STATE OF WASHINGTON
DEPARTMENT OF ENTERPRISE SERVICES
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The following sections are from "Deschutes Estuary Feasibility Study, Phase 3, Engineering Design and Cost Estimates, FINAL REPORT," February 9, 2007

Prepared for Washington Department Fish and Wildlife

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Executive Summary

Section 3.4, "Barrier for Reflecting Pool (Alternative D)"

A full copy of the report is available at:

http://des.wa.gov/SiteCollectionDocuments/About/CapitolLake/08-DEFS-EngineeringDesignAndCostEstimates(February20.pdf

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

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.

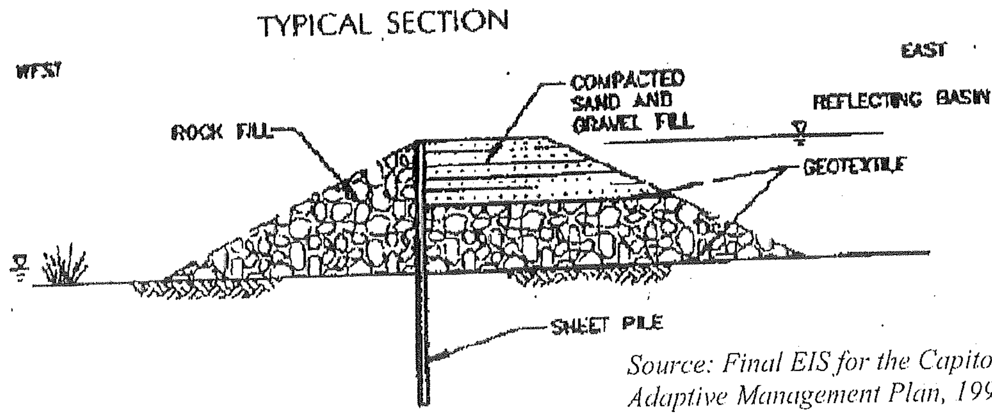
3.4.1 Barrier Materials

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.

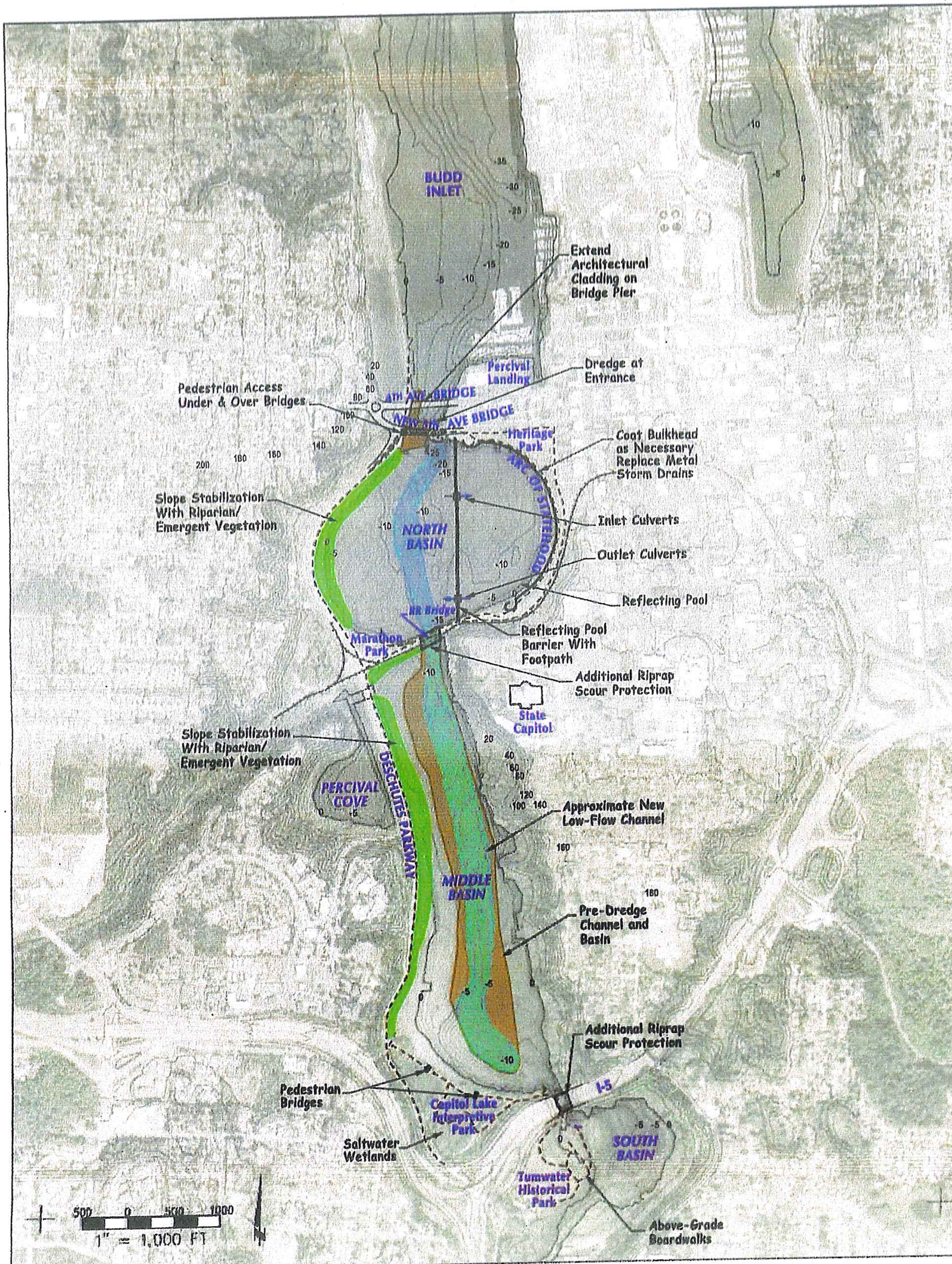
This tidally flushed saltwater option is recommended over the freshwater option because it is generally self-sustaining, less costly, and less artificial.

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.



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

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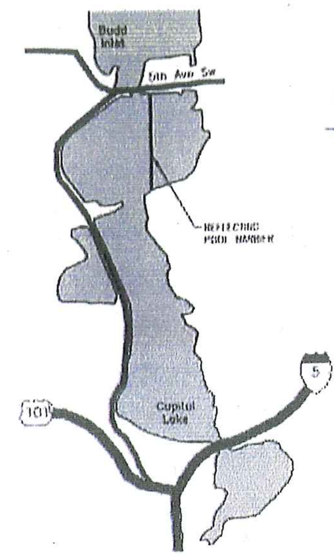
Exhibit 4

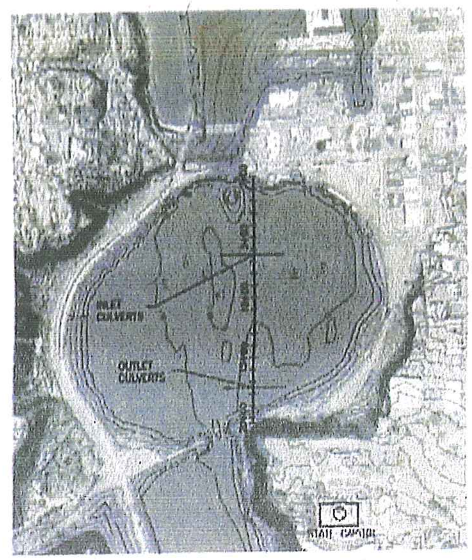
ALTERNATIVE D: NEW 5TH AVENUE BRIDGE WITH REFLECTING POOL

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



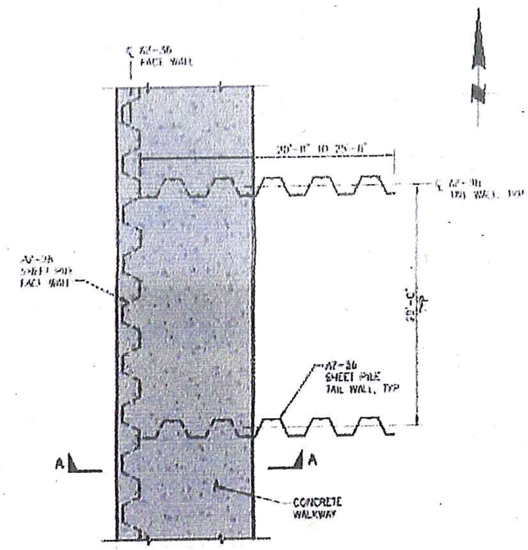
VICINITY MAP

NTS



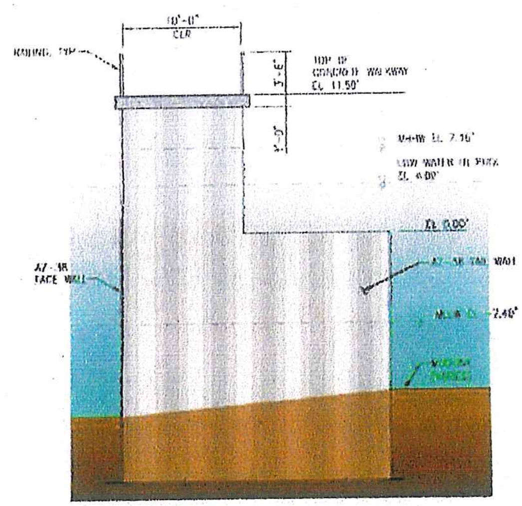
PLAN

SCALE 1" = 1600'



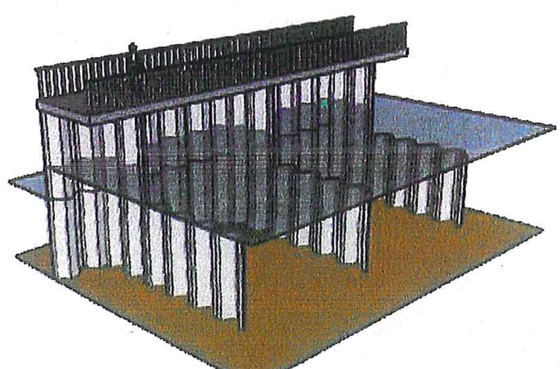
PARTIAL PLAN

SCALE: 1" = 10'



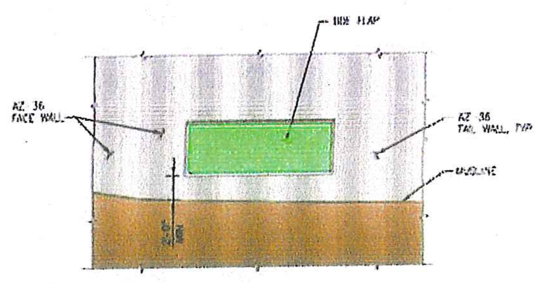
SECTION A-A

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

MOFFATT & NICHOL Prepared by: Moffatt & Nichol Date: DECEMBER 2008	DESCHUTES ESTUARY FEASIBILITY STUDY PHASE 3 ENGINEERING DESIGN AND COST ESTIMATES	REFLECTING POOL BARRIER	Exhibit 7