- Traffic flows "react" to system characteristics based on both a trip (e.g., maximum draft) and segment/node basis (tow operating speed). The model structure assigns certain characteristics on an origin/destination basis and then estimates individual segment/node factors using weighted values for these characteristics.

- Attempt to incorporate all possible efficiencies from tow operations to system management resulted in too complex a specification.

Model Features

In summary, the interesting features of the model include:

- applications of segment characteristics on both a trip and individual basis.

- individual flows and allocated cost and time factors based on commodity, barge, tow type (unit/mixed), and the specified combination of segments.

- rudimentary distribution functions (high, medium, low) more closely relate to actual distributions and permit different "reactions" to system conditions.

- equipment flows are balanced on an annual basis, but loaded and empty flows are allocated separately by season using weighting factors.

- lock delay calculator incorporates detailed representations of lock processing functions and operating procedures directly related to efficiency measure definitions. Estimated "non-scheduled" delay can be related directly to reduced tow speeds in lower and upper pools.

The consultant and others on the study team (as well as the Study Committee) will admit that the entire effort has been far more complex and challenging than anyone had envisioned at the outset. However, the final product will serve as a valuable tool in future inland waterway planning efforts.

The final report will be available through the Iowa Department of Transportation in late 1988. The software and documentation will be available through the Maritime Administration.

MIDDLE COLUMBIA RIVER STUDY
SHIP LIFT ALTERNATIVES

BY
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This paper summarizes the options for opening up the Middle Columbia River from Richland to Wenatchee, Washington, for navigation and commerce (See Figure 1).

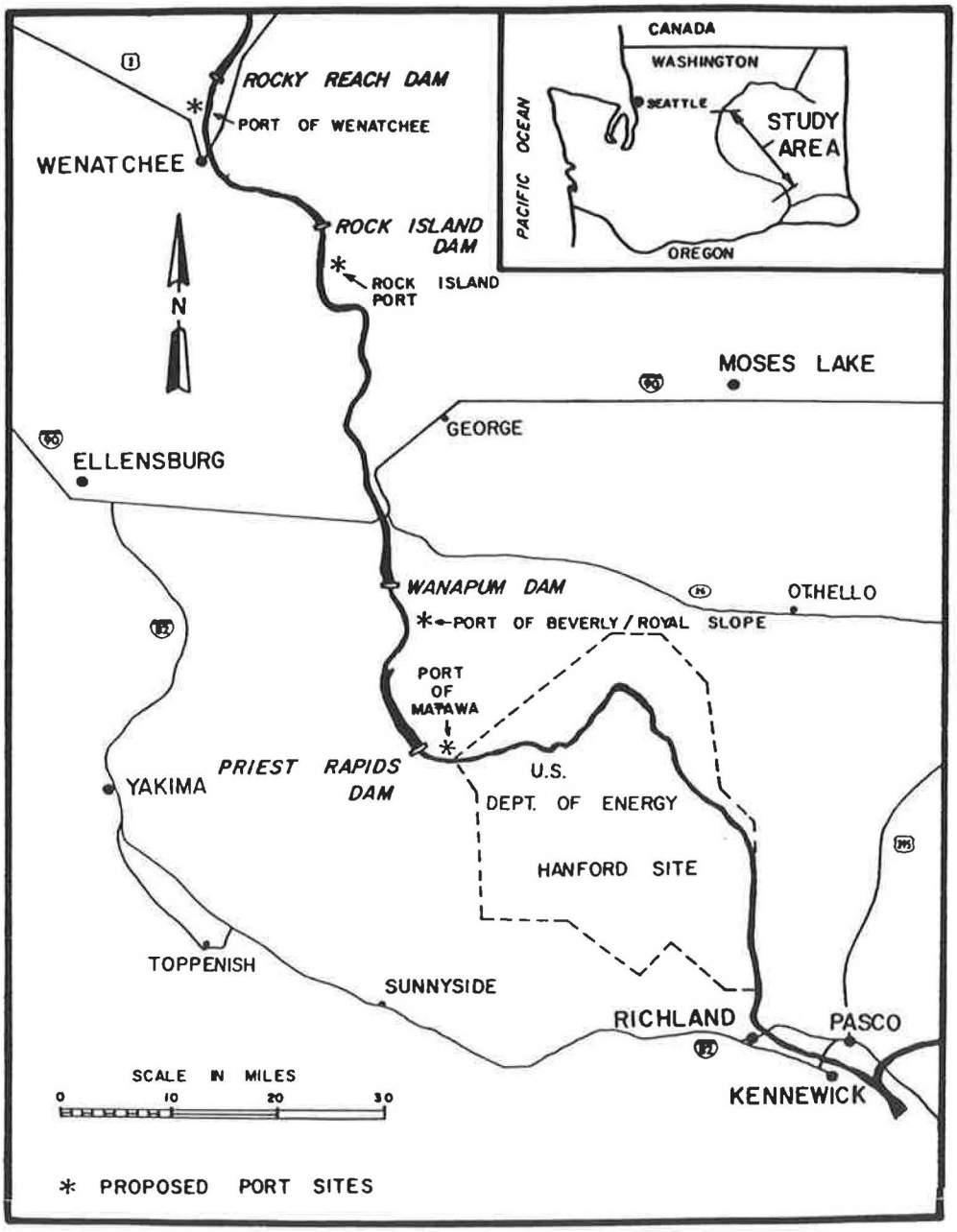


FIGURE 1. Middle Columbia River navigation study (Washington state)

Several alternatives have been proposed and investigated since 1967.

BACKGROUND

In the 1800's and early 1900's, much of the Columbia River system was open to navigation by stern and side wheel boats. The development of a major railroad system made this system non-cost effective.

Incremental expansion of the Columbia-Snake River Navigation system for modern barge traffic started with the construction of the Bonneville Dam in 1936. Through the years until the early 1970's, expansion for navigation and commerce purposes continued. However, the stretch of the Columbia River between Wenatchee and Richland remained nonnavigable. Over the course of the past twenty years, several projects have been proposed to further develop this portion of the Middle Columbia River.

In the late 1960's, the Corps of Engineers studied and proposed several conventional alternatives. They consisted of either a lock and dam on the

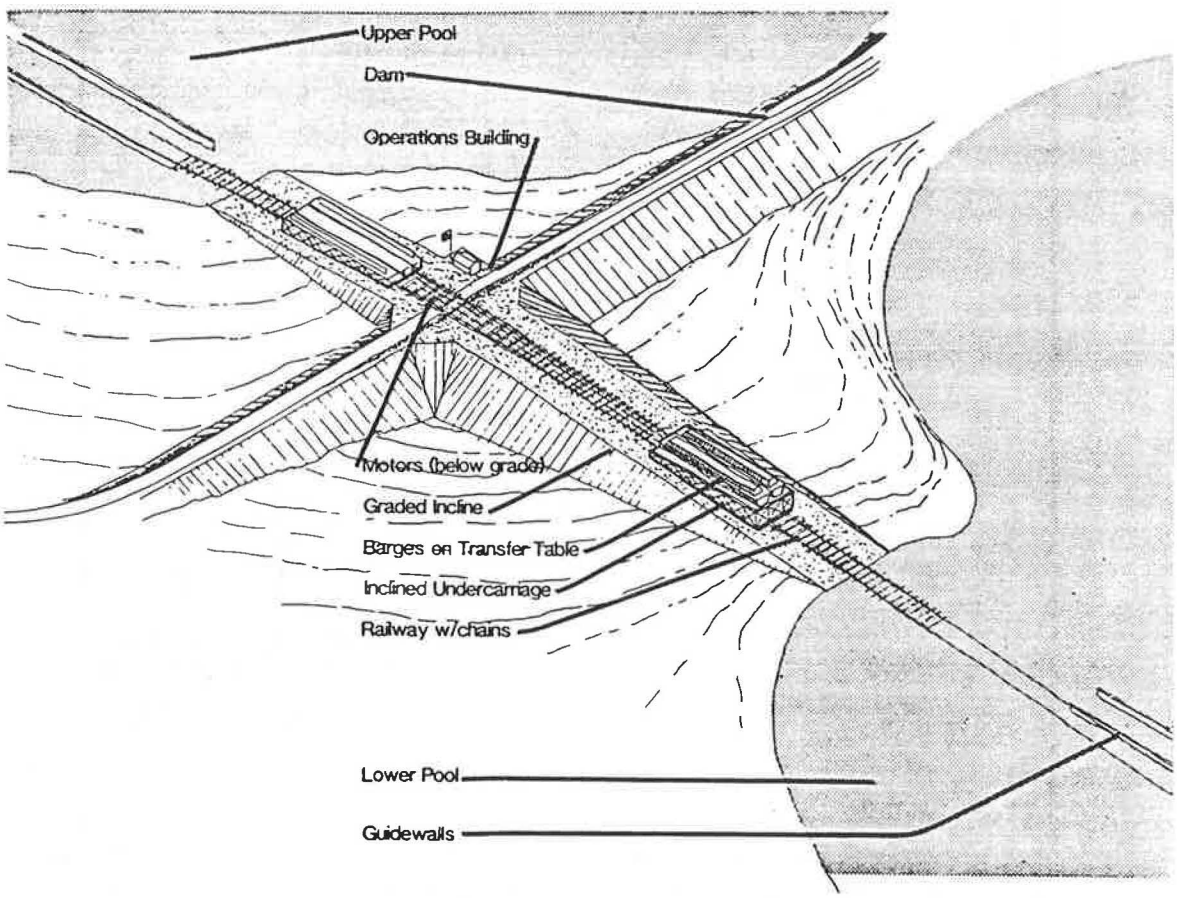


FIGURE 2. Inclined railway barge lift: concept

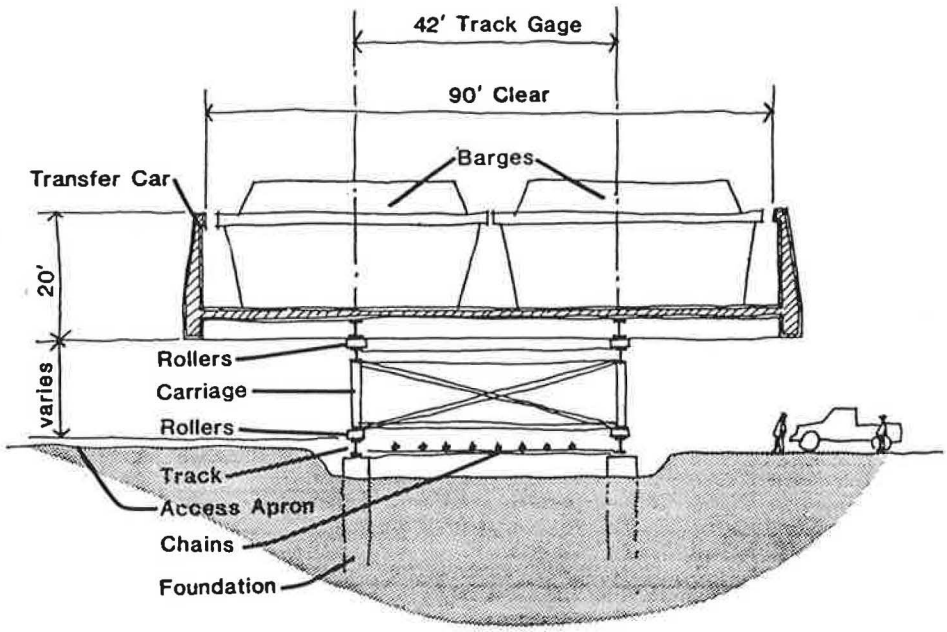


FIGURE 3. Inclined railway barge lift: cross section

Hanford Reach of the Columbia and conventional locks at the upstream dams, Priest Rapids, Wanapum and Rock Island. For many reasons none of these alternatives were found acceptable.

In 1984 the Corps initiated studies of an alternative that included a canal across the Hanford Reservation with a lock and powerhouse on its downstream end. This alternative would have eliminated some of the impacts of a dam or channel through the Hanford Reach. This alternative was not cost effective. In 1985, an alternative was suggested that would include the use of European styled barge lifts to reduce the overall cost of the project. It was also suggested that a peaking wave concept be investigated that would utilize the daily peaking flows out of Priest Rapids Dam to float heavily laden barges downstream and reduce the amount of dredging required in the Hanford Reach. This "peaking wave" and barge lift method led to the investigation of an alternative approach using an inclined railway barge lifting system (See Figures 2 and 3). This concept was deemed feasible and a detailed design study was undertaken.

Further research into this inclined railway lifting system triggered the inception of a vertical barge lifting system (See Figures 4 and 5).

In 1987, a similar design based on the vertical lifting concept using the Syncrolift system was proposed (See Figure 6).

In 1988 a study was conducted using both the Syncrolift and Crandall barge lift alternatives to evaluate the feasibility of using a smaller 2200 ton barge similar in size to a Mississippi River "Jumbo" barge.

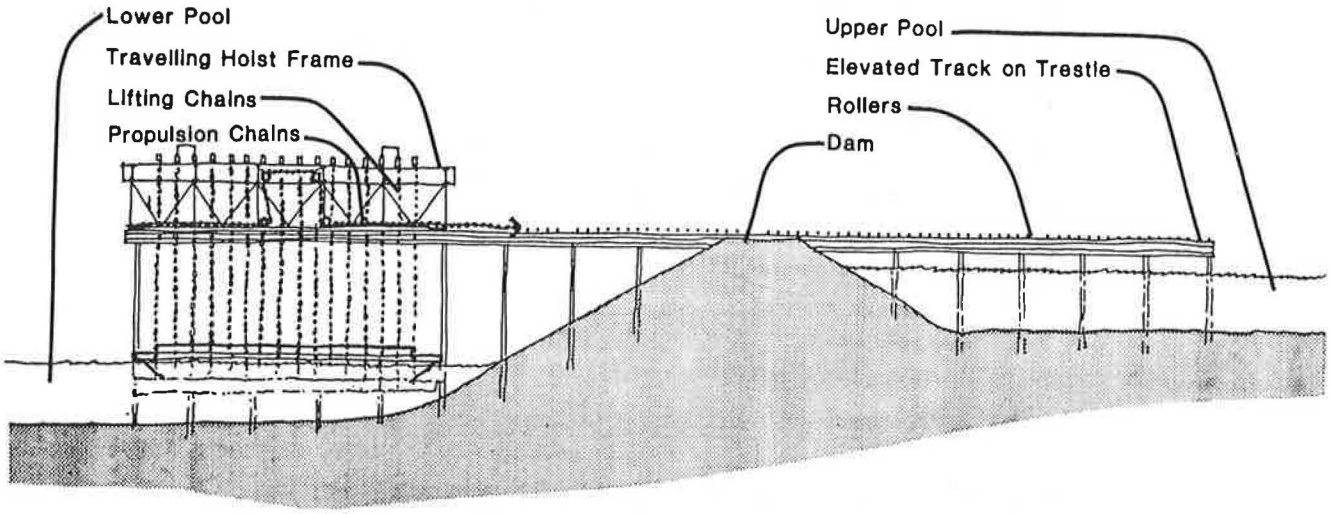


FIGURE 4. Vertical barge lift: Longitudinal section

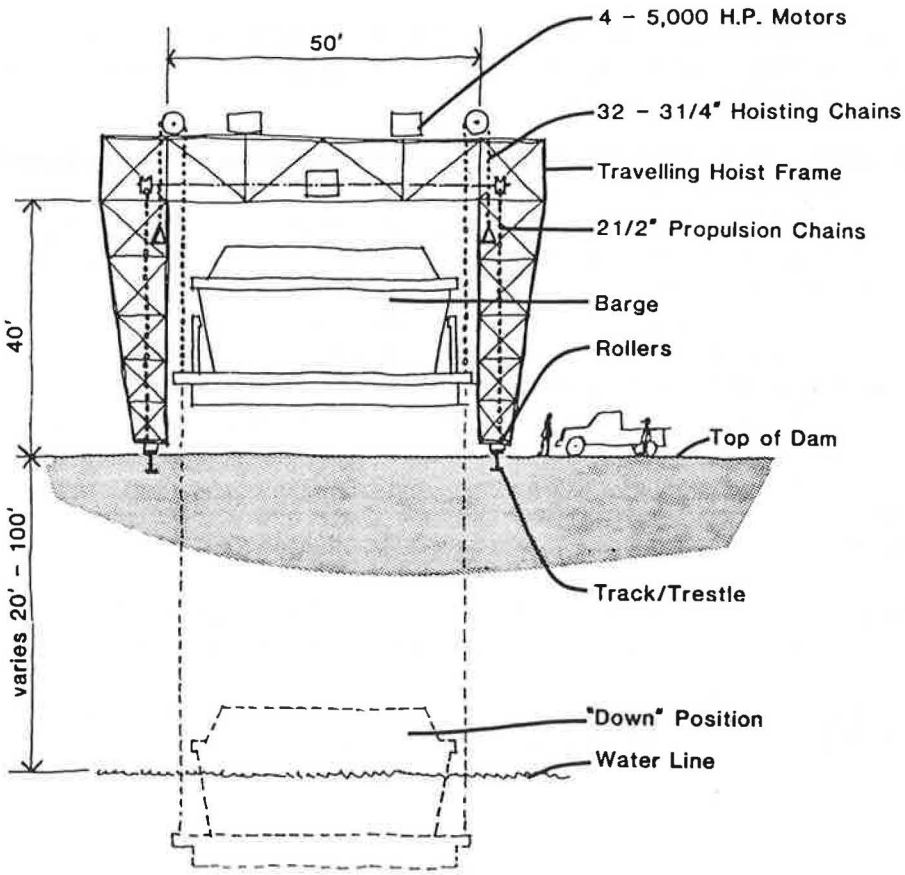
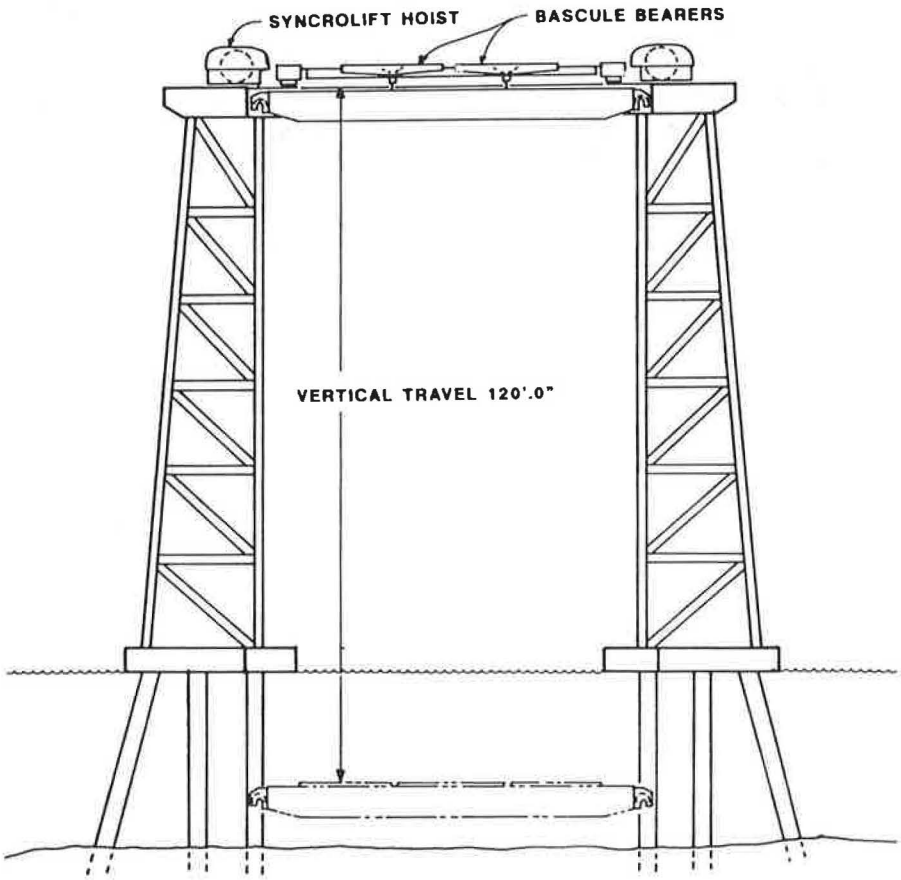


FIGURE 5. Vertical barge lift: cross section

Also in 1988, the Corps conducted a detailed navigation benefit study and found the 4500 ton barge lift to be the most cost effective because its higher capacity offset its higher costs. This study also showed that none of the barge lift alternatives were justified at this time. The following table is a comparison of the costs of a conventional lock and the other barge lift alternatives at Wanapum Dam.

Barge Lift System	Construction Cost
Conventional Locks	$157.0 million
Crandall Bargelift	49.0 million
Marine Railway	48.8 million
Syncrolift Bargelift*	40.0 million

* includes reduced channel size from the Crandall and Marine Railway alternatives.



BARGE LIFT

FIGURE 6. Syncrolift: end view

Summary

By 1985, the Corps of Engineers decided that the most feasible approach to opening the Middle Columbia River for navigation was to employ a horizontal or vertical lift system to by-pass the dams. Various and progressively more feasible designs were developed. In 1985/1986 the horizontal lift design using a marine inclined railway system was proposed. A thorough review and analysis of this design led to the development of another concept, the vertical barge lifting design. In June 1987 a report was completed that recommended a design using a chain driven, vertical, dry barge lifting system. Also in 1987, a similar design which uses a cable driven, vertical, dry barge lifting system was presented.

In 1988 an analysis was conducted of a smaller 2200 ton barge instead of the 4500 ton alternative. Presently, for use on the Middle Columbia River, the 4500 ton design appears to be the most feasible.

In this study numerous alternatives were investigated and a vertical barge lift was found to be the most cost effective. Even though a barge lift system was shown to not be cost effective on other similar navigation reaches where conventional locks have proven economically infeasible, if detailed design studies were conducted on the barge lift alternatives in the future, all systems shown in this paper would deserve more extensive research before choosing a construction alternative.