no action is taken, the sediments around this pier would be scoured away as a result of the increased currents once the dam is opened. Rather than artificially maintain the ground surface at its current elevation, the approach will be to dredge around this pier and extend the cladding on this pier down to the anticipated final mud-line.

4th Avenue Bridge Pier to be Extended Down

One possible construction sequence for the new bridge and access roads is as follows.

1. Construct a temporary, two-lane, access road from Deschutes Parkway up the hill to the roundabout. This temporary access road would be slightly west of the final roadway alignment. A temporary retaining wall and fill would be constructed to bring the grade of the two-lane access road from the shoreline of Capitol Lake up to the roundabout. Access to the existing Fifth Avenue Bridge would be maintained throughout this construction phase, although with a reduced lane width on Deschutes Parkway.
2. Widen the temporary access road and complete construction of the new roadway west of the bridge (including the west and south legs of the T-junction). During the later parts of this phase, access to the existing Fifth Avenue Bridge would be cut off. Access from Deschutes Parkway to downtown Olympia would be via the roundabout and Fourth Avenue Bridge. The temporary retaining wall would remain in place as a new, permanent, retaining wall is constructed to retain fill for the entire new roadway.
3. Using land-based equipment, overexcavate around the Fourth Avenue bridge pier shown above. Place precast concrete cladding to match the existing piers, and place riprap scour protection around the base of the pier.
4. Construct a cofferdam around the Fifth Avenue Dam and extending east to the location of the planned new Fifth Avenue Bridge abutment on the east bank. This construction will include a 96-inch diameter pipe for bypassing Deschutes River flow past the cofferdam.
5. Working in the dry and using conventional equipment, demolish the dam, excavate the new channel within the area encompassed by the cofferdam, and construct the east abutment of the new bridge and associated riprap scour protection. Dam demolition should include the excavation of micropiles supporting the dam, in the vicinity of planned new bridge piers. Excavate sufficiently deep into the channel that significant scour is not anticipated as a result of the initial tidal fluctuations.
6. Remove the cofferdam, and allow tidal flow to enter the restored Deschutes Estuary. This should be performed at slack tide, during a neap tidal cycle, to decrease the immediate tidal flows through the new opening.
7. Using land-based equipment, complete demolition of the roadway and excavate the remainder of the 500-foot channel. (Parts of this work can be completed prior to allowing tidal flow to enter the restored estuary).
8. Construct the new Fifth Avenue Bridge across the newly opened inlet.

Several alternative construction methods are possible. For example, a much larger cofferdam could be used to allow the full 500-foot channel to be excavated in the dry. The construction sequence described here is only one possibility, intended to demonstrate feasibility.

The new alignment of Deschutes Parkway may extend further west than the current alignment. Even if this is not the case, temporary access from Deschutes Parkway to the roundabout may require extension to the west. This may call for some right of way acquisition. A single property, immediately south of the roundabout, would be affected; some non-buildable land (up to one-quarter acre) would be taken, but the single structure on the property itself would not be affected. The cost estimate provides an allowance to cover the right of way acquisition costs, including both compensation to the property owner and associated administrative costs.

Although this construction sequence is described first, it would occur near the end of the overall construction sequencing (see Section 5). This is because in-water construction is generally easier (and therefore less costly) if water levels can be controlled than if the construction equipment must cope with tidal fluctuations. Therefore, it is anticipated that the majority of construction will take place in Capitol Lake before the new Fifth Avenue Bridge is constructed and tidal flow is re-established.

3.3 New Railroad Bridge (Alternative B)

Alternative B includes a new railroad bridge and pedestrian bridge adjacent to Marathon Park, between the north and middle basins. Exhibit 6 illustrates a possible alignment and sections for the new railroad bridge. The purpose of the new bridge would be to provide a 500-foot opening, consistent with the opening at the entrance to Budd Inlet, and thereby to allow a less-constrained tidal flow into the middle and south basins.

As with the Fifth Avenue Bridge, the pedestrian bridge supports major utility lines (sanitary sewer and reclaimed water). These utility lines would be moved to the new railroad bridge after construction. This could be a permanent location, or (as shown) they could eventually be moved to the new pedestrian bridge.

The loading on a railroad bridge is much greater than the typical loading on a highway bridge, so a stronger foundation type is needed. One possible foundation type would include a grid of 15 steel pipe piles for each bridge pier, connected together by a concrete pile cap that supports the bridge piers. It is important that this concrete pile cap not be undermined as a result of scour, so riprap scour protection is proposed to be placed around each bridge pier. The riprap scour protection would be covered by normal estuarine sediments during normal flows – meaning it would have little impact on habitat. While it would be possible to select a foundation type that would not require any riprap placement, this would likely be more costly than that proposed here.

The proposed railroad alignment is slightly south of the current railroad alignment, so that the new railroad bridge can be constructed while the existing bridge remains in service. This will require fill placement at the south of Marathon Park, extending the existing levee up to about 30-feet to the south on the west bank. The fill placement will include a rock buttress, similar to that required along much of Deschutes Parkway (see Section 3.5). As described in the context of Deschutes Parkway, the rock buttress would be overlaid with dredge material or topsoil (depending on elevation) and planted with native vegetation.

One possible construction sequence is as follows.

1. Working from the land, place fill and rock buttress to the south of Marathon Park in the area needed to support the new railroad track.
2. Construct the new railroad bridge. Connect the railroad tracks to the new railroad bridge.

3. If desired, construct a temporary pedestrian access route. This could be a fixed or floating bridge.
4. Demolish the existing railroad bridge. Excavate the levee west of the existing railroad bridge, to provide the full 500-foot channel.
5. Construct the new pedestrian bridge across the inlet, along the alignment of the existing (old) railroad bridge.

Once the bridge construction is complete, some site work would be needed to clean up and make the best use of the new land area at Marathon Park. Placement of sediment and topsoil, and planting along the filled area south of the railroad track, would occur as part of the Deschutes Parkway stabilization work.

3.4 Barrier for Reflecting Pool (Alternative D)

The purpose of the reflecting pool barrier, in Alternative D, is to provide for the continued classical view of the State Capitol envisioned by the 1912 Olmstead Brothers Plan for the State Campus. This was an alternative proposal to the 1911 Wilder and White plan. The barrier would cut across the north basin in a generally north-south direction, preventing the water in the eastern part of the basin from emptying during low tide.

Given this basic layout, there are several permutations. The two main questions that were addressed during the engineering study were as follows:

- What materials should be used to construct the reflecting pool? Both rubblemound and sheet pile construction were considered.
- How should water quality in the reflecting pool be maintained? Two main alternatives were considered: a freshwater pool with a recirculation system and use of reclaimed water, and a saltwater pool with water regularly replaced by estuarine water.

With all alternatives, a pedestrian trail would be constructed atop the barrier, enhancing Olympia's trail system.

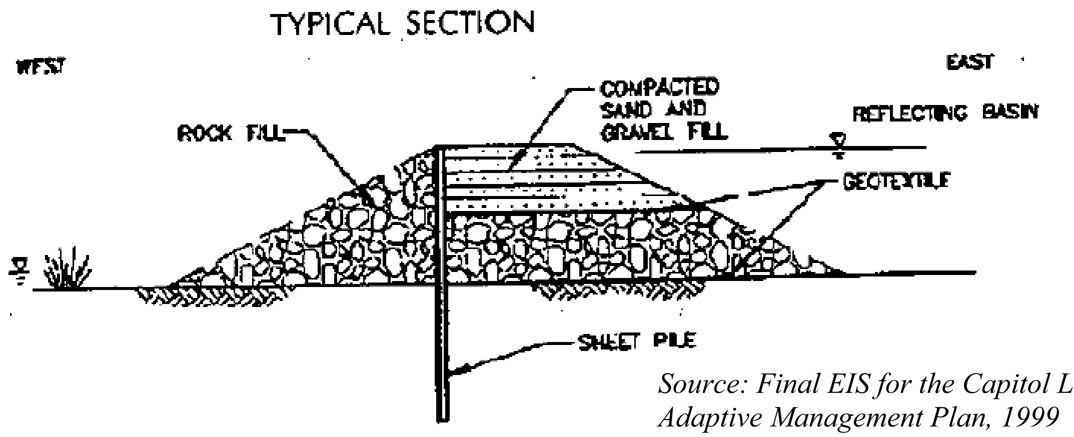
3.4.1 Barrier Materials

Initial discussions of the reflecting pool barrier assumed a rubblemound dike, possibly including a sheet pile section to retain water within the barrier. For example, the typical section in Figure 4 below was shown in the Final Environmental Impact Statement for the Capitol Lake Adaptive Management Plan (Washington Department of General Administration 1999).

There are three drawbacks to this approach. First, a very large amount of rock would be needed. Assuming a bottom surface elevation of -15 feet NGVD29 (which is fairly typical for the North Basin) a top elevation of +10 feet NGVD 29, a 2H:1V side slope as shown here, and a crest 10-feet wide, the dike would be 25 feet high and over 100 feet wide at the bottom. Even with a 1.5H:1V slope, the bottom width would be 85 feet. The wall is about 1,900 feet long, which would require approximately 150,000 tons of rock, sand, and gravel (assuming the design shown here).

Second, it would be difficult to place the rock, because the bottom sediments in the North Basin are soft and fine – weight for the fill over the soft surficial sediments will likely cause significant settlement and may well cause instability and overturning failures at the base. This settlement would result in great difficulties during construction and significantly increase the quantity of fill beyond that approximately estimated above, as well as increasing construction costs and time.

Figure 4: Rubblemound Alternative for Reflecting Pool Barrier



Source: Final EIS for the Capitol Lake Adaptive Management Plan, 1999

Finally, after construction, the west toe (within the estuary) would be highly susceptible to erosion that would reduce the rubble mound stability and cause failures. It is very difficult to create a sufficient erosion control surface over the embankment because the erosion will tend to extend into the softer silts beneath the barrier and embankment over time.

These considerations led to the investigation of a less massive and less risky option. A sheet pile wall, illustrated in Exhibit 7, would have a much smaller footprint than the rubblemound dike. The tip elevation of the sheet pile wall would be approximately -60 feet NVGD29, making the wall 70-feet top to bottom. Tailwalls, shown in Exhibit 7, would help stabilize the wall and support the concrete walkway. The extended part of the tailwall would be underwater at all times, so it would not be visually obtrusive.

This is not an inexpensive alternative. The price of steel has increased dramatically in recent years, and the sheet pile wall would be a heavy section. The estimated cost of the sheet pile alone would be \$8-\$12 million in 2006 dollars. However, the cost of the rubblemound dike could be very much higher depending on the final solutions to the geotechnical challenges associated with the soft bottom sediments. The sheet pile option is recommended because it is lower in risk and is less obtrusive than the rubblemound option.

3.4.2 Water Quality Within the Pool

Initial discussions of the reflecting pool assumed that it would be a freshwater pool, similar to the current reflecting pool, meaning that there would be no exchange of water between the pool and the estuary. With this assumption, it would be necessary to take measures to safeguard the water quality within the pool.

Water quality in artificial (or artificially impounded) lakes can be mechanically achieved through a combination of measures such as filtration systems and aeration systems.

- A gravel bed filtration system consists of a gravel bed at the lake bottom, with a pump that draws the lake water through the gravel bed. The gravel bed mechanically filters out particulate matter, while nutrients and organic matter are digested by bacteria within the gravel bed. With a soft bottom such as that in the North Basin, it may be necessary to line the lake with a PVC or similar liner to keep the gravel bed in place.
- A typical aeration system consists of an air compressor that provides an air flow, together with distribution tubing installed throughout the lake bottom. This continually adds oxygen to the water, and also provides the motive force to mix the lake water column.

- Water must be regularly added to the system in greater quantities than would be required simply to replace water lost to evaporation, to avoid concentrating alkalinity in the lake water. The water used could be the Class A reclaimed water provided by LOTT. Class A water is clean enough for virtually all uses except for drinking; it is specifically approved for stream flow augmentation and wetland enhancement. As such, it is not expected that it would adversely affect the water quality in the pool.

Based on discussions with specialty designers of such systems, the construction cost of an aeration and circulation system would be in the range of $3 million to $5 million (2006 dollars) (Alderman Engineering 2006). Ongoing maintenance requirements would include electrical and maintenance costs for the aeration system and 100,000 to 200,000 gallons per day of water (well within the capacity of the Class A reclaimed water available from the LOTT Budd Inlet treatment plant). These costs would be manageable. However, the system described here would be very artificial – not in keeping with the overall program of estuarine restoration.

In an attempt to design a more self-sustaining system, the possibility of a saltwater pool was considered. Two sets of culverts are let into the sheet pile barrier, one set at either end of the barrier. The culverts are fitted with flap-type tide gates, such that the culvert to the north (the inlet culvert) only allows flow into the pool while the culvert to the south (the outlet culvert) only allows flow out of the pool. The inlet culverts would be placed low in the water, close to the mudline, while the outlet culverts would be placed with an invert elevation of about +4 feet NGVD 29 (that is, about midway between mean tide level and MHHW). Exhibit 7 shows the locations of the proposed culverts and illustrates the tide gate at the inlet culvert; the outlet culvert would be similar. At each end, four culverts approximately 4 by 12 feet in size are provided to allow easy fish passage and to keep the maximum flow velocities below 3 feet per second.

As the water level in the estuary (outside the reflecting pool) drops from high tide, water in the reflecting pool will flow out of the outlet culvert until the water surface reaches an elevation of +4 feet NGVD29. The water level inside the pool will remain at this elevation – which is high enough to fill the reflecting pool – as the water level in the estuary continues to drop. When the tide rises past +4 feet NGVD29 again, water will flow from the estuary to the reflecting pool through the inlet culvert. This will cause an overall circulation of water within the reflecting pool – both horizontally (with overall flow from north to south) and vertically (since water enters the pool near the mudline and leaves it near the water surface). The residence time for water in the pool is estimated to be 4 days, which is less than the residence time for Capitol Lake under current summer conditions (11 days; CLAMP 1999). This suggests that the water quality in the pool should be an improvement over the current water quality within Capitol Lake.

This tidally flushed saltwater option is recommended over the freshwater option because it is generally self-sustaining, less costly, and less artificial.

3.4.3 Construction Methods

The vast majority of the construction for the sheet-pile reflecting pool barrier will be driving the sheet-pile wall. The steel sheet piles will be coated before installation to reduce rusting exacerbated by the saltwater environment. Additional protection may include sacrificial anodes.

The sheet-piles will be driven from a barge using a vibratory hammer. This works by reducing the friction between the sheet-pile and the soil to enable the sheet to penetrate the soil. Vibratory installation is much less noisy than traditional impact hammer installation. Once the sheet-piles are driven, the pedestrian walkway can be installed.

No scour protection is required – the depth of the sheet-piles is selected to avoid undermining due to scour.

3.5 Deschutes Parkway Stabilization and Channel Dredging

3.5.1 Slope Stabilization

Deschutes Parkway, along the west side of the North and Middle Basins, is constructed on roadway fill, generally gravelly sand, overlaid on native soils that are generally loose silts and sands with some gravel admixture. These native materials are subject to liquefaction and lateral spreading, resulting in shallow and deep-seated slope failures during earthquake conditions, such as that illustrated here from the 2001 Nisqually Earthquake.


Deschutes Parkway slope failure after the Nisqually Earthquake

Similar shallow and deep-seated slope failures could result from the rapid changes in water level, and the corresponding changes in pore water pressure, that would come with the restoration of tidal action. As water levels drop rapidly during an ebbing tide or a receding flood, the water within the soil drains less rapidly than the river water level, resulting in a build up of excess pore water pressure in the soil. As this excess pore water pressure increases, the effective strength of the soil, and the corresponding factor of safety, decreases. One way to protect against this is through soil improvement methods such as grouting, vibro-densification, or pinch piles. However, these methods tend to be costly, particularly for large sites such as the west side of the two basins.

A more cost effective method for stabilization is to add a rock buttress that weighs down and confine the soft slope. The amount of rock needed depends on the slope and soil conditions at the site: initial recommendations are shown in Exhibit 8. In the North Basin and adjacent to Percival Cove (sections A, B, and C), the existing slope is relatively steep, and the rock buttress would have to extend over the full intertidal range (from MLLW to MHHW). Further south, at sections D and E, the slope is more gradual and the rock buttress would have a smaller vertical extent. Typically, the rock buttress would be placed such that the toe is keyed in to the shoreline – the new rock surface would approximately match the current slope.

An important point is that the purpose of the rock buttress is not just erosion protection – stabilizing the slope against wave and current action – although if the rock slope were exposed then it would have a positive effect on preventing erosion. More importantly, the rock buttress protects against deeper slope failures. Additionally, the rock buttress would reduce the risk of a slope failure during certain sized earthquakes. Preliminary analysis indicates that the factor of safety against slope failures is on the order of 1.0 to 1.2 for a 100-year event, such as the Nisqually earthquake. With this level of factor of safety, some downslope movements could still occur in some areas, however, the size and extent of such failures is expected to be relatively small. However, during a larger event, such as a 500-year return period earthquake (i.e., the 1949 or 1965 events), the factor of safety reduces to less than one, resulting in more extensive downslope movements along larger portions of the slopes in the North and Middle basins.

3.5.2 Channel Dredging and Sediment Placement

While the shoreline along much of Deschutes Parkway is currently steep and protected with rock, it would not be in keeping with the intent of an estuary restoration to allow almost all of the western bank to be a rock slope – this has relatively low habitat value. The proposed shoreline treatment would place material dredged from Capitol Lake over the rock buttress, to provide intertidal estuarine habitat. This dredging and placement would have two goals:

- To approximate the long-term, evolved, condition of the estuary bathymetry, and thereby to reduce the quantity of sediment that would be flushed from the newly restored estuary into the marina and port areas in Budd Inlet.
- To provide intertidal habitat along Deschutes Parkway.

The intent would be to balance the dredging and fill.

The dredged material placement is *not* intended to provide structural stability or erosion protection. Upper portions will provide some erosion protection once vegetation is established; however, the hydrodynamic and sediment transport modeling shows that the shoreline along Deschutes Parkway is generally accretional or neutral rather than erosional (USGS 2006).

After placement of the marine sediments, the slope above the intertidal zone would be improved and treated with topsoil treatment, to allow a variety of riparian vegetation to flourish. Planting at the edge might include the following:

- Native seeding within the intertidal zone – primarily brackish sedges and rushes.
- Wetland herbaceous plugs at the upper intertidal zone.
- Native seeding (or possibly lawn) in the riparian zone.
- Woody trees and shrubs in the riparian zone.

The placement of dredged materials and sediments, together with an outline of the plantings, is shown in Exhibit 8.

The habitat benefits would include about 5 acres of new high marsh habitat. No additional intertidal mudflat habitat would be provided: as shown in Exhibit 8, the lake bottom in the areas receiving dredged materials is typically at lower intertidal elevations. However, the dredged material placement would allow the mudflat to transition more gradually to the upper intertidal high marsh habitat – a great improvement over a sharp transition via a steep rocky slope to the upland.

3.5.3 Dredge Quantities

The quantity of sediment proposed to be dredged is based on the modeling results of USGS 2006. Among other items, this report provides the quantity of sediment eroded from the Middle Basin in the first three years after restoration of tidal flow (assuming no initial dredging before restoration of tidal flow); and the quantity that settles in the marina and port areas in the same period. These predictions, shown in Table 4 on the following page, have a relatively large uncertainty, which results from a lack of knowledge about the erodibility of the bottom sediments in Capitol Lake. The bathymetry within the lake footprint is anticipated to approach equilibrium after three years.

The range in proposed dredge quantities is based on the USGS predictions of the quantity to be eroded from the Middle Basin, and deposited in the marina and port areas, in the first three years after restoration of tidal flow:

- The minimum dredge quantity is equal to the minimum predicted erosion from the Middle Basin; this is similar to the quantity required to construct the edge treatment shown in Exhibit 8 with a 50% overfill ratio.
- The maximum dredge quantity is the smaller of the maximum predicted erosion from the Middle Basin and the maximum predicted deposition in the marina and port areas.

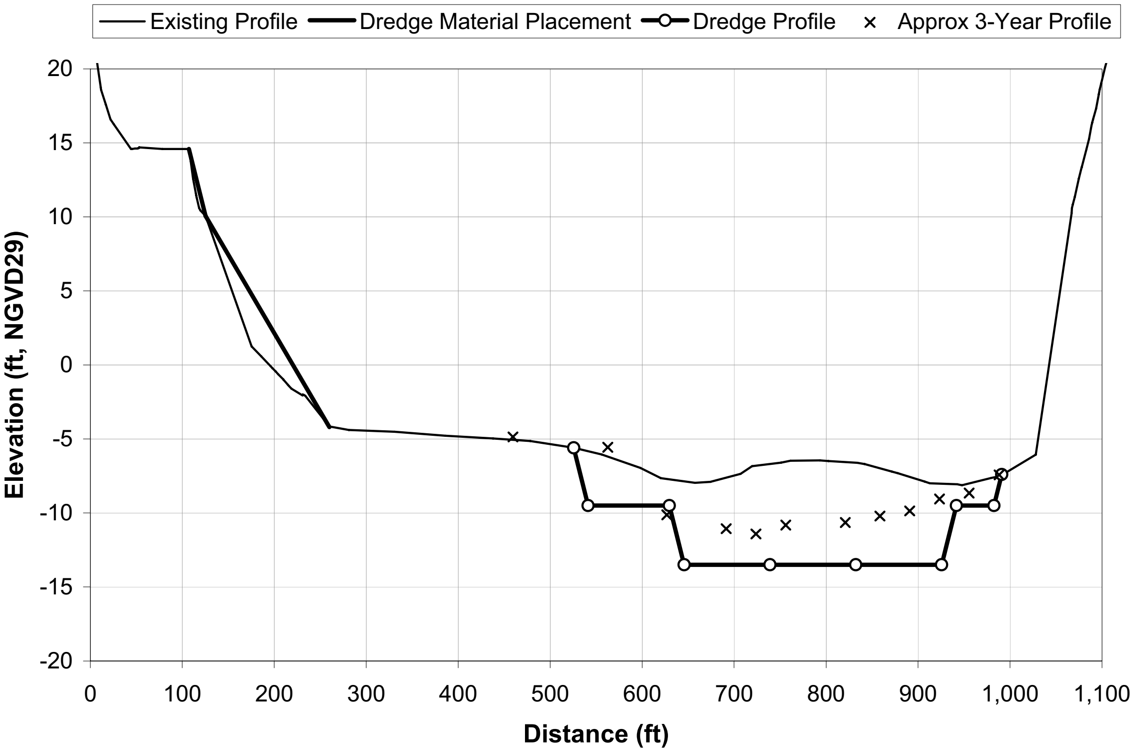
For Alternatives A and B, between 180,000 and 360,000 cubic yards of material would be dredged from the Middle Basin and along the main tidal channel and placed over the buttressed slope. For Alternative D, the quantity dredged and placed would be between 180,000 and 420,000 cubic yards. More sediment is anticipated to settle in the marina and port areas under Alternative D because the eastern half of the North Basin is not available to trap sediment in that alternative.

Table 4: Predicted 3-Year Sediment Erosion and Settlement

Quantity	Minimum (low erodibility)	Maximum (high erodibility)
Alternative A		
Eroded from Middle Basin (cy)	180,000	360,000
Settled in Marina and Port (cy)	160,000	440,000
Alternative B		
Eroded from Middle Basin (cy)	180,000	360,000
Settled in Marina and Port (cy)	160,000	420,000
Alternative D		
Eroded from Middle Basin (cy)	180,000	420,000
Settled in Marina and Port (cy)	220,000	480,000

Figure 5 illustrates a representative set of sections across the Middle Basin (the plateau at about +15 feet NGVD29 is Deschutes Parkway). The existing section, proposed sections, and the anticipated section after 3 years in the absence of initial dredging, are all shown. Note that the cut and fill are not balanced across each individual cross section – only across the project as a whole.

Figure 5: Representative Dredging and Placement Sections for the Middle Basin



3.5.4 Construction Methods

Construction would most likely work from one end of Deschutes Parkway to the other, with the different activities described below occurring in parallel at different parts of the roadway. One possible construction method would be to draw down the water in the lake to about -5 feet NGVD29 (a little higher than MLLW), allowing the edge work to be carried out using land-based equipment.

1. Using land-based equipment, excavate the toe of the slope to allow the rock buttress to be keyed in. Any existing slope protection rock would be stockpiled for reuse. Place the rock buttress, working from the toe of the slope to the upper slope within each shoreline section.
2. Construct rock dikes along the toe of the slope using wide-tread or low-pressure tired equipment working on the mud flat. The rock dike will act as an offshore containment berm for the sediments placed in step 3.
3. Use hydraulic dredge equipment to dredge the channel with pipeline delivery of the dredge material slurry to the slope behind the low dike. More than one machine could work the lake to cut down on the construction time. Let the slurry water (supernatant) drain back into the lake and recycle with the dredging process.
4. After the dredged materials on the slope behind the dikes drain and dry, use the wide-tread or low-pressure tired equipment to smooth and shape it.
5. Remove the rock toe dikes. Apply any topsoil treatment to the upper slopes, together with other treatment (e.g., jute matting for short-term stabilization) that is required.
6. Hydroseed the slopes with appropriate intertidal and riparian vegetation. Plant any herbaceous plugs and/or woody trees and shrubs.

The final construction methods will selected by the successful bidding contractor. The contractor will develop the work plan based on their experience and available equipment. For example, there are at least two alternatives to the use of wide-tread or low-pressure tired equipment suggested in steps 2 and 4 above.

- The first option (using conventional equipment on mats) involves placing steel plates on the soft sediments to provide a mat or pad upon which conventional equipment can run and operate from. The method would involve placing several overlapping steel plates from the shore to the work area. The steel plates are similar to those used on the streets to temporarily cover excavated utility trenches. The plates would be laid ahead of the equipment as it moves along the shoreline during construction. Timber planks can also be used in lieu of the steel plates. When the work is complete, the plates or planks will be removed from the lake and salvaged for future projects.
- The second option involves working from shore using extended boom cranes or extended arm excavators from a stable shoreline pad. Extended boom cranes and extended arm excavators can typically reach out about 100 feet; specialty equipment is available that can reach even further

The contractor may elect to do something different again; the methods described here are intended to demonstrate feasibility, not to dictate the construction method.

The final design of the slope should take into account that the dredged sediments may bulk up during placement. The soft dredged materials would be reworked by wave and tidal action after placement. Over the long term, the slope would approach a more natural profile, with a shelf in the vicinity of MHHW and flatter mudflats beneath. The sediment transport study (USGS 2006) predicts that the areas adjacent to the shoreline will accrete over the long term, so the mudflats should be stable. In the short term, some erosion can be anticipated. This will be limited by the establishment of vegetation; in the worst case it could expose the rock buttress in places. If this does occur, a retrofit of soft shoreline protection such as large woody debris could be applied.

3.6 Bridge Scour Protection

Scour protection at the new bridges will be minimized by design. The drilled shaft foundations for the new Fifth Avenue Bridge will be designed to support the bridge even in the event of the scour anticipated during a major flood event – only the side slopes will be treated with rock. While rock will be used to protect the pile caps in the new railroad bridge from undermining, that rock will be buried so that it is only exposed during major flood events.

Existing bridges, however, have not been designed for the high currents that will be introduced by daily tidal flows or by high river flows that are not slowed by the impoundment at Capitol Lake. It will therefore be necessary to retrofit these bridges with rock scour protection.

- The existing scour protection at the I-5 Bridge will not require much upgrade. The tidal prism upstream of this bridge is relatively small, so the currents induced by tidal action will be correspondingly small. In addition, the high currents resulting from riverine flooding will not be increased greatly by the free flow of the river. The only change is that the size of the rocks currently protecting the banks may need to be replaced by larger-sized rock. The existing rock could be reused elsewhere in the project.
- The existing railroad bridge, which will remain in place for Alternatives A and D, will require significant scour protection because of the narrow channel. (While the original railroad bridge was constructed before the impoundment of Capitol Lake, it has been extended and modified since that time). Most likely it will be necessary to place rock across the entire river channel in this area.
- The recently constructed Fourth Avenue Bridge has light scour protection at the base of the bridge piers. As with the I-5 bridge, it is recommended to replace this light scour protection with a similar quantity of larger rock to withstand the tidal flows.

A detailed scour study would be needed at a later stage in design to identify the precise scour protection requirements at each bridge.

3.7 Existing Wetland and Recreational Facilities

The extensive network of parks, trails, and habitat areas surrounding Capitol Lake will be modified by the presence of tidal fluctuations and saltwater influence. Some of these facilities, for example, the restrooms at Marathon Park, will be unaffected. Others, such as the boat float at Marathon Park, will have to be modified, replaced, or relocated – the boat float would be stranded in mudflats over much of the tidal range. Some of the most significant items that have been identified are the following.

- At Tumwater Historical Park, the marsh trails are at relatively low elevations and would be flooded at high tide. These trails could be replaced with elevated boardwalks.
- At Capitol Lake Interpretive Park, the current freshwater wetland would be replaced with a saltwater wetland. There are culverts in place that allow water levels within and outside the wetland to equilibrate. However, with the

Tumwater Historical Park Trail

greater tidal fluctuations, it would be beneficial to replace these with bridges that allow for lower currents and free fish passage. It may also be necessary to raise some of the trail elevations at this park and to provide for erosion and/or slope stability protection along parts of the berm.

- The canoe launch and overlook at Capitol Lake Interpretive Park could be rebuilt and/or relocated to allow for the tidal variations in water level.
- At Marathon Park under Alternative B, the new pedestrian bridge, the realignment of the railroad track, and the changes in upland area (increased to the south while decreased to the east) would lead to some upland redevelopment – including modifications to the pedestrian trail and landscaping. The boat launch would be modified or relocated under all alternatives.
- There would be little change to the recreational facilities at Heritage Park. The bulkhead may require modification; this is described under the following section.

A detailed design process will be needed to identify and plan for all of the necessary changes.

At all recreational facilities, changes or upgrades to the interpretive signage would be appropriate. Throughout the shoreline, including Percival Cove, the progression of vegetation (including die-off of freshwater species and the establishment of both desirable and undesirable salt-tolerant species) should be carefully monitored in the years after reestablishment of tidal flow. Removal of decaying vegetation, removal of invasive species, and replanting would be carried out as needed based on this monitoring program.

3.8 Additional Protection and Upgrade Work

Additional protection and upgrade work to protect miscellaneous infrastructure would be identified during later design stages. Items that have been identified to date include the following.

- Stormwater outfalls along Deschutes Parkway would be replaced as part of the Deschutes Parkway stabilization work.
- Metal stormwater outfalls elsewhere in Capitol Lake would be identified and replaced, since they would not withstand attack by salt water. In particular, a number of metal outfalls have been identified as penetrating the bulkhead at the Arc of Statehood.
- The Arc of Statehood itself was not designed to withstand salt water. In particular, the thickness of concrete overlaying steel reinforcement does not match marine standards, and the concrete mix may not be adequate for marine standards. Nevertheless, given that it is of recent and high-quality construction, the concrete may be adequate to protect the steel reinforcement. It is recommended that the concrete be tested for integrity before the overall construction program begins. If necessary, the concrete would be coated with an epoxy mix for protection. This would involve excavating down to the concrete footing to expose the entire concrete surface.

As described in Section 2.4, many of the parks around Capitol Lake are vulnerable to flooding, and will remain so whether or not the estuary restoration is accomplished. Flood protection measures, while desirable, are not included in the present cost estimate.

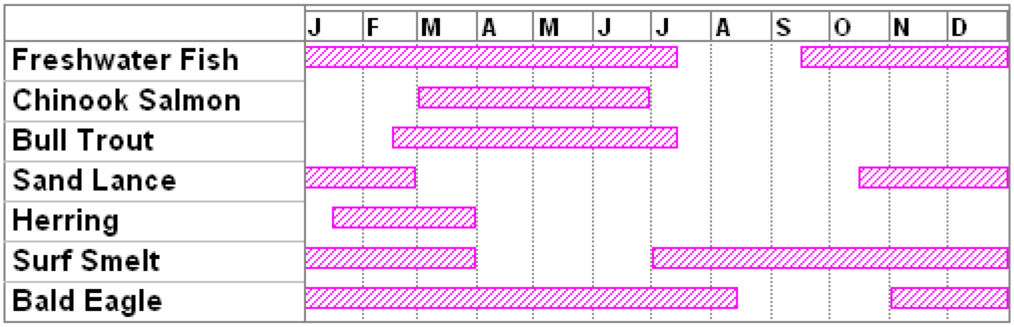
4. Regulatory and Permitting Issues

4.1 Overview

Any one of the three restoration alternatives would have an overall positive effect on the environment by bringing the area back into its more natural and historic condition. This suggests that the regulatory agencies will generally be supportive of the project, and that separate mitigation (beyond the use of construction Best Management Practices) will not be required. However, public approval of the project will require significant outreach and discussion; permit timing and approval for this project would most likely be dictated by the public review process. Given the scope and complexity of the proposed restoration project, it is critical that the planning and design be developed so as to provide the optimal net benefit to all potential users of the area: plants, fish, animals and people.

An Environmental Impact Statement (EIS) will be required for the project. Endangered Species Act (ESA) consultation will require a Biological Evaluation (BE) or a Biological Assessment (BA) report. Current fish and bird windows for Olympia, shown in Figure 6, indicate that there are no clear openings for project construction due to the multiple overlapping closures. Therefore, studies will be required to identify species presence (or absence) to create a construction window for this project.

Figure 6: Published Fish and Bird Windows for Olympia



The construction schedules shown in the next section assume that only the chinook salmon and bull trout windows will be observed, with minor restrictions at other times. The rationale for this is based on the likely effects of construction on the different species.

For example, bald eagle nesting could potentially be disrupted by the noise from project construction if there are active nests in the vicinity of the project site at the time of construction. Bald eagle wintering activities occur from October 31 to March 31, with nesting occurring from January 1 to August 15. Since bald eagles in the vicinity of Olympia are accustomed to urban environments, it is likely that the regulatory agencies will allow construction to continue through the nesting and wintering activities, with the use of appropriate Best Management Practices (BMPs). Likely BMPs include: vibrating rather than impact driving steel piles where possible; the use of noise shrouds to reduce pile driving noise in air, if there are eagles likely to be affected in the vicinity; and monitoring both noise levels and eagle behavior at critical periods. With proper BMPs, it does not appear that bald eagles are likely to constrain the schedule significantly.

As a second example, there are no known surf smelt or sand lance spawning beaches within or within a mile of Capitol Lake. As a result, these windows are unlikely to affect the construction schedule.

4.2 Permits and Approvals Required

The permitting of the Deschutes Estuary restoration project is multifaceted. A variety of permit applications will need to be prepared, submitted and approved. The following list outlines the most likely regulatory and permitting requirements.

- NEPA: Federal funds may be needed for a project of this magnitude, which would trigger specific NEPA requirements.
- SEPA Environmental Impact Statement: Required. Washington State Department of General Administration will probably be lead agency for this.
- Washington Department of Natural Resources (DNR) Lands Lease: A tidelands lease, easement, or right of entry may be required. Additionally, depending on how the dredge materials are handled, a royalty may be owed to the State.
- U.S. Army Corps of Engineers (Corps) Section 10/404 Permits: These are initiated through the Joint Aquatic Resource Permit Application (JARPA). A Section 10 permit is required for work in or under navigable waters of the United States; a Section 404 Permit is required for in-water discharge of dredged or fill material. Copies of the completed JARPA will then be submitted to the Corps for Section 10/404 Permits, to WDFW for a Hydraulic Project Approval (HPA), and to the Cities of Olympia and Tumwater for a Shoreline Substantial Development Permit.
- BE/BA, including the Essential Fish Habitat: The BE/BA is required due to federal nexus with Corps permitting. A BE/BA report with a Not Likely to Adversely Affect (NLAA) or Likely to Adversely Affect (LA) effects determination will be needed.
- Washington Department of Ecology (Ecology) Section 401 Water Quality Certification: Required with federal permitting, triggered by the Corps.
- Ecology National Pollution Discharge Elimination System Stormwater Permit for Construction: Will be required.
- WDFW HPA: Initiated through the JARPA process. Required as activity is waterward of the Ordinary High Water Mark (OHWM).
- City of Olympia and City of Tumwater Shoreline Substantial Development Permits: Required as project involves substantial work within 200 feet of the marine shoreline. Since most of the South Basin and parts of the Middle Basin are within the City of Tumwater, a combined or parallel process would be required for the Cities of Olympia and Tumwater.
- City of Olympia and City of Tumwater Critical Areas Ordinance: Compliance and mitigation required to the extent project would affect designated wetlands, fish and wildlife habitat areas.
- Other City of Olympia and City of Tumwater Permits and Approvals: These may include: Demonstrating compliance with Zoning and Comprehensive Plan and with Flood Hazard Ordinance; Grading Permit; and Site Development Permit among others.

4.3 Dredging and Fill

The channel dredging program outlined in Section 3.5 will likely call for sediment sampling and analysis beyond that already carried out. The sampling results reported by Herrera (2000a&b) were reviewed relative to Washington State Sediment Management Standards (SMS) for marine sediments to evaluate general sediment quality with respect to reuse of in-water materials as near-shore fill. Marine SMS criteria were used for this evaluation because the SMS have not established criteria for freshwater sediment at this time. The data generally indicate the following:

- Benzoic acid, benzyl alcohol and phenol are present in sediment samples at three stations at concentrations that could potentially affect aquatic organisms. Additional chemical analysis and/or bioassays would likely be required prior to approval of material dredged from these stations for use as in-water fill; however, the material may be suitable for use as upland fill.
- General sediment quality at the remaining stations appears to be potentially suitable for both in-water and upland fill. However, additional chemical analysis would be needed to verify suitability. The analyses reported by Herrera (2000a&b) were not sufficiently sensitive to detect all of the relevant organic compounds at concentrations that would prohibit their reuse as near-shore fill, according to the marine SMS evaluation criteria.

In other words, it currently appears that the sediment quality in the lake is adequate to allow for the project as described in this report. Further sediment sampling will be necessary to confirm this. In particular, the recent discovery of dioxins at the Port of Olympia's dredged navigation channel highlights the risks associated with dredging in urbanized areas.

5. Schedule

5.1 Public Process and Regulatory Schedule

At the national level, Sunding & Zilberman (2002) have studied the economics of completing an Individual Wetland Fill permit through the Corps. They found that the average applicant for an individual permit spends 788 days in completing the process, not counting costs of mitigation or design changes. It is a well known fact that most of the United States does not have the level of environmental permitting and review that projects in Washington experience. With that in mind, and the fact that this is such a large project in the middle of an environmentally sensitive city, the time scale and process associated with federal, state, and local permitting should be anticipated to be at least twice this time – or 4 to 5 years. If a decision were made to proceed with the project in mid-2007, this would allow for construction to start by mid-2012.

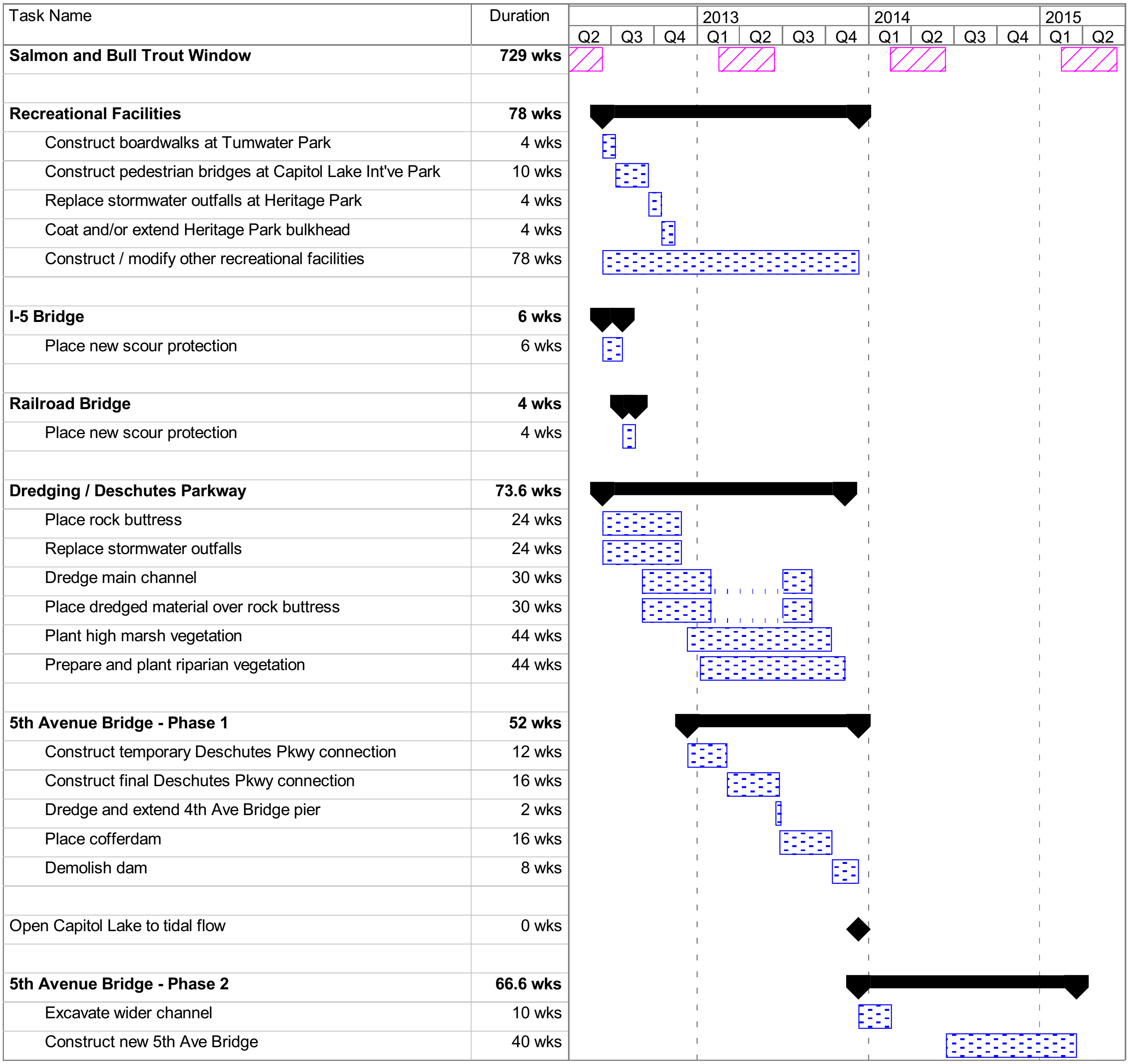
As is typical with marine projects in Washington, the regulatory rather than the engineering process is likely to control the construction start date.

5.2 Construction Schedule

Outline construction schedules have been developed for the three alternatives described above. These schedules, shown on the next three pages, assume that in-water work will be allowed from mid-July to mid-February of each year – completely avoiding only the salmon and bull trout windows. In addition, it is assumed that barges will be allowed throughout the year, if required, to act as work platforms for construction of bridge decks and similar over-water work. Current standard BMPs, such as the use of bubble curtains during steel pile driving, are assumed.

With these assumptions, and multiple elements of the project occurring simultaneously, a minimum construction timescale of three to four years is predicted. With construction starting in mid-2012, the dam would be opened at the end of 2013 and the Fifth Avenue Bridge complete in early 2015. This timescale could increase dramatically depending on the timing requirements and work practices imposed by the regulatory agencies.

Figure 7: Outline Construction Schedule – Alternative A



Task Name	Duration
Salmon and Bull Trout Window	**729 wks**
Recreational Facilities	**78 wks**
Construct boardwalks at Tumwater Park	4 wks
Construct pedestrian bridges at Capitol Lake Int've Park	10 wks
Replace stormwater outfalls at Heritage Park	4 wks
Coat and/or extend Heritage Park bulkhead	4 wks
Construct / modify other recreational facilities	78 wks
I-5 Bridge	**6 wks**
Place new scour protection	6 wks
Railroad Bridge	**4 wks**
Place new scour protection	4 wks
Dredging / Deschutes Parkway	**73.6 wks**
Place rock buttress	24 wks
Replace stormwater outfalls	24 wks
Dredge main channel	30 wks
Place dredged material over rock buttress	30 wks
Plant high marsh vegetation	44 wks
Prepare and plant riparian vegetation	44 wks
5th Avenue Bridge - Phase 1	**52 wks**
Construct temporary Deschutes Pkwy connection	12 wks
Construct final Deschutes Pkwy connection	16 wks
Dredge and extend 4th Ave Bridge pier	2 wks
Place cofferdam	16 wks
Demolish dam	8 wks
Open Capitol Lake to tidal flow	0 wks
5th Avenue Bridge - Phase 2	**66.6 wks**
Excavate wider channel	10 wks
Construct new 5th Ave Bridge	40 wks

Figure 8: Outline Construction Schedule – Alternative B

Task Name	Duration
Salmon and Bull Trout Window	**729 wks**
Recreational Facilities	**78 wks**
Construct boardwalks at Tumwater Park	4 wks
Construct pedestrian bridges at Capitol Lake Int've Park	10 wks
Replace stormwater outfalls at Heritage Park	4 wks
Coat and/or extend Heritage Park bulkhead	4 wks
Construct / modify other recreational facilities	78 wks
I-5 Bridge	**6 wks**
Place new scour protection	6 wks
Railroad Bridge	**84.4 wks**
Widen levee at Marathon Park	6 wks
Construct new railroad bridge	44 wks
Demolish existing bridges and excavate 500' span	12 wks
Construct new pedestrian bridge	20 wks
Dredging / Deschutes Parkway	**73.6 wks**
Place rock buttress	24 wks
Replace stormwater outfalls	24 wks
Dredge main channel	30 wks
Place dredged material over rock buttress	30 wks
Plant high marsh vegetation	44 wks
Prepare and plant riparian vegetation	44 wks
5th Avenue Bridge - Phase 1	**52 wks**
Construct temporary Deschutes Pkwy connection	12 wks
Construct final Deschutes Pkwy connection	16 wks
Dredge and extend 4th Ave Bridge pier	2 wks
Place cofferdam	16 wks
Demolish dam	8 wks
Open Capitol Lake to tidal flow	0 wks
5th Avenue Bridge - Phase 2	**66.6 wks**
Excavate wider channel	10 wks
Construct new 5th Ave Bridge	40 wks

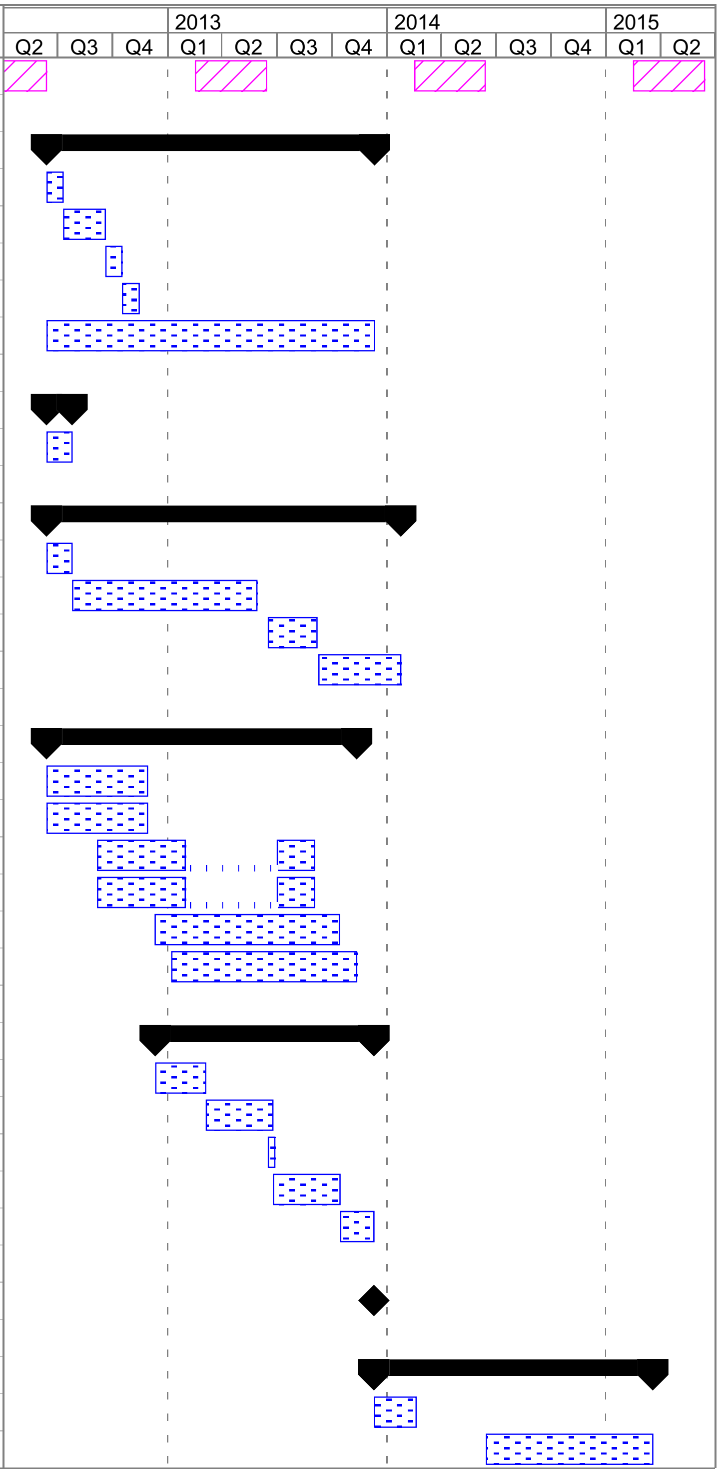
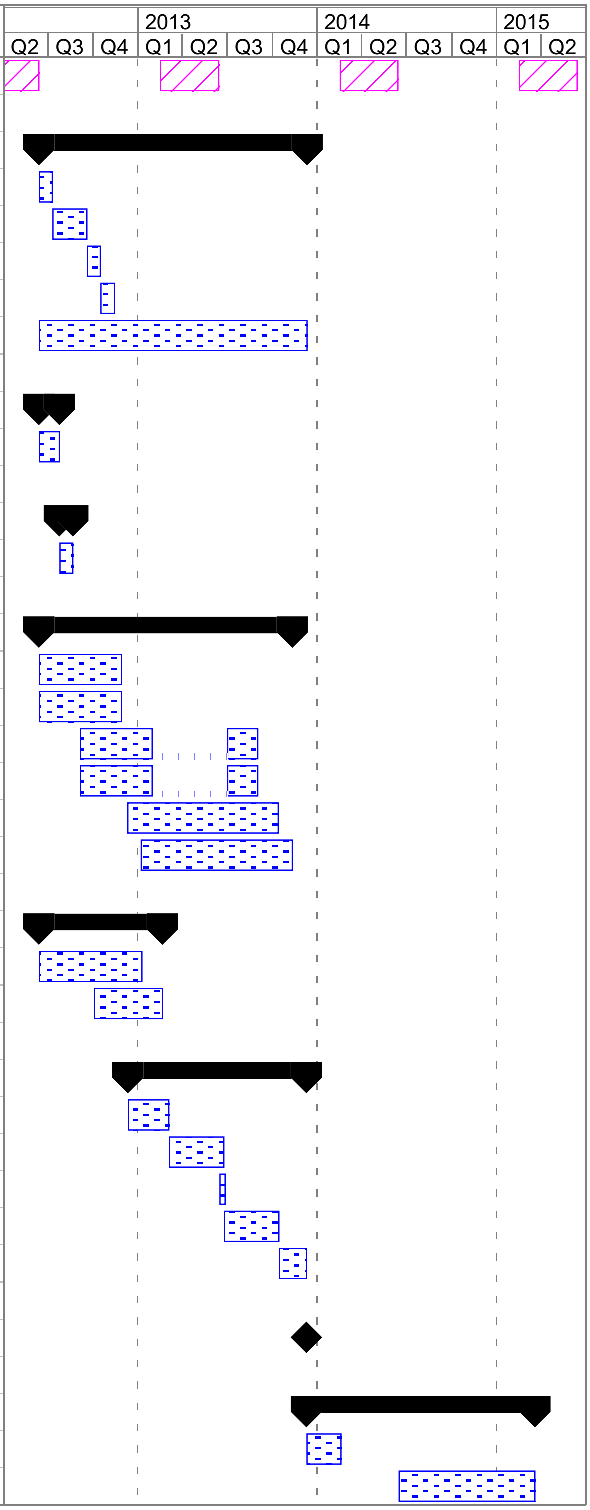


Figure 9: Outline Construction Schedule – Alternative D

ID	Task Name	Start
1	**Salmon and Bull Trout Window**	**2/16/12**
6		
7	**Recreational Facilities**	**6/14/12**
8	Construct boardwalks at Tumwater Park	6/14/12
9	Construct pedestrian bridges at Capitol Lake Int've Park	7/12/12
10	Replace stormwater outfalls at Heritage Park	9/20/12
11	Coat and/or extend Heritage Park bulkhead	10/18/12
12	Construct / modify other recreational facilities	6/14/12
13		
14	**I-5 Bridge**	**6/14/12**
15	Place new scour protection	6/14/12
16		
17	**Railroad Bridge**	**7/26/12**
18	Place new scour protection	7/26/12
19		
20	**Dredging / Deschutes Parkway**	**6/14/12**
21	Place rock buttress	6/14/12
22	Replace stormwater outfalls	6/14/12
23	Dredge main channel	9/6/12
24	Place dredged material over rock buttress	9/6/12
25	Plant high marsh vegetation	12/11/12
26	Prepare and plant riparian vegetation	1/8/13
27		
28	**Reflecting Pool Barrier**	**6/14/12**
29	Drive sheet piling	6/14/12
30	Construct concrete walkway	10/4/12
31		
32	**5th Avenue Bridge - Phase 1**	**12/12/12**
33	Construct temporary Deschutes Pkwy connection	12/12/12
34	Construct final Deschutes Pkwy connection	3/6/13
35	Dredge and extend 4th Ave Bridge pier	6/17/13
36	Place cofferdam	6/26/13
37	Demolish dam	10/16/13
38		
39	Open Capitol Lake to tidal flow	12/10/13
40		
41	**5th Avenue Bridge - Phase 2**	**12/11/13**
42	Excavate wider channel	12/11/13
43	Construct new 5th Ave Bridge	6/16/14



6. Cost Estimates

6.1 Cost and Design Variability: Three-Point Estimate

Cost estimates are first developed at an early stage in the design of any project, and updated as the project progresses through the stages of design and permitting. Since the project design will evolve through this process, the project cost estimate will also change. Traditionally, the unknowns in the project have been captured through the addition of a contingency factor, often 30%, added to the identified project costs. While this has often been successful in giving a reasonable prediction of the final construction costs, the provision of a single number still tends to overstate the precision with which costs can be identified at an early stage.

The development of a three-point cost estimate is an attempt to overcome the problem of overly precise estimates. The purpose of a three-point estimate is to capture the range of likely costs – including a minimum cost (most optimistic), either the average or the most likely cost, and a maximum cost (pessimistic but excluding very remote eventualities).

This report provides a low, average, and high cost estimate for each alternative. The low and high construction costs are defined as the 10% and 90% values – meaning that, based on the assumptions made here, there is a 10% chance that the eventual costs will be lower than the low value and a 10% chance that it will be higher than the high value provided here. See Appendix A for more details of the analysis.

A 30% contingency is added to each line item in the cost estimate, as shown in the detailed estimates in Appendices B through D. Other, non-construction items, such as engineering, geotechnical and other investigations, and permitting, are provided as a fixed percentage of these values. The 5% construction contingency shown in Tables 5 through 7 accounts for changes to the design during construction (e.g., due to unanticipated soil conditions), and is in addition to the overall 30% contingency.

6.2 Inflation

Construction costs over the past two to three years have increased dramatically – a shock in the price of steel was followed by dramatic increases in the price of concrete and petroleum-based products such as asphalt. This has led to an increased emphasis on the effects of inflation on construction cost estimates for long-term projects.

The effect of inflation on the overall project costs depends on two items: the year in which the mid-point of construction occurs, and the inflation rate between now and that year. This report provides costs for three construction periods: 2012-2014 (the earliest feasible date), 2016-2018, and 2020-2022.

Three inflation rates are used:

- 2%, based on economic forecasts of the Implicit Price Deflator (IPD) for personal consumption, as measured by the U.S. Department of Commerce. Washington State has typically used the IPD for determining inflation for state budgeting purposes because it is considered more representative of the general mix of goods and services purchased by the state than other indicators available (Washington State Economic and Revenue Forecast Council 2006).
- 3.5%, based on the Construction Cost Index (CCI) produced by Engineering News Record (ENR) for the years 1990-2005 (Engineering News Record 2006).

- 6%, based on the increases in construction cost experienced by WSDOT between 2001 and 2006 (WSDOT 2006 – the increase since 2001 was an average 12% annually but this is not expected to continue).

The results show that the variability in the year of expenditure dollar costs resulting from inflation is much greater than the variability associated with the uncertainties in quantities and unit costs. The costs associated with delaying the project could be significant.

6.3 Alternative A

Table 5 shows the costs developed for Alternative A. Construction costs in 2006 dollars are shown in the range $46.3 million to $61.0 million, with the average cost at $53.3 million. The majority of the costs are evenly divided between the 4th / 5th Avenue Corridor – the new Fifth Avenue Bridge and associated improvements – and the combination of Deschutes Parkway shoreline stabilization with channel dredging. Scour protection at the other bridges and parks and recreational improvements contribute much less to the overall project costs. A more detailed cost breakdown in shown in Appendix B, with line-by-line assumptions shown in Appendix E.

Much of the uncertainty in the total project costs, for all three alternatives, is associated with the channel pre-dredging. As described in Section 3.5.3, the range in dredging quantity results from a lack of knowledge about the erodibility of the bottom sediments in Capitol Lake (USGS 2006). The range in dredging unit cost is representative of the range obtained from recently constructed projects (see Appendix E). Because of the double-handling required to place the dredged material at the shoreline, the unit cost for this project is anticipated to be higher than the average for recent dredging projects of moderate size.

The addition of “soft” costs such as engineering and right of way acquisition increases the overall project cost to between $65.9 million and $87.2 million, with an average of $76.1 million. These costs are also in 2006 dollars.

The inclusion of inflation in the calculation increases the costs dramatically – to as much as $203 million, assuming project construction starting in 2020 and a construction inflation rate of 6% in the intervening years. Assuming average project costs and average (3.5%) inflation, with relatively early construction starting in 2012, the project cost in year of expenditure dollars would be $95.2 million.

6.4 Alternative B

Table 6 shows the costs developed for Alternative B. Construction costs in 2006 dollars are shown in the range $55.9 million to $71.6 million, with the average cost at $63.3 million. The higher cost relative to Alternative A is approximately $10 million associated with the new railroad bridge. A more detailed cost breakdown in shown in Appendix C, with line-by-line assumptions shown in Appendix E. As with Alternative A, much of the uncertainty in total project costs is associated with the channel pre-dredging.

The addition of “soft” costs such as engineering and right of way acquisition increases the overall project cost to between $79.6 million and $102.3 million, with an average of $90.3 million. These costs are also in 2006 dollars.

As with Alternative A, the inclusion of inflation in the calculation increases the costs dramatically – to as much as $238 million, assuming project construction starting in 2020 and a construction inflation rate of 6% in the intervening years. Assuming average project costs and average (3.5%) inflation, with relatively early construction starting in 2012, the project cost in year of expenditure dollars would be $112.9 million.

6.5 Alternative D

Table 7 shows the costs developed for Alternative D. Construction costs in 2006 dollars are shown in the range $65.9 million to $84.1 million, with the average cost at $74.5 million. The higher cost relative to Alternative A is approximately $20 million associated with the reflecting pool barrier. A more detailed cost breakdown in shown in Appendix D, with line-by-line assumptions shown in Appendix E. As with Alternative A, much of the uncertainty in total project costs is associated with the channel pre-dredging.

The addition of "soft" costs such as engineering and right of way acquisition increases the overall project cost to between $93.8 million and $120.0 million, with an average of $106.2 million. These costs are also in 2006 dollars.

As with the other alternatives, the inclusion of inflation in the calculation increases the costs dramatically – to as much as $280 million, assuming project construction starting in 2020 and a construction inflation rate of 6% in the intervening years. Assuming average project costs and average (3.5%) inflation, with relatively early construction starting in 2012, the project cost in year of expenditure dollars would be $133 million.

Table 5

ALTERNATIVE A - PROGRAM COSTS

PROJECT TOTALS IN 2006 DOLLARS DESCRIPTION		PRICE VARIATION LOW (10%)	MEAN	HIGH (90%)
CONSTRUCTION				
CHANNEL PRE-DREDGING		$8,660,000	$13,910,000	$19,810,000
4TH / 5TH AVENUE CORRIDOR		$19,750,000	$21,880,000	$24,040,000
RAILROAD BRIDGE - SCOUR PROTECTION		$130,000	$170,000	$220,000
DESCHUTES PARKWAY		$11,860,000	$14,410,000	$17,130,000
I-5 BRIDGE - SCOUR PROTECTION		$380,000	$490,000	$610,000
PARKS		$1,930,000	$2,480,000	$3,120,000
ESTIMATE OF CONTRACTOR'S BID		**$46,300,000**	**$53,300,000**	**$61,000,000**
CONSTRUCTION CONTINGENCY	5%	$2,315,000	$2,665,000	$3,050,000
SALES TAX	9%	$4,167,000	$4,797,000	$5,490,000
CONSTRUCTION ENGINEERING	10%	$4,630,000	$5,330,000	$6,100,000
RIGHT OF WAY ACQUISITION		$200,000	$400,000	$600,000
PUBLIC PROCESS, PERMITTING, ENGINEERING	15%	$6,945,000	$7,995,000	$9,150,000
STATE OVERSIGHT	3%	$1,389,000	$1,599,000	$1,830,000
PROJECT TOTAL (2006 DOLLARS)		**$65,900,000**	**$76,100,000**	**$87,200,000**

PROJECT TOTALS INCLUDING INFLATION			
INFLATION AT 2% (BASED ON IMPLICIT PRICE DEFLATOR)			
PROJECT CONSTRUCTION 2012 TO 2014	$75,000,000	$86,500,000	$99,200,000
PROJECT CONSTRUCTION 2016 TO 2018	$81,200,000	$93,700,000	$107,400,000
PROJECT CONSTRUCTION 2020 TO 2022	$87,900,000	$101,400,000	$116,200,000
INFLATION AT 3.5% (BASED ON ENR CONSTRUCTION COST INDEX, 1990-2005)			
PROJECT CONSTRUCTION 2012 TO 2014	$82,500,000	$95,200,000	$109,100,000
PROJECT CONSTRUCTION 2016 TO 2018	$94,700,000	$109,200,000	$125,200,000
PROJECT CONSTRUCTION 2020 TO 2022	$108,600,000	$125,300,000	$143,600,000
INFLATION AT 6% (BASED ON WSDOT CONSTRUCTION COST INDEX, 2001-2006)			
PROJECT CONSTRUCTION 2012 TO 2014	$96,500,000	$111,300,000	$127,500,000
PROJECT CONSTRUCTION 2016 TO 2018	$121,800,000	$140,500,000	$161,000,000
PROJECT CONSTRUCTION 2020 TO 2022	$153,800,000	$177,400,000	$203,300,000

Table 6

ALTERNATIVE B - PROGRAM COSTS

PROJECT TOTALS IN 2006 DOLLARS DESCRIPTION		PRICE VARIATION LOW (10%)	MEAN	HIGH (90%)
CONSTRUCTION				
CHANNEL PRE-DREDGING		$8,670,000	$13,910,000	$19,770,000
4TH / 5TH AVENUE CORRIDOR		$19,790,000	$21,880,000	$24,050,000
RAILROAD BRIDGE - REPLACEMENT		$9,110,000	$10,020,000	$11,020,000
DESCHUTES PARKWAY		$11,850,000	$14,410,000	$17,130,000
I-5 BRIDGE - SCOUR PROTECTION		$380,000	$490,000	$610,000
PARKS		$2,040,000	$2,640,000	$3,300,000
ESTIMATE OF CONTRACTOR'S BID		**$55,900,000**	**$63,300,000**	**$71,600,000**
CONSTRUCTION CONTINGENCY	5%	$2,795,000	$3,165,000	$3,580,000
SALES TAX	9%	$5,031,000	$5,697,000	$6,444,000
CONSTRUCTION ENGINEERING	10%	$5,590,000	$6,330,000	$7,160,000
RIGHT OF WAY ACQUISITION		$200,000	$400,000	$600,000
PUBLIC PROCESS, PERMITTING, ENGINEERING	15%	$8,385,000	$9,495,000	$10,740,000
STATE OVERSIGHT	3%	$1,677,000	$1,899,000	$2,148,000
PROJECT TOTAL (2006 DOLLARS)		**$79,600,000**	**$90,300,000**	**$102,300,000**

PROJECT TOTALS INCLUDING INFLATION			
INFLATION AT 2% (BASED ON IMPLICIT PRICE DEFLATOR)			
2012 PROJECT TOTAL	$89,000,000	$100,900,000	$114,300,000
2016 PROJECT TOTAL	$96,300,000	$109,200,000	$123,700,000
2020 PROJECT TOTAL	$104,200,000	$118,200,000	$133,900,000
INFLATION AT 3.5% (BASED ON ENR CONSTRUCTION COST INDEX, 1990-2005)			
2012 PROJECT TOTAL	$99,600,000	$112,900,000	$127,900,000
2016 PROJECT TOTAL	$114,300,000	$129,600,000	$146,800,000
2020 PROJECT TOTAL	$131,100,000	$148,700,000	$168,400,000
INFLATION AT 6% (BASED ON WSDOT CONSTRUCTION COST INDEX, 2001-2006)			
2012 PROJECT TOTAL	$116,400,000	$132,100,000	$149,600,000
2016 PROJECT TOTAL	$147,000,000	$166,700,000	$188,800,000
2020 PROJECT TOTAL	$185,600,000	$210,500,000	$238,400,000

Table 7

ALTERNATIVE D - PROGRAM COSTS

PROJECT TOTALS IN 2006 DOLLARS		**PRICE VARIATION**		
DESCRIPTION		**LOW (10%)**	**MEAN**	**HIGH (90%)**
CONSTRUCTION				
CHANNEL PRE-DREDGING		$10,000,000	$16,240,000	$23,520,000
4TH / 5TH AVENUE CORRIDOR		$19,770,000	$21,880,000	$24,050,000
RAILROAD BRIDGE - SCOUR PROTECTION		$130,000	$170,000	$220,000
DESCHUTES PARKWAY		$11,880,000	$14,410,000	$17,180,000
I-5 BRIDGE - SCOUR PROTECTION		$380,000	$490,000	$610,000
PARKS		$1,930,000	$2,480,000	$3,110,000
REFLECTING POOL BARRIER		$15,470,000	$18,850,000	$23,210,000
ESTIMATE OF CONTRACTOR'S BID		**$65,900,000**	**$74,500,000**	**$84,100,000**
CONSTRUCTION CONTINGENCY	5%	$3,295,000	$3,725,000	$4,205,000
SALES TAX	9%	$5,931,000	$6,705,000	$7,569,000
CONSTRUCTION ENGINEERING	10%	$6,590,000	$7,450,000	$8,410,000
RIGHT OF WAY ACQUISITION		$200,000	$400,000	$600,000
PUBLIC PROCESS, PERMITTING, ENGINEERING	15%	$9,885,000	$11,175,000	$12,615,000
STATE OVERSIGHT	3%	$1,977,000	$2,235,000	$2,523,000
PROJECT TOTAL (2006 DOLLARS)		**$93,800,000**	**$106,200,000**	**$120,000,000**

PROJECT TOTALS INCLUDING INFLATION			
INFLATION AT 2% (BASED ON IMPLICIT PRICE DEFLATOR)			
2012 PROJECT TOTAL	$104,800,000	$118,700,000	$134,100,000
2016 PROJECT TOTAL	$113,500,000	$128,500,000	$145,200,000
2020 PROJECT TOTAL	$122,800,000	$139,100,000	$157,200,000
INFLATION AT 3.5% (BASED ON ENR CONSTRUCTION COST INDEX, 1990-2005)			
2012 PROJECT TOTAL	$117,300,000	$132,800,000	$150,100,000
2016 PROJECT TOTAL	$134,600,000	$152,400,000	$172,300,000
2020 PROJECT TOTAL	$154,500,000	$174,900,000	$197,700,000
INFLATION AT 6% (BASED ON WSDOT CONSTRUCTION COST INDEX, 2001-2006)			
2012 PROJECT TOTAL	$137,200,000	$155,400,000	$175,500,000
2016 PROJECT TOTAL	$173,300,000	$196,100,000	$221,600,000
2020 PROJECT TOTAL	$218,700,000	$247,600,000	$279,800,000

6.6 Maintenance Costs

The majority of maintenance costs associated with the restoration alternatives are for dredging the marinas along Percival Landing and at the Port of Olympia. These costs, shown in Table 8, are higher for Alternative D because more sediment is discharged to Budd Inlet and available to settle in the dredged areas for that alternative – see Section 2.3. Details of the assumptions underlying the costs and quantities are given in Appendix E.

Because maintenance costs are likely to continue indefinitely, they are provided here only in 2006 dollars. There is considerable uncertainty in the dredging costs and schedule after the recent discovery of dioxins at the Port's navigation channel. The assumption is made here that the dioxins are from local sources, affecting only Budd Inlet, and that the sediments flushed from Capitol Lake will not contain contaminants beyond those already addressed.

For all three alternatives, initial dredging will occur after three years, once the initial discharge of trapped sediment to Budd Inlet has occurred and the estuary is close to its equilibrium bathymetry. The associated maintenance cost is anticipated at between $2 million and $11 million (construction only). Subsequent dredging is assumed to occur on a 10-year cycle, with between $11 million and $35 million in dredging costs every ten years.

The wide range of uncertainty in these dredging costs is associated with two main items:

- the uncertainty in the erodibility of the sediments within Capitol Lake – in particular, whether sediment will continue to erode from the Middle Basin and be flushed to Budd Inlet for many years after the restoration of tidal flow; and
- the uncertainty as to whether the sediment deposited in the marinas along Percival Landing and at the Port of Olympia is likely to be contaminated with dioxins and other contaminants.

Further investigations of the sediment properties in Capitol Lake could greatly narrow the range of costs presented herein.

Table 8

PERIODIC MAINTENANCE COSTS - 2006 PRICES

ALTERNATIVES A & B

			QUANTITY			UNIT PRICE			MEAN TOTAL	PRICE VARIATION		
ITEM	DESCRIPTION	UNIT	LOW	MEAN	HIGH	LOW	MEAN	HIGH	PRICE	LOW (10%)	MEAN	HIGH (90%)
	TOTAL - 3-YEAR INITIAL DREDGING								**$4,914,000**	**$1,710,000**	**$4,910,000**	**$8,440,000**
61	DREDGING - MARINA & PORT (3-YEAR)	CY	0	90,000	180,000	$18	$25	$40	$2,250,000			
62	CONTAMINATED MATERIAL DISPOSAL	CY	0	9,000	22,500	$66	$170	$273	$1,530,000			
	CONTINGENCY AT 30%								$1,134,000			
	TOTAL - DREDGING EVERY 10-YEARS								**$19,656,000**	**$10,870,000**	**$19,680,000**	**$30,830,000**
63	DREDGING - MARINA & PORT (10-YEAR)	CY	300,000	360,000	500,000	$18	$25	$40	$9,000,000			
64	CONTAMINATED MATERIAL DISPOSAL	CY	0	36,000	90,000	$66	$170	$273	$6,120,000			
	CONTINGENCY AT 30%								$4,536,000			

PROJECT TOTALS IN 2006 DOLLARS		**3-YEAR INITIAL DREDGING**			**DREDGING EVERY 10-YEARS**		
DESCRIPTION		**LOW (10%)**	**MEAN**	**HIGH (90%)**	**LOW (10%)**	**MEAN**	**HIGH (90%)**
ESTIMATE OF CONTRACTOR'S BID		**$1,710,000**	**$4,910,000**	**$8,440,000**	**$10,870,000**	**$19,680,000**	**$30,830,000**
CONSTRUCTION CONTINGENCY	5%	$85,500	$245,500	$422,000	$543,500	$984,000	$1,541,500
SALES TAX	9%	$153,900	$441,900	$759,600	$978,300	$1,771,200	$2,774,700
CONSTRUCTION ENGINEERING	10%	$171,000	$491,000	$844,000	$1,087,000	$1,968,000	$3,083,000
PERMITTING, ENGINEERING	15%	$256,500	$736,500	$1,266,000	$1,630,500	$2,952,000	$4,624,500
PORT OVERSIGHT	3%	$51,300	$147,300	$253,200	$326,100	$590,400	$924,900
PROJECT TOTAL (2006 DOLLARS)		**$2,400,000**	**$7,000,000**	**$12,000,000**	**$15,400,000**	**$27,900,000**	**$43,800,000**

ALTERNATIVE D

			QUANTITY			UNIT PRICE			MEAN TOTAL	PRICE VARIATION		
ITEM	DESCRIPTION	UNIT	LOW	MEAN	HIGH	LOW	MEAN	HIGH	PRICE	LOW (10%)	MEAN	HIGH (90%)
	TOTAL - 3-YEAR INITIAL DREDGING								**$6,552,000**	**$2,350,000**	**$6,540,000**	**$11,220,000**
61	DREDGING - MARINA & PORT (3-YEAR)	CY	0	120,000	240,000	$18	$25	$40	$3,000,000			
62	CONTAMINATED MATERIAL DISPOSAL	CY	0	12,000	30,000	$66	$170	$273	$2,040,000			
	CONTINGENCY AT 30%								$1,512,000			
	TOTAL - DREDGING EVERY 10-YEARS								**$21,840,000**	**$11,710,000**	**$21,870,000**	**$34,790,000**
63	DREDGING - MARINA & PORT (10-YEAR)	CY	300,000	400,000	600,000	$18	$25	$40	$10,000,000			
64	CONTAMINATED MATERIAL DISPOSAL	CY	0	40,000	100,000	$66	$170	$273	$6,800,000			
	CONTINGENCY AT 30%								$5,040,000			

PROJECT TOTALS IN 2006 DOLLARS		**3-YEAR INITIAL DREDGING**			**DREDGING EVERY 10-YEARS**		
DESCRIPTION		**LOW (10%)**	**MEAN**	**HIGH (90%)**	**LOW (10%)**	**MEAN**	**HIGH (90%)**
ESTIMATE OF CONTRACTOR'S BID		**$2,350,000**	**$6,540,000**	**$11,220,000**	**$11,710,000**	**$21,870,000**	**$34,790,000**
CONSTRUCTION CONTINGENCY	5%	$117,500	$327,000	$561,000	$585,500	$1,093,500	$1,739,500
SALES TAX	9%	$211,500	$588,600	$1,009,800	$1,053,900	$1,968,300	$3,131,100
CONSTRUCTION ENGINEERING	10%	$235,000	$654,000	$1,122,000	$1,171,000	$2,187,000	$3,479,000
PERMITTING, ENGINEERING	15%	$352,500	$981,000	$1,683,000	$1,756,500	$3,280,500	$5,218,500
PORT OVERSIGHT	3%	$70,500	$196,200	$336,600	$351,300	$656,100	$1,043,700
PROJECT TOTAL (2006 DOLLARS)		**$3,300,000**	**$9,300,000**	**$15,900,000**	**$16,600,000**	**$31,100,000**	**$49,400,000**

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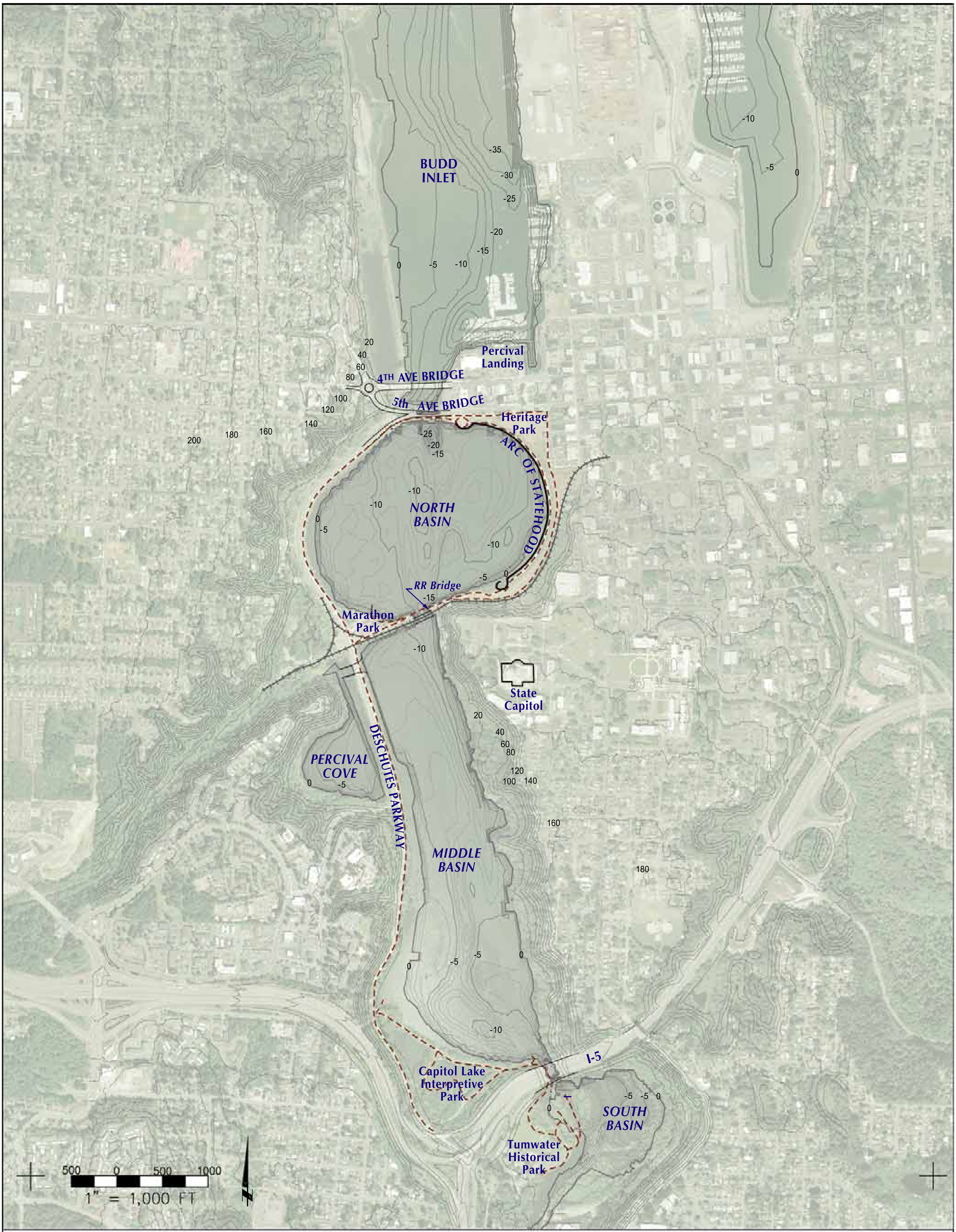
Exhibits



Pedestrian Trails - - - - -

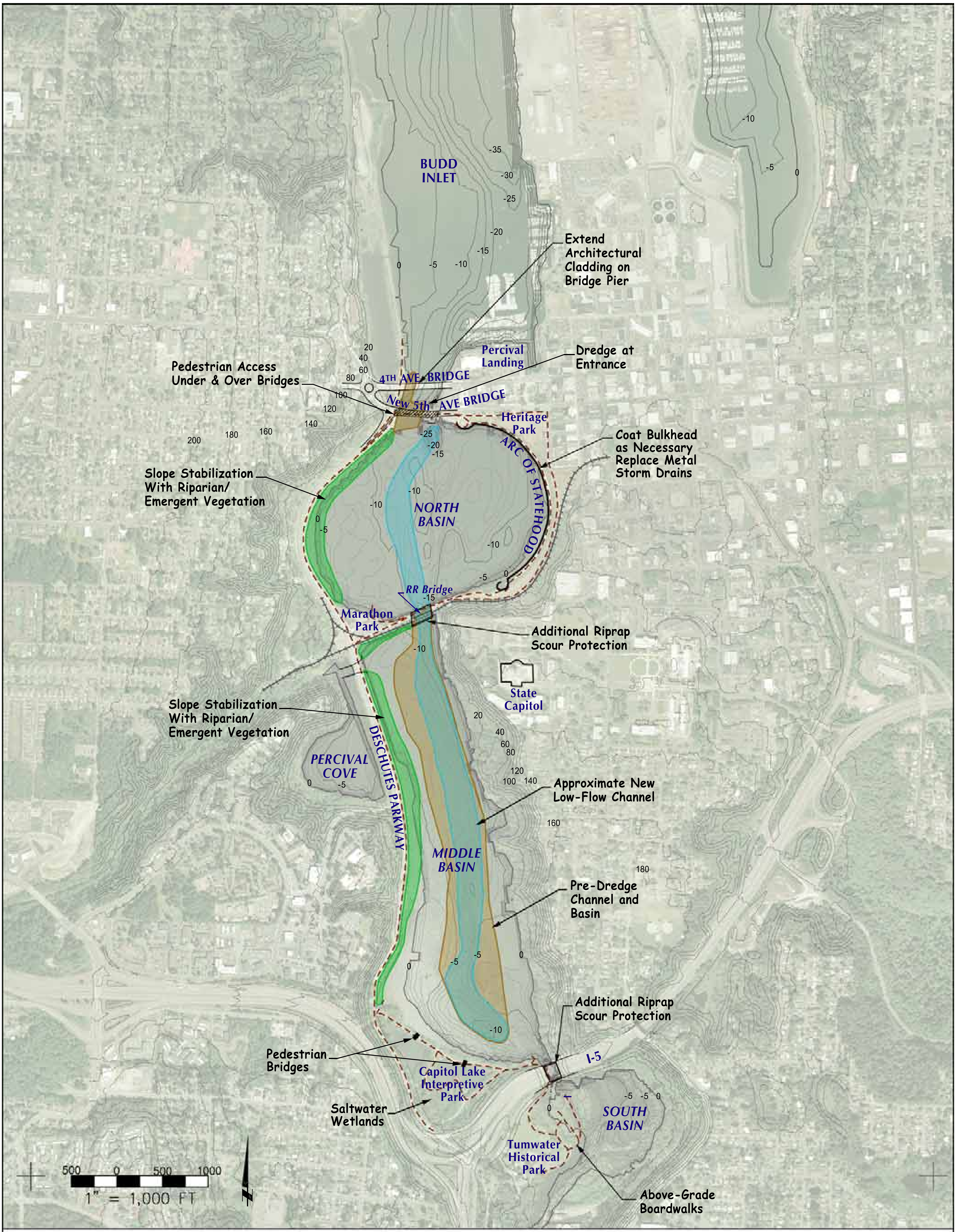
Vertical datum: NGVD 29
Bathymetric data: various sources, 2004-2005
compiled by USGS, 2006
Upland contours: Puget Sound Lidar Consortium, 2002

Exhibit 1
EXISTING CONDITION

Prepared by: Moffatt & Nichol
Date: December 2006

MOFFATT & NICHOL

Deschutes Estuary Feasibility Study, Phase 3, Engineering Design and Cost Estimates



Pedestrian Trails _ _ _ _ _

Vertical datum: NGVD 29
Bathymetric data: various sources, 2004-2005
compiled by USGS, 2006
Upland contours: Puget Sound Lidar Consortium, 2002

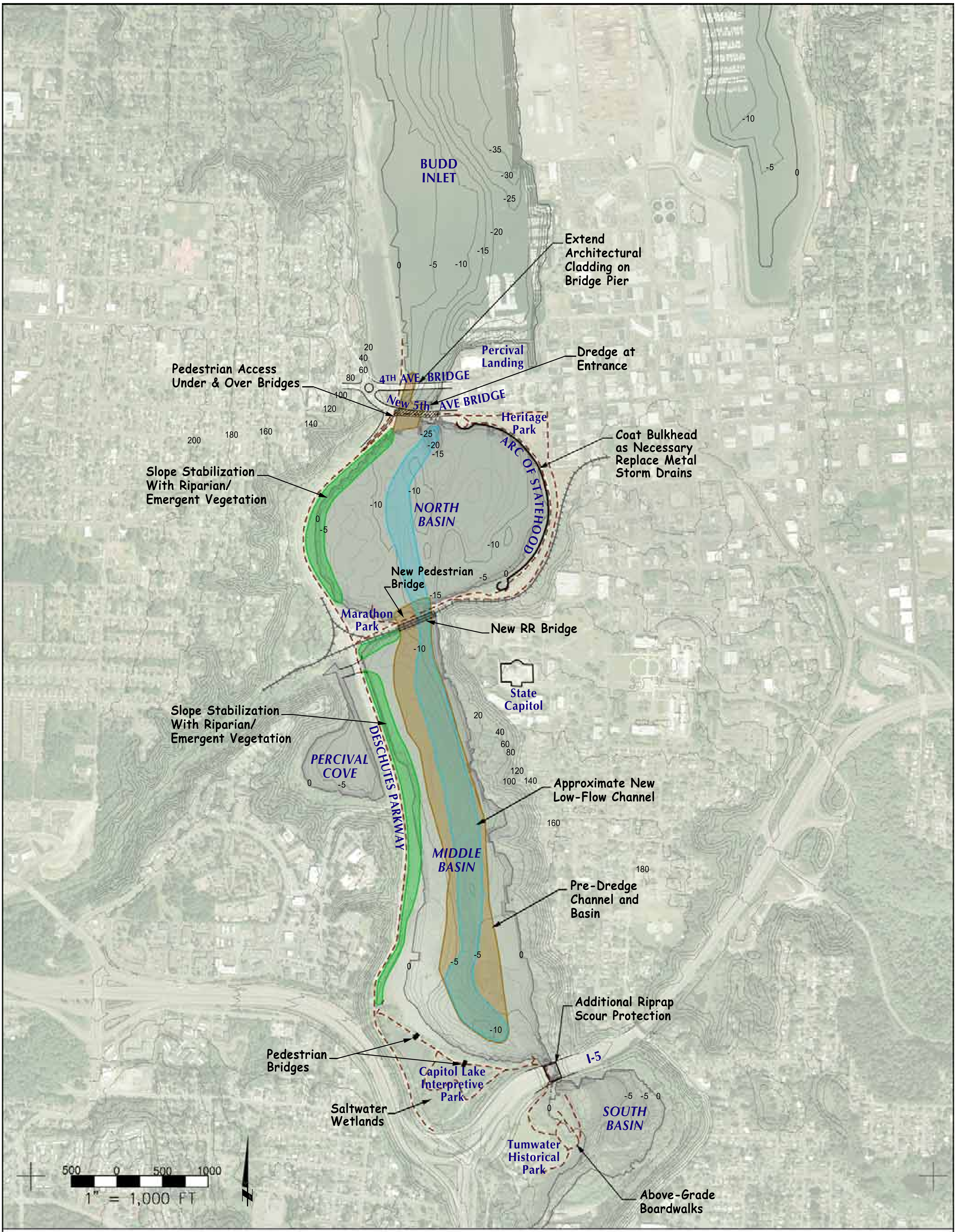
Exhibit 2

ALTERNATIVE A: NEW 5TH AVENUE BRIDGE

Prepared by: Moffatt & Nichol
Date: December 2006

MOFFATT & NICHOL

Deschutes Estuary Feasibility Study, Phase 3, Engineering Design and Cost Estimates



Pedestrian Trails _ _ _ _ _

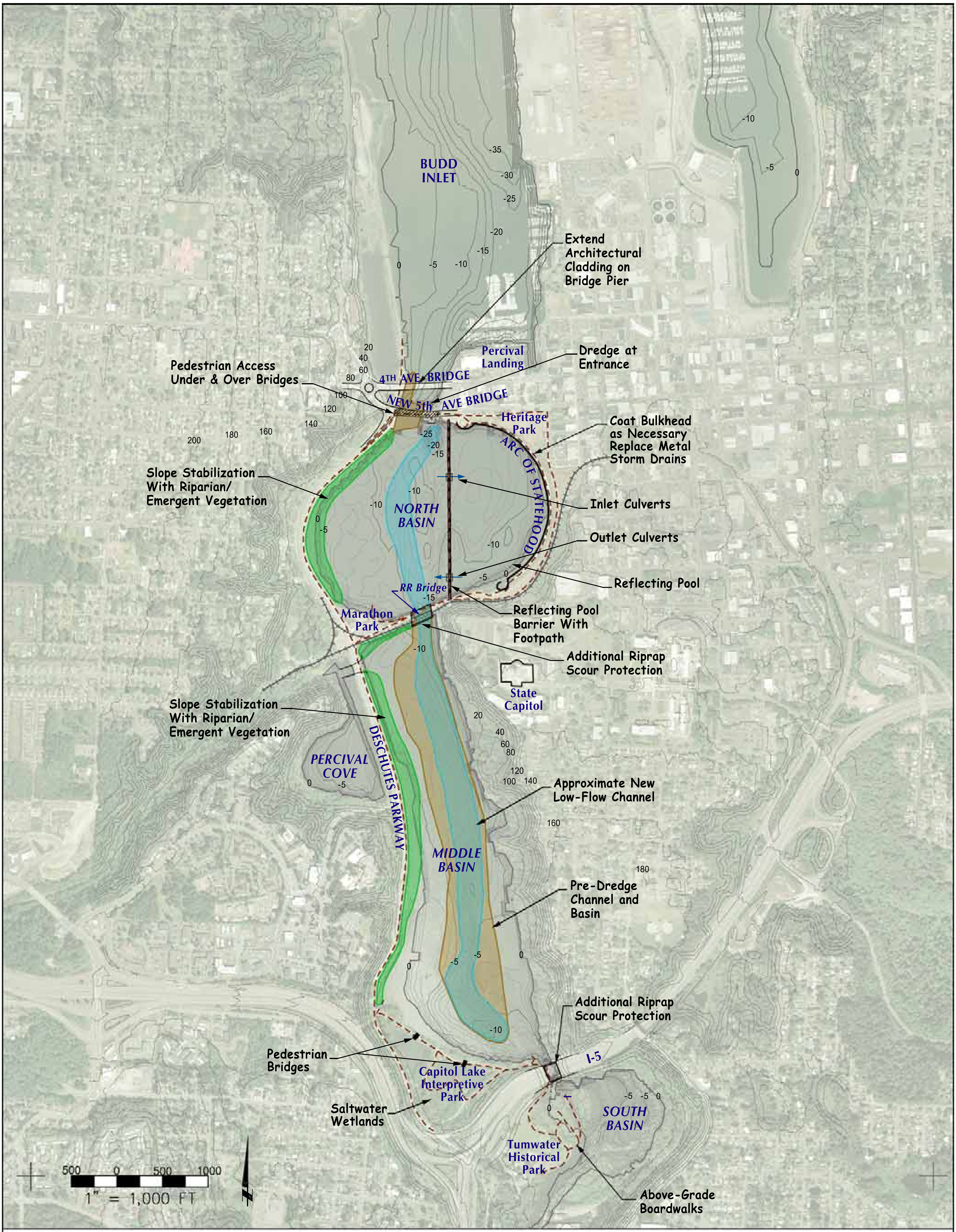
Vertical datum: NGVD 29
Bathymetric data: various sources, 2004-2005
compiled by USGS, 2006
Upland contours: Puget Sound Lidar Consortium, 2002

Prepared by: Moffatt & Nichol
Date: December 2006

Exhibit 3

ALTERNATIVE B: NEW 5TH AVENUE BRIDGE AND NEW RAILROAD BRIDGE

Deschutes Estuary Feasibility Study, Phase 3, Engineering Design and Cost Estimates



Pedestrian Trails - - - - -

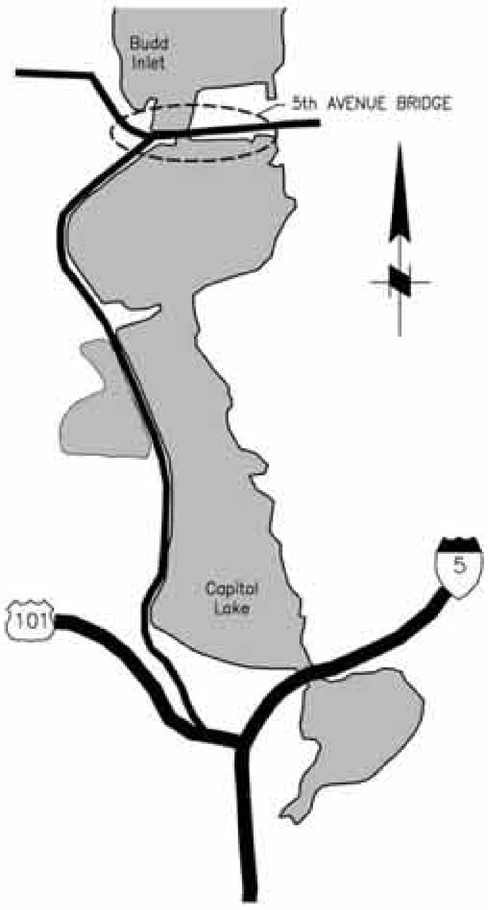
Vertical datum: NGVD 29
Bathymetric data: various sources, 2004-2005
compiled by USGS, 2006
Upland contours: Puget Sound Lidar Consortium, 2002

Prepared by: Moffatt & Nichol
Date: December 2006

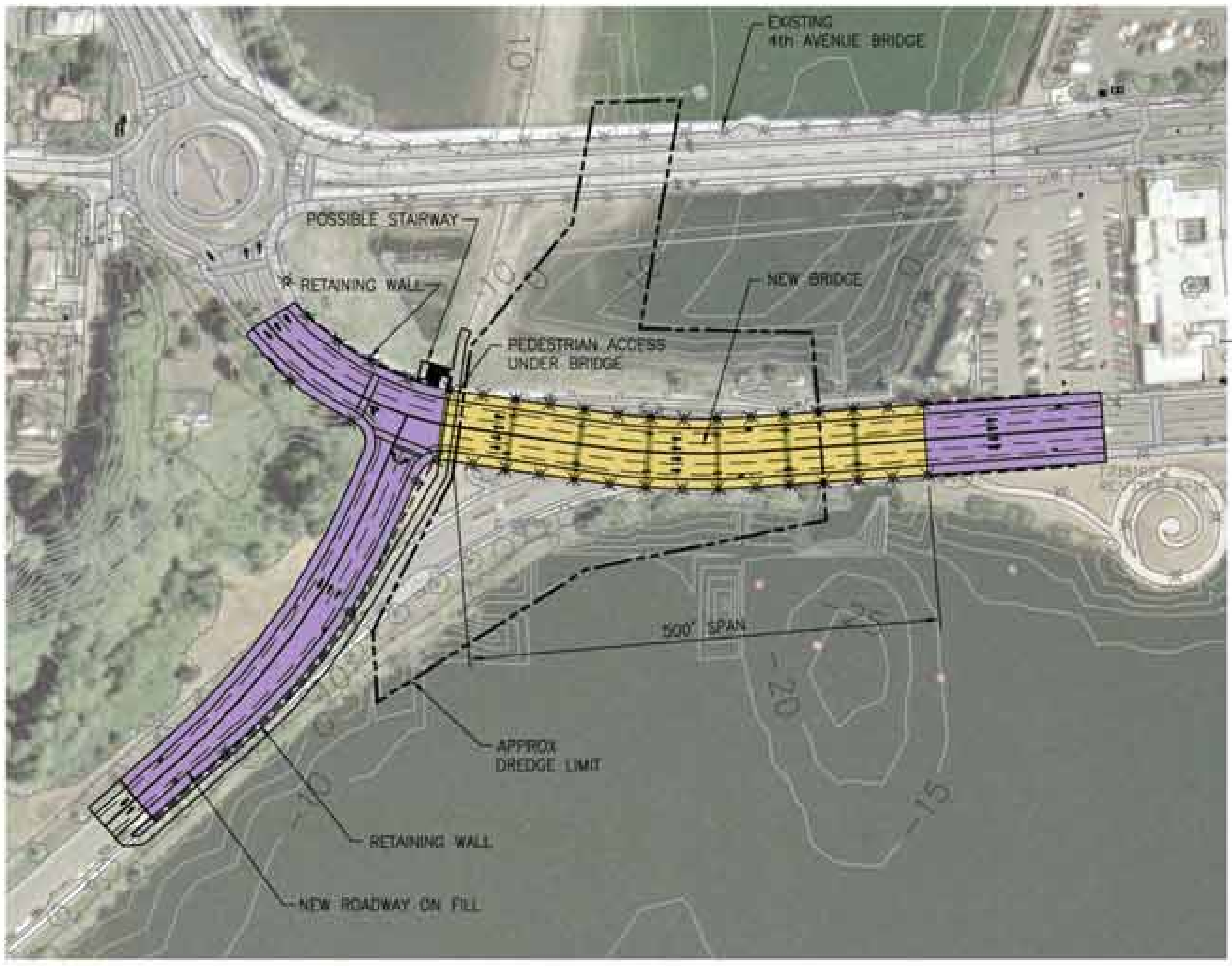
MOFFATT & NICHOL

Exhibit 4
ALTERNATIVE D: NEW 5TH AVENUE BRIDGE WITH REFLECTING POOL

Deschutes Estuary Feasibility Study, Phase 3, Engineering Design and Cost Estimates



VICINITY MAP
NTS



PLAN
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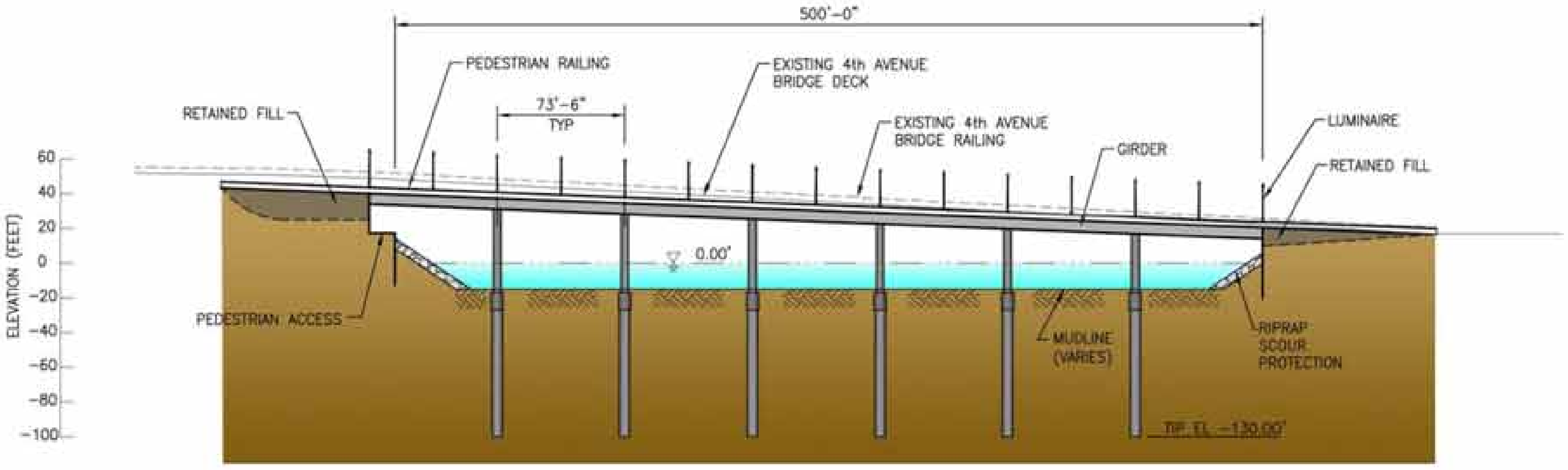

LONGITUDINAL SECTION
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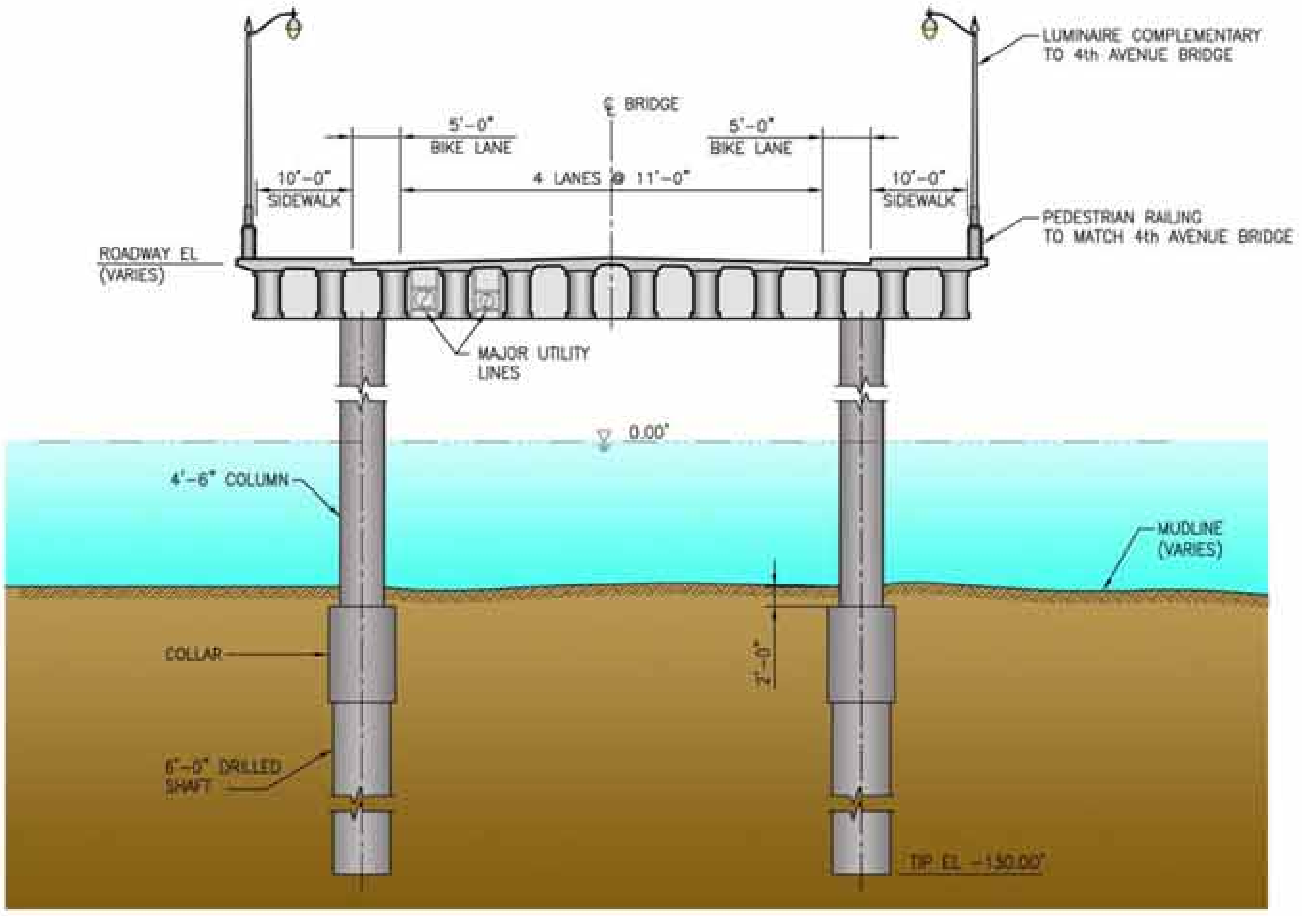

PIER SECTION
SCALE: 1" = 20'

NOTE:
ALL ELEVATIONS ARE RELATIVE TO NGVD29.

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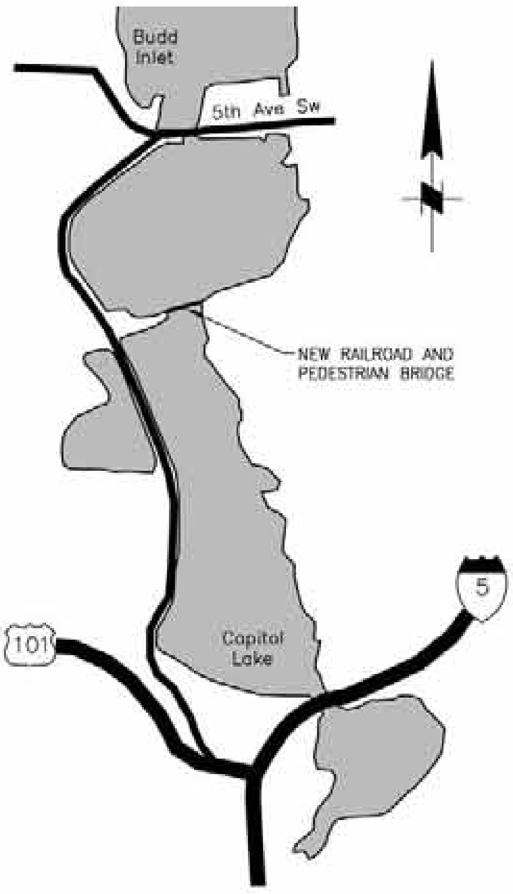
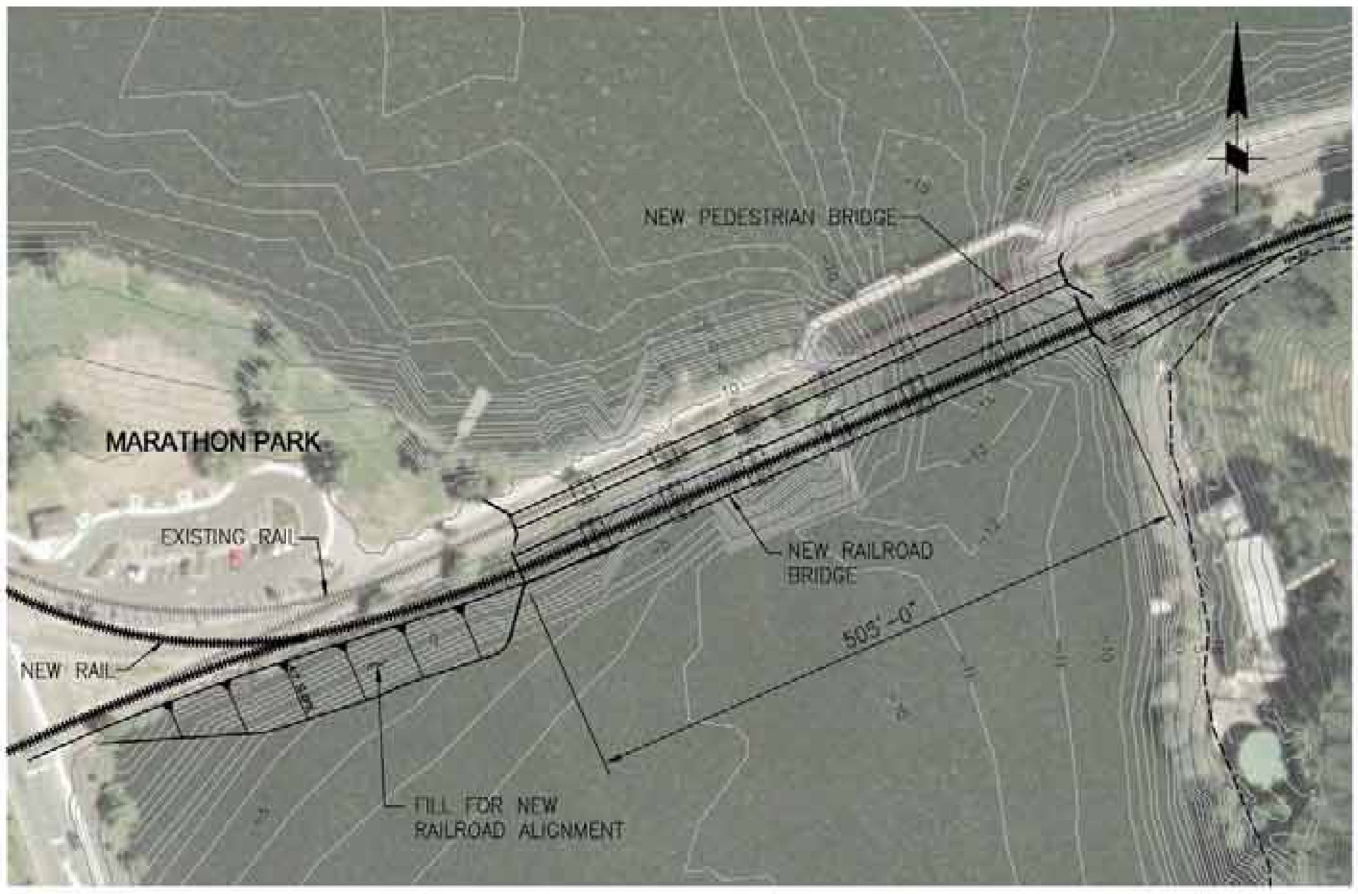
Prepared by: Moffatt & Nichol
Date: DECEMBER 2006

DESCHUTES ESTUARY FEASIBILITY STUDY
PHASE 3
ENGINEERING DESIGN AND COST ESTIMATES

NEW 5th AVENUE BRIDGE

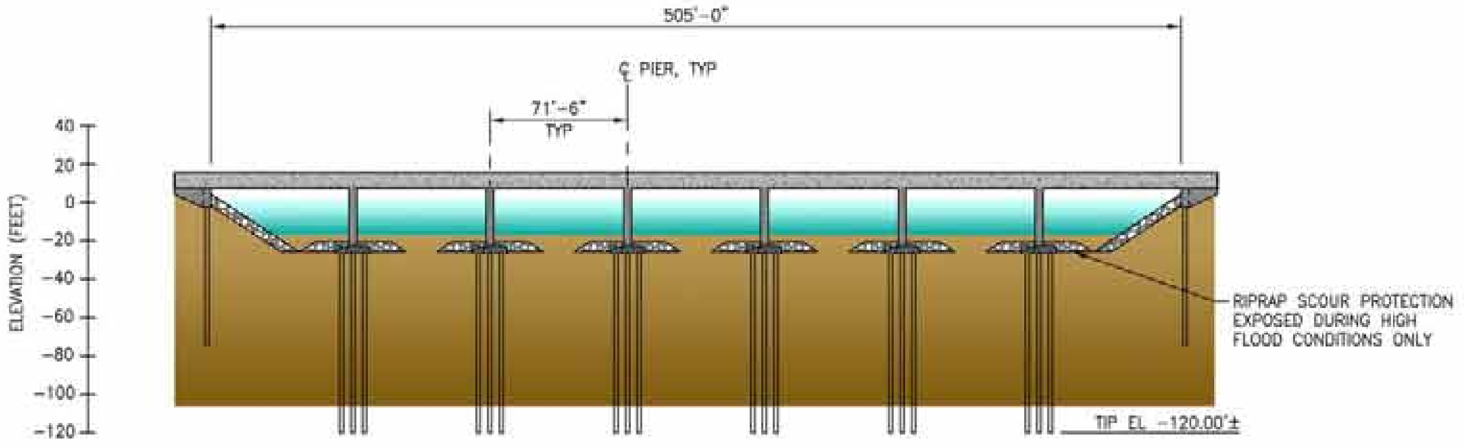
Exhibit
5



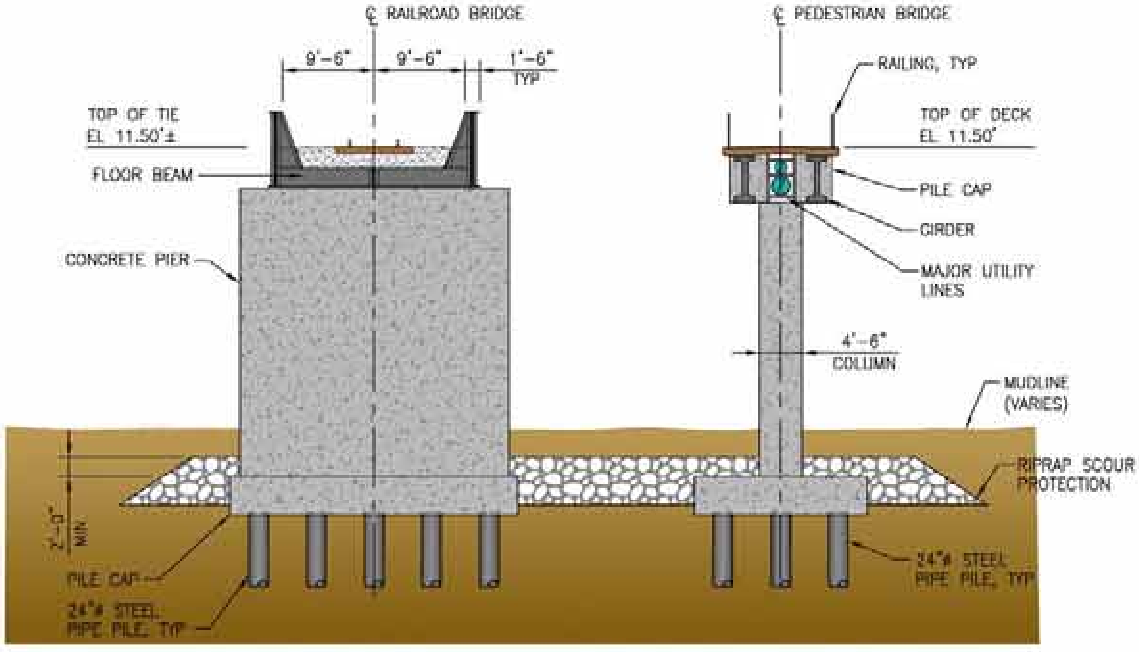


VICINITY MAP
NTS

PLAN
SCALE: 1" = 200'



LONGITUDINAL SECTION - RAILROAD BRIDGE
SCALE: 1" = 100'



TRANSVERSE SECTION
SCALE: 1" = 20'

NOTE:

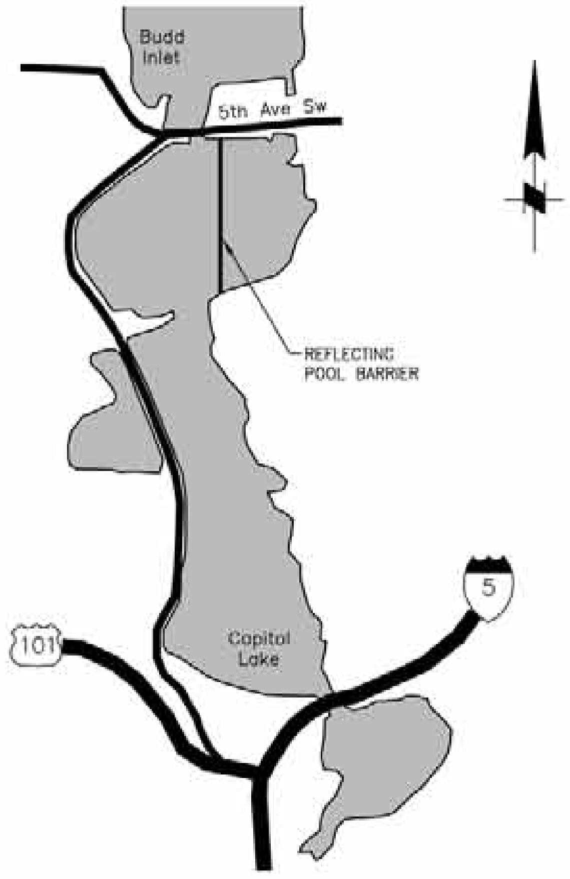
ALL ELEVATIONS ARE RELATIVE TO NGVD29.

MOFFATT & NICHOL
Prepared by: Moffatt & Nichol
Date: DECEMBER 2006

DESCHUTES ESTUARY FEASIBILITY STUDY
PHASE 3
ENGINEERING DESIGN AND COST ESTIMATES

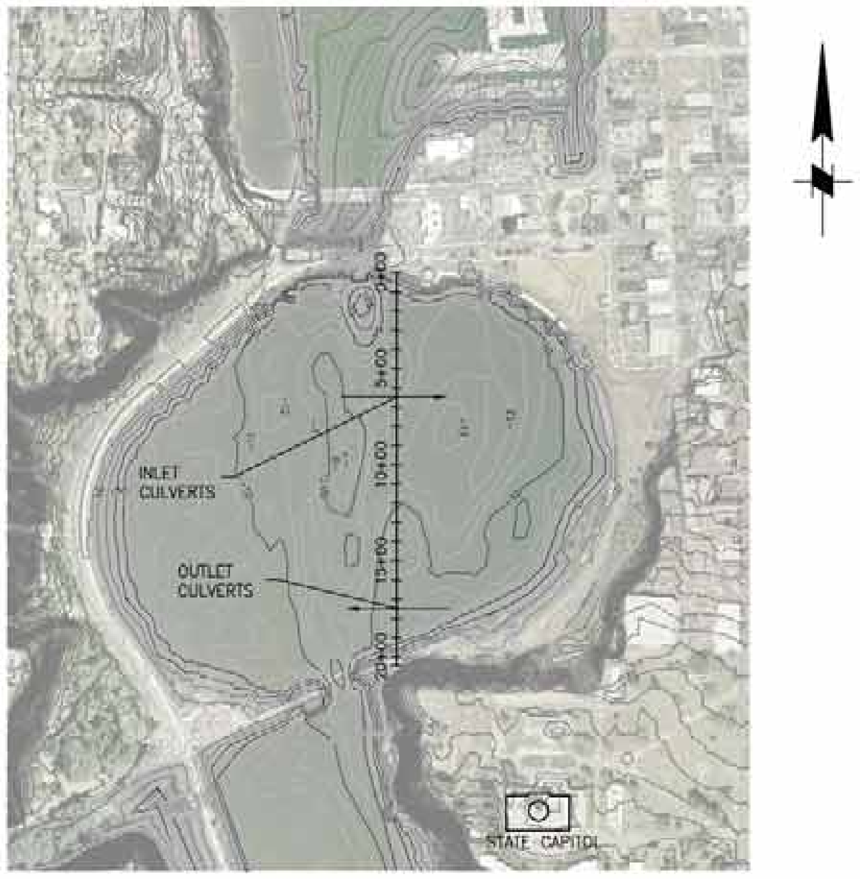
RAILROAD BRIDGE

Exhibit
6



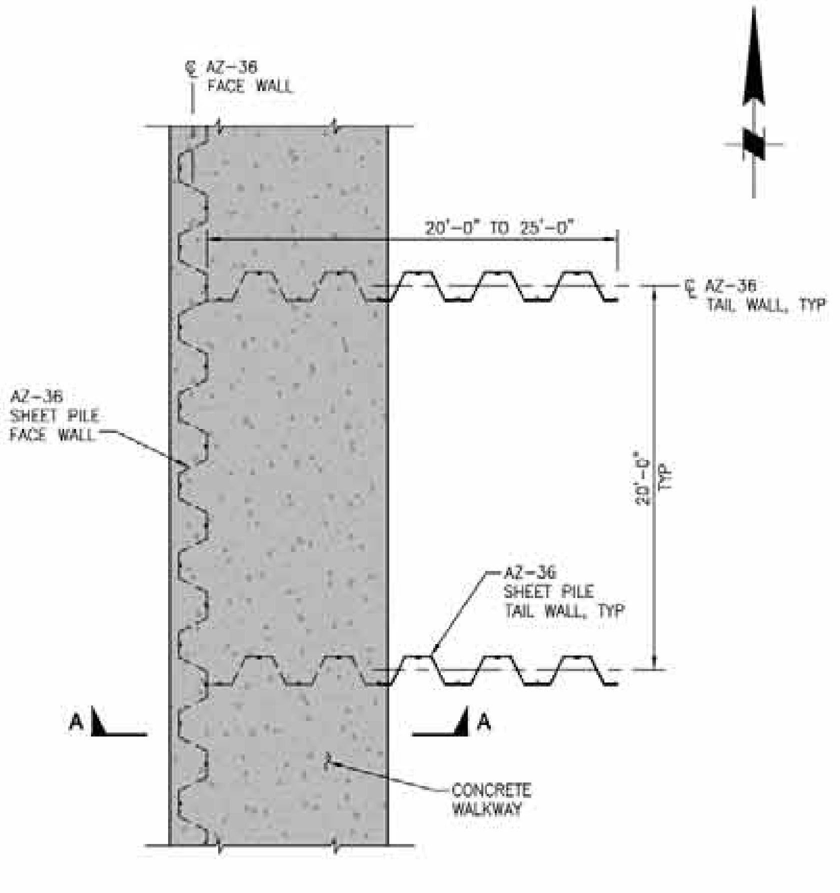
VICINITY MAP

NTS



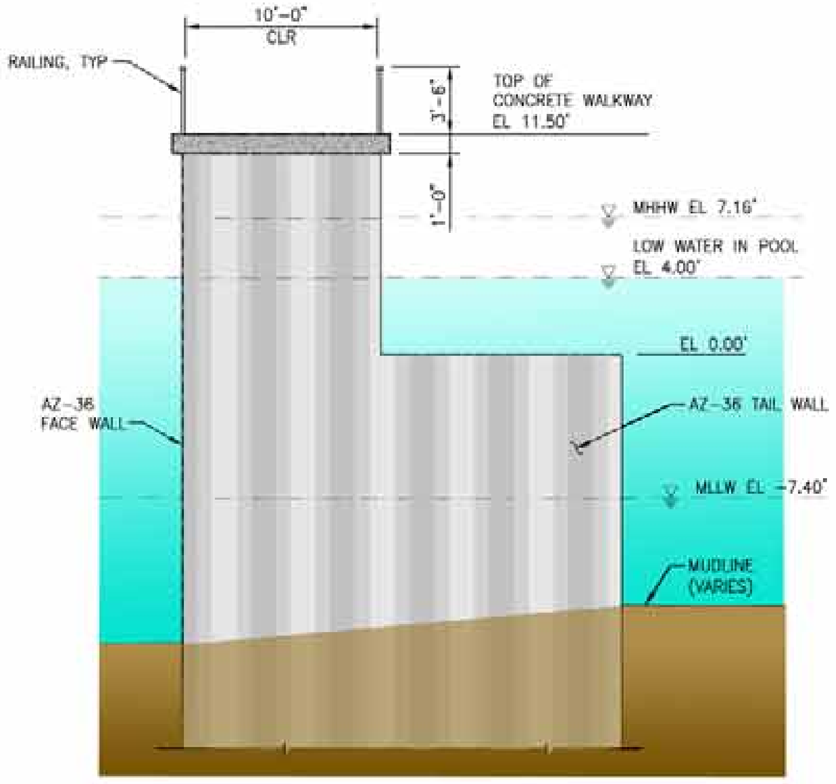
PLAN

SCALE: 1" = 1000'



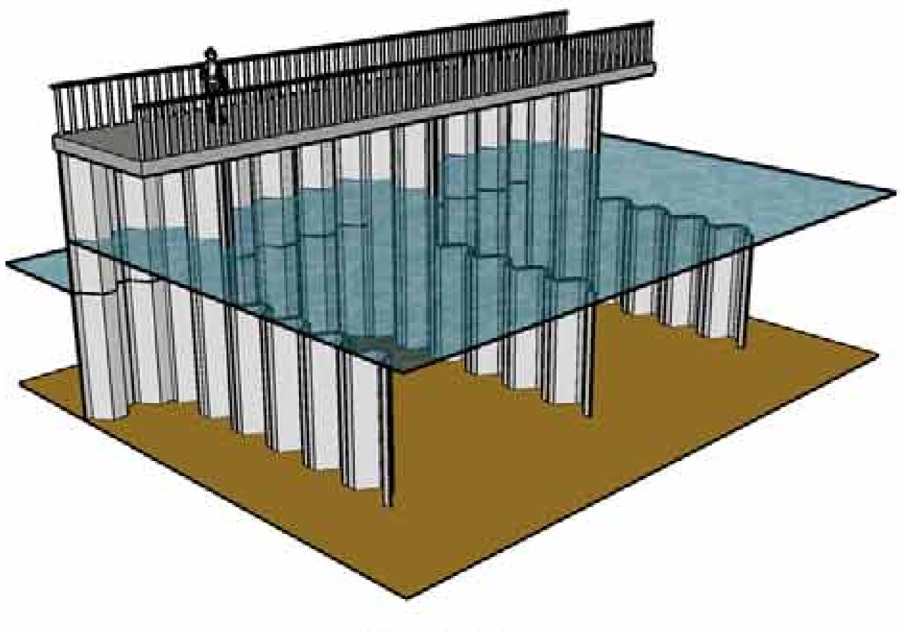
PARTIAL PLAN

SCALE: 1" = 10'



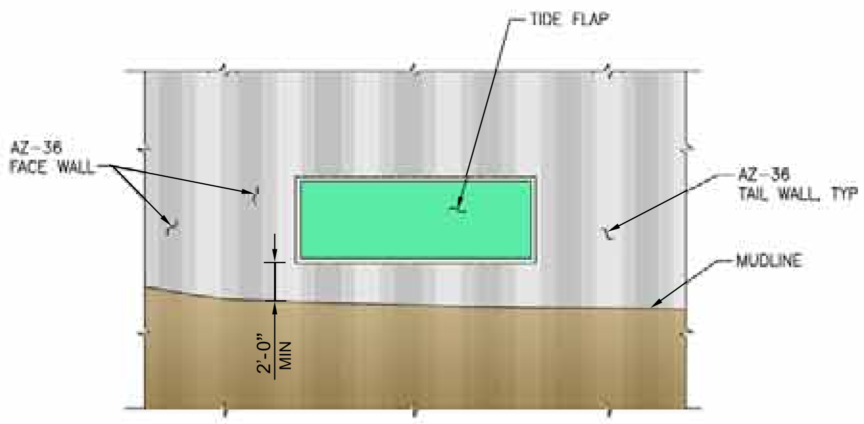
SECTION A-A

SCALE: 1" = 10'



3D BARRIER MODEL

NTS



INLET CULVERT (1 OF 4)

SCALE: 1" = 10'

NOTE:
OUTLET CULVERTS SIMILAR EXCEPT WITH INVERT ELEVATION AT +4.0'

NOTE:
ALL ELEVATIONS ARE RELATIVE TO NGVD29.

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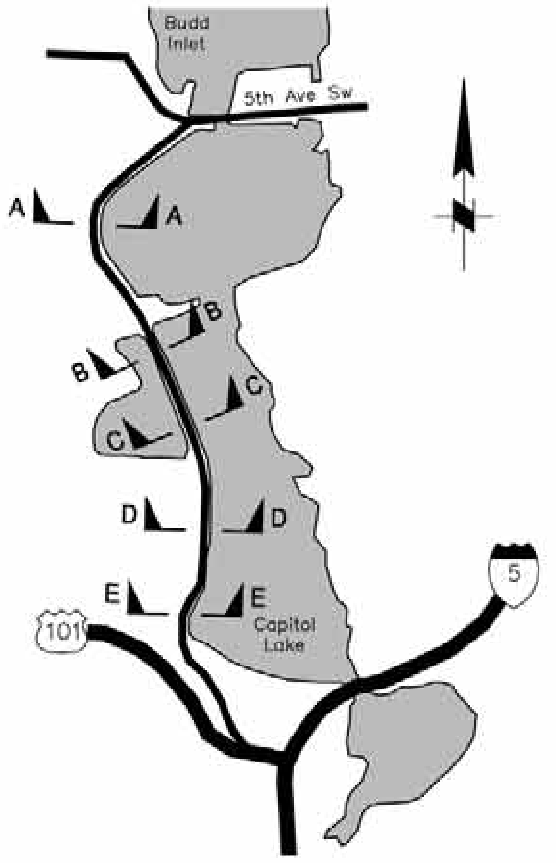
DESCHUTES ESTUARY FEASIBILITY STUDY
PHASE 3
ENGINEERING DESIGN AND COST ESTIMATES

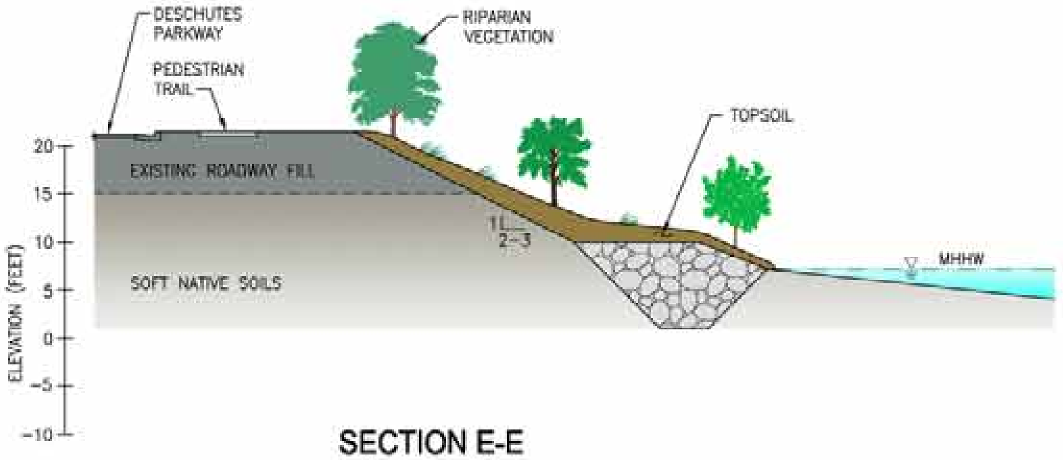
REFLECTING POOL BARRIER

Exhibit
7



VICINITY MAP

NTS



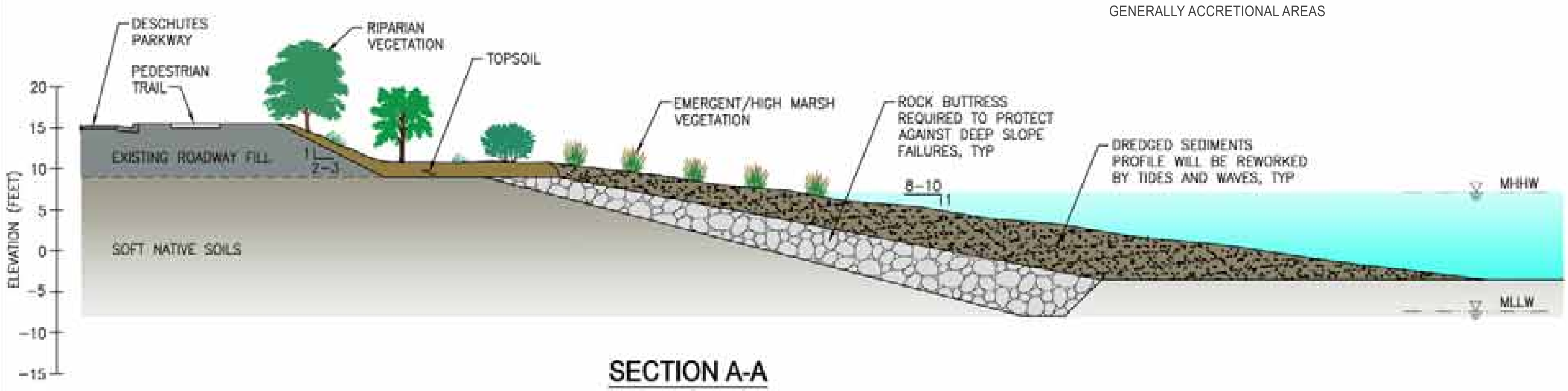
SECTION E-E

SCALE: 1" = 20'

NOTE:

ROCK BUTTRESS PROTECTS AGAINST DEEP SLOPE FAILURES

DREDGED SEDIMENTS PROVIDE HABITAT IN GENERALLY ACCRETIONAL AREAS

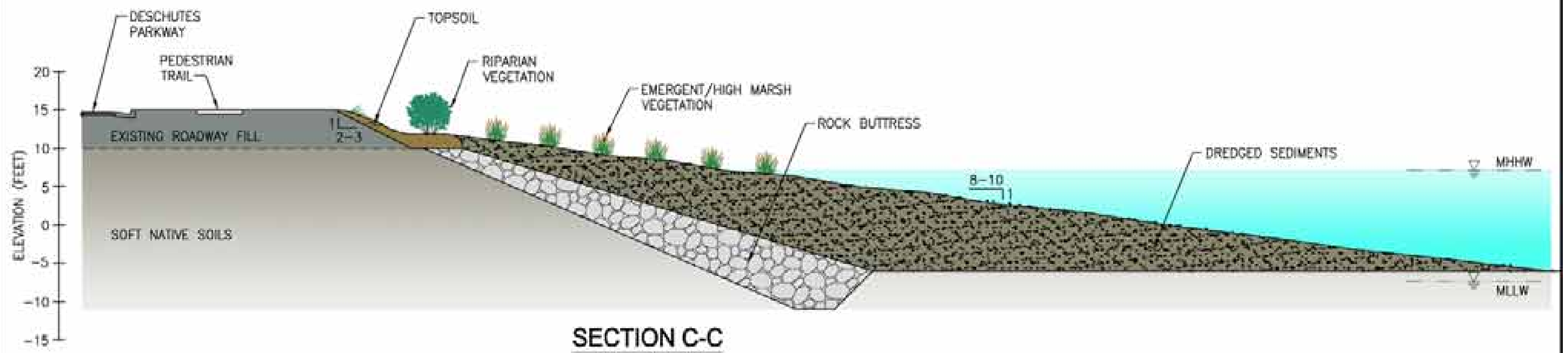


SECTION A-A

SCALE: 1" = 20'

SECTION B-B

SCALE: 1" = 20'



SECTION C-C

SCALE: 1" = 20'

SECTION D-D

SCALE: 1" = 20'

NOTE:

ALL ELEVATIONS ARE RELATIVE TO NGVD29.

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Prepared by: Moffatt & Nichol

Date: DECEMBER 2006

DESCHUTES ESTUARY FEASIBILITY STUDY
PHASE 3
ENGINEERING DESIGN AND COST ESTIMATES

DESCHUTES PARKWAY
SHORELINE SECTIONS

Exhibit
8

Appendix A : Three-Point Cost Estimate

The three-point cost estimates in this report are calculated by allowing both the quantities and the unit costs of each construction item to vary. For each item, a low, average, and high quantity and unit cost are specified – in contrast to a regular engineering estimate in which only a single quantity and a single cost are specified for each item. A Monte Carlo analysis is performed to take these quantity and unit cost values, and to predict the overall low, average, and high cost for the entire project.

The Monte Carlo method is just one of many methods for analyzing uncertainty, where the goal is to determine how random variation or lack of knowledge affects costs or other characteristics of a project. The name "Monte Carlo" is taken from Monte Carlo, Monaco, where the primary attractions are casinos containing games of chance. Games of chance such as roulette wheels, dice, and slot machines, exhibit random behavior in their results. The random behavior in games of chance is similar to how a Monte Carlo simulation selects values at random to simulate a model.

In the development of a Monte Carlo-based cost estimate, the quantities and unit costs for each line item are randomly generated from probability distributions to simulate the process of obtaining actual costs and quantities for each item. For each quantity and unit cost, a probability distribution is chosen to best represent the current data and state of knowledge. The final data generated by the Monte Carlo simulation is a probability distribution for the total cost of the project. This probability distribution can be represented in terms of a confidence interval. In this report, the average cost as well as the 10% cost (i.e., there is a 10% probability that the cost will be lower than this value) and the 90% cost (i.e., there is a 90% probability that the cost will be lower than this value) are given.

The steps in setting up the Monte Carlo simulation for a 3-point cost estimate are as follows.

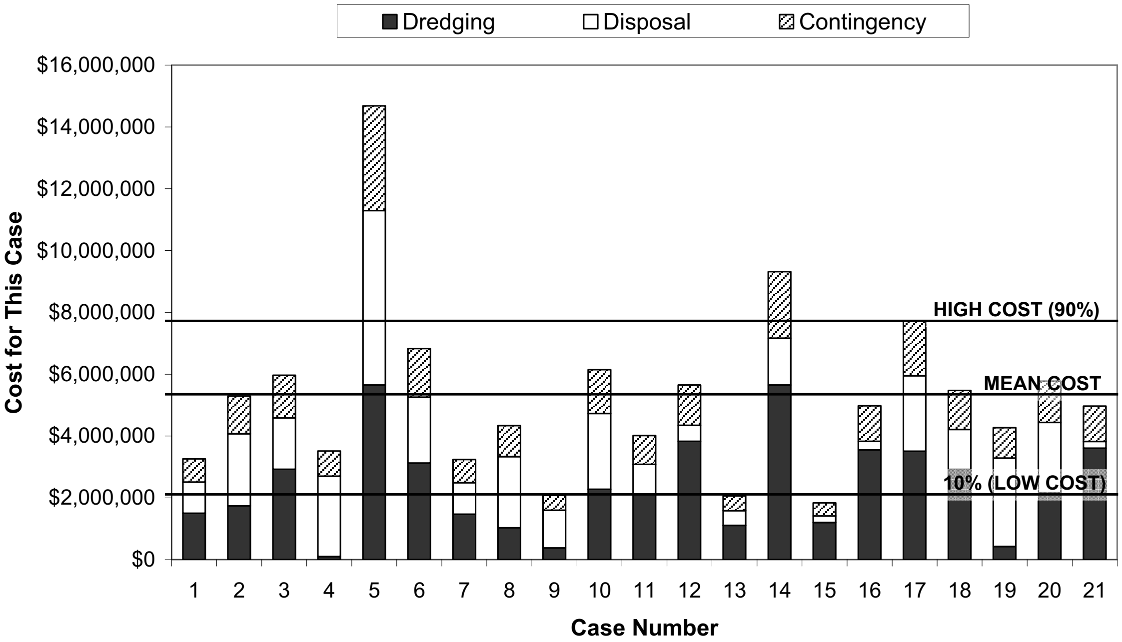
- For each line item in the cost estimate, define an average, minimum, and maximum quantity and unit cost. The calculations use these values to define a probability distribution for each individual quantity and unit cost.
- Generate a set of random inputs (this is done by an Excel add-in program, @RISK), one for each of the quantities and unit costs. In other words, randomly select one actual quantity and unit cost for each line item. These actual values will lie between the minimum and maximum originally selected. Multiply the two together to obtain the extended cost for that line item
- Sum the extended line item costs to obtain a total cost. Save this single total cost.
- Repeat the last two steps a large number of times (100,000 cases were used here). This provides a total of 100,000 independent cost estimates.
- Calculate the average total cost, and the 10% and 90% percentiles, from these100,000 independent estimates.

The average total cost calculated in this way is just equal to the total cost that would be calculated from the average quantity and the average unit cost for each item. However, the low and high total costs are not equal to the total costs calculated from the low (or high) quantity and the low (or high) unit cost for each item. This is because many of the costs vary independently – relatively high dredging costs may coincide with relatively low planting costs.

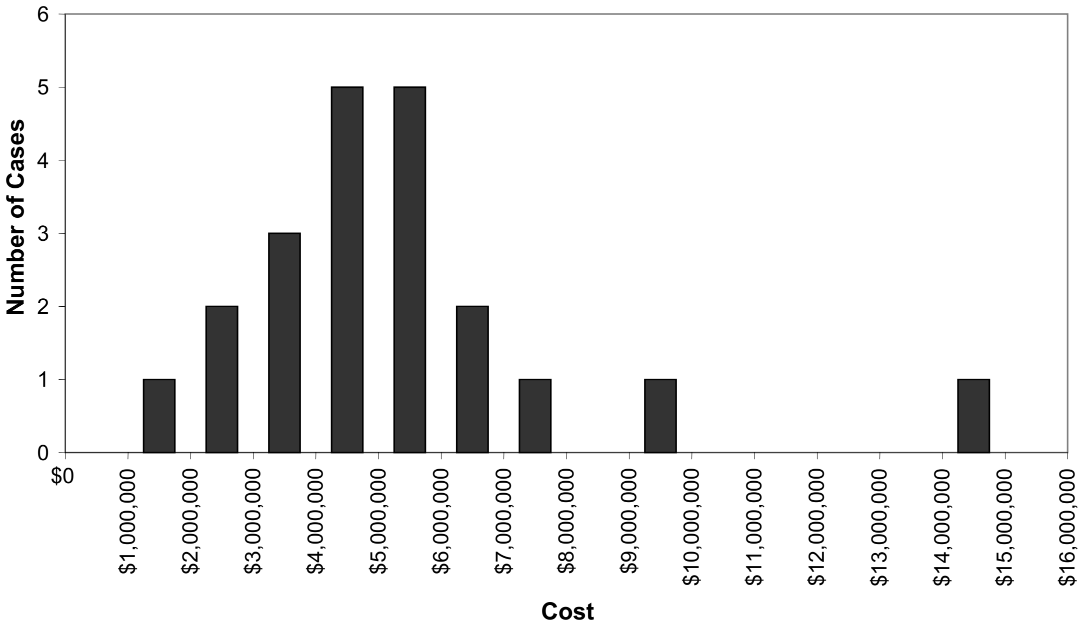
As an example, consider the construction cost estimate for maintenance dredging after 3 years, under Alternative A (Table 8). The maintenance dredging cost consists of two line items – a base cost for dredging, and disposal of contaminated materials – plus a 30% contingency. The lowest possible cost for both dredging and disposal of contaminated materials is $0 (since the lowest possible quantity for both is 0 cubic yards) – therefore the lowest possible total cost is also $0. The highest possible cost for dredging alone is 180,000 cy × $40/cy = $7,200,000. The highest possible overall cost, including contaminated materials disposal and contingency, is over $17,000,000. Both the lowest possible and highest possible costs are extremely unlikely.

To generate a single total cost for the maintenance dredging, the @RISK add-in generates 4 random values – a quantity and a unit cost for each of the dredging and the contaminated material disposal. From these random values, the total cost for dredging and the total cost for contaminated material disposal are calculated; the 30% contingency is added to the sum of these. Case Number 1 in the following chart represents a single total cost. The total cost for dredging was calculated as $1.5M, the total cost for disposal as $1.0M, and the contingency as 30%×$2.5M = $0.75M, for a single total cost of $3.25M.

The chart below shows 21 different total costs generated randomly in this way; the chart on the next page shows a histogram of these costs. The minimum (zero) cost and the maximum ($17M) cost do not appear (although Case 5 approaches the maximum possible – the chart histogram on the next page shows that this is an outlier). The mean cost, from the 21 cases shown here, is $5.3M. The more accurate mean cost calculated from 100,000 cases is $4.9M (Table 8).



The low (10%) and high (90%) costs given in this report are not the lowest and highest possible costs, but rather the 10th and 90th percentile costs. These costs, for the 21 cases considered here, are $2.1M and $7.7M respectively: two of the single total costs, or 10% of the set of 21, lie below $2.1M, while two of them lie above $7.7M. Again, a more accurate set of values is given in Table 8.


Number of Cases
6
5
4
3
2
1
0
$0
$1,000,000
$2,000,000
$3,000,000
$4,000,000
$5,000,000
$6,000,000
$7,000,000
$8,000,000
$9,000,000
$10,000,000
$11,000,000
$12,000,000
$13,000,000
$14,000,000
$15,000,000
$16,000,000
Cost

Appendix B : Detail Cost Estimate – Alternative A

ALTERNATIVE A - PURE CONSTRUCTION COSTS - 2006 PRICES

			QUANTITY			UNIT PRICE			MEAN	PRICE VARIATION		
ITEM	DESCRIPTION	UNIT	LOW	MEAN	HIGH	LOW	MEAN	HIGH	TOTAL PRICE	LOW (10%)	MEAN	HIGH (90%)
CHANNEL PRE-DREDGING									**$13,907,400**	**$8,660,000**	**$13,910,000**	**$19,810,000**
1	CHANNEL PRE-DREDGING	CY	180,000	270,000	360,000	$18	$30	$46	$8,100,000			
2	CONTAMINATED SEDIMENT DISPOSAL	CY	0	15,000	30,000	$66	$170	$273	$2,550,000			
3	INTERTIDAL ZONE DEBRIS REMOVAL	ALL	1	1	1	$24,000	$48,000	$72,000	$48,000			
	CONTINGENCY AT 30%								$3,209,400			
4TH / 5TH AVENUE CORRIDOR									**$21,882,250**	**$19,750,000**	**$21,880,000**	**$24,040,000**
4	MOB/DEMOB	LS	1	1	1	$1,100,000	$1,500,000	$2,300,000	$1,500,000			
5	FILL FOR NEW ROADWAY ALIGNMENT	CY	16,000	22,000	30,000	$28	$37	$49	$814,000			
6	TEMPORARY RETAINING WALL	SF	8,000	9,000	12,000	$15	$25	$30	$225,000			
7	PERMANENT RETAINING WALL	SF	8,000	9,000	12,000	$35	$45	$55	$405,000			
8	TEMPORARY ROADWAY	SF	20,000	24,000	36,000	$3	$4	$6	$96,000			
9	TEMPORARY UTILITY LINE RELOCATION	LS	1	1	1	$530,400	$663,000	$994,500	$663,000			
10	COFFERDAM	LS	1	1	1	$2,000,000	$2,600,000	$4,000,000	$2,600,000			
11	DEMO EXISTING BRIDGE AND DAM	LS	1	1	1	$288,000	$384,000	$576,000	$384,000			
12	DEMO AND EXCAVATE EXISTING ROADWAY	CY	100,000	120,000	150,000	$2	$3	$5	$360,000			
13	NEW CLADDING FOR 4TH AVENUE PIERS	CY	120	140	180	$2,000	$2,500	$4,000	$350,000			
14	SCOUR PROTECTION AT BRIDGES	CY	1,500	2,100	3,900	$70	$95	$120	$199,500			
15	NEW ROADWAY AND APPURTENANCES	SF	48,000	53,000	60,000	$6	$8	$13	$424,000			
16	NEW 5TH AVENUE BRIDGE	SF	38,625	40,000	44,000	$132	$165	$198	$6,600,000			
17	PERMANENT UTILITY LINE RELOCATION	LS	1	1	1	$249,600	$312,000	$468,000	$312,000			
18	STORM DRAINAGE	ALL	1	1	1	$544,000	$680,000	$1,020,000	$680,000			
19	LUMINAIRES AND ELECTRICAL SUPPLY	ALL	1	1	1	$616,000	$770,000	$1,155,000	$770,000			
20	SEATS, RAILINGS, ARTWORK, ETC	ALL	1	1	1	$225,000	$450,000	$900,000	$450,000			
	CONTINGENCY AT 30%								$5,049,750			
RAILROAD BRIDGE - SCOUR PROTECTION									**$173,680**	**$130,000**	**$170,000**	**$220,000**
21	MOB/DEMOB	LS	1	1	1	$9,000	$12,000	$18,000	$12,000			
22	SCOUR PROTECTION	CY	900	1,280	1,500	$70	$95	$120	$121,600			
	CONTINGENCY AT 30%								$40,080			
DESCHUTES PARKWAY									**$14,407,900**	**$11,860,000**	**$14,410,000**	**$17,130,000**
33	MOB/DEMOB	LS	1	1	1	$700,000	$1,000,000	$1,500,000	$1,000,000			
34	DREDGING FOR ROCK PLACEMENT	CY	55,000	72,000	88,000	$18	$30	$46	$2,160,000			
35	ROCK SLOPE STABILIZATION	CY	60,000	75,000	90,000	$70	$95	$120	$7,125,000			
36	STORMWATER OUTFALL REHAB/REPLACE	ALL	1	1	1	$24,000	$30,000	$45,000	$30,000			
37	TOPSOIL FOR RIPARIAN PLANTING	AC	4.0	5.0	6.0	$25,000	$30,000	$40,000	$150,000			
38	PLANTING AND MONITORING - RIPARIAN	AC	4.0	5.0	6.0	$16,000	$24,000	$36,000	$120,000			
39	PLANTING AND MONITORING - EMERGENT	AC	3.5	5.5	7.5	$12,000	$36,000	$60,000	$198,000			
40	STREET FURNITURE AND DISPLAYS	ALL	1	1	1	$150,000	$300,000	$600,000	$300,000			
	CONTINGENCY AT 30%								$3,324,900			

			QUANTITY			UNIT PRICE			MEAN	PRICE VARIATION		
ITEM	DESCRIPTION	UNIT	LOW	MEAN	HIGH	LOW	MEAN	HIGH	TOTAL PRICE	LOW (10%)	MEAN	HIGH (90%)
I-5 BRIDGE - SCOUR PROTECTION									**$488,800**	**$380,000**	**$490,000**	**$610,000**
41	MOB/DEMOB	LS	1	1	1	$24,000	$34,000	$51,000	$34,000			
42	SCOUR PROTECTION	CY	3,000	3,600	4,500	$70	$95	$120	$342,000			
	CONTINGENCY AT 30%								$112,800			
PARKS									**$2,483,000**	**$1,930,000**	**$2,480,000**	**$3,120,000**
43	MOB/DEMOB	LS	1	1	1	$120,000	$170,000	$260,000	$170,000			
MARATHON PARK												
44	PLANTING AND MONITORING	AC	0.8	1.0	1.2	$12,000	$36,000	$60,000	$36,000			
45	RECREATIONAL FACILITIES / DISPLAYS	ALL	1	1	1	$36,000	$72,000	$144,000	$72,000			
CAPITOL LAKE INTERPRETIVE PARK												
46	NEW PEDESTRIAN / EMERGENCY BRIDGES	SF	400	600	800	$120	$150	$180	$90,000			
47	PLANTING AND MONITORING	AC	1.0	2.0	3.0	$12,000	$36,000	$60,000	$72,000			
48	RECREATIONAL FACILITIES / DISPLAYS	ALL	1	1	1	$72,000	$144,000	$288,000	$144,000			
TUMWATER HISTORICAL PARK												
49	NEW BOARDWALKS	LF	2,000	2,400	3,600	$300	$400	$600	$960,000			
50	PLANTING AND MONITORING	AC	0.8	1.0	1.2	$12,000	$36,000	$60,000	$36,000			
51	RECREATIONAL FACILITIES / DISPLAYS	ALL	1	1	1	$36,000	$72,000	$144,000	$72,000			
HERITAGE PARK												
52	STORMWATER OUTFALL REHAB/REPLACE	ALL	1	1	1	$120,000	$160,000	$270,000	$160,000			
53	COATING HERITAGE PARK BULKHEAD	LS	1	1	1	$12,000	$26,000	$40,000	$26,000			
54	STREET FURNITURE AND DISPLAYS	ALL	1	1	1	$36,000	$72,000	$144,000	$72,000			
	CONTINGENCY AT 30%								$573,000			
TOTAL CONSTRUCTION COST (2006 DOLLARS)									**$53,300,000**	**$46,300,000**	**$53,300,000**	**$61,000,000**

UNIT ABBREVIATIONS:

LS	LUMP SUM
SF	SQUARE FEET
EA	EACH
ALL	ALLOWANCE
YRS	YEARS
AC	ACRES
CY	CUBIC YARDS

Appendix C : Detail Cost Estimate – Alternative B

ALTERNATIVE B - PURE CONSTRUCTION COSTS - 2006 PRICES

			QUANTITY			UNIT PRICE			MEAN	PRICE VARIATION		
ITEM	DESCRIPTION	UNIT	LOW	MEAN	HIGH	LOW	MEAN	HIGH	TOTAL PRICE	LOW (10%)	MEAN	HIGH (90%)
CHANNEL PRE-DREDGING									**$13,907,400**	**$8,670,000**	**$13,910,000**	**$19,770,000**
1	CHANNEL PRE-DREDGING	CY	180,000	270,000	360,000	$18	$30	$46	$8,100,000			
2	CONTAMINATED SEDIMENT DISPOSAL	CY	0	15,000	30,000	$66	$170	$273	$2,550,000			
3	INTERTIDAL ZONE DEBRIS REMOVAL	ALL	1	1	1	$24,000	$48,000	$72,000	$48,000			
	CONTINGENCY AT 30%								$3,209,400			
4TH / 5TH AVENUE CORRIDOR									**$21,882,250**	**$19,790,000**	**$21,880,000**	**$24,050,000**
4	MOB/DEMOB	LS	1	1	1	$1,100,000	$1,500,000	$2,300,000	$1,500,000			
5	FILL FOR NEW ROADWAY ALIGNMENT	CY	16,000	22,000	30,000	$28	$37	$49	$814,000			
6	TEMPORARY RETAINING WALL	SF	8,000	9,000	12,000	$15	$25	$30	$225,000			
7	PERMANENT RETAINING WALL	SF	8,000	9,000	12,000	$35	$45	$55	$405,000			
8	TEMPORARY ROADWAY	SF	20,000	24,000	36,000	$3	$4	$6	$96,000			
9	TEMPORARY UTILITY LINE RELOCATION	LS	1	1	1	$530,400	$663,000	$994,500	$663,000			
10	COFFERDAM	LS	1	1	1	$2,000,000	$2,600,000	$4,000,000	$2,600,000			
11	DEMO EXISTING BRIDGE AND DAM	LS	1	1	1	$288,000	$384,000	$576,000	$384,000			
12	DEMO AND EXCAVATE EXISTING ROADWAY	CY	100,000	120,000	150,000	$2	$3	$5	$360,000			
13	NEW CLADDING FOR 4TH AVENUE PIERS	CY	120	140	180	$2,000	$2,500	$4,000	$350,000			
14	SCOUR PROTECTION AT BRIDGES	CY	1,500	2,100	3,900	$70	$95	$120	$199,500			
15	NEW ROADWAY AND APPURTENANCES	SF	48,000	53,000	60,000	$6	$8	$13	$424,000			
16	NEW 5TH AVENUE BRIDGE	SF	38,625	40,000	44,000	$132	$165	$198	$6,600,000			
17	PERMANENT UTILITY LINE RELOCATION	LS	1	1	1	$249,600	$312,000	$468,000	$312,000			
18	STORM DRAINAGE	ALL	1	1	1	$544,000	$680,000	$1,020,000	$680,000			
19	LUMINAIRES AND ELECTRICAL SUPPLY	ALL	1	1	1	$616,000	$770,000	$1,155,000	$770,000			
20	SEATS, RAILINGS, ARTWORK, ETC	ALL	1	1	1	$225,000	$450,000	$900,000	$450,000			
	CONTINGENCY AT 30%								$5,049,750			
RAILROAD BRIDGE - REPLACEMENT									**$10,020,400**	**$9,110,000**	**$10,020,000**	**$11,020,000**
23	MOB/DEMOB	LS	1	1	1	$490,000	$700,000	$1,050,000	$700,000			
24	DREDGING	CY	40,000	46,000	60,000	$18	$30	$46	$1,380,000			
25	SCOUR PROTECTION AT BRIDGE	CY	4,000	5,500	7,000	$70	$95	$120	$522,500			
26	FILL FOR NEW RR ALIGNMENT	CY	8,000	10,000	16,000	$28	$37	$49	$370,000			
27	ROCK SLOPE STABILIZATION FOR FILL	CY	2,500	3,300	4,500	$70	$95	$120	$313,500			
28	NEW RR BRIDGE	SF	11,000	11,100	11,200	$245	$260	$300	$2,886,000			
29	TEMPORARY UTILITY LINE RELOCATION	LS	1	1	1	$130,400	$163,000	$244,500	$163,000			
30	DEMO EXISTING RR AND PED BRIDGES	LS	1	1	1	$170,000	$220,000	$280,000	$220,000			
31	PERMANENT UTILITY LINE RELOCATION	LS	1	1	1	$130,400	$163,000	$244,500	$163,000			
32	NEW PEDESTRIAN BRIDGE	SF	5,000	6,000	7,500	$132	$165	$198	$990,000			
	CONTINGENCY AT 30%								$2,312,400			

			QUANTITY			UNIT PRICE			MEAN	PRICE VARIATION		
ITEM	DESCRIPTION	UNIT	LOW	MEAN	HIGH	LOW	MEAN	HIGH	TOTAL PRICE	LOW (10%)	MEAN	HIGH (90%)
DESCHUTES PARKWAY									**$14,407,900**	**$11,850,000**	**$14,410,000**	**$17,130,000**
33	MOB/DEMOB	LS	1	1	1	$700,000	$1,000,000	$1,500,000	$1,000,000			
34	DREDGING FOR ROCK PLACEMENT	CY	55,000	72,000	88,000	$18	$30	$46	$2,160,000			
35	ROCK SLOPE STABILIZATION	CY	60,000	75,000	90,000	$70	$95	$120	$7,125,000			
36	STORMWATER OUTFALL REHAB/REPLACE	ALL	1	1	1	$24,000	$30,000	$45,000	$30,000			
37	TOPSOIL FOR RIPARIAN PLANTING	AC	4.0	5.0	6.0	$25,000	$30,000	$40,000	$150,000			
38	PLANTING AND MONITORING - RIPARIAN	AC	4.0	5.0	6.0	$16,000	$24,000	$36,000	$120,000			
39	PLANTING AND MONITORING - EMERGENT	AC	3.5	5.5	7.5	$12,000	$36,000	$60,000	$198,000			
40	STREET FURNITURE AND DISPLAYS	ALL	1	1	1	$150,000	$300,000	$600,000	$300,000			
	CONTINGENCY AT 30%								$3,324,900			
I-5 BRIDGE - SCOUR PROTECTION									**$488,800**	**$380,000**	**$490,000**	**$610,000**
41	MOB/DEMOB	LS	1	1	1	$24,000	$34,000	$51,000	$34,000			
42	SCOUR PROTECTION	CY	3,000	3,600	4,500	$70	$95	$120	$342,000			
	CONTINGENCY AT 30%								$112,800			
PARKS									**$2,636,400**	**$2,040,000**	**$2,640,000**	**$3,300,000**
43	MOB/DEMOB	LS	1	1	1	$130,000	$180,000	$280,000	$180,000			
MARATHON PARK												
44	PLANTING AND MONITORING	AC	1.6	2.0	2.4	$12,000	$36,000	$60,000	$72,000			
45	RECREATIONAL FACILITIES / DISPLAYS	ALL	1	1	1	$72,000	$144,000	$288,000	$144,000			
CAPITOL LAKE INTERPRETIVE PARK												
46	NEW PEDESTRIAN / EMERGENCY BRIDGES	SF	400	600	800	$120	$150	$180	$90,000			
47	PLANTING AND MONITORING	AC	1.0	2.0	3.0	$12,000	$36,000	$60,000	$72,000			
48	RECREATIONAL FACILITIES / DISPLAYS	ALL	1	1	1	$72,000	$144,000	$288,000	$144,000			
TUMWATER HISTORICAL PARK												
49	NEW BOARDWALKS	LF	2,000	2,400	3,600	$300	$400	$600	$960,000			
50	PLANTING AND MONITORING	AC	0.8	1.0	1.2	$12,000	$36,000	$60,000	$36,000			
51	RECREATIONAL FACILITIES / DISPLAYS	ALL	1	1	1	$36,000	$72,000	$144,000	$72,000			
HERITAGE PARK												
52	STORMWATER OUTFALL REHAB/REPLACE	ALL	1	1	1	$120,000	$160,000	$270,000	$160,000			
53	COATING HERITAGE PARK BULKHEAD	LS	1	1	1	$12,000	$26,000	$40,000	$26,000			
54	STREET FURNITURE AND DISPLAYS	ALL	1	1	1	$36,000	$72,000	$144,000	$72,000			
	CONTINGENCY AT 30%								$608,400			
TOTAL CONSTRUCTION COST (2006 DOLLARS)									**$63,300,000**	**$55,900,000**	**$63,300,000**	**$71,600,000**

UNIT ABBREVIATIONS:

LS	LUMP SUM
SF	SQUARE FEET
EA	EACH
ALL	ALLOWANCE
YRS	YEARS
AC	ACRES
CY	CUBIC YARDS

Appendix D : Detail Cost Estimate – Alternative D

ALTERNATIVE D - PURE CONSTRUCTION COSTS - 2006 PRICES

			QUANTITY			UNIT PRICE			MEAN	PRICE VARIATION		
ITEM	DESCRIPTION	UNIT	LOW	MEAN	HIGH	LOW	MEAN	HIGH	TOTAL PRICE	LOW (10%)	MEAN	HIGH (90%)
CHANNEL PRE-DREDGING									**$16,247,400**	**$10,000,000**	**$16,240,000**	**$23,520,000**
1	CHANNEL PRE-DREDGING	CY	180,000	330,000	420,000	$18	$30	$46	$9,900,000			
2	CONTAMINATED SEDIMENT DISPOSAL	CY	0	15,000	30,000	$66	$170	$273	$2,550,000			
3	INTERTIDAL ZONE DEBRIS REMOVAL	ALL	1	1	1	$24,000	$48,000	$72,000	$48,000			
	CONTINGENCY AT 30%								$3,749,400			
4TH / 5TH AVENUE CORRIDOR									**$21,882,250**	**$19,770,000**	**$21,880,000**	**$24,050,000**
4	MOB/DEMOB	LS	1	1	1	$1,100,000	$1,500,000	$2,300,000	$1,500,000			
5	FILL FOR NEW ROADWAY ALIGNMENT	CY	16,000	22,000	30,000	$28	$37	$49	$814,000			
6	TEMPORARY RETAINING WALL	SF	8,000	9,000	12,000	$15	$25	$30	$225,000			
7	PERMANENT RETAINING WALL	SF	8,000	9,000	12,000	$35	$45	$55	$405,000			
8	TEMPORARY ROADWAY	SF	20,000	24,000	36,000	$3	$4	$6	$96,000			
9	TEMPORARY UTILITY LINE RELOCATION	LS	1	1	1	$530,400	$663,000	$994,500	$663,000			
10	COFFERDAM	LS	1	1	1	$2,000,000	$2,600,000	$4,000,000	$2,600,000			
11	DEMO EXISTING BRIDGE AND DAM	LS	1	1	1	$288,000	$384,000	$576,000	$384,000			
12	DEMO AND EXCAVATE EXISTING ROADWAY	CY	100,000	120,000	150,000	$2	$3	$5	$360,000			
13	NEW CLADDING FOR 4TH AVENUE PIERS	CY	120	140	180	$2,000	$2,500	$4,000	$350,000			
14	SCOUR PROTECTION AT BRIDGES	CY	1,500	2,100	3,900	$70	$95	$120	$199,500			
15	NEW ROADWAY AND APPURTENANCES	SF	48,000	53,000	60,000	$6	$8	$13	$424,000			
16	NEW 5TH AVENUE BRIDGE	SF	38,625	40,000	44,000	$132	$165	$198	$6,600,000			
17	PERMANENT UTILITY LINE RELOCATION	LS	1	1	1	$249,600	$312,000	$468,000	$312,000			
18	STORM DRAINAGE	ALL	1	1	1	$544,000	$680,000	$1,020,000	$680,000			
19	LUMINAIRES AND ELECTRICAL SUPPLY	ALL	1	1	1	$616,000	$770,000	$1,155,000	$770,000			
20	SEATS, RAILINGS, ARTWORK, ETC	ALL	1	1	1	$225,000	$450,000	$900,000	$450,000			
	CONTINGENCY AT 30%								$5,049,750			
RAILROAD BRIDGE - SCOUR PROTECTION									**$173,680**	**$130,000**	**$170,000**	**$220,000**
21	MOB/DEMOB	LS	1	1	1	$9,000	$12,000	$18,000	$12,000			
22	SCOUR PROTECTION	CY	900	1,280	1,500	$70	$95	$120	$121,600			
	CONTINGENCY AT 30%								$40,080			
DESCHUTES PARKWAY									**$14,407,900**	**$11,880,000**	**$14,410,000**	**$17,180,000**
33	MOB/DEMOB	LS	1	1	1	$700,000	$1,000,000	$1,500,000	$1,000,000			
34	DREDGING FOR ROCK PLACEMENT	CY	55,000	72,000	88,000	$18	$30	$46	$2,160,000			
35	ROCK SLOPE STABILIZATION	CY	60,000	75,000	90,000	$70	$95	$120	$7,125,000			
36	STORMWATER OUTFALL REHAB/REPLACE	ALL	1	1	1	$24,000	$30,000	$45,000	$30,000			
37	TOPSOIL FOR RIPARIAN PLANTING	AC	4.0	5.0	6.0	$25,000	$30,000	$40,000	$150,000			
38	PLANTING AND MONITORING - RIPARIAN	AC	4.0	5.0	6.0	$16,000	$24,000	$36,000	$120,000			
39	PLANTING AND MONITORING - EMERGENT	AC	3.5	5.5	7.5	$12,000	$36,000	$60,000	$198,000			
40	STREET FURNITURE AND DISPLAYS	ALL	1	1	1	$150,000	$300,000	$600,000	$300,000			
	CONTINGENCY AT 30%								$3,324,900			

			QUANTITY			UNIT PRICE			MEAN	PRICE VARIATION		
ITEM	**DESCRIPTION**	**UNIT**	**LOW**	**MEAN**	**HIGH**	**LOW**	**MEAN**	**HIGH**	**TOTAL PRICE**	**LOW (10%)**	**MEAN**	**HIGH (90%)**
I-5 BRIDGE - SCOUR PROTECTION									**$488,800**	**$380,000**	**$490,000**	**$610,000**
41	MOB/DEMOB	LS	1	1	1	$24,000	$34,000	$51,000	$34,000			
42	SCOUR PROTECTION	CY	3,000	3,600	4,500	$70	$95	$120	$342,000			
	CONTINGENCY AT 30%								$112,800			
PARKS									**$2,483,000**	**$1,930,000**	**$2,480,000**	**$3,110,000**
43	MOB/DEMOB	LS	1	1	1	$120,000	$170,000	$260,000	$170,000			
MARATHON PARK												
44	PLANTING AND MONITORING	AC	0.8	1.0	1.2	$12,000	$36,000	$60,000	$36,000			
45	RECREATIONAL FACILITIES / DISPLAYS	ALL	1	1	1	$36,000	$72,000	$144,000	$72,000			
CAPITOL LAKE INTERPRETIVE PARK												
46	NEW PEDESTRIAN / EMERGENCY BRIDGES	SF	400	600	800	$120	$150	$180	$90,000			
47	PLANTING AND MONITORING	AC	1.0	2.0	3.0	$12,000	$36,000	$60,000	$72,000			
48	RECREATIONAL FACILITIES / DISPLAYS	ALL	1	1	1	$72,000	$144,000	$288,000	$144,000			
TUMWATER HISTORICAL PARK												
49	NEW BOARDWALKS	LF	2,000	2,400	3,600	$300	$400	$600	$960,000			
50	PLANTING AND MONITORING	AC	0.8	1.0	1.2	$12,000	$36,000	$60,000	$36,000			
51	RECREATIONAL FACILITIES / DISPLAYS	ALL	1	1	1	$36,000	$72,000	$144,000	$72,000			
HERITAGE PARK												
52	STORMWATER OUTFALL REHAB/REPLACE	ALL	1	1	1	$120,000	$160,000	$270,000	$160,000			
53	COATING HERITAGE PARK BULKHEAD	LS	1	1	1	$12,000	$26,000	$40,000	$26,000			
54	STREET FURNITURE AND DISPLAYS	ALL	1	1	1	$36,000	$72,000	$144,000	$72,000			
	CONTINGENCY AT 30%								$573,000			
REFLECTING POOL BARRIER									**$18,850,000**	**$15,470,000**	**$18,850,000**	**$23,210,000**
55	MOB/DEMOB	LS	1	1	1	$900,000	$1,300,000	$2,000,000	$1,300,000			
56	SHEET PILE BARRIER	SF	240,000	300,000	440,000	$28	$32	$40	$9,600,000			
57	PEDESTRIAN WALKWAY	LS	1	1	1	$1,600,000	$1,800,000	$2,000,000	$1,800,000			
58	TIDE GATE STRUCTURES	EA	8	8	8	$50,000	$100,000	$150,000	$800,000			
59	FISH PASSAGE	ALL	1	1	1	$200,000	$500,000	$1,000,000	$500,000			
60	MONITORING	YRS	5	10	15	$25,000	$50,000	$100,000	$500,000			
	CONTINGENCY AT 30%								$4,350,000			
TOTAL CONSTRUCTION COST (2006 DOLLARS)									**$74,500,000**	**$65,900,000**	**$74,500,000**	**$84,100,000**

UNIT ABBREVIATIONS:

LS	LUMP SUM
SF	SQUARE FEET
EA	EACH
ALL	ALLOWANCE
YRS	YEARS
AC	ACRES
CY	CUBIC YARDS

Appendix E : Cost Estimate Assumptions

ITEM	DESCRIPTION	QUANTITY	UNIT COST
GENERAL DREDGING			
1	CHANNEL PRE-DREDGING	Low quantity is based on the erosion from the Middle Basin predicted by the USGS report, for lower erodibility. This is similar to the quantity needed for the dredge material placement requirement along Deschutes Parkway (Figure 8) with a 50% overfill ratio. High quantity is based on the lower of the erosion from the Middle Basin and the deposition in the Marina and Port areas predicted by the USGS report, for higher erodibility.	Dredging based on several recent maintenance projects; costs include mob/demob, transport, and disposal fees - Port of Everett 2001 maintenance dredging ($640,000/44,000 cy) at $15/cy (low), escalates to $18/cy in 2006 - Port of Seattle Duwamish maintenance dredging, $18/cy in 2006 - Port of Seattle Fisherman's Terminal, $18/cy in 2006 - Point Hudson Marina, $20/cy plus 10% mob/demob gives $22/cy overall, in 2006 (note the second low bid was $40/cy) - Port of Skagit County maintenance dredging, $40/cy in 2002, escalates to $46/cy in 2006; included problems with debris in marina This line item is anticipated to be on the high side due to rehandling on the shoreline, therefore a range of $18-$46 and an average of $30/cy is assumed
2	CONTAMINATED SEDIMENT DISPOSAL	Up to 25% of dredge material quantity may be contaminated. Larger contaminated quantities would call for redesign. Note this is just the disposal quantity - this quantity does not sum to the pre-dredging quantity. Even though the most likely quantity for contaminated sediments may be zero, the mean quantity (based on a minimum of zero and a non-zero maximum) must be greater than zero.	Disposal based on 2004 quotes by Rabanco from Seattle to Arlington, OR, Subtitle D landfill by 100-ton gondola at $41/ton (low) or to Subtitle C landfill by 30-ton truck boxes at $170/ton (high); prices converted at 1.5 ton/yard and escalated to 2006 dollars using standard 3.5% rate.
3	INTERTIDAL ZONE DEBRIS REMOVAL	Allowance	Covers 3 weeks typical labor crew and equipment at $3,200/day
4TH / 5TH AVENUE CORRIDOR			
4	MOB/DEMOB	Lump sum, based on construction cost for this item before contingency.	Mobilization/demobilization costs generally applied at 7% (low), 10% (mean), and 15% (high) of the total project construction costs.
5	FILL FOR NEW ROADWAY ALIGNMENT	Quantity based on design in Figure 5.	Used RSMeans (2006) Heavy Construction Cost Data unit costs for an aggregate base course with compaction.
6	TEMPORARY RETAINING WALL	Quantity based on design in Figure 5.	Unit prices from WSDOT (2006) Bridge Design Manual M 23-50 Appendix 12 - Structural Estimating Aids. Used Stabilized Earth Wall Welded Wire.
7	PERMANENT RETAINING WALL	Quantity based on design in Figure 5.	Unit prices from WSDOT (2006) Bridge Design Manual M 23-50 Appendix 12 - Structural Estimating Aids. Used Stabilized Earth Wall CIP Conc. Fascia Panels (Special Design)

ITEM	DESCRIPTION	QUANTITY	UNIT COST
8	TEMPORARY ROADWAY	Based on 600 LF roadway at 40' wide. Actual road width is unlikely to be much less.	Used RSMeans (2006) Heavy Construction Cost Data unit costs for aggregate base course and asphalt concrete pavement, with 100% added for miscellaneous work.
9	TEMPORARY UTILITY LINE RELOCATION	Lump sum to reroute 1,700 feet of new 20" DI sewer line, 12" DI water line, and two 6" steel gas lines from 5th Avenue bridge to 4th Avenue bridge. Sewer line may not be needed during temporary construction, so this is conservative.	Utility connections based on RSMeans (2006) Heavy Construction Cost Data unit costs for new pipe. Added 20% allowance to account for trenching and mounting on bridge.
10	COFFERDAM	Lump sum to provide cofferdam 220' long surrounding existing dam and abutment of new bridge.	Assume parallel, braced sheet pile coffer dam on north side (220' long by 75' high by 20' wide) and south side (220' long by 60' high by 15' wide). Include 500' long by 96" diameter pipe to carry Deschutes River diversion flow through coffer dam. Pipe has tide gate at downstream end and butterfly valve at upstream end to regulate flow. Use $30/sf for coffer dam sheeting, bracing, drive and extract. Fill for coffer dams at $28/cy. Diversion structure is $500,000. All values based on RSMeans (2006).
11	DEMO EXISTING BRIDGE AND DAM	Remove dam and retainer gates. Includes demolition of estimated 132,200 cf or 10,300 tons of reinforced concrete and 17 tons of steel.	Dam and bridge demolition based on Washington State General Administration demolition of a warehouse in 1997 with unit prices of ($294,068/16,256 ton) $18.09/ton for concrete and ($69,773/876 tons) $79.65/ton for steel. Escalated to 2006 using standard 3.5% rate plus 50% increase for work within cofferdam gives $37/ton for concrete and $163/ton for steel. These unit costs do not include credit for recycling.
12	DEMO AND EXCAVATE EXISTING ROADWAY	Remove existing 5th Avenue bridge by excavating approach peninsula(s) to widen tidal entrance. Excavate to elevation -10 feet (NGVD29) for 120,000 cy.	Excavation unit price per RSMeans 02315-424-0300 with Olympia factor rounded up to $3/cy. Excavation uses land-based equipment after cofferdam is removed.
13	NEW CLADDING FOR 4TH AVENUE PIERS	Concrete shroud assumes the mudline will be taken to -10' and the precast concrete shroud cladding the pier will be extended by 12-feet in depth. Concrete volume required is approximately 140 cy. Excavation can be performed from land before tidal flow is reestablished (included in previous line item). Shroud placement by divers.	Assume $2,500 / cy for shroud based on Olympia, 4th Ave Bridge, bid tabs, escalated from 2001. Values are increased to allow for extremely small quantities.
14	SCOUR PROTECTION AT BRIDGES	Quantity assumes: replace existing riprap protection at 4th Avenue Bridge on east abutment and two piers with same volume of larger stone; increase riprap quantity and stone size at extended pier to match the other two piers; and new riprap protection on both banks of new 5th Avenue Bridge	For small rock quantities (less that 1,000 cy), WSDOT bid tabs for heavy riprap for October 2005-October 2006 projects in the Olympia region give costs varying from $53.50 to $110 per ton, or $80 to $165/cy with 1.5 tons per cy. For larger quantities in recent marine projects, e.g., Port of Everett 12th St Marina, costs have been in the range of $30-$45/ton or $45-$68/cy, May 2006. Costs used here range from $70-$120/cy; this is intermediate between the two extremes and in part allows for possible difficulties in furnishing such large quantities.
15	NEW ROADWAY	Quantity based on design in Figure 5.	Used RSMeans (2006) Heavy Construction Cost Data unit costs; 30% added to allow for crosswalks, temporary controls, etc. Lighting and storm drainage not included.

ITEM	DESCRIPTION	QUANTITY	UNIT COST
16	NEW 5TH AVENUE BRIDGE	515' long by 75' wide minimum bridge size. Added 15' over minimum span to accommodate pedestrian underpass. Mean and maximum areas include wider railings, overlooks, etc.	Assume concrete girder bridge with piling, WSDOT Bridge Design Manual Chapter 12 gives $125/SF for October 2004, inflated by 15% annually based on recent concrete inflation gives $165/SF
17	PERMANENT UTILITY LINE RELOCATION	Lump sum to return 800 feet of new 20" DI sewer line, 12" DI water line, and two 6" steel gas lines back to 4th Avenue bridge.	See item 9.
18	STORM DRAINAGE	Allowance - storm drainage regulations are constantly changing and a reasonable design cannot be provided at this stage.	Cost based on Olympia, 4th Ave Bridge bid tabs escalated from 2001 to 2006.
19	LUMINAIRES AND ELECTRICAL SUPPLY	Allowance - the number and quality of luminaires can be determined through the design and public process.	Cost based on Olympia, 4th Ave Bridge bid tabs escalated from 2001 to 2006.
20	SEATS, RAILINGS, ARTWORK, ETC	Allowance - the level of street furniture and artwork can be determined through the design and public process	2%, 3%, or 4% of construction cost chosen based on minimum State requirement of 1% for Art.
RAILROAD BRIDGE - SCOUR PROTECTION (ALTS 1, 3)			
21	MOB/DEMOB	Lump sum, based on construction cost for this item before contingency.	Mobilization/demobilization costs generally applied at 7% (low), 10% (mean), and 15% (high) of the project construction costs. Use of this value assumes scour protection is included with other work, e.g., new 5th Ave Bridge, in a single contract.
22	SCOUR PROTECTION	Assumes scour pad across full 180-foot channel, average 4-feet deep, 48-feet alongshore.	See item 14.
RAILROAD BRIDGE - REPLACEMENT (ALT 2)			
23	MOB/DEMOB	Lump sum, based on construction cost for this item before contingency.	See item 4.
24	DREDGING	Assumes dredging to -12 feet NGVD29.	See item 1.
25	SCOUR PROTECTION AT BRIDGE	Buried riprap at piers, 5' thick and to 10' distance from each pier (pedestrian and RR bridge), plus bank scour protection 5' thick.	See item 14.
26	FILL FOR NEW RR ALIGNMENT	Fill extends 30-feet south of existing edge of bank, then drops at 4H:1V slope to approx -5' NGVD29. Fill extends 500-feet along bank.	See item 5.
27	ROCK SLOPE STABILIZATION FOR FILL	Rock stabilization for fill assumes riprap stabilization an average 3 ft thick by 60 ft on slope by 500 ft long.	See item 14.
28	NEW RR BRIDGE	Bridge 500 to 505 feet long by 20-feet wide.	RR bridge assumes E-80 loading, 8 piers each with pile cap and 15 each 24' steel pipe piles 150-feet deep for foundation. Total bridge cost calculated using unit material costs from WSDOT (Aug 2006) Bridge Design Manual, divided by bridge deck area to give unit costs used here.

ITEM	DESCRIPTION	QUANTITY	UNIT COST
29	TEMPORARY UTILITY LINE RELOCATION	Lump sum to reroute 600 feet of new 24" DI sewer line and 16" DI water line from existing pedestrian bridge to RR bridge. Sewer line may not be needed during temporary construction, so this is conservative.	See Item 9.
30	DEMO EXISTING RR AND PED BRIDGES	Lump sum to remove concrete piers, steel at trestle, timber piles and decking, tracks, and pedestrian bridge.	See item 11. Timber pile costs are in addition, assume $200/ton to dispose of treated timber and $400/pile to pull (average). Lighter pedestrian bridge estimated at 20% of RR bridge costs.
31	PERMANENT UTILITY LINE RELOCATION	Lump sum to return 600 feet of new 24" DI sewer line and 16" DI water line to new pedestrian bridge.	See item 9.
32	NEW PEDESTRIAN BRIDGE	10' clear walkway and 500' long	Assume concrete girder bridge with piling, WSDOT Bridge Design Manual Chapter 12 gives $125/SF for October 2004, inflated by 15% annually based on recent concrete inflation gives $165/SF
DESCHUTES PARKWAY AND PERCIVAL COVE			
33	MOB/DEMOB	Lump sum, based on construction cost for this item before contingency.	See item 4.
34	DREDGING FOR ROCK PLACEMENT	Quantity based on design in Figure 8; in Sections B and E, rock toe is keyed in to slope but most of the rock is an overlay; in other sections the rock slope is entirely set into the existing slope.	See item 1.
35	ROCK SLOPE STABILIZATION	Quantity based on design in Figure 8.	See item 14.
36	STORMWATER OUTFALL REHAB/REPLACE	Allowance, assumes replacement of existing outfalls in kind during the major construction process of rock and dredge material placement.	Includes $10,000 to survey existing outfalls prior to construction and $20,000 for costs associated with new piping.
37	TOPSOIL FOR RIPARIAN PLANTING	Quantity based on design in Figure 8.	Typical cost for soil improvement based on recent project experience
38	PLANTING AND MONITORING - RIPARIAN	Quantity based on design in Figure 8 - same area is planted as is improved with topsoil.	Includes 2 years monitoring at $5,000 - $8,000 / year /acre and native seeding. Average and maximum values include 40 trees/100 shrubs and 75 trees / 200 shrubs per acre in addition. Based on recent project experience.
39	PLANTING AND MONITORING - EMERGENT	Quantity based on design in Figure 8.	Includes 2 years monitoring at $5,000 - $8,000 / year /acre and native seeding. Average and maximum values include wetland plugs planted at 15" spacing over one-quarter and one-half of the area in addition. Based on recent project experience.
40	STREET FURNITURE AND DISPLAYS	Allowance - the level of street furniture and artwork can be determined through the design and public process	Assumes average street furniture costs will match average planting and monitoring costs.
I-5 BRIDGE			
41	MOB/DEMOB	Lump sum, based on construction cost for this item before contingency.	See item 21.
42	SCOUR PROTECTION	Assumes 4-feet deep riprap placed over river banks. Existing lighter riprap may be removed first.	See item 14.

ITEM	DESCRIPTION	QUANTITY	UNIT COST
PARKS			
43	MOB/DEMOB	Lump sum, based on construction cost for this item before contingency.	See item 21.
MARATHON PARK			
44	PLANTING AND MONITORING	Allowance - Assumes 1 acre of emergent planting for Alternatives 1 and 3, with an additional acre of riparian planting for Alternative B	See items 38 and 39
45	RECREATIONAL FACILITIES / DISPLAYS	Allowance - the level of new facilities and displays can be determined through the design and public process	Assumes average recreational facility costs will be twice planting costs.
CAPITOL LAKE INTERPRETIVE PARK			
46	NEW PEDESTRIAN / EMERGENCY BRIDGES	Assumes 2 new bridges, 15' x 20'.	Typical cost for a single-span precast concrete bridge
47	PLANTING AND MONITORING	Allowance based on 1 acre of emergent vegetation planting	See item 39
48	RECREATIONAL FACILITIES / DISPLAYS	Allowance - the level of new facilities and displays can be determined through the design and public process	Assumes average recreational facility costs will be twice planting costs.
TUMWATER HISTORICAL PARK			
49	NEW BOARDWALKS	3,000 feet length - could be varied	8' wide, elevated, on ground beams anchored to low -impact precast concrete pier & pin system on an 8' spacing; unit costs for construction from RSMeans.
50	PLANTING AND MONITORING	Allowance based on 1 acre of emergent vegetation planting	See item 39
51	RECREATIONAL FACILITIES / DISPLAYS	Allowance - the level of new facilities and displays can be determined through the design and public process	Assumes average recreational facility costs will be twice planting costs.
HERITAGE PARK			
52	STORMWATER OUTFALL REHAB/REPLACE	Allowance based on single large pipe (36" corrugated metal pipe at 7th Avenue) which is known to need replacement	Used RSMeans (2006) Heavy Construction Cost Data unit costs. Assume 400-feet of 36" concrete pipe to be replaced at average 12' trench depth. Double cost to allow for other pipes not yet identified, and add $10,000 to account for connections to Heritage Park bulkhead.
53	COATING HERITAGE PARK BULKHEAD	Lump sum based on 16,000 SF of coating and 3,000 cy of excavation and backfill if needed.	$12,000 for testing (based on 20 samples, approx 1 sample per 150 feet at $320/sample for collection and testing, plus interpretation costs). Minimum cost assumes only testing. Average and maximum costs include excavating to the toe of the bulkhead and epoxy coating
54	STREET FURNITURE AND DISPLAYS	Allowance - the level of new facilities and displays can be determined through the design and public process	Assumed similar to Tumwater Historical Park.

ITEM	DESCRIPTION	QUANTITY	UNIT COST
REFLECTING POOL BARRIER (ALT 3)			
55	MOB/DEMOB	Lump sum, based on construction cost for this item before contingency.	See item 4.
56	SHEET PILE BARRIER	Sheet pile quantity based on design in Figure 7. Piles driven to approx -50' NGVD29.	Used RSMeans (2006) Heavy Construction Cost Data unit costs for driven AZ36 sheet piles.
57	PEDESTRIAN WALKWAY	Lump sum to include 10-feet clear walkway over 2,100 LF of barrier.	Assumes concrete deck plus decorative railing at $150/feet.
58	TIDE GATE STRUCTURES	Four inlet and four outlet culverts with tide gates.	Allowance - tide gate type has not been finalized.
59	FISH PASSAGE	Allowance to cover further fish passage costs.	Allowance - design has not been finalized.
60	MONITORING	Monitoring of water quality as well as fish passage from 5-15 years.	Higher annual costs include dive surveys and a significant research component.
MAINTENANCE COSTS - PERIODIC			
61	DREDGING - MARINA & PORT (AFTER 3-YR)	Low value assumes that pre-dredging in the lake is successful in removing the need for dredging at 3 years. High value is based on 3-year deposition with higher erodibility, based on USGS predictions, and assumes that pre-dredging in the lake decreases the need for dredging at 3 years by 50%. Average value is half-way between the two.	See item 1. Part of the maintenance work will be in the deep draft navigation channel at the Port of Olympia, and part in the marina. Open water disposal at the Anderson Island site is assumed; the distance from the project to the disposal site is relatively far (more than 20 miles), therefore the overall cost is expected to be slightly higher than the typical $18-$22 given in item 1. Since part of this dredging is at the Port of Olympia (rather than within the marina fairways), the worst-case costs are not likely to be as high here. Minimum of $18/cy, maximum of $40/cy, and average of $25/cy are used based on these considerations.
62	CONTAMINATED SEDIMENT DISPOSAL	Average and high values are 10% and 25% respectively of average dredge material amount. See item 2.	See item 2. Costs are for upland disposal and are the same for material from Capitol Lake and from Budd Inlet.
63	DREDGING - MARINA & PORT (EVERY 10-YR)	Low and high values bracket the 10-year sediment deposition based on the average annual sediment input from the Deschutes River between 1952 and 1998 (Capitol Lake Adaptive Management Plan 1999 - 35,000 cy/year), and the predicted average annual deposition between 4 and 10 years after construction (USGS 2006 - 45,000 cy/year, Alternatives A&B, and 53,000 cy/year, Alternative D). Average value is taken closer to the lower end, since eventually an equilibrium is expected to be reached.	See items 1 and 61.
64	CONTAMINATED SEDIMENT DISPOSAL	Average and high values are 10% and 25% respectively of average dredge material amount. See item 2.	See items 2 and 62.