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LAKE RESTORATION BY DREDGING

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ABSTRACT

This paper is a summary overview of the $17 million Vancouver Lake Restoration Project, the largest project of its type ever undertaken through the Federal Clean Lakes Program. It was funded jointly by the US Environmental Protection Agency, the Washington State Department of Ecology, and the Port of Vancouver. Although the project was conceived in 1965, a nationwide program to help fund such projects did not exist until 1976. Then, final approval was not received until 1981, after many volumes of studies and reviews. Construction was completed in June 1983, after 30 months--6 months ahead of schedule and underbudget.

A great deal of time, money, and energy was expended to demonstrate to Federal and state environmental agencies that dredging was a key tool in effecting this lake's restoration. Their collective resistance to this notion has been challenged by the project's success. This paper focuses primarily on the dredging aspects of the project. It identifies the concerns raised, the dredging and materials handling methods used, and the relative success of the techniques, not only in terms of operational effectiveness but in terms of environmental protection.

BACKGROUND

Vancouver Lake is a 2,600-acre (6,425-ha) lake lying in the floodplain of the lower Columbia River in the southwestern corner of Washington State on the west side of the City of Vancouver and north--across the Columbia River--from the City of Portland, Oreg. It is within a 45-min drive of the million-plus residents of the Portland-Vancouver metropolitan area and, in its restored condition, has become an immensely popular recreational resource for our regional community.

Until the early years of this century, Vancouver Lake was a relatively clear, moderately deep (6 to 8 m) lake cleansed twice yearly by the spring and fall freshets of the Columbia River. Over the years, construction of dams on the Columbia and dikes on the lowlands surrounding the lake virtually eliminated this natural flushing system.

At the same time, urbanization in the 27-square mile (70-km^2) drainage basin feeding the lake's only tributary contributed substantial siltation and pollution. At the start of project construction in early 1981, the lake's depth averaged 1 m (at low water). It was not safe for human use and was in a highly advanced state of eutrophication.

APPROACH

The $17 million Vancouver Lake Restoration Project is the largest project of its type ever undertaken in the United States under the National Clean Lakes Program. By the phrase, "of its type," I refer specifically to a project having three key elements:

a. Limiting the inflow of pollutants from both urban and agricultural nonpoint sources.

b. Flushing the lake with relatively clean Columbia River water.

c. Deepening and contouring the bottom of the lake.

Limiting the inflow of pollutants involved three actions, all of which are being phased in over several years:

a. Elimination of septic tanks in the basin by a major expansion in the city's sewer system.

b. Institution of a storm drainage and runoff control management plan in the tributary drainage basin.

c. Establishment of an agricultural practices management program to control erosion, manage the application of fertilizers, and contain animal wastes to prevent entry to the waterway.

Flushing the lake with relatively clean Columbia River water was the key, however. In constructing the 4,300-ft (1,310-m) flushing channel from the Columbia River, we were merely imitating the natural system, based on the fact that water flows downhill.

Specifically, the water flows on an 18-in. (46-cm) gradient over the length of the channel and enters two 7-ft (2-m) culverts fitted with flap gates that lead into the lake. Whenever the river water elevation is higher than the lake water elevation, the riverflow opens the gates and flushes the lake; at equilibrium or lower, the lake waters close the gates and backflow is prevented.

Before construction, it was estimated that the waters of the lake turned over every 25 to 28 years; with the flushing system in place, the waters of the lake are renewed every 21 days or so. The improvement in water quality has been significant.

The benefits of this system are twofold. First, and most obvious, is the cleansing action itself. Secondly, the infusion of this "new" water inhibits algae blooms. In short, the lake becomes a better habitat for fish and safer for human contact.

As complex as this hydrological problem was, the key was dredging the lake and handling the dredged material--about 9 million cubic yards (almost 6.9 million cubic meters). The intent and purpose of the dredging was threefold. The first and most important objective was to aid the flushing action. The point was not simply to deepen the lake, but to contour and sculpt the bottom of the lake to maximize the benefits of the flushing action.

Second, deepening selected portions or segments provided sump areas for heavy sediments to settle. Three were built--one where the river enters the flushing channel, one where the flushing channel enters the lake, and one where the lake enters its only outlet, appropriately called "Lake River." These "holes" also provide for ease of any future maintenance dredging, for that is where the sediments collect.

Third, dredging and periodic overdredging provided environmental and recreational benefits. This deepening allowed more year-round boating and fishing and closer-to-shore swimming areas. The holes provided deeper and cooler water for the fish species in the lake, and the deepening somewhat reduced turbidity caused by wind and wave action stirring the bottom sediments.

Several concerns had to be addressed:

a. What kinds of materials would be dredged.

b. How much material should be dredged.

c. Where in the lake would dredging occur.

d. Were any of the materials contaminated.

e. How would contaminated sediments be handled and disposed.

f. How would the uncontaminated sediments be handled and disposed.

g. What types of equipment would be used for dredging.

h. How would dredging occur, that is, where and when.

i. What would the total environmental impacts be and how would they be minimized.

As it turned out, the bulk of the sediments dredged were fine silts, some with clay, others more sandy in nature. There were also pockets of sands, sands and gravel, and clays. Dredge production throughout was greater than predicted.

Determination of the amount of material was the result of a carefully designed hydrological plan to maximize the benefits of flushing, including channel width, depth, distance from shore, and specific locations for overdredging and for disposal of certain materials. The "operations plan," as it was called, was executed with very few problems.

After much study it was discovered that some areas of the lake had contaminated sediments, specifically, with heavy metals and certain pesticides.

However, the studies and bioassays also demonstrated that these contaminants were bound up in the soil particles and not available to the biota. This also proved true with land disposal. No leaching of contaminants into the ground water occurred. In short, no unique dredging or disposal methods were necessary to handle these sediments.

As one might imagine, identifying disposal sites for such a large volume of material proved difficult. During the project, we constructed one island, modified the shoreline on the east side of the lake, and filled about 600 acres of uplands (about 243 ha) in five locations (Figure 1).

Because of the nature and quantity of the material, the upland disposal sites were constructed with large cells to provide sufficient time for decanting the dredged material before the return water went back to the lake. In fact, the lake became the last "settling pond" in the chain; however, no water quality standard violations occurred during the entire project.

Initially, we had intended to build two islands, using silt curtains. However, these did not perform as predicted. They did not contain the fine sediments, and the outer rim of the one island that was built finally had to be constructed using a clamshell dredge. In place of the second island, we filled a portion of the east shore. Silt curtains proved only marginally successful in containing that site.

The Port went through a lengthy evaluation of dredging methods and equipment, including the "Pneuma" system used in Japan and Europe, a system that, in spite of its lower production and higher operating costs, might have been required had our studies not shown that the contaminated sediments posed no danger.

The contractor used a 24-in. (64-cm) cutter suction dredge (after dry land excavation to the water table) to construct the flushing channel from the Columbia River. As indicated above, a clamshell was used in constructing the outer edge of the island.

The real ingenuity of the contractor was demonstrated in the lake dredging. Because of the shallow water, the boom on a 30-in. (76-cm) cutter suction dredge was shortened. However, to maximize production, the hull length was doubled by welding another dredge hull with it. The arc of the dredge swath was huge. Finally, to minimize costs, the dredge was electrified. An 18,000-ft (5,500-m) electrical cable supplied power. Further, transponders were set up at key locations around the lake. The dredge captain always knew exactly where he was operating relative to the dredging plan.

SUMMARY

The lake project not only resulted in improved water quality and aquatic habitat but provided additional wetlands (east shore), additional waterfowl habitat (the island), and better and higher agricultural land (the sediments are quite fertile). The project actually increased the shoreline length in the lake. Usage of the park on the lake's west shore went from a few hundred visitors per day during the summer months to several thousand.

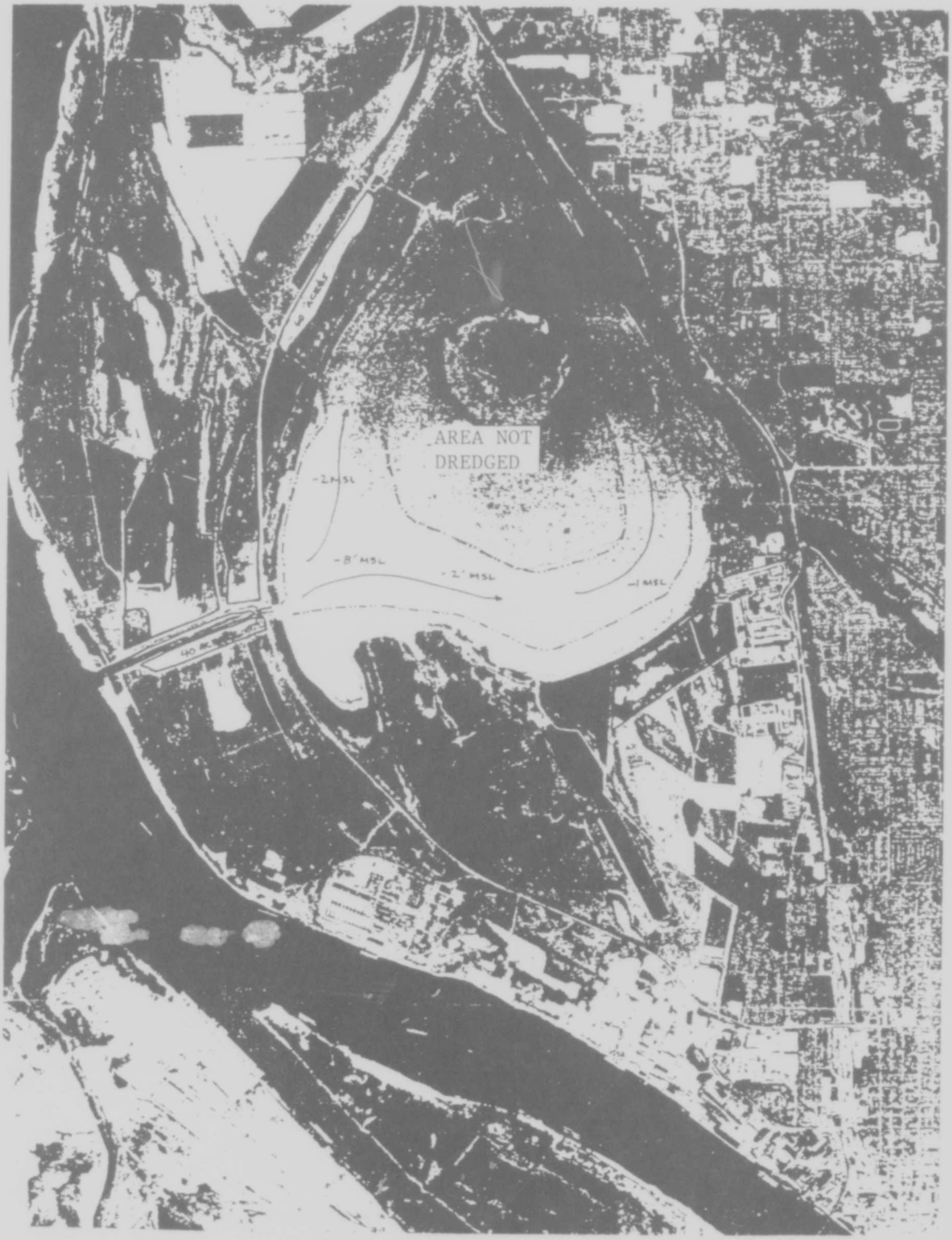

Figure 1. Vancouver Lake, Washington, restoration project area

The Vancouver Lake Restoration Project has, thus far, been a success. The water quality improvements exceeded prediction, and after nearly 5 years, it appears that dredging maintenance will be much less than had been predicted--once every 5 to 7 years in the flushing channel sediment sump (estimated at 40,000 to 45,000 yd^3 (about 3,060 to 3,440 m^3) and perhaps once every 40 to 50 years in the lake itself. Moreover, the environmental and recreational benefits are substantial.

That success would not have occurred without two key ingredients. First, the documentation developed by the US Army Engineer Waterways Experiment Station's Dredged Material Research Program was vital in demonstrating that the dredged materials would behave as predicted. Second, the dredging industry and our contractor, Reidel International, in particular, demonstrated an ingenuity and knowledge that not only overcame problems and reduced costs, but proved irrefutably that dredging is a tool not only for waterways development but for environmental restoration and enhancement as well.

In conclusion, projects such as this one affirm that man can lay a kind hand on the environment. Conferences such as this allow us to share these experiences and our growing knowledge and practical expertise. One wishes such understanding could be spread to a broader audience.