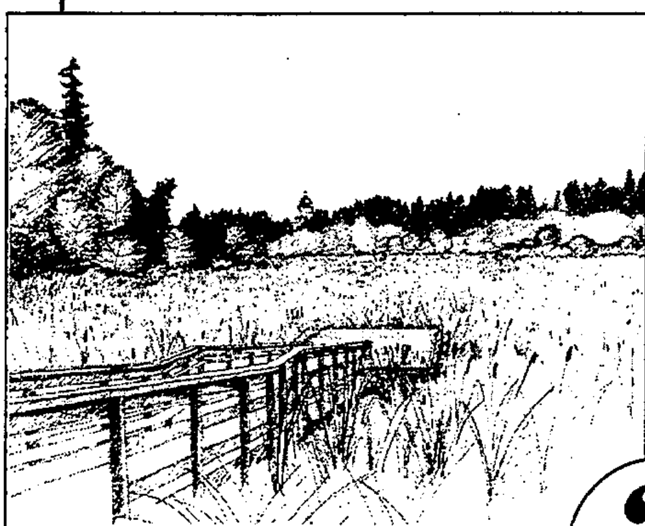
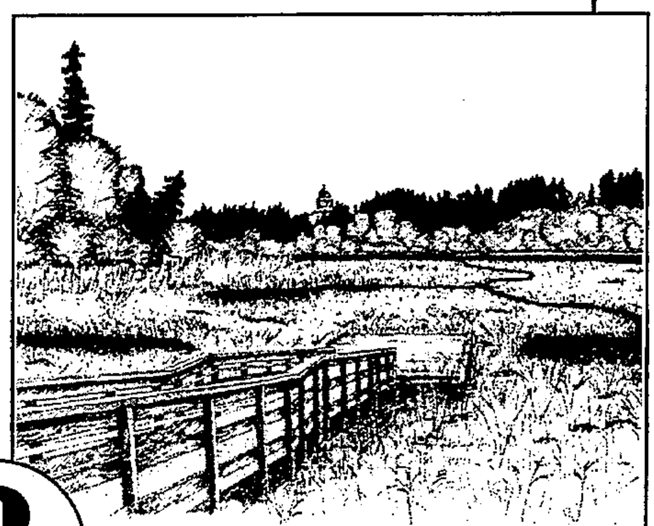
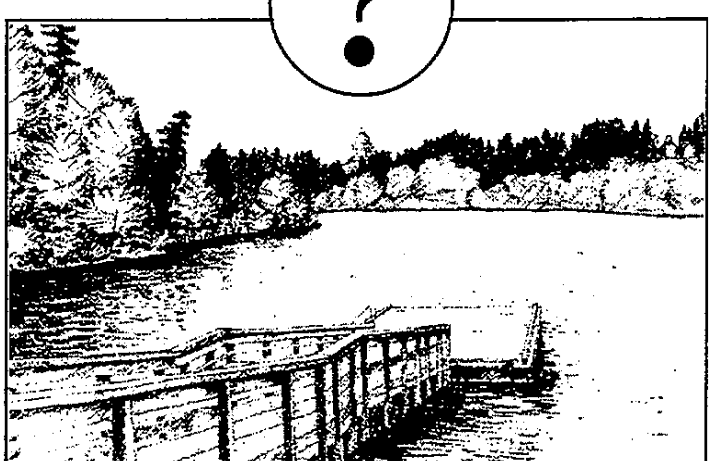
Capitol Lake
Adaptive Management Plan
Draft Environmental Impact Statement







October 1998

Capitol Lake
Adaptive Management Plan

Draft Environmental Impact Statement

Prepared for

Washington State
Department of General Administration
206 General Administration Building
Olympia, Washington 98504

Prepared by

Entranco, Inc.
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October 23, 1998

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Programmatic Environmental Impact Statement – Capitol Lake Adaptive Management Plan.

Description of Proposal and Alternatives

Existing conditions, five action alternatives, and the No-Action Alternative are addressed in this programmatic, non-project Environmental Impact Statement (EIS). The alternatives addressed are:

- Lake/River Wetland Without Trap
- Lake/River Wetland With Trap
- Lake
- Estuary
- Combined Lake/Estuary
- No Action

The key features distinguishing the alternatives are related to the following questions:

Would the system be a freshwater or estuary (brackish water) dominant system?

Would the tide gate at the Capitol Lake dam at 5th Avenue be retained or removed (or locked in the open position)?

Would maintenance dredging be part of the alternative and if so where and when?

Would modified drawdown/saltwater backfill be continued or not?

Using these key features, the five action alternatives were developed. Each one looks at a different combination of these features and how the lake, or estuary, would evolve over time.

Proponent/Lead Agency

Washington State
Department of General Administration
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Responsible Official

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Licenses and Permits Potentially Required

Recommendation from Capitol Lake Adaptive Management Plan - Steering Committee

Approval by Director of Department of General Administration

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Date of Issue of Draft EIS

October 23, 1998

Date of Hearing on Draft EIS

November 18, 1998
GA Auditorium
11th Avenue and Columbia Streets
Olympia, Washington

6:00 p.m. Workshop with Staff
7:00 p.m. Public Hearing

Date Comments are Due on Draft EIS

November 23, 1998 by 5:00 p.m.
to Thurston Regional Planning Council

Tentative Date of Issue of Final EIS

January 23, 1998

Tentative Date of Plan Implementation

The Capitol Lake Adaptive Management Plan is scheduled to be adopted in early 1999.

Location of Background Information

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Cost to Public of a Copy of the Draft EIS

$10.00

Chapter 1. Summary

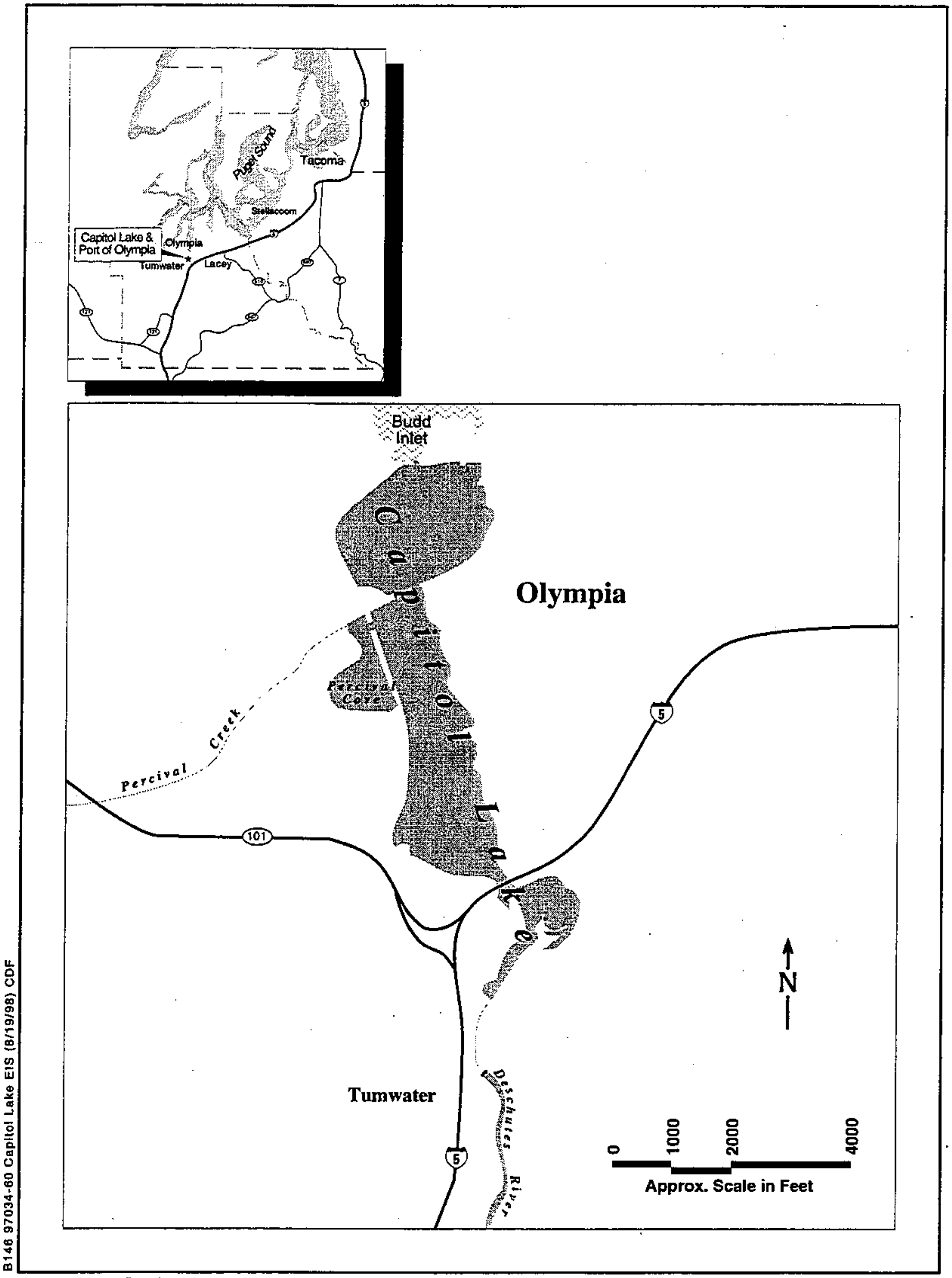
INTRODUCTION

Prior to 1951, the area occupied by Capitol Lake, located in north Thurston County within the cities of Tumwater and Olympia (**figure 1-1**), was a tidal estuary of the Deschutes River. The character of the estuary was different than present lake conditions, its brackish waters being influenced by both the salt water tidal action of Puget Sound and freshwater flow from the Deschutes River. Capitol Lake was created in 1951 with the construction of a dam and tide gate along 5th Avenue. The lake, which is actually a freshwater reservoir of the Deschutes River, was formed to serve as a reflecting pool for the State Capitol Building as envisioned by architects White and Wilder in the 1911 Capital Campus Plan. Since its formation, the Washington State Department of General Administration (DGA) has been the lead agency responsible for operation and maintenance of the dam and tide gate, and other management activities in and around Capitol Lake. Past management activities have involved coordination with other state agencies, local governments, tribal interests, and the public (e.g., **Thurston Regional Planning Council 1988**).

What is the Capitol Lake Adaptive Management Plan?

With recent efforts to obtain permit and environmental approvals for the construction of Heritage Park on the eastern shore of the North Basin (**Portico 1997**), and for maintenance dredging of Capitol Lake in the Middle Basin and Percival Cove (**Entranco 1996**), various agencies and organizations expressed interest in developing a Capitol Lake Adaptive Management Plan.

The Capitol Lake Adaptive Management Plan (the Plan) will be a written document, developed by an interagency/jurisdiction Steering Committee, to provide guidance on how Capitol Lake will be managed and operated in the future. A key question to be addressed in the Plan is "Should Capitol Lake be restored to a tidal estuary?", or "Should it continue to be maintained as a freshwater lake?" The reason the Plan is called "adaptive" is because it will be frequently updated and possibly modified as studies are triggered and more is learned about how the water resource responds to different management/operational strategies.



BASE SOURCE: USGS MAP TUMWATER, WA, 1994

Figure 1-1
Project Vicinity Map

To date, key features of the Plan process have been to:

- promote coordinated agency participation,
- rely upon best available science,
- identify how and when necessary technical data will become available,
- outline the implementation roles for each jurisdiction, and
- commit to a continuing process of updating the Plan based on new data.

Broad participation has been promoted by DGA and is reflected in the membership of the Adaptive Management Plan Steering Committee:

- Washington State Department of General Administration (DGA)
- Washington State Department of Ecology (Ecology)
- Washington State Department of Fish and Wildlife (WDFW)
- Washington State Department of Natural Resources (DNR)
- Squaxin Island Tribe
- Thurston County
- City of Olympia
- City of Tumwater
- Port of Olympia

Relationship of this Environmental Impact Statement to the Capitol Lake Adaptive Management Plan

A Plan has not yet been formulated and is expected to be available in February 1999. However, the key aspects of the Plan, as currently envisioned by the Steering Committee, are included in this Environmental Impact Statement (EIS). The planning process, which began in June 1997 and will continue into the future, gives interested parties the opportunity to provide input on a range of management/operational alternatives for the lake (refer to Chapter 3, Alternatives).

The EIS, including public comments, will be used by the Steering Committee to formulate the draft and final Capitol Lake Adaptive Management Plan in the next several months.

Proposed Action and SEPA Requirements

The proposed action is the adoption of a management plan to optimize the beneficial uses of Capitol Lake, or Capitol Estuary, and to provide DGA with operational certainty over the next 10 to 20 years.

Under the rules of the State Environmental Policy Act (SEPA), two types of "actions" are recognized: "project" and "non-project". Since the adoption of a management plan represents a program, as opposed to a specific construction project, this EIS follows SEPA guidelines for a non-project action. As a result, the level of detailed environmental analysis has been limited, compared to a typical project EIS.

The purpose of this Capitol Lake Adaptive Management Plan and EIS is to fulfill the requirements of SEPA by:

- Presenting a number of alternative planned actions, plus a no-action alternative.
- Evaluating the impacts of the alternatives.
- Presenting mitigation measures for identified impacts.

As a non-project action, the proposed action would not of itself, have a direct impact on land uses or the environment in the planning area. Additional SEPA review would be required for actions authorized by the Plan. Nonetheless, the Plan will provide a framework to guide future management of Capitol Lake or the Capitol Estuary for the next 20 years and beyond. The Plan will also help to define future shoreline uses surrounding the basin.

How You Can Become Involved in the Capitol Lake Adaptive Management Plan Process

The SEPA process is one way you can become involved in the Capitol Lake Adaptive Management process. The SEPA review was initiated with a public scoping meeting on November 20, 1997. During this meeting, preliminary alternatives were presented, key environmental issues were identified, and the public was provided the opportunity to comment. Following issuance of the Draft EIS, additional community input will be obtained at a public open/house and hearing, where citizens can comment on relevant concerns. All meetings of the Steering Committee are open to the public and the agenda allows for public comment. Please contact those listed on the EIS Fact Sheet for a schedule of the planning process.

DESCRIPTION OF THE ALTERNATIVES

Existing conditions, five action alternatives, and the No-Action Alternative are addressed in this non-project EIS. The alternatives are briefly described in the following pages.

The time involved in realizing each alternative's full impact is referred to as "the time of maturity[1]." At the time of maturity, it is assumed that wetland vegetation—either freshwater or brackish estuary[2]—would almost completely occupy any basin that would not be dredged and would be allowed to fill with sediment, and that the only remaining open-water habitat would be restricted to the remaining river channel. Figures of the alternatives depict how the basins would be expected to look at the time of maturity. More detailed figures for each alternative are provided in Chapter 3. These detailed figures provide a breakdown of the different vegetation types conceptually illustrated in this Summary. Renderings are included with the descriptions that illustrate how the environment would appear from a view point located at the Capitol Lake Interpretive Center in the southwest corner of the Middle Basin.

The following impact and mitigation discussion refers to dredging in one location or another, as a key component of all alternatives. The level of detail in this discussion has been kept general to facilitate a clear comparison of the relative impacts between alternatives. Please note there are several technical options within dredging components that could affect the degree of impacts. These are discussed in more detail in the main text of Chapter 4 and in **Appendix B**.

1. All estimates of time of basin filling (also referred to as time of maturity), are based on estimated sediment loading rates from the Deschutes River, which can vary from year to year. Therefore, actual times of filling could vary significantly from estimates provided.

2. Brackish water is a mixture of saltwater and freshwater that has lower salinity than saltwater.

Lake/River Wetland Without Trap Alternative

Under this alternative, the tide gate would remain and there would be no maintenance dredging in the South and Middle basins. These basins would evolve into freshwater wetlands over a period of 50 to 85 years as the lake filled with sediment from the Deschutes River. Once the South and Middle basins have filled with sediment, the North Basin would be retained as an open-water area by maintenance dredging in this basin (repeated every 2 years). Refer to **figures 1-2** and **1-3**.

Figure 1-2
Conceptual Illustration of Habitat Types at Maturity for Lake/River Wetland Without Trap Alternative

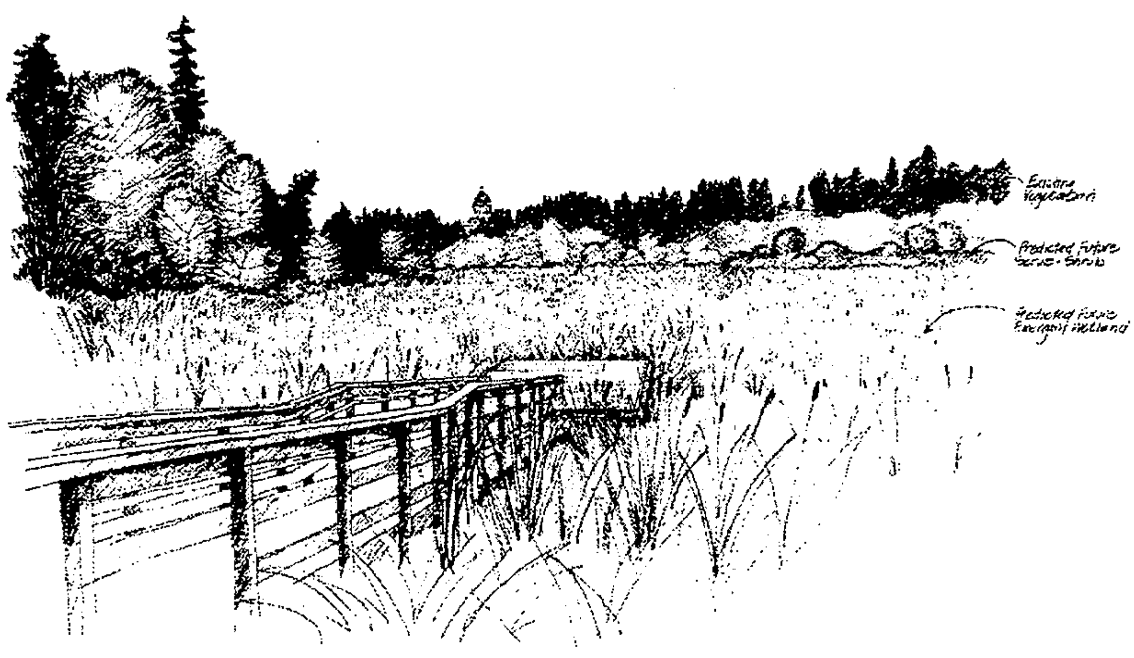
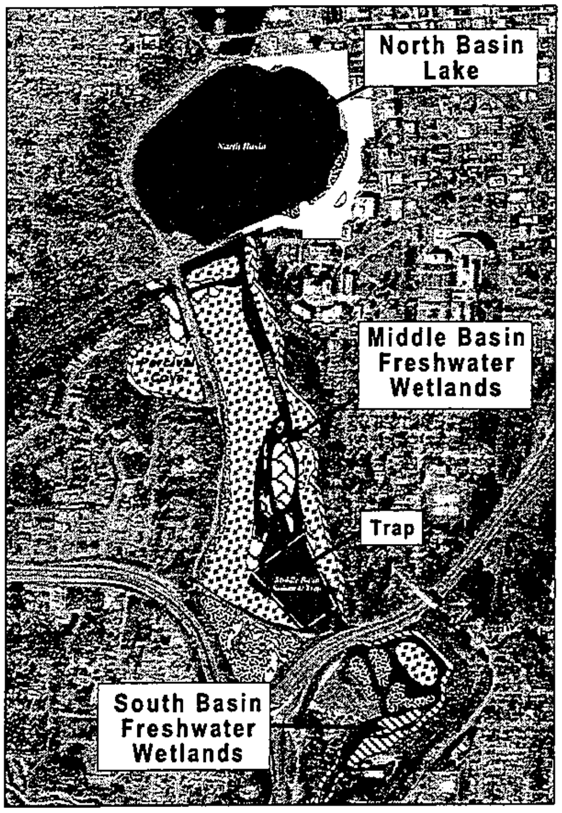


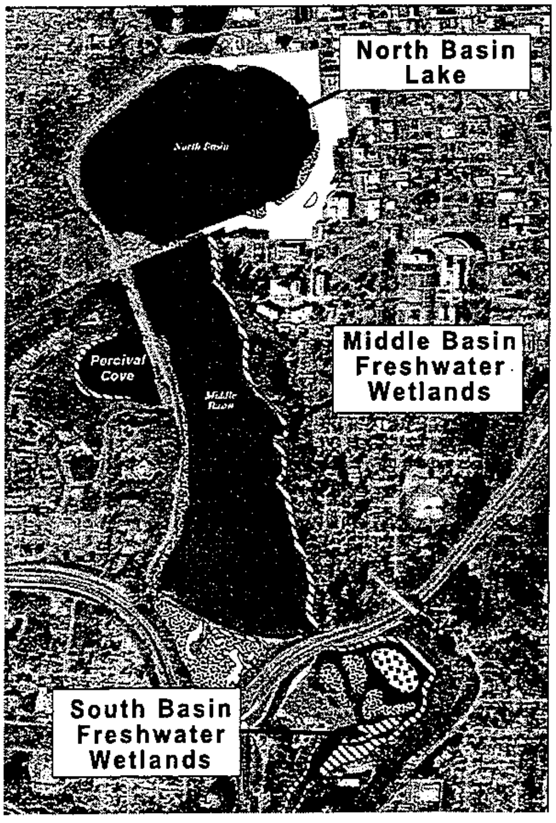
Figure 1-3
View from Capitol Lake Interpretive Center of Both Lake/River Wetland Alternatives at Maturity



Lake/River Wetland With Trap Alternative

This alternative would be similar to the Lake/River Wetland Without Trap Alternative, except the Middle Basin sediment trap (located at the south end of the Middle Basin) would be dredged every 6 to 10 years. The principal effect would be to extend the amount of time it would take for wetlands to develop (75 to 115 years). At the end of this period, maintenance dredging would begin (repeated every 2 years) in the North Basin. Refer to **figures 1-3** and **1-4**.

Figure 1-4
Conceptual Illustration of Habitat Types
Lake/River Wetland With Trap Alternative



Lake Alternative

This alternative would retain the lake as it presently is—open water throughout the Middle and North basins. Maintenance dredging would be initiated in two years in the Middle Basin and Percival Cove and would be repeated every 2 years. This alternative would also involve annual lake drawdown and saltwater backfill, using the modified procedure developed by DGA in 1997. Refer to **figures 1-5** and **1-6**.

Figure 1-5
Conceptual Illustration of Habitat Types
Lake Alternative

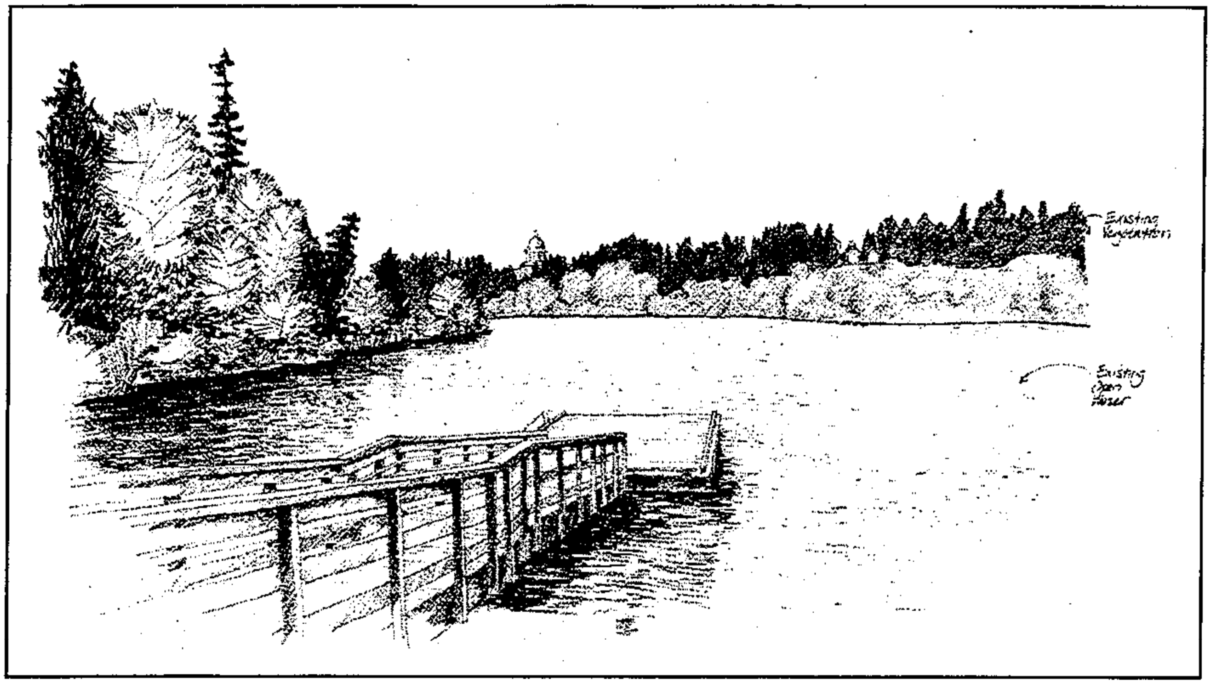


Figure 1-6
View from the Capitol Lake Interpretive Center of the Lake Alternative

Estuary Alternative

This alternative would involve removing the tide gate to allow tidal action throughout the basin. No dredging would be performed within the basin. At maturity, in 100 to 150 years, brackish estuary marsh plants would occur throughout the basin. At maturity, dredging operations would begin in Lower Budd Inlet to maintain boating and shipping activities (dredging frequency would be determined by monitoring). Short-term dredging may be required as mitigation in Lower Budd Inlet. Refer to **figures 1-7** and **1-8**.

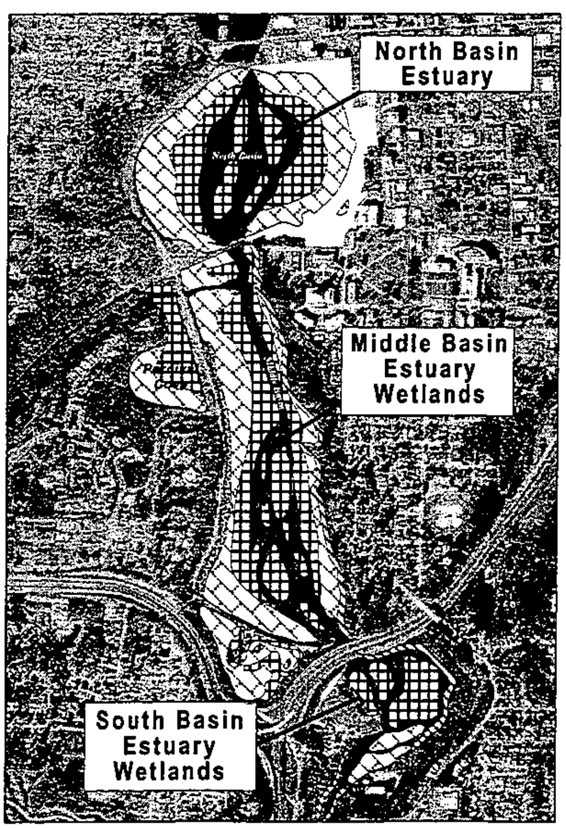


Figure 1-7
Conceptual Illustration of Habitat Types Estuary Alternative

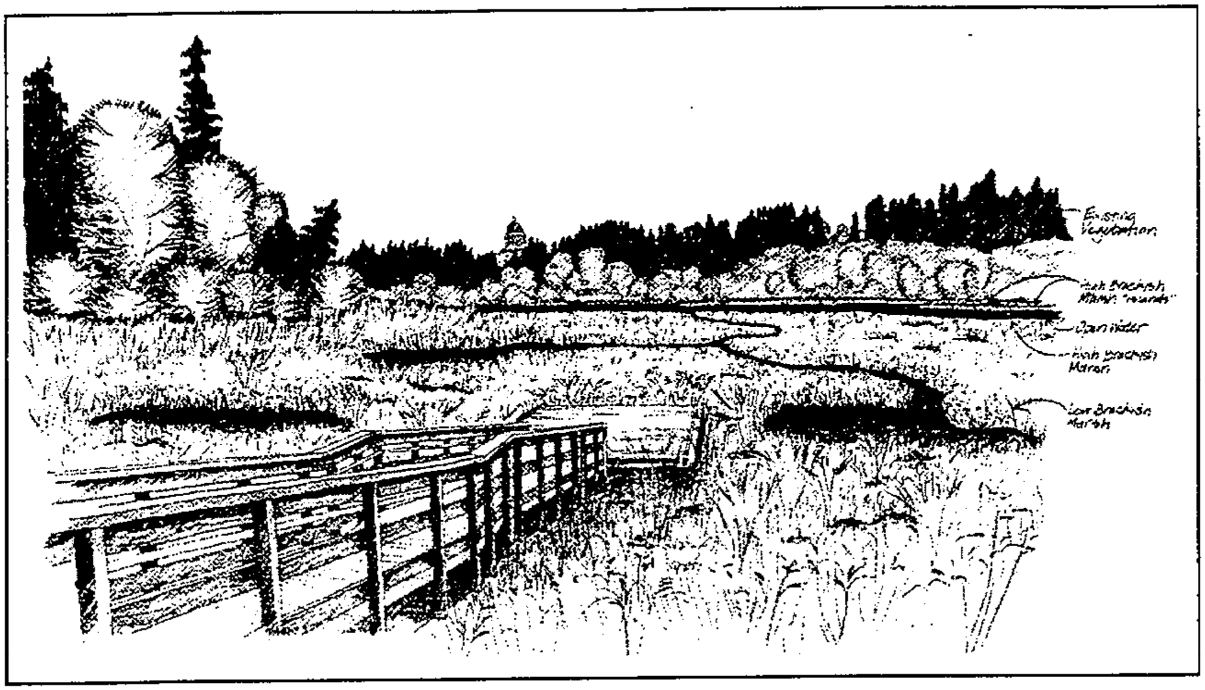


Figure 1-8
View from Capitol Lake Interpretive Center of the Estuary and Combined Lake/Estuary Alternatives at Maturity

Combined Lake/Estuary Alternative

This alternative would be similar to the Estuary Alternative, except that a reflecting pool dam would be constructed north to south along the center of the North Basin. This would provide a permanent, freshwater reflecting pool on the eastern half of the North Basin, adjacent to Heritage Park. High quality water would be added to maintain good water quality in the new lake. At maturity, in 100 to 125 years, brackish estuary marsh plants would occur throughout the lake basin, with the exception of the eastern half of the North Basin, which would support fresh-water aquatic and wetland plants. At maturity, dredging would begin in Lower Budd Inlet to maintain boating and shipping activities. Short-term dredging may be required as mitigation in Lower Budd Inlet. Refer to **figures 1-8** and **1-9**.

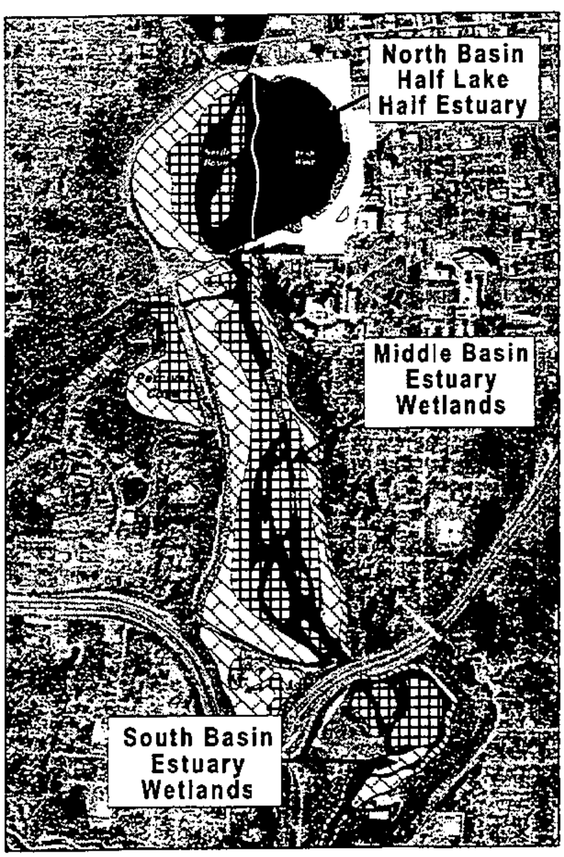
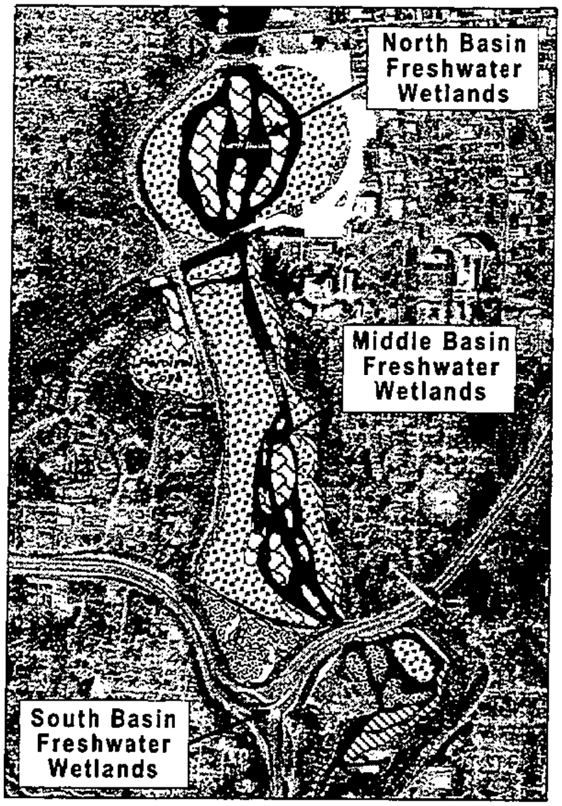


Figure 1-9
Conceptual Illustration of Habitat Types Combined Lake/Estuary Alternative



No-Action Alternative

Under this alternative, the tide gate would continue to be operated as it presently is, to maintain freshwater conditions upstream of the 5th Avenue dam. No maintenance dredging would be performed and all three basins would gradually evolve into freshwater wetlands over a period of 100 to 150 years. At the time of maturity, dredging operations would begin in Lower Budd Inlet to maintain boating and shipping activities. Refer to **figures 1-10 and 1-3**.

Figure 1-10
Conceptual Illustration of Habitat Types
No Action Alternative

SUMMARY OF IMPACTS AND MITIGATION

The key features distinguishing the alternatives are summarized in **table 1-1** and a summary cost comparison is provided in **table 1-2**. More detailed descriptions are provided in Chapter 3, Description of the Alternatives.

A summary of the impacts and proposed mitigation measures for the action and no-action alternatives is presented in **table 1-3**.

	Existing Conditions	Lake/River Wetland Without Trap Alternative	Lake/River Wetland With Trap Alternative	Lake Alternative	Estuary Alternative	Combined Lake/Estuary Alternative	No-Action Alternative
Dredging Scheme	Major lake dredging occurred in 1978. Trap maintenance dredging in 1986.	North Basin to be dredged once the South and Middle basins have in-filled with sediment in 50 to 85 years.	Dredge Middle Basin trap every 6–10 yrs. Dredge North Basin when other two basins fill, in 75 to 115 years.	Dredge 2 sectors in the Middle Basin and Percival Cove beginning now and repeated every 2 years.	Maintenance dredging of Budd Inlet when entire lake basin filled with sediment in 100 to 150 years. Short term dredging may be needed in Budd Inlet as mitigation	Maintenance dredging of Budd Inlet when entire lake basin filled with sediment in 100 to 125 years. Short term dredging may be needed in Budd Inlet as mitigation	No dredging in the existing lake. Begin maintenance dredging in Lower Budd Inlet when lake basin fills, in 100 to 150 years.
Time of Maturity	N/A	50 to 85 yrs	75 to 115 yrs	Mature now	100 to 150 yrs	100 to 125 yrs	100 to 150 yrs
Tide Gate Retained or Removed[3]	Retained	Retained	Retained	Retained	Removed	Removed	Retained
Freshwater or Estuary System	Freshwater	Freshwater	Freshwater	Freshwater	Estuary	Estuary with freshwater in east half of the North Basin	Freshwater
Open-Water Habitat[1]	241 acres	140 acres	149 acres	236 acres	56 acres	89 acres	72 acres
Freshwater Wetlands[1]	48 acres	149 acres	140 acres	53 acres	20 acres	22 acres	216 acres
Brackish Estuary Wetlands[1]	0 acres	0 acres	0 acres	0 acres	213 acres	178 acres	0 acres
Modified Drawdown	As needed[2]	As needed[2]	As needed[2]	Yes, annually	No	No	No

1. The total of 290 acres represents 270 acres of lake surface and 20 acres of adjacent wetlands.
2. Drawdown would be used only to provide limited flood control until the South and Middle basins fill with sediment. There would be no saltwater backfilling.
3. The tide gate may be removed or left in an open position.

Table 1-1
Key Distinguishing Features of the Alternatives

	Existing Conditions	Lake/River Wetland Without Trap Alternative	Lake/River Wetland With Trap Alternative	Lake Alternative	Estuary Alternative	Combined Lake/Estuary Alternative	No-Action Alternative
Dredging Scheme	Major lake dredging occurred in 1978. Trap maintenance dredging in 1986.	North Basin to be dredged once the South and Middle basins have in-filled with sediment in 50 to 85 years.	Dredge Middle Basin trap every 6–10 yrs. Dredge North Basin when other two basins fill, in 75 to 115 years.	Dredge 2 sectors in the Middle Basin and Percival Cove beginning now and repeated every 2 years.	Maintenance dredging of Budd Inlet when entire lake basin filled with sediment in 100 to 150 years. Short term dredging may be needed in Budd Inlet as mitigation	Maintenance dredging of Budd Inlet when entire lake basin filled with sediment in 100 to 125 years. Short term dredging may be needed in Budd Inlet as mitigation	No dredging in the existing lake. Begin maintenance dredging in Lower Budd Inlet when lake basin fills, in 100 to 150 years.
Costs for the First 20 yrs	N/A	$0	2 to 3 dredging cycles = $1.1 to $3 million[1]	10 dredging cycles = $7 to $15 million[1]	Tide gate removal – $0.5 million; Dredging in Budd Inlet - $0 to $15 million[1]; **Total** = $0.5 to $15.5 million[1]	Tide gate removal = $0.5 million; Dam construction = $9.4 million; Dredging Budd Inlet - $0 to $15[1]; **Total** = $10 to $25 million[1]	$0
Cumulative Costs in 50 to 85 yrs	N/A	$0[2]	5 to 14 dredging cycles = $3 to $13 million	25 to 42 dredging cycles = $18 to $64 million	Begin Lower Budd Inlet dredging $0.5 to $15.5 million	Begin Lower Budd Inlet dredging $10 to $25 million	$0
Cumulative Costs in 75 yrs to 115 yrs	N/A	Dredging in North Basin -- 20 cycles = $9 to $23 million	Dredging switched to North Basin - 20 cycles = $12 to $36 million	37 to 57 dredging cycles = $26 to $86 million	$18 to $31 million	$17 to $40 million	$0
Cumulative Costs in 100 to 150 yrs	N/A	Up to 37 dredging cycles = $18 to $49 million	Up to 37 dredging cycles = $21 to $62 million	50 to 75 dredging cycles = $35 to $113 million	$24 to $64 million	$24 to $56 million	$0
Cumulative Costs in 150 to 250 yrs	N/A	Up to 62 dredging cycles = $35 to $124 million	Up to 62 dredging cycles – $38 to $137 million	75 to 125 dredging cycles = $53 to $188 million	$59 to $139 million	$68 to $150 million	$0

1. Dredging costs range due to variables in sediment loading rates and costs for different dredging methods. Costs are in 1998 dollars. See Appendices A and B. For Lower Budd Inlet, dredging costs are highly variable due to the uncertainty of when and where sediment will be deposited.
2. No dredging costs accrue until after the South and Middle basing are completely filled at the time of maturity.

Table 1-2
Alternative Cost Comparison Summary

EARTH






	Lake/River Wetland without Trap Alternative	Lake/River Wetland with Trap Alternative	Lake Alternative	Estuary Alternative	Combined Lake/Estuary Alternative	No-Action Alternative
IMPACTS	• No dredging for the next 50 to 85 years. • Open-water areas of South and Middle Basins allowed to fill with sediments and convert to freshwater wetlands. • Dredging resumed in North basin after Middle basin filled in 50 to 85 years. Increased truck traffic and increased noise associated with truck traffic and use of dredging equipment.	• Sediment trap dredging (south end of Middle Basin) every 6 to 10 years over the next 75 to 115 years. • Dredging resumed in North basin in 75 to 115 years. Increased truck traffic and increased noise associated with truck traffic and use of dredging equipment.	• Dredging required to maintain open-water environment in North and Middle basins beginning now and repeated every 2 years to remove sediment loading from Deschutes River. Increased truck traffic and increased noise associated with truck traffic and use of dredging equipment.	• No dredging would be performed. Most of the North and Middle basins would eventually fill with sediment and convert to brackish marsh. • Possible transport of sediment from the former lake basin to Lower Budd Inlet during periods of low tide and high river flows, especially following removal of the tide gate. • Dredging would be required in Lower Budd Inlet after 100 to 150 years. Increased truck traffic and increased noise associated with truck traffic and use of dredging equipment. • Opening the dam to tidal action would result in increased erosional forces at the tide gate dam, railroad trestle, and along Deschutes Parkway.	• Similar to Estuary Alternative, except a reflecting pool dam would also be constructed in the North basin so that the east half of the North Basin would remain open freshwater. The remainder of the basin would gradually convert to brackish marsh over a period of 100 to 125 years. • Dredging would be required in Lower Budd Inlet after 100 to 125 years. Increased truck traffic and increased noise associated with truck traffic and use of dredging equipment. • Dam construction would place 120,000 cubic yards of rock, gravel, and earth fill and would replace 4 acres of aquatic habitat. • During dam construction there would be truck traffic, pile driving, and associated noise impacts. • Temporary construction access roads would disrupt Heritage Park. • The dam could also experience potential erosion, settling and earthquake damage following construction.	• No dredging would be performed. The lake would fill with sediment and convert to a freshwater wetland over a period of 100 to 150 years. • Dredging would be required in Lower Budd Inlet after 100 to 150 years. Increased truck traffic and increased noise associated with truck traffic and use of dredging equipment.
MITIGATION	• Schedule work consistent with state and local noise ordinances. • Develop traffic control plan for trucks.	• Schedule work consistent with state and local noise ordinances. • Develop traffic control plan for trucks.	• Schedule work consistent with state and local noise ordinances. • Develop traffic control plan for trucks.	• Conduct further analysis of potential for erosion and appropriate control actions. • Annual inspections at potential erosion sites and repairs as needed. • Schedule work consistent with state and local noise ordinances. • Develop traffic control plan for trucks. • Dredge Lower Budd Inlet to compensate for increased sediment load in first few years due to tide gate removal.	• Schedule work consistent with state and local noise ordinances. • Develop traffic control plan for trucks. • Use appropriate dam engineering and construction methods to mitigate erosion, settling, and earthquake damage. Implement repairs if needed. • Restore Heritage Park following construction of the dam. • Dredge Lower Budd Inlet to compensate for increased sediment load in first few years due to tide gate removal.	• Schedule work consistent with state and local noise ordinances. • Develop traffic control plan for trucks.

Table 1-3
Summary of Earth Impacts and Mitigations

WILDLIFE

	 Lake/River Wetland without Trap Alternative	 Lake/River Wetland with Trap Alternative	 Lake Alternative	 Estuary Alternative	 Combined Lake/Estuary Alternative	 No-Action Alternative
IMPACTS	• Increased wildlife diversity and species richness with gradual shift over time (50 to 85 years) from open water to freshwater wetland habitat in the South and Middle basins. • Intermittent disturbance of wildlife due to dredging and dredge disposal operations in the North Basin when dredging resumes in 50 to 85 years. • Abundance of Canada geese may increase during lake filling due to the increase of wetland food sources. At maturity of this alternative, however, dense wetlands may reduce geese abundance because they prefer open water habitat.	• Similar to Lake/River Wetland Without Trap Alternative, except for minor disturbance of wildlife due to sediment trap dredging every 6 to 10 years in the Middle basin over the next 75 to 115 years. • Similar disturbance of wildlife in the North basin when dredging resumes there in 75 to 115 years. • Abundance of Canada geese may increase during lake filling due to the increase of wetland food sources. At maturity of this alternative, however, dense wetlands may reduce geese abundance because they prefer open water habitat.	• Temporary disturbance of wildlife in the Middle basin due to dredging and dredge disposal operations, beginning now and repeated every 2 years. • Abundance of Canada geese will likely stay similar to existing conditions.	• Rapid shift in wildlife to species preferring estuary habitat. • Gradual increase in species abundance and richness with conversion from open water to brackish wetland habitat over 100 to 150 year period. • Temporary disturbance of wildlife in Lower Budd Inlet in 100 to 150 years when dredging begins. • Abundance of Canada geese will likely decrease because they prefer freshwater habitat over estuarine (salt water) habitat.	• Rapid shift in wildlife to species preferring estuary habitat throughout the basin, except for the 40 acres of freshwater habitat retained on the east half of the North Basin. • Gradual increase in species abundance and richness with conversion from open water to brackish wetland habitat over 100 to 125 year period. • Temporary disturbance of wildlife in Lower Budd Inlet in 100 to 125 years when dredging begins. • Abundance of Canada geese will likely decrease because they prefer freshwater habitat over estuarine (salt water) habitat.	• Gradual shift in species abundance and richness over 100 to 150 years as North and Middle basins convert to freshwater wetlands. • Temporary impacts (e.g., noise disturbance of wildlife) in Lower Budd Inlet with dredging and dredge disposal operations in 100 to 150 years. • Abundance of Canada geese may increase during lake filling due to the increase of wetland food sources. At maturity of this alternative, however, dense wetlands may reduce geese abundance because they prefer open water habitat.
MITIGATION	• Provide large woody debris and wetland plantings as sediment in-filling progresses. • A Canada goose management program is needed to limit their abundance and interference with human activities.	• Provide large woody debris and wetland plantings as sediment in-filling progresses. • A Canada goose management program is needed to limit their abundance and interference with human activities.	• A Canada goose management program is needed to limit their abundance and interference with human activities.	• Provide large woody debris and wetland plantings as sediment in-filling progresses. • A Canada goose management program is needed to limit their abundance and interference with human activities.	• Provide large woody debris and wetland plantings as sediment in-filling progresses. • A Canada goose management program is needed to limit their abundance and interference with human activities.	• Provide large woody debris and wetland plantings as sediment in-filling progresses. • A Canada goose management program is needed to limit their abundance and interference with human activities.

Table 1-5
Summary of Wildlife Impacts and Mitigations

	 Lake/River Wetland without Trap Alternative	 Lake/River Wetland with Trap Alternative	 Lake Alternative	 Estuary Alternative	 Combined Lake/Estuary Alternative	 No-Action Alternative
IMPACTS	• Gradual shift over 50 to 85 years to more riverine habitat in the Middle Basin, with concurrent shift in species to anadromous fish favoring riverine habitat. • Increased shallow water wetland habitat in the South and Middle basins favoring the Olympic mudminnow (a State candidate species). • In the absence of maintenance dredging in Percival Cove, the 200,000 yearling chinook net pen operation and the chinook fingerling feeding/imprinting program would be displaced. • Intermittent fish passage problems at the existing fish ladder at the tide gate dam under certain lake level/tide conditions. • Intermittent impacts to fish and fish habitat during dredging operations, which would begin in the North basin in 50 to 85 years.	• Gradual shift over 75 to 115 years to more riverine habitat in the Middle Basin, with concurrent shift in species to anadromous fish favoring riverine habitat. • Temporary impacts to fish and fish habitat during dredging operations, which would resume in the North basin in 75 to 115 years. • Other impacts similar to Lake/River Wetland Without Trap Alternative.	• Intermittent impacts (every two years) to fish in the Middle Basin during dredging operations, beginning now and continuing into the future. • Intermittent fish passage problems at the existing fish ladder at the tide gate dam under certain lake level/tide conditions. • Fish kills during modified lake draw-down operations.	• Rapid shift in species favoring brackish estuary habitat and loss of freshwater fish, including the Olympic mudminnow (a State candidate species). • Gradual shift over 100 to 150 years to estuarine wetland habitat in the South, Middle and North basins, with concurrent shift in species favoring estuarine habitat. • In the absence of maintenance dredging in Percival Cove, the 200,000 yearling chinook net pen operation and the chinook fingerling feeding/imprinting program would be displaced. • Intermittent impacts to fish and fish habitat during future dredging operations, which would resume in Lower Budd Inlet in 100 to 150 years.	• Impacts would be the same as those for the Estuary Alternative except that (1) some freshwater habitat would be retained in the eastern half of the north basin with construction of the reflecting pool dam, and (2) the gradual shift in habitat is expected to occur over a period of 100 to 125 years.	• Gradual shift over 100 to 150 years to more riverine habitat in the middle basin, with concurrent shift in species to anadromous fish favoring riverine habitat. • Increased shallow water wetland habitat in the South, Middle, and North basins favoring the Olympic mudminnow (a State candidate species). • In the absence of maintenance dredging in Percival Cove, the 200,000 yearling chinook net pen operation and the chinook fingerling feeding/imprinting program would be displaced. • Intermittent fish passage problems at the existing fish ladder at the tide gate dam under certain lake level/tide conditions. • Intermittent impacts to fish and fish habitat during dredging operations, which would begin in Lower Budd Inlet in 100 to 150 years.
MITIGATION	• Provide replacement rearing, feeding, imprinting facilities for loss of Percival Cove operations. • Reconstruct the fish ladder to eliminate existing fish passage problems. • Perform future dredging operations during periods of least fish and water quality impacts (December through February).	• Same as Lake/River Wetland Without Trap Alternative	• Perform dredging operations during periods of least fish and water quality impacts (December through February). • Reconstruct the fish ladder to eliminate existing fish passage problems. • Discontinue modified lake draw-down events	• Modify the Heritage Park wetland mitigation site (southwest end of Middle basin) to provide adequate shallow freshwater habitat for the Olympic mudminnow. • Provide replacement rearing, feeding, imprinting facilities for loss of Percival Cove operations. • Perform future dredging operations during periods of least fish and water quality impacts (December through February).	• Mitigation would be the same as for the Estuary Alternative, except that additional mitigation for impacts to the Olympic mudminnow would be implemented in the freshwater side of the north basin.	• Same as Lake/River Wetland Without Trap Alternative.

Table 1-6
Summary of Fisheries Impacts and Mitigations

AQUATIC AND WETLAND VEGETATION

	 Lake/River Wetland without Trap Alternative	 Lake/River Wetland with Trap Alternative	 Lake Alternative	 Estuary Alternative	 Combined Lake/Estuary Alternative	 No-Action Alternative
IMPACTS	• Gradual shift over 50 to 85 years with emergent and scrub-shrub habitat increasingly replacing submerged aquatic plants in the South and Middle basins. • Sediment accumulation in the lower Middle Basin eventually would clog culverts (25 to 50 years) and would cut off the main water source to the Heritage Park wetland mitigation site (behind the dike in southwest corner of Middle Basin). • During the interim period, there could be increased submerged aquatic plants.	• Impacts would be similar to the Lake/River Setland Without Trap Alternative, except: • Gradual shift over 75 to 115 years with emergent and scrub-shrub habitat increasingly replacing submerged aquatic plants in the South and Middle basins. • During the interim period there could be increased submerged aquatic plants.	• Minor increase in freshwater emergent wetlands in the south basin. • Possible increase in submerged aquatic vegetation throughout the North and Middle basins due to modified draw-down control.	• Rapid elimination of all submerged freshwater aquatic plants in the basin. • Probable adverse saltwater impacts to the Heritage Park wetland mitigation site (southwest Middle Basin). • Gradual in-filling of the South, Middle and North basins with brackish marsh habitat over a period of 100 to 150 years. • Large woody debris could be flushed into Budd Inlet during flood events.	• Same as the Estuary Alternative, except that: (1) the east half of north basin would remain as freshwater habitat, and (2) the time for conversion to brackish marsh habitat would be over 100 to 125 years. • Large woody debris could be flushed into Budd Inlet during flood events.	• Same as the Lake/River Wetland Without Trap Alternative, except that: (1) the gradual transition from submerged aquatic plants to freshwater emergent and scrub-shrub habitat would affect the North Basin as well as the South and Middle basins, and (2) the period of gradual transition would be 100 to 150 years.
MITIGATION	• Maintain water flow through culverts or provide alternative water supply to maintain hydrology in the Heritage Park wetland mitigation site.	• Same as Lake/River Wetland Without Trap Alternative	• If aquatic plants reach nuisance levels, develop an integrated aquatic vegetation management plan for the lake.	• Alternative water supply to maintain hydrology in the Heritage Park wetland mitigation site • Additional harbor maintenance to remove large wood debris.	• Same as the Estuary Alternative.	• Same as Lake/River Wetland Without Trap Alternative.

Table 1-7
Summary of Aquatic and Wetland Vegetation Impacts and Mitigations

LAND USE, RECREATION, AND SHORELINE USE

	 Lake/River Wetland without Trap Alternative	 Lake/River Wetland with Trap Alternative	 Lake Alternative	 Estuary Alternative	 Combined Lake/Estuary Alternative	 No-Action Alternative
IMPACTS	• Long term preservation of the North Basin as a reflecting pool. • Eventual loss of the Middle Basin as a reflecting pool for the Capitol Building. • Consistent with Shoreline Master Program (SMP). • Recreational use of the Middle Basin would change gradually from open-water recreation (boating & fishing) to riverine recreation, over a period of 50 to 85 years. • At the time of maturity, increased lake and shoreline vegetation could become a public safety issue for Deschutes Parkway or shoreline trail users.	• Same as the Lake/River Wetland Without Trap Alternative regarding reflecting pool, Shoreline Master Program, recreational use, and public safety. • Gradual transition from open-water recreation to riverine recreation in the Middle Basin would occur over a period of 75 to 115 years.	• Long-term preservation of both the Middle and North basins as reflecting pools. • Consistent with Shoreline Master Program (SMP).	• Immediate partial loss of the reflecting pool function of the Middle and North basins with twice daily tidal exchange. • Gradual reduction in reflecting pool area to the remaining open-water river channel over a period of 100 to 150 years. • Consistent with Shoreline Master Program (SMP). • Recreational use of the Middle and North basins would change gradually from open-water (with twice daily tidal exchange) recreation (boating & fishing) to riverine recreation, over a period of 100 to 150 years.	• Same as the Estuary Alternative, except that: (1) the eastern half of the North Basin is retained as open-water reflecting pool, and (2) the time of maturity is estimated at a 100 to 125 years. • Consistent with Shoreline Master Program (SMP).	• Gradual loss of the reflecting pool function of the North and Middle basins, over a period of 100 to 150 years. • Gradual conversion from open-water recreation (boating and fishing) to riverine recreation in the North and Middle basins. • At the time of maturity, with increased scrub-shrub vegetation, public safety could become an issue for shoreline trail users. • Consistent with Shoreline Master Program (SMP).
MITIGATION	• Increased illumination, cut back shoreline vegetation and increased police patrols for public safety.	• Same as Lake/River Wetland Without Trap Alternative.	• None required.	• Same as Lake/River Wetland Without Trap Alternative.	• Same as Lake/River Wetland Without Trap Alternative.	• Same as Lake/River Wetland Without Trap Alternative.

Table 1-8
Summary of Land Use, Recreation, and Shoreline Use Impacts and Mitigations

CULTURAL RESOURCES

	 Lake/River Wetland without Trap Alternative	 Lake/River Wetland with Trap Alternative	 Lake Alternative	 Estuary Alternative	 Combined Lake/Estuary Alternative	 No-Action Alternative
IMPACTS	• The Middle Basin portion of the historically significant Capitol Lake reflecting water body (originally conceived by architects White and Wilder as part of the Capitol Campus Plan) would eventually be lost in 50 to 85 years. • Gradual conversion from open-water habitat to emergent wetlands in the middle basin would provide an additional source of wetland plants historically used by Native Americans.	• Same as the Lake/River Wetland Without Trap Alternative, except that the reflecting pool function of the Middle Basin would be lost over a period of 75 to 115 years.	• No impacts to cultural resources.	• Immediate conversion to a tidal estuary in which the permanent freshwater reflecting pool would be replaced by alternating views of open-water and tidal mud flats twice daily. • The Middle and North basins of the historically significant Capitol Lake reflecting pool (originally conceived by architects White and Wilder as part of the Capitol Campus Plan) would eventually be reduced to the area of the remaining river channel in 100 to 150 years. Loss of freshwater wetland plants used by Native Americans.	• Same as the Estuary Alternative except that: (1) the eastern half of the North Basin would be retained to function as a reflecting pool for the Capitol Building, and (2) the time of conversion to brackish tidal marsh for the remainder of the basin would be 100 to 125 years. • Loss of freshwater wetland plants used by Native Americans, except for the area in the eastern half of the North Basin.	• Gradual loss of the reflecting pool function (originally conceived by architects White and Wilder as part of the Capitol Campus Plan) of the North and Middle basins over a period of 100 to 150 years. • Gradual conversion from open-water habitat to emergent wetlands in the Middle and North basins would provide an additional source of wetland plants used by Native Americans.
MITIGATION	• None proposed.	• None proposed.	• None required.	• None proposed.	• None proposed.	• None proposed.

Table 1-9
Summary of Cultural Resources Impacts and Mitigations

AESTHETICS

	 Lake/River Wetland without Trap Alternative	 Lake/River Wetland with Trap Alternative	 Lake Alternative	 Estuary Alternative	 Combined Lake/Estuary Alternative	 No-Action Alternative
IMPACTS	• Gradual conversion of open-water vistas to views of dense emergent and scrub-shrub wetland vegetation in the Middle Basin over a period of 50 to 85 years.	• Same as the Lake/River Wetland Without Trap Alternative, except: (1) a small area of open-water habitat would be retained over the sediment trap in the south end of the Middle Basin, and (2) the gradual conversion of views in the Middle Basin would occur over a period of 75 to 115 years.	• No impacts	• Tidal exchange would expose mud flats twice daily. • Gradual conversion of open-water vistas to views of dense brackish marsh vegetation in the Middle and North basins over a period of 100 to 150 years. • Undesirable odors may be experienced when tidal mudflats are exposed.	• North Basin views modified by the addition of the reflecting pool dam. • Otherwise, the same as the Estuary Alternative except that open freshwater habitat would be retained in the eastern half of the North Basin.	• Gradual conversion of open-water vistas to views of dense emergent and scrub-shrub wetland vegetation in the Middle and North basins over a period of 100 to 150 years.
MITIGATION	• None proposed.	• None proposed.	• None required.	• None proposed.	• None proposed.	• None required.

Table 1-10
Summary of Aesthetics Impacts and Mitigations

Chapter 2. Lake Description and Related Activities

INTRODUCTION

The Budd Inlet-Deschutes River Watershed includes Capitol Lake, a 270-acre freshwater reservoir in northern Thurston County, within the cities of Olympia and Tumwater (**figure 2-1**). As of 1973, the lake had an average depth of 9 feet. Typical summer depths for the North, Middle, and South basins are[1]:

North Basin......0 to 14 feet
Middle Basin....0 to 10 feet
South Basin........0 to 3 feet

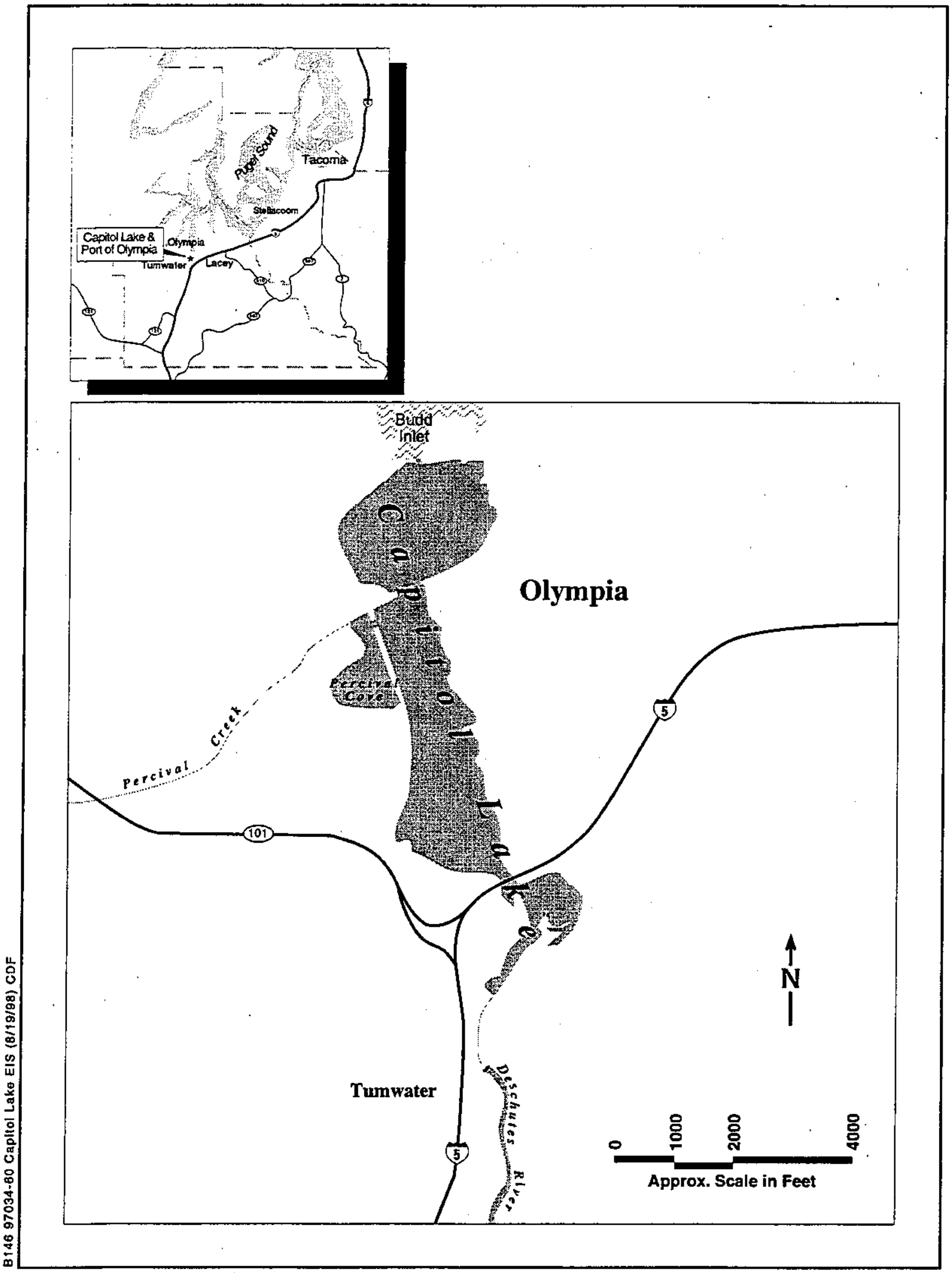
The lake is at the mouth of the Deschutes River and has a drainage area of 185 square miles.

Prior to 1951, the area occupied by Capitol Lake, which is located in north Thurston County, was a tidal estuary of the Deschutes River. The character of the estuary was different than present lake conditions, with brackish marsh vegetation being influenced by both the salt water tidal action of Puget Sound and freshwater flow from the Deschutes River. The lake was formed to serve as a reflecting pool for the Capitol Building and was first envisioned by architects Wilder and White in their conceptual design for the Capital Campus in 1911. Construction of the lake was authorized by the State Legislature in the late 1930s and funding was authorized to build the tide gate and dam along 5th Avenue in 1947. The lake project was completed in 1951.

The perceived benefits of forming the lake included:

- A Capital Campus reflecting pool and improved aesthetics
- Public access and recreational uses such as swimming[2], boating, and fishing
- Limited flood control for the City of Olympia during high tides and for less intense floods
- New fish rearing facilities in Percival Cove

1. Typical depths are for areas outside the river channel, which is somewhat deeper. In addition, there is a small, deep hole near the tide gate, which is approximately 40 feet deep.
2. Swimming was discontinued in 1985 due to high fecal coliform levels and poor water clarity.



BASE SOURCE: USGS MAP TUMWATER, WA, 1994

Figure 2-1
Project Vicinity Map

- Elimination of tide flats and associated odors

There were also some negative impacts with lake formation, including:

- intermittent fish passage problems at the tide gate,[3]
- excessive aquatic plant growth,
- reduced water circulation, and
- increased algal growth and reduced water clarity.

Since the lake was constructed by the State of Washington, it has been managed by the Washington State Department of General Administration (DGA). Management activities have historically been coordinated with the Washington State departments of Ecology, Fish and Wildlife; Thurston County; and the cities of Olympia and Tumwater.

As early as 1970, DGA recognized that sediment accumulation in the lake would have to be actively managed if the lake's beneficial uses were to be maintained. Walker and Byrne (**1970**) estimated that 739,000 cubic yards of sediment had accumulated in the lake between 1949 and 1970, or the equivalent of 41,000 cubic yards per year. Since the Walker and Byrne report (**1970**), various investigators have estimated the annual sediment load to the lake at between 20,000 to 57,000 cubic yards per year[4] (**Entranco 1990a**).

Based on further studies by Washington State University (**Orsborn et al. 1975**), plans were proposed to remove as much as 360,000 cubic yards of sediment from the lake during an initial sediment removal project, and to construct sediment traps in the South and Middle basins. This led to development of the Capitol Lake Restoration and Recreation Plan (**CH2M Hill 1977**).

Recent estimates of sediment accumulation, which compared 1983 and 1991 aerial topographic lake bottom surveys (performed when the lake is drained and most of the lake bottom is exposed), indicate a sedimentation rate of approximately 35,000 cubic yards per year. Based on this average annual rate, it is estimated that a total of 1.5 million cubic yards of sediment have been deposited in the lake since its formation in 1951. Deposition has occurred prima-

3. A fish ladder was constructed to allow fish passage around the tide gate.
4. The broad range is due to the application of several different methodologies, and the inherent variability caused by year-to-year changes in land use, rainfall, river discharge, etc.

rily in the South and Middle basins where as much as 71 to 78 percent of the sediment load accumulates.

CAPITOL LAKE AND ITS BENEFICIAL USES

The residents of Olympia, Tumwater, Lacey, Thurston County, and Washington State place a high value on the visual and scenic qualities of Capitol Lake and the surrounding area. The lake and shoreline environment is also highly valued for recreation. The lake itself is used for fishing (salmon, trout, and bass), boating, canoeing, and other aquatic recreation. Shoreline parks include Capitol Lake Park, Marathon Park, Capitol Lake Interpretive Center, and Tumwater Historical Park. These parks are all connected by pedestrian trails along the north and western shorelines of the lake. There is also a pedestrian trail parallel to the Burlington Northern Railroad crossing that separates the North and Middle basins. Walking, jogging, bicycling, bird-watching, picnicking, canoeing, fish-watching (salmon runs at the fish ladder), and other recreational activities are enjoyed at these park facilities. Each year, the lake becomes the central attraction of Lake Fair, a community event that attracts more than 75,000 visitors and features many activities focused on the lake and adjacent shorelines. Other community events occur in the lakeside parks, including Fourth of July celebrations, the Bon Odori Japanese Cultural Celebration, state employee picnics, and outdoor concerts (**CH2M Hill 1977, Entranco 1990a**).

Tourists and visitors to the state capitol, along with local residents, participate in the annual Lake Fair and other community events. This fair also stimulates the local economy through sales of gas, food, lodging, crafts, souvenirs, etc. Jogging trails and parks around the lake also mean that running shoes, clothing, and picnic supplies are needed and supplied by local merchants.

The lake provides fish habitat for various life stages of chinook, coho, sockeye, and chum salmon; steelhead; cutthroat and rainbow trout; largemouth bass; and carp. Anadromous fish pass upstream into the lake from Budd Inlet through a fish ladder at the dam, while downstream migrants pass through the tide gates or over the fish ladder. Each year, two million chinook salmon fry (juveniles less than one year of age) are planted in Capitol Lake/Percival Cove in March and April. The fry are fed by the Washington State Department of Fish and Wildlife (WDFW) from mid-April to late May or early June. Between late May and early June, the fry begin their migration out to Puget Sound. The WDFW and the Olympic Salmon Club also raise 200,000 yearling chinook salmon (juveniles greater than one year old) in two net pens in Percival Cove, adjoining Capitol Lake. The lake is thus an important rearing habitat for commercial, sport, and Indian salmon fisheries.

Some rainbow trout planted in Black Lake also migrate down Percival Creek and reside in Capitol Lake along with steelhead and other resident fish such as cutthroat trout, largemouth bass, and carp. This abundance of fish also makes Capitol Lake an important sport fishery (**Entranco 1990a**).

Sport fishing contributes to the local economy through the sale of licenses, boats, motors, and other fishing gear. Hatchery, net pen, and feeding operations support commercial, sport, and Native American salmon fishing operations and are a very important source of economic support to both the state and local economy.

When this area was a tidal estuary and no human development encroached on the floodplain, flood waters would disperse over the entire inlet. Once the inlet began to be filled and developed, including the constriction provided by the Capitol Lake dam, flood waters have had a limited area for dispersement and flooding began to occur. The Capitol Lake dam tide gate provides limited flood control for the City of Olympia. The tide gate prevents high tides from flooding downtown Olympia for some flood events. During the 100-year storm, flooding can occur near the northeast shore of Capitol Lake under conditions of high tide and concurrent, high winter Deschutes River discharge.

However, Capitol Lake is managed by the DGA to minimize flood impacts. The winter elevation of the lake is one foot below the summer lake level. As needed, the tide gate at the Capitol Lake dam is opened to lower the lake level and to provide additional flood storage prior to major rainstorms. The lake is lowered during a low tidal cycle, providing additional flood storage during the period when high tides prevent discharge from the lake. Although flooding can still occur during extremely large flood events, like the 100-year storm, flooding can be reduced or prevented for flows of lower magnitude (**Entranco 1990a**).

CAPITOL LAKE ADAPTIVE MANAGEMENT PLAN

With recent efforts to obtain permit and environmental approvals for the construction of Heritage Park on the eastern shore of the North Basin (**Portico 1997**), and for maintenance dredging of Capitol Lake in the Middle Basin and Percival Cove (**Entranco 1996**), various agencies and organizations expressed interest in developing a Capitol Lake Adaptive Management Plan (the Plan).

The Plan will be a written document, developed by an inter-agency/jurisdiction Steering Committee, to provide guidance on how Capitol Lake will be managed and operated in the future. For example, a key question to be addressed in the Plan is, "Should Capitol Lake be restored to a tidal estuary?" or "Should it continue to be maintained as a freshwater lake?" The reason the Plan is called "adaptive" is because it will be frequently updated and possibly modified as studies are triggered and more is learned about how the water resource responds to different management/ operational strategies.

The following sections present projects or activities that are planned in the Capitol Lake area.

RELATED ACTIVITIES

Heritage Park

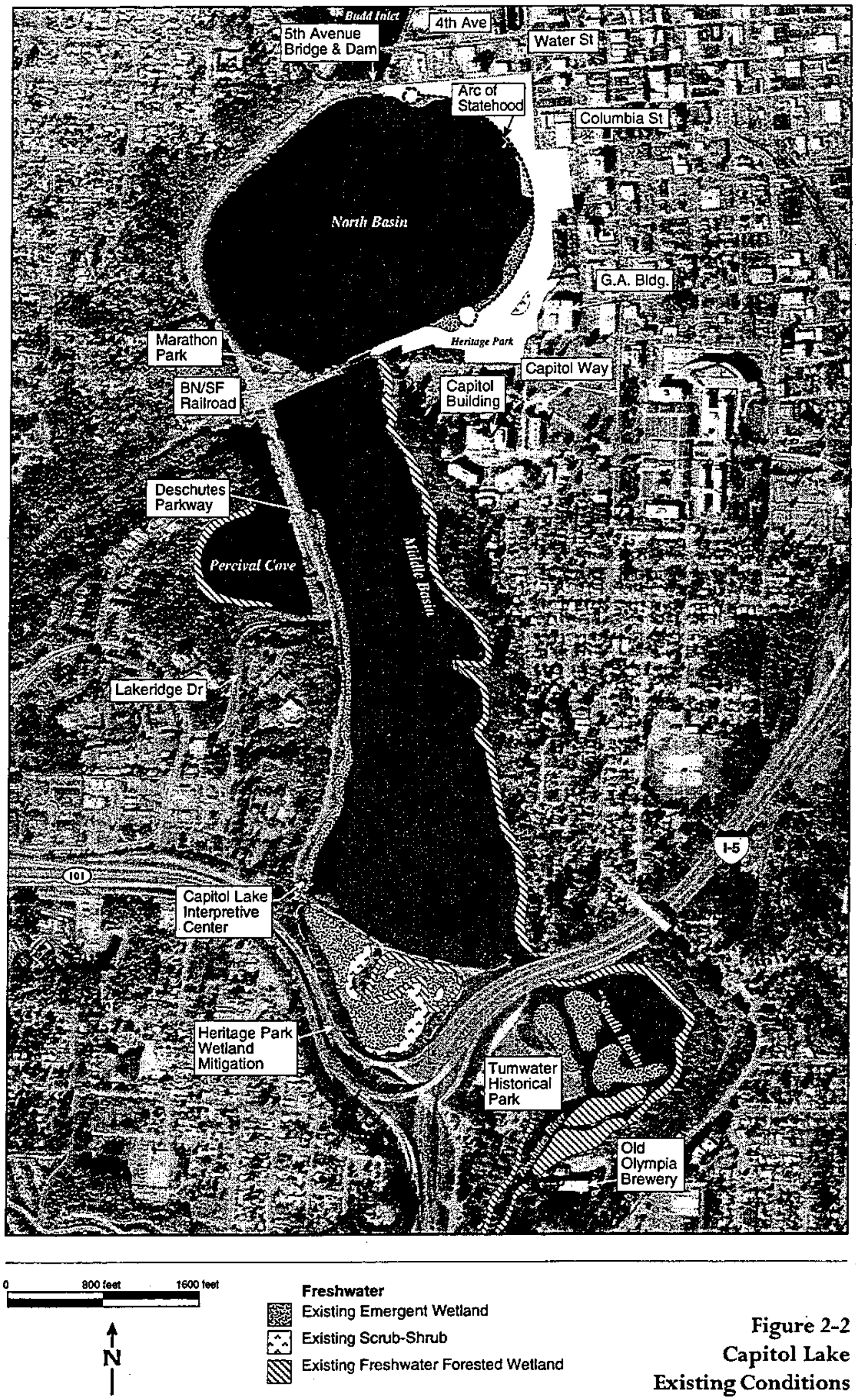
The entire eastern shore of the North Basin of Capitol Lake is the setting for the new Heritage Park, sponsored by DGA. Heritage Park is the realization of one major element of the original Capital Campus plan prepared by New York architects Wilder and White.

The park encompasses 46 acres, including part of the North Basin. A key feature of the park is the Arc of Statehood, a large semicircular, tree-lined walkway, which encompasses the entire eastern shoreline of the lake (**figure 2-2**). A network of trails connects the new shoreline trail with the Capitol grounds to the south and Olympia's Heritage Fountain and Percival Landing (a marine waterfront park on Budd Inlet) to the north. The park plan includes new aquatic and wetland habitat on the eastern shore of the North Basin, as well as newly constructed and enhanced wetlands in the southwestern corner of the Middle Basin (**figure 2-2**).

Park construction started in summer 1998 and Phase I is scheduled for completion by fall 1999. Construction of other park elements could extend into the year 2000 or 2001.

New Market Historic District

Tumwater's New Market Historic District borders most of the South Basin of Capitol Lake. A master plan for this district was adopted by the City of Tumwater in 1993. It describes future land uses, shoreline improvements, and cultural and recreational



B124 97034-60 Capitol Lake EIS (8/25/98) AGT

Freshwater
- Existing Emergent Wetland
- Existing Scrub-Shrub
- Existing Freshwater Forested Wetland

Figure 2-2
Capitol Lake
Existing Conditions

facilities planned for the district. Key components of the master plan include expansion of the City's Historical Park to include a trail system around the south basin (including pedestrian bridges over the Deschutes River and Capitol Lake near the Interstate 5 bridge), and rehabilitation of the Old Olympia Brewery buildings for beneficial use to the public. Other existing and future cultural and archaeological resources of the district also are identified in the master plan.

Deschutes Parkway Improvements

A recent study (**JWMSA 1997**) was performed to evaluate the existing condition of the Deschutes Parkway, which runs along the entire western shoreline of Capitol Lake. This two-lane roadway was constructed between 1949 and 1952 to improve transportation access between Olympia and Tumwater. The roadway is 8,550 feet long and extends from Interstate 5 (I-5) on the south to 5th Avenue on the north.

The recent assessment shows that the roadway continues to show damage from being built almost 50 years ago and an earthquake in 1965. Various repairs are recommended for Deschutes Parkway, including a combination of roadway reconstruction, roadway reinforcement, roadway structural support, slope retaining structures, and toe/roadway drainage. Estimated construction cost is $9.9 million. A date for construction has not been established.

Since stormwater runoff from the existing roadway is not treated currently, the proposed upgrade should provide for stormwater treatment.

Currently the only utility corridor along Deschutes Parkway is the pressurized sewer line from the Westside Lift Station to the Lacey-Olympia-Tumwater-Thurston County partnership (LOTT) Treatment Plant in downtown Olympia. The Westside Lift Station is located west of Marathon Park and serves the sanitary sewer needs of a large portion of West Olympia. This facility is currently rated at 6 million gallons per day (mgd) and needs to be upgraded to 12 mgd. In a related sewerage improvement, the Washington State Department of Ecology has notified LOTT that the emergency repairs to the Southern (Tumwater) Interceptor, currently on the eastern hillside of the South Basin, will not be an adequate long-term solution. Therefore, LOTT is seeking an alternative route to the treatment plant.

The most appropriate alternative appears to be a route extending along Deschutes Parkway from Tumwater to the Westside Lift Station. Such a proposal would require an additional upgrading of the Westside Lift Station from 12 to 24 mgd and a new, parallel pressure line from the lift station to the general area of the Olympia Center where it flows by gravity to the treatment facility. Plans for these facility improvements have not been finalized, but preliminary discussions indicate that this work would require the temporary closure of the western 20 feet of Deschutes Parkway. Also, any utilities constructed within Deschutes Parkway would need to be constructed to withstand future seismic events. Therefore, these lines would have to be designed to withstand vertical and lateral failures.

Another upland project, which may occur in the South Basin vicinity, is the Olympia Woodland Trail. This urban trail would extend the existing bikeway along I-5 from Tumwater Historical Park to the Chehalis Western trail head near Lacey. A new pedestrian bridge would need to be constructed across Capitol Lake, just south of the I-5 bridge. Once completed, the trail would be 3.8 miles long. Timing is subject to funding availability.

Capitol Lake Restoration Report and Action Plan (1988)

Developing a management plan for Capitol Lake is not a new idea. The *Capitol Lake Restoration: Committee Report and Proposed Action Plan* was completed in 1988. A summary of this existing plan is provided below to provide historical context to the new Capitol Lake Adaptive Management Planning Process. The *Capitol Lake Restoration: Committee Report and Proposed Action Plan* was prepared by an intergovernmental staff committee. The committee's goal was to address the water quality degradation in the lake that was adversely affecting recreational activities in the lake and led to the closing of the swimming beach at Capitol Lake Park. The Action Plan contained four goals and 21 action recommendations, aimed at improving the water quality of Capitol Lake. The process predated many other nonpoint pollution rules and planning processes, which occurred in adjacent watersheds and later within the Deschutes River/Capitol Lake watershed.

There was little incentive for the state departments or local jurisdictions, which helped prepare the 1988 Action Plan, to actually adopt it as a decision-making document. Therefore, any implementation of its recommendations has been an indirect result of other ongoing water quality activities or projects. For example, the *Budd Inlet - Deschutes River Watershed Action Plan* responded to the need for a watershed planning process (Rec. 21). The Steering Committee for the Capitol Lake Adaptive Management Plan process could also be considered the interjurisdictional guidance body suggested in the first recommendation.

Regarding water quality, monitoring has been done on a limited basis within the watershed (Rec. 5), stormwater outlets to Capitol Lake have been sampled in several intensive monitoring operations by the Thurston County Health Department (Rec. 12), and the NPDES permit for the Olympia Brewery was updated (Rec. 10). A stormwater basin plan for Percival Creek has been prepared (Rec. 19) along with an evaluation of Black Lake water quality (Rec. 18). Implementation of these basin plans have resulted in the construction of a new stormwater treatment facility at Mottman Road.

New stormwater facilities are now required to meet new treatment standards (Rec. 6 & 7) and the Thurston County Conservation District has targeted the Deschutes River as a priority area for new farm plans (Rec. 15 & 16). The Budd-Deschutes Plan and Long-Term Forestry zoning have identified the extent of forestry in the watershed (Rec. 14), and the Timber-Fish and Wildlife process has been adopted in to the Forest Practices Act (Rec. 13). Wetlands throughout the watershed were mapped in 1995 (Rec. 20); an evaluation of creating a wetland in the middle basin was completed (**Entranco 1990a**) and is being re-evaluated under the current planning process (Rec. 22).

Even though a majority of the recommendations have been addressed, there are still unresolved issues. The first is the lack of "maintenance dredging on a planned and regular basis" (Rec. 3); this is one reason for the current planning process. The County and State have adopted a number of new water quality regulations, but providing adequate staffing level and enforcement of those regulations is still difficult (Rec. 8). Ineffective enforcement may also lower voluntary compliance for actions such as implementing farm plans (Rec. 15 & 16). It is unknown if nutrient loading from the Percival Cove fisheries operation has been monitored or reduced (Rec. 11), and correcting erosion problems along the Deschutes River is and will continue to be a long-term water quality issue (Rec. 17).

Watershed Activities for Erosion and Sedimentation Control

Recognizing that the rate of sediment delivery to Capitol Lake is partially determined by land and water use management activities in the watershed, DGA contracted work to identify and mitigate erosion in the watershed (**Thurston Conservation District 1984 and 1994, Entranco 1990b**). Timber practices historically involved clear-cutting and construction of erosion-prone logging roads. These practices were believed to have a significant influence on erosion and changing hydrology in the watershed. Other sources of erosion/sedimentation were livestock trampling of river/stream banks and clearing and grading activities associated with urban development.

A recent investigation of erosion/sedimentation concerns in the Deschutes River was completed by Collins (**1994**) on behalf of the Squaxin Island Tribe and the Thurston Conservation District, in which the following conclusions were drawn regarding reductions in sediment loading to Capitol Lake:

> "While it is worth reducing land-use sources of erosion as a means to reducing sedimentation to the lake (and for meeting other objectives such as improving aquatic habitat by improving riparian conditions), it may be more sound for the watershed's overall habitat to emphasize dredging rather than a widespread program of bank protection, and the tradeoffs between the two need to be evaluated."

This comment was supported by an assessment of the relative contributions of natural and man-induced erosion/sedimentation problems in the watershed. Collins (**1994**) also concluded that natural sources of erosion/sedimentation were considered greater than those due to man-related activities such as forestry and agriculture.

The DGA is also involved in cooperative efforts with the Thurston Conservation District, Ecology, WDFW, and other organizations to install bioengineering improvements—river bank stabilization efforts involving vegetation plantings and related work—on a total of seven upstream reaches of the Deschutes River. This is referred to as the Upper Deschutes River Sediment Reduction Project. Three of these improvements were installed in 1993 (**Thurston Conservation District 1994**) and four were installed in 1994 (**M. Turner, personal communication**). Several farm management plans were also developed and implemented as a part of the sediment reduction project.

These efforts, and the efforts of other state, federal, local, and tribal interests are expected to reduce Capitol Lake's sedimentation rate in the years ahead. The amount of sediment load reduction expected from these efforts is uncertain. However, it is clear that some degree of erosion and sedimentation will continue, primarily due to natural causes, despite the benefits of improved control efforts in the watershed. The report concludes:

> "Therefore, the maintenance sediment removal of Capitol Lake is expected to be a long-term, ongoing need, even with the best watershed management practices in place."

Deschutes River Watershed Action Plan

A long-term Watershed Action Plan for the Budd Inlet-Deschutes River watershed was completed by Thurston County (**Thurston County Advance Planning and Historic Preservation 1995a**). The problem of erosion/sedimentation in the Deschutes River and the associated filling of Capitol Lake is recognized in the plan.

In the Flooding, Sedimentation and Bank Erosion (SED) chapter of the action plan there are 18 action recommendations which seek to improve the river ecosystem. Since the adoption of the Watershed Action Plan, moderate progress has been made to address this topic. Thurston County will conclude its "reach scale analysis" of the river habitat (Action Recommendation SED 4) by mid-1999. This project targets areas of existing off channel rearing habitat and erosion concerns (SED 11) and has built on data already collected by the Squaxin Island Tribe on the distribution of large woody debris along the mainstem of the river.

Funding for suggested restoration projects has been less available. Currently unfunded projects are the Conservation District riparian revegetation program (SED 3), bioengineering projects (SED 6), new farm plans (also include revegetation) (SED 8), and the City of Tumwater riparian vegetation restoration project along the Tumwater Valley Golf Course (SED 10). The Stream Team has been active along the river and helped to replant streamside vegetation in Tumwater's Pioneer Park. The Capitol Land Trust has set aside funds for protecting riparian vegetation on a few properties along the river (SED 7) and for a small property in the South Basin of Capitol Lake. The Weyerhaeuser Corporation and the Washington State Department of Natural Resources (DNR) have not yet begun a Watershed Analysis process in the upper watershed (SED 1). Also, the entire forest practices industry, including DNR, is re-evaluating streambank stability with respect to salmon habitat (SED 16).

As indicated by these action recommendations, the intent is to minimize erosion and sedimentation in the Deschutes River watershed to the extent feasible using available local, state, tribal, and federal resources. Depending on the degree of success, and the funding availability for implementation, these actions are expected to result in some reduction in sediment loading to Capitol Lake over time.

The Watershed Action Plan also includes recommendations on agricultural practices, wastewater management and stormwater quality which, if implemented, would result in improved water quality in the Deschutes River and Capitol Lake over time.

Chapter 3. Alternatives

INTRODUCTION

This chapter expands the description of alternatives presented in Chapter 1, Summary.

The SEPA review process was initiated with a public scoping meeting on November 20, 1997. During this meeting, preliminary alternatives were presented, key environmental issues were addressed, and the public was provided the opportunity to comment. Following issuance of this Draft Environmental Impact Statement (EIS), additional community input will be obtained at a public meeting, where citizens can comment on relevant concerns.

Existing conditions, five action alternatives, and the No-Action Alternative are addressed in this non-project EIS. The alternatives described in detail are:

- Lake/River Wetland Without Trap
- Lake/River Wetland With Trap
- Lake
- Estuary
- Combined Lake/Estuary
- No Action

The key issues distinguishing the alternatives involve the following questions:

1. Would the system function as a freshwater or estuary (brackish water) dominant ecosystem?
2. Would the tide gate at the Capitol Lake Dam at 5th Avenue be retained or removed (or locked in the open position)?
3. Would maintenance dredging be part of the alternative and if so, how, where, and when?
4. Would the modified drawdown/saltwater backfill operation be continued or discontinued?

Each action alternative was developed using a different combination of these features to determine how the keep basin would evolve over time.

Freshwater or estuary system, retention or removal of the tide gate, dredging, and continued drawdown all have a role in how long it would take for the full impact of the alternatives to be realized. These factors also would determine the relative amounts of open-water, freshwater, and estuary habitats that would distinguish the alternatives (see **figures 3-1** to **3-10** under Alternatives Description).

The time involved in realizing the alternatives' full impacts is referred to as "the time of maturity." At the time of maturity, it is assumed that wetland vegetation—either freshwater or brackish (a mix of fresh and saltwater with medium salinity)—would almost completely occupy any basin that was not dredged and was allowed to fill with sediment, and open-water habitat would be restricted to the remaining river channel. The time of maturity is based on measured sedimentation rates in Capitol Lake, caused by inflows primarily from the Deschutes River.

This EIS uses the phrases short-term, intermediate or interim, and long-term impacts. Short-term impacts refer to those that would occur immediately or within the first 20 years. Intermediate or interim refers to the period from 20 years up to the time of maturity, and long-term refers to conditions at the time of maturity. All figures depicting the alternatives show how the basins would be expected to look at the time of maturity. In addition, the figures showing the Combined Lake/Estuary and Estuary alternatives (see **figures 3-6** to **3-9** under Alternatives Description) show the conditions that would occur during high tide.

Freshwater or Estuary Dominant System/Tide Gate

A key distinguishing feature between alternatives is whether the existing tide gate at the Capitol Lake dam at 5th Avenue would be retained or removed. The tide gate and dam were constructed in 1951 and resulted in the creation of the lake and its separation from the saltwater of Lower Budd Inlet. Retention of the tide gate would maintain freshwater ecosystems in the existing lake basin (all alternatives except the Estuary and Combined Lake/Estuary alternatives). Removal of the tide gate would re-establish a tidal estuary—this would occur with the Estuary and Combined Lake/

Estuary alternatives. Re-establishment of tidal circulation could be accomplished by raising the tide gate and leaving them in the open position or by physically removing the tide gate from the dam.

Maintenance Dredging

Two important distinctions between alternatives are the timing of dredging and whether or not maintenance dredging is included as a part of the alternative description, or it is proposed as mitigation. There are two alternatives that include short-term dredging in Budd Inlet as potential mitigation: the Estuary Alternative and the Combined Lake/Estuary Alternative. These alternatives would allow sediment from the Deschutes River to accumulate in the South, Middle, and the North basins until they become completely filled except for the river channel. As indicated in **table 1-1**, it is estimated that this would occur over a period of 100 to 150 years. However, with these options, the removal or permanent opening of the tide gate would allow sediment to be flushed into Budd Inlet during high river flows. This may require mitigation dredging before maturity.

Under the Lake/River Wetland Without Trap Alternative, sediment would be allowed to accumulate in the Middle Basin until it becomes full (time of maturity is estimated at 50 to 85 years); maintenance dredging would then resume in the North Basin every other year to maintain an open-water habitat. The Lake/River Wetland With Trap Alternative would dredge the Middle Basin sediment trap every 6 to 10 years for the foreseeable future. The Middle Basin would eventually fill under this alternative but it would take longer—estimated at 75 to 115 years.

It should be noted that visible changes in the amount of wetland vegetation—either freshwater or brackish—would probably be minor during the first 20 years. However, as time goes by, it is expected that wetland habitat could increase and open-water habitat would decrease in those basins allowed to fill with sediment.

Under the Lake Alternative, dredging would be initiated in ten sectors throughout the Middle Basin and Percival Cove. Of these sectors, two sectors would be dredged every other year for the foreseeable future. With this alternative, the existing lake would be maintained. No regular maintenance dredging would be performed in the South Basin, but may be performed in the event that sediment accumulation causes flooding, interferes with park uses, or blocks boat ramp access to the lake.

Summer Lake Drawdown

Another key distinguishing feature is whether modified lake drawdown/saltwater backfill would occur. Between late 1971 and 1995, Capitol Lake was drawn down (tide gate was opened at low tide and all freshwater drained from the lake) every summer and the lake was then refilled with saltwater on the incoming tide. Drawdown and saltwater backfill was practiced to:

- Control freshwater plants and algae.
- Assist outmigration of juvenile salmon (discontinued in the mid 1980s).
- Facilitate in-lake or shoreline construction projects.

In 1996 and 1997, the drawdown/backfill practice was modified to limit the volume and upper vertical limit of saltwater backfill. This was done to avoid adverse saltwater impacts on shallow freshwater aquatic and wetland plant communities, especially the wetlands in the North and Middle basins that were required as mitigation for the Heritage Park project. This modified practice would continue with the Lake Alternative only.

ALTERNATIVE DESCRIPTIONS

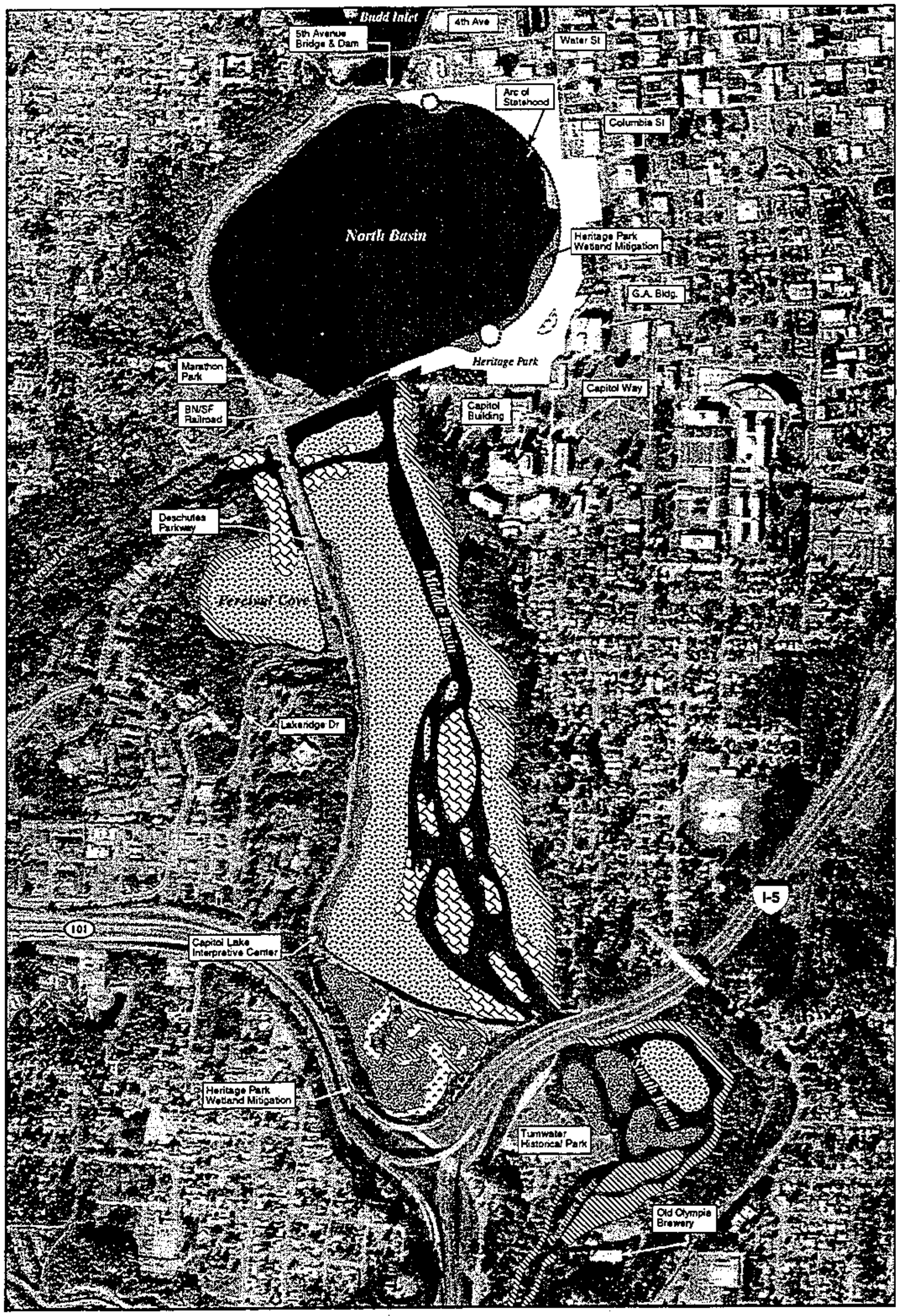
Each alternative is described in detail in the following sections.

Lake/River Wetland Without Trap Alternative

Under this alternative, the South and Middle basins would be allowed to fill with sediment and would slowly evolve into freshwater wetlands (**figures 3-1** and **3-2**)[1]. The North Basin would be retained as open-water habitat and would function as a reflecting pool for the Capitol Building. Heritage Park and its freshwater mitigation wetlands (wetlands created to mitigate impacts of park construction) would be integral elements of this alternative.

There would be no maintenance dredging under this alternative and sediments would gradually in-fill the South and Middle basins. The time of sediment infilling for the South Basin is estimated at 20

1. Lake bottom sediments are comprised primarily of silts, sands, and clays. There is some sorting of material within the lake. Sand and gravel-sized material settles out in the South (upper) Basin; sand is the dominant material in the Middle Basin trap (just north of the I-5 bridge), while the remainder of the Middle and North basins is characterized by a sand/silt/clay mixture. Sand and gravel material may have some commercial value for structural fill.



0 800 feet 1600 feet

N

Freshwater

- Existing Emergent Wetland
- Existing Scrub-Shrub
- Existing Freshwater Forested Wetland
- Predicted Future Emergent Wetland
- Predicted Future Scrub-Shrub

Figure 3-1
Lake/River Wetland
Without Trap Alternative

Estimated Time to Maturation: 50 to 85 Years

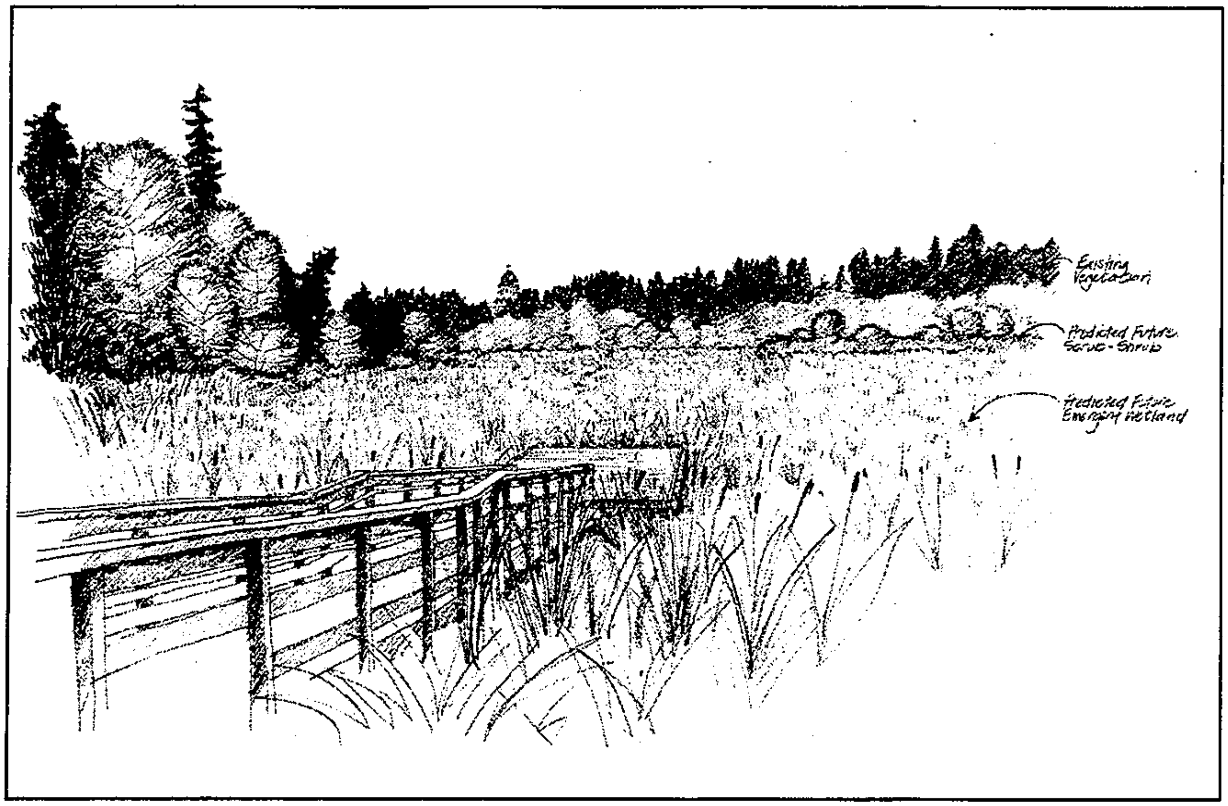


Figure 3-2
View from Capitol Lake Interpretive Center of Both Lake/River Wetland Alternatives at Maturity

to 25 years, and 50 to 85 years for the Middle Basin. During the first 20 years, there may be little visual evidence of change in the Middle Basin; but during the interim period (20 to 50 years), freshwater emergent and scrub-shrub wetlands would begin to replace open-water habitat. It is predicted that the most mature wetland vegetation communities (scrub-shrub wetlands) would develop along the central axis of the Middle Basin on sandbar islands created by the deposition of sediment delivered by the Deschutes River. Emergent wetland vegetation is expected to grow along the shorelines of the sandbar islands and progress shoreward as sediment continues to fill the basin over time. Freshwater wetlands (emergent and scrub-shrub) would occupy much of the South and Middle basins at the time of maturity (**figures 3-1 and 3-2**).

Once the Middle Basin is filled with sediment, maintenance dredging would be required to maintain open-water habitat in the North Basin. It is assumed that North Basin dredging would require removal of an estimated 70,000 cubic yards every two years to keep pace with sediment loading from the Deschutes River.

Under this alternative, mitigation steps could be taken to place large woody debris in locations that would enhance development of wetland and/or shoreline fish and wildlife habitat. This material would be anchored in place to avoid impacts to downstream structures.

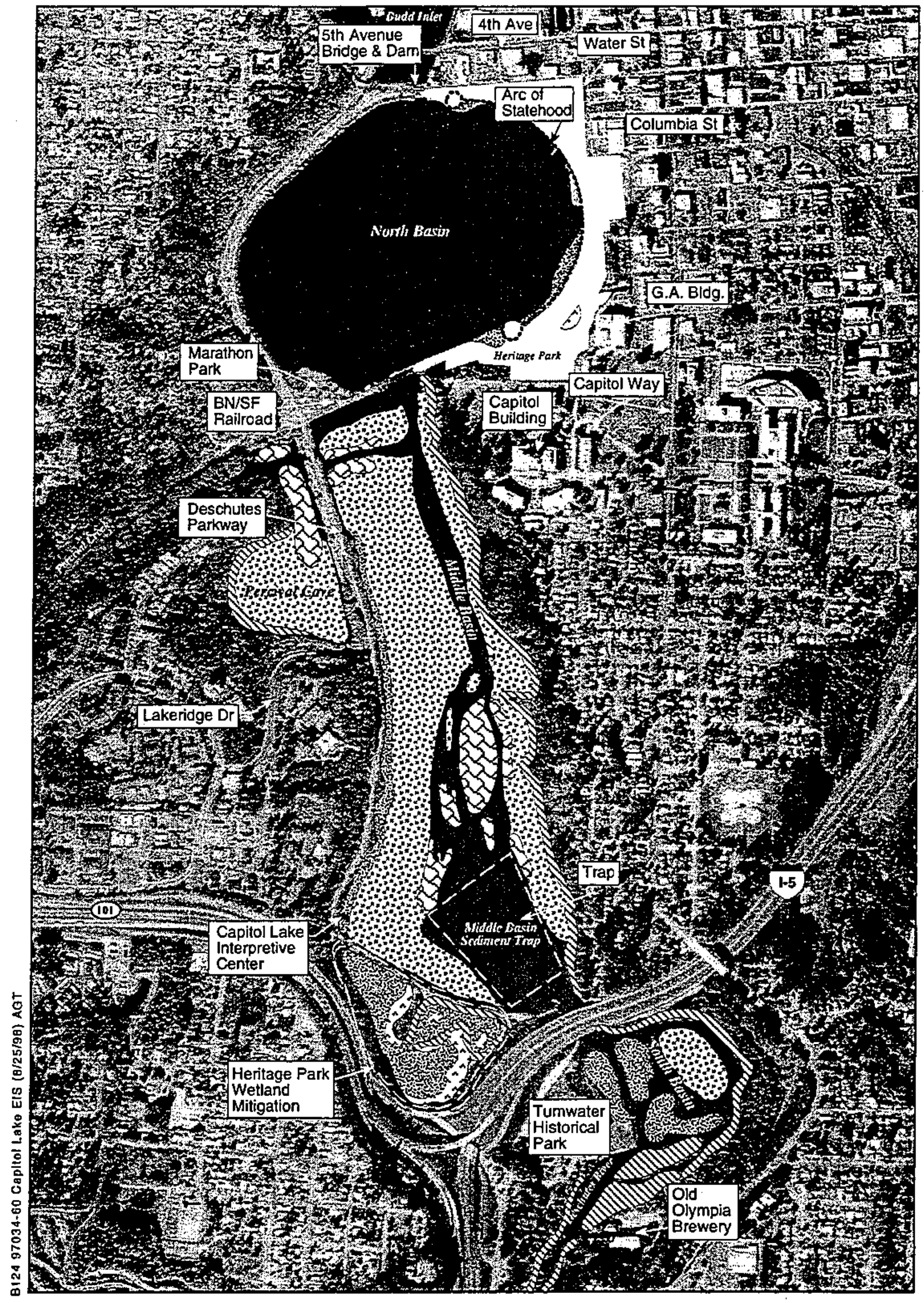
Dam operation would be used to provide limited flood control benefits until the South and Middle basins are filled with sediment. Once these basins are filled with sediment, flood storage capacity would be substantially reduced and there would probably be no value in drawing the lake down prior to predicted flood events.

Lake/River Wetland With Trap Alternative

As with the Lake/Wetland Without Trap Alternative, the South and Middle basins would be allowed to fill with sediment and would slowly evolve into freshwater wetlands (**figures 3-2** and **3-3**). With periodic maintenance dredging in the Middle Basin sediment trap, the rate of sediment loading would be reduced and the time to maturity for the Middle Basin wetlands would be extended. The time of sediment filling for the South Basin is estimated at 20 to 25 years, and 75 to 115 years for the Middle Basin. During the interim period (20 to 75 years), the Middle Basin would be increasingly occupied by emergent and scrub-shrub wetland vegetation similar to the process described for the Lake/River Wetland Without Trap Alternative. The North Basin would be retained as open-water habitat and would function as a reflecting pool for the Capitol Building. As with the Lake/River Wetland Without Trap Alternative, Heritage Park and its mitigation wetlands would be included as integral elements.

Maintenance dredging would be performed in the Middle Basin sediment trap (**figure 3-3**) on a 6- to 10-year cycle, and at the mouth of Percival Creek. Freshwater wetlands (emergent and scrub-shrub) would occupy much of the South and Middle basins at the time of maturity (**figures 3-2 and 3-3**). Once the Middle Basin completely filled with sediment, maintenance dredging would be required to retain open-water habitat in the North Basin. It is assumed that North Basin dredging would require removal of 70,000 cubic yards every two years to keep pace with sediment loading from the Deschutes River.

Dam operation would be used to provide limited flood control benefits until the South and Middle basins are filled with sediments.



0 800 feet 1600 feet

N

Estimated Time to Maturation:
75 to 115 Years

Freshwater
- Existing Emergent Wetland
- Existing Scrub-Shrub
- Existing Freshwater Forested Wetland
- Predicted Future Emergent Wetland
- Predicted Future Scrub-Shrub

Figure 3-3
Lake/River Wetland With Trap Alternative

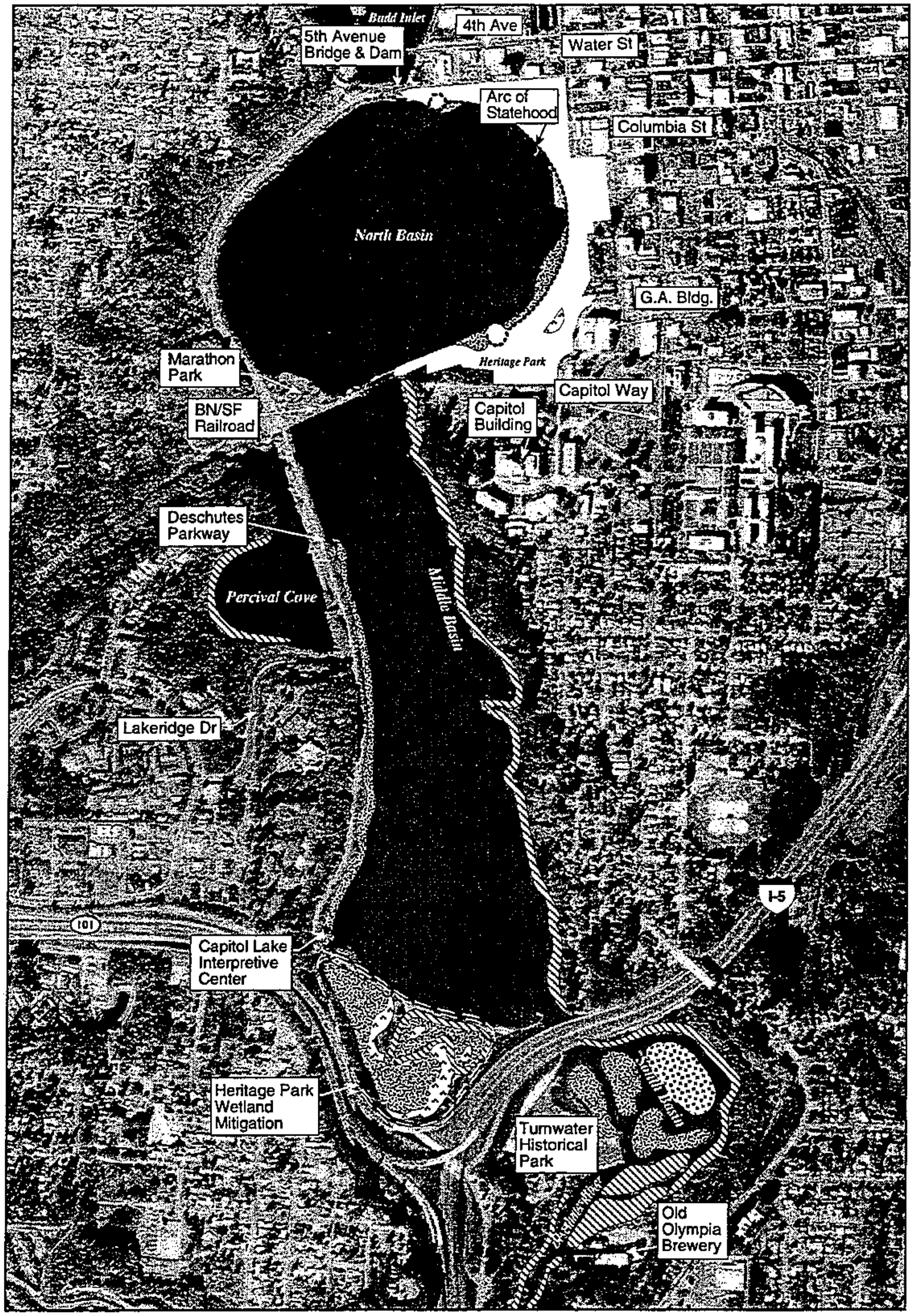
Lake Alternative

Under this alternative, the North Basin, Middle Basin, and Percival Cove would be retained as open-water habitat (**figures 3-4** and **3-5**) and would function as a reflecting pool for the Capitol Building. The South Basin would experience additional sediment filling and wetland habitat development over a period of approximately 20 to 25 years. Heritage Park and its freshwater mitigation wetlands (wetlands created to mitigate impacts of park construction) would be integral elements of this alternative.

Open-water habitat in the Middle Basin and the mouth of Percival Cove would be preserved by maintenance dredging of approximately 70,000 cubic yards of sediment every other year. Maintenance dredging would occur in two different sectors during each cycle, rotating the dredging so that the entire Middle Basin and Percival Cove would be dredged twice over a 20-year period, after which dredging would start again at the original two sectors. An illustration of proposed dredging sectors is provided in **Appendix B**. Existing nearshore wetlands and riparian habitat would be retained and would not expand significantly due to maintenance dredging (**figure 3-5**).

For purposes of alternative comparison, modified lake drawdown is assumed for only the Lake Alternative. It also could be used for the Lake/River Wetland With and Without Trap alternatives. Annual summer lake drawdown and modified saltwater flushing would be practiced similar to the procedure used in 1997 (**Entranco 1997**). This modified drawdown procedure would minimize saltwater impacts to freshwater plants and would facilitate near-shore construction and maintenance operations.

Under the Lake Alternative, flood control operations at the dam would remain unchanged, and the lake would be drawn down to provide increased flood storage prior to expected high rainfall and river discharge.



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0 800 feet 1600 feet

N

Freshwater
- Existing Emergent Wetland
- Existing Scrub-Shrub
- Existing Freshwater Forested Wetland
- Predicted Future Emergent Wetland

Figure 3-4
Lake Alternative

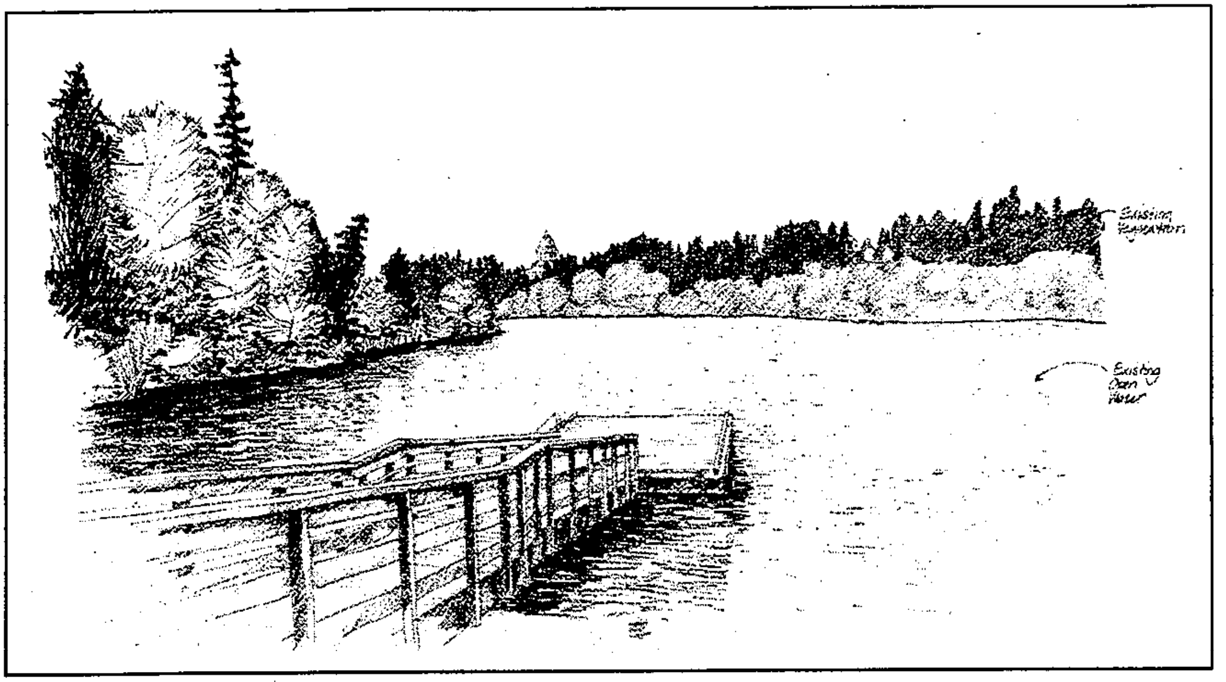

Figure 3-5
View from the Capitol Lake Interpretive Center of the Lake Alternative at Maturity

Estuary Alternative

Under this alternative, the tide gate would be removed[2] from the dam at the 5th Avenue Bridge to restore tidal flushing to the entire basin and return the ecosystem to an estuary. During high tides, the basin would continue to function as a reflecting pool for the Capitol Building. However, twice per day, at low tide, mudflats would be partially exposed with the remaining open-water river channel providing a limited reflection function. Heritage Park would be an integral element of this alternative but its freshwater mitigation wetlands in the North and Middle basins would be displaced by vegetation that would tolerate brackish water conditions (see **figures 3-6** and **3-7**).

There would be no dredging in the North, Middle, or South basins, and the entire basin would gradually fill in with sediment from the Deschutes River. With the tide gate removed and downstream sediment transport, maintenance dredging could be required in Lower Budd Inlet at maturity. It also is possible that in the short term dredging may be required as mitigation in Lower Budd Inlet.

2. Another option, which would be explored if this alternative was selected as the preferred alternative, would be to simply open the tide gate and leave it in the open position.

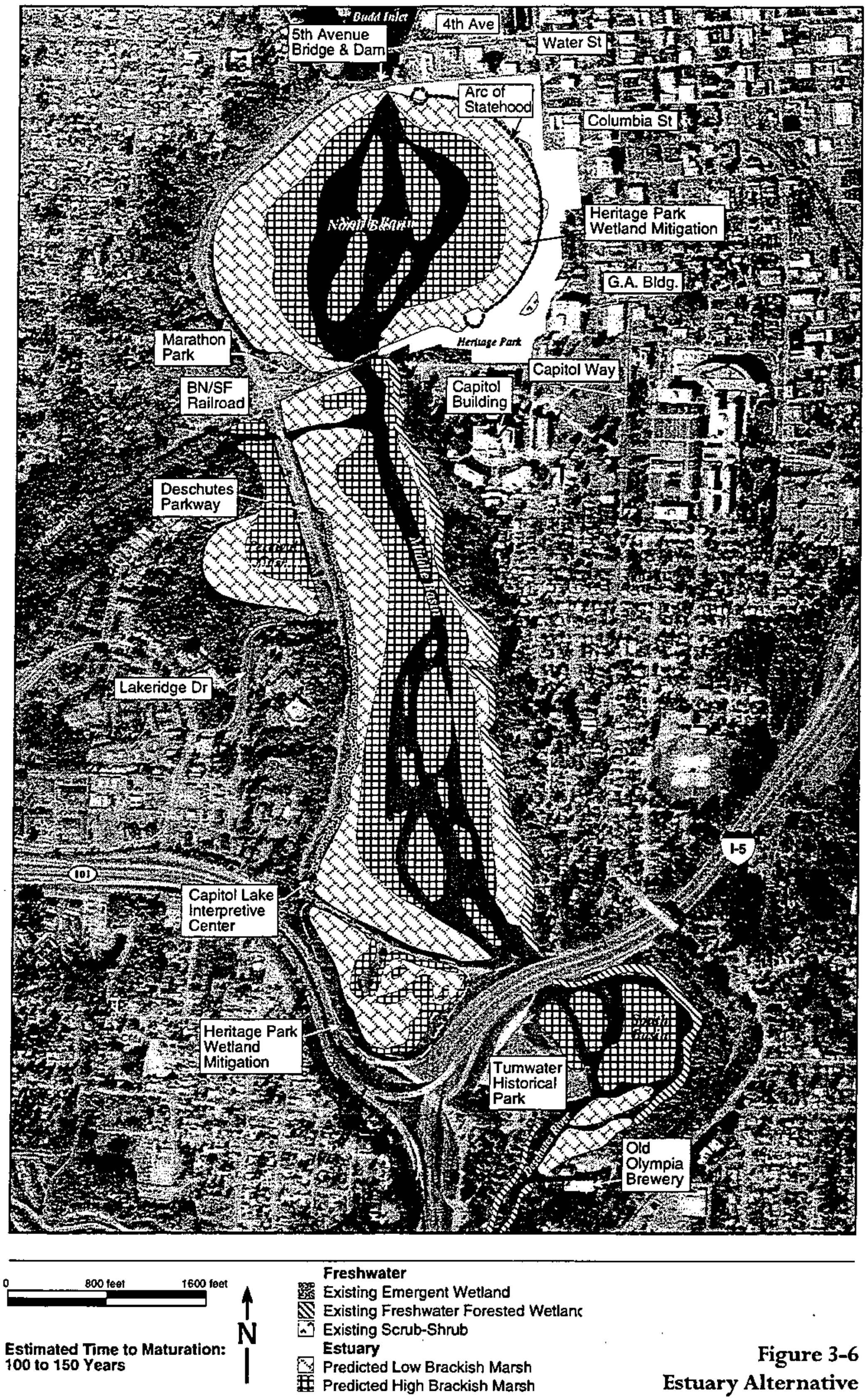

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Figure 3-6
Estuary Alternative

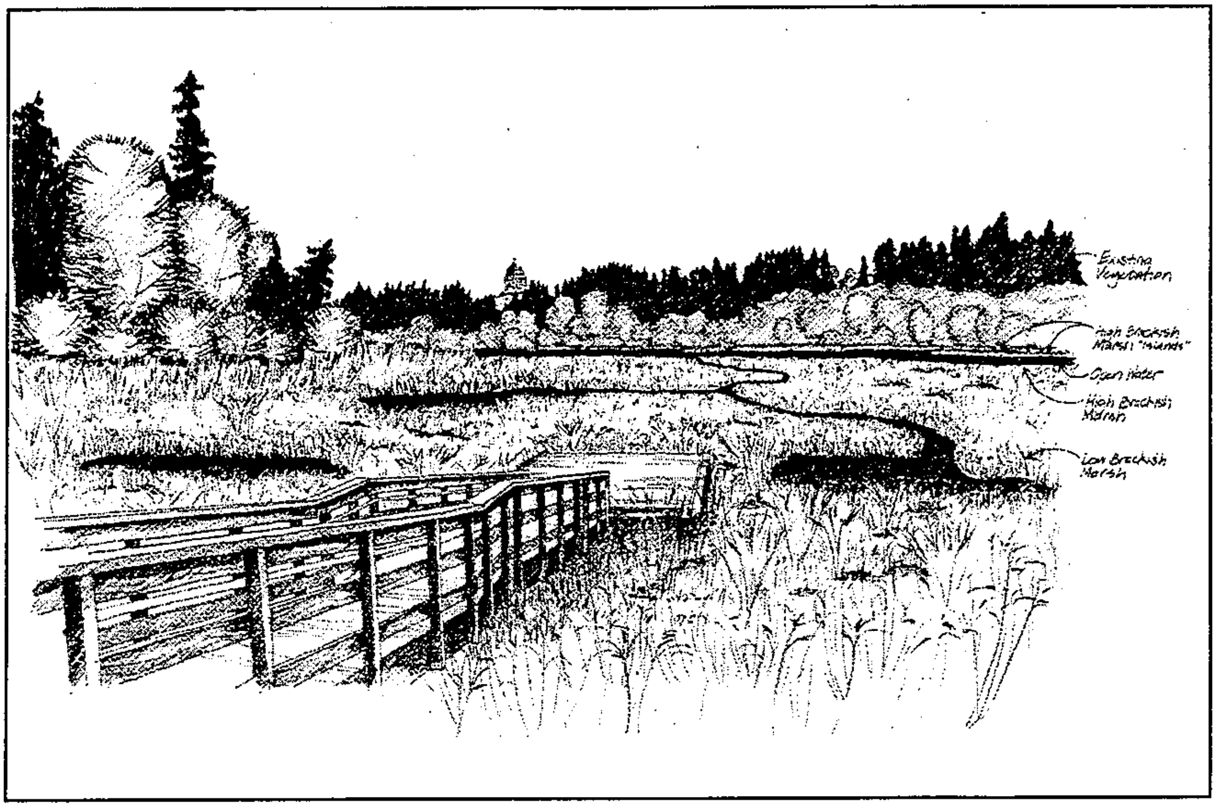

Figure 3-7
View from Capitol Lake Interpretive Center of the Estuary and Combined Lake/Estuary Alternatives at Maturity

Estimated times of filling for the South, Middle, and North basins would be 100 to 150 years. During the interim period (20 to 100 years), sand bars would be expected to form along the central axis of the Middle Basin, and later the North Basin, and would be colonized by wetland vegetation that would tolerate brackish water conditions. Sediment filling and wetland plant communities would be expected to gradually move shoreward over time. At maturity, much of the entire basin would be occupied by low brackish marsh and high brackish marsh (**figures 3-6** and **3-7**). At the time of maturity, open water with a reflecting pool function would be limited to the remaining river channel during high tide.

Existing constricted areas in the lake (Capitol Lake dam, railroad trestle, I-5 bridge, and the edge of the Deschutes Parkway) may have to be armored to prevent increased erosion from tidal action.

Combined Lake/Estuary Alternative

This alternative would be similar to the Estuary Alternative, except the eastern half of the North Basin (approximately 40 acres) would be separated from tidal influence and preserved as a freshwater reflecting pool for the Capitol Building (**figures 3-7** and **3-8**). The saltwater and freshwater environments would be separated by constructing an earth-fill dam as shown in **figure 3-9.** There would be no dredging and the entire basin, except the east half of the North Basin, would gradually fill in with sediment from the Deschutes River. The time of maturity is estimated for the South Basin at 20 to 25 years, the Middle Basin at 50 to 85 years, and the North Basin at 100 to 125 years. At maturity, dredging could be required in Lower Budd Inlet to maintain boating and shipping activities. It also is possible that in the short term dredging may be required as mitigation in Lower Budd Inlet.

Construction of the new dam would require engineering measures to supply freshwater flow to the eastern half of the North Basin. The DGA, LOTT Partnership, and the City of Olympia are considering the Class A reuse water from the LOTT treatment system as a source for irrigating lawns at Heritage Park and the State Capitol Campus. Another use of this water may be to serve as the source of water for the freshwater reflecting pool in the North Basin. It may also be possible to provide water:

- from the Deschutes River during low tide conditions by:
  - a. using a gravity-flow pipe system
  - b. pumping water from the river during low tide conditions
- from an in-lake spring source
- from a groundwater source

If the Combined Lake/Estuary Alternative is selected as the preferred alternative, further analysis of source water for the freshwater pool in the North Basin would be needed. This analysis would have to consider the quality and quantity of the supply sources, as well as the relative influence of other inputs (e.g., stormwater) to the reflecting pool.

The elevation of the top of the dam would be set at 12.0 to 13.0 feet mean sea level (MSL) and would minimize, or possibly eliminate flooding in historically flood-impacted areas of the north and east side of the North Basin. Further analysis of the potential for flood impacts and corrective actions are needed for the dam

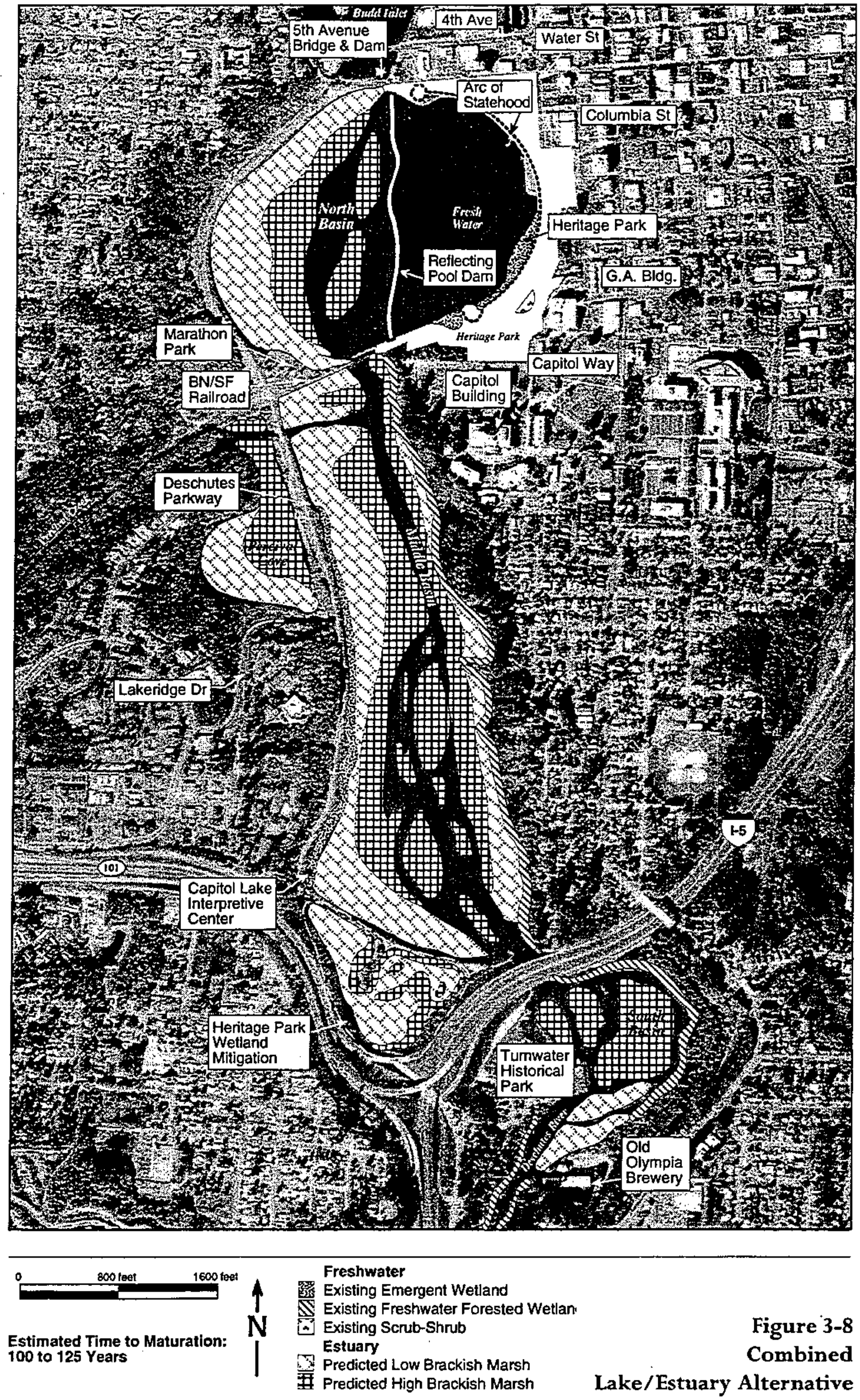

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Figure 3-8
Combined
Lake/Estuary Alternative

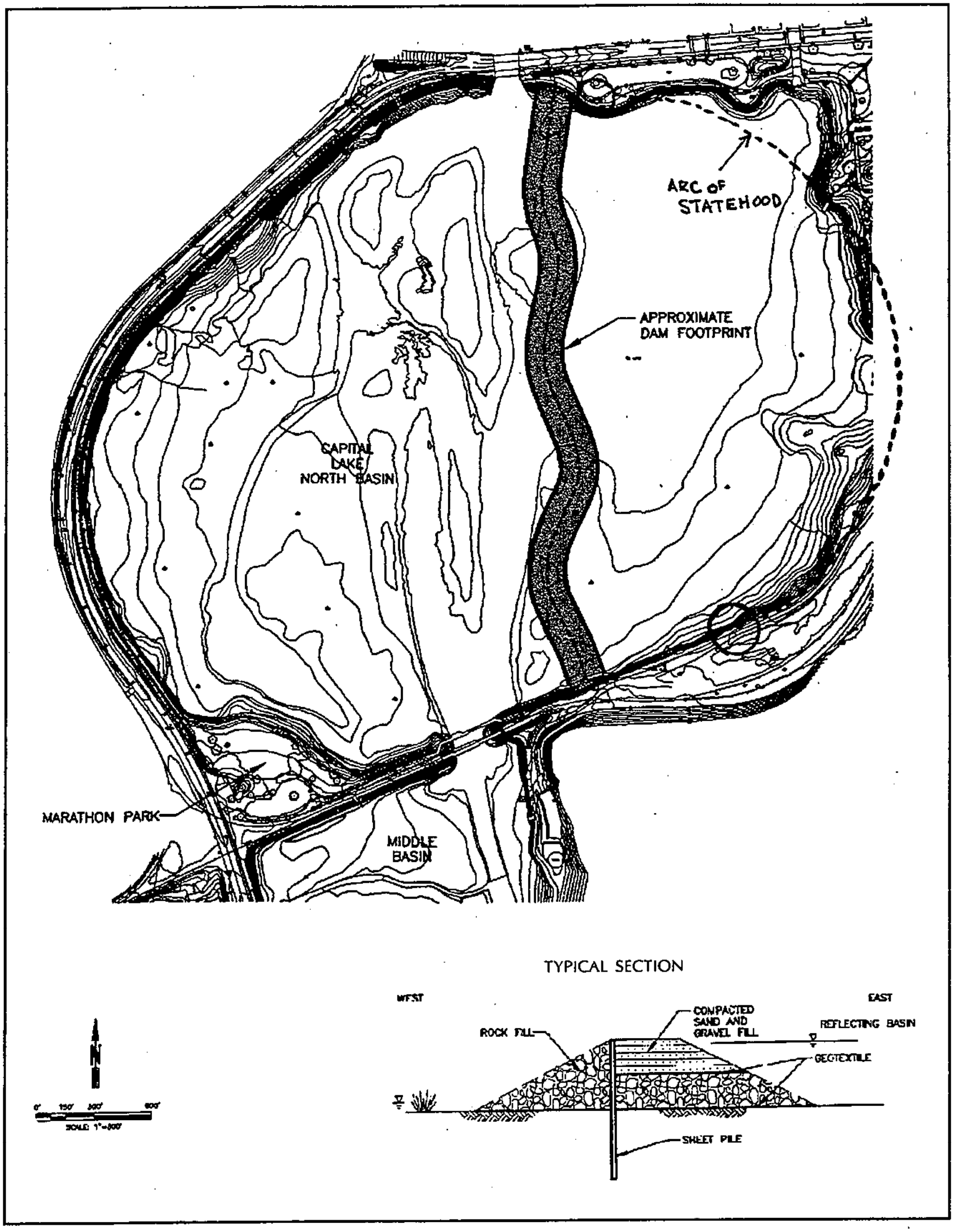


Figure 3-9
Conceptual Layout of Dam for Reflecting Pool

design. This analysis should consider the possible effects of fluctuations in sea level due to changing climate.

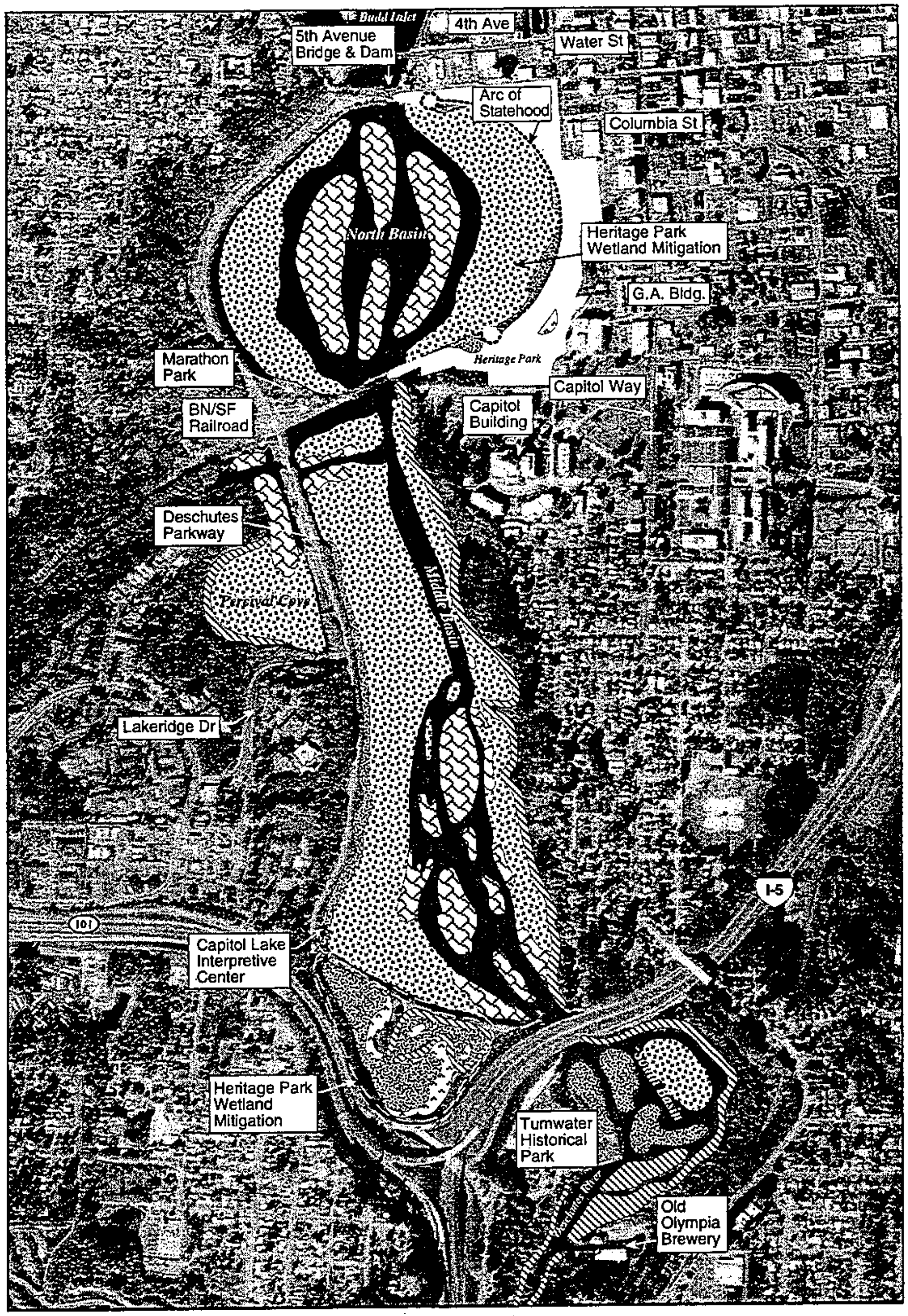
Preserving freshwater in the North Basin would make it possible to retain the Heritage Park freshwater mitigation wetlands in the North Basin; however, the mitigation freshwater wetlands in the Middle Basin would by displaced by salt-tolerant plant species.

As with the Estuary Alternative, tidal action may require armoring of selected areas within the basins.

No-Action Alternative

Under the No-Action Alternative, there would be no dredging of the lake as part of the proposed action and the tide gate would remain in place. Eventually, in approximately 100 to 150 years, the entire lake basin would become filled with sediment and would develop into emergent and scrub-shrub wetlands (**figure 3-10**). At maturity, dredging would begin in Lower Budd Inlet to maintain boating and shipping activities. During the interim period (20 to 100 years), wetland communities would gradually begin to replace open-water habitat in the Middle and North basins as described for the Middle Basin under the Lake/River Wetland Without Trap Alternative. Additional wetlands would also be expected to develop in the South Basin.

Annual summer lake drawdown and saltwater back-flushing would no longer be practiced. Filling of the entire lake basin with sediments would eliminate flood control benefits because there would be no significant live flood storage volume remaining.



0 800 feet 1600 feet

N

Estimated Time to Maturation: 100 to 150 Years

Freshwater
- Existing Emergent Wetland
- Existing Scrub-Shrub
- Existing Freshwater Forested Wetland
- Predicted Future Emergent Wetland
- Predicted Future Scrub-Shrub

Figure 3-10
No-Action Alternative

Chapter 4. Existing Conditions, Impacts, and Mitigation

INTRODUCTION

This Draft Environmental Impact Statement (DEIS) discusses the impacts that implementing the Capitol Lake Adaptive Management Plan would have on earth, water resources, wildlife, fisheries, aquatic resources, land use/recreation/shoreline use, cultural resources, and aesthetics. For each element of the environment, the DEIS describes the existing conditions, the potential impacts of each action alternative and the no-action alternative, and the mitigation measures planned for each alternative. Unavoidable significant adverse impacts are also discussed.

This EIS uses the phrases short-term, intermediate or interim, and long-term impacts. Short-term impacts refer to those that would occur immediately or within the first 20 years. Intermediate or interim refers to the period from 20 years up to the time of maturity, and long-term refers to conditions at the time of maturity.

EARTH

Affected Environment

Capitol Lake

Capitol Lake is a 270-acre freshwater reservoir located in northern Thurston County within the cities of Olympia and Tumwater (**figure 2-1**). As of 1973, the lake had an average depth of 9 feet. Typical summer depths for the North, Middle, and South Basins are[1]:

North Basin......0 to 14 feet

Middle Basin....0 to 10 feet

South Basin........0 to 3 feet

The lake is at the mouth of the Deschutes River and has a drainage area of 185 square miles.

1. Typical depths are for areas outside the river channel, which is somewhat deeper. In addition, there is a small, deep hole near the tide gate, which is approximately 40 feet deep.

The physical and chemical characteristics of Capitol Lake sediments are discussed below as it relates to (1) potential sediment removal by dredging, as proposed with some alternatives, and (2) potential dam construction in the North Basin, as proposed with the Combined Lake/Estuary Alternative.

The upper 15 to 20 feet of lake bottom sediments are comprised of soft, loose silt/sand/clay materials, which are underlain by very dense, glacially-derived, sand and gravel deposits.

Based on the average of 15 sediment cores taken throughout the Middle Basin, the grain size distribution of surface sediments (core samples taken at depths of 0 to 3 feet) is highly variable, but the sediments are typically composed of silts (60 percent), sands (27 percent), and clays (13 percent) (**CH2M Hill 1976 and Hong West 1994**). Some natural sorting of material occurs in the lake—sands have a tendency to drop out in the upper (south) portion of the Middle Basin in the sediment trap, and finer silts and clays tend to accumulate throughout the lake's Middle and North basins.

The study area is seismically active with recent earthquakes occurring in 1949 (centered near Olympia - magnitude 7.2) and 1965 (centered between Seattle and Tacoma - magnitude 6.5). The site is located in Seismic Zone 3, and is subject to moderately high seismic activity. Substantial damage was caused to Deschutes Parkway on the west side of Capitol Lake during the 1965 earthquake. New structures should be designed to compensate for seismic activity.

Loose, sandy zones of sediment in the bottom of Capitol Lake may be susceptible to liquefaction (they may behave as a liquid when shaken) during an earthquake event. For structures constructed on top of such material, this could lead to failure, spreading, cracking, settling, or a combination of these problems. The soft, loose soils on the bottom of the lake are also highly compressible, so that any fill placed on top of these soils may settle over time.

Alluvial material—sand, gravel, and cobbles—is transported to Percival Cove by Percival Creek. Most of this material drops out in Percival Cove just west of the Deschutes Parkway bridge; however, some material also passes under the bridge into the upper end of the Middle Basin.

The current annual sediment deposition rate for Capitol Lake (including Percival Cove) is estimated at 30,000 to 35,000 cubic yards per year or a total of 60,000 to 70,000 cubic yards every two years.

Chemical tests of lake bottom sediments were performed for two recent studies to determine if there were any toxic chemicals present that would affect possible dredging or sediment disposal operations. The first study (samples collected in 1994) showed that sediments were free of toxic levels of arsenic, cadmium, copper, lead, mercury, zinc, polychlorinated biphenyls (PCBs), and total petroleum hydrocarbons (**Entranco 1994**). The second study (samples collected 1995), which involved a more comprehensive list of chemical tests (76 organic and inorganic chemicals were tested per Puget Sound Dredged Disposal Analysis requirements), revealed high concentrations of only one of the 76 chemicals—benzoic acid[2] (**Entranco 1996**). Benzoic acid exceeded maximum contaminant levels in three of six sediment test sites in the Middle Basin[3]. Sediments containing high concentrations of benzoic acid can be safely disposed of at upland disposal sites, but cannot be disposed of at deep, open-water marine disposal sites.

An important concern with disposal of lake bottom sediments is that they may be contaminated with viable seeds from the noxious wetland weed known as purple loosestrife *(Lythrum salicaria).* The possibility exists that seeds contained in lake bottom sediments could be transferred to upland disposal sites where they could germinate and result in the spread of purple loosestrife. A similar concern exists for open-water disposal in the marine environment where it has been speculated that the seeds might float to an adjacent shoreline habitat and germinate. In either case, appropriate control measures would be required to obtain a permit to dispose of sediments at either upland or deep, open-water marine disposal sites.

Capitol Lake has been dredged on two previous occasions. The first dredging project occurred in 1979 (**CH2M Hill 1977**) and involved:

- Removal of 360,000 cubic yards of sediment, primarily in the South and Middle basins
- Construction of sediment traps in the South and Middle basins, and
- Construction of the dike and gravity dewatering facility in the southwest corner of the Middle Basin (present location of the Capitol Lake Interpretive Center).

2. Benzoic acid or sodium benzoate is an anti microbial agent used as a preservative in soft drinks, jams, etc. Some plants also naturally produce it.
3. Contact was made with the Olympia Brewing Company to determine if they use benzoic acid in any of their operations, and they indicated that they do not. There are two or three soft drink bottling companies in the watershed and these are possible sources. Natural plant sources are also possible.

In the mid-1980s the South Basin sediment trap was abandoned because sand bar formation and channel meander separated the trap from the main channel (**Entranco, Inc. 1984**). These changes precluded further sediment deposition in the trap. At that time, DGA decided to discontinue further dredging in the South Basin unless it became necessary to mitigate flooding impacts or to provide recreational boating access to the lake. Therefore, no dredging work has occurred in the South Basin since the original work in 1979.

The second dredging operation in 1986 involved removal of approximately 57,000 cubic yards of sediment from the Middle Basin trap and the area around the trap. This material was deposited in the gravity dewatering facility in the southwest corner of the Middle Basin.

Impacts

Lake/River Wetland Without Trap Alternative

This alternative would have only minor short-term impacts due to the filling in of the South Basin. Its impacts would occur over the long-term and are described below.

Sediment would continue to accumulate in the South and Middle Basins at a rate of 30,000 to 35,000 cubic yards per year. At this rate, the South Basin would fill over a 20- to 25-year period and the Middle Basin would fill in over an estimated 50 to 85 years. During this time, open-water habitat in the Middle Basin would be replaced gradually by freshwater emergent and scrub-shrub wetlands. This change would affect the aesthetics, recreation, fish and wildlife, and flood control functions of the Middle Basin (refer to other sections of this EIS for a discussion of impacts and possible mitigation measures).

As the Middle Basin approaches complete in-filling by sediment (50-85 years), long-term dredging in the North Basin would need to begin to maintain the open-water habitat and the basin's function as a reflecting pool. This would involve removal of approximately 70,000 cubic yards of sediment every two years to keep pace with sediment loading from the Deschutes River. A 75- to 115-year cost would be $9 to $23 million (1998 dollars) depending on the method selected for dredging and (see **table 4-1** and **Appendices A** and **B**). **Figure 3-1** shows this alternative at maturity.

	Existing Conditions	Lake/River Wetland Without Trap Alternative	Lake/River Wetland With Trap Alternative	Lake Alternative	Estuary Alternative	Combined Lake/Estuary Alternative	No-Action Alternative
Dredging Scheme	Major lake dredging occurred in 1978. Trap maintenance dredging in 1986.	North Basin to be dredged once the South and Middle basins have in-filled with sediment in 50 to 85 years.	Dredge Middle Basin trap every 6–10 yrs. Dredge North Basin when other two basins fill, in 75 to 115 years.	Dredge 2 sectors in the Middle Basin and Percival Cove beginning now and repeated every 2 years.	Maintenance dredging of Budd Inlet when entire lake basin filled with sediment in 100 to 150 years. Short term dredging may be needed in Budd Inlet as mitigation	Maintenance dredging of Budd Inlet when entire lake basin filled with sediment in 100 to 125 years. Short term dredging may be needed in Budd Inlet as mitigation	No dredging in the existing lake. Begin maintenance dredging in Lower Budd Inlet when lake basin fills, in 100 to 150 years.
Costs for the First 20 yrs	N/A	$0	2 to 3 dredging cycles = $1.1 to $3 million[1]	10 dredging cycles = $7 to $15 million[1]	Tide gate removal = $0.5 million; Dredging in Budd Inlet - $0 to $15 million[1]; **Total** = $0.5 to $15.5 million[1]	Tide gate removal = $0.5 million; Dam construction = $9.4 million; Dredging Budd Inlet - $0 to $15[1]; **Total** = $10 to $25 million[1]	$0
Cumulative Costs in 50 to 85 yrs	N/A	$0[2]	5 to 14 dredging cycles = $3 to $13 million	25 to 42 dredging cycles = $18 to $64 million	Begin Lower Budd Inlet dredging $0.5 to $15.5 million	Begin Lower Budd Inlet dredging $10 to $25 million	$0
Cumulative Costs in 75 yrs to 115 yrs	N/A	Dredging in North Basin – 20 cycles = $9 to $23 million	Dredging switched to North Basin - 20 cycles = $12 to $36 million	37 to 57 dredging cycles = $26 to $86 million	$18 to $31 million	$17 to $40 million	$0
Cumulative Costs in 100 to 150 yrs	N/A	Up to 37 dredging cycles = $18 to $49 million	Up to 37 dredging cycles = $21 to $62 million	50 to 75 dredging cycles = $35 to $113 million	$24 to $64 million	$24 to $56 million	$0
Cumulative Costs in 150 to 250 yrs	N/A	Up to 62 dredging cycles = $35 to $124 million	Up to 62 dredging cycles = $38 to $137 million	75 to 125 dredging cycles = $53 to $188 million	$59 to $139 million	$68 to $150 million	$0

1. Dredging costs range due to variables in sediment loading rates and costs for different dredging methods. Costs are in 1998 dollars. See Appendices A and B. For Lower Budd Inlet, dredging costs are highly variable due to the uncertainty of when and where sediment will be deposited.
2. No dredging costs accrue until after the South and Middle basing are completely filled at the time of maturity.

Table 4-1
Alternative Cost Comparison Summary

Sediment removal would be accomplished using a hydraulic dredge (**Entranco 1996**). There are three potential options for dewatering and disposal. Refer to **Appendix B** for a detailed description of dredging method, dewatering options, and disposal options.

Significant truck traffic (and noise) impacts would occur between the lake and the upland disposal site(s) (estimated at 33 truck trips per day for 65 days every other year) if one of the dewatering options was selected for dredging. Over time, truck haul costs may increase if nearby upland disposal sites are filled and haul distances increase.

Gravity dewatering would require construction of a new sedimentation facility (approximately 10 to 20 acres). Locations for this large dewatering facility are limited; it may be feasible to locate the facility at an upland location or in-lake. Further analysis would be needed if gravity dewatering is chosen. Mechanical dewatering could be performed at the site west of Marathon Park[4]. Although more costly, an advantage is that mechanical dewatering can be performed in a relatively confined space (less than one acre). Important advantages associated with marine disposal are the absence of truck traffic on local streets and highways, and a lower overall cost.

Another disposal option would be to spread out fine-grained sediments in one-foot lifts over the surface of existing park facilities. This would require temporary park closure and reseeding or placement of grass sod over disposal sites to restore park use. Approval from park departments would be required.

The South The South Basin would not be dredged, unless sediment accumulation: (1) causes flooding, (2) interferes with park use, or (3) interferes with boat access at the boat launch.

Lake/River Wetland With Trap

This alternative would have short-term impacts associated with the filling of the South Basin and periodic sediment removal from the existing Middle Basin sediment trap (once every 6 to 10 years) (**figure 3-3**). Dredging the sediment trap would involve removing an estimated 40,000 to 55,000 cubic yards of material with every dredging cycle. A 20-year cost would be $1.1 to $3 million (1998

4. The Washington State DGA owns an 11-acre undeveloped piece of property on the west side of Deschutes Parkway, across from Marathon Park, and just north of Percival Cove. This site could be used as the construction site for mechanical dewatering operations.

dollars) depending on the method selected for dredging and (see **table 4-1** and **Appendices A** and **B**).

If upland disposal of sediment is selected, impacts from truck traffic and truck noise would occur. There would be an estimated 33 truck trips per day for approximately 50 days, every 6 to 10 years.

Long-term impacts on beneficial uses of the Middle Basin would be similar to the Lake/River Wetland Without Trap Alternative described above (due to conversion from open water to a river with freshwater wetlands).

Because periodic sediment removal would reduce the rate of sediment loading to the Middle and North Basins, the time to maturity would be 75 to 115 years, compared to 50 to 85 years estimated for the Lake/River Wetland Without Trap Alternative. As with the Lake/River Wetland Without Trap Alternative, the Lake/River Wetland With Trap Alternative would eventually require maintenance sediment removal from the North Basin to maintain open-water conditions. Impacts for dredging the North Basin would be the same as those discussed for the Lake/River Wetland Without Trap Alternative.

The South Basin would not be dredged, unless sediment accumulation: (1) causes flooding, (2) interferes with park use, or (3) interferes with boat access at the boat launch.

Lake Alternative

Maintenance dredging would be performed throughout the Middle Basin and Percival Cove to keep pace with the estimated 30,000 to 35,000 cubic yards per year of sediment loading from the watershed. The Middle Basin and Percival Cove would be divided into 10 sectors for dredging (see **Appendix B**).

Two of the ten sectors would be dredged sequentially, every other year (**Entranco 1996**). With this approach, existing lake depths would be maintained.

Methods of dredging and disposal would be the same as described under the Lake/River Wetland Without Trap Alternative. If gravity or mechanical dewatering are employed, with upland disposal, there would be significant truck traffic (and truck noise) on local streets and highways every other year (estimated at 33 truck trips per day for 65 days). Over the first 20-year planning period, dredging costs would range from $7 to 15 million (1998 dollars) depending on the dredging method selected (see **table 4-1** and **Appendices A** and **B**).

Because the entire lake basin would be maintained similar to existing conditions, there would be no impacts on existing aesthetic, recreation, fish and wildlife (with proper sediment removal mitigation), or flood control functions of the lake due to sediment accumulation in the Middle Basin or Percival Cove (see **figure 3-4**).

Long-term impacts would include on-going maintenance dredging (and associated costs), truck traffic, and truck noise. Over the long term, sediment disposal costs could increase significantly if nearby disposal sites are filled and haul distances increase. The South Basin would not be dredged, unless sediment accumulation: (1) causes flooding, (2) interferes with park use, or (3) interferes with boat access at the boat launch.

The South Basin would not be dredged, unless sediment accumulation: (1) causes flooding, (2) interferes with park use, or (3) interferes with boat access at the boat launch.

Estuary Alternative

Under this alternative, the tide gate would be removed (or permanently opened) to allow free tidal exchange. The estimated cost to remove the tide gate is $500,000. With free tidal exchange at the 5th Avenue Bridge, at the railroad trestle crossing between the North and Middle Basins, and at the I-5 bridge, there would be increased erosive forces. The tidal movement could undermine the dam or erode the fill material at the railroad crossing or the I-5 bridge.

Whenever high river flows coincided with low tides, erosion and redeposition of lake bottom sediments would occur throughout the system. Erosion would occur primarily in the vicinity of the river channel at low tide. Following removal of the tide gate, there could temporarily be increased sediment loading to Lower Budd Inlet. This could impact boating at the Olympia Yacht Club and shipping activities at the Port of Olympia.

In addition, daily tidal cycles could lead to increased shoreline erosion on the west side of the lake along Deschutes Parkway. As water moved in and out of the roadway fill with each tide, it could wash out small soil particles. Over an extended period of time, this erosion could lead to additional settling problems and the need for roadway repairs.

Sediment loading from the Deschutes River would lead to the gradual in-filling of the South (20 to 25 years), Middle (50 to 85 years), and North (100 to 150 years) basins (see **figure 3-6**). This would affect the aesthetic, recreational, fish and wildlife, and flood control benefits of the existing basin (refer to other sections of this EIS for a discussion of impacts and possible mitigation measures).

Eventually, sediment loading from the Deschutes River (approximately 30,000 to 35,000 cubic yards per year) would pass into the upper (south) end of Budd Inlet. The sediment loading would decrease water depths in the vicinity of the Olympia Yacht Club and the Port of Olympia and could interfere with navigation.

Combined Lake/Estuary Alternative

This alternative would be similar to the Estuary Alternative except that a north-south dam would be constructed in the North Basin to create a freshwater reflecting pool on the eastern half of the North Basin at an estimated cost of $9.4 million (see **figure 3-8**). As with the Estuary Alternative, the tide gate would be removed (estimated removal cost would be $500,000) to allow tidal exchange throughout the basin, except for the eastern half of the North Basin.

To create a freshwater (lake) reflecting pool on the eastern half of the North Basin, a 2,000-foot-long earth/rock fill dam would be constructed[5] (see **figure 3-9** and **Appendix C** for additional details on the dam). The western half of the North Basin, as well as the Middle and South basins, would function as a tidal estuary. The dam would be approximately 120 feet wide at the base, 20 feet wide at the top, and would have a footprint covering approximately 5.5 acres of the bottom of the basin. Total fill material for the dam would be about 120,000 cubic yards.

A single wall of sheet pile would be installed the length of the dam, down the center, to prevent seepage of water from the freshwater side to the saltwater side during low tide conditions. The sheet pile

5. The design concept for the proposed reflecting pool dam, and associated costs, are preliminary and subject to change following more detailed geotechnical analysis and engineering analysis. More detailed analysis would be required to develop a final design and cost estimate, in the event this alternative is selected.

also would help strengthen the dam against damage in the event of an earthquake[6].

Construction of the dam would require as many as 35 truck trips per day over a 130-day period, with associated noise and traffic impacts along the truck route[7]. Additional noise impacts would occur in the North Basin area in conjunction with sheet pile driving operations. Truck traffic would access the construction site through Heritage Park and would disturb the park environment temporarily.

Because the underlying soils are soft/loose silts and sands, the dam may experience substantial settling following construction. This may also result in displacement filling, where soft/loose sediments under the fill are forced upward above the existing sediment surface. The fill and displacement fill would reduce the volume of the North Basin. Settling may be worsened in the event of an earthquake and if sandy subsoils undergo liquefaction during an earthquake.

It is anticipated that the western side of the new dam would experience major erosive forces due to:

- Normal tidal action
- High tidal flushing velocities near the opening to Budd Inlet,
- High river velocities during low tide/high river flow at both the railroad trestle constriction and in the vicinity of the existing Capitol Lake dam.

The dam would be protected against these erosive forces by placing riprap along the entire western face of the dam. Other potential erosion impacts at the Capitol Lake dam, the railroad trestle, I-5 bridge, and Deschutes Parkway would be similar to those described for the Estuary Alternative.

The top of the dam would be constructed to elevation +13.0 feet mean sea level (MSL) to preclude flooding of the eastern shore of the lake during the 100-year flood condition, which occurs at

6. As indicated in **Appendix C**, three design options were evaluated for the reflecting pool dam, including one option without a sheet pile core. For purposes of this non-project EIS, the geotechnical consultant recommended the dam with the sheet pile core. Additional design review would be performed if the Combined Lake/Estuary Alternative is selected as the preferred alternative. During a more detailed design review, it may be determined that the sheet pile core is not required, resulting in a less costly design solution.

7. Traffic and noise impacts associated with dredging are addressed in the earth section as they apply mainly to dredging or dam construction activities.

elevation +11.4 feet MSL to 12.4 feet MSL (**FEMA 1982**)[8]. The top of the dam would also be landscaped with native trees and shrubs and would be designed to function as a pedestrian trail connection across the basin.

Long-term impacts would be similar to those described for the Estuary Alternative, except that the time of maturity would be shorter (100 to 125 years) due to the fact that the total estuary basin volume would be reduced by construction of the reflecting pool dam (see **figure 3-8**).

No-Action Alternative

Sediment loading from the Deschutes River would lead to the gradual in-filling of the South (20 to 25 years), Middle (50 to 85 years), and North (100 to 150 years) basins. Over this period of time open-water habitat would be replaced gradually by freshwater emergent and scrub-shrub wetlands. This change would affect the aesthetics, recreation, fish and wildlife, and flood control functions of the lake (refer to other sections of this EIS for a discussion of impacts and possible mitigation measures). At maturity, sediment loading would begin to affect Lower Budd Inlet.

Cumulative and Secondary Impacts

For the alternatives that include dredging, there would be substantial cumulative cost impacts associated with dredging operations. This includes the Lake/River Wetland Without Trap, the Lake/River Wetland With Trap, and the Lake Alternative.

With the Estuary and Combined Lake/Estuary alternatives there would be secondary impacts to Lower Budd Inlet. In the near term, there could be transport of sediment to Lower Budd Inlet and a need for maintenance dredging. In the long term, once the entire basin in-filled with sediment, the Deschutes River would then carry almost all its sediment load into Budd Inlet where it would begin to accumulate. Without maintenance dredging, Budd Inlet would become increasingly shallow and could experience warmer summer water temperatures and reduced dissolved oxygen levels. If the Port of Olympia is required to assume the responsibility for

8. The official FEMA (Federal Emergency Management Administration) flood elevation for the 100-year flood is 11.4 feet MSL along the eastern shore of the North Basin, for a corresponding maximum river discharge of 7,813 cubic feet per second (cfs). Preliminary flood impact analyses performed by Entranco for this EIS indicate that the flood elevation may be as high as 12.4 feet MSL for the maximum flood of record (January 1990), measured at 9,600 cfs.

maintenance dredging in Lower Budd Inlet, there would be associated economic impacts to the Port. If the cost of mitigation dredging is considered for the Estuary and Combined Lake/Estuary alternatives due to impacts to Budd Inlet, and worst case assumptions are applied, there would also be substantial dredging costs associated with these alternatives (see **table 4-1**).

Mitigations

Mitigation for Freshwater Alternatives Involving Dredging

Dredging is part of the proposed action for the Lake/River Wetland Without Trap, the Lake/River Wetland With Trap, and the Lake alternatives and as mitigation for the No-Action Alternative at maturity. Mitigation for proposed dredging is discussed below.

Selection of deep, open-water marine disposal or mechanical dewatering with upland disposal would be considered as mitigation measures that would avoid the impact of constructing a new 10- to 20-acre gravity dewatering sedimentation facility. Selection of deep, open-water marine disposal is also the least cost method of sediment disposal.

If gravity dewatering is selected and a new 10- to 20-acre sedimentation facility is constructed, some constructed wetland and fish habitat mitigation would be required.

All machinery used for dredging (including trucks) would be equipped with mufflers, and would be limited to weekdays only from 7:00 a.m. to 6:00 p.m., consistent with City of Tumwater and City of Olympia ordinances. No additional mitigation would be proposed.

Mitigation for truck traffic impacts in the vicinity of the dredging area would include flashing traffic barricades and traffic flaggers to assist with orderly traffic control during construction. In addition, the contractor would be required to repair any roadway damage within 100 feet of the truck access turnouts.

All other mitigation measures for dredging activities are addressed in the Water Resources section.

Mitigation Common to the Estuary and Combined Lake/Estuary Alternatives

Bathymetric surveys would be performed periodically (every ten years) in Lower Budd Inlet to assess sediment accumulation rates and patterns and to determine whether any maintenance dredging was needed.

Once maintenance dredging begins in Budd Inlet (after 150 years), the mitigation measures previously listed for the freshwater alternatives could be used for the estuary dredging. In the short-term, dredging could be used as mitigation for the Estuary and Combined Lake/Estuary alternatives if a flood event transported sediment into Lower Budd Inlet.

Annual inspections would be made at the Capitol Lake dam, new reflecting pool dam, and railroad trestle crossing to assess the degree of erosion and any need for corrective actions. Annual inspections would also be made for potential shoreline erosion impacts and impacts to Deschutes Parkway and the I-5 bridge.

Mitigation Unique to the Combined Lake/Estuary Alternative

There are several mitigation measures that could be used in construction of the earthen dam to minimize settlement problems. Two methods are described below:

- Placing a geotextile fabric on the bottom of the lake basin prior to fill in the dam structure with rock and gravel. This would reduce settlement of the new dam. Constructing the dam embankment in stages may also help to minimize settling.

- Using ground improvements, such as stone columns, vibroflotation and resonant compaction methods, would be considered during design to protect the dam against potential impacts from liquefaction.

If these techniques cannot fully mitigate settlement due to the soft subsoils or liquefaction, any settlement can be compensated by placing new fill material to bring the reflecting pool dam back to its original height.

To mitigate noise impacts during dam construction, work would be scheduled within hours allowed by local noise ordinances, and would use equipment with the best possible mufflers.

Special measures would be needed to close the affected portions of Heritage Park during construction, to notify the public about the construction schedule, to route pedestrian traffic around or away from construction activities, and to restore the park environment following construction.

Unavoidable Significant Adverse Impacts

With the mitigation measures listed above, there would be no unavoidable significant adverse impacts.

WATER RESOURCES

Existing Conditions

Water Quantity and Flooding

Water in Capitol Lake originates from three principal sources. The Deschutes River with its 162 square mile watershed contributes 85 percent of the water for Capitol Lake. The Percival Creek basin drains 10 square miles of urbanized areas in West Olympia and West Tumwater and provides approximately 12 percent of the lake's water. The remainder of the water entering Capitol Lake comes from the local drainage area of approximately 1 square mile, brewery discharges, precipitation, and miscellaneous point or pipe discharges. Impoundment of these waters created Capitol Lake, in which water residence time during the winter averages two days and about 11 days during the summer (**Thurston County Environmental Health Division 1997**). Lake volume and height are regulated by the tide gate in the North Basin.

Summer lake elevation is maintained at 6.4 feet MSL. During winter months, the lake is maintained 1 foot lower to provide increased flood storage capacity.

Water flow rates in the Deschutes River are low in summer months and high in winter months. Average daily flows are less than 200 cubic feet per second (cfs) from June through October. In winter and spring, average daily flows range from approximately 500 cfs to 850 cfs (USGS Station 12080000, Deschutes River near Olympia).

Flooding occurs periodically along the northern and eastern shores of the North Basin, when the right combination of high precipitation, high river flow, and corresponding high tides occur. The maximum recorded river flow is 9,600 cfs (**USGS personal communication**). When flood flows occur at the same time as high tides, Capitol Lake accumulates water from the Deschutes River and other tributaries until the lake elevation slightly exceeds the tide elevation.

During some high tides, lake elevation can reach a flood elevation of 11.4 feet MSL[9] (**FEMA 1982**), compared to the normal winter lake elevation of 5.4 feet MSL. Flooding affects the north shore parking lot (elevation 8.0 feet MSL), east shore railroad tracks (9.0 feet MSL), Water Street (9.5 to 10.5 feet MSL), Columbia Street (10.0 feet MSL), and 5th Avenue (11.0 feet MSL). Flooding of commercial buildings on the northeast side of the North Basin would occur at the 100-year flood elevation of 11.4 feet MSL to 12.4 feet MSL. Sand-bagging and other flood prevention measures have been used in the past to minimize these impacts.

The DGA, in coordination with the Washington State Department of Fish and Wildlife (WDFW), lowers the lake elevation prior to, or during, major precipitation events to provide as much flood storage as possible. The lake can be lowered all the way to the tide gate sill elevation (-7.7 feet MSL) prior to a flood event, if river discharge and tide conditions permit. However, under typical winter flow conditions, preflood drawdown lake levels are more likely to be in the range of -5.7 to -6.7 feet (**C. Ikerd, personal communication**). This means that actual flood protection capacity is typically less than the maximum possible (lake lowered to -7.7 MSL). Nevertheless, lowering the lake in response to heavy rainfall can avoid or mitigate flood impacts to some degree, depending on the size of the storm.

This kind of lake management provides the greatest benefit for the lower flow, higher frequency flood events, such as storms with a probability of recurrence of 5, 10, and 25 years, but it provides limited benefits during large storms such as the 100-year storm (see **table 4-2**). For example, complete drawdown (emptying to elevation -7.7) of Capitol Lake prior to a 100-year storm would result in a maximum lake elevation of 10.9 feet, compared to an elevation of 11.4 feet (a 0.5-foot difference) that would occur with no lake drawdown during the same 100-year storm.

9. U.S. Geological Survey datum. The official FEMA (Federal Emergency Management Administration) flood elevation for the 100-year flood is 11.4 feet MSL along the eastern shore of the North Basin, for a corresponding maximum river discharge of 7,813 cubic feet per second (cfs). Preliminary flood impact analyses performed by Entranco for this EIS indicate that the flood elevation may be as high as 12.4 feet MSL for the maximum flood of record (January 1990), measured at 9,600 cfs.

Recurrence Interval in Years	Flow (cubic feet per second)
1	1,878
2	3,803
5	4,926
10	5,644
25	6,529
100	7,813
Maximum discharge of record	9,600

Source: USGS 1985 and USGS personal communication.

Table 4-2
Predicted Flood Flows for the Deschutes River

Capitol Lake Water Quality

Capitol Lake and the lower portion of the Deschutes River (mouth to river mile 20) are listed on Ecology's proposed 1998 Section 303(d) list of Impaired and Threatened Surface Waters. Surface waters on this listing are not expected to meet state water quality standards even after implementation of technology-based controls. The lower Deschutes River did not meet state standards for seven water/habitat quality parameters: fecal coliform bacteria, temperature, pH, fine sediment, large woody debris, instream flow, and mercury.

Capitol Lake did not meet state water quality standards for fecal coliform bacteria and total phosphorus. Low dissolved oxygen, high turbidity, and fine sediments also have been identified as water quality problems in Capitol Lake (**Entranco 1984**). In addition, poor water quality in Capitol Lake has been linked to excessive algal growth associated with shallow depth, high water temperatures, and high nutrient levels. Swimming at the Olympic Capitol Lake Park occurred from 1965 to 1985, but has been prohibited since 1985 to protect public health (high fecal coliform levels) and public safety (limited water clarity).

Historically, unique dissolved oxygen problems developed immediately south (on the freshwater side) of the Capitol Lake dam, in a localized area known as the tide gate crater (**Entranco, Inc. 1984**). The crater, which is an erosion-scoured depression, was created by the practice of summer drawdown. During the summer, all freshwater would be drained from the lake, and then, on the incoming tide, the tide gate would be held open and saltwater from Lower Budd Inlet would tumble into the North Basin. This tumbling action scoured and eroded a deep hole on the lake side of the dam. Over a period of years, water depths increased from approximately 25 to 40 feet. Saltwater, which is more dense than freshwater, settled into this crater and would remain for extended periods of time. Under these conditions, oxygen levels in the crater would fall to zero and toxic hydrogen sulfide gas developed. On one occasion in 1981, a release of hydrogen sulfide gas caused a fish kill in Lower Budd Inlet. This problem was eventually corrected with the installation of a siphon connecting the crater and Lower Budd Inlet. The siphon made it possible to maintain a steady flow of water through the crater, thus avoiding the problem of stagnation, oxygen depletion, and formation of toxic hydrogen sulfide gas.

High turbidity levels in the Deschutes River and Capitol Lake can occur during peak flow periods due to river bed and bank erosion and corresponding sediment transport. Turbidity levels in the lower river have been measured as high as 87 NTU during flood conditions (**Davis, Berg, and Michaud 1993**). Capitol Lake also experiences elevated turbidity associated with freshwater algal blooms in summer months. Phosphorus is thought to trigger the algal blooms, and limited water exchange in the lake aids their persistence. Algal blooms form dense mats and are undesirable for several reasons: they detract from aesthetic appreciation of the lake; decaying vegetation can lead to reduced dissolved oxygen levels; and low dissolved oxygen can be stressful or lethal to fish. Noxious blooms of algae in Capitol Lake have been managed by periodic lake drawdowns that allowed for intrusion of saltwater from Budd Inlet.

Limited water exchange and circulation in Capitol Lake in summer months also contribute to an increase in water temperature. Water quality standards for surface water temperatures were established to protect sensitive aquatic species, such as salmonids. Water temperature in the North Basin is often 3 to 5 degrees C warmer than in the Deschutes River and typically near or above Ecology's Class A standard (18 degrees C maximum) during summer months (**Thurston County Environmental Health Division 1997**).

Pollutants in storm drains and surface waters of the Deschutes River, Percival Creek, and local watersheds can reach Capitol Lake. An evaluation of nonpoint pollution sources by the Thurston County Environmental Health Division (**1993**) stated that upstream pollutant sources included agricultural, residential, forestry, and urban stormwater. The most common pollutants were fecal coliform bacteria, phosphorus, and sediment.

The possibility of reduced dissolved oxygen levels in the South Basin during late summer and early fall concerns the WDFW, because large numbers of adult salmon return to the Capitol Lake/ Deschutes River system and typically congregate in the South and Middle basins. Where there are large congregations of fish, oxygen consumption can be substantial and can result in dissolved oxygen levels that are "several parts per million lower than the surrounding water (**Orsborn et al. 1975 - page 213**)." Therefore, there is a potential for fish kills in the lake at this time of year (**K. Keown, personal communication**). Refer to the Fisheries section for more information.

Adequate oxygen supply has also been a consideration in rearing juvenile salmonids in net pens in Percival Cove. In the past, the WDFW has used flow diversion baffles at the mouth of Percival Creek to divert high-oxygen-content water into the net pen area (south of the main channel) to maintain adequate oxygen supplies in the cove. However, this is no longer practiced due to physical limitations caused by sediment accumulation in the cove.

The major sources of bacterial contaminants in Capitol Lake are polluted runoff in the Deschutes River, storm sewers, and fecal material from Canada geese and other waterfowl (**Thurston County Environmental Health Division 1993, CH2M Hill 1978**). Livestock in the watershed are the most likely source of bacterial loading to the river itself, although failing septic tanks, storm sewers, Percival Creek waters, birds, and other wild animals are also potential contributors. Human health is the primary concern associated with fecal coliform contamination. Class A standards for surface waters, in which primary contact recreation is acceptable, allow for a maximum of 100 colonies per 100 mL for freshwaters. The Class A standards for marine waters allow 14 colonies per 100 millimeters (mL) for marine waters (geometric mean, with no more than 10 percent of all samples exceeding 200 or 43 colonies per 100 mL, respectively) and are based on protections against shellfish contamination.

Fecal coliform counts in the Deschutes River are generally low, with occasional peak values in excess of water quality standards. For the period 1992 to 1996, water samples collected from the Deschutes River at the E Street Bridge (approximately 1 mile upriver from South Basin) had a geometric mean of 53 colonies per 100 mL. Fecal coliform counts in excess of 100 colonies per 100 mL were found in 25 percent (3 of 12) of these samples (**Thurston County Environmental Health Division 1997**). Data reviewed for the Wetland Development Feasibility Analysis (**Entranco 1990a**) indicated that nearshore water samples were more likely to have higher fecal coliform levels than open-water samples. This effect was attributed to a combination of potential factors, including waterfowl activity, polluted discharge from pipe outfalls, and reduced water exchange rates in the nearshore zone.

Localized zones of poor water quality are typically found in backwater areas during low flow periods (June through October), particularly in the South Basin (**CH2M Hill 1978**). Because the majority of the flow in the South Basin is restricted to the main river channel during low flow periods, backwater channels can have poor water circulation, elevated temperatures, and reduced dissolved oxygen levels. Another indicator of and contributor to poor water quality are thick algal mats that develop only in these backwater areas.

Despite periodic standards violations, water temperature, pH, dissolved oxygen, and turbidity values usually occur within optimal ranges for fish and other aquatic life (see **table 4-3**), as specified for Class A Waters of the State, especially in the lake's main channel where the river flow maintains relatively good water quality conditions even during late summer and early fall periods.

Parameter	Range	Mean	State Standard - Class A[2]
Water Temperature (degrees C°)	8.5-21.0	15.6	Not to exceed 18.0 C°. No increases above 0.3 C°, when natural temperature is above 18.0 C°.
pH	7.3-8.6	8.0	6.5 to 8.5 and human-caused variation less than 0.5.
Dissolved Oxygen (mg/l)	7.8-12.8	10.2	Shall exceed 8.0 mg/l.
Turbidity (NTUs)[3]	2.8-23.0	5.8	Not to exceed 5 NTU over background

1. **Entranco 1984.**
2. WAC 173-201A 1992.
3. Nephelometric Turbidity Units. Also note that turbidity levels have been measured as high as 87 NTU during flood conditions (**Davis, Berg and Michaud 1993**).

Table 4-3
Summary Water Quality Data for Capitol Lake - March to August 1983[1]

Budd Inlet Water Quality

Freshwater from Capitol Lake spills over tide gate to enter Lower Budd Inlet where water salinity is about 28 parts per thousand. The tide gate prevents Budd Inlet waters from entering Capitol Lake. Budd Inlet is well mixed vertically during winter months. During summer months, Budd Inlet is typically stratified, which means that the surface layer (stratum) in the inlet does not mix well with deeper waters. The warm, freshwater from Capitol Lake remains near the water surface in the vicinity of the tide gate without significant mixing into the water column (**S. Giles, personal communication**).

Thermal and saline stratification of the water column in Lower Budd Inlet contributes to depressed oxygen levels in near-bottom waters where dissolved oxygen concentrations are commonly below 4 milligrams per liter (mg/L) in summer months. Dissolved oxygen levels below 5 mg/L (i.e., the Class B marine water quality standard) are undesirable and potentially harmful to fish and shellfish spawning, rearing, and harvesting.

Recent monitoring in Lower Budd Inlet revealed fecal coliform levels were 60 to 80 colonies per 100 mL except during periods of high rains and runoff, when levels were approximately 200 to 300 colonies per 100 mL (**S. Giles, personal communication**). Waters from the Deschutes River, Capitol Lake and Moxlie Creek are the predominant sources (93 percent) of fecal coliform loading to Lower Budd Inlet (**Aura Nova Consultants, et al. 1998**).

Summer Lake Drawdown

Since 1971, marine saltwater back flushing has been used to limit summer algal blooms and freshwater aquatic plant growth in the lake. This is possible because of the tide gate in the North Basin, which normally maintains a barrier between the freshwater of Capitol Lake and the marine waters of Budd Inlet. It was the custom, from 1971 through 1995, for DGA to draw the lake down (to the sill elevation at the dam at -7.0 feet MSL, if possible) at least once during the summer, and to refill it with marine water on an incoming tide. During saltwater refilling operations, saltwater influence could extend upstream into the South Basin. In the past, a practice known as bumping (stepwise drawdown) was supported by WDFW to assist juvenile salmon to migrate out of the lake and into Budd Inlet. Saltwater flushing also helped to control the growth of freshwater plants and algae, because most freshwater species die when exposed to the high salt levels in marine water.

During 1996 and 1997, modified drawdown and saltwater backfill operations were tested. The primary goal was to limit the amount of saltwater backfilling to avoid adverse impacts to freshwater aquatic plants in the nearshore zone of the lake. This avoidance procedure was tested as a method to protect aquatic and wetland plant communities established as mitigation for Heritage Park impacts.

Monitoring results indicated that the 1997 modified drawdown was successful in limiting the vertical influence of saltwater backfilling and did not affect nearshore aquatic plant communities which was one of the goals (**Entranco 1997**). However, the duration of salt-water/brackish water influence in the North Basin was limited to only a few days (compared to a few weeks in historic drawdown events), and may not have had any significant (controlling) influence on aquatic plant communities in that basin. Furthermore, saltwater/brackish water influence affected only a very small area (estimated at 5 percent) of the Middle Basin, and had no influence on control of aquatic plants in the remainder of the Middle Basin (95 percent) or in the South Basin.

In addition, water quality data showed no noticeable impact on freshwater algal growth in any of the three basins (**Entranco 1997**). This was due to the absence of significant saltwater/brackish water influence in the Middle and South basins, and to the retention of a 1-foot to 9-foot freshwater layer in the North Basin. Since only surface water samples were collected, the results showed no impact.

It was concluded that, although modified drawdown did protect nearshore aquatic and wetland plant communities, continued implementation of the modified drawdown would have limited value in achieving either of the original objectives of reducing freshwater algal blooms or of reducing aquatic plant growth. Recent studies also have documented fish kills and water quality impacts during the modified drawdown (**Herrera 1997, Entranco 1997,** and **Aura Nova, et al. 1998**).

Impacts to Water Resources

Lake/River Wetland Without Trap Alternative

Under this alternative, the South and Middle basins would fill in with sediment over a period of 50 to 85 years (time of maturity). At the time of maturity, open-water habitat in these two basins would be limited to the remaining river channel meanders and water quality would be riverine in character. River water quality would be expected to meet all state water quality standards, except for periodic violations of temperature, pH, mercury, and fecal coliform bacteria (parameters of concern from Ecology's 1998 proposed 303(d) listing).

Elimination of saltwater flushing during summer months could lead to increased growth of aquatic plants (e.g., *Elodea canadensis*) and algal blooms. Excessive aquatic plant growth (which may or may not occur) could inhibit water circulation and lead to localized conditions of higher temperature and lower dissolved oxygen. An increase in algal blooms also could lead to depressed oxygen levels when the blooms decompose. Any reduction in dissolved oxygen levels could have adverse impacts on fish and other aquatic life.

High fecal coliform levels would likely continue to be a problem unless corrective measures like goose management and watershed controls are implemented.

Prior to maturity, it is anticipated that water quality in the South and Middle basins would deteriorate in most areas except for the main river channel. With increasing sediment deposition, water depths would decrease and be more subject to higher temperatures. In addition, exchange with river water would be reduced or eliminated, especially during low-flow summer months. In these backwater areas, a large percentage of these two basins would be expected to have higher water temperatures at maturity, and reduced oxygen levels, along with higher levels of algal growth. Such conditions presently exist in the backwater areas of the South Basin (**Entranco 1996**).

Floating algal mats could form in the Middle Basin, as they presently do in the South Basin during summer months, resulting in lower dissolved oxygen levels in backwater areas, especially during evening hours, when photosynthesis (oxygen production) stops, and bacterial decomposition of organic matter (increased by more algal growth) consumes oxygen at higher rates (**Entranco 1996**).

Poorer water quality might also occur in the North Basin, and Budd Inlet, with some increase in aquatic plant and algal material passing from the South and Middle basins into the North Basin and beyond. These plant/algal materials could increase nutrient loading and biochemical oxygen demand and lead to reduced oxygen levels in the North Basin and Budd Inlet.

Impaired water quality conditions could be detrimental to fish and other aquatic life depending on location, time of year, and time of day. Poorest water quality would be expected in late summer or early fall in areas with poor water circulation and high plant biomass (aquatic plants or algae).

Because the South and Middle basins would fill in with sediment, 100-year flood elevations would increase from the existing 10.9 feet MSL (with drawdown to elevation -7.7 feet prior to flood) to 11.7 feet, an increase of 0.8 foot, under the 100-year flood condition (**Entranco 1990a**). This would cause limited additional flooding in the City of Olympia along the northern and eastern shores of the North Basin. Increased frequency and/or magnitude of smaller, more frequent floods also would be expected to occur with the loss of flood storage in the South and Middle basins.

With increased sediment accumulation in the South Basin, flooding might also occur at Tumwater Historical Park; however, the actual extent of a 100-year flood has yet to be determined.

In 50 to 85 years, when the Middle Basin has completely filled with sediment except for the river channel, maintenance dredging operations would be required to maintain open-water conditions in the North Basin. Temporary water quality impacts (e.g., turbidity) would occur with dredging operations, which would be performed every other year for approximately 65 days. The nature of the impacts would depend on the method of dredging, sediment dewatering, and disposal. **Appendix B** provides a detailed description of dredging options.

Significant water quality impacts could occur if a 10- to 20-acre gravity dewatering facility was constructed in the lake. At an upland site, a dewatering facility could have construction-related erosion/sedimentation water quality impacts to downgradient receiving waters, whether Capitol Lake, local stream, or groundwater resource. There would also be potential erosion/sedimentation and turbid water runoff at upland disposal sites.

Return flows from either dewatering method could have sedimentation and turbidity imports.

With hydraulic dredging, barge transport, and deep open-water marine disposal, there would be potential turbidity impacts in the vicinity of the barge loading operations at the Port of Olympia in Lower Budd Inlet and at the open-water disposal site off Anderson-Ketron Island, in Puget Sound, southwest of Tacoma.

A potential toxic impact would occur with disturbance of lake bottom sediments contaminated with benzoic acid. Because sediment testing has shown there are no toxic levels of any other chemicals in the sediment, there would be no other expected impacts.

Lake/River Wetland With Trap Alternative

For the first 75 to 115 years, the Middle Basin trap would be dredged every 6 to 10 years and would cause temporary increases in turbidity and suspended solids levels lasting approximately 50 days. The nature of impacts would depend on the dredging option selected and would be similar to the impacts discussed for the Lake/River Wetland Without Trap Alternative. Water quality violations due to fecal coliform contamination would be expected to continue, unless corrective measures like goose management and watershed controls were implemented.

Long-term impacts would be similar to those described for the Lake/River Wetland Without Trap Alternative regarding both water quality and flooding.

Lake Alternative

Under the Lake Alternative, there would be temporary water quality impacts associated with dredging operations every other year. Dredging would occur in two of the ten sectors, every other year (see **Appendix B**). This cycle would be repeated as necessary to maintain the lake. The nature of impacts would depend on the method for dredging, as described for the Lake/River Wetland Without Trap Alternative.

Annual summer lake drawdown and saltwater backfilling would be performed according to the modified procedures used in 1997 (**Entranco 1997**). Under this procedure, reduced volumes of saltwater would be used to fill the lake following drawdown. The modified procedure maintains freshwater conditions in upper water layers and protects nearshore aquatic and wetland plants from negative saltwater impacts.

This revised summer drawdown procedure may lead to increased aquatic plant growth and nutrient cycling in the lake over time. If aquatic plant growth becomes excessive, it could cause reduced water circulation (within plant beds), increased water temperatures, and reduced oxygen levels (especially during late summer or early fall when plant decay is highest). Increased nutrient cycling also could lead to increased growth of algal mats with cumulative impacts on dissolved oxygen levels at the time of decay. These impacts could be detrimental to fish and other aquatic life, depending on the timing and location of impaired water quality.

Recent studies by Aura Nova Consultants et al. (**1998**) have shown that the modified drawdown procedure results in short-term increases in nutrient and biochemical oxygen demand loading to Lower Budd Inlet at the time the lake is drained. This short-term loading is apparently caused by the large volume of lake water and contributes to low dissolved oxygen problems in Lower Budd Inlet.

Periodic violations of fecal coliform bacteria would be expected to continue in the absence of additional lake and watershed control efforts. With on-going dredging operations, the flood storage capacity of the lake would be maintained, and there would be no negative impacts on flood control practices.

Long-term impacts would be the same as short-term impacts under this alternative.

Estuary Alternative

Removal of the tide gate would allow saltwater from Budd Inlet to flow freely into the basin when the tidal elevation is above -7 feet MSL or approximately +1 foot mean lower low water (MLLW). The basin would be converted from a freshwater reservoir to a tidal estuary. Conversion to an estuarine habitat would eliminate freshwater algal blooms and submerged aquatic plants, and the associated problems of high turbidity and depressed dissolved oxygen levels caused by organic decomposition. Under estuary conditions, mudflats (bottom of the lake) would be exposed, particularly at low tide. Odors originating from decomposing algae and other organic matter may be noticeable along the shoreline.

Tidal exchanges would occur with two high and two low tides each day. The pattern and extent of saltwater influence would depend on the relative mixing volumes of saltwater and freshwater and the shape of the basin. Freshwater influence would be greater during winter months with high river discharge, while saltwater influence would be greater during summer months when river discharge is at its lowest.

With removal of the tide gate, saltwater is likely to dominate all areas of the estuary at a depth of less than 0.0 foot MSL. Presently, nearly all of the North Basin and the northern quarter of the main channel in the Middle Basin lie at or below 0.0 foot MSL. At high tide and when the river flow is low during summer months, salinity should be greater than 20 parts per thousand (ppt) in most of the North Basin, and greater than 10 ppt in the northern third of the Middle Basin.

Removal of the tide gate would reduce the average volume and residence time for water in the basin. Under existing conditions, the lake is maintained at elevation +6.4 feet MSL during summer months. With removal of the tide gate, average water level would be 0.0 foot MSL, but would vary throughout the day, and seasonally, depending on the high and low tide elevations. Under existing conditions, it takes approximately two weeks for a complete lake volume exchange when the Deschutes River is at low flow (summer months). With removal of the tide gate, the entire basin would exchange volumes twice daily. Poor water quality, which presently results from poor circulation and relatively long residence time in the lake (i.e., increased temperature, deposition of fine particles, nutrient cycling, algal blooms, and high turbidity) would occur less frequently under the Estuary Alternative. The net effect would be improved water quality.

The benefit of improved circulation and reduced residence time would be offset to some extent by the introduction of low-oxygen waters from Lower Budd Inlet (see **table 4-4**). With the sill of the tide gate (estuary mouth) at -7.0 feet MSL, low-oxygen water from Lower Budd Inlet would enter the estuary during each incoming tide. Tidal exchange of waters between the estuary and Lower Budd Inlet, however, would improve water mixing near the estuary mouth. Increased mixing would moderate extreme low dissolved oxygen levels found in Lower Budd Inlet. Stratification of the water column in the estuary is unlikely to occur during summer months because tidal and riverine currents would provide significant mixing.

Because estuarine organisms are generally adapted to an environment with extreme fluctuations in water quality, dissolved oxygen concentrations in the estuary would likely be suitable for most organisms. Nevertheless, dissolved oxygen in the lower estuary may be less than 5 mg/L and, therefore, could be stressful to juvenile fish.

Parameter	Lower Budd Inlet	Capitol Lake North Basin	Deschutes River
Temperature (C)	13.0 - 16.5	12.7 - 22.0	5.0 - 17.3
Dissolved Oxygen (mg/L)	5.5 - 11.2	8.9 - 17.5	9.4 - 14.8
Turbidity (NTUs)	1.6 - 2.8	2.2 - 6.6	1.2 – 37

Data Sources: Entranco Engineers (1984)
Ecology Ambient Water Quality Data (1984 - 1990)
Thurston County Environmental Health Division (1997)

a. Recent monitoring in Lower Budd Inlet has shown even lower dissolved oxygen concentrations, with 2.3 mg/l near the bottom and 4.4 mg/l near the surface (S. Giles, personal communication).

Table 4-4
Comparison of Selected Water Quality Measurements from Budd Inlet, the North Basin of Capitol Lake, and the Deschutes River During Summer Months (April through August)

Some negative water quality impacts also would occur with removal of the tide gate. It is expected that there would be increased erosion and sediment deposition during periods of high river flow and low tides. This would result in temporary increases in turbidity within the estuary and in Lower Budd Inlet.

In general, an estuary would be expected to lower fecal coliform levels because of reduced bacterial survival rates in saltwater. Also, fecal coliform levels would probably be lower because Canada geese prefer freshwater habitat and they would probably use the estuary less. Waters from both the Deschutes River and Lower Budd Inlet periodically exceed maximum fecal coliform levels set for Class A water quality standards. The marine water quality criterion for fecal coliforms (14 colonies per 100 mL for Class A water) would apply in the North Basin and northern portions of the Middle Basin where salinity is likely to be greater than 10 ppt, and would also be exceeded.

Restoration of an estuarine habitat would provide salinity conditions suitable for development of a natural shellfish community, particularly of bivalves such as clams, mussels, and oysters. However, shellfish harvesting would be prohibited due to the high concentrations of fecal coliform levels originating from the Deschutes River, waterfowl, and pipe discharges to the basin.

At maturity, filling of the South, Middle, and North basins with sediment would result in increased flood impacts along the northeastern shore of the North Basin, including Water Street and Columbia Street, during the 100-year flood event. During 100-year flood conditions, flood elevations could increase by 0.5 foot or more over existing conditions. Flooding could also occur at Tumwater Historical Park following sediment in-filling of the South Basin.

With increased saltwater influence throughout the basin, freshwater wetlands at the Heritage Park mitigation site in the southwest corner of the Middle Basin may be adversely impacted. With increased saltwater influence, freshwater plant species may be replaced by salt-tolerant species.

In the mature estuary, a hydraulic connection or channel between Percival Creek and the Deschutes River estuary may become shallow or indistinct at low tide. If significant deposition or accumulation of sediments occurs in this area, the existing channel may become insufficient to accommodate adult and juvenile fish passage, particularly at low tide.

Poor water quality conditions due to low dissolved oxygen levels in isolated backwater portions of a mature estuary would be likely to occur. Whereas this problem is currently limited to the South Basin, it would extend to portions of the Middle Basin where side channels would form and would become isolated seasonally from adequate water circulation patterns that help maintain good oxygen supply.

As the estuary matures, there would be an increase in the amount of plant material produced by salt marshes. Some of this plant material may be flushed into Budd Inlet and may contribute to nutrient cycling and biochemical oxygen demand. This could lead to marine algal blooms and/or reduced dissolved oxygen levels.

Combined Lake/Estuary Alternative

Changes in circulation, salinity and other water quality aspects of the estuary portion of the basin (all of the South and Middle basins and the western half of the North Basin) would be similar to those described for the Estuary Alternative.

The estuary side of the new reflecting pool dam in the North Basin would have high potential for erosion and violations of the state water quality standard for turbidity during construction. Constrictions at the railroad trestle (between the Middle and North basins) and at the Capitol Lake dam would create high current velocities and increased erosive forces in these areas. Construction-related erosion impacts would be greatest in these areas.

Potential water quality problems that could develop in the freshwater reflecting pool on the eastern half of the North Basin include high nutrient and algal levels, high fecal coliform concentrations, high turbidity, high temperature, excessive aquatic plant growth, and reduced dissolved oxygen levels. These problems could occur because of stormwater discharges, poor water circulation and flushing, fecal contamination from waterfowl (including Canada geese), and nutrient release from bottom sediments.

The quantity and quality of source water for the freshwater pool will have an important influence on water quality. These potential water quality problems (except for excessive aquatic plant growth) may be adequately controlled by proposed circulation and flushing with Class A reuse water from the LOTT treatment system, or with water from the Deschutes River, springs, or a groundwater supply. If circulation and flushing do not prove to be effective, additional water quality management measures may be necessary to provide good water quality on the freshwater side of the reflecting pool dam. Further analysis of source water for the freshwater pool in the North Basin is needed. This analysis would have to consider the quality and quantity of the supply sources, as well as the relative influence of other inputs (e.g., stormwater) to the refecting pool.

Because the top of the new dam would be constructed at elevation +13.0 feet MSL, the northeastern shore of the North Basin, including Water and Columbia Streets, would no longer be subject to flooding during the 100-year flood. This assumes the construction of an outlet weir to allow discharge of excess stormwater to be discharged via a pipe connection (with flapgate) to the marine side of the new dam in the North Basin.

Flooding could still occur at Tumwater Historical Park following additional sediment filling in the South Basin.

No-Action Alternative

Elimination of annual summer drawdown and saltwater backfilling would probably lead to increased aquatic plant and algal growth in the lake over time, with potential water quality impacts similar to those described under short-term impacts for the Lake/River Wetland Without Trap Alternative. Under this alternative, there would be no water quality impacts due to dredging. Long-term impacts would be the same as those described for the Lake/River Wetland Without Trap Alternative, except that (1) the entire system would be riverine at the time of maturity (estimated at 100 to 150 years), and (2) interim adverse impacts described for the South and Middle basins also would occur in the North Basin.

Cumulative and Secondary Impacts

Secondary water quality impacts would occur with all the alternatives, as additional aquatic and wetland plant growth develops and reaches maturity. Impacts would involve the discharge of additional plant and algal material into Lower Budd Inlet, where the additional nutrients could lead to undesirable algal growth, and the additional biochemical oxygen demand (BOD) could lead to reduced oxygen levels. This could add to the existing nutrient and BOD loading contributed by the Deschutes River and other sources, and could worsen existing algae and dissolved oxygen problems in Lower Budd Inlet.

With the Combined Lake/Estuary Alternative and the Estuary Alternative, there may be a need for a short-term dredging program in Lower Budd Inlet, depending on the amount of sediment transport/deposition after the tide gate is removed. There would also be a need for long-term dredging operations in Lower Budd Inlet, once the South, Middle, and North basins fill with sediment. These mitigation dredging efforts would have water quality impacts similar to those alternatives for which dredging is a part of the proposed action. In addition, the expense associated with daily and seasonal operation of the tide gate would be eliminated.

Mitigations

Mitigation Common to All Alternatives

To mitigate water quality impacts, the following steps should be taken:

- Develop a long-range water quality monitoring program to assess changes in water quality and plant and algal growth over time. Use monitoring data to assist in making Capitol Lake Adaptive Management[10] Plan decisions.
- Implement BMPs (e.g., Canada goose management, stormwater treatment) in the lake and watershed to reduce nutrient and fecal coliform loading to the lake basin. Refer to Chapter 2 for a summary of actions proposed under the *Budd Inlet - Deschutes River Watershed Action Plan*, which may result in improved water quality over time.

Mitigation Common to the Freshwater Alternatives

These alternatives would involve dredging at some point in time, either as part of the proposed action or as mitigation. Mitigation measures associated with dredging would depend on the method of dredging, dewatering, and disposal (see **Appendix B**). Some mitigation methods would be used regardless of the dredging method selected:

- Mitigation for sedimentation and turbidity impacts would include use of silt curtains, silt fences, and other temporary erosion/sedimentation control BMPs.

10. Adaptive management is an on-going type of management which involves on-going collection and evaluation of new data and makes adjustments in management approach as warranted.

- Chemical treatment would be used to reduce turbidity in flows returning to the lake from the dewatering facility. Acute bioassay tests would be performed to ensure treatment chemicals are safe for freshwater aquatic life.

- Mitigation for erosion and sedimentation at upland disposal sites would use interceptor ditches, silt fencing, cover practices, biofiltration swales, and other appropriate erosion/ sedimentation BMPs to treat runoff at upland disposal sites prior to discharge to ground or surface waters.

- Mitigation Unique to Deep, Open-water Marine Disposal. Perform updated PSDDA sediment testing to determine if sediments are suitable for marine disposal. Require good seals on marine barges to minimize or avoid leakage during loading at the Port of Olympia. Prepare a barge dumping control plan to assure that barge dumping occurs within the designated Anderson/Ketron Island disposal zone, given the effect of tides, winds, and currents.

Flood Impact Mitigation

- Perform detailed flood impact and mitigation studies regarding the northern and eastern shores of the North Basin and in the vicinity of Tumwater Historical Park in the South Basin. This mitigation would not be needed in the North Basin for the Combined Lake/Estuary Alternative since the reflecting pool dam would preclude flooding of the eastern shore for the 100-year event.

Mitigation Common to the Freshwater Wetland Alternatives

- Develop an Integrated Vegetation Management Plan for the lake. Use one or more control techniques to prevent excessive aquatic plant growth, if monitoring shows that excessive growth is occurring.

- Modify tide gate operations to increase vertical water level fluctuations to prevent stagnant water conditions and associated poor water quality as sediment accumulation reduces water depths and increases opportunity for increased growth of aquatic and wetland plant communities.

Mitigation Unique to the Lake Alternative

- Eliminate the modified summer drawdown procedure to avoid fish stranding, impacts to vegetative communities, and impacts to water quality.

Mitigation for the Estuary and Combined Lake/Estuary

- Mitigation dredging would be required for these alternatives and would require water quality mitigation similar to that described earlier for the freshwater alternatives above, depending on the method of dredging, dewatering and disposal (see **Appendix B**).
- To preserve the freshwater mitigation wetlands in the southwest corner of the Middle Basin, block culverts that provide a hydraulic connection with the lake. This would preclude saltwater intrusion into the wetland. In addition, consider the feasibility of routing additional freshwater sources into the wetland to maintain adequate freshwater wetland hydrology.
- Analyze the potential for erosion at constriction points (dam, railroad trestle, I-5 bridge, and along Deschutes Parkway) and consider streambank armoring to prevent erosion.

Mitigation Unique to the Combined Lake/Estuary Alternative

- Use silt curtains, silt fencing, cover practices, and other temporary erosion/sedimentation control BMPs to control water quality impacts (primarily turbidity) during construction of the reflecting pool dam. Use riprap or large river rock to prevent erosion of the western face of the dam by tidal or river action.

Unavoidable Significant Adverse Impacts

Alternatives that involve dredging would probably experience some temporary violations of turbidity water quality standards at the dredge site, dewatering sites, and upland or marine disposal sites.

Alternatives that allow sediment in-filling and development of mature wetlands in the basins, would experience some reduction in water quality in areas of reduced water depth and circulation.

Higher water temperatures, higher nutrient levels and reduced oxygen levels would be expected.

WILDLIFE

Wildlife species use and distribution in an area is determined primarily by availability of food, water, and cover appropriate to the species. The presence or absence of these physical characteristics determines whether or not appropriate nesting, rearing, foraging, and resting habitat is available for a particular species of wildlife.

The species richness—the number of different species found in a defined area—and the abundance of a species in an area are influenced by the diversity and size of habitats. Habitats that are large in area, and rich in plant species and vegetation structure, generally have a greater richness and abundance of wildlife. Habitats with few plant species and uniform vegetative structure tend to have a lower richness and abundance of wildlife.

Existing Conditions

Animal Life

Wildlife observations in the Capitol Lake area and wildlife occurrences documented in the literature, were reviewed to determine the species using habitat in and around Capitol Lake (**CH2M Hill 1977**). **Appendix D** lists some of the wildlife species based upon this literature review.

The general classes of birds that were observed include dabbling ducks, diving ducks, Canada geese, shore birds, perching birds, and raptors (see **Appendix D**). Mammals that were observed include deer, muskrat, beaver, mink, otter, striped skunk, raccoon, voles, mountain beaver, fox, deermouse, bushytail woodrat, mole, sea lion, and bats. Other wildlife reported to be present in the area include chipmunks, frogs, turtles, snakes, lizards, crayfish, and snails (**The Portico Group 1997a**).

The U.S. Fish and Wildlife Service (USFWS) reports that the bald eagle *(Haliaeetus leucocephalus)*—federally listed as a threatened species in accordance with the endangered species act—occurs in the vicinity of Capitol Lake (**N. Gloman, personal communication**). Bald eagles have been observed perching in mature trees along the South Basin of Capitol Lake near the Tumwater Historical Park and along Percival Cove. It was also noted that the birds occasionally seen there are accustomed to the relatively busy environment, given the proximity of Interstate 5 (I-5) and human activity in the park (**Entranco 1996**). Bald eagles and peregrine falcons also have been sighted hunting in the lake, but no nesting sites have been identified in the area (**G. Shirato, personal communication**).

The USFWS has identified three species of concern as possibly occurring in the vicinity. "Species of concern are those species whose conservation standing is of concern to the USFWS, but for which further status information is still needed." These species of concern include the long-eared bat *(Myotis evotis),* the long-legged bat *(Myotis volans),* and the Pacific Townsend's big-eared bat *(Corynorhinus townsendii townsendii)* (**N. Gloman, personal communication**).

The WDFW priority habitat and species program data were reviewed to identify wildlife species and habitats requiring protective measures and/or management guidelines in the Capitol Lake area. Washington State species of concern documented in the area include the purple martin, the green-backed heron, the great egret, the wood duck, and mink (**L. Guggenmof, personal communication**).

The purple martin is a candidate species, which means that WDFW is sufficiently concerned about the status of this species that it is conducting additional studies to determine if it should be listed as a sensitive, threatened, or endangered species. "Federal Candidate species are evaluated individually to determine their status in Washington and whether inclusion as a priority species is justified (**WDFW 1996**)."

The green-backed heron is a state-monitored species, which means that it is being monitored by WDFW to preclude it from becoming a rare, threatened, or endangered species. The great egret also has been observed in the Budd Inlet vicinity and is a state-monitored species. Data are kept on wood duck and mink because they are game species (**L. Guggenmof, personal communication**).

Current impacts to wildlife include periodic disturbances from dredging of the Middle Basin and Percival Cove, an annual summer lake drawdown with modified saltwater flushing, and occasional lake drawdowns to increase flood storage. Dredging activity and noise may cause waterfowl to temporarily move to areas with less disturbance. Drawdown of the lake temporarily reduces open-water habitat available to waterfowl for resting and feeding. Other disturbances to wildlife at the lake include urban noise, human activity, and predation from domestic pets.

Impacts

Lake/River Wetland Without Trap Alternative

With a gradual increase in emergent and scrub-shrub wetland vegetation in the South and Middle basins, a gradual increase in wildlife richness and abundance would be anticipated. The existing open-water habitat in the South and Middle basins, which covers approximately 170 acres, supports low-to-moderate densities of submersed aquatic plants and is primarily used by waterfowl. This habitat would be replaced gradually by emergent and scrub-shrub wetlands with much higher plant densities (plants per unit area) and much higher plant species diversity. There would be more food, cover, shelter for wildlife. This more diverse habitat would support an increased abundance and richness of wildlife.

Wildlife that would be expected to benefit from the Lake/River Wetland Without Trap Alternative include waterfowl that prefer to forage, shelter, and nest next to open-water habitat; song birds; small mammals; and amphibians. The addition of large woody debris would create greater diversity of habitat for wildlife. More raptors may use the area in response to the increased prey base.

Waterfowl that prefer large areas of open water (e.g., geese) may reduce their use of the South and Middle basins and move to other open-water areas as the South and Middle basins fill in with sediment and riparian vegetation is established. The abundance of Canada geese may increase during lake filling due to the increase of wetland food sources. At maturity of this alternative, dense wetlands may reduce geese abundance because they prefer open-water habitat. However, existing large grass areas will be a primary factor in attracting geese to shoreline areas for feeding and resting.

After the Middle Basin has filled with sediment, the bi-annual dredging activity and noise in the North Basin would disturb waterfowl intermittently. These disturbances are not expected to be significant when the noise and activity that are normally present in this urban area are considered. Disturbances to wildlife from current periodic dredging of the Middle Basin would cease.

Temporary reduction of open-water habitat, caused by flood control drawdowns would occur occasionally under the Lake/

River Wetland Without Trap Alternative. Drawdown of the lake would temporarily reduce open-water habitat available to waterfowl for resting and feeding.

Lake/River Wetland With Trap Alternative

At maturity, the Lake/River Wetland With Trap Alternative would be expected to exhibit the same increased richness and abundance of wildlife as the Lake/River Wetland Without Trap Alternative. The increase in wildlife would occur at a slower rate than for the Lake/River Wetland Without Trap Alternative because the Middle Basin sediment trap would continue to be dredged and the basin would take longer to fill with sediment and establish wetland vegetation, 75 to 115 years compared to 50 to 85 years.

Periodic disturbances to wildlife in the Middle Basin would occur due to dredging of the sediment trap. Disturbances to wildlife caused by dredging the North Basin would occur every two years once the Middle Basin has filled with sediment.

Lake Alternative

Wildlife richness and abundance would not be expected to increase within the Middle and North basins. Increases in wildlife would be limited primarily to the South Basin, and would correspond to the increase in emergent wetlands created as mitigation wetlands for Heritage Park. The richness and abundance of waterfowl that prefer large open-water habitat would not be expected to change with this alternative. The abundance of Canada geese would likely remain similar to existing conditions.

Wildlife disturbances from bi-annual dredging of the Middle Basin and Percival Cove, annual summer lake drawdown with modified saltwater flushing, and occasional lake drawdowns to increase flood storage would be expected. Dredging activity and noise may cause waterfowl to move temporarily to areas with less disturbance. Drawdown of the lake temporarily reduces open-water habitat available to waterfowl for resting and feeding.

Estuary Alternative

With restoration of tidal saltwater, marsh, and mudflats to the South Basin, the Middle Basin, and the North Basin, a rapid transition from species preferring freshwater and lake habitat to estuarine and tidal habitat would occur. Total species richness and abundance would be expected to increase over existing conditions.

Substantial rapid declines in the presence and abundance of species that are dependent on or prefer freshwater habitat, such as beaver, muskrat, mallard ducks, and amphibians would be expected. The presence and abundance of species that prefer tidal mudflats, such as shore birds, would be expected to increase. Species that prefer salt marsh would gradually increase as salt marsh is established. Many species of wildlife, which presently use the lake (e.g., waterfowl) may continue to use the estuary with little change in their presence or distribution. Also, more raptors may use the area in response to the increased prey base.

Like the Lake/Wetland Without Trap Alternative, waterfowl that prefer large areas of open water (e.g., Canada geese) may reduce their use of the South, Middle, and North basins and move to other open-water areas as the basins fill in with sediment and estuarine vegetation is established. The abundance of Canada geese will likely decrease because they prefer freshwater habitat over estuarine (saltwater) habitat. However, existing large grass areas will be a primary factor in attracting geese to shoreline areas for feeding and resting.

The temporary disturbances to wildlife from periodic dredging and lake drawdowns would cease.

Combined Lake/Estuary Alternative

Impacts to wildlife richness and abundance would be similar to the Estuary Alternative. The conversion of only half of the North Basin to estuary habitat would have lesser transition from species preferring freshwater and lake habitat to estuarine and tidal habitat than the Estuary Alternative.

No-Action Alternative

The No-Action Alternative would have similar impacts to wildlife as the Lake/River Wetland Without Trap Alternative. In addition, as the North Basin filled in with sediment and wetland vegetation became established, waterfowl that prefer large areas of open water would reduce their use of the basins and move to other open-water habitats.

Disturbance to wildlife caused by dredging and drawdown of the lake would cease.

Cumulative and Secondary Impacts

No specific cumulative or secondary impacts to wildlife are anticipated from any of the management alternatives.

Mitigations

All of the management alternatives would result in improved habitat for the species of significant management concern. Therefore no specific mitigation measures are proposed for the potential impacts to wildlife populations with the exception of Canada geese. However, time to maturity for alternatives could be accelerated by placement of large woody debris and wetland plantings. This would benefit wildlife.

A Canada goose management program is needed to limit their abundance and interference with human activities.

Unavoidable Significant Adverse Impacts

- Continued periodic displacement of waterfowl due to dredging for the Lake/River Wetland and Lake alternatives.
- Continued periodic displacement of waterfowl with the Lake Alternative during the lake drawdown and saltwater backfilling process.
- Reduction of the lake environment and associated wildlife populations that prefer lake habitats with all alternatives except the Lake Alternative.
- Reduction of the freshwater environment and associated wildlife population that prefer freshwater habitats with the Combined Lake/Estuary and Estuary alternatives.

FISHERIES

Existing Conditions

Numerous fish species inhabit Capitol Lake and the Deschutes River. **Table 4-5** provides a list of fish species observed since 1975. Fish use of these waters includes habitat for rearing and reproduction, a migration corridor both upstream and downstream to Budd Inlet, and the hatchery and rearing facilities in Capitol

Fish Type	Common Name	Scientific Name	Prevalence	Literature Sources
Salmon	Pink salmon [1]	*Oncorhynchus gorbuscha*	Uncommon	WDFW Hatcheries Program 1997
	Chum salmon	*Oncorhynchus keta*	Uncommon	WSU 1975, Williams et al. 1975, CH2M Hill 1977, Entranco 1990a
	Coho salmon	*Oncorhynchus kisutch*	Common	WSU 1975, Williams et al. 1975, CH2M Hill 1977, Entranco 1983 and 1990a
	Sockeye salmon	*Oncorhynchus nerka*	Uncommon	Entranco 1990a, Uehara 1995 personal communication
	Chinook salmon	*Oncorhynchus tshawytscha*	Abundant	WSU 1975, Williams et al., CH2M Hill 1977, Entranco 1983 and 1990a
Trout	Sea-run cutthroat trout	*Oncorhynchus clarki clarki*	Common	WSU 1975, CH2M Hill 1977, Entranco 1983 and 1990a
	Coastal cutthroat trout [1]	*Oncorhynchus clarki*	Common	Entranco 1997
	Resident rainbow trout	*Oncorhynchus mykiss*	Common	WSU 1975, CH2M Hill 1977, Entranco 1983 and 1990a
	Steelhead trout	*Oncorhynchus mykiss*	Common	WSU 1975, CH2M Hill 1977, Entranco 1983 and 1990a
Spiny rays	Large-scale sucker	*Catostomus macrocheilus*	Abundant	WSU 1975, CH2M Hill 1977
	Prickly sculpin	*Cottus asper*	Common	WSU 1975, CH2M Hill 1977
	Reticulate sculpin [1]	*Cottus perplexus*	Common	Entranco 1997
	Coastrange sculpin [1]	*Cottus aleuticus*	Common	Entranco 1997
	Riffle sculpin [1]	*Cottus gulosus*	Common	Entranco 1997
	Carp	*Cyprinus carpio*	Common	WSU 1975, CH2M Hill 1977, Entranco 1990a
	Three-spine stickleback	*Gasterosteus aculeatus*	Common	WSU 1975, CH2M Hill 1977, Entranco 1990a

1. Previously unreported by Washington State Department of General Administration (1977).

Table 4-5
Fish Observed in Capitol Lake and the Deschutes River

Fish Type	Common Name	Scientific Name	Prevalence	Literature Sources
	Bullhead catfish	*Ictalurus nebulosus*	Uncommon	WSU 1975, CH2M Hill 1977
	Western brook lamprey [1]	*Lampetra richardsoni*	Common	Entranco 1997
	Pumpkinseed sunfish	*Lepomis gibbosus*	Uncommon	DGA 1977
	Smallmouth bass [1]	*Micropterus dolomieui*	Common	Entranco 1997
	Largemouth bass	*Micropterus salmoindes*	Uncommon	WSU 1975, DGA 1977, Entranco 1990a
Spiny rays (Continued)	Peamouth [1]	*Mylocheilus caurinus*	Common	Entranco 1997
	Olympic mudminnow[1]	*Novumbra hubbsi*	Uncommon	Entranco 1997
	Yellow perch	*Perca flavescens*	Common	WSU 1975, DGA 1977
	Starry flounder	*Platichthys stellatus*	Uncommon	DGA 1977
	Black crappie	*Pomoxis nigromaculatus*	Common	WSU 1975
	Red-sided shiner	*Richardsonius balteatus*	Common	WSU 1975, DGA 1977
	Speckled dace [1]	*Rhinichthys osculus*	Common	Entranco 1997

1. Previously unreported by Washington State Department of General Administration (1977).

Table 4–5
Fish Observed in Capitol Lake and the Deschutes River (cont.)

Lake itself and at the WDFW Tumwater State Hatchery. Other fisheries related facilities include a fish ladder at the tide gate that allows upstream and downstream migration by anadromous salmonids into and out of Capitol Lake. There is also a ladder at Tumwater Falls which allows upstream migration of adult salmonids to the upper Deschutes watershed. A fish trap is used at the Tumwater Falls hatchery to collect fish (adult chinook and steelhead trout) to provide an egg supply for the hatchery. A recreational fishery also is associated with many of the fish populations both in Capitol Lake and the upper Deschutes River.

The following discussion provides an overview of the status of fish populations and their habitat for the species of greatest interest in Capitol Lake. Please note that this information is based, in part, on opinions of staff from WDFW. In some cases, as noted below, the opinion of the Squaxin Island Tribe's biologist may differ.

The Pacific salmon inhabiting Capitol Lake and the Deschutes River include chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), and, in very small numbers, sockeye salmon (*O. nerka*) and pink salmon (*O. gorbuscha*) (**K. Keown, personal communication**). Resident and anadromous trout include coastal cutthroat trout (*O. clarki clarki*) and resident rainbow and anadromous steelhead trout (*O. mykiss*). Presently only chinook salmon, winter-run steelhead, and legal-sized rainbow trout are cultured at the Tumwater Falls facilities and/or planted in the lake (**K. Keown, personal communication**). Chum, coho, cutthroat, and steelhead are planted from other hatcheries into the upper Deschutes watershed (**K. Kloempken, personal communication**—please note, the opinion of the Squaxin Island Tribe's biologist may differ).

Chinook Salmon

Because Tumwater Falls presented a barrier to anadromous migration near the upstream end of present-day Capitol Lake, it is believed that no historic chinook runs existed in the Deschutes River nor Percival Creek, which is probably neither large enough nor cool enough to support an historic chinook run (**C. Smith, personal communication; please note,** the opinion of the Squaxin Island Tribe's biologist differs—Percival Creek may have supported wild chinook salmon, **J. Dickison, personal communication**). With the initiation of chinook juvenile plantings in the 1950s and construction of the fish ladder to allow upstream migration around Tumwater Falls in 1954, a naturally spawning population of chinook salmon developed and continues to return to the upper Deschutes River to spawn (**please note,** the opinion of the Squaxin Island Tribe's biologist differs – although the Deschutes River is managed for natural spawning above Tumwater Falls, the presence of chinook is due to the enhancement program, **J. Dickison, personal communication**). Systematic and well-documented fish planting began in the 1950s with the completion of the Capitol Lake Dam. Since that time, the chinook hatchery stock has been supported through a combination of: incubation of eggs in Percival Creek, and spring and fall release of fish less than one year old and yearlings (fish over one year old) into Capitol Lake (see **Appendix E**). The Deschutes/Percival Cove chinook culture program is one of the most successful in the Puget Sound and is an important contributor of chinook to the state non-Native American and Native American commercial and sports fisheries (**J. Frasier, personal communication**). Chinook spawning survey numbers for the Deschutes River and Percival Creek are also provided in **Appendix E**.

A large downstream migration of chinook fry immediately after emergence is typical of most natural populations, especially populations that spawn near the downstream end of rivers (**Groot and Margolis 1991**). Estuaries provide an important nursery habitat and many, if not most, juvenile fry in natural populations will rear in downstream estuaries and in a wide range of salinities. Stream-type chinook juveniles (which rear in freshwater for up to a year) use low velocity waters along stream margins and behind instream structures, but will tend to move to higher velocity waters before either coho or steelhead juveniles. This behavior appears to provide habitat segregation between these potentially competing species in waters they cohabit. Freshwater rearing chinook are not known to prefer lake rearing during their freshwater residence, although net pen rearing and feeding has proven to be highly successful in producing returning adults for fisheries (**C. Smith, personal communication**).

Coho Salmon

As with all the anadromous salmonids, no historic coho stock existed in the upper Deschutes River above Tumwater Falls. Percival Creek, however, probably has supported an historic coho stock. Supplementation of coho also occurs in the upper Deschutes River (**K. Kloempken, personal communication**; **Appendix E**). Like chinook, a naturally spawning population inhabits both the Deschutes River and Percival Creek.

Coho juveniles have a year of freshwater residence where they typically inhabit their natal streams. However, coho do rear in lakes for this first year of residence, and their growth and survival can be equally good or better than stream rearing (**Johnston et al. 1987**).

Chum Salmon

Chum salmon also historically spawned in Percival Creek and continue to do so. Chum salmon are also stocked in the upper watershed above Tumwater Falls, but chum salmon do not readily ascend the fish ladder at the falls, so the development of a self sustaining population in the upper watershed has been limited (**Williams et al. 1975**).

Sockeye and Pink Salmon

While sockeye and pink salmon have been observed at Tumwater Falls hatchery trap, these fish are thought to be members of extremely small populations, and do not constitute a population that is of management interest in the basin (**K. Keown, personal communication**).

Searun Cutthroat Trout and Steelhead Trout

These anadromous trout also use the Capitol Lake tide gate fish ladder to enter Capitol Lake. They also use the Tumwater Falls fish ladder to extend their access into the upper Deschutes watershed. Winter-run steelhead are supplemented from the Tumwater Falls hatchery by trapping adults at the hatchery, hatching the eggs at other WDFW hatcheries, and raising the subyearling juveniles at the hatchery holding ponds from January through April so that they acclimate to and imprint on the Deschutes River waters. These yearling fish are then released to Capitol Lake.

Both cutthroat and steelhead trout will reside for at least two years in freshwater before migrating to coastal and offshore waters. These fish are multiparous (can spawn more than once in a lifetime) and so adult fish can be two to five years of age. Spawning and rearing of these fish mostly occur upstream of Tumwater Falls in the Deschutes watershed.

Other Freshwater Fish

Numerous other freshwater fish inhabit Capitol Lake (**table 4-5**). Virtually all of these fish prefer lake or shallow, low velocity environments. None have been identified as significant to fish population management in Capitol Lake with the exception of the Olympic mudminnow.

Fish Culture Program and Fish Passage Structures

The Tumwater Falls hatchery and Percival Cove rearing pens are part of the WDFW "South Sound Complex." The fish culture and passage facilities at Capitol Lake include (going from downstream to upstream) the Capitol Lake tide gate fish ladder, the Percival Cove net pens and open-cove rearing facility, a fish release point at the I-5 boat ramp in Capitol Lake operated by WDFW, Tumwater Falls hatchery, holding ponds, and the Tumwater Falls fish ladder (**Figure 4-1**). While adult chinook and steelhead trout are trapped

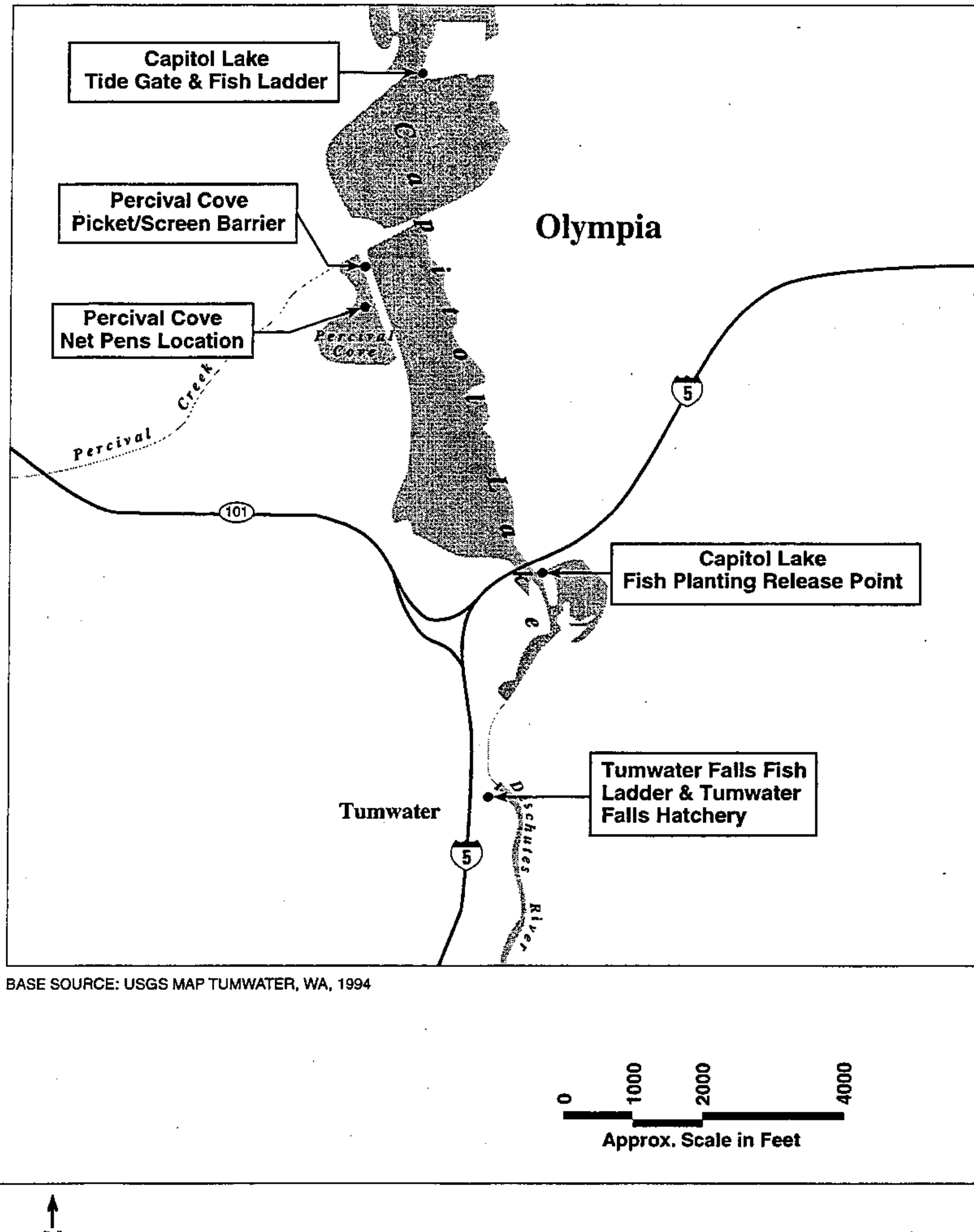


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Figure 4-1
Fish Culture and Passage Facilities

at the hatchery for eggs and milt (sperm), the eggs are raised at other hatcheries and returned to either Capitol Lake directly or Percival Cove for continued rearing (for chinook), or to the hatchery rearing ponds (for steelhead).

Both chinook fingerlings (2 million) and yearlings (200,000) are fed and reared in Percival Cove and Capitol Lake. These fish supplement the chinook salmon return, which supports the recreational chinook fishery in Capitol Lake. Net pens are presently operating in Percival Cove to rear yearling chinook between November and April each year, and fingerlings are raised (free-swimming) in the cove from April to early June each year. Pickets are placed at the mouth of Percival Cove during the chinook run to capture adult fish for egg supply, and any surplus fish are lifted over the pickets and allowed to migrate to Percival Creek (**K. Keown, personal communication**).

Fish passage conditions at the tide gate may present difficulty to steelhead migration during winter (**K. Keown, personal communication**). The entrance to the fish ladder at the tide gate is relatively high, and during winter, the lake level is often maintained at a level where flow does not occur through the ladder. Although adult salmonids are able to pass through the tide gate when it is open at low tidal elevations, fish are likely delayed in their upstream migration when the tide gate is closed and there is no flow through the ladder. This delay may result in predation by marine mammals and overall delayed spawning.

Existing Fish Habitat

The existing habitat in Capitol Lake can be characterized as a shallow lake environment with low to moderate densities of aquatic macrophytes covering most of the lake shoreline (**Entranco 1997**). The Deschutes River stream current also produces downstream currents and circulation patterns that are more pronounced than for rivers of similar size and volume. See the Water Resources section for a more detailed description of the hydrology and water quality.

During summer months warm temperatures and low dissolved oxygen concentrations can increase respiratory stress on various fish populations. Low dissolved oxygen conditions can be even lower within macrophyte beds (**Moore et al. 1994**). While these conditions are less than optimal for salmonid fish, the macrophyte beds still provide good refuge habitat for small prey fish such as crappie or pumpkin seed. While much of the shoreline has some macrophyte and/or riparian cover, some areas are lined by riprap and are largely devoid of either aquatic or terrestial vegetation.

Between 1971 and 1995 Capitol Lake was completely drained (during low tide) and allowed to backfill with saltwater to control macrophytes, aid in juvenile salmonid out-migration (discontinued in the mid-1980s), and facilitate maintenance activities in the lake. This procedure was implemented one to three times per year. In 1996 and 1997, the drawdown procedure was modified to only partially drain the lake and limit the amount of saltwater backfill. Modified drawdown was implemented to minimize adverse impacts on freshwater aquatic and wetland plant communities established as mitigation for the Heritage Park project (**Entranco 1997**).

While the intent of modified drawdown was to produce lake water quality benefits, it was determined that it had the adverse side effect of causing fish stranding and mortality due to predation and exposure from heat or stranding out-of-water. A wide variety of fish were observed either stranded in isolated pools or dead on mudflats (**Entranco 1997**). Many hundreds of fish were killed or temporarily stranded by the drawdown.

Fish Species of Special Concern

The only aquatic species of special concern that has been identified in the Capitol Lake basin is the Olympic mudminnow (*Novumbra hubsi*). The Olympic mudminnow is presently under review as a Washington State candidate species by the WDFW Fish Management Program, Native Non-game Fishes Office. This fish, up to the early 1990s, was listed as a federal Category 2 species under the Endangered Species Act, but no longer carries any classification as a federal species of concern. The Non-game Fishes Office will, within the next few months, be proposing to list the Olympic mudminnow as a state sensitive species. Washington State sensitive species are used as an indicator of degrading habitat condition (**M. Hallick, personal communication**).

The Olympic mudminnow prefers habitat that is well shaded by vegetation with muddy substrate and very low (less than 0.1 feet per second) water velocities. The fish has good tolerance for low dissolved oxygen levels or high temperatures, but not for any measureable salinity or stream flow velocities. They can be found in lake shallows but also small stream tributaries, and often in association with coho salmon juveniles (**M. Hallick, personal communication**). Often underground springs are numerous where mudminnows collect (**Wydoski and Whitney 1979**).

The Puget Sound chinook stocks are proposed for a threatened listing, which is likely to occur in late 1998 (**J. Caldwell, personal communication**). For rivers where there are, or were, genetically wild fish stocks, a recovery plan will have to be developed. As mentioned in the existing conditions, there is some difference of opinion as to whether or not Percival Creek may have supported (wild) chinook. WDFW staff feel that it is not likely that a recovery plan will be developed for the Deschutes River because they believe chinook stocks in the Deschutes River are genetically hatchery stock (**J. Caldwell, personal communication**). Regarding the potential listing of Puget Sound chinook salmon as a federally listed species under the Endangered Species Act, the WDFW view is, "that any listing of Puget Sound chinook under the Endangered Species Act will probably not affect the Deschutes/Percival Cove chinook culture program." (**J. Fraser, personal communication).**

Recreational Fisheries

Recreational fisheries in Capitol Lake exist primarily for chinook salmon in the fall, rainbow trout especially during the first week-end of fishing season, and to a lesser extent carp. While small and large mouth bass exist in the lake, the recreational fishery is not significant (**J. Fraser, personal communication**).

Impacts

Impacts Common to the Freshwater Alternatives

Under the freshwater alternatives, a freshwater dominate environment would remain in Capitol Lake. With the two Lake/River Wetland alternatives, there would be varying degrees of transition from the present, lake environment to a more riverine environment. During the transition process, the resident fish population age distributions and relative abundances of the various species would shift according to changes in the available habitat between open-water habitats to a more river-like environment. The main effect on fish populations would be to cause a spatial partitioning of the fish populations between fish that prefer open-water lake environments, and those that prefer more riverine environments.

Also, for the alternatives that allow Percival Cove to fill with sediments, the WDFW net pen facilities and cove rearing would have to be discontinued at the time the pens could not function, or the cove depth decreased to levels unfeasible for fish rearing. Unless mitigated, this would result in loss of the sport-caught "blackmouth" chinook in Puget sound that originate from the Percival Cove net pens.

Table 4-6 provides a summary of the potential effects, either positive, negative, or neutral, on the major fish groups in Capitol Lake.

In each freshwater alternative, except the Lake Alternative, the total lake habitat would decrease to some extent. Where dredging is continued, impacts to fish due to turbidity include localized decreases in dissolved oxygen and direct suffocation by clogging and abrading the gills. Short-term and localized physiological stress may result in decreased life span or greater susceptibility to predation.

In general, the more open-water areas would maintain a low velocity, lake-like environment that supports lake-based rearing habitats for salmonids as well as the non-salmonid fish such as the crappie, pumpkin seed, bass, carp, and non-game fish seen in the lake. The salmonid fish also would inhabit the riverine portions of the lake as they develop during the process of sediment accumulation.

The one species of special concern, the Olympic mudminnow, would continue to have shallow, low velocity, muddy substrate habitat preferred by that species in the shorelines with the lake habitat. Increasing amounts of shallow submergent aquatic habitat and emergent wetland habitat, may represent increasing habitat area for the Olympic mudminnow, assuming adequate water circulation and water quality. There may be a reversal of this trend at the time of maturity, as aquatic and emergent habitats are replaced by scrub-shrub wetlands and riverine habitats.

As the lake filled with sediments, portions of the lake would gradually transition to riverine conditions. The lake would become shallower and aquatic macrophyte (e.g., common waterweed, *Elodea canadensis*) densities and areal coverage will increase throughout areas that would not be dredged. This process of macrophyte growth would have an effect on all lake dwelling fish by increasing food supply and refuge for small fish.

The classic view of the effects of macrophyte density on fish populations is that at low and intermediate densities, prey fish populations (such as blue gill or pumpkin seed) increase with increasing macrophyte densities, thus providing more prey for piscivorous fish (such as bass). As macrophyte densities grow to high densities, however, more refuge area is provided to the prey species, thus reducing predator efficiency. Small prey fish classes can then become large in number within the dense macrophyte beds resulting in competition between individuals (**Olson et al. 1998**).

Fish Group	Alternatives[1]					
	Lake/River Wetland w/o Trap	Lake/River Wetland w/ Trap	Lake	Estuary	Combined Lake/ Estuary	No-Action
Salmonids						
Chinook						
Natural reproduction[2]	+	+	-	+	+	+
Pen and cove rearing[3]	-	-	+	-	-	-
Directly-stocked juveniles[2]	+	+	-	+	+	+
Coho[4]	+	+	0	+	+	+
Chum[5]	-	-	-	+	+	-
Steelhead/rainbow trout[6]	+	+	0	+	+	+
Cutthroat[6]	+	+	0	+	+	+
Other freshwater fish[7]	-	-	+	-	-	-
Olympic mudminnow[8]	+	+	0	-	-	+
Marine fish[9]	-	-	-	+	+	-
Net Impact[10]	+2	+2	-2	+4	+4	+3

+, -, and 0 indicate a likely improvement or decline in or neutral effect on habitat, respectively, for the fish group under the given alternative.

1. Assumes alternatives are at future mature condition.
2. Assumes juvenile chinook prefer stream and estuary rearing over lake rearing.
3. Assumes pen rearing of juveniles will become infeasible with lake filling with sediments.
4. While coho are known to rear in lakes, it is assumed they will rear more successfully in a river because of relatively poor water quality in Capitol Lake. While estuary use by juvenile coho is not as significant as for other salmonids, osmoregulatory benefits of an estuary will likely improve survival.
5. Assumes chum prefer estuary rearing, and stream and lake rearing is not ecologically significant.
6. Assumes steelhead, rainbow, and cutthroat adult and juvenile trout will prefer stream and estuary rearing. While lake rearing is common, water quality in Capitol Lake to support trout throughout the year is poor.
7. Assumes that most of the other freshwater fish occurring in Capitol Lake prefer lake environments.
8. Assumes the Olympic mudminnow will find more low velocity mud substrate habitat under lake conditions.
9. Assumes marine fish will not make significant use of marine backfilled waters in any of the lake alternatives that continue a modified drawdown procedure.
10. The net impact was calculated by adding the + and – from above, without assigning relative values of species.

Table 4-6
Impacts to Fish from Proposed Alternatives

Ultimately, when the various alternatives (except the Lake Alternative) reach maturity, the riverine habitats would be dominated by salmonid fish. The remaining lake areas would continue to support all the fish presently inhabiting the lake.

The riverine environments would provide habitat preferred by some of the salmonid fish, including coho, chinook, cutthroat, and steelhead, especially during the summer months. These fish also can migrate downstream to lake environments and survive and grow successfully. Johnston et al. (**1987**) found coho used small lakes as rearing habitats during their freshwater residence, and rainbow trout also migrated to lakes for over-winter rearing. Cutthroat trout likewise can be potomodromous in their migratory behavior, moving downstream to larger rivers or lakes during the winter, and returning to upstream tributaries to spawn (**Trotter 1989**). So where a lake environment remains in Capitol Lake, these salmonid fish can be expected to use both the river and lake during different life phases.

In each freshwater alternative, the tide gate would remain in place and continue to function to prevent saltwater intrusion into the lake. Because the tide gate is closed much of the time, a fish ladder was built into the dam to provide fish passage upstream. This ladder can delay adults in their upstream migration when the gate is closed and the lake is too low for the fish ladder to function. Any delay to upstream migrating fish can make them susceptible to predation by marine mammals or birds (**K. Keown, personal communication**).

The primary impact of any alternative on the recreational fishery in Capitol Lake would be from those alternatives that allow Percival Cove to fill and thereby ultimately cause the discontinuation of chinook rearing in Capitol Lake. The chinook sport fishery is presently the most significant fishery in Capitol Lake. The fishery would then rely on a smaller population supported only by natural spawning in the upper Deschutes watershed and to a lesser extent in Percival Creek. The "put and take" rainbow trout fishery, which is significant only in the first two weeks of June, also would be affected by any reduction of lake.

The following discussion of each of the specific alternatives and their potential impacts on fish in Capitol Lake is summarized in **table 4-6**.

Lake/River Wetland Alternatives

Under the Lake/River Wetland alternatives, chinook natural reproduction would continue in the upper Deschutes and possibly Percival Creek basins. In the absence of mitigation, net pen and cove rearing of fingerlings and juveniles would be discontinued due to sedimentation of Percival Cove. Direct stocking of fingerlings to Capitol Lake would continue, but could be relocated to the North Basin. It is assumed that the natural stream channel through present-day Capitol Lake would remain passable to all the migrating salmonids.

It is assumed, in the case of all the salmonids found in Capitol Lake, that the juvenile life phase is the most important one that occurs in the lake as long as passage and upstream spawning habitat are maintained. It is also assumed that spawning habitat would probably not develop within the newly created riverine portions of the present-day lake because of the excessive fine sediment load, which would likely constitute the substrate as the lake fills with sediment.

In the case of chinook and coho salmon and steelhead, rainbow, and cutthroat trout, a riverine environment would provide more desirable habitat and water quality for these fish, especially when instream habitat structures, such as large woody debris, are added to the system. While coho salmon juveniles and both the adult and juvenile forms of trout can thrive in lake environments, the poor water quality of Capitol Lake during the summer would make the riverine environment more desirable habitat. Although winter residence in the North Basin would remain likely and could provide good refuge from high stormwater flows for these fish (**Johnston et al. 1987**), the riverine environment would likely develop braided side channel habitats, which more typically serve as high flow refuge habitats. Chum salmon juveniles tend to migrate directly to estuaries upon emergence from their redds (egg nests), and therefore would make little use of either a riverine or lake environment.

The remaining freshwater fish found in Capitol Lake generally prefer lake environments, and can tolerate the poor lake water quality conditions such as increased temperatures and decreased dissolved oxygen during summer. Therefore any decrease in lake environment would be a negative impact for these, mostly non-game fish.

This generalization may not apply to the Olympic mudminnow, which prefers shallow, well-shaded habitats, with low-velocity and muddy substrates. Since the Olympic mudminnow can also tolerate high temperatures and low dissolved oxygen levels, the increasingly shallow water habitats of the Lake/River Without Trap, Lake/River With Trap, and No-Action alternatives may actually lead to an increase in desirable habitat for this species during the interim period prior to maturity.

Lake Alternative

Under this alternative, dredging in the Middle Basin and Percival Cove would continue, and Capitol Lake would remain largely an open-water lake environment. Net pen and cove rearing of chinook would continue. Naturally reproduced and directly stocked chinook juveniles are not thought to benefit from lake rearing and so would not benefit greatly from maintenance of a lake. While coho, steelhead, rainbow, and cutthroat trout can use the lake environment, water quality would continue to be poor in the summer, and no side channel riverine habitats would be developed. Continued dredging in the Middle Basin and Percival Cove would cause intermittent turbidity impacts on fish as mentioned above. The remaining, non-salmonid, freshwater fish would continue to benefit from the maintenance of a lake environment, and desirable habitat for the Olympic mudminnow population would remain unaffected.

The modified drawdown practice would continue to cause fish kills every year, with mortalities to salmon, Olympic mudminnows, and other species of fish. It appears that water quality could deteriorate with the modified drawdown/backfilling procedure, which seems to have little impact on freshwater algae or aquatic plants.

Impacts Common to the Estuary and the Combined Lake/Estuary Alternatives

Restoration of an estuarine habitat would provide water quality conditions suitable for development of a natural shellfish community, particularly bivalves such as clams, mussels, and oysters. Mussels and oysters prefer hard substrate for attachment. Clams typically live in soft substrates. Interest in recreational harvest of shellfish would develop if resources were adequate to support this activity. However, fecal coliform levels in bivalve tissues are likely to periodically exceed acceptable levels for protection of human health. Although no known paralytic shellfish poison problems have been documented in Budd Inlet, it is possible that this could occur, as it has in other Puget Sound embayments. Monitoring by the Washington State Department of Health (DOH) would be necessary to determine the suitability of shellfish resources for human consumption. Temporary or long-term postings by the DOH may be required. It is probable that harvesting shellfishing would not be certified by the DOH due to existing high fecal coliform levels.

Restoration of estuarine habitat in the lake basins would likely benefit anadromous fish species, including chinook, chum, and coho salmon, as well as steelhead, and cutthroat trout. All of these species would benefit from improved water quality with tidal exchange between Budd Inlet and the Deschutes River.

Over the next 50 years, the estuary would not change much from the existing mudflats and shoreline wetlands. From a habitat perspective, there would be little improvement over existing conditions without active measures (e.g., placement of large woody debris and wetland plantings) to enhance habitat.

At the time of maturity, in 100 to 150 years, the estuary alternatives would support a more diverse range of estuarine habitat types that would enhance fish feeding and rearing functions. Estuaries can be tremendously productive and provide direct and indirect benefits for fish migrations, feeding, refuge, and reproduction (**Thom 1987**). Estuarine wetlands have the highest production of organic matter by plant growth of any ecosystem in the world, particularly if dominated by larger plants such as marsh grasses, seagrasses, and macroalgae (**Nixon 1981**). Although the future estuary would probably not support seagrasses and macroalgae, dense marsh grass habitat is anticipated.

The habitat value of estuarine wetlands is high for fish because such systems can provide shelter from predation, as well as the basis for a productive and complex food chain (**Shreffler et al. 1990 and 1991**). The critical function of the tidal mudflat/emergent marsh systems of Puget Sound in support of juvenile salmon feeding and rearing is well documented (**Simenstad and Salo 1980, Simenstad et al. 1982, Shreffler et al. 1990 and 1991, Miller and Simenstad 1997**).

Habitat for freshwater species such as rainbow trout, largemouth bass, smallmouth bass, pumpkinseed, sunfish, yellow perch, black crappie, and the Olympic mudminnow would decrease significantly. These fish would be virtually eliminated from the system. This impact would be immediate.

Fish species that can tolerate a wide range of salinity, such as starry flounder, English sole, shiner perch, sticklebacks, and sculpins, would replace the existing freshwater fish. These new inhabitants would not be expected to have much recreational value. Hence, recreational fishing opportunities would likely be reduced. However, the Heritage Park reflecting pool/lake would still provide some freshwater habitat and possible fishing opportunities under the Combined Lake/Estuary Alternative.

Aquatic and terrestrial insect larvae, pupae and adults; harpacticoid copepods; amphipods; and other small invertebrates that live near the sediment surface are often very important in the estuarine diet of juvenile Pacific salmon. Tidal creeks and mudflats with fringing marsh lands that support these types of prey organisms are thus favored habitats for outmigrating juvenile salmon, in particular chum, chinook, and coho salmon (**Healey 1982**).

All salmonids would benefit from estuary restoration through creation of high quality feeding and rearing habitat. All species would use food resources available on the mudflats and marsh edges. A mixture of tidal channels, mudflats, and fringing marshes that provide complex cover would provide rearing habitat and potential refuge from predation for various life stages. All salmonid outmigrating juveniles need to undergo a gradual body fluid salinity (osmoregulatory) adaption as they transition from freshwater to saltwater. This is accomplished as they migrate from freshwater (the Deschutes River and Percival Creek), to brackish water (the new estuary and the brackish water portion of Lower Budd Inlet), to the true saltwater conditions of south Puget Sound.

As previously described, the chinook fish culture program includes chinook rearing in both Capitol Lake and Percival Cove (2,000,000 fingerlings and 200,000 yearlings). Both estuary alternatives would also eliminate the Capitol Lake and Percival Cove freshwater rearing. WDFW would not release chinook fry directly into the estuary (**J. Fraser, personal communication**). Loss of a freshwater lake would immediately impact WDFW's existing chinook rearing program unless mitigated. The WDFW estimates that a replacement facility would cost approximately $1,000,000 to construct.

Capture of adult chinook salmon for spawning stock would be more difficult than at present because it is assumed that the fish ladder at the outlet of the North Basin would no longer function. Chinook adults may still be captured at the Tumwater Falls fishway trap. Thus, restoration of the estuary would complicate but not prevent collection of spawning adults to continue the chinook rearing program.

Compared to the Lake Alternative that requires periodic drawdown and saltwater flushing, a restored estuary with tidal exchanges would not result in regular fish stranding once the channel system had adjusted to the hydraulic effects of tidal flushing. However, this may not be the situation in the earlier stages of estuary establishment. Existing lake bottom contours include areas where fish stranding was documented during the modified drawdown monitoring. This could lead to fish mortality due to isolation from the main river channel or poor water quality conditions in the backwater channels. The species most likely to be affected are coho salmon, which often rear in side channels with slow flows. As many as 100,000 wild coho smolts migrate down the Deschutes River each spring, but only a small portion would be affected.

Permanent water channels in the Deschutes River would be maintained naturally by erosion during high flow periods. Peak water flows out of Percival Cove would be insufficient to maintain a deep channel between the cove and the estuary. Deposit of sediment materials in this area may eventually fill the channel connecting Percival Cove to the Deschutes River estuary and may limit fish passage from the cove, particularly at low tide.

Although mitigation for some of these impacts may not be possible, restoration of a natural flow of the Deschutes River with an estuarine connection to marine waters is likely to provide the most productive habitat for juvenile salmon feeding and rearing. In fact, habitat restoration to natural conditions is a standard practice for restoring natural salmon runs.

Estuary Alternative

There are few impacts unique to the Estuary Alternative. Freshwater habitat would be eliminated from the entire basin. The estuarine habitat in the North Basin (i.e., mudflat, marsh, and emergent wetland) would be approximately double in area compared to the Combined Lake/Estuary Alternative.

Combined Lake/Estuary Alternative

The Combined Lake/Estuary Alternative would preserve some open freshwater habitat adjacent to Heritage Park. The open freshwater habitat coupled with continued submerged vegetation growth in the reflecting pool/lake would provide habitat for freshwater fish.

No-Action Alternative

For the No-Action Alternative, both the Middle and North basins would be allowed to fill with sediment creating a riverine environment throughout the present-day Capitol Lake boundaries. This alternative would have the greatest reduction of lake open-water habitat of all the freshwater alternatives, and therefore the greatest impact on fish that prefer lake environments (i.e., all non-salmonid fish). Conversely, this alternative would develop the greatest amount of new riverine habitat and would benefit the salmonids that prefer riverine habitats (all except the juvenile chum salmon). While most of the juvenile salmonids would use any newly developed riverine habitat, continued use of the tide gate would affect outmigrating juvenile salmonids by precluding development of a natural estuarine environment. Estuaries provide juvenile salmonids an environment where they physiologically adapt to the saltwater, and also feed and grow in a productive habitat. Both of these ecological functions contribute to improved salmonid marine survival.

Cumulative and Secondary Impacts

Cumulative impacts to fish populations would be related to alternatives which decrease the chinook salmon and Olympic mudminnow populations. Both are species of special concern, and their numbers and/or distribution in the Puget Sound region are being monitored as part of the state and federal endangered species programs. Any incremental decline in these species at Capitol Lake would contribute to a decline in the overall regional populations.

Because a restored estuary is anticipated to be more productive for recreationally important fish species, implementation of either estuarine alternative may have a positive effect on recreational fisheries in South Puget Sound. Secondary impacts on the fish populations largely affect the recreational fishery in Capitol Lake. Under all the alternatives, except the Lake alternative, the recreational chinook salmon fishery and the other lake-based fisheries (such as, rainbow trout and carp) would decline unless mitigated. Another secondary impact resulting from any decline in chinook net pen rearing would be administrative impacts to the Tumwater Falls hatchery as a result of decreased work load.

Mitigations

Mitigation Common to All Alternatives

Habitat restoration can be applied to all alternatives. One possibility would be to cable large woody debris, which is delivered routinely to the basin by the Deschutes River, to the shorelines. Large woody debris is particularly lacking on the western shores of the basin. Large woody debris would add shelter and cover from bird predation and would also provide the physical structure for growth of aquatic insects and other fish food organisms. If large woody debris was anchored in the main channel in the vicinity of the existing Middle Basin sediment trap, it would likely accelerate the accumulation of sand bars and formation of marsh habitat.

Shoreline plantings of shrubs and trees would improve the vegetation canopy along portions of the western shoreline and would also provide some habitat benefits to fish, including shading, increased leaf fall (food source for aquatic insects), and terrestrial insect food supply.

Mitigation for All Alternatives Except the Lake Alternative

To ensure their continued survival, adult salmon and trout must have free upstream access to the Deschutes River and Percival Cove at all times of the year. Moreover, access by juvenile salmon to habitat within the estuary, Percival Cove, and the Deschutes River should be maximized. Mitigation actions would include tidal channel reconfiguration, diversion of flows, and maintenance dredging of Percival Cove and the channel to Percival Cove.

If maintenance dredging is deemed undesirable, the following mitigation measures would be implemented for all alternatives except the Lake Alternative:

- Develop an alternative rearing facility for the 200,000 chinook yearlings (including concrete raceways, rearing equipment, and housing) on the vacant land north of Percival Cove. Water supply (8 cfs) could be provided from Percival Creek and/or LOTT reuse water. An optional upriver site is also possible (**WDFW 1998**). The WDFW estimates the cost of such a replacement facility at approximately $1,000,000 (**WDFW**).

- An upriver site would be necessary to replace the 2,000,000 fingerling chinook production with constructed raceways or ponds. Optional mitigation would be to expand existing rearing facilities at the WDFW Tumwater Falls/Deschutes rearing facility, if permitted by Ecology and the City of Tumwater (**WDFW 1998**).

Mitigation Common to All Freshwater Alternatives

All freshwater alternatives would require reconstruction of the fish ladder at the Capitol Lake dam to ensure upstream fish passage throughout the year (**WDFW 1998**).

Mitigation for Both Lake/River Wetlands and No-Action Alternatives

Because impacts to the Olympic mudminnow are uncertain (probably more positive than negative impacts), it is recommended that a long-term monitoring plan be implemented. The monitoring effort would assess the health of the Olympic mudminnow population, and would lead to an adaptive management approach to preserve and/or enhance this fish species in the basin.

Mitigation for the Lake Alternative

For the Lake Alternative, modified drawdown would be eliminated, unless it could be demonstrated that the drawdown can be performed in a manner that enhances anticipated benefits and minimizes fish kills.

Mitigation for the Estuary and Combined Lake/Estuary Alternatives

It is the view of the WDFW habitat biologist that a decline in the non-salmonid, principally lake-based, recreational fish populations would not require mitigation. Neither the populations nor their associated recreational fishery are significant enough to warrant mitigation for their lake-based habitat (**J. Fraser, personal communication**).

Mitigation for loss of Olympic mudminnows might be possible in the Heritage Park mitigation wetland in the southwest corner of the Middle Basin, assuming that actions are taken to prevent saltwater intrusion into this freshwater wetland (adding flap gates to culvert connections) and providing supplemental freshwater flow. Additional off-site mitigation at other freshwater lakes or wetlands in north Thurston County may also be possible.

For the Estuary and Combined Lake/Estuary alternatives, modification or management via dredging of tidal channels to ensure adequate water depths (minimum of 1 foot) at all tidal elevations would minimize fish stranding. Dredging all tidal channels in the system, however, would be impractical as a management option. The channel leading from Percival Cove could become shallow enough to limit fish passage. If this were to occur, water depth would be limited only at low tide. Maintenance of adequate depth for adult and juvenile fish passage throughout the tidal cycle may require periodic dredging.

One option to mitigate the elimination of the freshwater chinook rearing program in Capitol Lake would be to provide an alternative rearing facility, similar to or combined with the upriver site described for Percival Cove mitigation

Mitigation for the Combined Lake/Estuary

The Heritage Park reflecting pool/lake could possibly be used for a chinook salmon rearing program at a reduced scale. However, the size of the pool/lake would limit the number of chinook fry that could be reared, as well as the pool/lake's ability to produce prey resources of the appropriate size and quantity for rearing chinook fry; thus, an artificial feeding program would be necessary. At this time, the WDFW is not interested in the site for mitigation.

For the Combined Lake/Estuary Alternative, potential for stranding impacts to salmon fry or smolts could be mitigated by restrictions on water diversions, if diversion from the river is the proposed method of water supply. Water diversions into a reflecting pool/lake in the North Basin would need to be managed to avoid removal of too much water from the river and to minimize entrapment of fish in diversion structures.

Unavoidable Significant Adverse Impacts

Unavoidable significant adverse impacts would include:

- Continued impacts to fish from dredging with all alternatives.
- Continued stranding of fish with the Lake Alternative during the modified drawdown and saltwater backfilling process, unless this procedure is eliminated as a mitigation measure.

- Reduction of the lake environment and associated fish populations that prefer lake habitats for all the alternatives except the Lake alternative. Greatest impacts would occur with the No-Action and Estuary alternatives; lesser impacts would occur with the Combined Lake/Estuary alternative (open freshwater habitat retained in the east half of the North Basin), Lake/River Without Trap and Lake/River Wetland With Trap alternatives (open freshwater habitat retained in the North Basin).

- Loss of all habitat preferred by the Olympic mudminnow, and possible loss of the Olympic mudminnow with the Estuary Alternative, and significant loss of habitat and Olympic mudminnows with the Combined Lake/Estuary Alternative.

AQUATIC AND WETLAND VEGETATION

Existing Conditions

Water depth, water level fluctuations, circulation, velocity, dredging history, and salt content all play a role in what type of freshwater plant community currently exists in Capitol Lake's basins. The existing conditions reflect a plant community that has been affected by:

- Recent dredging of the Middle Basin (1986).

- Historical dredging and dredge spoil disposal (1979) in the South and Middle Basins.

- Summer lake drawdowns and backflushing with saltwater.

- Daily and annual variations in the volume and velocity of water entering the basins from the Deschutes River.

- Variation of 1 foot in lake level between summer (higher) to winter (lower).

Capitol Lake vegetation can be classified primarily as lacustrine (**Cowardin et al. 1979**). Open-water areas of the lake contain rooted aquatic macrophytes as well as seasonal floating algal mats. The lake is fringed on most shores by emergent wetland vegetation typical of the lower Puget Sound region. Wet-tolerant scrub-shrub vegetation and freshwater forested wetlands occur either landward of the emergent wetland or immediately adjacent to the waters edge along much of the shoreline (see Chapter 2,

figure 2-2). These vegetation communities have developed since the lake was formed in 1951. Prior to that, the system consisted of tidal mudflats with fringing tidal wetlands.

The existing vegetation communities, in and around Capitol Lake, have been described in previous reports (**Entranco 1990, 1997,** and **Entranco et al. 1996**). The communities are distributed primarily in relation to topography (elevation), which determines plant exposure to changing water levels. Normal lake levels are maintained at +6.4 feet MSL during summer months and at +5.4 feet MSL during winter months. The upland vegetation occurs above approximately +8 MSL. Shrub and forested wetlands occur at about +6 to +8 MSL, and emergent wetlands are found at about +4 to +6 MSL. Submerged aquatic vegetation is found in permanently submerged areas between approximately +2 to +4 MSL.

High turbidity appears to limit growth of submerged aquatic vegetation in portions of the lake deeper than about +4 MSL. Periodic flushing of the lake with saltwater from Budd Inlet has been used to control growth and distribution of submerged aquatic vegetation.

The following description of existing conditions assumes that the Heritage Park mitigation wetland in the Middle Basin and enhanced shoreline wetland features in the North Basin have already been built.

South Basin

The South Basin is characterized by islands formed by sediment deposition from the Deschutes River. The southernmost of three islands is a forested wetland dominated by red alder (*Alnus rubra*) and black cottonwood (*Populus balsamifera*) (**Entranco 1990**). Similar types of forested wetlands also form the eastern and southern perimeter of the South Basin and the riparian corridor of the lower Deschutes River. This forested wetland area has been estimated at 10 acres (not including the lower Deschutes riparian corridor). The remaining two islands in the South Basin are comprised of mixed scrub-shrub and emergent vegetation, estimated at 7 acres. The dominant plant is cattail (*Typha latifolia*), which forms a wide expanse around the islands, with other emergents (reed canarygrass [*Phalaris arundinacea*] and spikerush [*Eleocharis palustris*]) along the edge. The center of the islands support a community of red alder (*Alnus rubra*) with willow (*Salix* sp.) and black cottonwood as a subdominant species. Since these islands are comprised primarily of emergent species, they have been classified as such in the tables and figures. **Table 4-7** provides estimates of existing vegetation types.

	Existing Conditions	Lake/River Wetland w/o Trap	Lake/River Wetland w/Trap	Lake	Estuary	Combined Lake/Estuary	No-Action
SOUTH BASIN							
Submerged	3	2	2	2	0	0	2
Emergent	7	11	11	11	0	0	11
Scrub-Shrub	0	0	0	0	0	0	0
Forested	10	10	10	10	4	4	10
Low Brackish Marsh	0	0	0	0	6	6	0
High Brackish Marsh	0	0	0	0	13	13	0
Total	20	23	23	23	23	23	23
MIDDLE BASIN							
Submerged[1]	93	4[2]	4[2]	93	0	0	4[2]
Emergent	13	86	85	13	0	0	89
Scrub-Shrub	3	26	18	3	0	0	26
Forested	13	13	13	13	9	9	11
Low Brackish Marsh	0	0	0	0	54	54	0
High Brackish Marsh	0	0	0	0	67	67	0
Total	122	129	119	122	130	130	130
NORTH BASIN							
Submerged	29	29	29	29	0	6	minimal
Emergent	2	2	2	2	0	2	45
Scrub-Shrub	0.5	0.5	0.5	0.5	0.5	0.5	24
Forested	0	0	0	0	0	0	0
Low Brackish Marsh	0	0	0	0	39	21	0
High Brackish Marsh	0	0	0	0	34	17	0
Total	31.5	31.5	31.5	31.5	73.5	46.5	69
WHOLE-LAKE TOTALS							
Submerged	125	35	35	124	0	6	6
Emergent	22	99	98	26	0	2	145
Scrub-Shrub	3.5	26.5	18.5	3.5	0.5	0.5	50
Forested	23	23	23	23	13	13	21
Low Brackish Marsh	0	0	0	0	99	81	0
High Brackish Marsh	0	0	0	0	114	97	0

These represent gross estimates and were determined from the alternative figures, rather than field survey measurements. Estimates for the freshwater alternatives are based on the assumption that the Heritage Park wetland mitigation site in the Middle Basin is completely retained as designed. Under the estuary alternatives, it is assumed that all of the Heritage Park wetland mitigation site would become colonized by saltwater tolerant species.

1. This includes 82 acres measured in the main body of the Middle Basin in 1997, plus 11 acres from Percival Cove. (Assuming most existing open water in Percival Cove supports submerged plants.)
2. These acreages were estimated by the difference between existing submerged plant acreage and predicted emergent acreage.

Table 4-7
Estimated Acreage of Aquatic and Wetland Vegetation Plants in Each Basin of Capitol Lake Under Various Management Alternatives

The primary submerged aquatic plants observed in the South Basin in 1997 were somewhat sparse algal mats (periphyton) located in shallower areas nearer shore (**Entranco 1997**). These mats were attached directly to the sediments on the lake bottom. The South Basin is most affected by river flows and has some riverine characteristics. It is assumed that the lack of rooted aquatic plants (aquatic macrophytes) is due to the faster water movement. This is also the explanation for the fact that the algal mats do not occupy the main channel of the South Basin, but instead have colonized the margins of the basin. The algae were identified as spirogyra (*Spirogyra* sp). Other algal species have been identified in previous years. In past years (1971 to 1995), physical flushing during drawdown, and in some cases, saltwater backflushing provided some control of these mats. During 1996 and 1997, under the modified drawdown/backflushing scenario, no saltwater has reached this South Basin and physical flushing during drawdown was the only mechanism involved in removing algal mats from the South Basin.

Few rooted aquatic plants were observed in the South Basin during the 1997 survey, those observed were mostly common waterweed (*Elodea canadensis*). During the 1997 survey, it was estimated that 3 acres of submerged plants (primarily algae) existed in the South Basin. In previous surveys, the rooted, submerged plant community was dominated by common waterweed and thin-leaved pondweeds (*Potamogeton pectinatis*, and P. *foliosus*). Annual changes in plant dominance may be a reflection of changes in flow, flood regime, and the drawdown/backflushing program. However, the total acreage devoted to aquatic macrophytes is somewhat consistent between years.

Since 1993, Thurston County Noxious Weed Control Agency has quarantined portions of Capitol Lake because of the presence of purple loosestrife (*Lythrum salicaria* and *Lythrum virgatum*) (**Entranco et al. 1996**). The County has been working to eradicate purple loosestrife from wetlands in the Middle and South basins.

Middle Basin

Freshwater wetlands currently exist along the margins of the long, somewhat narrow Middle Basin of Capitol Lake, and in Percival Cove. Percival Cove is hydrologically connected to the Middle Basin through a narrow channel at its northern end. Under existing conditions, the southwest corner of the Middle Basin contains a 12-acre wetland mitigation site. The Heritage Park mitigation site comprises the most diverse wetland complex in the basin.

The eastern shoreline of the Middle Basin is characterized by steep, forested slopes, dominated by mixed coniferous and deciduous forest, which limit the riparian wetland to a narrow band. Forested wetland exists along this nearshore margin (9 acres), and along the perimeter of Percival Cove (2 acres), and the Heritage Park mitigation wetland located in the southwest corner of the Middle Basin (2 acres). Altogether, forested wetlands occupy approximately 13 acres in the Middle Basin (**table 4-7**). Forested wetland species include; red alder, black cottonwood, western redcedar (*Thuja Plicata*), red salmonberry (*Rubus spectabilis*), blackberry (*Rubus* sp.), Indian plum (*Osmaronia cerasiformis*), with willows and cattails nearshore (**Entranco 1990**).

A scrub-shrub type wetland community occupies an estimated 3 acres in the southwest corner of the Middle Basin. This area had been used as a disposal site for spoils from lake dredging operations, and had naturally developed into a scrub-shrub, emergent wetland system. The area has been redesigned and planted as part of a wetland mitigation effort for Heritage Park. The scrub-shrub vegetation includes willow, red osier dogwood (*Cornus stolonifera*), black twinberry (*Lonicera involucrata*), Pacific ninebark (*Physocarpus capitatus*), salmonberry, red alder, and Douglas hawthorn (*Cratagues douglasii*) (**The Portico Group 1997**). The forested wetland edges include red alder, big leaf maple (*Acer macropyllum*), black cottonwood, and western redcedar with an understory of scrub-shrub type plants. The riparian corridor of Percival Creek also has a fringe of scrub-shrub wetland. This is a structurally-diverse community dominated by red alder, reed canarygrass, skunk cabbage (*Lysichiton americanum*), salmonberry, and Indian plum. Most of this area is outside the immediate area affected by the alternatives, and is not described or included in discussions or estimates of impacts.

The majority of the western shoreline of the Middle Basin is comprised of emergent wetlands. However, the most extensive emergent wetland area in the Middle Basin is at the Heritage Park mitigation site. There are approximately 6 acres of emergent vegetation in the main body of the Middle Basin, and 7 acres at the mitigation site, for a total of 13 acres of emergent vegetation. The dominant emergent vegetation outside of the mitigation site is cattails; however, various rushes and sedges (*Carex* sp.), reed canarygrass, and purple loosestrife also exist in the emergent zone. Very little purple loosestrife is present now because the DGA has implemented an effective eradication/control program over the past seven years. The riparian edge consists primarily of willows, spirea, blackberry, skunk cabbage, salmonberry, and others. Emergent vegetation at the mitigation site includes slough sedge, tufted hairgrass (*Deschampsia caeptiosa*), common spikerush (*Eleocharis palustris*), daggerleaf rush (*Juncus ensifolius*), yellow pond lily (*Nuphar polysepalum*), pondweed, wapato (*Saggitaria latifolia*), and small-fruited bulrush (*Scirpus macrocarpus*) (**The Portico Group 1997**).

Common waterweed was the dominant submerged aquatic plant, representing 95 to 100 percent of the plant community, in the Middle Basin (**Entranco 1997**). Thin-leaved pondweed was present in deeper waters in the Middle Basin, but was quite sparse elsewhere. Many plants in the Middle Basin were covered with attached algae. Aerial photos of the lake, clearly depict how the river affects plant growth; bare (plant free) sediments exist along the main channel of the Middle and North basins. The submerged plant community in the Middle Basin was estimated at 93 acres; 82 acres in the main body of the basin (**Entranco 1997**), plus an additional 11 acres in Percival Cove.

North Basin

Forested wetlands, dominated by red alder and black cottonwood, are to the north of the intersection of Deschutes Parkway and the railroad tracks. However, this wetland community is not expected to be affected by the alternatives, and therefore has not been included in descriptions of impacts or estimates of acreage of wetland communities. There is no existing forested wetland in the immediate (affected) vicinity of the North Basin, and only a small (0.5 acre) scrub-shrub wetland located in a small depression a few hundred feet from the shoreline.

The southeastern shoreline of the lake, adjacent to Heritage Park includes constructed and enhanced emergent wetland sites. This includes a narrow band of emergent wetland and a small island of cattails along the southeastern shoreline of the basin (approximately 2 acres). These wetlands have a mix of emergent vegetation that can tolerate water fluctuations. These include slough sedge, common spikerush, daggerleaf rush, small-fruited bulrush, tufted hairgrass, wapato, yellow pond lily, and pondweed. The majority of the remaining shoreline of the North Basin is abrupt and has little emergent vegetation, other than a few small patches of cattail and willow.

The submerged plant population in the North Basin was entirely dominated by common waterweed during the 1997 survey. Similar to the Middle Basin, plant growth was denser in deeper water further from shore. As described for the other basins, the plant community composition in 1997 was not the same as observed in past surveys (**Entranco 1990**). It is not known why common waterweed currently dominates the plant community; this dominance possibly results from the modified drawdown and backflushing regime used in the past few years.

Overall

Forested wetland in the three basins accounts for approximately 23 acres in perimeter areas around the basins. Forested wetlands consist primarily of red alder, black cottonwood, and western redcedar with Douglas Fir and an understory of willows, alder, Indian plum, salmonberry, and blackberry. Scrub-shrub wetlands occupy 3.5 acres, dominated by red alder and willow. Emergent vegetation occupies another 22 acres, dominated by common cattail.

Although the types of submerged aquatic plant appear to change due to influences from the river and other factors, the acreage supported by submerged plants is fairly consistent. According to the 1997 survey, an estimated 3 acres of the South Basin (12 percent) contained in aquatic plants. The Middle Basin had 82 acres (68 percent) and the North Basin 29 acres (29 percent). This plus the additional 11 acres in Percival Cove, represents a total of 125 acres of submerged aquatic plant habitat under existing conditions.

Under existing conditions, logs and root wads are frequently carried into the lake by the Deschutes River. Much of this large woody debris is trapped in the South and Middle basins, and some is carried into the North Basin. In the North Basin, DGA has installed a log boom upstream of the Capitol Lake dam and tide gate to intercept any logs or root wads to avoid possible damage to the tide gate. Periodically, DGA removes and disposes of this material so that it doesn't impact the tide gate or recreational activities in the lake.

Impacts

Impacts Common to All Action Alternatives

For all action alternatives, the South Basin would continue to fill-in forming a fourth large island of emergent vegetation near the center of the existing open-water area. The type of wetland vegetation found on this island would differ depending upon whether it was tidally inundated with brackish water (salt marsh) or remained a freshwater system (freshwater emergent wetland). Also, the riparian forested wetland communities that occur along the perimeter of the South Basin, and along the eastern shoreline of the Middle Basin, would not be expected to change significantly under any alternative.

Lake/River Wetland Without Trap

Under this alternative, the South and Middle basins of the lake would be allowed to fill-in with sediments, eventually resulting in replacement of the majority of the submerged aquatic plant community with scrub-shrub and emergent wetland plants (**figure 3-1**). Plant community estimates for this alternative are provided in **table 4-7**.

South Basin. No change would be expected in either the forested wetland or scrub-shrub community wetlands in the South Basin under this alternative. The South Basin is already fairly well filled in; the wetland communities along the shore have extended into the basin and a number of islands have formed where sediments have built up. The only expected change to the freshwater plant community is development of another island of emergent wetland vegetation in the remaining large open-water area. This island should be similar in terms of plant community and size to those already in existence (i.e., primarily cattail with reed canarygrass, and a few rushes and sedges near the shore and possibly a small stand of alder and willow near the center of the island). The newly formed island would be approximately 4 acres in size, thus emergent wetland vegetation would occupy 11 acres under this alternative compared to 7 acres under existing conditions.

Due to the predicted location of this island, and the fact that the algae currently found in the South Basin are located along the margins of the river and islands, it has been assumed that the impact to submerged vegetation would be small. Algal mats would still be expected to occupy approximately 2 acres of lake/river bottom along the margins of the islands and shoreline.

Middle Basin. The Middle Basin would experience the greatest change. However, there would be no expected change to the size or quality of the forested wetland that forms the eastern shoreline, and the perimeter of Percival Cove. Islands of scrub-shrub type wetland vegetation would form in depositional areas within the main channel, along the margins of some emergent wetland vegetation stands, and in Percival Cove. At maturity (50 to 85 years), the scrub-shrub community should reach approximately 26 acres (including the 3.4 acres at the Heritage Park mitigation site).

At maturity, the majority of the area occupied by submerged aquatic plants (currently open water) would be replaced by emergent (and to a lesser extent scrub-shrub) wetland plants. Approximately 86 acres of emergent wetland vegetation community would occupy most of the Middle Basin and Percival Cove. This emergent zone could be expected to be similar to existing expansive emergent zones and would consist primarily of common cattail. The submerged aquatic plant community would be largely lost. Small patches would still exist along the margins of the emergent zone where river velocities would be minimal.

The previous discussion assumes that the Heritage Park mitigation site would not be affected by lake filling. However, the existing design for the Heritage Park mitigation site relies on the exchange of water between the site and the Middle Basin via two culverts (**D. Meyer, personal communication**). This hydrologic connection would be lost over time as the area filled in with sediment and emergent wetland vegetation. Although freshwater currently enters the site from hillside seeps, runoff, and possibly other sources, it is not known whether these would provide enough water to maintain the existing configuration. This change in hydrology could affect the extent and type of wetland communities that would exist. In general, drier conditions would result in a transition of open water and emergent zones to scrub-shrub vegetation and of scrub-shrub to upland conditions. In the worst case, it could result in total loss of this wetland and replacement with upland plant species.

It has been estimated that it would take 50 to 85 years for the Middle Basin to fill in under this alternative. During this time, the basin could be expected to slowly transition from a submerged plant dominated to emergent plant dominated community. The islands of scrub-shrub vegetation would first appear as exposed sediments, then be colonized by emergent vegetation before developing into a scrub-shrub community. This is similar to the process currently occurring in some of the islands in the South Basin.

North Basin. Under this alternative, the North Basin would be retained as open water. Once the Middle Basin has filled-in with the exception of the river channel, maintenance dredging would be required to maintain the open water in the North Basin. Thus, the emergent plant community along the shoreline would not be expected to change (2 acres). The extent of the submerged plant community would be maintained at its existing level (29 acres). However, discontinuation of annual summer drawdowns and backfilling can be expected to affect the submerged plant community; possibly resulting in greater diversity, and taller, denser stands of plants.

Lake/River Wetland With Trap

The main difference between this alternative and the Lake/River Wetland Without Trap is that periodic maintenance dredging would be performed in the sediment trap (Middle Basin) and at the mouth of Percival Creek (Percival Cove). Periodic removal of sediments would affect the time it takes to reach maturity. Under this alternative, it has been estimated that maturity would be reached in 75 to 115 years compared to 50 to 85 years for the Lake/River Wetland Without Trap Alternative. **Figure 3-3** and **table 4-7** show the extent of the various freshwater plant communities.

South Basin. Under this alternative, the South Basin would be the same as described under the Lake/River Wetland Without Trap Alternative.

Middle Basin. Forested wetlands existing in the Middle Basin would not be affected by this alternative.

When compared to the previous alternative, this alternative would result in only a slight decrease in the predicted emergent plant community in the Middle Basin (85 acres compared to 86 acres), and would affect primarily formation of islands of scrub-shrub vegetation in the main channel area. The scrub-shrub type vegetation would be approximately 18 acres under this alternative, versus 26 acres under the Lake/River Wetland Without Trap Alternative and 3 acres under existing conditions (**table 4-7**).

As with the previous alternative, the filling in of the Middle Basin would affect the hydrologic connection with the Heritage Park wetland mitigation site. Without a detailed hydrologic analysis, it is unknown how this might affect existing wetland vegetation. Inadequate water supply could decrease the area of open water and emergent plant communities, or as a worse case, could result in the loss of the wetland system.

Although there would be periodic dredging near the mouth of Percival Cove, this would be a localized effort and would not be expected to cause a large change in the plant community beyond what would occur under the Lake/River Wetland Without Trap Alternative. Periodic dredging of the Middle Basin sediment trap would result in a significant change only in the length of time it is expected to take for the basin to fill in with sediment. Under this alternative, it has been predicted that it would take 75 to 115 years to fill the Middle Basin. Thus, the Middle Basin would retain open water for a longer time.

North Basin. Under this alternative, periodic maintenance dredging would maintain open water in the North Basin once the Middle Basin has filled in with sediment. Without annual summer drawdowns and backfilling, the type and density of submerged plants could change, as described for the previous alternative. Therefore, the North Basin would be the same as described under the Lake/River Wetland Without Trap Alternative and would remain primarily open-water habitat.

Lake Alternative

Under this alternative, the South Basin would be allowed to fill in, while the Middle and North basins would be retained as open-water habitat by performing maintenance dredging. Annual modified drawdown and saltwater backflushing would be used to control submerged plant populations. The habitat types for this alternative are shown in **figure 3-4** and **table 4-7**.

South Basin. Similar to the Lake/River Wetland alternatives, no dredging would occur in the South Basin, and increased filling would be expected to form an additional island of emergent vegetation in the South Basin. Thus, the freshwater plant communities would increase by 4 acres of emergent wetland vegetation and with approximately 1 acre less of submerged vegetation, compared to existing conditions.

Middle Basin. In terms of freshwater plants in the Middle Basin, the Lake Alternative would be similar to existing conditions. The acreage of forested, scrub-shrub, emergent plant, and submerged vegetation communities would remain the same. No change would occur to the Heritage Park mitigation wetland complex located in the southwest corner of the Middle Basin.

North Basin. Modified annual drawdown and backflushing would be continued with this alternative to maintain freshwater conditions in the upper water layers. This approach would protect nearshore aquatic and wetland plants, such as those occurring near the Heritage Park shoreline, while continuing to decrease or control submerged plants in deeper water areas. The end result should be a plant community and coverage in the North Basin similar to existing conditions.

Estuary Alternative

This alternative would result in a radical change in the aquatic system with a shift from the existing lake ecosystem to an estuary as was the case prior to lake formation in 1951. **Figure 3-6** and **table 4-7** depict the expected changes to the plant community. Salinity would be in the 5 to 25 parts per thousand (ppt) range in the North Basin, and the northern end of the Middle Basin. Salinity would be fresh to brackish in the southern portion of the Middle Basin and in the South Basin, depending on the magnitude of high tidal cycles. The mudflats would be exposed to the air with tides below 5, 10, and 12 feet MLLW (-3, +2, +4 MSL) in the North, Middle, and South basins, respectively. This exposure would occur almost daily throughout the year. It is expected that the flats would retain water in small pools and that most of the flats would remain moist. The acreage exposed would decrease during high flow river conditions.

In the long term (at maturity), salinity would increase in both the mudflats and the tidal marshes. Sedimentation would increase the elevation of the flats and fringing marsh areas. Both of these factors would result in the gradual spread and development of a strong salt-tolerant tidal community. To bring elevations up to those capable of supporting low and high brackish marshes would take approximately 100 to 150 years. The sea level rise would slightly decrease this rate. The existing scrub-shrub community below extreme high water (EHW) would be replaced with a high brackish marsh system along the fringe of the lake. Forested communities may be slightly changed, especially those that are somewhat affected by the tidal fluctuations.

Cattail, although a freshwater species, can withstand relatively high salinity after it has become established. Hence, this community may remain and eventually expand seaward. Examples of the predicted habitat types and distribution can be found in Kennedy Creek, Skookum Inlet, and Nisqually delta (**Kunze 1984**).

The rate of change is somewhat uncertain, but studies in the Snohomish River Delta and in the Elk River and Chehalis River indicate that, once exposed to tidal inundation and some salinity, the community can change from freshwater to brackish tidal within 3 to 4 years (**Thom and Borde 1997**).

Noxious vegetation including purple loosestrife, floating algal mats, and reed canarygrass would likely be reduced significantly under this alternative because of tidal action as well as reduced water levels and increased salinity.

In the short term, the shift in salinity and filling would result in a fringing tidal marsh, extensive mudflats, and a relatively narrow and possibly braided river channel running through the center of the estuary (**figure 3-6**). The vegetation on the mudflats (i.e., the muddy areas below about 12 ft MLLW [+4 ft MSL]) would likely include microalgae consisting of benthic diatoms and single-celled and filamentous green algae. Seaweeds including sea lettuce (*Ulva* sp) and rockweed (*Fucus* spp) also would likely colonize rocks and cobble at least in the North Basin. Thus, there would be a shift from an open-water area and a lake bottom covered with submerged aquatic macrophytes to an exposed sediment and microalgal-dominated community. These communities often are broadly distributed on flats in spring and summer as evidenced by a green or brownish hue to the sediments.

With the removal or opening of the tide gate, it is possible that some large woody debris (logs and root wads) could be washed into Lower Budd Inlet where it would be a threat to the operation of marine watercraft. Although DGA would retain the log boom and would continue removal and disposal operations upstream of the Capitol Lake dam and tide gate, some large woody debris might escape past the log boom, especially during major flood events.

South Basin. The forested wetland community along the perimeter of the basin would remain largely unchanged. The forested island would likely be lost due to expected water level fluctuations. This either would be replaced by high brackish marsh or by scrub-shrub freshwater wetlands, depending upon salinity levels.

As with the previous three alternatives, without further dredging, another island would form in the South Basin. In this case, the island would be slightly larger than under the freshwater alternatives due to the longer time to maturity. Under worst case conditions (i.e., those exhibiting the largest change over existing conditions), all other freshwater plant communities (scrub-shrub, emergent, and submerged) would be lost (approximately 16 acres) and would be replaced by low brackish marsh (6 acres) and high brackish marsh (13 acres) species (**table 4-7**). However, the exact extent of the saltwater intrusion into the South Basin and its degree of salinity is unknown. It is possible that a freshwater community would still be established in portions of the South Basin; especially along the nearshore margins.

Middle Basin. The existing forested wetland community that forms the eastern shoreline of the Middle Basin would remain largely unchanged. However, the forested wetland that forms the perimeter of Percival Cove would be replaced by high brackish marsh.

Much of the Middle Basin would eventually fill-in, forming islands of high brackish marsh communities and an extended shoreline of low and high brackish marsh. At maturity (100 to 150 years), existing submerged (93 acres), emergent (13 acres), and scrub-shrub (3 acres) wetlands would be lost and replaced by low brackish marsh (54 acres), and high brackish marsh (67 acres) communities. During interim conditions, these islands and extended shoreline would appear as unvegetated mudflats. The southernmost end of this basin may retain a freshwater community along the nearshore margin, depending upon the location and extent of the saltwater intrusion.

Assuming necessary hydrologic modifications are undertaken to ensure the mitigation wetland site remains hydrologically connected to the Middle Basin, the mitigation wetland would still exist, but would be comprised of low brackish marsh and high brackish marsh species. A transition from freshwater to brackish water tolerant species would occur due to the influence of tidal exchanges. With daily tidal exchanges, brackish water conditions would be expected as far upstream as the mitigation wetland during high tide conditions. As with previous alternatives, it is possible that the mitigation site wetlands would be lost entirely if the hydrologic connection to the Middle Basin is lost.

North Basin. No change would occur to the small scrub-shrub community in the North Basin. However, all of the emergent (2 acres) and submerged (29 acres) freshwater plant community in the North Basin would be lost and would be replaced by salt-tolerant species. The North Basin would consist largely of low (39 acres) and high (34 acres) brackish marsh surrounding the main river channel. During the interim period before plants are able to colonize newly exposed sediments, these areas would appear as mudflats. The submerged (6 acres) and emergent (2 acres) freshwater plant communities along the eastern shoreline of the North Basin, would remain unchanged as they would be protected by the earthen dam built to retain an open-water area.

Combined Lake/Estuary Alternative

Similar to the Estuary Alternative, this alternative would have significant changes to the type and quantity (acreage) of freshwater plants in each basin, since freshwater plants would be replaced by saltwater tolerant species. As with the Estuary Alternative, this alternative would radically change the aquatic system and would have similar shifts in salinity, vegetation communities, and long-term development patterns. The primary differences are that time to maturity would be

100 to 125 years and half of the North Basin would be returned as an open-water area. **Figure 3-8** and **table 4-7** show the predicted changes in the freshwater plant community.

South Basin. Changes to the South Basin would be the same as those described for the Estuary Alternative.

Middle Basin. Changes to the Middle Basin would be the same as those described for Estuary Alternative. Interim conditions also would be similar.

North Basin. No change would occur to the small scrub-shrub community currently in the North Basin. However, all of the emergent and submerged freshwater plant community in the western portion of the North Basin would be lost and replaced by salt-tolerant species. The western half of the North Basin would consist of low brackish marsh (21 acres) and high brackish marsh (17 acres). Interim conditions would be similar to those described for the Estuary Alternative, except that additional mudflats would occupy the eastern shoreline of the basin.

It is assumed that freshwater flow to this pond (flushing) would maintain fairly high quality (low algae) conditions. However, there would be an expansion of submerged aquatic plants, such as common waterweed, in the pond. Freshwater emergent plants, such as cattail, would colonize and expand along the eastern shoreline of the pond.

It can be predicted that noxious algal mats would occur in the reflecting pond, because the pond would trap nutrients. Submerged macrophytes, such as pond weed, would also be expected to expand in the pond. Freshwater emergent plants should colonize the eastern shoreline of the pond.

No-Action Alternative

Under the No-Action Alternative, the South Basin would be the same as for the first three alternatives (Lake/River Wetland alternatives and the Lake Alternative) (**figure 3-10**). Without dredging, a large island of emergent freshwater vegetation would form in the remaining large open-water area. This would result in loss of a portion of submerged plant (algae) habitat.

The Middle Basin also would fill in with emergent and scrub-shrub wetland vegetation communities, and would have communities similar to the Lake/River Wetland Without Trap Alternative. Also, there would be the same potential for impact at the Heritage Park wetland mitigation site.

Without periodic dredging or annual drawdowns, the North Basin would eventually fill in. It has been estimated that it would take 100 to 150 years for filling to occur. It is predicted that islands of scrub-shrub type freshwater vegetation would form near the center of the North Basin, and that emergent vegetation would eventually occupy the shoreline area in a wide band along the eastern and western shores. The area that would be occupied by emergent vegetation has been estimated at 45 acres. The submerged plant community would be limited to plants that could occupy the margins of the emergent plant beds, inside the area of higher river water velocities.

Cumulative and Secondary Impacts

There are no cumulative impacts associated with changes in freshwater plant communities.

The changes in type and quantity of freshwater plants determine the type of and quantity of habitat available for fish, birds, bottom dwelling organisms, and other associated life forms. It also would greatly affect the visual aesthetics of the area. These secondary impacts are described in detail in other sections of this DEIS.

Mitigations

To mitigate impacts to the Heritage Park wetland mitigation site due to sediment clogging of the culverts, dredging could be performed to maintain the hydrologic connection for the two Lake/River Wetland alternatives. Alternatively, a new water supply could be provided to maintain site hydrology; this would involve diversion of river water, diversion of nearby drainages, or application of LOTT re-use water.

For the Estuary and Combined Lake/Estuary alternatives, a combination of providing a freshwater supply source and installation of a flap gate on the culverts could maintain the Heritage Park wetland mitigation site in the Middle Basin.

Another mitigation measure may be to restore or create freshwater wetlands at another site within the lake basin or upstream along the Deschutes River or Percival Creek.

Expansion of submerged aquatic plants and emergent communities in the North Basin under the Combined Lake/Estuary Alternative could be mitigated by using mechanical or chemical (herbicides or saltwater flushing) control techniques. Note that use chemical controls is discouraged by WDFW (**J. Fraser, personal communication**).

The Port of Olympia and Olympia Yacht Club may have to initiate maintenance activities to remove any large woody debris that passes into Lower Budd Inlet.

Unavoidable Significant Long-Term Impacts[11]

The action alternatives and the No-Action Alternative would allow the South Basin to fill in and the open-water submerged habitat would be replaced by emergent and scrub-shrub wetland habitat.

With the exception of the Lake Alternative, all the action alternatives and the No-Action Alternative would fill the Middle Basin and would result in the transition from an open-water submerged plant habitat to a primarily emergent wetland habitat. This would be a significant adverse impact to the submerged plant community.

The estuary alternatives would have the most significant adverse impact on existing freshwater plant communities. Under both of these alternatives, the entire freshwater submerged, emergent, and scrub-shrub communities in the South and Middle basins would be lost. (This includes the Heritage Park mitigation wetland site.) With the two estuary alternatives all or the majority of these communities would be lost in the North Basin as well.

11. The unavoidable impacts discussed in this section involve the replacement of open-water habitat with either freshwater or brackish wetland plant communities. This change can be viewed either as an adverse impact or a positive change.

LAND USE, RECREATION, AND SHORELINE USE

Existing Conditions

Land Use and Recreation

Capitol Lake is an artificial lake consisting of three basins created by landfill and construction of a dam at the mouth of the Deschutes River. In 1951, construction of the dam across the Deschutes River tidal basin at its convergence with Budd Inlet created the North Basin of Capitol Lake. The North Basin, created as a reflecting pool for the Capitol Building, was envisioned in the original Capital Campus plan developed by the architects Wilder and White in 1911. In 1956, the I-5 bridge was constructed, separating the South and Middle basins of Capitol Lake.

The immediate Capitol Lake shoreline is primarily open space, trails, and park lands. Heritage Park, formerly Capitol Lake Park, is located on the shores of the eastern half of the North Basin; Marathon Park is on the southwest shore of the North Basin; the Capitol Lake Interpretive Center is in the Middle Basin's southwest corner; and Tumwater Historical Park is on the western shore of the South Basin (see **figure 2-2**). Recreational fishing occurs throughout the lake. Other recreational uses include jogging, walking, or bicycling along the lake shore; sight-seeing (including open-water vistas); bird-watching; boating; canoeing; fish-watching (at the fish ladders and traps constructed around the Tumwater Falls); and Lake Fair (an annual, week-long, community event). From 1965 to 1985, the northeastern shoreline of the North Basin was used as a swimming beach.

Marathon Park and the Capitol Lake Interpretive Center and other parks are owned by the State and are operated and maintained by DGA. Marathon Park has picnic areas, water fountains, restrooms, and jogging trails. The Capitol Lake Interpretive Center has two fishing/observation piers, and fishing also is possible from the footbridge that crosses the constriction between the North and Middle basins near Marathon Park.

Tumwater Historical Park is partly on state land leased to the City of Tumwater and partly on property donated to the City by the Olympia Brewery. There is a boat launch for fishing boats at the north end of Tumwater Historical Park near the I-5 freeway. In addition, there are trails through the wetlands, picnic areas, a playground, a large play area, and restrooms. The North Basin of Capitol Lake, most of the Middle Basin (the portion north of the

Capitol Lake Interpretive Center), and the eastern half of the lake's South Basin are within the City of Olympia, while the remainder of the Middle and South basins are within the City of Tumwater.

Tumwater's New Market Historic District borders most of the South Basin of Capitol Lake. A master plan for this district was adopted by the City of Tumwater in 1993. It describes future land uses, shoreline improvements, and cultural, and recreational facilities planned for the district. Key components of the master plan include expansion of the City's Historical Park to include a trail system around the south basin (including pedestrian bridges over the Deschutes River and Capitol Lake near the Interstate 5 bridge), and rehabilitation of the old Old Olympia Brewery buildings for beneficial use to the public. Other existing and future cultural and archaeological resources of the district also are identified in the master plan.

Heritage Park encompasses 46 acres located directly north of the historic Capital Campus, including 22 acres of lake surface (only a portion of the eastern side of the North Basin). The park is the final part of the original 1911 plan for the State Capital Campus. The park, which has as its theme Washington State's heritage, includes walking trails, paths along the lake, civic space for events and public gatherings, an amphitheater, and areas for state landmarks and commemorations. The symbolic center piece of the park plan is the Arc of Statehood, a wide semicircular tree-lined walkway defining the lakeshore between the overlooks of the lake. This feature requires 3 acres of fill within the lake and a replacement wetland of 9 acres in the Middle Basin. The other major park features include a trail meandering through a heather-planted slope, extensive native landscaping, enhancement of the shoreline with public access, and outdoor gathering spaces.

Historically, the most intensive use of Capitol Lake Park (now Heritage Park) has been the annual Capitol Lake Fair celebration. Lake Fair was started 40 years ago as a fund raiser for nonprofit organizations. The six-day fair, preceded by two days of related events, is held in July and typically is attended by 60,000 to 100,000 people. Additional activities that occur in conjunction with Lake Fair include a parade, fireworks across Capitol Lake, a golf island, stage entertainment, fair royalty coronation, and a carnival. The carnival is held on the shores of Capitol Lake just south of the existing park, extending to the end of Water Street.

Existing trails follow the entire length of the lake's west side, running from Tumwater Historical Park to the Capitol Lake Interpretive Center, then north along the western side of the Deschutes Parkway, on to Marathon Park, and around the lake's north end. The City of Olympia's Comprehensive Plan designates a Class II bicycle path along this route. This new path would connect to other east-west bicycle routes along 4th and 5th avenues. A system of sidewalks and trails also bounds the entire North Basin of Capitol Lake and loops back across, the lake adjacent to the railroad right-of-way (the railroad track forms the constriction separating the lake's North and Middle basins), to Marathon Park. The existing rail corridors in the lake's vicinity are identified by the City of Olympia as future urban trails (**City of Olympia 1994a**).

Steep, wooded slopes are located along the entire west side of the lake basin between Deschutes Parkway and the developed lands at the top of the bluff. Steep, wooded slopes also adjoin the southeast portion of the North Basin, and the eastern margins of the Middle and South basins. Developed lands around the North Basin are primarily commercial on the east side and a mixture of commercial and residential on the west side. Existing land uses up slope of the Middle Basin include the Capital grounds and residential uses on the east, and the Thurston County courthouse complex, motel, office, and residential uses on the west. In the South Basin, existing land uses include residential and commercial on the east and residential and park use on the west.

Just north of Capitol Lake, along the shores of Budd Inlet, there are a mix of various land uses. Land uses on the east side of the inlet include Percival Landing (a waterfront park), commercial and office buildings, a marina (Olympia Yacht Club), and industrial uses associated with the Port of Olympia (northern half of the eastern shore). Land uses to the west are primarily residential, but also include office, commercial, and industrial.

Land Use and Recreation Plans

Existing land use and land use trends in the vicinity of Capitol Lake are generally consistent with City of Olympia future land use policies (**City of Olympia 1994a**).

Among future land uses designated in the Tumwater Land Use Plan (**City of Tumwater 1994**) is the Shoreline Environment - Deschutes River Special Area River Management Plan, which includes the New Market Historic District (surrounding the South Basin on the southeast and southwest sides), and a park/open space designation for the Capitol Lake Interpretive Center. These designated future uses are consistent with existing land uses and trends.

Shoreline Use

The State Shoreline Management Act (SMA) and the local Shoreline Master Program (SMP) for the Thurston Region, both contain guidance on how shorelines of the state should be managed. The SMA contains eight State "Priorities" and the local Master Program contains another eight "Regional Criteria". Unless an activity or use is clearly prohibited by its shoreline environment, these Priorities and Criteria are given equal weight. However, the individual shoreline permit process addresses how to balance potentially competing (conflicting) interests. None of the alternatives contained within this EIS are clearly prohibited.

Budd Inlet, the Deschutes River, and Capitol Lake are examples of the marine, river, and lake shorelines governed by the SMA and SMP. The Capitol Lake shoreline environment is somewhat unique, being created from a portion of Budd Inlet prior to adoption of the SMA and SMP, and being adjacent to the State Capital Campus. Since both the State Priorities and Regional Criteria suggest preserving the natural character of the shoreline, it is not clear if "existing character" refers to the status quo condition (e.g., maintaining Capitol Lake) or to restoring the water body to its original condition (e.g., part of the Budd Inlet estuary). When the SMA was adopted in 1971, conservation and preservation of what natural shoreline remained was a key focus. The concept of restoring a shoreline to its previous unaltered condition is not contained within the SMP, whereas the restoration of blighted or abandoned buildings along the shoreline is noted.

The SMA requires that local SMPs establish shoreline zones called "shoreline environments" to limit upland and over-the-water land uses and activities. Even though Capitol Lake is a collection of four separate basins (e.g., north, middle, south, and Percival), its shoreline designations were tied to zoning boundaries and have not been changed since the SMP was adopted in 1976. These shoreline designations allow a wide range of uses and activities, and the relationship between the upland and over-the-water activities usually is not well defined.

In an attempt to eliminate conflicting shoreline guidance and case by case review of shoreline permits, the cities of Olympia and Tumwater have adopted Special Shoreline Management Areas for the Deschutes River, Capitol Lake and Percival Creek. The adoption of any of the alternatives other than the No-Action Alternative would provide a greater degree of future shoreline guidance than currently exists.

The local SMP for the Thurston Region contains guidance on many shoreline activities including dredging. The SMP allows dredging when certain conditions are present to warrant the activity. These generally include "to deepen navigational channels, improve water quality, bury public utilities, increase recreational benefits, maintain water flow, or (to support) an activity permitted by this Master Program". Of course any dredging activity would need to balance the Regional Criteria and State Priorities.

Capitol Lake is considered a water of the State and, along with those shoreline areas within 200 feet of the ordinary high water mark, is protected under the SMA. It is also historically significant because it was "created" in 1951 as a reflecting pool in response to the vision of the architects Wilder and White, who developed the original Capital Campus plan in 1911.

The lake has been dredged twice (1979 and 1986), both times since the adoption of the SMA. The two past dredging operations were performed primarily to maintain adequate lake depth to support recreational uses, although fisheries, water quality, land value, and aesthetic benefits were also identified under the original dredging plan (**CH2M Hill 1977**).

With sediment continuing to flow down the Deschutes River, the lake serves as a sediment trap for the Port of Olympia. Dredging for navigation is one of the conditions listed above, but in this unique condition the SMP does not identify where the sediment should be controlled (e.g., in the lake, in Budd Inlet, or upstream in the river).

Other competing values would be the protection of aesthetic shoreline qualities and recognition of state-wide over local interests (Regional SMP Priority). A number of other conditions are also SMP Priorities, such as the protection of property from flooding and the enhancement of habitat (then called the "ecology of the shoreline"). With none of the alternatives being clearly prohibited, all the alternatives appear to be within the range of activities allowed by the local SMP.

Preparing an EIS is one way to evaluate systematically the impacts or benefits of various management alternatives for Capitol Lake. While the State Environmental Policy Act encourages jurisdictions to explore alternatives with the least environmental impact, it recognizes that the environment must include human uses, community values, and historical conditions and also must address the financial costs of those alternatives.

All development activity within Shoreline Jurisdiction must be consistent with the SMP and hence its policies and regulations. The goals and policies of the SMP make it clear that such resources are to be preserved, protected, restored, conserved, managed, and used for their scenic, aesthetic, historic, cultural, recreational, and ecological qualities.

The entire shoreline of Capitol Lake and Percival Cove is designated as a Conservancy Environment under the SMP except for the portion of the North Basin of Capitol Lake from the tide gate east to a point opposite 8th Avenue SE (approximately midway down the east shore of the North Basin), which is designated Urban Environment. Budd Inlet, north of Capitol Lake, also is designated as an Urban Environment.

The intent of a Conservancy Environment designation is to protect, conserve, and manage existing resources and valuable historic and cultural areas to ensure a continuous flow of recreational benefits to the public and to achieve sustained resource utilization (**Thurston Regional Planning Council 1990**). The preferred uses are nonconsumptive of the physical and biological resources of the area and are of a nonpermanent nature, which do not substantially degrade the existing character of the areas. Nonconsumptive uses are those that use resources on a sustained yield basis while minimally reducing opportunities for other future uses of the area resources.

Applicable goal statements for the Conservancy Environment have been selected from the SMP and are presented below.

4. *Recreation. Recreational opportunities are to be preserved and expanded through programs of development (public and private), and various means of public acquisition, such as purchase, leased easements, and donations. The intensity of the recreational use will be limited by the capacity of the environment to sustain it.*

5. *Shoreline Use. A goal is to locate structures and uses in such a position that they are not highly visible from the water.*

6. *Conservation. The goal of this element is to protect, conserve, and manage existing natural resources and valuable historical and cultural areas to ensure a continuous flow of recreational benefits to the public, and to achieve sustained resource utilization.*

7. *Historical and Cultural Values. This goal shall be to promote, protect, and preserve historical, cultural, scientific, or educational values on shorelines where these values are acknowledged.*

8. *Restoration. The goal of this element is to restore to a useful or original condition those areas (including waters which are blighted by present uses) and dilapidated or abandoned structures.*

Impacts

Lake/River Wetland Without Trap and Lake/River Wetland With Trap Alternatives

Land Use. According to Olympia's Comprehensive Plan, the land surrounding most of the lake has environmental limitations for slope stability and soils. These areas are designated as Open Space by Olympia's Plan for Parks, Open Space, and Recreation. Because the lake's function would be retained as a natural resource that provides aesthetic, recreation, and habitat benefits, it would be compatible with the existing and designated uses adjacent to the lake. No changes to land use, other than the types of recreation uses, would be expected. Impacts to recreation are discussed below.

Recreation. The open-water views available in the Middle Basin, and specifically at the Capitol Lake Interpretive Center, and along lakeside trails would be lost. These lake views would be replaced by views of emergent, scrub-shrub, and forested wetlands. It is likely that these formerly unrestricted views would be blocked by wetland vegetation such as willow, black cottonwood, alder, or shrubs like blackberry and hardhack. Although park use and walking, jogging, and bicycling on existing trails would still be possible, such view blockages would change the outdoor experience that many lakeside park and trail users presently enjoy. Increased trailside vegetation could reduce visibility and lead to reduced pedestrian security and safety.

Open-water boating, fishing, and sight seeing recreational opportunities would be lost in the Middle Basin and South Basin. These opportunities would be replaced with river boating, fishing, and sight-seeing. The water level in the river is expected to vary between 4 to 10 feet in depth and the river width is expected to be somewhere around 150 feet. Because emergent wetlands would encompass most of the Middle Basin, boats would need to be launched from the North or South basins. However, pier fishing may still be possible at the south end of the Middle Basin, just north of the I-5 bridge.

A potential benefit of these two alternatives, is that bird and wildlife watching opportunities would increase due to the increase in wetland area.

Because the North Basin would be dredged, it would continue to serve as a reflecting pool for the Heritage Park and Capitol Campus. Dredging operations would be performed every other year for approximately 65 days, after the Middle Basin has filled in with sediment.

Shoreline Use. Maintaining the North Basin as a reflecting pool is consistent with the general goals and policies of the SMP for the Thurston Region (**Thurston Regional Planning Council 1990**) as summarized earlier. It would preserve, protect, restore, conserve, manage, and use the lake and its shorelines for its scenic, aesthetic, historic, cultural, recreational, and ecological qualities.

Although, the Middle and South basins would change from open water to wetlands they would still function as a natural resource. This would be consistent with the general goals and policies of the SMP for the Thurston Region.

Any dredging activities that would occur with these alternatives would have to be consistent with the policies and regulations for dredging in the SMP.

Lake Alternative

Land Use. Land use would not change under this alternative.

Recreation. Park users would continue to experience the open-water views available at Heritage Park, the Capitol Lake Interpretive Center, Marathon Park, and along lakeside trails.

The North and Middle Basins would continue to serve as reflecting basins for the Heritage Park and the Capitol Building.

Capitol Lake would continue to provide open-water recreational opportunities like boating, fishing, and sight seeing.

Shoreline Use. This alternative would be consistent with the general goals and policies of the SMP for the Thurston Region (**Thurston Regional Planning Council 1990**) as summarized for the Lake/River Wetland Alternatives.

Any dredging activities that would occur with this alternative must be consistent with the policies and regulations for dredging in the SMP, and should be scheduled to avoid conflicts with boating activities.

Estuary and Combined Lake/Estuary Alternatives

Land Use. Impacts to land use would be the same as those described for the Lake/River Wetland alternatives.

Recreation. The open-water views available at Heritage Park, Marathon Park, the Capitol Lake Interpretive Center, and along lakeside trails would be lost. Lake views would be replaced by views of tidal flats and marshes, and with the Combined Lake/Estuary Alternative, a dam in the North Basin. Although, park use and walking, jogging, and bicycling on existing trails would still be possible, the loss of open-water views would change the outdoor experience that many lakeside park and trail users presently enjoy. Conversion to estuary conditions would expose large expanses of mudflat, particularly at low tide. Odors originating from decomposing algae and other organic matter may be noticeable along the shoreline.

Tidal exchanges would occur with two high and two low tides each day. Open-water recreational opportunities like boating and fishing in the North Basin, Middle Basin, and South Basin would be possible only during high tide conditions.

Restoration of an estuarine habitat would provide conditions suitable to develop a natural shellfish community, particularly of bivalves such as clams, mussels, and oysters. However, shellfish harvesting would be prohibited by the DOH due to high fecal coliform levels in Capitol Lake and the Deschutes River.

The primary difference between the Combined Lake/Estuary Alternative and the Estuary Alternative, is that the Combined Lake/Estuary Alternative would retain one-half of the North Basin as a reflecting pool through construction of a dam. Poor water quality could develop on the freshwater side of the dam and interfere with aesthetic enjoyment without an adequate freshwater source.

Either alternative would change the Heritage Park recreational experience. However, the Estuary Alternative would have the greatest potential to detract from the park and the vision of the 1911 master plan for the Washington State Capitol Building, and would be inconsistent with many of the park's features. The symbolic centerpiece of the park plan is the Arc of Statehood, a wide semicircular tree-lined walkway defining the lakeshore between the overlooks of the lake.

Existing freshwater wetlands adjacent to the Capitol Lake Interpretive Center would become a combination of low and high salt marsh. It would still serve as a park, but would provide a new recreational experience centered around brackish wetland habitats.

Shoreline Use. The historic value of the lake as a reflecting pool for the Capitol Building would either change or be reduced, depending on the estuary alternative selected. With the Combined Lake/Estuary Alternative, one-half of the North Basin would be retained as a reflecting pool while the other half would become estuary. The reflecting pool dam would interfere with distant views of open-water habitat and the west shore, especially at low tide. One of the SMP goals is to locate structures and uses in such a position that they are not highly visible from the water. The reflecting pool dam would be highly visible.

With the Estuary Alternative, the entire North Basin would become an estuary. The estuary would still function as a natural resource and would be consistent with the general goals and policies of the SMP for the Thurston Region. With both alternatives, the entire Middle Basin, and South Basin would become an estuary and for the same reasons would be consistent with the general goals and policies of the SMP.

The construction activities that would occur with the Combined Lake/Estuary Alternative would have to be consistent with the policies and regulations for landfilling in the SMP. A site-specific environmental review and analysis would be needed to determine if the dam could meet all the regulations.

No-Action Alternative

Land Use. Impacts to land use would be the same as those described for the Lake/River Wetland alternatives.

Recreation. As described for the Lake/River Wetland alternatives the open-water views available at Marathon Park, Capitol Lake Interpretive Center, and along lakeside trails would be replaced by views of emergent, scrub-shrub, and forested wetlands. In addition, open-water views available at Heritage Park would be lost.

Open-water recreational opportunities like boating and fishing would be lost in the entire lake.

Like the Estuary alternatives, the No-Action Alternative would change the Heritage Park recreational experience and would detract from the vision of the 1911 master plan for the Washington State Capitol Building.

A potential benefit of the No-Action Alternative, is that bird and wildlife watching opportunities would increase with the increase in area wetlands.

Shoreline Use. Although, the entire North, Middle, and South basins would change from open water to wetlands, they would still function as a natural resource. This would be consistent with the general goals and policies of the SMP for the Thurston Region.

Impacts would be similar to those described for the Lake/River Wetland alternatives.

Cumulative and Secondary Impacts

Projected increases in population will result in an increase in the demand for parks and trails. If open-water recreational opportunities like boating and fishing are lost, the demand for these opportunities would be redirected to other parks in the Thurston region.

Mitigations

Up to three new boardwalk trails would be constructed at several locations in the Middle Basin to enhance the recreational and educational value of newly formed wetlands.

Mitigation for reduced pedestrian/trail safety caused by additional wetland vegetation would involve vegetation control, additional trail lighting and more frequent police patrols.

Mitigation may be required for the Combined Lake/Estuary Alternative to resolve possible water quality problems in the freshwater pool in the North Basin. This problem may be adequately controlled by proposed circulation and flushing with LOTT re-use water or water from the Deschutes River, a spring, or a groundwater supply. If not, additional water quality management measures may be necessary to mitigate poor water quality on the freshwater side of the reflecting pool dam.

Unavoidable Significant Adverse Impacts

Open-water recreational opportunities like boating and fishing would be lost.

The recreational experience at existing parks and trails would change. Reduction of the reflecting pool function, with the Estuary alternatives and the No-Action Alternative, would be inconsistent with the Heritage Park objectives.

CULTURAL RESOURCES

Existing Conditions

Native Americans from the tribes now known as the Squaxin, Nisqually, and Chehalis tribes gathered shellfish and frequented the inlets and prairies of Puget Sound. The rivers of Thurston County were long-established sites for salmon harvesting, and the prairies of the County were popular hunting, planting, and harvesting sites.

Capitol Lake is, itself, considered an historically significant resource given the fact the lake was conceived as part of the 1911 Capital Campus Plan prepared by architects Wilder and White. The lake was originally formed to serve as a reflecting water body for the Capitol Building.

With respect to other historic resources, there are numerous historical buildings in the vicinity of Capitol Lake.

Cultural Background and Resources - Capitol Lake

Capitol Lake, particularly the area around the South Basin, was the site of significant prehistoric and historic activities. Two sites along the lake have been registered with the Washington Archaeological Research Center in Pullman as prehistoric resources. One two-acre site in the Tumwater Historical Park contains evidence of a Native American fishing village and shellfish collecting site. Artifacts indicate this site may have been a permanent village of the Native Americans for 500 years or more. Another area on the east shore of the South Basin was probably occupied for hunting and fishing activities. An unregistered third site, discovered along the west shore of the South Basin, was most likely a fishing location and contains scattered cultural materials. The exact location of these sites have not been given in this document to avoid the possibility of unauthorized removal of archaeologically important material.

The traditions and lifestyle of the Native Americans of Southern Puget Sound, specifically in the Budd Inlet area, depended substantially on seafood gathered from the beaches and saltwater. Coho and chum salmon, dried and smoked, were the staple of winter and early spring food for the inhabitants of the area. Shellfish of many kinds, including native oysters, abounded on the gravelly shores and exposed tide flats. Budd Inlet was a favorite area for digging, drying, and smoking clams. Remains of shell mounds in the area indicate that besides, several species of clams and the goeduck, the Native American diet included whelks, mussels, moon snails, large barnacles, and limpets.

The lifestyle of the Native Americans also depended on the plants in the adjacent woods and prairies. Roots, bulbs (especially the blue flowering camas), nuts such as acorns, and berries of many kinds were gathered.

Large cedar logs were used to build canoes by a process of controlled burning and dazing. Cedar roots were woven into baskets. Woven cattails were used as ponchos for protection from the rain. Tule reeds and cattails were woven into mats of various sizes which served a variety of purposes including kneeling pads for canoe paddlers, table cloths, padding for sleeping platforms, wall hangings to keep the draft out from between the wall planks of dwellings, and coverings to keep beached canoes from warping or splitting. These mats also served a very important use as portable coverings for lightweight house frames that were used during the more migratory life of root gathering and berry picking during spring and summer.

Until shortly after the mid-18th century, the Native Americans of southern Puget Sound lived in a cultural pattern strong in traditions. This was interrupted by the westward expansion of European settlement. In 1841, American exploration of Puget Sound was undertaken by Lt. Commander Charles Wilkes, who mapped and named landmarks throughout the region. Four years later in 1845, Michael T. Simmons led the first group of permanent American settlers to Tumwater Falls. He settled in the area that would become Tumwater while others settled in the rich prairies to the south.

Today, members of the Squaxin Island Tribe maintain an active cultural interest in the rearing and harvesting of salmon, as well as other fish and shellfish resources of the southern Puget Sound, including those of Capitol Lake and the Deschutes River.

Impacts

Lake/River Wetland Without Trap and Lake/River Wetland With Trap Alternatives

Because the Middle and South basins would not be maintained as open-water areas, their associated historic and cultural values would change. The lake would fill with sediment over time and become a freshwater marsh and river channel. This would affect the fish and plant resources that have played an important role in the culture of the Native Americans of Southern Puget Sound. The net effect would be the replacement of open-water habitat with wetland habitat, a shift that would provide enhanced habitat value that could be used to plant and cultivate wetland plants suitable for traditional Native American cultural uses, but which would reduce open-water habitat for fish. Impaired water quality conditions could be detrimental to fish and other aquatic life depending on location, time of year, and time of day. The poorest water quality would be expected in late summer or early fall in areas with poor circulation and high plant biomass (aquatic plants or algae).

Without mitigation, the loss of open-water habitat throughout the lake could eliminate the WDFW chinook freshwater rearing program and could affect the capacity for rearing juvenile salmon (see the Fisheries section).

Lake Alternative

There would be no impacts to cultural or historic resources.

The Estuary and Combined Lake/Estuary Alternatives

The historic value of the lake as a reflecting pool for the Capitol Building would be reduced.

Because the Middle and South basins would not be maintained as open-water areas, their associated historic and cultural values would change. The conversion back to estuary conditions would expose mudflats, particularly at low tide. This would eliminate some fish and freshwater plant resources that have played an important role in the culture of the Native Americans of southern Puget Sound. Restoration of an estuarine habitat would provide water quality conditions suitable to develop a natural shellfish community, particularly of bivalves such as clams, mussels, and oysters. However, harvesting would be prohibited due to possible contamination by fecal coliform bacteria from the Deschutes River and Capitol Lake.

Replacement of open-water habitat with estuarine habitat would reduce open-water habitat for fish and, without mitigation, could eliminate the WDFW chinook freshwater rearing program (see the Fisheries section) and other culturally important fish produced by this operation.

The estuary that existed prior to the formation of Capitol Lake would be restored and would become a compatible setting for the prehistoric sites described earlier.

No-Action Alternative

Impacts would be similar to those described for the Lake/River Wetland alternatives. However, in addition, the historic value of the lake as a reflecting pool for the Capitol Building would be reduced, and without mitigation, its use as an important salmon rearing facility in Percival Cove would be eliminated.

Mitigations

Refer to the Water Resources and Plants and Wildlife sections for a discussion of mitigation measures associated with potential impacts to fisheries.

Unavoidable Significant Adverse Impacts

The Combined Estuary/Lake Alternative, Estuary Alternative, and No-Action Alternative would result in the reduction of the historic value of the lake as a reflecting pool for the Capitol Building.

AESTHETICS

View Analysis Methodology

Aesthetic Criteria

When assessing an area for visual quality (aesthetics) and its potential for impacts from proposed changes, both the perspective of the viewer and the characteristics of the site are considered. The following criteria for the viewer's perspective were used to assess the existing visual character of the site and the potential for impact:

- **Viewer Distance.** The distance at which an area is viewed influences the amount of objects that can be seen and the panoramic quality of the view. Views can be divided into foreground, middleground, and background. These ranges are established by using distinguishable details in the landscape. Foreground views are between 0 and 500 feet, with clearly distinguishable features in landscape elements. Impacts to the foreground view would have greater impact than changes to the background view. Middleground views are from 500 feet to one-half mile, with broadly distinguishable features. Background views are one-half mile and beyond, with no individually distinguishable features.

- **Viewer Activity.** The viewer's activity often determines the sensitivity of the viewer to the surrounding views. For example, a person using a park is usually more sensitive to visual degradation than a person within an industrial setting. Therefore, the sensitivity of a viewer can often be inferred from the land use. For Capitol Lake, the major land uses seen by the viewer include recreational, commercial, residential and transportation corridors.

- **Duration of View.** This criterion refers to the length of time that the area is viewed. For example, motorists using I-5 would view the area for a relatively short time, when compared with nearby residents, and therefore the potential for significant impacts is less.

- **Viewer Position.** The viewer's relative position above or below the area. For example, is the viewer on a hill overlooking Capitol Lake, or is the viewer at the shoreline?

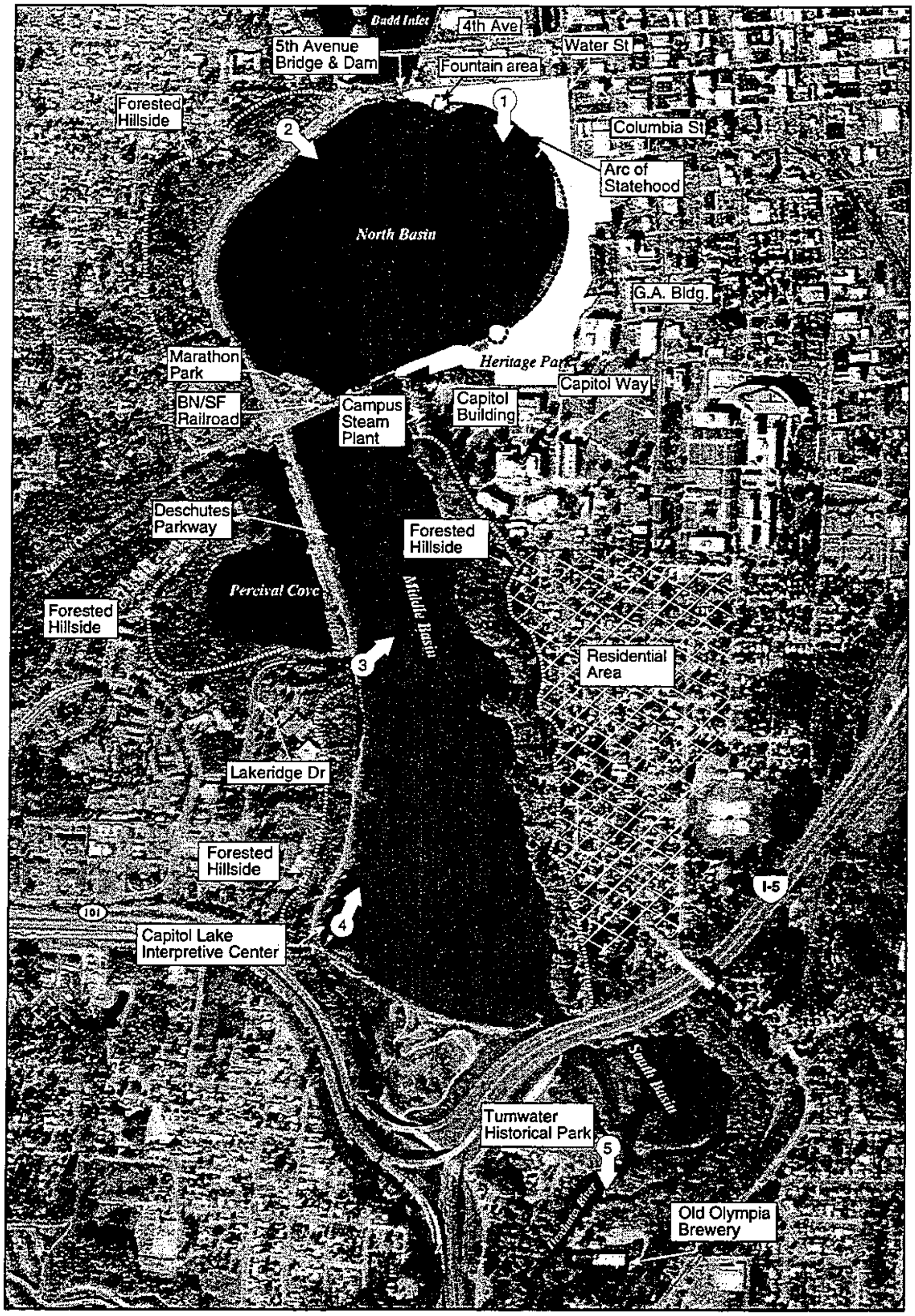
- **Number of Viewers.** The relative number of viewers is an important consideration in evaluating the area's visual quality.

In addition to the viewer's perspective, the following characteristics of the site were considered to determine the site's vulnerability to visual impacts:

- Encroachment by manmade structures, such as utility poles or railroad tracks.
- The presence of distinctive landscape features, for example, open water, steep slopes, or tall buildings.
- Contrasting elements, such as differences in color, line, or shape, which create a more memorable landscape. Ordinary landscapes lack these distinguishing elements.
- The presence of historic or culturally significant resources.

View point	Location	Direction of View	Characteristics	Purpose
1	North Basin - On south side of 5th Avenue at Simmons Street	South	Has views through Heritage Park of the North Basin and the Capital Campus Building.	Assess change in views of the North Basin for people in the downtown area on the north side of the lake.
2	North Basin - Along sidewalk adjacent to Deschutes Parkway.	Southeast	Has the widest expanse of open views toward the Capitol Building and the reflecting pool aspects of the North Basin.	Assess change in views of the North Basin for people along Deschutes Parkway.
3	Sidewalk - adjacent to the Lakeridge Drive/Deschutes Parkway intersection	East	Has the closest view of Capitol Building and includes motorists' views at the Lakeridge Drive/Deschutes Parkway intersection and pedestrian views from the west shore sidewalk.	Assess change in views of the Middle Basin for motorists and recreational users along Deschutes Parkway.
4	Capitol Lake Interpretive Center	North	Has extended views of the Middle Basin.	Assess changes within the Middle Basin
5	Tumwater Historical Park	Southeast	Has views from Tumwater Historical Park across the South Basin and Deschutes River toward the historic Olympia Brewery. The location is near the point where the River enters the South Basin.	Access change in views from Tumwater Historical Park.

Table 4-8
Description of Key Viewpoints



0 800 feet 1600 feet

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Figure 4-2
Viewpoint Locations

Five key viewpoints were selected to assess existing conditions and the potential for impacts (**table 4-8**). **Figure 4-2** shows the viewpoint locations and view directions used in this section. The viewpoints were selected by the Capitol Lake Adaptive Management Steering Committee. These viewpoints are susceptible to substantial impacts from the alternatives and represent different sections of the lake. To evaluate the potential visual impacts of the alternatives, conceptual drawings were developed depicting future views from the viewpoints.

Existing Conditions

Capitol Lake is a unique resource that is highly valued for its scenic, aesthetic, and historic qualities. In addition, the setting that Capitol Lake provides for the culturally and historically significant Capital Campus and the Capitol Building is important to state residents and tourists.

The North Basin, created as a reflecting pool for the Capitol Building, was envisioned in the original Capital Campus plan developed by the architects Wilder and White in 1911. As stated prior to the creation of the lake,

> "The area has long been considered by Olympians as an eye-sore. Now it will be replaced with a clear beautiful freshwater lake with mirrored reflections of the Capitol Building dome and the spires of the tall stately trees for which the Evergreen State is noted." (**Heritage Park EIS, The Portico Group 1997**)

Viewpoint 1: Views of the North Basin from 5th Avenue at Simmons Street

The existing view from 5th Avenue next to the Corrections Building (Viewpoint 1, see **figures 4-2** and **4-3**) includes the eastern half of the North Basin, generally unobstructed views of the north side of the Capitol and General Administration buildings, and the forested hillside. Fifth Avenue can be seen in the foreground. The parking lot and telephone poles detract from the scenic quality of views.

The impact analysis of views from this location assume that Heritage Park is in place (that is, the park is already constructed). Therefore, views south from Viewpoint 1 will likely consist of a formal stand of trees as shown by the proposed design of Heritage Park (**figure 4-4**). In addition, a large portion of the open-water area will be filled to construct the park.

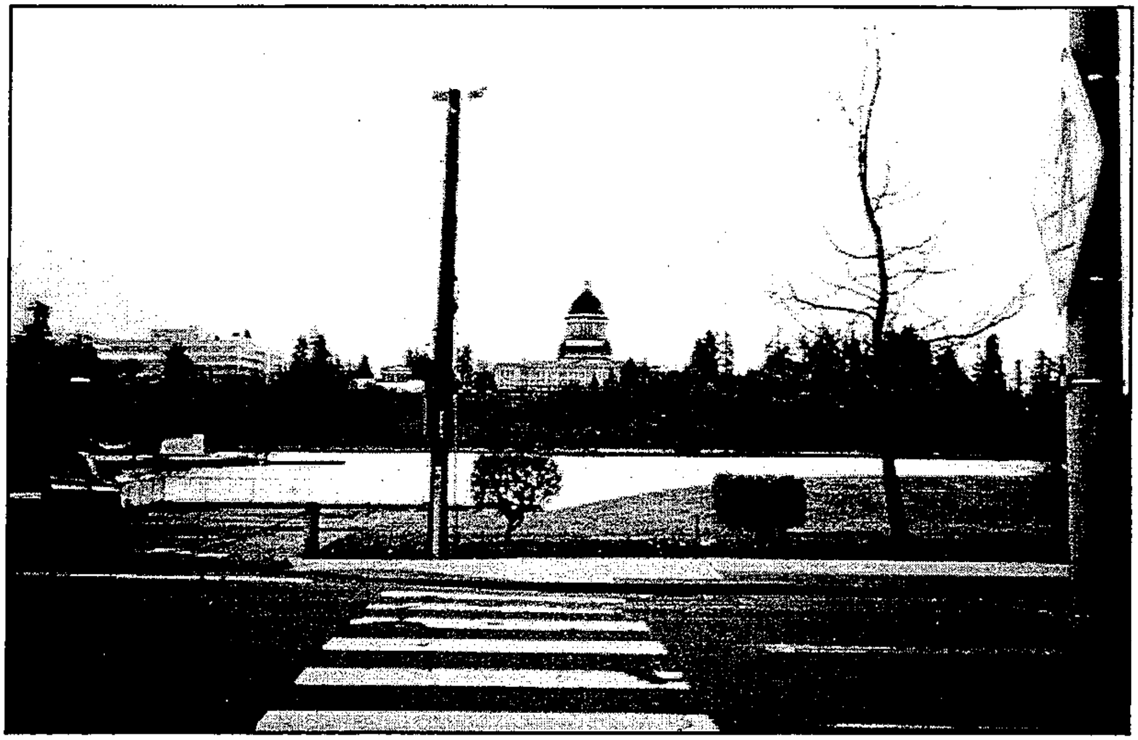
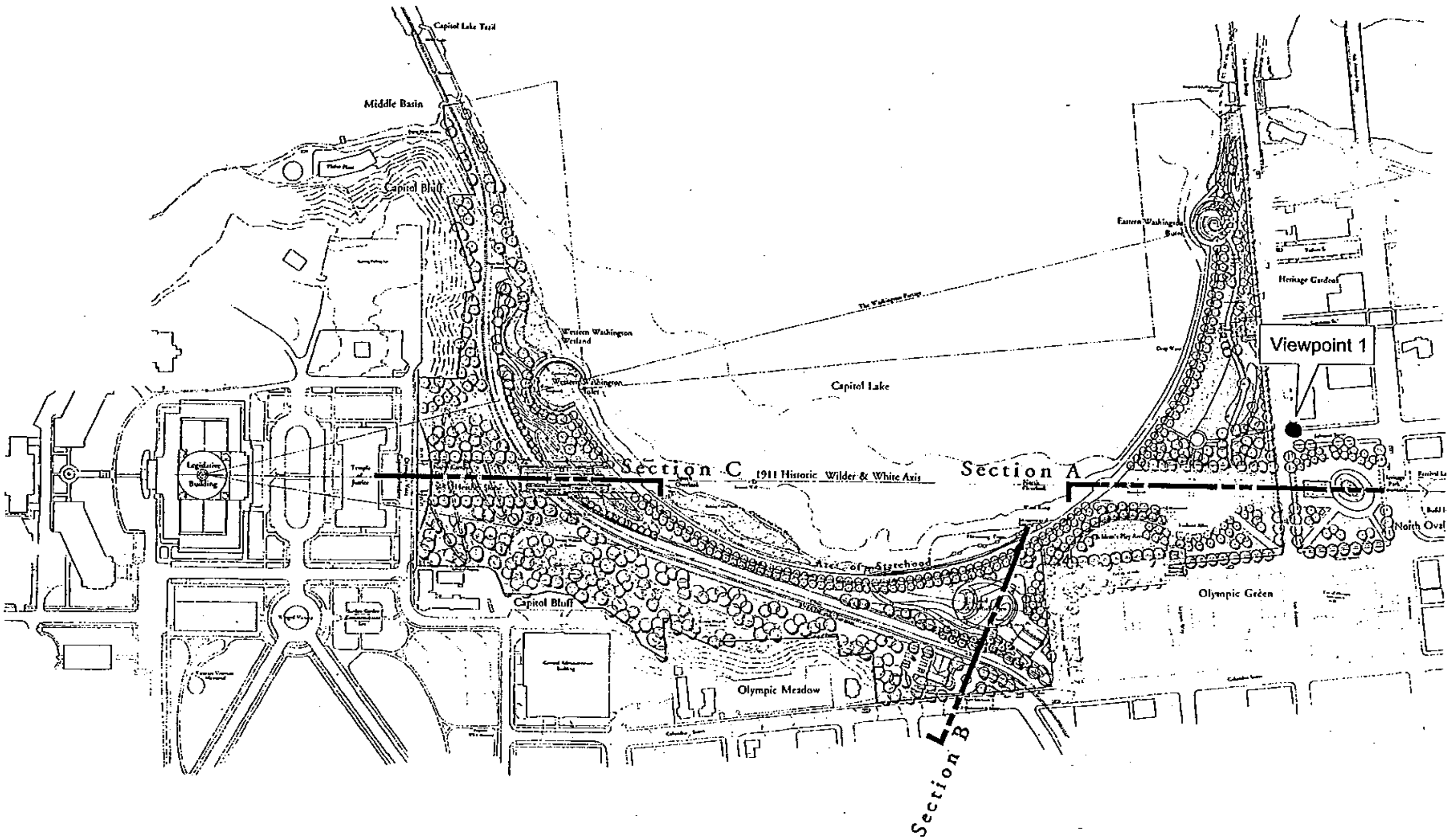


Figure 4-3
Viewpoint 1 - Existing Conditions

Viewpoint 2: Views of the North Basin from Deschutes Parkway

Views from the northwestern shore of the North Basin include the north side of the Capitol Building, which lies on the eastern plateau above the lake, Heritage Park, and a partial view of the downtown commercial/retail core toward the east and north (**figure 4-5**). On calm days, the Capitol Building is reflected in the lake. The downtown section is relatively flat when compared with the land surrounding the rest of the North and Middle basins. From Viewpoint 2 (**figure 4-2**), the North Basin appears as a wide, circular body of water. From this location, views of the Middle Basin are blocked by the dike and railroad trestle separating the basins. This area is viewed by a large number of pedestrians and motorists along Deschutes Parkway.

There are unobstructed scenic views of open water and the Capitol Building with its tree-filled hillside. However, other dominant buildings of contrasting architectural styles within the downtown core toward the east and the north and within the Capital Campus detract from the scenic views.



Source: Heritage Park EIS, The Portico Group

Figure 4-4
Plan View of Future Phasing of Heritage Park

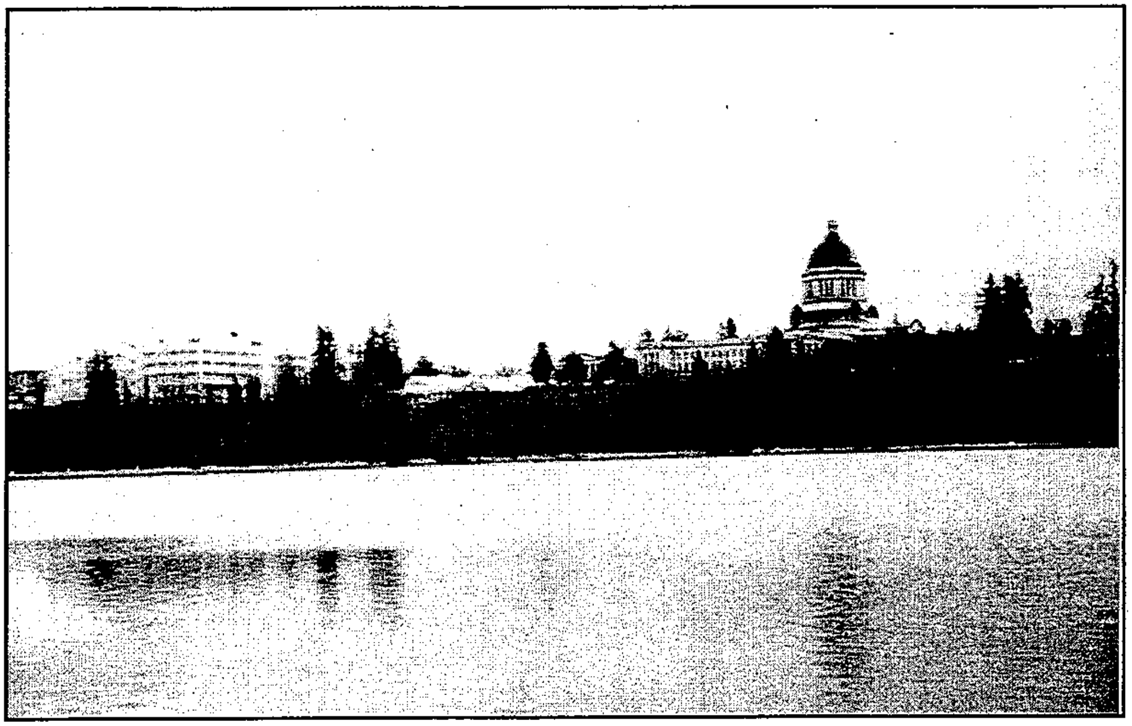


Figure 4-5
Viewpoint 2 - Existing Conditions

The principal land use activity that can be seen from Viewpoint 2 is commercial development in the downtown core; a rail line at the south end of the North Basin; recreation, such as Marathon and Heritage parks; and forested hillsides toward the west. In the background to the south, are views of I-5 and homes along the hillsides.

Viewpoint 3: Views of the Middle Basin from Deschutes Parkway/Lakeridge Drive Intersection

Views along the Deschutes Parkway from the northern half of the Middle Basin provide the closest and most complete views of the Capitol Building from Capitol Lake. As viewed from the sidewalk adjacent to the Deschutes Parkway/Lakeridge Drive intersection, the Capitol Building is framed on both sides by evergreen and deciduous trees. The Capitol Building and trees are reflected in the water in a relatively narrow section of the Middle Basin (**figure 4-6**).

The steep hillside along the eastern shore of the Middle Basin is densely wooded with red alder, bigleaf maple, and Douglas fir.

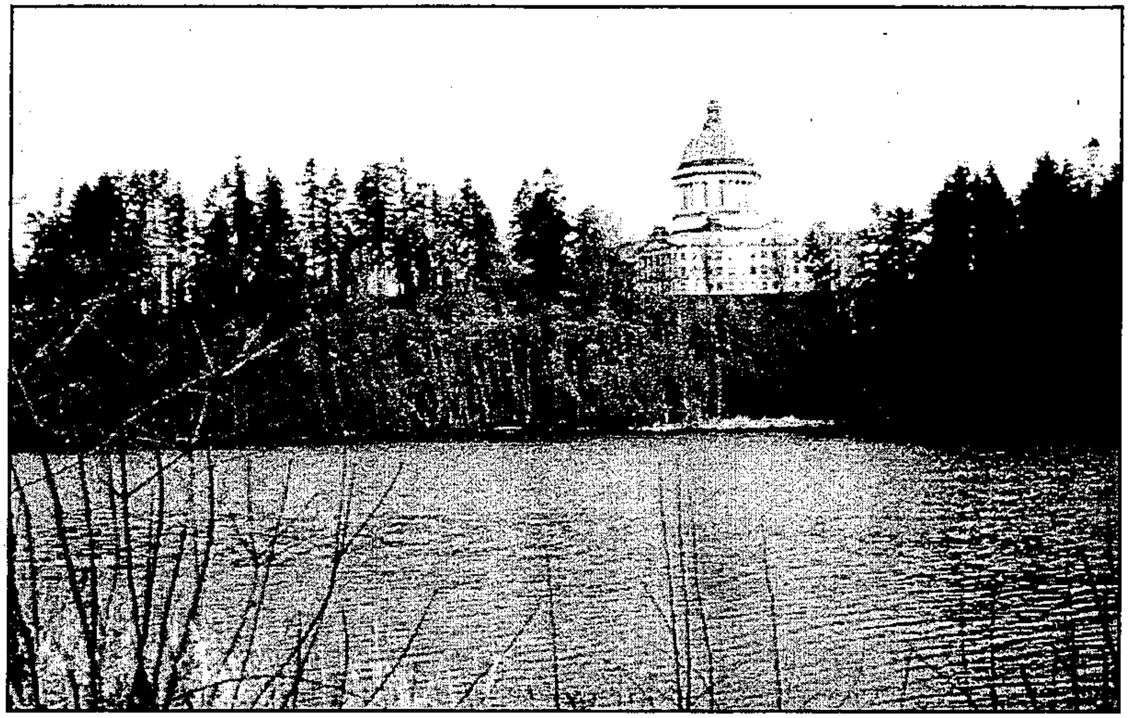


Figure 4-6
Viewpoint 3 - Existing Conditions

The hillside rises to a plateau about 100 feet from the lake shore elevation. The plateau is occupied by the Capitol Building (**figure 4-6**) and residential development to the south (**figure 4-2**).

From Viewpoint 3, homes on the edge of the plateau are generally screened by trees, but can be seen partially in winter. The eastern shoreline of the Middle Basin usually has overhanging vegetation, and has a more natural appearance than the shoreline of the North Basin. Views of the North Basin are restricted by the shoreline and the railroad trestle dividing the two basins.

Views for motorists at the Deschutes Parkway/Lakeridge Drive intersection are not as scenic due to the presence of distracting elements, such as the roadway, a light pole directly east of the intersection (which interferes with views of the Capitol Building), and a bus shelter. It should be noted that drivers at the intersection are focusing on turning and therefore, their main attention is on the traffic along Deschutes Parkway, rather than on views east toward Capitol Lake.

Homes along Capitol Lake's eastern plateau of the Middle Basin have views of the lake that generally are partially or completely blocked by vegetation. In contrast, views from buildings along the lake's western bluff, such as portions of the Thurston County Courthouse and the homes above Percival Cove, have mostly unobstructed views of the lake and the Capitol Building.

Viewpoint 4: Views of the Middle Basin from Capitol Lake Interpretive Center

Views northeast from the dock of the Capitol Lake Interpretative Center are toward the eastern forested hillside of the Middle Basin as well as a wooded peninsula along the western shore (**figure 4-7**). A large section of the open water of the Middle Basin can be seen in the foreground and the dome of the Capitol Building can be seen in the background. The lower portions of the Capitol Building are blocked by vegetation. Homes along the edge of the eastern plateau, particularly along the basin's southern end, can be seen partially from Viewpoint 4 (**figure 4-2**). Trees on either shore are reflected in the Middle Basin of the lake.

The uniform (without distracting elements) forested eastern and western shores and the dome of the Capitol Building provide a scenic background for the open waters of the Middle Basin. The Capitol Building is less dominant from Viewpoint 4 than from Viewpoint 3, and the few scattered homes along the eastern bluff are generally screened by dense vegetation.

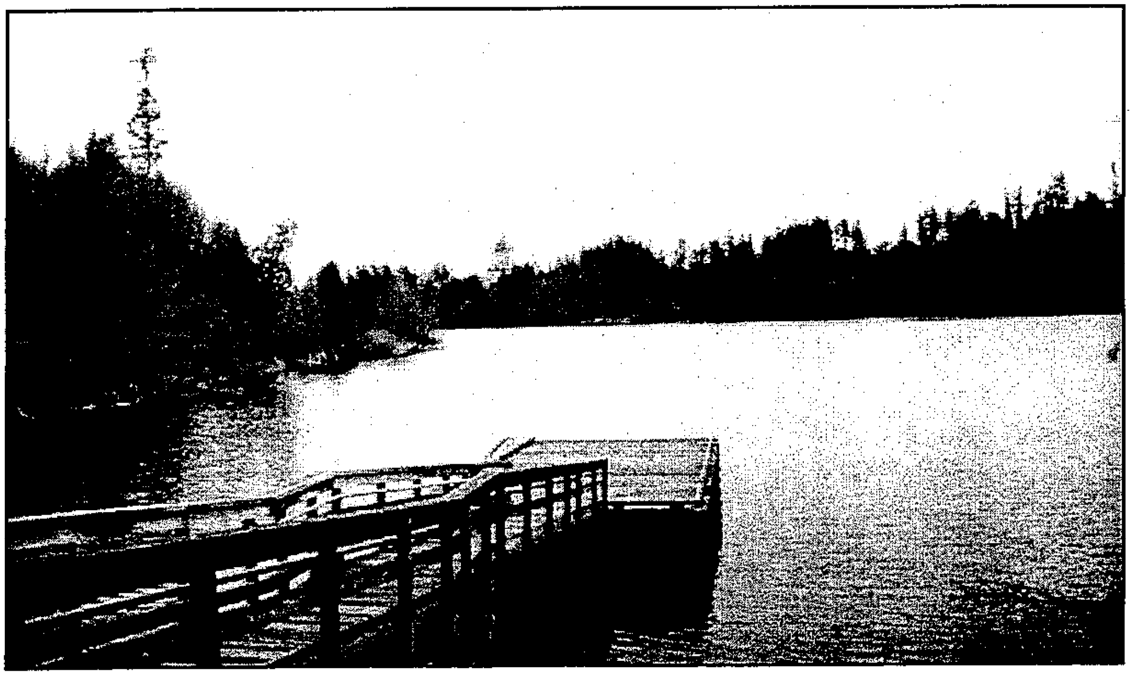


Figure 4-7
Viewpoint 4 - Existing Conditions

Viewpoint 5: View of South Basin from the Tumwater Historical Park

This view from Tumwater Historical Park looks to the southeast toward the historic Olympia Brewery (photograph of existing conditions not shown as it looks very similar to the future rendering that is shown in **figure 4-11**). Formal park landscaping is visible in the foreground, including a sidewalk, park bench, and handrail. The open water of the Deschutes River is visible in the middleground. This viewpoint is where the river enters the South Basin. Along the eastern edge of the river is a stand of mature cattails. Beyond the brewery, the view encompasses a mixed forest of deciduous (mostly red alder and big leaf maple) and conifer trees (Douglas fir, cedar, etc.)

The park landscaping, the water element, and the uniform (without distracting elements) forested background, make this view of the historic Olympia Brewery very scenic. Only the more industrial character of some of the buildings associated with the brewery detract from the quality of the view.

Impacts

The impact of each alternative on Capitol Lake's visual quality would depend on the area of open water replaced by freshwater vegetation or salt marsh vegetation and mudflats. The scenic qualities that open water provides—such as extended vistas, reflections of the Capitol Building and the sky—would be reduced or lost, depending on the viewpoint, as freshwater wetlands or salt marsh wetlands and mudflats replaced open water.

Another important aesthetic issue is how the estuary alternatives would differ from the freshwater alternatives. With the estuary alternatives, mudflats would be exposed twice per day, to a greater or lesser extent, depending on the magnitude of tidal highs and lows. Some reflecting pool function would be visible in the estuary alternatives, depending on the point in the tidal cycle and the amount of water in each basin. In contrast, the reflecting pool function would be constant (there would always be water in the basin) for all freshwater alternatives.

Unless otherwise noted, the impacts are based on the mature state of the alternatives.

Lake/River Wetland Without Trap and Lake/River Wetland With Trap Alternatives

The open-water condition of the North Basin would be retained in both Lake/River Wetland alternatives. Therefore, changes in views would not occur in the North Basin with either alternative. Maintaining the North Basin as a reflecting pool is consistent with the general goals and policies of the City of Olympia's Comprehensive Plan. Park users in the North Basin would continue to experience the scenic open-water views from locations along shoreline sidewalks and trails. The historic value of Capitol Lake as a reflecting pool would be retained.

Significant visual changes would occur in the Middle Basin. As sediment in-filling progresses, the entire basin, with the exception of the main river channel, would be covered by thick freshwater wetland vegetation such as cattails. Lake views would be replaced primarily by views of emergent, wetlands consisting of cattails, and to a lesser extent, scrub-shrub vegetation (e.g., willows and hardhack). With wetlands replacing open-water areas, it is likely that formally unrestricted views from the lakeshore would be at least partially blocked by wetland vegetation (**figure 4-8**).

Views from Viewpoint 3 would change as open-water areas are reduced to the main river channel. The scenic qualities of large open-water vistas would be replaced with expansive views of freshwater wetlands (**figure 4-8**). Foreground and middleground views would be dominated by emergent wetland vegetation, such as cattails (**figure 4-8**) and the main channel of the Deschutes River would be screened. The loss of open-water areas, except for the river channel, would almost eliminate the Middle Basin's current ability to serve as a reflecting pool for the Capitol Building.

Similarly, foreground and middleground views from the Capitol Lake Interpretive Center (Viewpoint 4) would be dominated by cattails and other emergent wetland plants. Scrub-shrub vegetation would be seen in the middleground distance. The main river channel would be screened by the vegetation (**figure 4-9**). The scenic open-water views would be replaced by wetland vegetation.

In the near-term (10 to 20 years), prior to the establishment of emergent vegetation, open-water areas would be viewed in the foreground of Viewpoint 4, while scrub-shrub vegetation would begin to occupy newly forming sand bars along the central axis of the Middle Basin (**figure 4-10**). Over time, emergent vegetation would become established, restricting the open-water views to the main river channel.

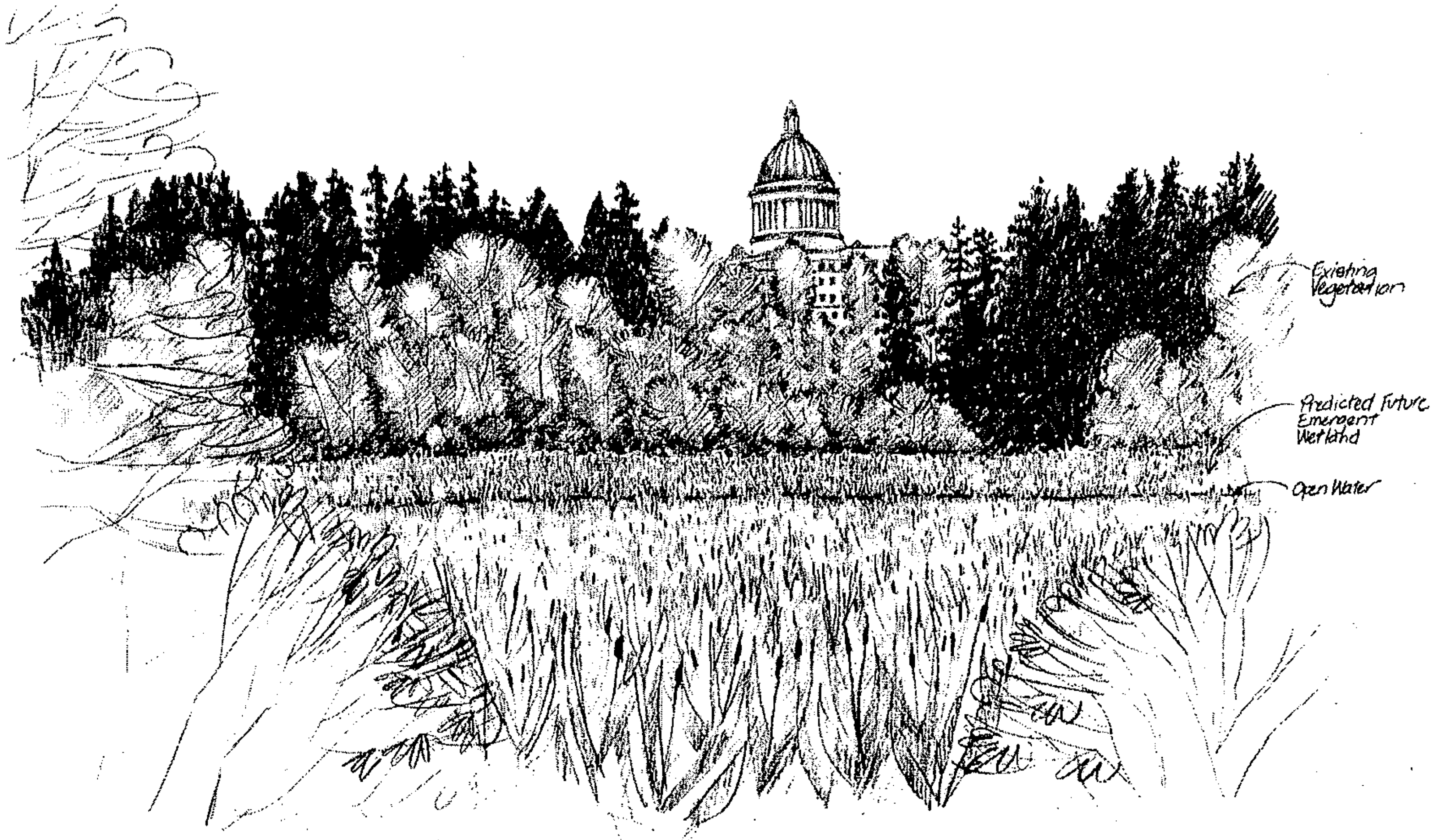


Figure 4-8
Alternative: Lake/River Wetland Without Trap
Viewpoint 3 - At Mature Development

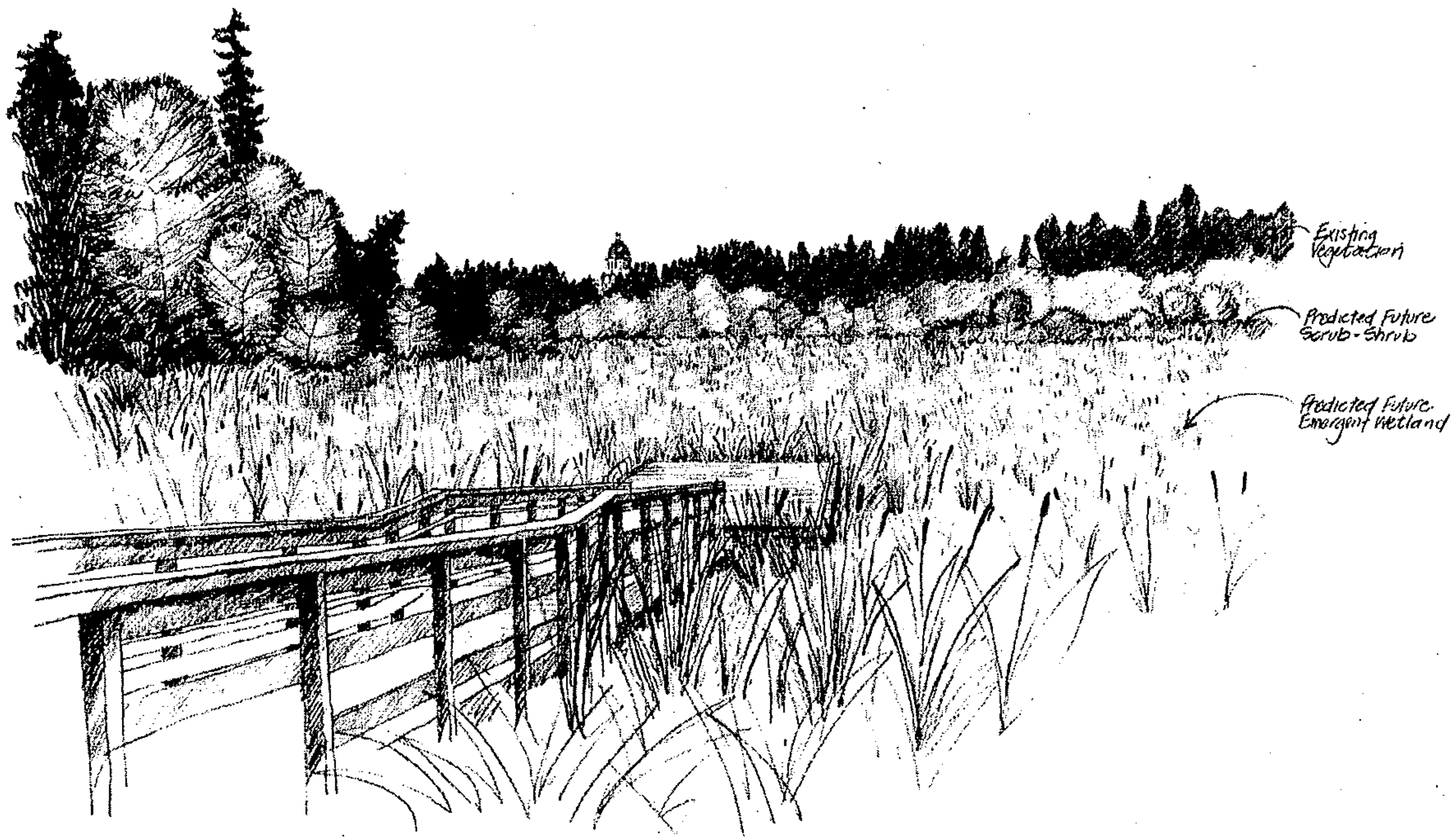


Figure 4-9
Alternative: Lake/River Wetland Without Trap
Viewpoint 4 - At Mature Development

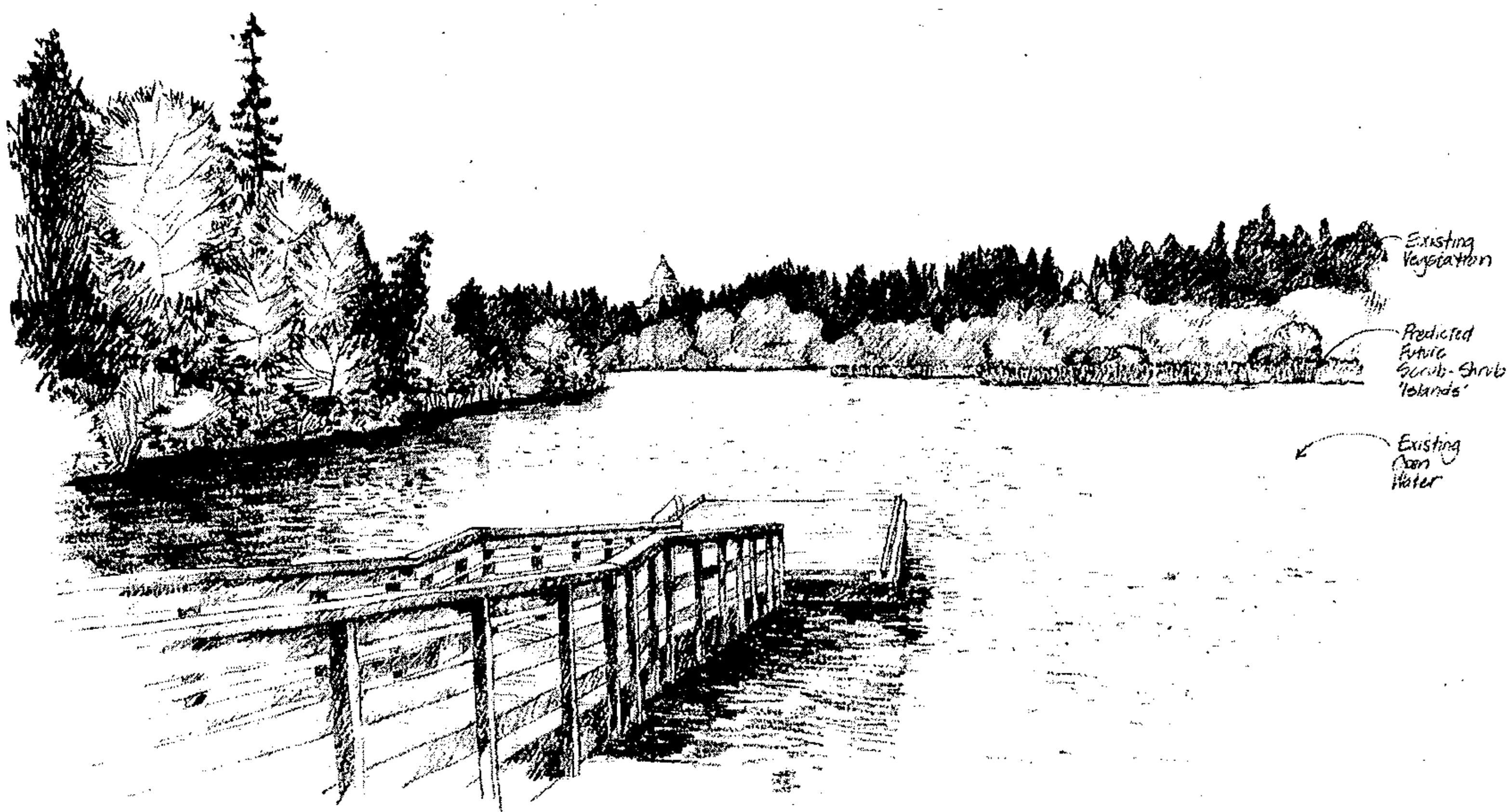


Figure 4-10
Alternative: Lake/River Wetland Without Trap
Viewpoint 4 - At Intermediate Development

At viewpoint 5 there would be little change from existing conditions (**figure 4-11**). The open-water aspect of middleground views would be retained. There could be some additional development of cattail beds and scrub-shrub vegetation between the river channel and brewery, but no major changes in the forested background terrain would be expected.

Lake Alternative

Only minor visual changes would occur in the South Basin with additional development of vegetated islands. No significant changes would be visible at Viewpoint 5. Because the Middle and North basins would be maintained in their existing condition there would be no impacts at any of the viewpoints. Important scenic and historic views would be preserved. Park users would continue to experience the scenic open-water views available from Heritage Park, the Capitol Lake Interpretive Center, Marathon Park, shoreline sidewalks and trails, and Deschutes Parkway.

Estuary Alternative

From Viewpoint 1 (**figure 4-12**), the Estuary Alternative would appear similar to the freshwater alternatives because the foreground would be dominated by mature trees in Heritage Park.

However, from Viewpoint 2, there would be significant visual changes in the North Basin. The open-water views from Viewpoint 2, from the western shore, would be replaced by foreground views of salt marsh vegetation, and middleground views of open saltwater and islands of marsh plants (**figure 4-13**). During the intermediate period (not shown), the foreground and middleground views would consist primarily of mudflats and patches of salt marsh vegetation during low tide, and open water with salt marsh vegetation during high tide. Undesirable orders may be experienced during periods when tidal mudflats are exposed.

The reflecting pool function of the North Basin would be almost eliminated at the time of maturity, when only the river channel would be filled with water at high tide. The loss of the majority of the reflecting pool function of the North Basin would be inconsistent with the original design concept for Heritage Park, and the formal landscaping of Heritage Park would contrast with natural marsh vegetation.

When compared to the Lake/River Wetland alternatives, the salt marsh vegetation in the Estuary Alternative would be low to the

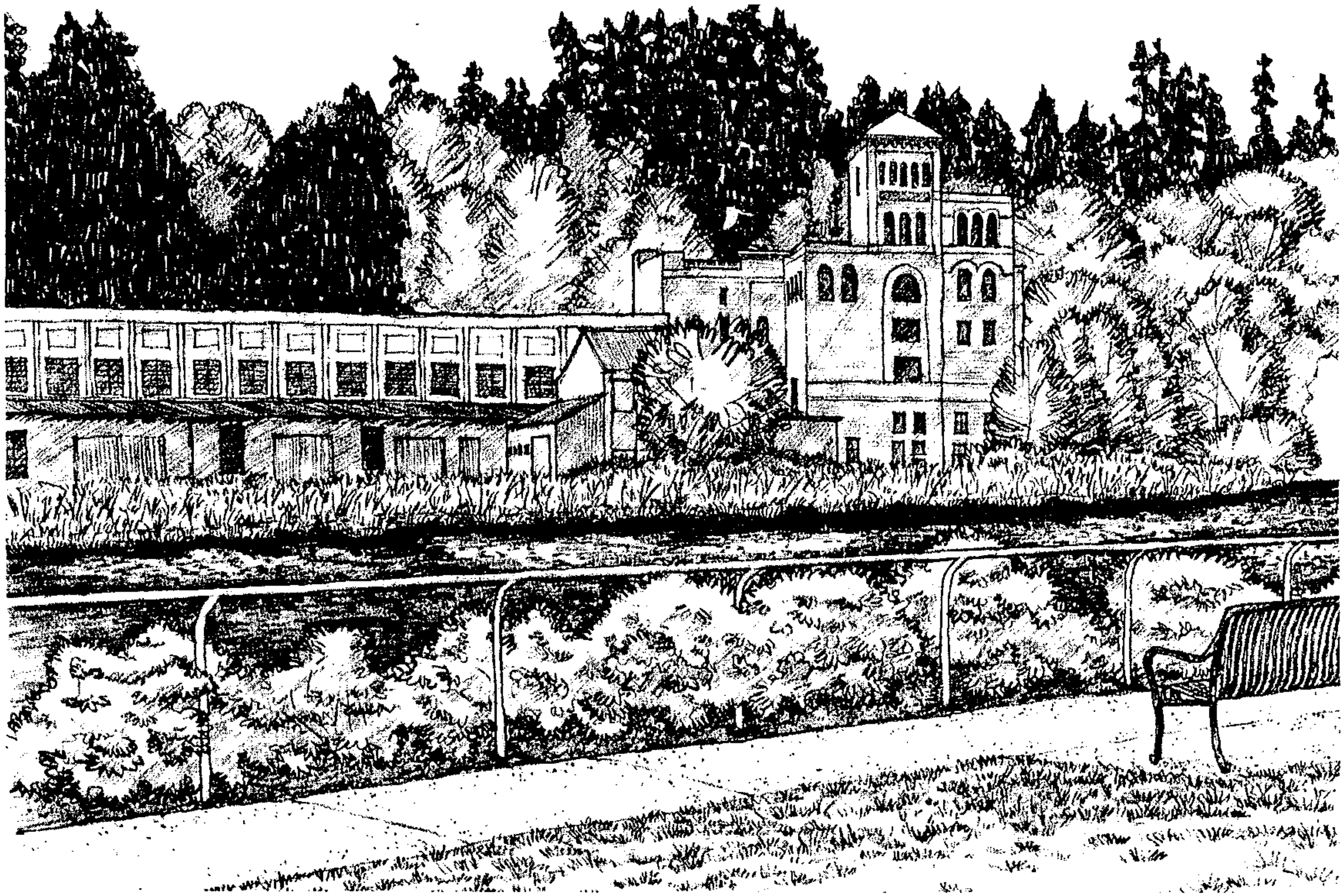


Figure 4-11
Alternative: Lake/River Wetland Without Trap
Viewpoint 5 - At Mature Development

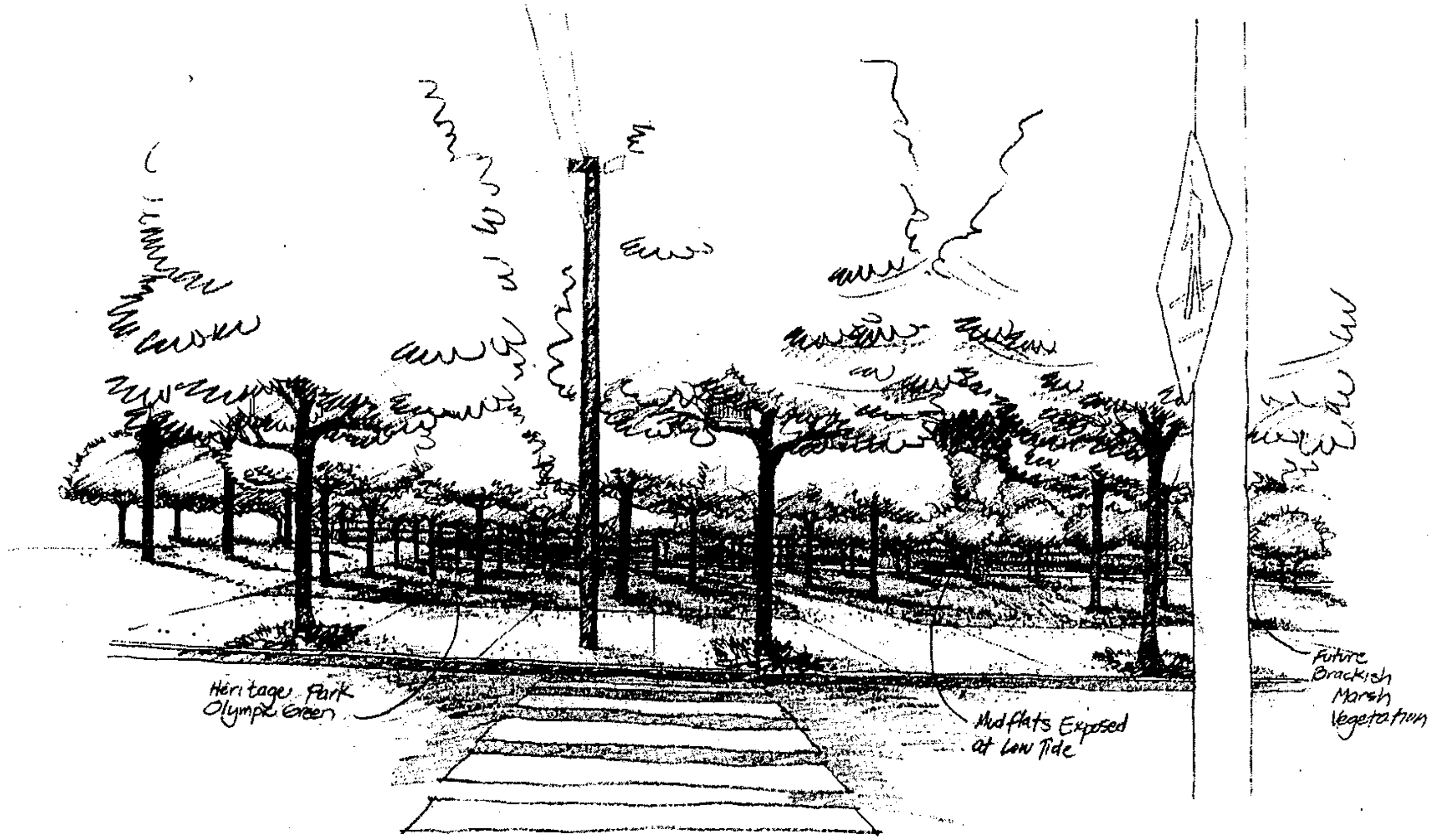


Figure 4-12
Alternative: Estuary
Viewpoint 1 - At Intermediate Development - Low Tide

Figure 4-13
Alternative: Estuary
Viewpoint 2 - At Mature Development - High Tide

ground and would be less uniformly distributed than the tall, dense, and uniform emergent freshwater vegetation.

In the Middle Basin, the Estuary Alternative would be similar to the Lake/River Wetland alternatives, because open-water views would be replaced with vegetation and the reflecting pool function would be almost lost. The vegetation would look different because the salt marsh vegetation in the Estuary Alternative would be lower to the ground and less dense than the emergent freshwater vegetation of the Lake/River Wetland alternatives from Viewpoints 3 and 4 (**figures 4-14** and **4-15**). The principal visual change would be the replacement of open water with salt marsh vegetation. Due to the relatively short height of salt marsh plants, the river's main channel would be visible in the Estuary Alternative (**figures 4-14** and **4-15**).

In the interim period, prior to full maturity, under low tide conditions in the Middle Basin, visual changes would be greater with the Estuary Alternative than for the Lake/River Wetland alternatives. Extensive mudflats would alter views from the Capitol Lake Interpretive Center (**figure 4-16**) and other views toward the Middle Basin. Under high tide conditions, visual changes for the Estuary Alternative would be similar to the two Lake/River Wetland alternatives since the mudflats would be covered by water. At high tide, there would be a better reflecting pool view during the interim period.

Combined Lake/Estuary Alternative

This alternative is distinguished from the Estuary Alternative by the presence of a new north-south reflecting pool dam just east of the central axis of the North Basin. The Capitol Building would be reflected in the eastern half of the North Basin from any viewpoint along the north shore and east of the new dam. However, with the development of brackish marsh vegetation, the appearance of the remainder of the basin would be similar to the Estuary Alternative. As with the Extuary Alternative undesirable odors may be experienced when tidal mud flats are exposed.

From Viewpoint 1, the visual impacts of the Combined Lake/Estuary Alternative would be similar to the Estuary Alternative, because the foreground view would be dominated by mature trees in Heritage Park (compare **figures 4-12** and **4-17**). Therefore, it would be difficult to distinguish the differences in the middleground views of vegetated versus open-water areas from this perspective.

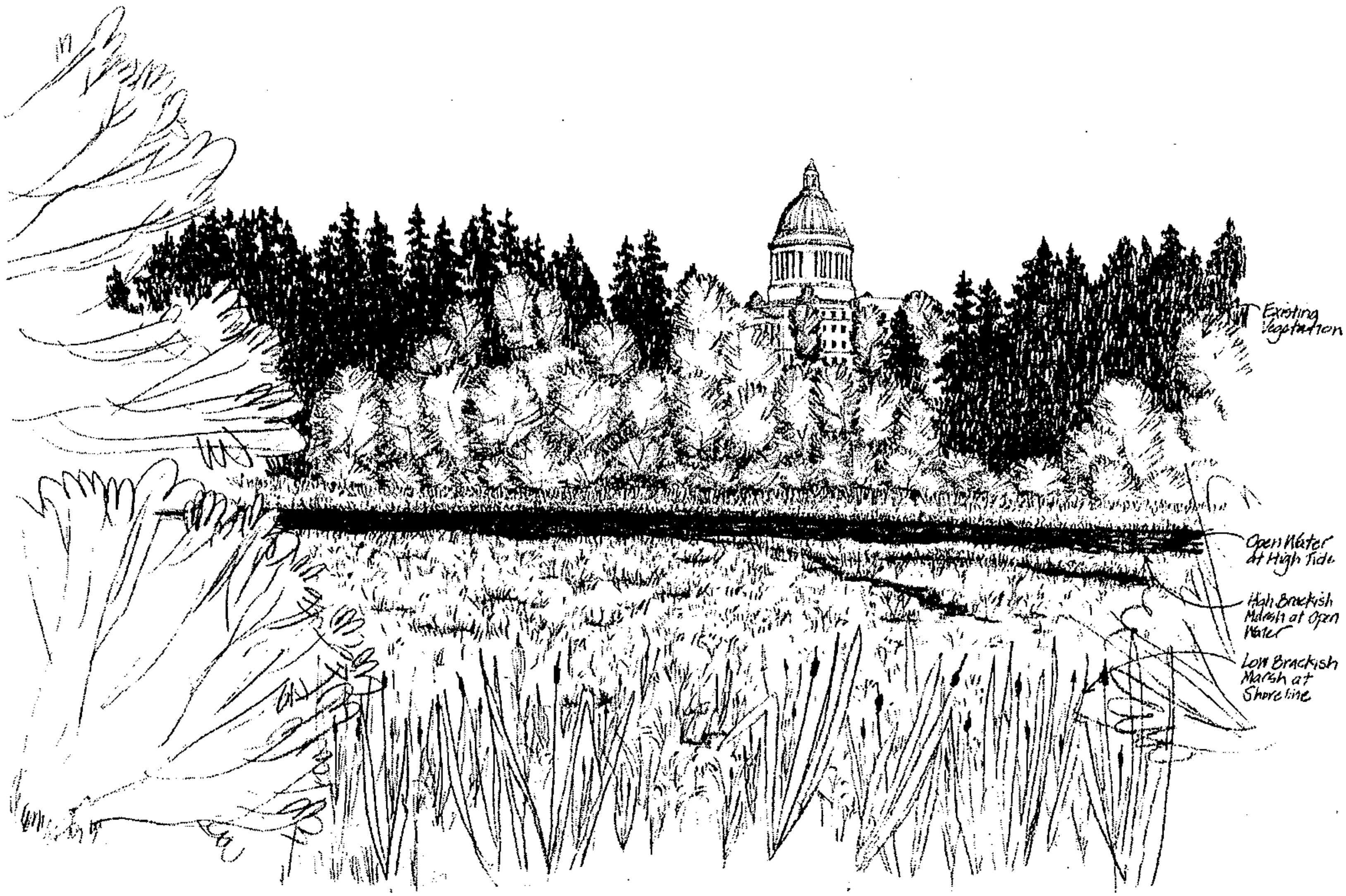


Figure 4-14
Alternative: Estuary
Viewpoint 3 - At Mature Development - High Tide

Figure 4-15
Alternative: Estuary
Viewpoint 4 - At Mature Development - High Tide

Figure 4-16
Alternative: Estuary
Viewpoint 4 - At Intermediate Development - Low Tide

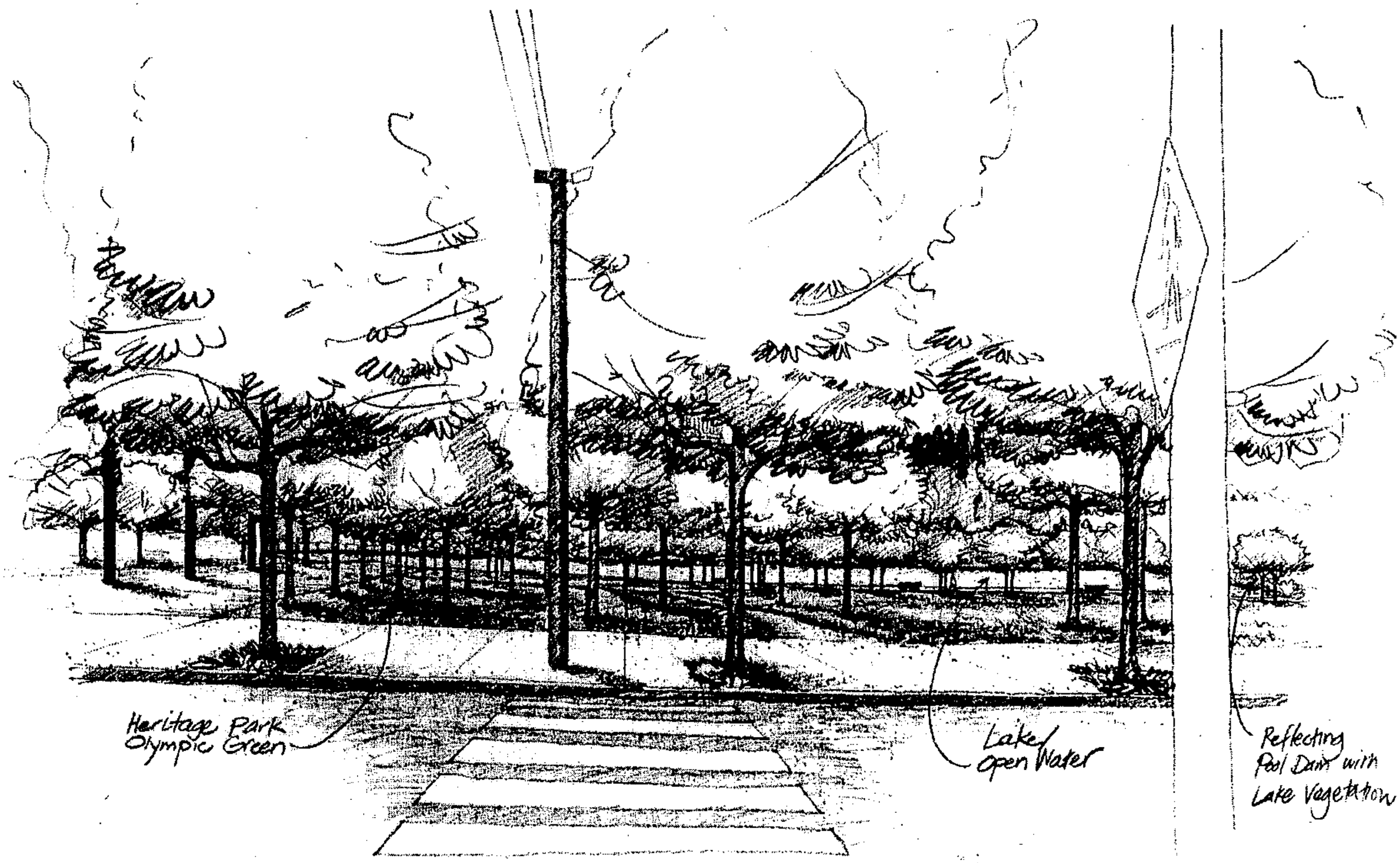


Figure 4-17
Alternative: Combined Lake/Estuary
Viewpoint 1 - At Mature Development - High Tide

From Viewpoint 2, the visual impacts of the Combined Lake/Estuary Alternative would be slightly greater than for the Estuary Alternative at high tide (compare **figures 4-13** and **4-18**). The reflecting pool dam would be visible in the middleground, but would not be a particularly prominent feature at high tide. However, at low tide, the dam would become a very dominant feature of the landscape (**figure 4-19**). From Viewpoint 2, the North Basin would not serve as a reflecting pool due to the new dam and its vegetation. As with the Estuary Alternative, the formal design of Heritage Park landscaping would contrast with the natural appearance of the salt marsh vegetation in the western half of the basin.

Views from Viewpoints 3 and 4 would be the same for the Combined Lake/Estuary Alternative as for the Estuary Alternative (see **figures 4-14, 4-15,** and **4-16**).

No-Action Alternative

In the South and Middle basins, the No-Action Alternative would have visual impacts similar to those of the two Lake/River Wetland alternatives.

In the North Basin, the No-Action Alternative would have visual impacts similar to the Estuary Alternative. Changes in views from the northeastern shore (Viewpoint 1) would be relatively minor due to the dominance of matures trees in the foreground (**figure 4-20**). At Viewpoint 2, cattails would be the dominant wetland vegetation, and would be taller and more dense than the salt marsh grasses of either estuary alternative. Freshwater emergent vegetation (such as cattails) and scrub-shrub wetland plants would replace open-water vistas. Also from Viewpoint 2, except for the main river channel (**figure 4-21**), the open-water lake vistas—visible from many vantage points in the area—would be lost. The lake would be completely replaced by riparian wetlands (an open-water body has to be greater than 20 surface acres to be defined as a lake under the SMA) and would no longer serve as a reflecting pool for the Capitol Building.

Cumulative and Secondary Impacts

Cumulative impacts are not anticipated with any of the alternatives.

Mitigations

No mitigation is proposed.

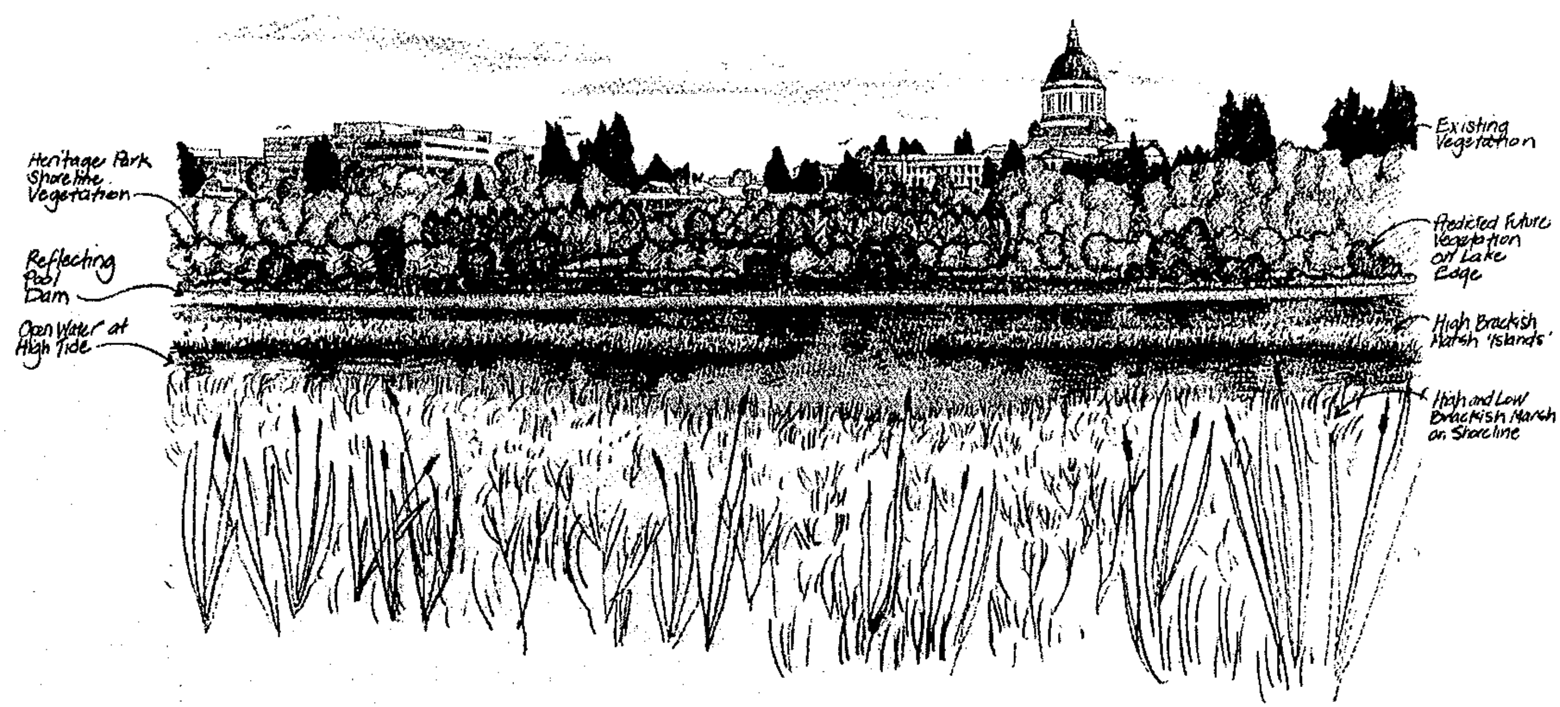


Figure 4-18
Alternative: Combined Lake/Estuary
Viewpoint 2 - At Mature Development - High Tide

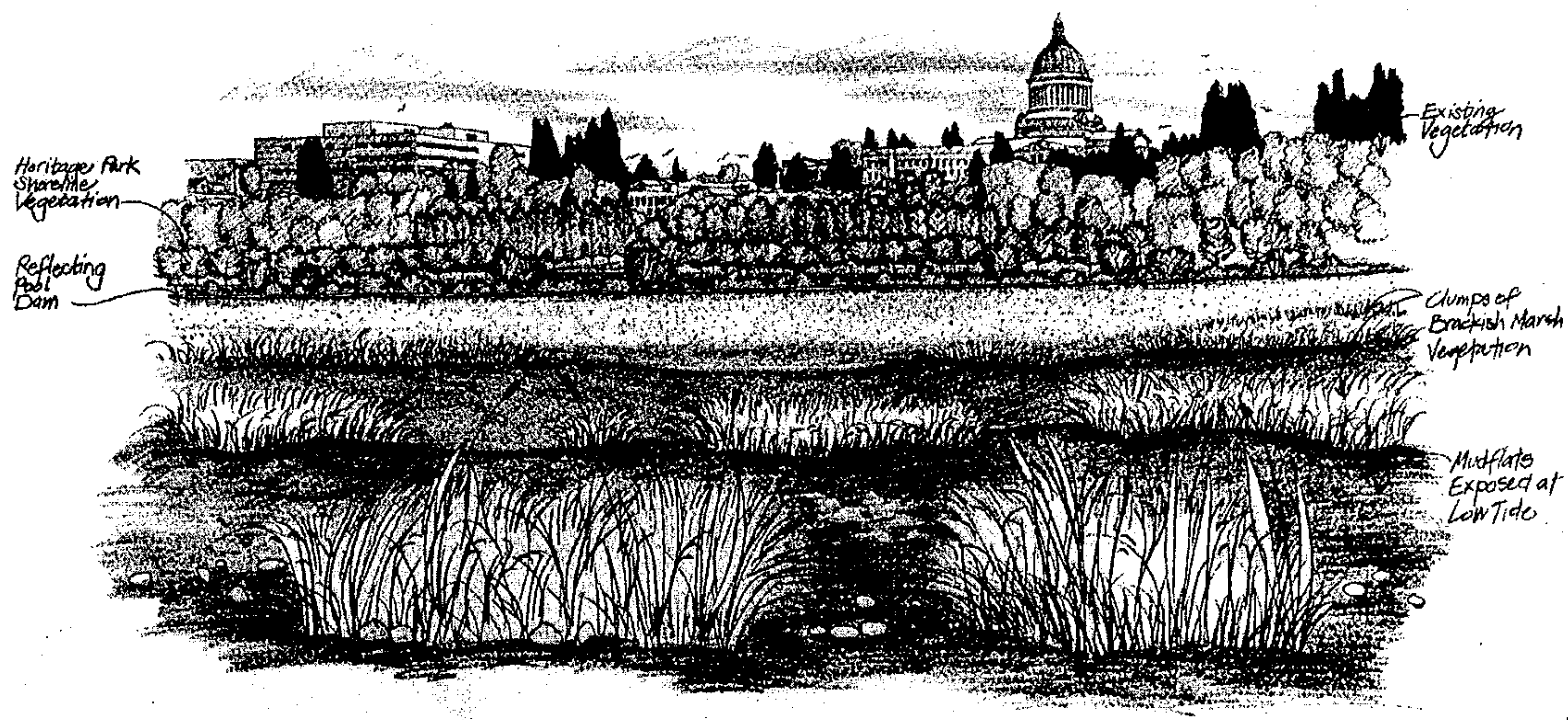


Figure 4-19
Alternative: Combined Lake/Estuary
Viewpoint 2 - At Mature Development - Low Tide

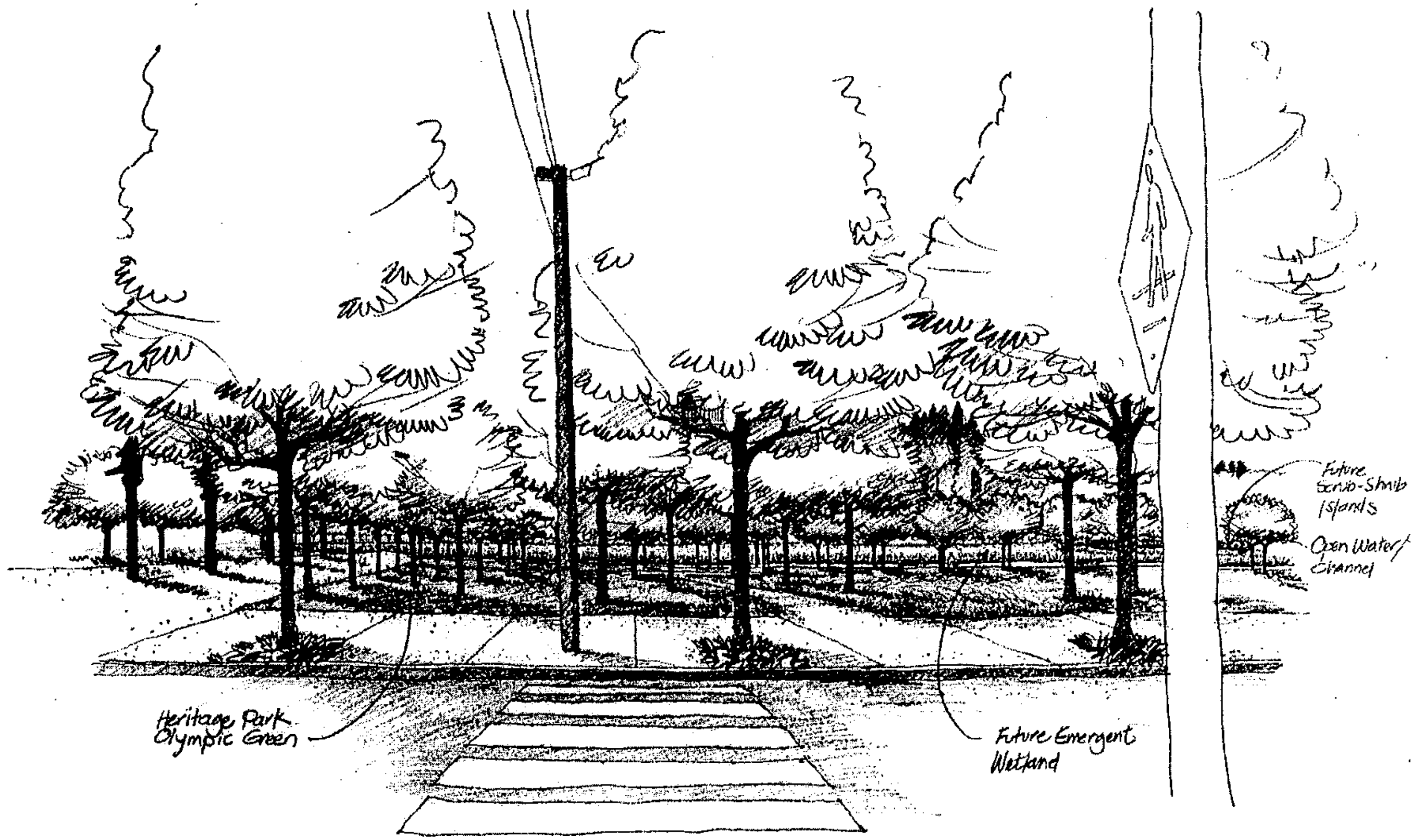


Figure 4-20
Alternative: No-Action
Viewpoint 1 - At Mature Development

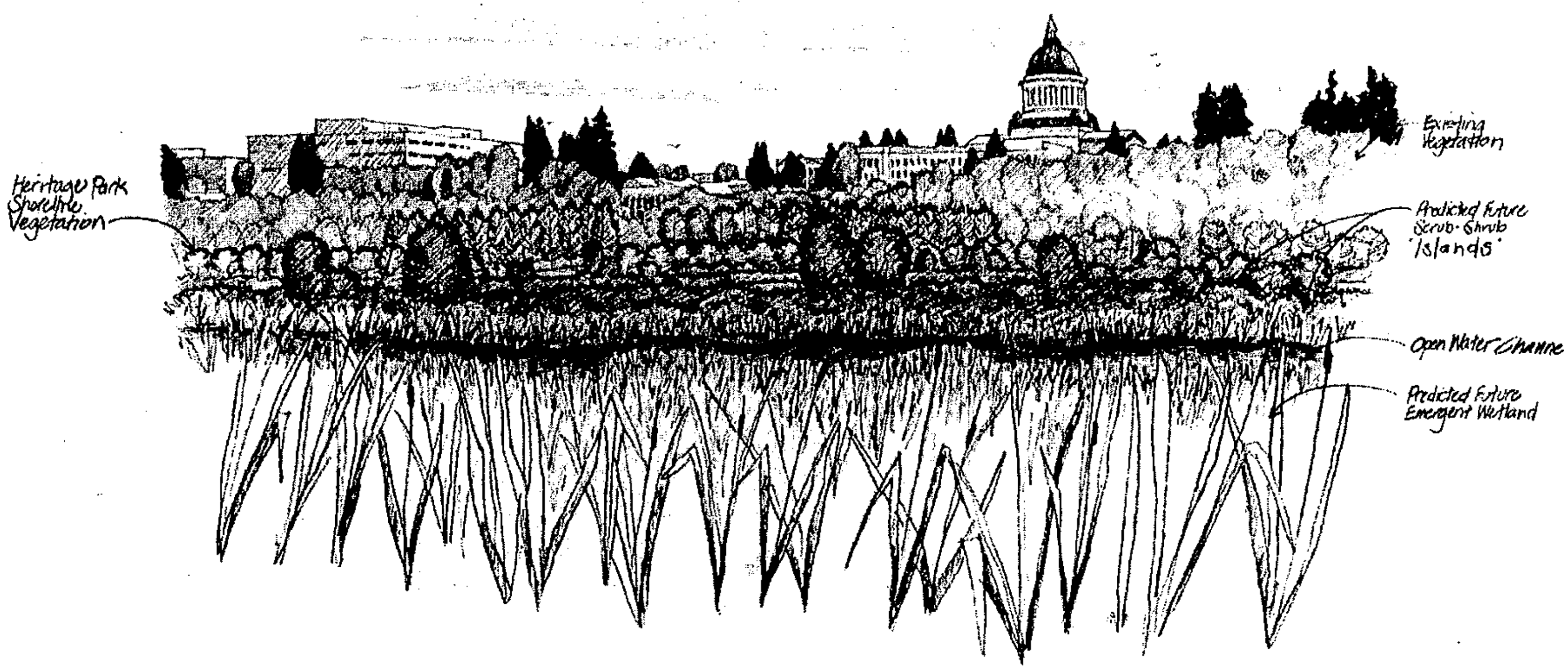


Figure 4-21
Alternative: No-Action
Viewpoint 2 - At Mature Development

Unavoidable Significant Adverse Impacts

At maturity, the reflecting pool function of the existing lake would be reduced or lost with the Estuary and No-Action alternatives, depending on the viewpoint. Therefore, at maturity, these alternatives would be least compatible with the original design intent of Heritage Park. The Combined Lake/Estuary Alternative retains approximately 40 acres of permanent freshwater reflecting pool function on the east side of the North Basin with construction of the reflecting pool dam. The east side reflecting pool partially retains the original design intent of Heritage Park. The Lake/River Wetland Without Trap and Lake/River Wetland With Trap alternatives would retain the reflecting pool function of the entire North Basin, but not the Middle Basin. The Lake Alternative is the only alternative that retains the reflecting pool function of the entire basin and is most consistent with the original design intent of the 1911 Capital Campus Plan.

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Carillon Association

People of Puget Sound

Capitol Lake Fair

North Capital Campus Heritage Park Development Association

Burlington Northern Santa Fe Railroad

LIBRARIES

Olympia Timberland Library

Tumwater Timberland Library

Appendix A

Cost Calculations for Dredging and Related Capital Improvements

Appendix A. Cost Calculations for Dredging and Related Capital Improvements

The purpose of this memorandum is to describe the cost calculations for dredging and related capital improvements for the alternatives described in the environmental impact statement (EIS). These costs are presented in **table 1**. The dredging cost calculations involve predictions of a range of sediment loading (or accumulation rates) and corresponding basin filling times, which vary among the alternatives; and a range of dredging costs, which vary depending on the method of dewatering and/or disposal. Assumptions and calculations for variable sediment loading rates and dredging costs are discussed below.

Sediment Loading Rates and Basin Filling Times

Two estimates of sediment loading rates have been made by Entranco for the Department of General Administration (unpublished reports) - one for the period 1983 to 1991, and one for the period 1991 to 1996. Both estimates were based on comparisons of aerial topographic maps of the lake bottom taken during drawdown. The total sediment load estimated for these two periods was 34,651 and 28,600 cubic yards per year, respectively (**table 2**). Differences in estimated sediment loading rates over the two periods reflect variable rainfall/river discharge (higher erosion/sedimentation during periods of higher flows), changes in watershed land use (e.g. the amount of timber harvest), changes in mass wasting over time (large slope failures along the banks of the Deschutes River), and related factors. This degree of variability in sediment loading rates is expected over time and is therefore reflected in the calculations.

Estimates were also made of the distribution of the accumulated sediment in each of the three basins - south, middle and north (**table 2**). Estimates of remaining water volume for each basin were divided by the range of sediment loading rates to provide estimates of time of filling for each basin (**table 2**). The calculations assume that the rate of filling of the north basin increases (equal to total annual sediment load) once the south and middle basins have filled. This approach was used to calculate filling times for the

Lake/River Wetland Without Trap and No-Action alternatives.

Similar assumptions were used for the Combined Lake/Estuary and Estuary alternatives. However, with these alternatives the possibility of increased erosion/sedimentation following removal of the tide gates was also recognized. Increase erosion/sedimentation is likely to occur during periods of low tide and high river flow because the bottom of the basin will be exposed to erosive river velocities. Increased river erosion may result in a short-term (1 to 5 years) re-distribution of sediment in the system with sediment in the south basin being transported to the middle basin, sediment from the middle basin being transported to the north basin, and some sediment being transported to Lower Budd Inlet. However, it would be highly speculative to attempt to estimate the amount of sediment that might transfer from one location to another. Therefore, for these two alternatives, the filling times are assumed to be the same as the Lake/River Without Trap and No-Action alternatives, "or more", depending on the degree of sediment transport due to tide gate removal.

Time of filling was assumed to be somewhat shorter for the Combined Lake/Estuary Alternative, since half of the north basin would be isolated from sediment loading influence with construction of the reflecting pool dam.

Time of filling was increased for the Lake/River Wetland With Trap Alternative, based on the assumption that 4,000 to 7,000 cubic yards per year (also estimated as part of previous studies) would be removed with periodic trap dredging (every 6 to 10 years).

Thus, the range in basin filling times shown in **table 1** reflects the range in sediment loading rates, as explained. The time of basin filling is an important consideration in estimating cumulative dredging cost, because it affects the time at which dredging would begin (which varies by alternative) and the duration of dredging.

Dredging Costs

A range of dredging costs was also used in calculating cumulative dredging costs in **table 1** (see **table B-1, Summary of Costs for Alternative Methods of Dredging, Dewatering and Disposal** in **Appendix B**). These costs were developed in 1996 during preparation of a sediment removal plan for the Washington State Department of General Administration (DGA) and have been used in this cost analysis (see detailed cost estimates for seven different dredging/dewatering/ disposal scenarios, attached). As shown in

table B-1, hydraulic dredging with marine disposal would be the least cost method ($10 per cubic yard), while hydraulic dredging with mechanical dewatering and upland disposal would be the highest cost method ($27 per cubic yard). Therefore, this cost range of $10 to $27 per cubic yard was multiplied by the estimated number of cubic yards per year and by the duration of dredging (number of years) to establish a cumulative dredging cost number (see **table 1**). Detailed costs for each method are shown in **tables 3** to **9**.

Note that the costs for gravity dewatering with upland disposal do not include the cost of a new gravity sedimentation facility to replace the one in the southwest corner of the middle basin. Therefore, the costs for gravity dewatering with upland disposal would be higher than shown.

Other Cost Estimates

There are only two other cost elements shown in **table 1**. These are the $9.4 million for the reflecting pool dam and the $500,000 for tide gate removal. The $9.4 million cost estimate was prepared by HWA Geosciences, Inc. as a part of their preliminary engineering analysis of the reflecting pool dam (see cost estimate detail attached). The $500,000 estimate for tide gate removal was a preliminary lump sum number provided by Entranco for the Draft EIS. We may want to eliminate this cost if DGA thinks that it would be acceptable to simply open the tide gate permanently and leave the tide gate in place. Or we may adjust this number following receipt of information from DGA on the cost of recent tide gate repairs. In either case, further assessment of the cost of tide gate removal is needed.

Table 1
Alternative Cost Comparison Summary[1]

	Existing Conditions	Lake/River Wetland Without Trap Alternative	Lake/River Wetland With Trap Alternative	Lake Alternative	Combined Lake/Estuary Alternative	Estuary Alternative	No-Action Alternative
Dredging Scheme	Major lake dredging occurred in 1978. Trap maintenance dredging in 1986.	North Basin to be dredged when the South and Middle basins have in-filled with sediment.	Dredge Middle Basin trap every 6–10 yrs. Dredge North Basin when other two basins fill.	Dredge two sectors every other year in the Middle Basin and Percival Cove beginning now.	Short-term dredging needed in Budd Inlet? Budd Inlet to be dredged when entire basin filled with sediment.	Short-term dredging needed in Budd Inlet? Budd Inlet to be dredged when entire basin filled with sediment.	No dredging.
Costs for the First 20 yrs	N/A	$0	$1.1 to $3 million	$7 to $15 million	Tide gate removal = $0.5 million; Dam cost = $9.4 million; Dredging - $0 to $15 million or more; Total = $10 to $25 million or more	Tide gate removal = $0.5 million; Dredging - $0 to $15 million or more; Total = $0.5 to $15. 5 million or more	$0
Cumulative Costs in 50 to 85 yrs	N/A	$0[2]	$3 to $13 million	$18 to $64 million	$10 to $25 million or more	$0.5 to $15.5 million or more	$0
Cumulative Costs in 75 yrs to 115 yrs	N/A	$9 to $23 million	$12 to $36 million	$26 to $86 million	$17 to $40 million or more	$18 to $31 million or more	$0
Cumulative Costs in 100 to 150 yrs	N/A	$18 to $49 million	$21 to $62 million	$35 to $113 million	$24 to $56 million or more	$24 to $64 million or more	$0

[1]The range of years reflects a range of sediment loading rates from the Deschutes River. The lower year numbers assume a higher sediment loading rate and the higher year number assumes a lower sediment loading rate. The year ranges in the separate rows reflects the time of maturity for the different alternatives. Cost ranges reflect the duration of maintenance dredging, the range of sediment loading rates, and a range of cost (reflecting cost differences between different dredging, dewatering and disposal methods).

[2]No dredging costs accrue until after the south and middle basins are completely filled at the time of maturity.

Table 1 (continued)

	Existing Conditions	Lake/River Wetland Without Trap Alternative	Lake/River Wetland With Trap Alternative	Lake Alternative	Combined Lake/Estuary Alternative	Estuary Alternative	No-Action Alternative
Cumulative Costs in 150 yrs to 250 yrs	N/A	$35 to $124 million	$38 to $137 million	$53 to $188 million	$68 to $150 million or more	$59 to $139 million or more	$0
Other Operationsl Costs		drawdown purple loosestrife goose management shoreline erosion large woody debris	drawdown purple loosestrife goose management shoreline erosion large woody debris	drawdown purple loosestrife goose management shoreline erosion large woody debris	horeline erosion large woody debris	horeline erosion large woody debris	purple loosestrife goose management shoreline erosion large woody debris

Table 2
Estimated Filling Times for the Three Basins of Capitol Lake

Basin	Area (ac)	Avg Depth (ft)	Volume (ac-ft)	Volume (cubic yd)	1983-91 Fill Rate (cu.yd/yr)	Estimated Fill Time (years)	1991-96 Fill Rate (cu.yd/yr)	Estimated Fill Time (years)
South	24	5	120	193600	7438	26.028502	8260	23.438257
Middle	120	6.3	756	1219680	23,338	52.261548	14,600	83.539726
North	100	10.6	1060	1710133	3875	101.61462	5740	143.3346

Notes:

1. Average depths from page A.9. of the Wetland Development Feasibility Study (WDGA 1990).

Alternative B, where middle basin trap is maintained. Assume 7,000 cy/year less sediment load for 1983-91 and 4,000 cy/year less for 1991-96 for the middle basin.

Basin	1983-91 Fill Rate (cu.yd/yr)	Estimated Fill Time (years)	1991-96 Fill Rate (cu.yd/yr)	Estimated Fill Time (years)
South	7438	26.028502	8260	23.438257
Middle	16,338	74.652956	10,600	115.06415
North	3875	136.50003	5740	184.58177

Table 3
COST ESTIMATE FOR HYDRAULIC DREDGING/MARINE DISPOSAL

Marine Disposal — **Design Report Cost Estimate**

Item	Unit	Unit Price	Quantity	Cost	
Dredging					**$259,000**
Mobilization / Demobilization	L.S.	$85,000.00	1	$85,000	
Hydraulic dredging	C.Y.	$2.90	60,000	$174,000	
Flocculents	C.Y.	$1.30	0	$0	
Silt Fence	L.F.	$6.00	0	$0	
Hydroseed	L.S.	$1,000.00	0	$0	
Survey	L.S.	$20,000.00	0	$0	
Transportation					**$186,000**
Barge Haul	C.Y.	$2.60	60,000	$156,000	
Disposal Fee	C.Y.	$0.50	60,000	$30,000	
Traffic control	HR.	$20.00	0	$0	
Remote Site Work					**$0**
Grading	L.S.	$0.00	0	$0	
Purple Loosestrife control	L.S.	$0.00	0	$0	
Temporary Water Pollution Control	L.S.	$0.00	0	$0	
Seeding	L.S.	$0.00	0	$0	
Miscellaneous @ 5 %	L.S.	$22,250.00	1	$22,250	**$22,250**
Construction Subtotal				$467,250	
Contingencies (10%)				$46,725	
Sales Tax (8.2%)				$38,315	
Subtotal				$505,565	
Design and Construction - Basic Services (8%)				$40,445	
Construction Total				$546,010	
TOTAL				$546,010	

Notes: L.S. = Lump Sum; L.F. = Linear Foot; C.Y. = Cubic Yard; H.R. = Rate per Hour.

Table 4

COST ESTIMATE FOR HYDRAULIC DREDGING/MECHANICAL DEWATERING/LANDFILL DISPOSAL

Mechanical Dewatering / Landfill — **Design Report Cost Estimate**

Item	Unit	Unit Price	Quantity	Cost	
Dredging and dewatering					**$746,400**
Mobilization / Demobilization	L.S.	$75,000.00	1	$75,000	
Dredge and Mechanical Dewatering	L.S.	$570,000.00	1	$570,000	
Flocculents	C.Y.	$1.30	60,000	$78,000	
Silt Fence	L.F.	$6.00	400	$2,400	
Hydroseed	L.S.	$1,000.00	1	$1,000	
Survey	L.S.	$20,000.00	1	$20,000	
Transportation					**$349,000**
Haul	C.Y.	$6.00	60,000	$360,000	
Credit for sand	C.Y.	($1.00)	15,000	($15,000)	
Traffic control	HR.	$20.00	200	$4,000	
Remote Site Work					**$22,000**
Grading	L.S.	$10,000.00	1	$10,000	
Purple Loosestrife control	L.S.	$5,000.00	1	$5,000	
Temporary Water Pollution Control	L.S.	$5,000.00	1	$5,000	
Seeding	L.S.	$2,000.00	1	$2,000	
Miscellaneous @ 5 %	L.S.	$55,870.00	1	$55,870	**$55,870**
Construction Subtotal				$1,173,270	
Contingencies (10%)				$117,327	
Sales Tax (8.2%)				$96,208	
Subtotal				$1,269,478	
Design and Construction - Basic Services (8%)				$101,558	
Construction Total				$1,371,036	
TOTAL				$1,371,036	
Notes: L.S. = Lump Sum; L.F. = Linear Foot; C.Y. = Cubic Yard; H.R. = Rate per Hour.					

Table 5

COST ESTIMATE FOR HYDRAULIC DREDGING/MECHANICAL DEWATERING/GRAVEL PIT DISPOSAL

Mechanical Dewatering / Gravel Pit — **Design Report Cost Estimate**

Item	Unit	Unit Price	Quantity	Cost	
Dredging and dewatering					**$746,400**
Mobilization / Demobilization	L.S.	$75,000.00	1	$75,000	
Dredge and Mechanical Dewatering	L.S.	$570,000.00	1	$570,000	
Flocculents	C.Y.	$1.30	60,000	$78,000	
Silt Fence	L.F.	$6.00	400	$2,400	
Hydroseed	L.S.	$1,000.00	1	$1,000	
Survey	L.S.	$20,000.00	1	$20,000	
Transportation					**$349,000**
Haul	C.Y.	$6.00	60,000	$360,000	
Credit for sand	C.Y.	($1.00)	15,000	($15,000)	
Traffic control	HR.	$20.00	200	$4,000	
Remote Site Work					**$22,000**
Grading	L.S.	$10,000.00	1	$10,000	
Purple Loosestrife control	L.S.	$5,000.00	1	$5,000	
Temporary Water Pollution Control	L.S.	$5,000.00	1	$5,000	
Seeding	L.S.	$2,000.00	1	$2,000	
Miscellaneous @ 5 %	L.S.	$55,870.00	1	$55,870	**$55,870**
Construction Subtotal				$1,173,270	
Contingencies (10%)				$117,327	
Sales Tax (8.2%)				$96,208	
Subtotal				$1,269,478	
Design and Construction - Basic Services (8%)				$101,558	
Construction Total				$1,371,036	
TOTAL				$1,371,036	

Notes: L.S. = Lump Sum; L.F. = Linear Foot; C.Y. = Cubic Yard; H.R. = Rate per Hour.

Table 6

COST ESTIMATE FOR HYDRAULIC DREDGING/MECHANICAL DEWATERING/COAL MINE DISPOSAL

Mechanical Dewatering / Coal Mine — **Design Report Cost Estimate**

Item	Unit	Unit Price	Quantity	Cost	
Dredging and dewatering					**$746,400**
Mobilization / Demobilization	L.S.	$75,000.00	1	$75,000	
Dredge and Mechanical Dewatering	L.S.	$570,000.00	1	$570,000	
Flocculents	C.Y.	$1.30	60,000	$78,000	
Silt Fence	L.F.	$6.00	400	$2,400	
Hydroseed	L.S.	$1,000.00	1	$1,000	
Survey	L.S.	$20,000.00	1	$20,000	
Transportation					**$589,000**
Haul	C.Y.	$10.00	60,000	$600,000	
Credit for sand	C.Y.	($1.00)	15,000	($15,000)	
Traffic control	HR.	$20.00	200	$4,000	
Remote Site Work					**$0**
Grading	L.S.	$10,000.00	0	$0	
Purple Loosestrife control	L.S.	$5,000.00	0	$0	
Temporary Water Pollution Control	L.S.	$5,000.00	0	$0	
Seeding	L.S.	$2,000.00	0	$0	
Miscellaneous @ 5 %	L.S.	$66,770.00	1	$66,770	**$66,770**
Construction Subtotal				$1,402,170	
Contingencies (10%)				$140,217	
Sales Tax (8.2%)				$114,978	
Subtotal				$1,517,148	
Design and Construction - Basic Services (8%)				$121,372	
Construction Total				$1,638,520	
TOTAL				$1,638,520	

Notes: L.S. = Lump Sum; L.F. = Linear Foot; C.Y. = Cubic Yard; H.R. = Rate per Hour.

Table 7

COST FOR HYDRAULIC DREDGING/GRAVITY SETTLING/LANDFILL DISPOSAL

Gravity Settling / Landfill — **Design Report Cost Estimate**

Item	Unit	Unit Price	Quantity	Cost	
Dredging and dewatering					**$379,400**
Mobilization / Demobilization	L.S.	$65,000.00	1	$65,000	
Dredging	C.Y.	$3.55	60,000	$213,000	
Flocculents	C.Y.	$1.30	60,000	$78,000	
Silt Fence	L.F.	$6.00	400	$2,400	
Hydroseed	L.S.	$1,000.00	1	$1,000	
Survey	L.S.	$20,000.00	1	$20,000	
Transportation					**$277,000**
Excavation and Haul of Dewatered Sediment	C.Y.	$7.00	39,000	$273,000	
Credit for sand	C.Y.	($1.00)	0	$0	
Traffic control	HR.	$20.00	200	$4,000	
Remote Site Work					**$22,000**
Grading	L.S.	$10,000.00	1	$10,000	
Purple Loosestrife control	L.S.	$5,000.00	1	$5,000	
Temporary Water Pollution Control	L.S.	$5,000.00	1	$5,000	
Seeding	L.S.	$2,000.00	1	$2,000	
Miscellaneous @ 5 %	L.S.	$33,920.00	1	$33,920	**$33,920**
Construction Subtotal				$712,320	
Contingencies (10%)				$71,232	
Sales Tax (8.2%)				$58,410	
Subtotal				$770,730	
Design and Construction - Basic Services (8%)				$61,658	
Construction Total				$832,389	
TOTAL				$832,389	

Notes: L.S. = Lump Sum; L.F. = Linear Foot; C.Y. = Cubic Yard; H.R. = Rate per Hour.

Table 8
COST FOR HYDRAULIC DREDGING/GRAVITY SETTLING/GRAVEL PIT DISPOSAL

Gravity Settling / Gravel Pit — **Design Report Cost Estimate**

Item	Unit	Unit Price	Quantity	Cost	
Dredging and dewatering					**$379,400**
Mobilization / Demobilization	L.S.	$65,000.00	1	$65,000	
Dredging	C.Y.	$3.55	60,000	$213,000	
Flocculents	C.Y.	$1.30	60,000	$78,000	
Silt Fence	L.F.	$6.00	400	$2,400	
Hydroseed	L.S.	$1,000.00	1	$1,000	
Survey	L.S.	$20,000.00	1	$20,000	
Transportation					**$277,000**
Excavation and Haul of Dewatered Sediment	C.Y.	$7.00	39,000	$273,000	
Credit for sand	C.Y.	($1.00)	0	$0	
Traffic control	HR.	$20.00	200	$4,000	
Remote Site Work					**$22,000**
Grading	L.S.	$10,000.00	1	$10,000	
Purple Loosestrife control	L.S.	$5,000.00	1	$5,000	
Temporary Water Pollution Control	L.S.	$5,000.00	1	$5,000	
Seeding	L.S.	$2,000.00	1	$2,000	
Miscellaneous @ 5 %	L.S.	$33,920.00	1	$33,920	**$33,920**
Construction Subtotal				$712,320	
Contingencies (10%)				$71,232	
Sales Tax (8.2%)				$58,410	
Subtotal				$770,730	
Design and Construction - Basic Services (8%)				$61,658	
Construction Total				$832,389	
TOTAL				$832,389	
Notes: L.S. = Lump Sum; L.F. = Linear Foot; C.Y. = Cubic Yard; H.R. = Rate per Hour.					

Table 9

COST ESTIMATE FOR HYDRAULIC DREDGING/GRAVITY SETTLING/COAL MINE DISPOSAL

Gravity Settling / Coal Mine — **Design Report Cost Estimate**

Item	Unit	Unit Price	Quantity	Cost	
Dredging and dewatering					**$379,400**
Mobilization / Demobilization	L.S.	$65,000.00	1	$65,000	
Dredging	C.Y.	$3.55	60,000	$213,000	
Flocculents	C.Y.	$1.30	60,000	$78,000	
Silt Fence	L.F.	$6.00	400	$2,400	
Hydroseed	L.S.	$1,000.00	1	$1,000	
Survey	L.S.	$20,000.00	1	$20,000	
Transportation					**$433,000**
Excavation and Haul of Dewatered Sediment	C.Y.	$11.00	39,000	$429,000	
Credit for sand	C.Y.	($1.00)	0	$0	
Traffic control	HR.	$20.00	200	$4,000	
Remote Site Work					**$0**
Grading	L.S.	$10,000.00	0	$0	
Purple Loosestrife control	L.S.	$5,000.00	0	$0	
Temporary Water Pollution Control	L.S.	$5,000.00	0	$0	
Seeding	L.S.	$2,000.00	0	$0	
Miscellaneous @ 5 %	L.S.	$40,620.00	1	$40,620	**$40,620**
Construction Subtotal				$853,020	
Contingencies (10%)				$85,302	
Sales Tax (8.2%)				$69,948	
Subtotal				$922,968	
Design and Construction - Basic Services (8%)				$73,837	
Construction Total				$996,805	
TOTAL				$996,805	
Notes: L.S. = Lump Sum; L.F. = Linear Foot; C.Y. = Cubic Yard; H.R. = Rate per Hour.					

Capital Lake Adaptive Management Plan EIS
Conceptual Cost Estimate
Option 1 - Dam Cross Section with Single Row of Sheet Piling

HWA Project No.: 92055

Date: February 27, 1998

Work Element	Estimated Quantity	Unit	Unit Cost	Total Cost	Notes
Mobilization @ 10%	1	lump sum	$565,000	$565,000	
Surveying @ 2%	1	lump sum	$113,000	$113,000	
Sheet Piling	80,000	square foot	$25	$2,000,000	
Rock Fill Incl. Haul	75,000	cubic yard	$30	$2,250,000	
Soil Fill Incl. Haul	25,000	cubic yard	$20	$500,000	
Geotextile Fabric in Place	31,000	square yard	$3	$93,000	
Rip-rap Slope Protection in Place	20,000	square yard	$25	$500,000	
Silt Curtains / Temporary Erosion Control	1	allow	$100,000	$100,000	
Dewatering	1	allow	$200,000	$200,000	
			Subtotal:	$6,321,000	
			Engineering/Design Fees @ 15%:	$948,150	
			Tax @ 8.6%:	$543,606	
			Bond and Insurance @ 5%:	$316,050	
			Contingency @ 20%:	$1,264,200	
			Estimated Total:	**$9,393,006**	

Note: This cost estimate is conceptual in nature, for use in planning, budgeting and evaluation of alternative concepts. Unit costs, quantities, and scope of work may vary substantially from that shown above, based on actual conditions encountered during construction, project schedule, the contractor's selected methods, and other factors.

Appendix B

Alternative Dredging Techniques

Appendix B. Alternative Dredging Techniques

Hydraulic Dredging, Gravity Dewatering, and Upland Disposal

Hydraulic dredges floats on the water and are equipped with a boom that extends to the bottom. At the end of the boom, is either a spiral auger or cutterhead which digs into and loosens the bottom sediments. As this mechanical action is loosening the sediment, a large pump motor (dredges come in different sizes) pumps the sediment-water slurry to the shore. Gravity dewatering refers to the use of two or three ponds to allow sediments time to settle out and separate from the water before discharging the water back to the receiving water.

Once the dredging/dewatering operation is complete, the ponds are drained and earth-moving equipment is used to load sediment on to trucks for delivery to upland disposal sites.

The old gravity dewatering facility in the southwest corner of the Middle Basin cannot be used in the future because it has been dedicated as a wetland mitigation site for Heritage Park. Therefore, if gravity dewatering is to be considered, a new facility that is 10 to 20 acres would be needed. In the event it is determined that gravity dewatering is a preferred method of construction, a new engineering study would be needed to determine the best location and design. Upland and in-lake sites may both be feasible.

No specific upland sites have been identified in this document for disposal of dewatered sediment. However, runoff at the upland disposal site(s) would discharge to either surface or groundwater systems.

Mechanical Dewatering and Upland Disposal

With this method, a mechanical centrifuge separates the sediment-water slurry. Like the spin cycle in a clothes washer, centrifugal force separates solids onto a conveyor belt for delivery directly to a haul truck.

There would be localized violations of state water quality standards for turbidity at the dredging site, but not for treated return flows (assumes chemical treatment with a non-toxic polymer like Cat-Floc 2953 – a Calgon product with the active ingredient polyaluminum hydroxychlorosulphate, or equivalent, prior to discharge as part of the normal mechanical dewatering operation—one reason for its higher cost). There also may be turbid water runoff at upland disposal sites. Potential toxic impacts associated with disturbance of lake bottom sediments would be the same as those described for gravity dewatering.

Hydraulic Dredging, Barge Transport, and Deep, Open-water Marine Disposal

Hydraulic dredging would be the same as described above, except that the dredge slurry would be pumped through a floating pipeline, north to a marine barge moored at the Port of Olympia. The entire sediment/water slurry would be loaded into the barge and transported by tug to the marine open-water disposal site off Anderson-Ketron Island, in Puget Sound, southwest of Tacoma. At the disposal site, gates in the bottom of the barge would be opened and the sediment/water slurry would be dumped into the water and the sediments would settle to the bottom of Puget Sound. Any sediment with undesirable concentrations of benzoic acid or any other chemicals tested under PSDDA (Puget Sound Dredged Disposal Analysis) sampling protocol, could not be disposed of in this manner.

Costs of Alternative Dredging, Dewatering, and Disposal Methods

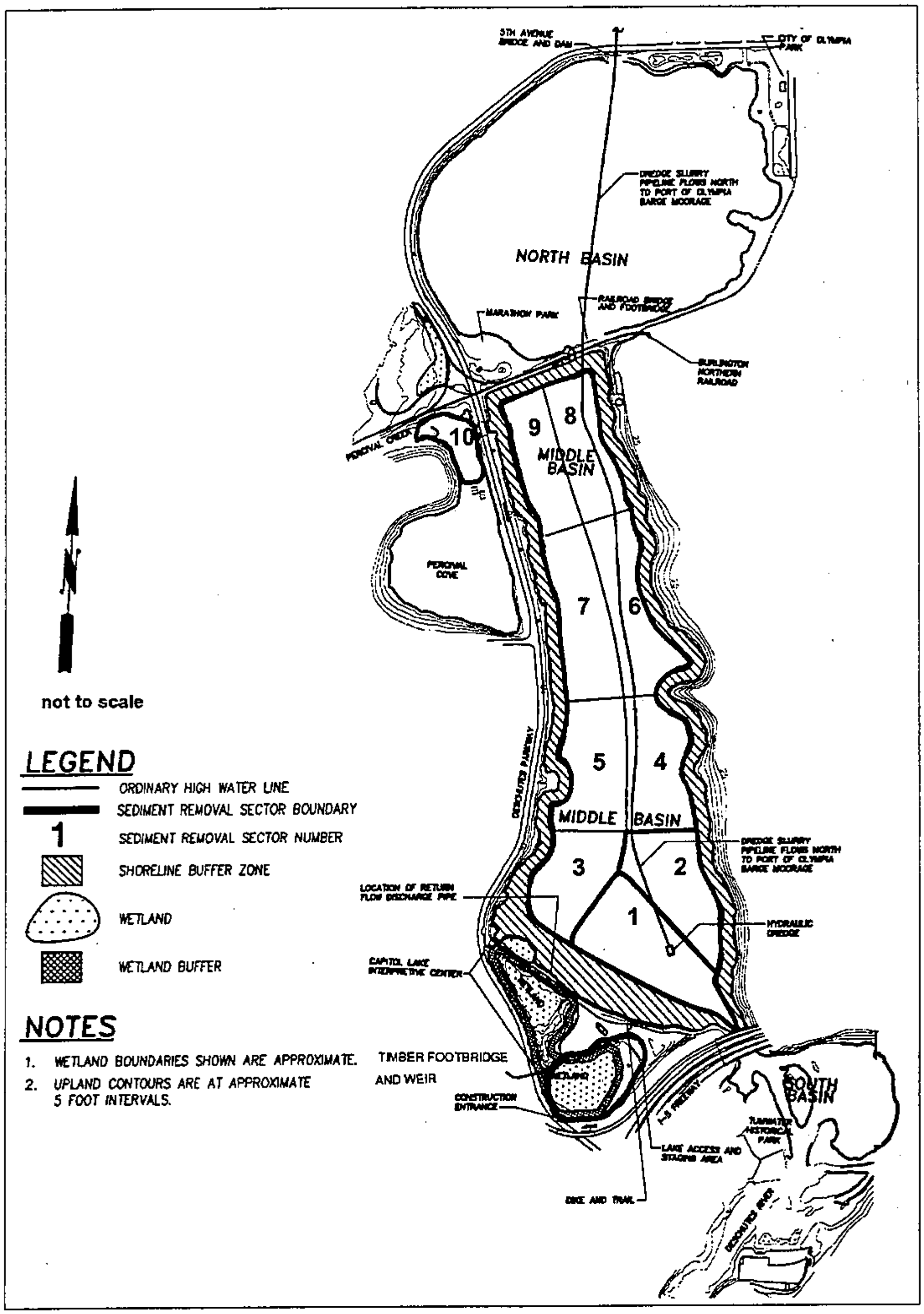
A comparison of cost per cubic yard of sediment removed for the three alternative methods of dredging, dewatering, and disposal is presented in **table B-1.**

Alternatives	Estimated Cost Per Yard (1998 dollars)
Gravity Dewatering and Upland Disposal	$17 to $21
Mechanical Dewatering and Upland Disposal	$23 to $27
Marine Disposal	$10

Table B-1
Summary of Costs for Alternative Methods of Dredging, Dewatering, and Disposal

Lake Alternative - Proposed Dredging Sectors in Percival Cove and the Middle Basin

Proposed dredging sectors for the Lake Alternative are shown in **figure B-1.**



B146 97034-80 Capitol Lake EIS (4/8/98) AGT

N

not to scale

Figure B-1
Potential Dredging Areas for the Lake Alternative

Appendix C

Geotechnical Evaluation for the Combined Lake/ Estuary Alternative

HWA
GEOSCIENCES INC.
19730-64TH AVE. W., SUITE 200
LYNNWOOD, WA 98036-5957
TEL. 425-774-0106
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February 27, 1998
HWA Project No. 92055

Entranco Engineers, Inc.
10900 NE 8th Street, Suite 300
Bellevue, Washington 98004

Attention: Mr. David Morency

Subject: **GEOTECHNICAL EVALUATION**
Capital Lake Adaptive Management Plan EIS
Olympia, Washington

Dear David:

Pursuant to your request, HWA GeoSciences Inc. (formerly HongWest & Associates, Inc.) performed geotechnical evaluations in support of the Capital Lake Adaptive Management Plan EIS. We understand several alternatives for managing Capital Lake are being evaluated. Our analysis considers the geologic hazards, impacts and mitigation measures associated with the Combined Lake/Estuary Alternative. The following letter report presents our findings.

INTRODUCTION

PROJECT DESCRIPTION

The proposed Combined Lake/Estuary Alternative involves constructing an earthen dam across the North Basin of Capital Lake, separating the lake into two areas, a fresh water reflecting pool on the east side and a natural estuary and tidelands on the west side, as shown on Figure 1. The proposed dam would be aligned in a generally north-south direction. The dam would be approximately 17 to 20 feet tall and 20 feet wide at the crest, to accommodate a walking path and service vehicles. Conceptually, the embankment side slopes would be no steeper than 3H:1V (horizontal:vertical). The dam embankment would be composed primarily of rock and soil fills, and designed to impound lake water against one side.

SCOPE OF SERVICES AND AUTHORIZATION

A proposal for this geotechnical evaluation was submitted by HWA to Entranco Engineers on January 20, 1998. Verbal authorization for the work was subsequently given by Mr. David Morency. The scope of work completed for this project was consistent with that described in our proposal and included reviewing available geologic information and previous geotechnical reports for related Capital Lake projects, performing a site reconnaissance, assessing geologic hazards, evaluating geologic and construction impacts, and developing methods of mitigating these impacts.

AFFECTED ENVIRONMENT

Subsurface and geologic conditions were determined based on information collected during our site reconnaissance and as part of our literature review. The following section summarizes HWA's literature review and site reconnaissance. Anticipated subsurface conditions at the site are described based on the data reviewed. This study did not include subsurface exploration.

FINDINGS FROM PREVIOUS GEOTECHNICAL INVESTIGATIONS

Previously, Milbor-Pita (1996), HWA (1994), RZA (1982), and CH2M Hill (1976) performed subsurface investigations at Capital Lake and prepared reports summarizing their findings and geotechnical recommendations for related improvement projects. These reports provide information on subsurface conditions for the South, Middle, and North Basins of Capital Lake. The Milbor-Pita report provided information on subsurface conditions at Heritage Park, along the southeast shoreline of the North Basin.

The general consensus of the available reports is that the site is underlain by soft/loose silts and fine sands with organic matter. These materials are the products of stream and lake depositional environments. The thickness of soft/loose silts and fine sands ranges from 15 feet thick in the Middle and South Basins to over 30 feet thick in the North Basin. Exploration logs from the Middle and South Basins indicate medium dense to very dense, sand and gravel deposits underlie the soft silts and sands. Explorations by Milbor-Pita, some ranging up to 45 feet deep along the southeast shoreline of the North Basin, did not encounter dense to very dense soil.

GEOLOGIC CONDITIONS

Geological information for the site was obtained from the *Geologic Map of Thurston County, Washington* (Noble, 1962). The geologic map indicates that the North Basin of Capital Lake and immediate vicinity are generally underlain by alluvium and recessional outwash. Alluvium, the more recent of the two geologic deposits, typically consists of fine-grained floodplain deposits. Lake bed deposits of similar composition are also included in the alluvium classification.

Recessional outwash consists of non-stratified, non-sorted sand and gravel deposits. These deposits were placed during glacial retreat and have not been consolidated by glacial ice. The geologic map denotes recessional outwash as a surficial deposit located on the hillsides around the lake.

HWA SITE RECONNAISSANCE

On February 13, 1998, HWA engineers performed a site reconnaissance in which they examined (1) the soil conditions on the banks of the lake, (2) rip rap protection on existing embankments, (3) soil conditions of surrounding topographical features, and (4) bridges at 4th Avenue on the north side of the lake, and the railroad crossing at the south side of the North Basin. This surficial reconnaissance confirmed, in part, the findings described by the above sources.

During the site visit HWA determined that portions of the hillsides south of the North Basin consist of glacial till. Till consists of a glacially consolidated, non-sorted mixture of clay, silt, sand, and gravel and typically underlies recessional outwash. Glacial till typically exhibits high shear strength, low compressibility, and low permeability characteristics. The till appears blanketed by a relatively thin layer of recessional outwash.

GEOLOGIC HAZARDS

Geologic hazards considered as part of this study include seismic, soil liquefaction potential, settlement and landslide hazards. These potential hazards are described in the following section.

SEISMIC HAZARDS

Seismic hazard areas are generally defined as areas subject to severe risk of earthquake damage as a result of seismically induced settlement or soil liquefaction. Since the 1850's, at least 25 earthquakes of Magnitude 5.0 (Richter Scale) or greater have reportedly occurred in the Puget Sound and North Cascades region. Four events may have exceeded Magnitude 6.0. These include a 1949 event near Olympia (Magnitude 7.2), and a 1965 event centered between Seattle and Tacoma (Magnitude 6.5). The subduction of the Juan De Fuca plate beneath the North American plate is believed to directly or indirectly cause most of the earthquakes in Washington (Noson et al., 1988).

The project site lies within Seismic Zone 3 as defined by the Uniform Building Code (ICBO, 1997). Seismic Zone 3 includes western Washington, and represents an area susceptible to moderately high seismic activity. For comparison, much of California and southern Alaska are defined as Seismic Zone 4, which is an area of higher seismic risk. Consequently, moderate levels of earthquake shaking should be anticipated during the design life of the proposed dam.

SOIL LIQUEFACTION POTENTIAL

When shaken by an earthquake, certain soils lose strength and temporarily behave as a liquid. This phenomenon is known as soil liquefaction. The seismically induced loss of soil strength can result in failure of the ground surface that is most typically expressed as landslides or lateral spreads, surface cracks and settlement, and/or sand boils. During a large seismic event, substantial damage to structures supported in or on soils susceptible to liquefaction can occur. Seismically induced liquefaction typically occurs in loose, saturated sandy materials commonly associated with recent river, lake and beach sedimentation. Based on the information collected as part of the literature review, the surficial lakebed sediments in Capital Lake are expected to consist of loose/soft soils. Loose, sandy zones within the lakebed deposits may be susceptible to liquefaction during a seismic event.

SETTLEMENT HAZARDS

Based on the literature review and site reconnaissance, as well as the depositional environment of the site, it is anticipated that the near-surface soils generally consist of silts and fine sands with occasional organics. High levels of settlement can occur when additional loads are applied to these types of soils. Structures constructed on such compressible soils will require mitigating measures to prevent damage to the structures.

LANDSLIDE HAZARD

During HWA's site reconnaissance, landslide debris was observed on the hillside south of the North Basin and partially covering the railroad tracks. Information on slope stability for the Capital Lake area was obtained from the *Slope Stability Map of Thurston County, Washington* (Artim, 1976). Although a landslide hazard is shown to exist in the vicinity of the North Basin, the potential for sliding debris to reach the proposed dam embankment or cause any damage is considered remote; landslide hazard areas are not identified within the dam footprint.

DAM DESIGN AND CONSTRUCTION ISSUES

ALTERNATIVES

Separating the North Basin into a fresh water reflecting basin and a natural estuary will require a relatively impervious dam to maintain the different water surface elevations on each side of the dam. In addition to an impervious core, the dam must be designed to be stable under static and seismic conditions.

Construction of the proposed dam will most likely have to occur under submerged conditions, as dewatering the entire North Basin is not feasible. HWA's research (Muller, 1982, and Rosenberg, 1983) indicates constructing a dam under submerged conditions will involve similar techniques as constructing breakwaters. Breakwaters typically consist of rock fills and are used to protect beaches and marinas from high tide levels and stormy weather. However, breakwaters allow surface water to pass through them and are not designed to be impervious. For the Combined Lake/Estuary Alternative, the dam must be designed to retain fresh water in the reflecting pool side and allow for fluctuating surface water levels on the opposite side.

Three dam alternatives are presented on Figure 2, which provide a relatively impervious boundary to control the varying water levels on each side of the dam. These alternatives include (1) building a single-walled cofferdam with a rock/soil fill embankment, (2) building a double-walled cofferdam and rock/soil fill embankment, or (3) using a geosynthetic or clay liner in conjunction with a rock/soil fill embankment. Rock fill and soil fill will have to be imported to the site, as dredge spoils from the lake are too fine-grained to be used for constructing the dam.

As discussed above, two of the three conceptual dam cross sections involve the use of cofferdams. Cofferdams are temporary or permanent walls used to perform excavations or to prepare sites so that work can be performed in dry conditions. They function to prevent surface water and groundwater flows. Cofferdams typically consist of rows and/or cells of steel sheet-piling driven into the ground.

Construction Methodology

Option 1 (see Figure 2) for constructing the earth dam involves using one row of sheet-piling for the entire length of the dam. The sheet-piling will act as an impervious boundary to retain surface water in the reflecting basin on the east side. Driving sheet-piling across the length of the lake will require the use of a barge if driving is performed without dewatering the lake. Once the sheet-piling is in place, rock fill would be placed on both sides of the sheet pile wall. For Option 1, a soil fill is placed and compacted on the surface of the rock fill. The two fill types would be separated by a geotextile fabric. The soil fill will most likely consist of a pit run sand and gravel material. Placement of the soil fill would involve some partial lowering of the lake level within the reflecting basin.

Option 2 is a variation on Option 1 which involves the use of two rows of sheet piling. The use of a "double-wall cofferdam" permits dam construction to occur in dry conditions and does not require any dewatering of the North Basin. The additional row of sheet-piling also allows constructing of the dam to be completed in a cellular sequence. The initial cofferdam cell would be constructed from the shore and would be backfilled with soil fill. Once the first cell was completed and backfilled, the operation could be moved onto the constructed cofferdam and the next cell constructed. This would allow construction to be completed without the use of a barge. Rock fill would be piled on the outside walls of the cofferdam as construction advanced across the lake.

Option 3 consists of using a clay liner or geosynthetic liner placed on the reflecting basin side of a rock fill dam. The impervious liner functions similarly to the sheet-piling, such that it restricts water flow through the rock fill. The dam is still constructed primarily of rock fill, with some relatively finer-grained sand and gravel fill used as a roadway surface on top of the dam. The limitation with this method is that the liner must be placed in dry conditions, which requires dewatering virtually the entire basin during construction.

Each of the options presented above has certain advantages and disadvantages. HWA examined several criteria for determining the preferred option, which included cost, constructability, design serviceability and environmental impact. The selection of the preferred dam cross section (see Figure 2) was based on the available design information and understanding of the potential impacts. Weighing these criteria, it is HWA's opinion that the Option 1 dam cross section alternative would be the preferred alternative from a geotechnical perspective.

DESIGN ISSUES

Selection of the most feasible and cost-effective alternative, and design of the dam embankment cross section would depend on information collected during a site specific subsurface investigation and geotechnical analysis. The collected information would be used, for example, in sizing sheet piling, determining thicknesses of liner materials, feasibility of construction methods, developing fill material and placement requirements, determining allowable side slope angles, and other issues. The following section presents several geotechnical issues which would require evaluation during the design process.

Embankment Stability

The stability of dam side slopes will be dependent, in part, on the materials used to construct the earth embankment. If rock fills and soil fills are used in dam embankment construction, side slopes can be inclined at angles of 2H:1V to 3H:1V. The erosive environment of the tidelands may cause some localized sloughing and raveling. As a minimum, side slopes should be armored with riprap rock to a level above maximum high tide levels on the west side of the berm.

Settlement

Typically when rock fills are placed on soft, loose sediments they tend to sink into these soils because of the void spaces between the rocks become filled with the sediment. As a result, the constructed dam will exhibit deformations at the surface over time and, potentially, failure of the dam may occur. Design of the dam must address potential settlements to ensure dam stability over the long term. A geotextile fabric provides physical separation between the fine-grained lakebed soils and the rock fill and should help to control and minimize dam settlement. However, some settlement should be expected even with use of a geotextile separator. A geotextile fabric will also help to limit the amount of rock and soil fill placed in the lakebed because the fill soils are more contained.

Corrosion

Steel sheet-piling used in a tidal, saltwater environment will be susceptible to corrosion. Protecting sheet piling is important to minimize rusting and deterioration of the dam structure. Protective measures may include, but are not limited to, placing well-graded soil between the rock fill and steel sheeting to act as a protective barrier and inhibit saltwater flow, using coatings that protect the steel sheet-piling, and using thicker gauge steel sheeting to allow for some "sacrificial" corrosion to occur without impacting the overall performance of the wall.

IMPACTS OF ALTERNATIVES

CONSTRUCTION-RELATED IMPACTS

The impacts of constructing an earthen dam across the North Basin of Capital Lake on the earth environment are summarized below.

- Construction of an earth dam across the lake will require imported rock and earth fill materials. Importing fill material using heavy trucks will increase the heavy truck traffic on local service roads. Potentially the additional truck traffic will create more air-borne dust, create additional noise associated with hauling, and deteriorate the condition of the existing pavements.

- Sheet-piling to construct a cofferdam is typically driven by a hammer using a free-falling ram (single-acting hammer), a pressure-assisted ram (double- and differential-acting hammer), or a combination of free-fall and explosive reaction (diesel hammer). Each of these hammer types are very noisy. In the case of the diesel hammer, minor amounts of hydraulic oil are sometimes discharged during the driving process.

- Fine-grained lakebed sediments will be disturbed while placing rock fill and earth fill. This disturbance will increase the turbidity of the water.

- Option 1 shown on Figure 2 would likely require partial dewatering of the reflecting basin for soil fill placement to occur. Option 3 would require nearly fully dewatering the reflecting basin so that the geosynthetic or clay liner could be placed in a dry condition. Dewatering the lake would impact existing vegetation, and fish and waterfowl habitats.

SETTLEMENT IMPACTS

Constructing a large earthen structure across Capital Lake may potentially result in settlement of loose/soft, fine-grained soils (clays, silts, and silty sands) and organic matter under static conditions. The amount of settlement will depend on the thickness, lateral extent, and type of compressible soils, and on the weight of the earth dam.

SEISMIC IMPACTS

Loose sand and silty sand interbeds anticipated in the lake bed sediments may have high liquefaction potential. Substantial damage to structures supported in or on potentially liquefiable soils may occur when these soils settle and/or exhibit lateral spreading.

Structures consisting of granular fill materials which are relatively loose and saturated may also sustain damage during a seismic event. Soil liquefaction of fill materials comprising the dam may cause deformation or, in the worst case, cause failure of the dam because of settling and lateral spreading of dam fill.

EROSION IMPACTS

Tidal fluctuations are expected to cause erosion impacts on the proposed earthen structure after the project is completed and the west side of the North Basin becomes an estuary and tide flats. The fluctuating tide level will increase surficial erosion of the earth structure as surface water rises and retreats in the narrow inlet. The fluctuating tide levels will have the greatest erosion impact on the dam near the 4th Avenue bridge. At 4th Avenue, water flowing through the narrow opening (presently gated) will exhibit larger velocities and subsequently the tides will have more impact on the side slopes than slopes further south of this opening.

High river levels, potentially during periods of heavy rainfall and when the tide is out, will tend to erode side slopes of the proposed dam. Wave action will cause erosion impacts on the upstream (lake) side of the dam. Protecting the earth dam from erosion caused by fluctuating river and tide levels is discussed in the following section.

MITIGATION

Impacts of constructing an earth dam over a geologic hazard area can be mitigated by a series of construction- and design-related measures which address these impacts. Mitigation measures are included herein to minimize construction, settlement, seismic and erosion impacts. Construction and design of the proposed earth dam must be performed in accordance with requirements of the Washington State Department of Ecology Dam Safety Department.

CONSTRUCTION MITIGATION MEASURES

Prior to construction and placement of rock and soil fills, a turbidity curtain should be installed along both sides of the proposed dam. The turbidity curtain would help confine lakebed sediments that are disturbed and become suspended during placement of fill materials. The turbidity curtain would consist of a geotextile fabric acting essentially as an underwater "silt fence."

SETTLEMENT MITIGATION MEASURES

Settlement impacts due to static loading can be reduced by placing a geotextile fabric on the lake bed before placing rock/earth fills. The geotextile fabric will provide a physical separation between the soils of varying particle sizes, acting as a separator to prevent large boulders and cobbles from sinking into the soft lake bed sediments. The geotextile will spread out the embankment load and will help to reduce the amount of fill material that would otherwise be required.

Constructing the dam embankment in stages may also help to facilitate the controlled settlement of the dam embankment as it is constructed and thereby reduce post-construction settlement. This will reduce the potential for cracking or settling of the embankment materials which could impact stability of the dam.

SEISMIC MITIGATION MEASURES

Liquefaction of loose lake bed soils will potentially result in settlement and lateral spreading of structures founded on these soils depending on the severity of the seismic event, the extent and thickness of liquefiable soils, and other factors. Measures can be taken to minimize the effects of lateral spreading and settlement on the new structure.

The use of steel sheet-piling may help limit the amount of lateral spreading which could occur during a seismic event. Row(s) of steel-sheet piling, though, may not provide sufficient support of the rock fill if soils liquefied beneath the dam. The need for ground improvements, such as stone columns, vibroflotation and resonant compaction methods, would be determined during the design phase.

Mitigation of dam settlement as a result of liquefaction will again depend of the thickness and extent of the underlying sand deposits, and other factors. Minor settlement of the dam can probably be repaired by filling sinkholes and other deformed areas using conventional grading methods, similar to those implemented during construction. If during the design phase it is determined that settlements will be large as the result of a seismic event, the ground improvement methods described above may be needed to reduce seismic-induced settlements to tolerable levels.

EROSION MITIGATION MEASURES

The side slopes of the dam embankment on the estuary/tideland side should be armored to protect against tidal and river scouring effects. The upstream (lake) side of the dam embankment should also be protected from erosion by wave action. Slope armoring should include the use of angular, rock fill materials (or riprap) which will be less susceptible to erosion than soil fill. Other armoring materials are available to protect the face of the dam, such as shot-crete or erosion-control geotextiles.

CONCEPTUAL DAM CONSTRUCTION COSTS

The costs for constructing an earthen dam across the North Basin will depend largely on the subsurface information obtained during the design phase and the feasibility of constructing the selected option. As mentioned earlier, Option 1 was determined to be the preferred dam cross section, based on a range of criteria evaluated during this phase of the planning process. Constructing an earth dam cross section similar to Option 1 (see Figure 2) that is approximately 2,000 feet long may cost approximately $9,400,000. An itemized list of costs for constructing Option 1 are presented on the attached spreadsheet.

This cost estimate is based on the available information, and our best judgement of the actual work which will be required to construct the dam. Actual costs may vary dramatically from those indicated, depending on the field conditions and dam design. If ground improvement measures, i.e. vibroflotation, are required for preparing the lake bed subgrade, costs should be expected to increase accordingly. This cost estimate does not include costs for control structures, spillways, or other structural improvements which may be planned.

—————O•O—————

We appreciate the opportunity to provide geotechnical services on this project. If you have any questions or if we can be of further service, please not hesitate to call.

Sincerely,

HWA GEOSCIENCES INC.

David L. Sowers, P.E.
Geotechnical Engineer

Scott L. Hardman, P.E.
Senior Geotechnical Engineer

DLS:SLH:dls(92055.doc)

Attachments:	Figure 1.	Site Map
	Figure 2.	Conceptual Dam Cross Sections

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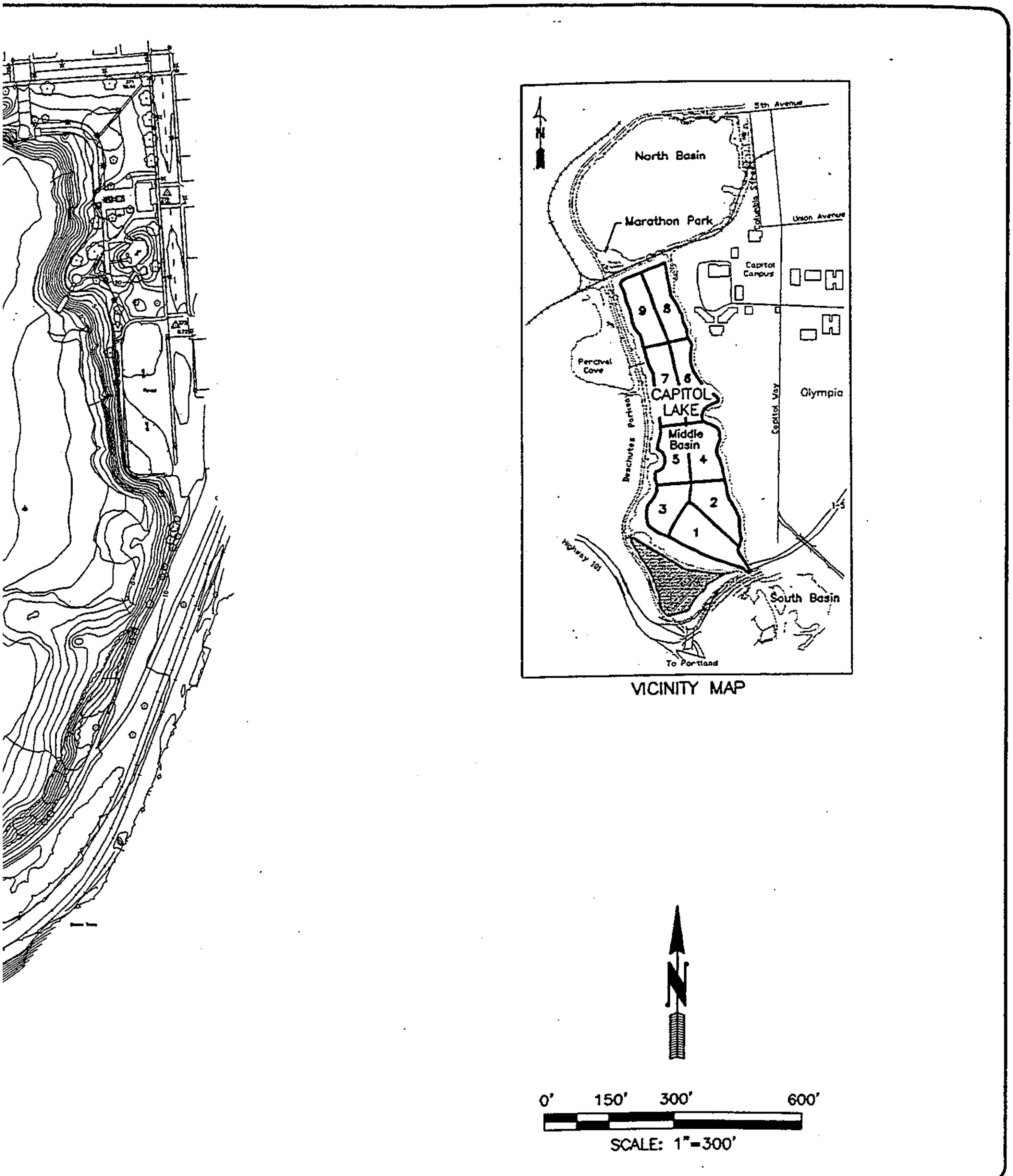
Capital Lake Adaptive Management Plan EIS
Conceptual Cost Estimate
Option 1 - Dam Cross Section with Single Row of Sheet Piling

HWA Project No.: 92055

Date: February 27, 1998

Work Element	Estimated Quantity	Unit	Unit Cost	Total Cost	Notes
Mobilization @ 10%	1	lump sum	$565,000	$565,000	
Surveying @ 2%	1	lump sum	$113,000	$113,000	
Sheet Piling	80,000	square foot	$25	$2,000,000	
Rock Fill Incl. Haul	75,000	cubic yard	$30	$2,250,000	
Soil Fill Incl. Haul	25,000	cubic yard	$20	$500,000	
Geotextile Fabric in Place	31,000	square yard	$3	$93,000	
Rip-rap Slope Protection in Place	20,000	square yard	$25	$500,000	
Silt Curtains / Temporary Erosion Control	1	allow	$100,000	$100,000	
Dewatering	1	allow	$200,000	$200,000	
			Subtotal:	$6,321,000	
			Engineering/Design Fees @ 15%:	$948,150	
			Tax @ 8.6%:	$543,606	
			Bond and Insurance @ 5%:	$316,050	
			Contingency @ 20%:	$1,264,200	
			Estimated Total:	**$9,393,006**	

Note: This cost estimate is conceptual in nature, for use in planning, budgeting and evaluation of alternative concepts. Unit costs, quantities, and scope of work may vary substantially from that shown above, based on actual conditions encountered during construction, project schedule, the contractor's selected methods, and other factors.



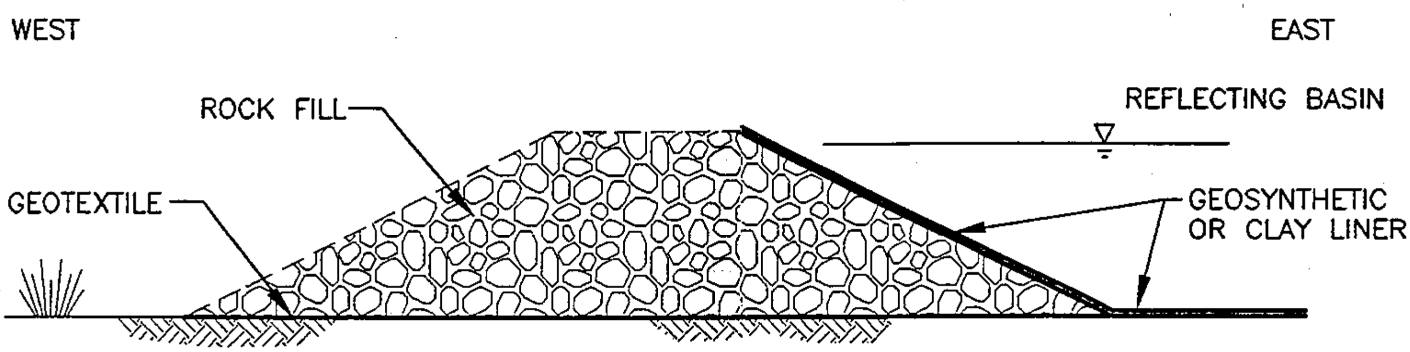
HWA GEOSCIENCES INC.

CAPITAL LAKE ADAPTIVE MANAGEMENT PLAN EIS
OLYMPIA, WASHINGTON

SITE MAP

PROJECT NO.: 92055

FIGURE: 1



OPTION 3

NOTE:

OPTION 3 INVOLVES PARTIAL OR FULL DEWATERING ON EAST SIDE OF DAM TO FACILITATE LINER PLACEMENT.

NOT TO SCALE

HWA GEOSCIENCES INC.

CAPITAL LAKE ADAPTIVE MANAGEMENT PLAN EIS
OLYMPIA, WASHINGTON

CONCEPTUAL DAM CROSS SECTIONS

PROJECT NO.: 92055 FIGURE: 2

Appendix D

Wildlife Species Information for the Capitol Lake Area

CAPITOL LAKE WILDLIFE POPULATION

The following animals, or recent signs of their presence, were observed in the Capitol Lake area on a field trip conducted 29 October 1975 by Charles Lindberg and Christopher Dlugokenski.

MAMMALS

Deer *Odocoileus* sp.
Muskrat *Ondatra zibethica*
Striped skunk *Mephitis mephitis*
Raccoon *Procyon lotor*
Voles *Microtus* sp., *Clethrionomys* sp.
Mink *Mustela vison*
Mountain beaver *Aplodontia rufa*
River otter *Lutra canadensis*
Deer mouse *Peromyscus maniculatus*
Bushytail woodrat *Neotoma cinerea*
Pacific mole *Scapanus orarius*
Bat *Myotis* sp.

AMPHIBIANS

Frogs
Turtles
Lizards

BENTHIC ANIMALS

Crayfish
Snails

FISH

Salmon
Steelhead
Cutthroat trout

Source: *Capitol lake Restoration and Recreation Plan Final Environmental Impact Statement*, Washington State Department of General Administration 1977

Source: *Final Environmental Impact Statement for Heritage Park*, Washington State Department of General Administration 1997

CAPITOL LAKE AREA BIRD POPULATIONS

These populations were compiled from the lists of the Black Hills Audubon Society, and are concerned with the area of the lake between the I-5 bridge and Tumwater Falls.

WINTER RESIDENTS	PERMANENT RESIDENTS
Common loon ***	Great blue heron ***
Horned grebe*	Green heron ***
Eared grebe*	Mallard*
Western grebe*	Sharp-shinned hawk**
Pied-billed grebe*	Cooper's hawk ***
Double-crested cormorant*	Red-tailed hawk
American bittern	California quail
Gadwall*	Ring-necked pheasant*
Pintail*	Killdeer ***
Green-winged teal*	Glaucous-winged gull*
American widgeon*	Belted kingfisher*
Northern shoveler	Common flicker ***
Ring-necked duck*	Pileated woodpecker ***
Canvasback**	Yellow-bellied sapsucker
Greater scaup ***	Hairy woodpecker*
Lesser scaup*	Downy woodpecker
Common goldeneye ***	Steller's jay ***
Barrows goldeneye***	Common crow*
Bufflehead*	Black-capped chickadee
Ruddy duck*	Chestnut-backed chickadee*
Hooded merganser*	Common bushtit ***
Common merganser ***	Red-breasted nuthatch ***
Red-breasted merganser*	Brown creeper
American coot*	Dipper ***
Common snipe*	Bewick's wren*
Spotted sandpiper	Long-billed marsh wren*
Least sandpiper	American robin ***
Dunlin ***	Cedar waxwing
Western sandpiper	Starling ***
California gull	Hutton's vireo ***
Ring-billed gull*	Yellow-rumped warbler*
Mew gull	House sparrow ***
Bonaparte's gull*	Red-winged blackbird ***
Winter wren ***	Brewers blackbird ***
Varied thrush ***	Purple finch ***
Golden-crowned kinglet	House finch*
Ruby-crowned kinglet ***	Pine siskin*
Northern shrike	American goldfinch
Evening grosbeak ***	Rufous-sided towhee ***
Golden-crowned sparrow ***	Dark-eyed junco*
Fox sparrow ***	Song sparrow*

* Indicates birds observed 29 October 1975, Charles Lindberg, Christopher Dlugokenski, and Douglas Canning, researchers.
** Indicates species that are unusual for the area.
*** Indicates species seen since 20 October 1975.
NOTE: Bald eagle observed 21 April 1976.

Source: *Capitol lake Restoration and Recreation Plan Final Environmental Impact Statement*, Washington State Department of General Administration 1977

SPRING AND SUMMER RESIDENTS

Turkey vulture
Band-tailed pigeon**
Common nighthawk
Rufous hummingbird ***
Violet-green swallow ***
Tree swallow
Rough-winged swallow
Barn swallow ***
Cliff swallow ***
Solitary vireo ***
Red-eyed vireo
Warbling vireo
Swainson's thrush
Orange-crowned warbler ***
Yellow warbler
Black-throated gray warbler
Yellowthroat ***
Wilson's warbler
Brown-headed cowbird
Western tanager
Black-headed grosbeak
Savanah sparrow
White-crowned sparrow ***

BREEDING BIRDS AND POTENTIAL BREEDERS

Green heron
Blue grouse**
Ruffed grouse**
California quail
American coot
Killdeer
Screech owl
Great horned owl
Saw-whet owl**
Rufous hummingbird
Belted kingfisher
Common flicker
Pileated woodpecker
Yellow-belled sapsucker
Hairy woodpecker
Downy woodpecker
American robin
Varied thrush
Swainson's thrush
Golden-crowned kinglet
Ruby-crowned kinglet
Cedar waxwing
Starling
Hutton's vireo
Violet-green swallow
Tree swallow
Rough-winged swallow
Barn swallow
Cliff swallow
Steller's jay
Common crow
Chestnut-backed chickadee
White-breasted nuthatch
Red-breasted nuthatch
Brown creeper
Dipper**
House wren
Winter wren
Bewick's wren
Long-billed marsh wren
House sparrow
Red-winged blackbird
Brewer's blackbird
Western tanager
Black-headed grosbeak
Evening grosbeak
Purple finch
House finch

Solitary vireo
Red-eyed vireo
Warbling vireo
Orange-crowned warbler
Yellow warbler
Yellow-rumped warbler
Yellowthroat
Wilson's warbler
Pine siskin
Rufous-sided towhee
Dark-eyed junco
Savannah sparrow
White-crowned sparrow
Song sparrow

Source: *Capitol lake Restoration and Recreation Plan Final Environmental Impact Statement*, Washington State Department of General Administration 1977

Wildlife observed during 1995 habitat surveys of Heritage Park site.

Wildlife Type	Scientific Name	Common Name
Bird	*Anas clypeata*	Northern shoveler
	Anas platyrhynchos	Mallard duck
	Ardea herodias	Great blue heron
	Branta canadensis	Canada goose
	Bucephala albeola	Bufflehead
	Corvus brachyrhynchos	Common crow
	Fulica americana	American coot
	Junco hyemalis	Dark-eyed junco
	Larus sp.	Seagulls
	Megaceryle alcyon	Belted kingfisher
	Passer domesticus	House sparrow
	Phalacrocorax auritus	Double-crested cormorant
	Turdus migratorius	American robin
Mammal	*Castor canadensis*	Beaver
	Odocoileus hemionus	Blacktail deer
	Zalophus californianus	California sea lion
Reptile	*Thamnophis ordinoides*	Northwestern garter snake

Source: *Final Environmental Impact Statement for Heritage Park*, Washington State Department of General Administration 1997

Area 5: Capitol Lake from Interstate 5 bridge to Tumwater Falls, Percival Cove, Percival Creek, and ravine bounded on the west by Highway 101

REPTILES AND AMPHIBIANS	REFERENCE
Northwestern garter snake	(Leonard, 1993b)
red-backed salamander	(Leonard, 1993b)
bullfrog	(Leonard, 1993a)
Pacific chorusfrog	(Leonard, 1992)
red legged frog	(Leonard, 1993c)
long toed salamander	(Leonard, 1993c)
northern alligator lizard	(Leonard, 1993c)
FISH	
salmon	(Lindberg, 1975)
steelhead	(Lindberg, 1975)
cutthroat trout	(Lindberg, 1975)
MAMMALS	
Columbian black-tailed deer	(Lindberg, 1975)
Douglas squirrel	(Lindberg, 1975)
mink	(Lindberg, 1975; WSW PHS, 1991)
beaver	(Lindberg, 1975)
muscrat	(Lindberg, 1975)
striped skunk	(Lindberg, 1975)
raccoon	(Lindberg, 1975)
bushytail woodrat	(Lindberg, 1975)
deer mouse	(Lindberg, 1975)
river otter	(Lindberg, 1975)
pacific mole	(Lindberg, 1975)
mountain beaver	(Lindberg, 1975)
voles *Microtus sp., Clethrionomys sp.*	(Lindberg, 1975)
flying squirrel	(Soule, 1993)
BIRDS	
dipper (B)	(Davis, 1983; McNett, 1993)
purple martin (B)	(Carnavali, 1993)
great blue heron (B)	(WDW, PHS data 1993)
green-backed heron (B)	(Davis, 1976)
Canada goose	(Davis, 1983)
saw-whet owl (B)	(Davis, 1983)
blue grouse (B)	(Davis, 1983)
ruffed grouse (B)	(Davis, 1983)
screech owl (B)	(Davis, 1983)
great horned owl	(Davis, 1983)
rufous hummingbird (B)	(Davis, 1983)
hairy woodpecker (B)	(Davis, 1983)
pileated woodpecker (B)	(Davis, 1983)
western wood pewee (B)	(Davis, 1983)
olive-sided flycatcher (B)	(Davis, 1983)
brown creeper (B)	(Davis, 1983)
Hutton's vireo (B)	(Davis, 1983)
western tanager (B)	(Davis, 1983)
yellow warbler	(Davis, 1983)
yellow-rumped warbler	(Davis, 1983)
Wilson's warbler (B)	(Davis, 1983)
MacGillivray's warbler (B)	(Davis, 1983)
band-tailed pigeon (B)	(Davis, 1983)

Source: City of Olympia, Wildlife Habitat Study, 1994

United States Department of the Interior

FISH AND WILDLIFE SERVICE
North Pacific Coast Ecoregion
Western Washington Office
510 Desmond Drive SE, Suite 102
Lacey, Washington 98501
Phone: (360) 753-9440 Fax: (360) 753-9008

February 23, 1998

Jonathan Olds
Entranco
10900 NE 8th Street, Suite 300
Bellevue, WA 98004

ENTRANCO
FEB 27 1998
RECEIVED

FWS Reference: 1-3-98-TA-0131

Dear Mr. Olds:

This is in response to your fax dated February 9, 1998, and received in this office on that same day. You requested information on listed and proposed threatened and endangered species, candidate species and species of concern (Attachment A) that may be present within the area of the proposed Management Plan Assessment for Capital Lake in Thurston County, Washington.

We are providing this information to you as technical assistance in determining possible impacts to species of Federal concern. Should there be future Federal agency involvement with this project (through funding, permitting, licensing, or other authorization), then that Federal agency will be required to assure that its responsibilities under section 7 of the Endangered Species Act of 1973, as amended (ACT), are met. We are enclosing an outline of those responsibilities for your information (Attachment B).

Species of concern are those species whose conservation standing is of concern to the Service, but for which further status information is still needed. Conservation measures for species of concern are voluntary, but recommended. Protection provided to these species now may preclude possible listing in the future.

In addition, please be advised that Federal and state regulations may require permits in areas where wetlands are identified. You should contact the Seattle District of the U.S. Army Corps of Engineers for Federal permit requirements and the Washington Department of Ecology for State permit requirements.

We appreciate your concern for endangered species. If you have any further questions, please contact Bobbi Barrera at (360) 753-6048) or John Grettenberger at (360) 753-6044 of this office.

Sincerely,

for

Nancy J. Gloman
Acting Supervisor

BB/jko
Enclosures
SE/1-3-98-TA-0131/Thurston
c: WDFW, Region 6
WNHP, Olympia

ATTACHMENT A

LISTED AND PROPOSED ENDANGERED AND THREATENED SPECIES, CANDIDATE SPECIES AND SPECIES OF CONCERN WHICH MAY OCCUR WITHIN THE VICINITY OF THE PROPOSED MANAGEMENT PLAN ASSESSMENT FOR CAPITAL LAKE THURSTON COUNTY, WASHINGTON (T18N R02W S22,4,47,55,56,58,63)

1-3-98-TA-0131

LISTED

Bald eagle (*Haliaeetus leucocephalus*) - wintering bald eagles may occur in the vicinity of the project. Wintering activities occur from October 31 through March 1.

PROPOSED

None

CANDIDATE

None

SPECIES OF CONCERN

The following Species of Concern may occur in the project vicinity:

Long-eared myotis (*Myotis evotis*)
Long-legged myotis (*Myotis volans*)
Pacific Townsend's big-eared bat (*Corynorhinus townsendii townsendii*)

ATTACHMENT B

FEDERAL AGENCIES' RESPONSIBILITIES UNDER SECTIONS 7(a) AND 7(c) OF THE ENDANGERED SPECIES ACT OF 1973, AS AMENDED

SECTION 7(a) - Consultation/Conference

Requires:

1. Federal agencies to utilize their authorities to carry out programs to conserve endangered and threatened species;

2. Consultation with FWS when a federal action may affect a listed endangered or threatened species to ensure that any action authorized, funded, or carried out by a federal agency is not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. The process is initiated by the federal agency after it has determined if its action may affect (adversely or beneficially) a listed species; and

3. Conference with FWS when a federal action is likely to jeopardize the continued existence of a proposed species or result in destruction or an adverse modification of proposed critical habitat.

SECTION 7(c) - Biological Assessment for Construction Projects *

Requires federal agencies or their designees to prepare a Biological Assessment (BA) for construction projects only. The purpose of the BA is to identify any proposed and/or listed species which is/are likely to be affected by a construction project. The process is initiated by a federal agency in requesting a list of proposed and listed threatened and endangered species (list attached). The BA should be completed within 180 days after its initiation (or within such a time period as is mutually agreeable). If the BA is not initiated within 90 days of receipt of the species list, please verify the accuracy of the list with our Service. No irreversible commitment of resources is to be made during the BA process which would result in violation of the requirements under Section 7(a) of the Act. Planning, design, and administrative actions may be taken; however, no construction may begin.

To complete the BA, your agency or its designee should: (1) conduct an onsite inspection of the area to be affected by the proposal, which may include a detailed survey of the area to determine if the species is present and whether suitable habitat exists for either expanding the existing population or potential reintroduction of the species; (2) review literature and scientific data to determine species distribution, habitat needs, and other biological requirements; (3) interview experts including those within the FWS, National Marine Fisheries Service, state conservation department, universities, and others who may have data not yet published in scientific literature; (4) review and analyze the effects of the proposal on the species in terms of individuals and populations, including consideration of cumulative effects of the proposal on the species and its habitat; (5) analyze alternative actions that may provide conservation measures; and (6) prepare a report documenting the results, including a discussion of study methods used, any problems encountered, and other relevant information. Upon completion, the report should be forwarded to our Endangered Species Division, 510 Desmond Drive SE, Suite 102, Lacey, WA 98503-1273.

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* "Construction project" means any major federal action which significantly affects the quality of the human environment (requiring an EIS), designed primarily to result in the building or erection of human-made structures such as dams, buildings, roads, pipelines, channels, and the like. This includes federal action such as permits, grants, licenses, or other forms of federal authorization or approval which may result in construction.

State of Washington
DEPARTMENT OF FISH AND WILDLIFE
Mailing Address: 600 Capitol Way N, Olympia, WA 98501-1091 - (360) 902-2200; TDD (360) 902-2207
Main Office Location: Natural Resources Building, 1111 Washington Street SE, Olympia, WA

Date: Feb 25, 1998

Dear Data Requester:

Enclosed is the information you requested from the Washington Department of Fish and Wildlife (WDFW) concerning the agency's priority habitats and species. This package may also contain documentation to help you understand and use these data.

This information only includes data that WDFW maintains in a centralized data system. It is not an attempt to provide you with an official agency response as to the impacts of your project on fish and wildlife. Nor is it designed to provide you with guidance on interpreting this information and determining how to proceed in consideration of fish and wildlife. This data only documents the location of important fish and wildlife resources to the best of our knowledge. It is important to note that priority habitats or species may occur on the ground in areas not currently known to WDFW biologists, or in areas for which comprehensive surveys have not been conducted. Site-specific surveys are frequently necessary to rule out the presence of priority habitats or species.

Your project may require further field inspection or you may need to contact our field biologists or others in WDFW to assist you in interpreting and applying these data. Refer to the enclosed directory and regional map for those contacts. Generally, for assistance on a specific project, you should contact the appropriate WDFW regional office and ask for the area habitat biologist for your project area.

Please note that sections potentially impacted by spotted owl management concerns are displayed on the 1:24,000 scale standard map products. If specific details on spotted owl site centers are required they must be specially requested.

WDFW periodically updates this information as additional data become available. Because fish and wildlife species are mobile and because priority habitats and species data is dynamic, project reviews for fish and wildlife should not rest solely on mapped information. Instead, they should also consider new data gathered from current field investigations. Remember, priority habitats and species data can only show that a species or habitat type is present, they cannot show that a species or habitat type is not present. These data should not be used for future projects. Please obtain regular (6 months) updates rather than use outdated information.

Because of the high volume of requests for information that WDFW receives, we need to charge for these data to recover some of our costs. Enclosed is an invoice itemizing the costs for your data and instructions for submitting payment.

Please note that sensitive information (e.g., threatened and/or endangered species) may be included in this data request. These species are vulnerable to disturbances and harassment. In order to protect the viability of these species we request that you not disseminate the information as to their whereabouts. Please refer to these species presence in general terms. For example: "A Peregrine Falcon is located within two miles of the project area".

If your request required a sensitive Fish and Wildlife Information Release Memorandum of Understanding (MOU) and you or your organization has one on file, please refer to that document for conditions regarding release of these data.

If you have any questions or problems with the data you received please call me at (360) 902-2543 or fax (360) 902-2946.

Sincerely,

Lori Guggenmos (Adkins)

Lori Guggenmos, Cartographer
Priority Habitats and Species

Enclosures

WDFW ADMINISTRATIVE REGIONS
AND LIST OF REGIONAL HABITAT PROGRAM MANAGERS

REGION 1

John Andrews
8702 North Division Street
Spokane, Washington 99218-1199
Phone: (509) 456-4082

REGION 2

Tracy Lloyd
1550 Alder Street N.W.
Ephrata, Washington 98823-9652
Phone: (509) 754-4624

REGION 3

Ted Clausing
1701 South 24th Avenue
Yakima, Washington 98902-5720
Phone: (509) 575-2740

REGION 4

Ted Muller
16018 Mill Creek Boulevard
Mill Creek, Washington 98012-1296
Phone: (206) 775-1311

REGION 5

Bryan Cowan
5405 N.E. Hazel Dell Avenue
Vancouver, Washington 98663-1299
Phone: (360) 696-6211

REGION 6

Dave Gufler
48 Devonshire Road
Montesano, Washington 98563-9618
Phone: (360) 249-6523

**** PHS POLYGON REFERENCE SHEET FOR TOWNSHIP T18R02W ****

POLY#	PHS DATAFORM NUMBER	PHS EOCODE/CRIT
1		
2	904754	ESTUR*-
3	900000	*-
4	900000	*-
5	904465	PHVI*HO-
6	904711	ESTUR*-
7	904451	WET*-
8	904465	PHVI*HO-
9	904754	ESTUR*-
10	902432	AISP*B-
11	900987	AISP*B-
12	904451	WET*-
13	904772	SLOUGH*-
14	900000	*-
15	904772	SLOUGH*-
16	900000	*-
17	904754	ESTUR*-
18	904451	WET*-
19	904772	SLOUGH*-
20	904451	WET*-
21	904772	SLOUGH*-
22	904762	LAGOON*-
23	904451	WET*-
24	900000	*-
25	904754	ESTUR*-
26	904711	ESTUR*-
27	904451	WET*-
28	904711	ESTUR*-
29	904451	WET*-
30	904451	WET*-
31	901114	MUVI*RC-
32	900000	*-
33	900987-901114	AISP*B-MUVI*RC-
34	902428	BUJA*B-
35	900987	AISP*B-
36	900000	*-
37	900000	*-
38	900937	AISP*B-

WASHINGTON DEPT OF WILDLIFE

PRIORITY HABITATS AND SPECIES
Tabular Data Report - General Information - DRAFT
02/24/1998

form: 900937 species/habitat: AISP species use: B season: U definition: 6 map accuracy: 1
sitename:
general description: WOOD DUCK PAIR OBSERVED WITH BROOD

source: SKRILETZ, JEFF, WDW date: 85 code: PROF
synopsis:

source: WDW BROOD SURVEYS date: 062373 code: BROOD
synopsis: WOOD DUCK PAIR AND BROODS OBSERVED IN S8 R2W T17N IN 1976, 77, 78, 79, 80, 81, 8
2.

form: 900987 species/habitat: AISP species use: B season: SUF definition: 6 map accuracy: 1
sitename: WEST OLYMPIA
general description: WOOD DUCK BREEDING AREA

source: SKRILETZ, JEFF WDW date: 05 91 code: PROF
synopsis: ROUTINE FIELD VISITS SINCE 1978

form: 901114 species/habitat: MUVI species use: RC season: definition: 6 map accuracy: 1
sitename: PERCIEVAL CREEK-CAPITOL LAKE
general description: MINK LOCATIONS

source: TRAPPER HARVEST date: 12 91 code: SIGN
synopsis: RON KERR AND CARL VOGTS HARVEST

WASHINGTON DEPT OF WILDLIFE

PRIORITY HABITATS AND SPECIES
Tabular Data Report - General Information - DRAFT
02/24/1998

form: 902428 species/habitat: BUJA species use: B season: SU definition: 6 map accuracy: 1
sitename: TUMWATER HILL
general description: RED TAIL HAWK NEST SITE

source: SCHIRATO, WDW date: 03 91 code: DRIVE
synopsis: NEST WAS FOUND IN 1989. IN 1990 NEST WAS MOVED BY COOT CO. AS PART OF TUMWATER H
ILL DEVELOPMENT PROJECT

form: 902432 species/habitat: AISP species use: B season: SUF definition: 6 map accuracy: 1
sitename: LACEY
general description: WOOD DUCK BREEDING AREA

source: FURRER, STEVE; SKRILETZ, JEFF date: 04 91 code: PROF
synopsis: ROUTINE FIELD VISITS OVER COMBINED SEVENTEEN YEARS OF OBSERVATIONS

form: 904451 species/habitat: WET species use: season: definition: 6 map accuracy: 1
sitename: REGION 6 SALTWATER WETLANDS
general description: COASTAL SALT MARSHES SALT MEADOWS AND BRACKISH MARSHES

source: WASHINGTON STATE COASTAL ZONE ATLAS D.O.E., 1979 date: 04 78 code: CZA
synopsis: D.O.E. SPONSORED MAPPING OF COASTAL FEATURES

form: 904465 species/habitat: PHVI species use: HO season: WSUF definition: 0 map accuracy: 1
sitename:
general description: HARBOR SEAL HAUL OUT SITE-YEAR AROUND

source: STEVE JEFFRIES, WDW date: 91 code: PROF
synopsis: AERIAL SURVEYS

form: 904711 species/habitat: ESTUR species use: season: definition: 0 map accuracy: 1
sitename:
general description: ESTVARINE ZONE-COASTAL ZONE ATLAS OF WASHINGTON-STRONGLY INFLUENCED BY THE MARIN
E ENVIRONMENT AND CAN BE DISTINGUISHED BY A BRANCHING CHANNEL PATTERN IN A BROAD
FLAT VALLEY. CZA CODE 511.
source: COASTAL ZONE ATLAS OF WASHINGTON. STATE OF WASHINGTON DEPT OF ECOLOGY. date: 78 code: CZA
synopsis:

form: 904754 species/habitat: ESTUR species use: season: definition: 0 map accuracy: 1
sitename:
general description: BAY/ESTUARY-COASTAL ZONE ATLAS CODE 54-MODERATELY PROTECTED MARINE EMBAYMENTS WI
TH FREE CONNECTIONS WITH THE OPEN SEA. BLUFFS, REACH SUBSTRATES MARSHES, EELGRAS
S BEDS, AND OTHER INTERTIDAL HABITATS ARE ASSOCIATED WITH IT.
source: COASTAL ZONE ATLAS OF WASHINGTON. STATE OF WASHINGTON DEPT OF ECOLOGY. date: 78 code: CZA
synopsis:

WASHINGTON DEPT OF WILDLIFE

PRIORITY HABITATS AND SPECIES
Tabular Data Report - General Information - DRAFT
02/24/1998

form: 904762 species/habitat: LAGOON species use: season: definition: 0 map accuracy: 1
sitename:
general description: OPEN LAGOON. COASTAL ZONE ATLAS CODE 562-PARTIALLY ENCLOSED LAGOON ARE COMMON, B EING FORMED WHEN FRESHWATER INFLOW HAS MAINTAINED A STREAM CHANNEL THROUGH BARS FORMED BY ALONGSHORE DEPOSITION.
source: COASTAL ZONE ATLAS OF WASHINGTON. STATE OF WASHINGTON DEPT OF ECOLOGY. date: code: CZA
synopsis:

form: 904772 species/habitat: SLOUGH species use: season: definition: 0 map accuracy: 1
sitename:
general description: MARINE SLOUGH-COASTAL ZONE ATLAS OF WASHINGTON-NARROW INLETS TYPICALLY FORMING O N RIVER DELTAS WHICH RECEIVE TIDAL BACKUP WATER AND VERY LITTLE FRESH WATER RUNO FF. CZA CODE 572.
source: COASTAL ZONE ATLAS OF WASHINGTON. STATE OF WASHINGTON DEPT OF ECOLOGY. date: 78 code: CZA
synopsis:

WASHINGTON DEPARTMENT OF FISH AND WILDLIFE (WDFW)
WILDLIFE HERITAGE (HRTG) GIS DATABASE REPORT
FOR TOWNSHIP T18R02W
REPORT DATE: February 24, 1998

CONTACT THE WDFW BIOLOGIST IN YOUR REGION IF YOU NEED MORE SPECIFIC INFORMATION. REGIONAL TELEPHONE NUMBERS ARE LISTED BELOW. TO FIND OUT WHICH REGION TO CALL LOOK FOR THE REGION NUMBER LISTED IN THE FOLLOWING REPORT.

REGION 1 - SPOKANE	(509)456 4082
REGION 2 - EPHRATA	(509)754 4626
REGION 3 - YAKIMA	(509)575 2740
REGION 4 - MILL CREEK	(206)775 1311
REGION 5 - VANCOUVER	(360)696 6211
REGION 6 - MONTESANO	(360)249 6523

quadpt: 4712218018 sppcode: BUVIRE crit: B name: GREEN HERON
year: 1980 class: SA accuracy: C state status: SM federal status: region: 7
township - range - section: T18N R02W S66
general description:
GREEN HERON NEST OLYMPIA .25 MI W INTERSECTION COOPER PT RD & KAISER RD 30 FT UP IN 60 FT DOUG FIR; MIXED FOREST BORDERING SWAMP, NEST IS 20 M FROM 4-PLEX OF COLLEGE COURT APTS; CAT KILLED 1 OF 4 YNG.

quadpt: 4712218028 sppcode: BUVIRE crit: B name: GREEN HERON
year: 1980 class: SA accuracy: C state status: SM federal status: region: 7
township - range - section: T18N R02W S55
general description:
GREEN HERON RI PERCIVAL CR-CAPITOL LK 1975,77,78,80. ALSO REPORTED TO BREED IN A REA.

quadpt: 4712218053 sppcode: CAMA crit: IO name: LARGESCALE SUCKER
year: 1994 class: SA accuracy: C state status: federal status: region: 7
township - range - section: T18N R02W S31
general description:
LARGESCALE SUCKER.

quadpt: 4712218013 sppcode: CASAL crit: RI name: GREAT EGRET
year: 1982 class: SA accuracy: C state status: SM federal status: region: 7
township - range - section: T18N R02W S14
general description:
GREAT EGRET RI, STANDING ON THE SHORE OF BUDD INLET BEHIND MARK-IT FOODS, OLYMPIA 1977-82. ALSO PERCIVAL CK & CAPITOL LK.

quadpt: 4712218045 sppcode: CHVA crit: CR name: VAUX'S SWIFT
year: 1994 class: SA accuracy: C state status: SC federal status: region: 7
township - range - section: T18N R02W S47 S 1/2
general description:
VAUX'S SWIFT OBSERVED ENTERING CHIMNEYS AT 1712 CAPITOL WAY FOR SECOND CONSECUTIVE DUSK. NIKKI MCCLURE ESTIM. 30-40. MOST WENT INTO CHIMNEY ON FRONT SIDE OF HOUSE (FACING WEST).

quadpt: 4712218040 sppcode: HALE crit: B name: BALD EAGLE
year: 1994 class: SA accuracy: C state status: ST federal status: FT region: 7
township - range - section: T18N R02W S31 NEOFSW
general description:
BALD EAGLE NEST ON W SIDE OF GRAND FIR ON NW SIDE OF BLACK LAKE.

quadpt: 4712218040 sppcode: HALE crit: B name: BALD EAGLE
year: 1995 class: SA accuracy: C state status: ST federal status: FT region: 7
township - range - section: T18N R02W S31 NEOFSW
general description:
BALD EAGLE NEST SOUTH OF OLD GRAND FIR TREE.

quadpt: 4712218018 sppcode: NOHU crit: IO name: OLYMPIC MUDMINNOW
year: 1980 class: SA accuracy: C state status: SC federal status: region: 7

township - range - section: T18N R02W S66
general description:
OLYMPIC MUDMINNOW 6 TRAPPED IN SWAMP .25 MILES SW OF INTERSECTION OF COOPER PT RD AND KAISER RD OLYMPIA.

quadpt: 4712218042 sppcode: NOHU crit: IO name: OLYMPIC MUDMINNOW
year: 1993 class: SA accuracy: C state status: SC federal status: region: 7
township - range - section: T18N R02W S08 OFSE
general description:
OLYMPIC MUDMINNOW. DIPNETTED. 5 FISH

quadpt: 4712218047 sppcode: PAHA crit: B name: OSPREY
year: 1994 class: SA accuracy: C state status: SM federal status: region: 7
township - range - section: T18N R02W S53 NE
general description:
OSPREY NEST IN TALL SNAG, NORTH OF ELLIS COVE.

quadpt: 4712218036 sppcode: PRSU crit: BOX name: PURPLE MARTIN
year: 1987 class: SA accuracy: C state status: SC federal status: region: 7
township - range - section: T18N R02W S03 SWOFNW
general description:
PURPLE MARTINS NEST IN BOXES ON PILING JUST SOUTH OF BUTLER CO COVE.

quadpt: 4712218059 sppcode: PRSU crit: BOX name: PURPLE MARTIN
year: 1988 class: SA accuracy: C state status: SC federal status: region: 7
township - range - section: T18N R02W S62
general description:
3 PURPLE MARTIN BOXES IN LIGHT TOWER.

quadpt: 4712218057 sppcode: PRSU crit: BOX name: PURPLE MARTIN
year: 1988 class: SA accuracy: C state status: SC federal status: region: 7
township - range - section: T18N R02W S53
general description:
3 PURPLE MARTIN BOXES IN LIGHT TOWER.

quadpt: 4712218037 sppcode: PRSU crit: BOX name: PURPLE MARTIN
year: 1987 class: SA accuracy: C state status: SC federal status: region: 7
township - range - section: T18N R02W S57
general description:
PURPLE MARTINS NEST IN BOXES ON PILINGS BETWEEN WEST BAY MARINA AND THE END OF THE LOG BOOM THAT STRETCHES TO THE NORTH.

quadpt: 4712218033 sppcode: PRSU crit: BOX name: PURPLE MARTIN
year: 1987 class: SA accuracy: C state status: SC federal status: region: 7
township - range - section: T18N R02W S11 SW
general description:
PURPLE MARTINS NEST IN BOXES ON PILINGS BETWEEN EAST BAY MARINA AND KGY RADIO STATION.

quadpt: 4712218055 sppcode: PRSU crit: BOX name: PURPLE MARTIN
year: 1996 class: SA accuracy: C state status: SC federal status: region: 7
township - range - section: T18N R02W S41 NW
general description:
PURPLE MARTIN BOXES PLACED ON PILINGS IN SOUTHERN MOST PART EAST BAY.

quadpt: 4712218009 sppcode: PRSU crit: BOX name: PURPLE MARTIN
year: 1985 class: SA accuracy: C state status: SC federal status: region: 7
township - range - section: T18N R02W S14
general description:
PURPLE MARTIN NESTS IN BOXES ON PILINGS AT PERCIVAL LANDING ON BUDD INLET IN DOWNTOWN OLYMPIA.

SEABIRD COLONIES FOR t18r02w
from the CATALOG OF WASHINGTON SEABIRD COLONIES by Steven Speich et al,1989
Colony ID: 175053 NOAA Flag: 1 Class of breeding species: A
Colony Name: OLYMPIA WATERFRONT

The following fields identify the number of breeding individuals by species for colonies where the NOAA flag = 1.

Storm Petrel:	0
Fork Tailed Storm Petrel:	0
Leachs Storm Petrel:	0
Cormorant:	0
Double Crested Cormorant:	0
Brandts Cormorant:	0
Pelagic Cormorant:	0
Black Oystercatcher:	0
Ring Billed Gull:	0
Western Gull:	0
Glaucous Winged Gull:	30
Caspian Tern:	0
Arctic Tern:	0
Common Murre:	0
Pigeon Guillemot:	12
Cassins Auklet:	0
Rhinoceros Auklet:	0
Tufted Puffin:	0
Total Population:	42

Information About The Seabird Colonies Report

The information in this report was taken from the CATALOG OF WASHINGTON SEABIRD COLONIES by Steven M Speich et al, published in 1989 by NOAA. Population numbers by species reflect counts of breeding individuals based upon the most recent or best estimates as indicated in the publication. If observations were not classed as most recent or best estimates, then population numbers were not provided.

Codes for class of breeding species:

code	description
A	Alcids (may include others)
AC	Alcids and comorants (may include others)
C	Cormorants (may include others)
O	Others (but no alcids or cormorants)
-	No breeding observed or no information.

Please note: This information is dated. Please contact the WDFW biologist for your project area for more recent information.

Appendix E

Fish Species in the Capitol Lake Area

Table E-1. Juvenile fall chinook salmon released into Capital Lake and Percival Cove from 1980 to 1994 by Washington State Department of Fish and Wildlife

Year of Release	Date of Release	Life Stage of Fish Released	Size of Fish (No./Pound)	Number of Fish Released	Location of Release
1980	Jan. 31	Yearling	12.0	380,000	Capitol Lake
	March 12	Yearling	9.0	801,294	Capitol Lake
	May 31	Fingerling	120.0	6,437,000	Capitol Lake
	Dec. 31	Fall release	12.5	422,025	Capitol Lake
1981	March 6	Yearling	8.0	1,191,144	Capitol Lake
	May 30	Fingerling	115.0	5,197,132	Capitol Lake
1982	March 1	Yearling	7.5	912,500	Capitol Lake
	May 15	Yearling	6.5	180,550	Capitol Lake
	May 25	Fingerling	125.0	8,760,221	Capitol Lake
1983	March 12	Yearling	9.3	680,863	Capitol Lake
	April 7	Yearling	7.0	113,601	Capitol Lake
	May 31	Yearling	7.0	227,141	Capitol Lake
	May 31	Fingerling	110.0	8,047,300	Capitol Lake
1984	April 9	Yearling	6.5	975,600	Capitol Lake
	June 15	Fingerling	82.0	6,416,000	Capitol Lake
1985	March 1	Fingerling	522.0	814,000	Deschutes River
	April 1	Yearling	8.0	659,400	Capitol Lake
	April 4	Fingerling	191.0	811,900	Deschutes River
	May 30	Fingerling	63.0	2,650,000	Capitol Lake
	June 13	Fingerling	139.0	3,243,400	Capitol Lake
1986	March 31	Yearling	7.9	1,142,700	Capitol Lake
	April 17	Fingerling	183.0	1,000,000	Capitol Lake
	May 4	Fingerling	93.0	360,000	Capitol Lake
	June 1	Fingerling	83.5	5,425,000	Capitol Lake
	Nov. 25	Fall release	18.3	546,540	Capitol Lake
	Dec. 20	Fall release	18.3	264,360	Capitol Lake
1987	May 26	Fingerling	101.0	7,788,300	Capitol Lake
	June 10	Fingerling	95.0	280,300	Capitol Lake
1988	April 30	Fingerling	179.0	1,150,000	Capitol Lake
	April 30	Fingerling	85.0	666,140	Capitol Lake
	May 15	Fingerling	144.0	1,110,300	Capitol Lake
	May 21	Fingerling	175.0	2,333,800	Capitol Lake
	June 27	Fingerling	63.0	264,600	Capitol Lake
1989	May 3	Yearling	5.5	102,500	Capitol Lake
	May 31	Fingerling	295.0	1,918,050	Capitol Lake
	May 31	Fingerling	288.0	750,000	Capitol Lake
	May 31	Fingerling	113.0	445,000	Capitol Lake
	May 31	Fingerling	112.0	1,407,900	Capitol Lake
	May 31	Fingerling	90.0	1,055,925	Capitol Lake
	Dec. 7	Eggs	1,490.0	1,000,000	Percival Creek

Table C-1. Continued

Year of Release	Date of Release	Life Stage of Fish Released	Size of Fish (No./Pound)	Number of Fish Released	Location of Release
1990	Jan. 12	Yearling	14.0	136,000	Capitol Lake
	May 15	Yearling	6.0	133,000	Capitol Lake
	June 1	Fingerling	97.5	3,825,000	Capitol Lake
1991	Jan. 22	Yearling	20.0	5,000	Capitol Lake
	May 5	Yearling	6.9	180,000	Capitol Lake
	June 1	Fingerling	73.0	4,480,000	Capitol Lake
1992	Feb. 27	Fingerling	220.0	795,500	Deschutes River
	March 27	Fingerling	130.0	605,300	Capitol Lake
	April 6	Fingerling	120.0	833,000	Capitol Lake
	April 24	Yearling	7.15	181,000	Capitol Lake
	April 28	Fingerling	190.0	1,461,100	Capitol Lake
	April 30	Fingerling	218.0	882,900	Capitol Lake
	May 6	Fingerling	73.0	533,400	Capitol Lake
	May 20	Fingerling	112.0	931,800	Capitol Lake
1993	March 2	Fingerling	307.0	1,482,100	Deschutes River
	April 22	Fingerling	95.0	1,915,800	Capitol Lake
	April 27	Fingerling	133.0	82,000	Capitol Lake
	May 23	Fingerling	110.0	1,555,400	Capitol Lake
1994	June 1	Yearling	6.8	166,870	Capitol Lake
	June 1	Fingerling	138.0	3,580,000	Capitol Lake

Table E-2. Fall chinook salmon spawning survey data from 1980 to 1993 in the Deschutes River basin according to Washington Department of Fish and Wildlife.

Water Body	Spawning Year	Sept.	Oct.	Nov.	Total Number of Fish
Deschutes River main stem from river mile 2.2 to 20.9	1990	-	1,811	-	1,811
Percival Creek (13-0029) tributary to Capitol Lake	1980	-	7	-	7
	1981	-	1	-	1
	1982	-	-	-	-
	1989	-	356	89	445
	1990	-	302	-	302
	1991	-	106	-	106
	1992	-	-	-	-
	1993	-	1	-	1
Little Percival Creek (13-0030) tributary to Capitol Lake	1980	8	-	-	8
	1981	-	5	-	5
	1982	-	-	-	-
	1989	-	178	-	178

Table E-3. Juvenile coho salmon released into Deschutes River basin from 1980 to 1994 by Washington Department of Fish and Wildlife.

Year of Release	Date of Release	Life Stage of Fish Released	Size of Fish (No./pound)	Number of Fish Released	Location of Release
1980	Feb. 14	Unfed fry	1200.0	23,336	Percival Creek
	May 12	Yearling	22.0	8,022	Deschutes River
1981	March 23	Fingerling	680.0	6,800	Fall Creek (13-0057) tributary to Deschutes River
	March 23	Fingerling	680.0	44,200	Mitchell Creek (13-0069) tributary to Deschutes River
	March 23	Fingerling	680.0	24,480	Johnson Creek (13-0089) tributary to Deschutes River
	March 23	Fingerling	680.0	51,680	Thurston Creek (13-0095) tributary to Deschutes River
	March 23	Fingerling	680.0	708,560	Deschutes River
	April 3	Fingerling	405.0	402,570	Deschutes River
	April 23	Yearling	23.0	2,019	Deschutes River
	May 5	Yearling	21.0	2,137	Deschutes River
	May 15	Yearling	19.0	1,523	Deschutes River
1982	June 15	Fingerling	220.0	38,060	Deschutes River
1983	May 6	Fingerling	531.0	7,700	Deschutes River
	May 6	Fingerling	531.0	13,300	West fork Deschutes River (13-0126)
1984	May 1	Fingerling	355.0	16,000	Deschutes River
	May 1	Fingerling	355.0	20,900	West fork Deschutes River
	May 1	Fingerling	355.0	18,100	Thorn Creek
1985	April 26	Fingerling	919.0	22,100	Deschutes River
	April 26	Fingerling	919.0	22,100	Thorn Creek
	May 13	Yearling	18.0	1,000	Deschutes River
1986	April 14	Unfed fry	1,110.0	20,000	Deschutes River
	April 14	Unfed fry	1,110.0	20,000	Thorn Creek
	April 22	Yearling	23.0	1,056	Deschutes River
1990	March 23	Unfed fry	1,500.0	500	Deschutes River

Table E-4. Coho salmon spawning survey data from 1980 to 1994 in the Deschutes River basin according to Washington Department of Fish and Wildlife.

Water Body	Spawning Season	Oct.	Nov.	Dec.	Jan.	Total Number of Fish
Deschutes River mainstem from river mile 4.6-20.9 and 38.2-39.9	1982-83	-	11	-	-	11
	1990-91	11	-	-	-	11
Percival Creek (13-0029) tributary to Capitol Lake	1981-82	1	-	-	-	1
	1985-86	-	-	25	-	25
Unnamed tributary (13-0032) to Deschutes River at river mile 4.0	1982-83	-	-	7	-	7
Spurgeon Creek (13-0037) tributary to Deschutes River at river mile 10.1	1979-80	-	-	-	20	20
	1980-81	-	-	5	-	5
	1985-86	-	-	-	2	2
Mitchell Creek (13-0069) tributary to Deschutes River at river mile 38.15	1980-81	-	2	-	-	2
	1981-82	-	22	4	-	26
	1989-90	-	4	-	-	4
Huckleberry Creek (13-0086) tributary to Deschutes River at river mile 38.2	1980-81	-	121	78	-	199
	1981-82	-	304	68	-	372
	1982-83	-	589	673	-	1,262
	1983-84	-	153	60	6	219
	1984-85	-	167	198	134	499
	1985-86	122	283	994	280	1,679
	1986-87	-	123	145	23	291
	1987-88	-	260	918	132	1,310
	1988-89	-	764	401	-	1,165
	1989-90	-	7	6	-	13
	1990-91	3	15	95	-	113
	1991-92	-	196	26	-	222
	1992-93	-	1	9	-	10
	1993-94	-	-	6	-	6
Johnson Creek (13-0089) tributary to Deschutes River at river mile 39.1	1980-81	-	17	8	-	25
	1981-82	-	25	23	-	48
	1982-83	-	93	108	-	201
	1983-84	-	43	4	-	47
	1984-85	-	38	3	-	41
	1985-86	26	40	160	72	298
	1986-87	-	72	32	-	104
	1987-88	-	-	285	22	307
	1988-89	-	101	19	-	120
	1989-90	-	-	1	-	1

Table E-4. Coho salmon spawning survey data from 1980 to 1994 in the Deschutes River basin according to Washington Department of Fish and Wildlife (continued).

Water Body	Spawning Season	Oct.	Nov.	Dec.	Jan.	Total Number of Fish
Johnson Creek (13-0089) tributary to Deschutes River at river mile 39.1	1990-91	-	-	14	-	14
	1991-92	-	42	-	-	42
	1992-93	-	-	-	-	-
	1993-94	-	-	-	-	-
Thurston Creek (13-0095) tributary to Deschutes River at river mile 39.4	1980-81	-	6	1	-	7
	1981-82	-	14	2	-	16
	1982-83	-	23	15	-	38
	1983-84	-	12	5	-	17
	1984-85	-	15	1	-	16
	1985-86	16	9	103	14	142
	1986-87	-	84	17	-	101
	1987-88	-	140	142	26	308
	1988-89	-	56	19	-	75
	1989-90	-	-	-	-	-
	1990-91	-	3	11	-	14
	1991-92	-	36	4	-	40
	1992-93	-	-	-	-	-
	1993-94	-	-	3	-	3

Table E-5. Chum salmon spawning survey data from 1980 to 1993 in the Deschutes River basin according to Washington Department of Fish and Wildlife.

Water Body	Spawning Year	Oct.	Nov.	Total Number of Fish
Percival Creek (13-0029) tributary to Capitol Lake	1989	65	23	88
	1990	5	-	5
Little Percival Creek (13-0030) tributary to Capitol Lake	1989	-	1	1

Appendix F

Vegetation Community Predictions

Appendix F. Vegetation Community Predictions

Background for Predicting for Vegetation Community Impacts for Estuary Development in Capitol Lake

The Combined Lake/Estuary Alternative and the Estuary Alternative will alter vegetation communities presently in the lake. The changes that will take place are predicted using a simple model which considers the primary factors that control the development of vegetation communities, along with the types of plants that would be expected to colonize the restored estuary. This section presents the simple model and assumptions used to make the predictions.

Primary Factors

The primary factors that control the type and extent of wetland vegetation communities, as well as the rate of change of one community type to another, include:

- hydrology (i.e., water level, flushing rate and dynamics)
- water quality (i.e., salinity, nutrient levels, dissolved oxygen, turbidity, temperature)
- soil type or substrata composition
- topography
- sedimentation/erosion processes
- plant species pool (i.e., source of colonizing plant material; plants existing on the site).

All of these factors will change to some degree with both the Combined Lake/Estuary Alternative and Estuary Alternative.

Under both alternatives, the factors that will likely control the short-term changes in vegetation are water level dynamics, salinity and sedimentation rate. Elevation and hydrology are highly correlated and strongly affect the types of plants that occupy an area. Any alterations in either elevation or water level will have dramatic effects on most wetland and upland plants.

Plant species vary in their tolerance to the salt concentration in water from highly tolerant, through variably tolerant, to intolerant. Plant distribution in a system with varying salinity is often controlled by the distribution of salinity (**Hutchinson 1989**).

Predicted Changes in Vegetation Communities

Changes in hydrodynamics under these alternatives will affect the patterns of sediment accretion and erosion. Through accretion, bottom elevation rises (i.e., the depth becomes shallower), which allows emergent marsh plants to colonize when the elevation becomes high enough. Much of the lake bottom presently is shallow and gently sloping, except for channels where the main flows occur during drawdowns or flushes with tidal water. The shallowest portions of the lake are colonized by SAV. Deeper areas would be expected to colonize with wetland plants when their elevation reaches the correct range.

Changes in vegetation, therefore, can be predicted to a great degree based upon information on existing elevation, salinity tolerance and elevation ranges of species that are available to colonize the area. Information on accretion rates can be used to predict colonization rates for areas that are presently too low to support vegetation. Elevation maps in the lake are available from photogrammetric surveys conducted in 1996 (available from Entranco Engineers). Data on salinity ranges in various portions of the lake were gathered during the 1997 Capitol Lake Drawdown study. Although salt water from Budd Inlet was allowed to flow into the North Basin for only a short period of time, these data can be used to indicate salinity patterns within the system under the two estuarine alternatives.

Although rates and locations of net accretion are more difficult to predict, average accretion rates from nearby sites can provide an indication of what would be expected in Capitol Lake. Sediment deposition in the lake following restoration of tidal action is predicted to be on the order of the current rate (**Entranco Inc. 1997**). Once marshes begin to develop, the accretion rate in the marshes will likely be on the order of 0.12 inches (3.0 mm/yr). This latter rate is based on data collected in the tidal marsh at Nisqually Delta in Puget Sound (**Thom 1992**).

Plant species information sources for plant species distributions and species tolerances are found in Berg et al. (**1980**), Frenkel et al. (**1981**), Kunze (**1984**), Hutchinson (**1982**), Bradfield and Porter (**1982**), Boule (**1981**), and Dethier (**1990**).

Typical wetland species and elevation range that would likely occur under brackish conditions. These species are based upon the list in "Wetland Plants of the Pacific Northwest" (**U.S. Army Corps of Engineers, no date**) and "A Marine and Estuarine Habitat Classification System for Washington State" (**Dethier 1990**). Both of these reports provide both elevation and salinity information that helps define communities expected to occur in the lake under the estuarine alternatives. Dethier (**1990**) also includes physical conditions that help further refine the predictions. Under the estuarine alternatives, the lake would become what Dethier calls an "estuarine intertidal, organic, sand, mixed-fine or mud: partly enclosed, backshore, oligohaline" system. The communities will initially develop in place of the present. It is not expected that *eelgrass (Zostera* spp.) would occupy the system because of the lack of deep areas (**Entranco Inc. 1997**).

Uncertainties Associated with Predictions

The predictions of vegetation changes are tied to changes in physical and chemical conditions of the system. Among the factors that may cause variance from these predictions are water level fluctuations caused by river flow following the return of tidal action to the system. There will likely be an increase in water level somewhat above the water level caused by tides only. The difference between tidal water level in Budd Inlet and actual water level will be greatest during periods of highest river discharge. The difference could be as great as 1 foot, but this is not well documented.

The relative sea level is rising in the south Puget Sound region at about 0.09 in/yr (2.4 mm/yr) (**Shipman 1990, Thom 1992**). Hence, accretion rates of 0.12 in/yr are balanced partially by sea level rise of 0.09 in/yr, for a net accretion rate of 0.03 in/yr. The influence of sea level rise is to slow the rate at which the tidal areas build up vertically, which will slow the rate that wetland vegetation colonizes the flats.

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