MEMORANDUM

Date: March 5, 1997

To: Nick Cockrell, Senior Facilities Planner, State of Washington Department of General Administration

From: David Morency

Subject: **Technical Memorandum - 1991-1996 Capitol Lake Survey - Sediment Volume Calculations**

cc: Dale Anderson
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Introduction

Updated calculations of net sediment accumulation (fill minus erosion volume) have been completed for the 1991-1996 period for comparison with similar calculations previously performed for the 1983-1991 period. New color-shaded maps have also been prepared showing areas of cutting (red), filling (blue), and no change (yellow) from the 1991 base map (enclosed).

The degree of comparability between new net sediment accumulation estimates and the older estimates is considered moderate to high because: (1) the areas surveyed are very similar with only minor differences in areas surveyed/not surveyed, (2) both surveys primarily involved the use of aerial photography for development of maps with 1 foot contour intervals, (3) Earthcalc, Inc. used the same methods and procedures to compute the volumes from the survey and mapping data.

There are other factors which could have a negative influence on comparability. These include: (1) natural climatic variability, (2) unpredictable mass wasting, (3) absence of underwater topographic data in some areas, especially in the north and south basins, and (4) some lake edge calculation anomolies indicating shoreline cutting where none would be expected.

As you know, natural climatic variability has the potential to influence the results. During periods of higher rainfall and higher river flows, there is a greater potential for erosion and downstream sediment transport. In addition, earth slides can occur unpredictably and contribute large amounts of sediment loading above and beyond what might occur from more typical river channel erosion. This kind of impact was seen in the south basin

when about 13,000 cubic yards of material washed in during the slope failure that resulted from the February 1996 storm.

Based on the comparison factors, we have concluded that comparability is valid for planning purposes. This conclusion is based, in part, on the fact that the annual average 1991-1996 net sediment volume increase of 28,600 cubic yards per year is within 17 percent of the 34,700 cubic yards per year estimated for the 1983-1991 period.

Results and Discussion

A comparison of net sediment fill volumes is presented for the two surveys in table 1. Net sediment fill volumes for the 1991-1996 survey were taken from the tabulated data submitted by Earthcalc, Inc., attached at the end of this tech memo. Net sediment fill volumes in the south basin were adjusted downward by 13,085 cubic yards to account for side slope mast wasting that deposited along the eastern shore during the storm of February of 1996, and adjusted upward by 1,649 cubic yards to account for material removed from the west shore during a construction project in the summer of 1995.

Table 1. Comparison of 1983-1991 and 1991-1996 Average Annual Rates of Net Sediment Fill Volumes for the Three Lake Basins.

Basin	1983-1991 Fill Volume (Cubic Yards)	Rate per Year (Cubic Yards per Year)	1991-1996 Fill Volume (Cubic Yards)	Rate per Year (Cubic Yards per Year)	Percent Change
North	59,500	7,438	41,300	8,260	+11%
Middle	186,700	23,338	73,000	14,600	-37%
South	31,000	3,875	28,700	5,740	+48%
Total	277,200	34,700	143,000	28,600	-17%

*All volumes rounded to the nearest 100 cubic yards.

The average annual sediment fill rate was 28,600 cubic yards for the 1991-1996 period and 34,650 cubic yards for the 1983-1991 period. Thus the lake-wide sediment fill rate was 17 percent lower in the 1991-1996 period. We believe that the lower rate of sedimentation for the 1991-1996 period is due primarily to reduced rates of sediment delivery from the Deschutes River.

From the percent change column in table 1 it is evident that the greatest changes occurred in the south and middle basins. Increased filling in the south basin may be attributed to increase channel meander and increased length of the main channel flow path with attendant reductions in flow velocity through the south basin. With reductions in flow velocity more sediment would settle out in the south basin rather than being carried into the middle basin trap. The change in channel meander is evident when comparing 1991 and 1996 aerial photos of the south basin (photos attached).

Another possibility is that more erosion actually occurred in the south basin than calculated. Since we did not compute sediment volume changes for south basin areas still under water at the time of drawdown, there may have been erosion that was not accounted. It would be possible to test this hypothesis by using the recording fathometer to make additional transects across the south basin, create appropriate contour lines on the 1996 map, and compute sediment volume changes against the 1991 topographic map.

It is likely that reductions in the percentage of sediment fill in the middle basin for the 1991-1996 period primarily reflect overall reductions in sediment loading to the lake from the Deschutes River, as indicated by the lake-wide reduction in annual average sediment fill volume of 17 percent compared to 1983-1991. However, it may also reflect, to a lesser degree, an increased rate of sediment accumulation in the south basin.

Based on our best available estimates, the middle basin sediment trap accumulated about 4,000 cubic yards per year over the 1991-1996 period compared to about 7,000 cubic yards per year in the 1983-1991 period. Again these numbers seem to reflect a reduction in annual sediment fill rate for the entire lake rather than a reduction in trap efficiency.

Conclusions.

1. Revised estimates of annual average net sediment fill volumes for Capitol Lake for the 1991-1996 period have been given as 28,600 cubic yards per year. This rate of filling, while 17 percent lower than the 34,700 cubic yards per year estimated for the 1983-1991 period, still represents a sizable amount of sediment load to the lake every year. If Capitol Lake is to be retained as a lake, a long-term sediment removal plan is still warranted. Otherwise, the lake will continue to rapidly convert to a riverine wetland.

2. Total net sediment fill volume for the 1991-1996 period is estimated at 143,000 cubic yards, with 20 percent accumulating in the south basin and another 14 percent accumulating in the middle basin sediment trap just north of the I-5 freeway. The remaining 66 percent of total fill volume is accumulating in the portion of the middle basin outside the trap and in the north basin. These data indicate that sediment removal from the trap area alone will not be sufficient to maintain the lake, if that is the goal of DGA and other state and local interests.

Recommendations for Additional Work

Additional transects could be performed for the north and south basins and in the channel areas of the middle basin to improve the net sediment volume estimates provided in this Technical Memorandum. This work is recommended because it will not only improve the present estimates, but also because it is needed to establish a better base topographic map to be used for future measurements of sediment volume changes. In addition, modifications to mapping boundaries could be made to eliminate lake edge calculation anomolies apparent in the color shaded maps. Making this modification is likely to yield a higher average annual net sediment fill volume for the 1991-1996 period, making it closer in volume with the 1983-1991 estimate.

Significance to the Capitol Lake Management Plan (CLMP)

1. In view of the relatively large percentage of sediment (66 percent of total annual sediment load or 18,900 cubic yards per year) which continues to deposit downstream of the south basin (where future sediment removal is not planned) and outside of the middle basin trap, it seems that any long term sediment removal plan would need to be designed to remove sediment in shallow 1-3 foot lifts throughout the middle basin. Because the Squaxin Island Tribe holds the view that a sediment removal plan of this nature could not be defined, under SEPA, as a supplemental action under the 1978 Capitol Lake Restoration and Recreation Plan EIS (**Entranco 1996**), we recommend, if desired by the CLMP stakeholders, that such a sediment removal plan be considered as an alternative lake management option in the new CLMP planning process and EIS.

2. A reasonable sediment removal plan needs to be worked out with the stakeholders participating in the development of the CLMP. The City of Tumwater and Ecology would prefer a removal plan that reduces the frequency and duration of construction activities along the shoreline of the lake. They believe this is necessary to maintain consistency with the goals and policies of the Shoreline Master Program. This may be possible if marine disposal of lake sediments (which contain seeds from the noxious purple loosestrife) is authorized by the State of Washington Department of Agriculture.

3. In the Heritage Park Final EIS a new lake level management scenario is being proposed in which the lake would not be drawn all the way down to the sill elevation during annual drawdown. This procedure would reduce the impacts of drawdown on fish stranding and would hopefully maintain a freshwater layer in the north basin in support of freshwater plant communities, which are a desirable element of the Heritage Park Plan. We note that the new lake drawdown/refill management scenario would preclude the use of aerial photography as a means of performing future estimates of lake sediment filling. Under the new lake level management scenario, increase use of the recording fathometer would be the only feasible means of updating sediment volume calculations.

References

Ecology

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Entranco

1984 Capitol Lake Restoration Analysis. Prepared for the State of Washington Department of General Administration.

1990 Capitol Lake Wetland Development Feasibility Study. Prepared for the State of Washington Department of General Administration.

1996 Draft Supplemental Environmental Impact Statement - Capitol Lake Restoration and Recreation Plan - Revised Maintenance Sediment

Removal Plan. Prepared for the Washington State Department of General Administration.

Herrera Environmental Consultants

1997 Final Environmental Impact Statement for Heritage Park. Prepare for the State of Washington Department of General Administration.

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TOTAL RAW VOLUMES IN PLACE

FILE #	AREA	SEDIMENT DEPOSIT	EROSION
NORTH BAY			
TOTAL NORTH BAY	3,013,008 FT2	31,820 CY	5,206 CY
AVE DEPOSIT/FT2 =		.28 FT	
TOTAL AREA N. BAY			4,432,288 FT2
AREA NOT CROSS SECTIONED =			1,419,280 FT2
ADDITIONAL VOLUME AT AVERAGE DEPTH OF DEPOSIT =			14,718 CY
TOTAL DEPOSIT MINUS EROSION =			41,332 CY
CENTRAL BAY			
TOTAL CENTRAL BAY	5,669,602 FT2	78,602CY	19,336 CY
AVE DEPOSIT/FT2 =		.37 FT	
TOTAL AREA CENTRAL BAY =			6,672,975 FT2
AREA NOT CROSS SECTIONED =			1,003,373 FT2
ADDITIONAL VOLUME AT AVERAGE DEPTH OF DEPOSIT =			13,750 CY
TOTAL DEPOSIT MINUS EROSION =			73,016 CY
SOUTH BAY			
TOTAL SOUTH BAY	1,166,694 FT2	40,582 CY	13,313 CY
AVE DEPOSIT/FT2 =		.94 FT	
TOTAL AREA SOUTH BASIN =			1,536,170 FT2
AREA NOT CROSS SECTIONED =			369,476 FT2
ADDITIONAL VOLUME AT AVERAGE DEPTH OF DEPOSIT =			12,863 FT2
TOTAL DEPOSIT MINUS EROSION =			40,132 CY
TOTAL DEPOSIT FOR CAPITAL LAKES =			154.480 CY

South Basin 1996

South Basin 1991