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DESCHUTES ESTUARY FEASIBILITY STUDY
FINAL REPORT

Prepared for

Washington Department of Fish and Wildlife

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1. INTRODUCTION

During the last ten years, there has been growing interest in exploring options for management of Capitol Lake in Olympia, WA. In 2002, the Capitol Lake Adaptive Management Plan (CLAMP) Steering Committee adopted a ten-year plan for the Capitol Lake basin that addressed a range of management issues. The plan was adopted by the State Capitol Committee, which included authorization to proceed with an estuary feasibility study to help inform a long-range management decision. The Deschutes Estuary Feasibility Study (DEFS) was initiated in 2003 to determine if restoration of the Deschutes River Estuary, by removing the dam along Fifth Avenue, is a feasible alternative for consideration in management of the lake.

As part of the broader-scoped Capitol Lake Alternatives Analysis, the DEFS considered four potential alternatives for future management of Capitol Lake. The estuary alternative includes a 500-foot opening to replace the current Fifth Avenue dam, and the construction of a bridge that mirrors the Fourth Avenue Bridge. A channel would be dredged through the lake before the dam is removed.

To inform CLAMP's assessment of the feasibility of estuary restoration, four technical studies were completed for the DEFS:

- Sediment Transport & Hydraulic Modeling (George and others, 2006)
- Reference Estuary Study & Biological Conditions (Garono and others, 2006)
- Engineering Design & Cost Estimate (Moffatt & Nichol Engineers and others, 2007)
- Net Social and Economic Benefit Analysis (Cascade Economics and others, 2007)

A separate Independent Technical Review (ITR) of these studies was carried out (PWA and others, 2007).

This Final Report summarizes the findings of the Deschutes Estuary Feasibility Study four Technical Studies and Independent Technical Review. To assist in transferring the technical information of these studies into a planning context a simple conceptual model of restoration ecological potential and list of project opportunities and constraints are presented.

2. PROJECT SETTING

Situated below the Washington State Capitol campus in Olympia, WA, the Deschutes Estuary became Capitol Lake upon construction of the Fifth Avenue Dam in 1951. Prior to the structure, the estuary was a tidally-dominated system at the southern end of Budd Inlet, Puget Sound, that experienced a tidal range of approximately 5 m (15 ft) and received freshwater input from the Deschutes River. Since dam construction, an estimated 60 to 80% of suspended sediment transported by the river has been trapped by the lake (George and others, 2006). Since the mid-1970s, several dozen studies investigating sediment removal, water quality and maintenance protocols have been conducted to preserve Capitol Lake. Portions of the lake were dredged twice (1978 and 1986) even as the shoreline was altered by the construction of various parks and highway improvements. In spite of these efforts, by 2004, lake volume had decreased by 28%. Sediment management, water quality and invasive species present challenges for on-going management of Capitol Lake.

3. GOAL AND OBJECTIVES

As part of the DEFS planning process, the CLAMP Steering Committee crafted a set of goals to determine if an estuary was a feasible management approach for the Capitol Lake basin. We have rearranged these goals to provide one overarching DEFS goal and a series of objectives to meet that goal. The goal describes a long-term desired outcome and the objectives describe specific actions that will help achieve the goal. The DEFS goal is:

- Determine if it is feasible to restore a self-sustaining Deschutes Estuary as an alternative to the continued management and maintenance of Capitol Lake.

The DEFS objectives are:

- Increase understanding of the estuary alternative to a level comparable with managing the lake environment;
- Identify the potential effects of the estuary alternative on sedimentation, water quality and existing infrastructure;
- Formulate, evaluate and screen potential benefits and shortcomings associated with the estuary alternative;
- Create a net-benefit matrix that will allow a fair evaluation of overall benefits and costs of the estuary alternative;
- Provide the feasibility analysis to the CLAMP Steering Committee so that a decision regarding the long-term future of the site can be made;
- Recommend a series of actions and projects that have a reasonable likelihood of success, and can be permitted by regulatory agencies.

We have also formulated a goal and objectives for estuary restoration from which we will focus and develop a conceptual model, and opportunities and constraints. The definition of this goal and objectives provides the parameters necessary to determine success of restoration efforts and the feasibility of estuary restoration within the context of DEFS, as well as in support of the Alternatives Analysis. The estuary restoration goal is:

- Restore hydrologic, morphologic and ecologic processes in the Deschutes River Estuary sufficient to develop and maintain estuarine habitats.

The estuary restoration objectives are:

- Restore estuarine habitat that is utilized by native plant and animal species.
- Improve water quality in the Deschutes Estuary and Budd Inlet.
- Enhance the estuary’s ability to provide economically valuable goods and services.

4. ESTUARY RESTORATION ALTERNATIVES

The DEFS considered three estuary restoration alternatives. These include various modifications to the openings beneath the Fifth Avenue and the Burlington Northern Santa Fe (BNSF) railroad crossing, as well as modifications to the North Basin of Capitol Lake.

- Alternative A includes a 500-foot opening width at the current Fifth Avenue dam, with necessary modifications to existing infrastructure. This alternative leaves the existing Fourth Avenue Bridge in place and restores full tidal hydrology.
- Alternative B includes the changes in Alternative A, plus an increase in opening width at the BNSF railroad crossing at the diversion between the North and Middle Basins of Capitol Lake. The span of the current bridge is 200 feet; increasing this span is thought to improve tidal circulation and reduce scour at this crossing.
- Alternative D includes the changes in Alternative A, plus a split basin design. The design divides the North Basin, creating a reflecting pool to the east and a free flowing estuary to the west. This alternative recognizes the value of both the reflecting pool for the State Capitol and reconnecting the Deschutes River with Budd Inlet.

An Alternative C was included in the early stages of the assessment but was later rejected. Alternative C included changes in Alternative A, plus a widening of the connection between Percival Cove and the Middle Basin. The existing 100-foot bridge in Deschutes Parkway would be widened to 200 feet. Alternative C was rejected because hydrodynamic modeling showed it did not cause significant change to the conditions within Percival Cove.

5. SUMMARY OF TECHNICAL STUDIES

To analyze the environmental and socio-economic consequences of the DEFS alternatives, four technical studies were commissioned by Thurston Regional Planning Commission Washington Department of Fish and Wildlife (WDFW), on behalf of the Capitol Lake Adaptive Management Plan (CLAMP) Steering Committee, detailing:

1) Sediment Transport & Hydraulic Modeling (George and others, 2006)
2) Reference Estuary Study & Biological Conditions (Garano and others, 2006)
3) Engineering Design & Cost Estimate (Moffat and Nichol and others, 2007)
4) Net Social and Economic Benefit Analysis (Cascade Economics and others, 2007)

Subsequently, an Independent Technical Review (PWA, and others 2006) was commissioned to assess whether the technical studies addressed the question: is it feasible to restore estuarine processes to Capitol Lake? The Independent Technical Review Team review provided an assessment of the scientific objectivity and technical merits of each report and provided a consensus review that integrated disciplines across the four reports.

Details of each study and the Independent Technical Review can be found in the technical reports available on the CLAMP website http://www.ga.wa.gov/CLAMP/EstuaryStudy.htm .

5.1 SEDIMENT TRANSPORT AND HYDRAULIC MODELING

A central aspect of the DEFS study is to understand how the lake/estuary environs would change under the proposed restoration scenarios, particularly how the accumulated sediments behind the dam will be redistributed following removal of the dam. To provide a scientific foundation the USGS was commissioned to develop a hydrodynamic and sediment transport model to characterize the flow of tidal waters and the movement of sediment (George and Others, 2006). Key concerns include adjustment of the lake bed morphology, development of scour zones under bridges, deposition of eroded sediment in the Port of Olympia, coarsening or fining of habitat substrate and exposure of biological communities to saline or brackish water.

To address these questions, the USGS used Delft3D, an established hydrodynamic and sediment transport numerical model developed by Delft Hydraulics. The model was driven using tides for Budd Inlet, river discharge from the Deschutes River with sediment input and salinity as constituents. The modeling results provided a quantified assessment of estuarine behavior both prior to dam construction and after each post-dam removal scenarios.

Overall, the modeling study found that after dam removal, tidal and estuarine processes would be immediately restored, with marine water from Budd Inlet being carried into North and Middle Basin on each rising tide and mud flats being exposed with each falling tide. Within the first year after dam removal, tidal processes, along with occasional river floods, would modify the estuary bed by redistributing sediment through erosion and deposition. The morphological response of the bed would occur most rapidly during the first couple of years, and slow over time. By ten years after dam removal, the USGS study concluded, the overall hydrodynamic and morphologic behavior of the estuary is similar to the pre-dam estuary, with the exception of South Basin, which has been extensively modified by human activities.

Predicted bathymetry and tidal elevation outputs from the model were used by the Reference Estuary and Biological Conditions Study, and estimates of flow velocities and mobilized sediment volumes by the Engineering Design and Cost Estimating Study.

5.2 REFERENCE ESTUARY STUDY AND BIOLOGICAL CONDITIONS

The task of the Biological Study was to determine whether an estuarine community, with diverse populations of plants and other organisms, could be reestablished in southern Budd Inlet. The study (Garano and others, 2006) was divided into two separate studies:

1. A Reference Estuary Study consisting of field sampling of selected environmental variable in several estuaries analogous to the potential Deschutes Estuary. Five reference estuaries were examined: Woodard Bay, Ellis Cove, Mud Bay, Kennedy Creek and Little Skookum Bay.

2. A Biological Conditions Study that sought to combine the collected field data with results from the USGS Hydrodynamic and Sediment Transport Study.

It was concluded that for all restoration alternatives the hydrology, salinity and topography within the Deschutes estuary, as predicted by the USGS analysis, would fall within the range of those occuring within nearby reference estuaries. The study described that following dam removal the estuary would consist primarily of intertidal mudflats (exposed during low tides and submerged during high tides) with a narrow fringe of vegetated marsh around the periphery of the estuary and with subtidal sandy channel connecting the river through to Budd Inlet.

5.3 ENGINEERING AND DESIGN COST ESTIMATING

Preliminary designs and cost estimate of each of the three proposed restoration alternatives were prepared. This study determined that there are no significant technological constraints to prevent restoration of tidal conditions to the Deschutes River estuary.

To address some concerns about sediment accumulating in dredged channels downstream of the dam the engineers recommended that, for any of the alternatives, the main channel be dredged before the reestablishment of tidal flow, and that dredged material be used to create intertidal habitat along Deschutes Parkway. It was anticipated that dredging the channel would reduce the amount of sediment that would scour from the reconnected estuary and be transported downstream to Port of Olympia and associated marina channels.

The engineers also recommended that the reflecting pool, in Alternative D, be a salt water pool with muted tidal flow. This would allow flushing of the pool to assist in maintaining water quality. If a freshwater pool were to be maintained, an artificial recirculation system and the use of reclaimed water in significant quantities would be necessary.

Construction for all alternatives could be achieved within three to four years, working under the assumption that the chinook salmon and bull trout windows for in-water work are observed.

An engineer's cost estimate is provided, based upon the developed designs. The average engineers' project cost estimates ranged from $76 million, $90 million and $106 million dollars for Alternatives A, B and D, respectively[1]. The low and high range of Alternatives A, B and D total project costs are $66 to $87 million dollars, $80 to $102 million dollars and $94 to $120 million dollars, respectively.

Approximately one-half of the variability in the estimated project costs are associated with the initial dredging of the basin and placement of the dredged material along the Deschutes Parkway to create intertidal habitat. The engineers estimate that a greater quantity of initial dredging, associated with initial costs, would most likely lead to lower costs in later years associated with dredging the marinas along Percival Landing and at the Port of Olympia.

5.4 NET SOCIAL AND ECONOMIC BENEFITS ANALYSIS

Placing an economic value on the environmental change is a challenging task. The socio-economic study was constrained by considerable information gaps that resulted in large uncertainties in the assessment of project benefits. Such a study outcome is a common occurrence when the requirements of an economic assessment are not directly incorporated into the planning of deliverables from scientific and engineering assessment studies. Nevertheless, by undertaking this pilot study at an early stage of the planning processes, a number of information needs have been identified wherein future assessment will improve understanding of project socio-economic costs and benefits. The DEFS Team convened a group of citizens to develop a set of community priorities and concerns. This "visioning" process set the framework for the social analysis. Not surprisingly, the Net Social Benefit and Economic Analysis (NSEBA) revealed a variety of opinions and values among community members.

[1] Dollar values are given based upon costs in 2006.

5.5 INDEPENDENT TECHNICAL REVIEW

The following conclusions were drawn by the Independent Technical Review (ITR).

Overall, the DEFS technical studies did not identify any significant impediments to restoring estuarine conditions in the lower Deschutes estuary. However, the technical studies did not cover the full range of analysis required to provide for a full feasibility assessment. Some uncertainties exist, which may not be reconcilable with the information at hand; for example: i) further refinement to estimates of the volume of sedimentation in downstream dredged channels post estuarine restoration; and ii) socio-economic implications of potential restoration activities. The ITR identified a number of additional studies to assist in filling data gaps.

5.5.1 Level of Certainty

The technical studies have different levels of certainty in defining the specific outcome of estuarine restoration (Table 1). Higher degrees of certainty are found within the hydraulic and sediment transport assessment, and the engineering cost estimates. Lesser degrees of certainty are associated with quantifying ecological outcome and defining socio-economic consequences of estuarine restoration. While restoration of estuarine conditions appears physically and biologically broadly feasible the socio-economic net benefits remain unclear at this stage.

Table 1. A Qualitative Summary of Confidence in Technical Study Results

DEFS Technical Reports	Confidence in General Outcome	Confidence in Accuracy of Predictions	Potential for Surprises
Tidal Exchange	High	High	Low
Sediment Transport	High	Medium	Medium
Estuarine Ecology	High	Medium	Low
Engineers Estimates	High	Medium	Medium
Socio-economic Net Benefit	Low	Low	High

5.5.2 Recommendations of the Independent Technical Review

The following recommendations were made in the ITR to facilitate the Alternatives Assessment:

1. **Develop a common project understanding.** Integrate level of understanding across project partners regarding key concepts and requirements.

2. **Set planning and study expectations.** "Feasibility study" and "net benefits analysis" are terms of specific reference the use of which set expectations of a particular product or process. Careful use of terminology was recommended, as well as documenting scope of technical study analysis within report documentation.

3. **Place technical information in a planning context.** The following planning steps were recommended to aid any subsequent alternatives assessment:

    a. Set project goals and objectives;

    b. Identify opportunities and constraints;

    c. Define evaluation criteria;

    d. Develop a conceptual model of restored estuarine system evolution and functioning;

    e. Fill data gaps;

    f. Refine alternatives, include business-as-usual (the lake management) alternative;

    g. Forecast future conditions;

    h. Comprehensively document preferred alternative and decision process.

4. **Integrate information transfer through the technical studies.** Information transfer across technical studies is necessary to provide a comprehensive feasibility assessment. It was recommended that information supply and needs be agreed prior to initiation of the feasibility analysis (for example, determine from the economists their information needs from the physical and biological assessments prior to science study initiation). Confirm that the temporal and spatial scale of analysis is comparable across studies. Include provision for information refinement and feedback loops as study progresses.

5. **Define baseline conditions.** At the time of the technical studies were initiated the Lake Management Alternative baseline condition was not defined. This information is required should a more refined full analysis be undertaken.

6. **Refine alternatives.** The alternatives developed so far are appropriate for a scoping level assessment of restoration potential. Should the feasibility assessment move forward these alternatives should be refined further to balance opportunities for restoration against constraints to meet selected restoration objectives.

6. CONCEPTUAL MODEL OF ESTUARINE RESTORATION

This review provides a simple conceptual model of the likely ecological outcomes with restoration of the Deschutes Estuary based information drawn from the four DEFS technical studies and restoration projects elsewhere[2]. Conceptual models (Simenstad and others, 2006), are a basic tool used to help clarify what will be achieved from a restoration project to help define what is known and not known, and the linkages between actions and outcomes. Based upon agreed desired outcomes, the conceptual model provides a basis for setting project evaluation criteria. Where possible, it is beneficial to supplement an ecological conceptual model with a socio-economic conceptual model.

6.1 RESTORATION ACTION AND RESPONSE

Our conceptual model summarizes the expected response of the nearshore ecosystem to a process-based restoration action:

- Baseline scenario: a dam across the former Deschutes Estuary remains in place, creating Capitol Lake, increasing sedimentation in the lake, reducing sediment supply to Budd Inlet, and impairing water quality in the lake and inlet.
- Change/action scenario: removal of a 500-foot length of dam at Fifth Avenue and dredging of a channel through the lake would re-establish hydrodynamic, sediment transport and ecologic processes in a restored nearshore estuary setting.
- Predicted functional response: re-establishment of diverse estuarine ecosystem attributes (e.g. tidally influenced mudflats and channels, supporting native plant and animal communities), with improvements in water quality. The predicted functional responses link to our objectives.

Figure 1 describes conceptual restoration pathways between engineering action and desired ecological functions associated with possible dam removal at Fifth Avenue. Once the dam is removed, physical estuarine processes could be quickly restored (George and others, 2006). Water quality, particularly water temperature and dissolved oxygen concentrations, would potentially improve in the basins because of the increased tidal flushing[3].

Re-establishment of tidal circulation, in concert with high river discharges, would re-suspend some of the surface sediment in Capitol Lake, left behind after any channel pre-dredge operation. This sediment would be transported downstream and re-deposited on intertidal and subtidal areas within the estuary and Budd Inlet (George and others, 2006). Increased sediment accumulations

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[2] Certain assumptions are made that are not drawn directly from the existing DEFS studies (for instance water quality).

[3] This assumption is currently under investigation by the Department of Ecology.

would potentially offset the loss of intertidal mudflats and other shallow water habitats expected to result from sea-level rise caused by global warming. Over time, in absence of dredging and reworking of lake bed sediments, the resulting physical and chemical environment would resemble the historical estuary that existed before the dam was built (Figure 2). In addition to restoring hydraulic connectivity, full tidal circulation and exchange would re-establish biological connectivity across the river-estuary-marine boundary, thus providing a source for the recruitment of a wide array of estuarine plants and animals. Restored elevations, substrate types and salinities would provide the habitat conditions necessary to support viable populations of native plants, invertebrates, birds and fish. Over time, a dynamic biological community and functioning estuarine ecosystem would develop (Garono and others, 2006).

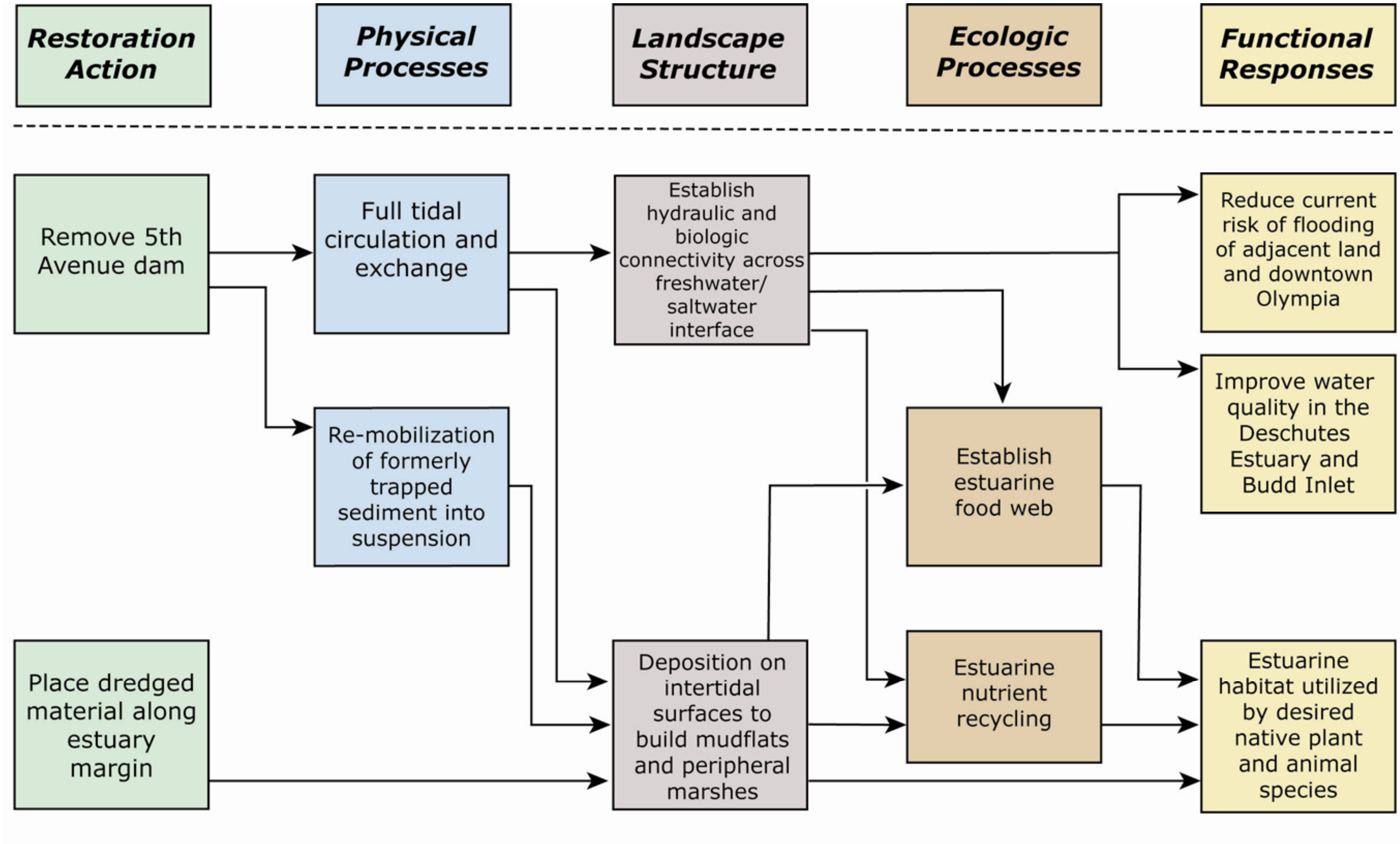

figure 1
DEFS Status Report

Conceptual Model of Restoring Tidal Action at Capitol Lake

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7. DESIGN OPPORTUNITIES AND CONSTRAINTS

Future identification of a preferred alternative for the management of Capitol Lake / Deschutes Estuary requires that project opportunities and constraints against be assessed against the project goals and objectives. Based upon the findings of the technical studies, and conceptual model provided in this report, a preliminary list of potential project opportunities and constraints is provided here[4]. Restoration should aim to capitalize on opportunities for desired environmental and economic outcomes, and reduce constraints that otherwise would limit these outcomes.

7.1 OPPORTUNITIES

1. Restore estuarine habitat. With full tidal circulation, intertidal habitats in the Deschutes Estuary could be restored. After a decade the system would function as an estuary similar to that before the dam was built, dominated by mudflats and channels. It is likely that the types of habitat restored could be similar in nature to those of nearby less disturbed estuaries.
2. Improve water quality. The increased circulation resulting from tidal estuary restoration could improve water quality for some parameters, such as dissolved oxygen and nutrients. Opportunities for water quality improvements have broader implications — particularly for the health of Budd Inlet.
3. Engage stakeholders and property owners. The public and community stakeholders have shown substantial interest in report findings during the DEFS technical report phase. Continue to engage stakeholders in a focus group or interview process, and seek opportunities to obtain public opinion when comparing the four management alternatives.
4. Savings in resource-management costs. Restoration of the estuary may lower the costs associated with managing the river (e.g. dredging of Capitol Lake), Budd Inlet and South Puget Sound. Restoration could also reinforce efforts by the Puget Sound Partnership and others to arrest and reverse ecological (and hence economic) problems throughout the Puget Sound Basin.

7.2 CONSTRAINTS

1. Increased sedimentation in downstream dredged channel. Opening up the system to tidal exchange could reinitiate the seaward movement of trapped sediment not removed during

[4] The list of opportunities and constraints may change as data gaps are filled by ongoing studies.

the channel pre-dredge. Over time, a quantity of sediment scoured from the former lake bed will be deposited down estuary in dredged channels.

2. Impacts of sea-level rise. Allowing the free movement of the tides would open the estuary to the impacts of relative sea-level rise. Global sea-level rise is predicted to accelerate over the next century (Puget Sound Action Team, 2005; IPCC, 2007) increasing the risk of flooding to low-lying areas adjacent to the estuary and potentially impacting stormwater management.

3. Impacts of climate change on ecology. Climate change will likely have wide-ranging effects on Puget Sound, Budd Inlet and the restored estuary. In the design and implementation of the estuary, it will be important to preserve the ability of mudflats, marshes and wetlands to migrate inland to ensure adequate nearshore habitat for plants and animals. Although not all species will be equally affected by climate change, changes in physical conditions in the inlet and estuary may alter species composition, distribution and abundance.

4. Equitable allocation of project related costs. To date, costs associated with management of lake sediments has been borne by the state, which owns the lake bed. Removal of the dam would impact downstream interests, including the Port of Olympia and private marinas which are on leased state aquatic lands. In order to be viable, the project would need to address this transference of sediment management costs, and find mechanisms to equitably allocate project capital and maintenance costs.

8. ESTUARY RESTORATION – A SUMMARY OF POTENTIAL

The DEFS four technical studies have determined that removing a 500-foot section of the dam would be sufficient to reinstate tidal circulation within the estuary. In doing so, intertidal habitat would be restored, along with a number of potential associated social and environmental benefits.

Figure 2 provides an artistic impression of the estuary at low tide. Each day, the tide will flood and ebb through the estuary, creating a mixing zone that will support invertebrates that feed a wide range of migratory birds and fish (Garono and others, 2006). At low tide, exposed mudflats would provide habitat for shorebirds and other species. As the tide rises, the mudflats will be submerged, creating habitat for fish and diving birds. Because of the low elevation of the mudflats relative to the tides, the estuary will be submerged for a large proportion of the time (George and others, 2006). The rise and fall of the tide has potential to provide an ever-changing environment of aesthetic value.

Two major engineering elements are associated with the design: Construction of a new Fifth Avenue Bridge and pre-dam removal dredging (Moffatt and Nichol and others, 2007).

The proposed new Fifth Avenue Bridge could provide four lanes for traffic, as well as bicycle and pedestrian lanes. In addition, the plan accommodates the City of Olympia's intentions to construct a pedestrian trail along the abandoned BNSF railroad corridor. A separate pedestrian trail will pass over the bridge to downtown Olympia.

Re-use of material dredged from the lake to excavate a main channel could have dual benefits: reducing sedimentation in maintained channels downstream of the dam, and enhancing high intertidal habitat around the edge of the estuary. Potentially, this approach provides an opportunity to enhance the aesthetic and ecological condition of the estuary.

figure 2

DEFS Status Report

Conceptual Vision of the Restored Deschutes Estuary at Low Tide

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9. INFORMATION GAPS

The ITR and this report have identified a number of information gaps:

- Definition of the lake management alternative (baseline conditions);
- Defined restoration opportunities and constraints;
- Economic consequences of altered patterns of sedimentation, particularly related to marinas and dredge-maintained channels;
- Sediment quality within Capitol Lake;
- Projected change in water quality under revised alternatives;
- An analysis of flood potential will need to be accomplished for the selected alternative to confirm that flooding is not worsened. Flood assessment should incorporate projections for sea level rise;
- A geomorphic perspective to guide restoration alternatives.

Based upon the ITR recommendation, the CLAMP Steering Committee has identified the following studies to be completed by July 2008:

- Dam Structural and Reservoir Report;
- Erodibility Assessment;
- Sea-Level Rise Impacts;
- Sediment Modeling;
- Comparative Dredge Design and Cost Estimates;
- Comparative Flood Report;
- Comparative Fish and Wildlife Report;
- Comparative Economic Impact Report.

10. NEXT STEPS

The findings from DEFS will feed into the Capitol Lake Management Study and will provide a technical basis for interpreting two of the alternatives to be documented within the CLAMP Alternatives Analysis Report. The goal of this analysis is to provide a valid comparison between lake management and estuarine restoration alternatives. The committee is scheduled to recommend one alternative to the Department of General Administration by July 2009.

Four alternatives have been identified by CLAMP as warranting further study within the Alternatives Analysis Report:

- **Managed Lake.** Capitol Lake has been a managed water body since the Fifth Avenue dam was constructed in 1951. The lake is now part of the State Capitol Campus and a backdrop for downtown Olympia. This alternative would see the lake depth increased by dredging, and then maintained through regular maintenance dredging.
- **Estuary.** This alternative includes a 500-foot opening in place of the current Fifth Avenue dam and construction of a bridge akin to the Fourth Avenue Bridge. To reduce the impact of large sediment release into Budd Inlet, a channel would be dredged through the lake before the dam is removed. Although mudflats would appear during low tide, they will be submerged during most of the tidal cycle.
- **Dual Basin Estuary.** This option includes the changes described in the Estuary Alternative, but also includes construction of a barrier that divides the north basin into two parts. The east-side section of the basin would be a salt water reflecting pool for the Capitol buildings. The other side of the basin would become an estuary, influenced by tidal action. Inlets in the barrier would allow salt water to move through the reflecting pool at high tide.
- **Status Quo Lake.** This alternative includes no dredging of the lake. Sediment would accumulate in the middle and north basins. Over time, these parts of the lake would change to emergent wetlands and then riparian woodland. Eventually the Deschutes River would discharge directly into Budd Inlet at the Capitol Lake Dam.

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The files for this document are maintained at PWA, San Francisco:

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