



Chelan County
Natural Resource
Program



Lake Wenatchee
Water Storage
Feasibility Study

June 2003



MWH
MONTGOMERY WATSON HARZA

in association with



MONTGOMERY
WATER GROUP, INC.

Jones & Stokes



Executive Summary

Chelan County Natural Resource Program

Lake Wenatchee Water Storage Feasibility Study—June 2003

Executive Summary Why is this study being done?



- The focus on reviewing all potential solutions to shortfalls in in-stream flow and water supply was sharpened in the drought year of 2001, when streamflows dropped to historic lows in late summer and many water users across the state had their water supply interrupted as a result.
- The Wenatchee River Watershed is listed as one of the State's sixteen "critical basins" because of the presence of Endangered Species Act (ESA) listed species, development pressures and the potential for future water shortages.
- Chelan County Natural Resources Department is leading the Wenatchee Watershed Planning effort, which is to identify and study solutions to watershed problems such as in-stream flow, water quantity, water quality and fish and wildlife habitat. The County is also the recipient of the water storage grant from the State and is administering the process of completing this feasibility study.
- A project team consisting of a diverse group of public, local agency (city and county), irrigation, conservation, state, federal and tribal interests was assembled to direct the content of this study. Meetings were held in 2001—2003 to prepare a scope of study, select a consultant and review study products.

This study results from a Washington State Legislature grant to study the feasibility of storing additional water in Lake Wenatchee. The Legislature acted upon recommendations of the State's Water Storage Task Force to study the issue of water storage across the State. Many other Watersheds throughout the State are also performing studies of the potential for increased water storage to meet the increasing competitive needs of fish, farms and people.

The Legislature appropriated funds for this study because of its location within the Wenatchee River Watershed, the history of past water storage studies and permits on Lake Wenatchee and ongoing efforts in Watershed Planning undertaken by the Wenatchee Watershed Planning Unit. Previous studies and planning on water storage in Lake Wenatchee were performed by the Wenatchee Reclamation District and Chelan County PUD. The Wenatchee Reclamation District initiated a water storage project in 1930 in response to drought conditions in the Wenatchee River Watershed. They obtained permits to construct a low dam near the mouth of the Lake which would impound water to the normal high water elevation. The project was not completed and Chelan County PUD acquired the permits from the District. The PUD envisioned a water storage project that was a component of a larger hydroelectric project. That project was dropped in the 1970's and the rights reassigned back to the District.

Five broad study areas were selected by the project team to cover the scope of the feasibility study. They are noted below as well as the objective they are intended to address:

Water Needs. Determine the water needs of the Wenatchee River watershed and how additional water supplies should be apportioned between fish and community interests.

Technical Feasibility. Evaluate the technical feasibility of constructing a dam on Lake Wenatchee that complies with current fish passage standards and provides storage to Ordinary High Water and other levels. Analyze wind-caused wave erosion and prepare construction and permitting cost estimates.

Legal Feasibility. Evaluate the legal feasibility of constructing the dam taking into account federal, state, and local laws, and Tribal Nations rights. A further objective is to establish the permitting requirements and the status of the existing storage permit.

Socioeconomic Impacts. Evaluate the impacts of the project on private lake front property and other private landowners, and state and federal lands. Assessment of impacts would include recreation, cultural resources, tourism, fishing, rafting, and other uses of the river. The assessment would include costs and benefits.

Environmental Impact. Determine the impacts of storing additional water on flood water levels, lands inundated for longer periods around the lake (including wetlands), and on the fishery resources of the lake and river with particular emphasis on endangered species. The beneficial impacts of releasing stored water later in the year would also be evaluated.

During the feasibility study, project team meetings were held on December 11, 2002; February 26; April 30 and June 4, 2003. Presentations of interim work products by the MWH team were made to the project team during those meetings and discussions held on a number of issues.

Chelan County Natural Resource Program

Lake Wenatchee Water Storage Feasibility Study—June 2003

Executive Summary Water Needs Assessment



- **Water demands will increase with expected population growth in the Wenatchee Watershed. The increase in water demands for municipal and domestic purposes is predicted to be 7.3 cfs on a peak basis and 1,868 acre-feet annually.**
- **Industrial water demands outside of municipalities are not expected to increase as minimum instream flows limit the ability to obtain new water rights.**
- **An estimated 12,836 acres of irrigated agriculture exist in the Wenatchee Watershed. Most of the agricultural land is in orchards. The agricultural land base has been stable and water use for irrigation will likely not decline on a peak daily basis.**
- **Instream flows set by WAC 173-545 are not met on an average of 87 days per year. Water rights issued after 1984 are conditioned on those instream flows being met.**
- **The average shortfall in instream flow in the Wenatchee River is 17,500 acre-feet per year. In 2001, the shortfall was over 50,000 acre-feet.**
- **Water use to meet future municipal and domestic use is predicted to reduce streamflow by 5 cfs in summertime.**
- **Approval of current water right applications for irrigation would reduce streamflow an additional 5.6 cfs in summertime.**

The water stored in Lake Wenatchee could be used for several purposes: instream flow augmentation, water supply for future surface water users in the Wenatchee River Basin Watershed or as mitigation for future groundwater use either in the aquifers supplying the Wenatchee River or in tributaries to the Wenatchee River. The Water Needs assessment portion of this study summarizes the current and potential future use of water in the Wenatchee River Watershed (also referred to as Water Resources Inventory Area [WRIA] 45) for municipal, residential, commercial, industrial and agricultural needs and environmental uses.

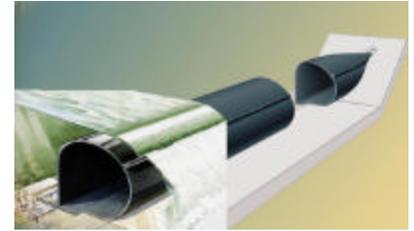
A review of potential population growth and growth in municipal, domestic, industrial and agricultural water needs was made. Chelan County is forecast to grow from 66,616 people to 101,860 people by 2025. Of that growth, an increase of 26,500 is forecast for the Wenatchee Watershed. The City of Wenatchee receives its water from wells located alongside the Columbia River and its future water use is not addressed in this study. The estimated increase in municipal and domestic water demands over the next 20 years is 7.3 cfs on a peak daily basis and 1,868 acre-feet annually. No growth in self-supplied industrial and commercial water use is forecast unless additional water is made available that would not be subject to interruption by minimum instream flows set by Chapter 173-545 WAC. The area of irrigated agriculture is estimated to be 12,863 acres and appears to be stable and not declining. There is a substantial area of land that is currently zoned for residential use that can be converted from agricultural use. Although annual water use may decline if that land is developed, peak water use may not change. The peak water demands are important as they have the most immediate effect on streamflow, especially during summer low flow periods.

Pending water right applications are requesting use of an additional 43 cfs from surface water and 10.9 cfs from ground water. The type of use requested on the applications is primarily municipal and domestic for surface water and irrigation for ground water. Most of the applications, if approved, would be subject to minimum instream flows and therefore interruptible during low streamflow periods. Some of the applications, such as those contained in the Peshastin Creek basin, would not likely be approved as the basin is closed for further appropriation from June 15 to October 15. It was estimated the increase in irrigation demand from approval of those applications to be 8 cfs; the estimated effect on streamflow is a reduction of 5.6 cfs. The estimated increase in municipal and domestic demand is 7.3 cfs and the estimated effect on streamflow is a reduction of about 5 cfs. The total estimated reduction in streamflow is estimated to be 10.6 cfs. That reduction would occur in the Wenatchee River.

The largest potential water need is for instream flow. Chapter 173-545 WAC has set minimum flows for the Wenatchee River and some tributaries. Hydrologic analyses have determined the average shortfall between Wenatchee River streamflow (measured at Plain) and the minimum flows is 17,500 acre-feet per year. In 2001, the shortfall was 50,400 acre-feet for the time period of July to October.

Lake Wenatchee Water Storage Feasibility Study—June 2003

Executive Summary Technical Feasibility



- **Ordinary High Water (OHW) is the most important water level evaluated because it is the demarcation between private property and State-owned shorelands, except those second-class shorelands sold to property owners. The OHW elevation is 1,870.3 ft.**
- **A low rubber dam was studied that would impound water to two elevations: 1,872.4 ft. or 1,870.3 ft. (OHW).**
- **The rubber dam and concrete supports would be submerged and mostly hidden from view**
- **The estimated costs of designing, permitting and constructing a rubber dam to impound water to 1872.4 ft are \$5.8M (excluding indirect costs such as financing, legal, interest, project mitigation, land purchase or easement, etc.)**
- **The estimated costs to construct a rubber dam to impound water to 1870.3 ft are \$5.4M (excluding indirect costs)**
- **Wind analysis shows a large potential increase in wave energy (and erosion) if water levels are maintained at 1872.4 ft and a much smaller or no increase if water levels are maintained at 1870.3 ft.**

To enable seasonal storage and release of water from Lake Wenatchee, an inflatable rubber dam was identified as the most suitable type of structure for the site. The dam would be located on the Wenatchee River approximately 1,600 feet downstream of the mouth of the lake where the river is narrowest. The flow stored and released would increase instream flow in the Wenatchee River in late summer, during the lowest flow period.

Two operating water levels were analyzed: 1) the Ordinary High Water (OHW), field surveyed and estimated to be 1870.3 ft., and 2) the spring high water level, estimated at 1872.4 feet, which occurs nine out of ten years. Five potential operating alternatives were analyzed with the model:

Alternative 1. Maximum lake level controlled by the rubber dam = 1872.4 ft. The dam would start storing water July 1 and releasing water August 23. Lake outflow would ramp up to 100 cfs in excess of historic outflows on September 1 and water released until storage is exhausted.

Alternative 2. Maximum lake level controlled by the rubber dam = 1872.4 ft. The dam would start storing water July 1 and releasing water August 23. Lake outflow would ramp up to 200 cfs in excess of historic outflows on September 1 and water released until storage is exhausted.

Alternative 3. Maximum lake level controlled by the rubber dam = 1872.4 ft. The dam would start storing water June 1 and releasing water July 1. Pulse flows would be released at a rate of 100 cfs for 4 hours per day until August 15. Lake outflow would be augmented by 100 cfs in excess of historic outflows starting August 16 and water released until storage is exhausted.

Alternative 4. Maximum lake level controlled by the rubber dam = 1870.3 ft. The dam would start storing water July 1 and releasing water August 23. Lake outflow would ramp up to 50 cfs in excess of historic outflows on September 1 and water released until storage is exhausted.

Alternative 5. Maximum lake level controlled by the rubber dam = 1870.3 ft. The dam would start storing water July 1 and releasing water August 23. Lake outflow would ramp up to 100 cfs in excess of historic outflows on September 1 and water released until storage is exhausted.

Alternative 2 provides the greatest flow augmentation, but for a shorter time period than Alternative 1, which can augment flow through much of October if needed. Alternative 3 has less water to store and release because it has different storage and release seasons in comparison to Alternatives 1 and 2. Alternatives 1 and 2 were found to provide a maximum storage of 12,300 af. The maximum increase in lake levels from historic levels is about 2.7 feet in July, 3.9 feet in August and 2.6 feet in September from Alternatives 1-3.

Alternative 5 can reliably provide a flow augmentation of 75 cfs in September. Alternative 4 can provide 50 cfs in September and for about one-half of October. Alternatives 4 and 5 would provide a maximum storage of 6,750 af. The increase in lake levels from historic for the two alternatives is about 0.6 feet in July, 2.0 feet in August and 1.0 feet in September.

Chelan County Natural Resource Program

Lake Wenatchee Water Storage Feasibility Study—June 2003



Executive Summary Legal and Permitting Requirements

- **The Wenatchee Reclamation District purchased an easement from the State of Washington in 1944 to overflow 2nd class shorelines in Lake Wenatchee.**
- **There exists 20,380 feet of 2nd class shoreline that is not subject to the easement. An easement to inundate those 2nd class shorelines would need to be acquired from adjacent property owners if a storage project was to be constructed to hold water to the Ordinary High Water level (1870.3 ft).**
- **If a storage project were to hold water to a level higher than the OHW, easements to inundate 70,000 lineal feet of shoreline on private property would be required.**
- **A number of permits that are required from Federal, State and local Agencies would be required. An EIS under SEPA or EA under NEPA would be required for the project. Because of the presence of endangered species, consultation with the U.S. Fish and Wildlife Service and NOAA Fisheries would be required. The permitting timeframe could stretch out over 3 years.**
- **Although no entity has proposed the project, a number of Federal, State and local agencies could construct and operate the project. The project would need to be operated with multiple objectives including instream flow augmentation, water supply and recreation.**

An assessment of legal and permitting requirements was made for construction and operation of a low dam at the outlet of Lake Wenatchee. The review covered existing permits to operate a reservoir and the requirements for acquiring new permits.

A reservoir permit was issued by the State of Washington in 1934 to the Wenatchee Reclamation District (WRD), which would have allowed the district to construct a dam at that time. The permit was transferred in 1963 to Chelan County PUD for their use in a potential water storage project. The PUD project did not proceed and the State cancelled the reservoir permit in 1976. In addition to the reservoir permit, the WRD obtained an easement in 1944 to overflow 2nd class shorelines around Lake Wenatchee. The easement is subject to the rights of previous purchasers of 2nd class shorelines around the lake. Second-class shorelands extend up to the line of Ordinary High Water (OHW). It was found that private property owners with a total of 10,950 feet and Washington State Parks and Recreation with 9,430 feet of waterfront own 2nd class shorelands that were purchased prior to the issuance of the overflow easement. An easement would need to be purchased or leased from those property owners to maintain water levels at the OHW level. A total of 70,000 feet of shoreline exists around Lake Wenatchee and overflow easements from all property owners on the lake would need to be obtained to maintain water levels at any water level higher than OHW, such as 1872.4 ft.

A review of the potential impact on Tribal fisheries was performed and the conclusion reached the project would have a negligible effect on Tribal fisheries in the Wenatchee River Watershed.

A review of permitting issues was performed and the types of permits that would be required from Federal, State and local agencies described. The typical timeframe for acquisition of those permits was also described. The project would likely be subject to the NEPA process and would require a Corps of Engineers permit, bringing in the need for consultation under ESA. Approaches to permitting and additional information needed for the permitting process are provided.

Because of the nature of the water storage project, it would be operated by a public entity. Although no entity has proposed the project, potential operators include the US Bureau of Reclamation, Washington State Department of Ecology, Chelan County PUD, and Wenatchee Reclamation District. The project would need to operate with multiple objectives including instream flow augmentation, water supply, recreation and other objectives.

Chelan County Natural Resource Program

Lake Wenatchee Water Storage Feasibility Study—June 2003

Executive Summary Socioeconomic Impact Assessment



- **Increase in water elevations could affect shoreline property values and potentially slow the rate of increase of property values, affect shoreline access, and affect shore facilities and improvements.**
- **Purchase of easements would be necessary for all alternatives and would range in cost from \$1.4 to \$3.5 million under Alts 4 and 5, to \$6.1 to \$15.3 million under Alts 1, 2, and 3.**
- **Impacts to lake-based recreation could include loss of shoreline access, and inundation of boat ramps and beaches.**
- **Estimated cost to retrofit the boat ramp at the State Park and to construct a new launch facility downstream of the dam would be approximately \$171,000.**
- **More detailed socioeconomic and parcel studies will be necessary if the project proceeds. Those studies could include shoreline topographic surveys, property-by-property appraisals, property-by-property survey of facilities and improvements, and a study of decision factors when buying shoreline property.**

The socioeconomic impact analysis of the Lake Wenatchee Water Storage Feasibility Study included a broad evaluation of property values, property improvements, lake-related recreation, river-related recreation, and potential effects on cultural resources. The analysis included a review of existing studies, acquisition and review of property assessments from the Chelan County Assessors Office, and field measurements and observations.

Land ownership on the lake includes U.S. Forest Service (45.3 percent), Washington State Parks and Recreation Commission (12.2 percent), County (0.5 percent) and private lands (42 percent). A review of Chelan County Assessor's records for 2002 indicates that there are 153 single-family residential parcels along the North Shore and 134 single-family residential parcels on the South Shore.

Recreation on the lake includes boating, fishing, wind surfing, camping and related activities, and beach recreation. Public access to the lake is provided at Lake Wenatchee State Park and from USFS land on the north and south sides of the lake. River-related recreation activities include whitewater rafting, kayaking, fishing, and access along the Wenatchee River. Two recorded archaeological sites occur on the north shore of the headwaters of the Wenatchee River; there are no recorded historic structures.

Increases in water elevations from the project could affect property values through 1) potentially slowing the rate of increase in property values, 2) perceived or real loss of property values, 3) affecting shoreline access or use, and 4) affecting shore facilities and improvements. The purchase of shoreline easements would be necessary and could range from a cost of \$1.4 to \$3.5 million under the OHW alternative (Alts. 4 and 5) to \$6.1 to \$15.3 million for elevation 1,872.4 ft. (Alts. 1, 2, and 3). The impacts to shoreline improvements would be greatest under Alts. 1, 2, and 3 and would vary on a parcel-by-parcel basis. Higher water elevations under Alts. 1, 2, and 3 and wind-driven waves, could erode shorelines and lead to damage. These potential impacts were not quantified in this study and more detailed studies will be necessary in the future if the project proceeds.

Impacts to lake-based recreation would include the loss of shoreline access at various locations on the lake, particularly under Alts. 1, 2, and 3. Boat ramps at Lake Wenatchee State Park and at the Glacier View campground would be inundated, thereby making access more difficult. The dock at the State Park boat ramp would need to be modified (i.e., extended or rebuilt) to allow access from shore. That cost is \$6,000. Beach recreation would be significantly affected by Alts. 1 - 3 for all but the Lake Wenatchee State Park beach.

River-based recreation would not be adversely affected by changes in river flows by the proposed project, but construction and operation of the dam would disrupt boating access from the lake to the river. To ensure access to the river is maintained, a new launch facility would need to be constructed downstream of the dam. Construction costs for such a facility were estimated to be \$165,000.

Cultural resources could be affected by the project by prolonging the saturation of artifact-bearing sediments and increasing the risk of erosion as a result of wave action. The magnitude of the impact would be greatest under Alts. 1, 2, and 3. A systematic survey of the dam site and other project elements should be conducted if future project studies are undertaken.

Chelan County Natural Resource Program

Lake Wenatchee Water Storage Feasibility Study—June 2003



Executive Summary Environmental Impact Assessment

- The sockeye salmon population in Lake Wenatchee is one of only two runs still existing in the Columbia River Basin. A popular recreational fishery exists for sockeye and kokanee.
- Spring chinook salmon and steelhead in the Wenatchee River system are listed as endangered under the Endangered Species Act. Bull trout are listed as threatened. Different life-stages of these fish can be found in the river or lake throughout the year.
- Low instream flows in the Wenatchee River may result in summer water temperatures that stress bull trout and other salmonid fish. Low instream flows can also delay upstream migration of adult salmonids and reduce the summer carrying capacity of juvenile fish.
- During low water years, the release of increased flows from Lake Wenatchee in late-summer and early-fall may improve fisheries habitat in the main-stem Wenatchee River. Alts. 1 and 2 would provide the greatest opportunity for benefit; Alts. 4 and 5 would provide some benefit, especially under extreme low flow conditions. Alt. 3 would benefit adult upstream passage during low flow conditions.
- The extended storage of high water in Lake Wenatchee may result in some alteration of the wetland community along the shoreline of the lake and in the backwatered areas of the White and Little Wenatchee rivers. Alts. 1—3 have a high probability of altering the communities; Alts. 4 and 5 a moderate probability.
- Construction and operation of the dam will need to consider and accommodate both upstream and downstream passage of anadromous salmonids and bull trout into and from Lake Wenatchee.

The storage of water in Lake Wenatchee and its release in late-summer and early-fall could have direct and indirect effects on the aquatic habitat and fish populations in the Wenatchee River system. This includes potential beneficial and negative effects on three fish species listed under the federal Endangered Species Act: spring chinook salmon, steelhead, and bull trout.

Lake Wenatchee is a cold, deep lake that is fed principally by the Little Wenatchee River and the White River. Extensive wetlands exist at the western end of the lake at the deltas of these two rivers. The lake drains to the Wenatchee River, which eventually empties into the Columbia River. Several populations of economically and culturally important fish species are found in the Wenatchee River system including chinook and sockeye salmon, kokanee, steelhead, bull trout, rainbow trout, westslope cutthroat trout, and Pacific lamprey. Coho salmon have recently been reintroduced to the basin. The Wenatchee River is an important migration corridor for many of these fish. In particular chinook, sockeye, steelhead, and Pacific lamprey mature in the ocean and then swim back upstream to spawn in the river, the smaller streams or along the shoreline of the lake. Bull trout are known to have a complex life history, where adult fish can spawn in the Chiwawa River and then return six miles upstream to feed in Lake Wenatchee. Their progeny may also migrate upstream as juveniles to rear in the lake. During the summer, low instream flow and associated warm water temperatures in the Wenatchee River have been identified as water quality concerns that can negatively affect many of these fish species.

The operation of the Lake Wenatchee Water Storage Project during low-flow water years could benefit anadromous salmonids in the Wenatchee River downstream of the lake outlet by providing added flows of cool water during the late-summer and early fall. This release of water could improve the quantity and quality of pool habitat used by adult fish for holding and passage conditions during their upstream migration, as well as result in more suitable areas to support spawning. Because of the greater volume of water that would be available for release, Alts. 1 and 2 would have the greatest potential instream flow benefit for salmonids. Some instream flow benefits would also be provided by Alts. 4 and 5 but these would be of lower magnitude and duration compared to Alts. 1 and 2. Alt. 3 could benefit early passage of sockeye and spring Chinook into the upper watershed. Potential negative impacts identified during this analysis include the potential stranding of juvenile fish and the possibility of dewatering of incubating eggs if river flows are rapidly reduced (as the amount of stored water becomes depleted) prior to Fall rains. However, these potential impacts can be avoided or minimized if ramping rates are used and flows are adjusted to consider egg incubation. The extended storage of water in Lake Wenatchee may result in some alteration of the wetland community along the shoreline of the lake and in the backwatered areas of the White and Little Wenatchee Rivers. Alts. 1—3 have a high probability of altering the communities; Alts. 4 and 5 a moderate probability. In addition, the location of a dam at the lake outlet could affect the overall connectivity of the lake with the lower Wenatchee River. Construction and operation of the dam will need to consider and accommodate both upstream and downstream passage of anadromous salmonids and bull trout into and from Lake Wenatchee.

TABLE OF CONTENTS

1.0 INTRODUCTION	1-1
2.0 WATER NEEDS	2-1
2.1 CURRENT AND PROJECTED WATER USE	2-1
2.1.1 Municipal and Domestic Water Use	2-1
2.1.2 Self-Supplied Commercial/ Industrial Water Use	2-8
2.1.3 Agricultural Water Use	2-10
2.2 INSTREAM FLOW NEEDS	2-21
2.3 WATER CONSERVATION OPPORTUNITIES	2-25
2.3.1 Municipal and Domestic	2-25
2.3.2 Agricultural Water Conservation	2-25
2.4 WATER RIGHTS	2-27
2.4.1 Surface Water Rights Summary	2-28
2.4.2 Ground Water Rights Summary	2-31
2.4.3 Summary of All Water Rights in WRIA 45	2-34
2.5 ALLOCATION OF NEW WATER RIGHTS	2-34
2.6 SUMMARY OF WATER NEEDS	2-36
2.7 USE OF STORED WATER	2-37
3.0 TECHNICAL FEASIBILITY	3-1
3.1 INTRODUCTION	3-1
3.2 DELINEATION OF ORDINARY HIGH WATER	3-1
3.2.1 Definition of Ordinary High Water	3-1
3.2.2 Fieldwork Performed to Interpret OHW	3-2
3.3 HYDROLOGY	3-6
3.3.1 Lake Wenatchee Historic Water Levels	3-6
3.3.2 Storage Operation Model	3-11
3.3.3 Operating Scenarios	3-28
3.3.4 Flood Operation	3-48
3.4 WIND AND WAVE EROSION ASSESSMENT	3-50
3.4.1 Wind Data	3-50
3.4.2 Wind Analysis	3-51
3.4.3 Wave-Height Analysis	3-52
3.4.4 Wave-Energy Analysis	3-53
3.5 IMPOUNDMENT STRUCTURE	3-56
3.5.1 Background	3-56
3.5.2 Field Reconnaissance	3-56
3.5.3 Rubber Dam Impoundment Structure	3-58
3.6 ADDITIONAL STUDY NEEDS	3-69

4.0	LEGAL AND PERMITTING REQUIREMENTS	4-1
4.1	STATUS OF PREVIOUS PERMIT AND EASEMENTS	4-1
4.1.1	Status of Reservoir Permit	4-1
4.1.2	Status of Overflow Easement	4-3
4.2	COMPLIANCE WITH TRIBAL NATION RIGHTS	4-4
4.2.1	Tribal Fishing Rights	4-4
4.2.2	Government-to-Government Consultation	4-5
4.2.3	PROJECT Effects on tribal fisheries	4-6
4.2.4	Recommendations.....	4-7
4.3	REGULATORY AUTHORITY	4-7
4.4	PERMITTING REQUIREMENTS.....	4-8
4.4.1	List of Permits.....	4-8
4.5	POTENTIAL ISSUES, APPROACHES AND MITIGATION REQUIREMENTS	4-15
4.5.1	Legal and Permitting Issues.....	4-15
4.5.2	Socioeconomic Impacts	4-16
4.5.3	Environmental Impacts.....	4-16
4.5.4	Mitigation Requirements	4-17
4.6	REQUIRED EASEMENTS.....	4-17
4.7	ADDITIONAL STUDY NEEDS.....	4-17
5.0	SOCIOECONOMIC IMPACT	5-1
5.1	STUDY METHODOLOGY AND EXISTING CONDITIONS.....	5-1
5.1.1	Land Use.....	5-1
5.1.2	Lake-related Recreation	5-10
5.1.3	River-related Recreation	5-13
5.1.4	Cultural Resources.....	5-14
5.2	EFFECTS OF PROPOSED PROJECT OPERATIONS.....	5-17
5.2.1	Land Use.....	5-17
5.2.2	Lake-related Recreation	5-19
5.2.3	River-related Recreation	5-23
5.2.4	Cultural Resources.....	5-27
5.3	CONCLUSIONS AND RECOMMENDATIONS	5-28
5.3.1	Land Use.....	5-28
5.3.2	Lake-related Recreation	5-29
5.3.3	River-related recreation	5-29
5.3.4	Cultural Resources.....	5-30
6.0	ENVIRONMENTAL IMPACT	6-1
6.1	WATER AVAILABILITY	6-1
6.2	OPERATIONAL ALTERNATIVES.....	6-1
6.3	ENVIRONMENTAL BASELINE OF THE AQUATIC RESOURCES.....	6-4
6.3.1	Areas Influenced by Lake Wenatchee Rubber Dam.....	6-4
6.3.2	Aquatic Species.....	6-8

6.3.3 Wetlands	6-19
6.3.4 Water Quality.....	6-20
6.3.5 Sediment Quality	6-26
6.4 ENVIRONMENTAL IMPACTS AND BENEFITS OF RUBBER DAM OPERATIONS.....	6-27
6.4.1 Effects of Rubber Dam Operations on Fish Habitat and Fish Use	6-28
6.4.2 Effects f Rubber Dam Operations On Riverine And Lacustrine Ecosystem Processes.....	6-40
6.4.3 Effects Of Rubber Dam Operations On Water Quality Conditions.....	6-47
6.5 CONCLUSIONS REGARDING POTENTIAL ENVIRONMENTAL IMPACTS AND BENEFITS	6-50
6.7 POTENTIAL ADDITIONAL STUDIES	6-50
7.0 SUMMARY AND CONCLUSIONS.....	7-1
7.1 SUMMARY	7-1
7.1.1 Summary of Water Needs.....	7-2
7.1.2 Summary of Technical Feasibility	7-3
7.1.3 Summary of Legal and Permitting Issues	7-5
7.1.4 Summary of Environmental Effects and Recommended Additional Studies	7-5
7.1.5 Summary of Socioeconomic Impacts	7-7
7.2 CONCLUSIONS.....	7-9
7.2.1 If Water Is Stored To El. 1870.3 Ft	7-9
7.2.2 If Water is Stored To El. 1872.4 Ft.....	7-10
8.0 REFERENCES.....	8-1
9.0 PUBLIC COMMENTS.....	9-1

TABLES

Table 2.1-1. Estimate of Current Population and Municipal/Domestic Water Use, by Water Use Category	2-3
Table 2.1-2. Forecasted Population Growth in Chelan County.....	2-6
Table 2.1-3. Forecasted Population Growth in Wenatchee River Watershed.....	2-7
Table 2.1-4. Wenatchee River Watershed Projected Municipal and Domestic Water Use in 2025.	2-8
Table 2.1-5. Estimate of Current Self-Supplied Commercial/Industrial Water Use.	2-9
Table 2.1-6. Pattern and Quantity of Diversions for Wenatchee Reclamation District, 2002.	2-11
Table 2.1-7. Monthly Diversions Icicle and Peshastin Irrigation Districts - Average of 1990 and 1991	2-12
Table 2.1-8. Average Crop Irrigation Requirements.....	2-14
Table 2.1-9. Expected Field Application Efficiencies in Washington.	2-14
Table 2.1-10. Summary of Potentially Irrigated Lands Based Upon 1992 Land Cover Database (acres).....	2-17
Table 2.1-11. Estimated Irrigation Water Demand for Consumptive Use Based Upon 1992 Land Cover Data (acre-feet).....	2-17
Table 2.1-12. Tree Fruit Acreage in Wenatchee Fruit Reporting District.....	2-18
Table 2.1-13. Irrigated Farmland in Chelan County.	2-18
Table 2.1-15. Estimates of Land Area and Zoning within Wenatchee River Watershed.	2-19
Table 2.2-1. WAC Stream Management Units in Wenatchee River Watershed.....	2-21
Table 2.2-1. WAC Instream Flow Requirements in Wenatchee River Watershed.....	2-22
Table 2.4-1. Surface Water Rights by Subbasin.	2-30
Table 2.4-2. Ground Water Rights by Subbasin.	2-33
Table 2.4-3. Surface and Ground Water Rights by Subbasin.	2-35
Table 3.2-1. Ordinary High Water Marks Interpreted and Surveyed.....	3-2
Table 3.3-1. Frequency data for historic Lake Wenatchee level (feet NGVD29).....	3-9
Table 3.3-2. Lake Wenatchee annual instantaneous peak lake level data for USGS Gage 12455000.	3-10
Table 3.3-3. Historic flow (cfs) at USGS Gage 12455000, Wenatchee River below Lake Wenatchee.	3-14
Table 3.3-4. Historic flow (cfs) Frequency at USGS Gage 12455000, Wenatchee River below Lake Wenatchee.....	3-14
Table 3.3-5. Historic flow (cfs) at USGS Gage 12457000, Wenatchee River at Plain.....	3-15
Table 3.3-6. Historic flow (cfs) Frequency at USGS Gage 12457000, Wenatchee River at Plain.	3-15
Table 3.3-7. Historic flow (cfs) at USGS Gage 12459000, Wenatchee River at Peshastin.	3-16
Table 3.3-8. Historic flow (cfs) Frequency at USGS Gage 12459000, Wenatchee River at Peshastin.	3-16
Table 3.3-9. Lake Wenatchee elevation-area-storage.	3-19
Table 3.3-10. Simulated Lake Wenatchee level (feet NGVD29) frequency data – Historic Operation.	3-20
Table 3.3-11. Simulated flow (cfs) frequency at USGS Gage 12455000, Wenatchee River below Lake Wenatchee – Historic Operation.....	3-21
Table 3.3-12. Instream flows (cfs) for the Wenatchee River (Ref: WAC 173-545-030, last update 6/9/88)	3-22
Table 3.3-13. Number of days with flow less than instream flow requirement at USGS Gage 12457000, Wenatchee River at Plain – Historic Operation.....	3-23

Table 3.3-14. Number of days with flow less than instream flow requirement at USGS Gage 12459000, Wenatchee River at Peshastin – Historic Operation.....	3-24
Table 3.3-15. Number of days with flow less than instream flow requirement at the Peshastin or Plain USGS Gages – Historic Operation.....	3-25
Table 3.3-16. Storage (acre-feet) necessary to be impounded by the rubber dam to meet instream flow requirements at Plain or at Plain and Peshastin	3-26
Table 3.3-17. Lake Wenatchee inflow (acre-feet) potentially available for storage with rubber dam.....	3-27
Table 3.3-18. Comparison of lake levels to potential storage.....	3-29
Table 3.3-19. Alternative 1 Lake Wenatchee Elevation-Frequency Difference (feet) from Historic.	3-34
Table 3.3-20. Alternative 2 Lake Wenatchee elevation-frequency difference (feet) from historic.	3-35
Table 3.3-21. Alternative 3 Lake Wenatchee elevation-frequency difference (feet) from historic.	3-35
Table 3.3-22. Alternative 4 Lake Wenatchee elevation-frequency difference (feet) from historic.	3-36
Table 3.3-23. Alternative 5 Lake Wenatchee elevation-frequency difference (feet) from historic.	3-37
Table 3.3-24. Alternative 1 Lake Wenatchee outflow-frequency difference (cfs) from historic.	3-42
Table 3.3-25. Alternative 2 Lake Wenatchee outflow-frequency difference (cfs) from historic.	3-43
Table 3.3-26. Alternative 3 Lake Wenatchee outflow-frequency difference (feet) from historic.	3-43
Table 3.3-27. Alternative 4 Lake Wenatchee outflow-frequency difference (cfs) from historic.	3-44
Table 3.3-28. Alternative 5 Lake Wenatchee outflow-frequency difference (cfs) from historic.	3-44
Table 3.3-29. Average number of days with flow less than instream flow requirement at USGS Gage 12457000, Wenatchee River at Plain – Historic and Alternative Operation.	3-47
Table 3.5-1. Lake Wenatchee Impoundment Structure - Feasibility Cost Estimate*.....	3-68
Table 5.1-1. Comparison of Assessed Value of Single-Family Parcels on Lake Wenatchee, 1997 & 2002.....	5-6
Table 5.1-2. Representative Improvements on Lands Adjacent to Lake Wenatchee.....	5-7
Table 5.1-3. Assumed Easement Costs, Sample Scenario	5-10
Table 6.2-1. Description of five alternatives and their resource targets considered in the environmental impact analysis of the Lake Wenatchee Water Storage Feasibility Study.....	6-4
Table 6.3-1. USEPA recommended temperature water quality guidelines for Pacific Northwest salmonid fish.	6-21
Table 6.3-2. Lake Wenatchee depth profiles of temperature, dissolved oxygen and pH (from Sylvester and Ruggles 1957).....	6-26
Table 6.4-1. Aquatic and fisheries impact evaluation matrix for three segments of the Wenatchee Watershed potentially influenced by project operations under Alternative 1 of the Lake Wenatchee Water Storage Feasibility Study.	6-32

Table 6.4-2. Aquatic and fisheries impact evaluation matrix for three segments of the Wenatchee Watershed potentially influenced by project operations under Alternative 2 of the Lake Wenatchee Water Storage Feasibility Study.	6-33
Table 6.4-3. Aquatic and fisheries impact evaluation matrix for three segments of the Wenatchee Watershed potentially influenced by project operations under Alternative 3 of the Lake Wenatchee Water Storage Feasibility Study.	6-34
Table 6.4-4. Aquatic and fisheries impact evaluation matrix for three segments of the Wenatchee Watershed potentially influenced by project operations under Alternative 4 of the Lake Wenatchee Water Storage Feasibility Study.	6-35
Table 6.4-5. Aquatic and fisheries impact evaluation matrix for three segments of the Wenatchee Watershed potentially influenced by project operations under Alternative 5 of the Lake Wenatchee Water Storage Feasibility Study.	6-36
Table 6.4-6. Predicted change in hydroperiod components as a result of five alternative rubber dam scenarios, Lake Wenatchee, WA.	6-46

FIGURES

Figure 2.1-1. Census County Divisions in Wenatchee Watershed.....	2-5
Figure 2.1-2. Forecasted Population Growth in Chelan County.	2-7
Figure 2.1-3. Wenatchee Reclamation District Diversions – 2002.....	2-12
Figure 2.1-4. Sub-basins in Wenatchee River Watershed.....	2-16
Figure 2.2-1. Comparison of Wenatchee River at Plain Flow to IRPP Flows.	2-23
Figure 2.2-2. Comparison of Wenatchee River at Monitor Flow to IRPP Flows.	2-23
Figure 2.2-3. Comparison of Wenatchee River at Plain Flow to IRPP Flows for 2001 and 2002.	2-24
Figure 2.2-4. Comparison of Wenatchee River at Monitor Flow to IRPP Flows for 2001 and 2002.2-.....	24
Figure 3.3-1. Representative wet, dry, and average year lake levels.	3-7
Figure 3.3-2. Lake Wenatchee level duration curve.....	3-7
Figure 3.3-3. Lake Wenatchee monthly lake level frequency curves.	3-8
Figure 3.3-4. Peak annual flows at USGS Gage 12457000, Wenatchee River at Plain.....	3-11
Figure 3.3-5. Annual average flow (cfs) at USGS Gage 12457000, Wenatchee River at Plain.	3-12
Figure 3.3-6. Monthly average flow (cfs) at USGS Gage 12457000, Wenatchee River at Plain. ...	3-13
Figure 3.3-7. Lake Wenatchee outflow rating curve.....	3-17
Figure 3.3-8. Rating curve for USGS Gage 12457000, Wenatchee River at Plain.....	3-17
Figure 3.3-9. Rating curve for USGS Gage 12459000, Wenatchee River at Peshastin.....	3-18
Figure 3.3-10. Illustration of Water Levels at Kane Boathouse.....	3-29
Figure 3.3-11. Alternatives 1, 2, and 3, and historic lake levels for an average water year – 1949.	3-32
Figure 3.3-12. Alternatives 4 and 5, and historic lake levels for an average water year – 1949.....	3-32
Figure 3.3-13. Alternatives 1, 2, and 3, and historic lake levels for a dry water year – 1941.....	3-33
Figure 3.3-14. Alternatives 4 and 5, and historic lake levels for a dry water year – 1941.....	3-33
Figure 3.3-15. Alternatives 1, 2, and 3, and historic lake outflows for an average water year – 1949.	3-38
Figure 3.3-16. Alternatives 1, 2, and 3, and historic lake outflows for the 1949 augmentation season.	3-38
Figure 3.3-17. Alternatives 4, and 5, and historic lake outflows for an average water year – 1949.	3-39
Figure 3.3-18. Alternatives 4, and 5, and historic lake outflows for the 1949 augmentation season.	3-39
Figure 3.3-19. Alternatives 1, 2, and 3, and historic lake outflows for a dry water year – 1941.	3-40
Figure 3.3-20. Alternatives 1, 2, and 3, and historic lake outflows for the 1941 augmentation season.	3-40
Figure 3.3-21. Alternatives 4 and 5, and historic lake outflows for a dry water year – 1941.....	3-41
Figure 3.3-22. Alternatives 4 and 5, and historic lake outflows for the 1941 augmentation season.	3-41
Figure 3.3-23. Alternatives 1, 2, and 3, and historic flows at Plain for the 1949 augmentation season.	3-45
Figure 3.3-24. Alternatives 4 and 5, and historic flows at Plain for the 1949 augmentation season.	3-46
Figure 3.3-25. Alternatives 1, 2, and 3, and historic flows at Plain for the 1941 augmentation season.	3-46

Figure 3.3-26. Alternatives 4 and 5, and historic flows at Plain for the 1941 augmentation season.	3-47
Figure 3.3-27. Lake levels during maximum floods having continuous records.	3-48
Figure 3.4-1. Prevailing Wind Velocity Occurance, RAWS Dry Creek Station, July-October, 2002.	3-51
Figure 3.4-2. Monthly Average Wind Speed	3-52
Figure 3.4-3. Wave Height Contours for 25 mph Wind Speed from WNW Direction.....	3-53
Figure 3.4-4. Comparison of Wave Energy at Site on South Shore Drive between Existing Conditions and the Operational Scenario that Impounds Water at El. 1872.4.....	3-54
Figure 3.4-5. Comparison of Wave Energy at Site on South Shore Drive between Existing Conditions and the Operational Scenario Which Impounds Water at El. 1870.3... ..	3-55
Figure 3.5-1. Lake Wenatchee Impoundment Structure – Construction Schedule.	3-66
Figure 4.1-1. Second Class Shorelands, Lake Wenatchee, WA.....	4-2
Figure 5.1-1. Land ownership, Lake Wenatchee.....	5-3
Figure 6.1-2. Temporal distribution of adult and juvenile salmonid habitat utilization in the Wenatchee River basin, Washington. Darker areas indicate times of peak occurrence at the mouth of the Wenatchee River. Data adapted from NMFS et al. 1998, Beery and Kelly 1982 and USFWS 1999.	6-11
Figure 6.3-3. WRIA 45 Sockeye distribution map.....	6-13
Figure 6.3-4. WRIA 45 steelhead distribution map.	6-15
Figure 6.3-5. WRIA 45 map of bull trout.....	6-17
Figure 6.3-6. WRIA 45 bull trout distribution map	6-18
Figure 6.3-7. Map of the Wenatchee River basin indicating stream reaches that were included on the 1998 303(d) list of impaired waters (from NPPC 2002).	6-23
Figure 6.4-1. Average lake level elevations under different rubber dam operational models, Lake Wenatchee Water Storage Feasibility Study.	6-47

PHOTOGRAPHS

Photograph 3.2-1. Approximately 300 yards south of YMCA Camp, El. 1870.5.	3-3
Photograph 3.2-2. Approximately 300 yards south of YMCA Camp, El. 1870.4.	3-3
Photograph 3.2-3. Approximately 300 yards south of YMCA Camp, El. 1870.2.	3-3
Photograph 3.2-4. Halfway between YMCA Camp and State Park, El. 1870.2.	3-4
Photograph 3.2-5. Near USGS BM at State Park, El. 1870.4 – 1870.2.	3-4
Photograph 3.2-6. Kane beach, El. 1870.8.	3-4
Photograph 3.2-7. Hoyt beach, El. 1870.7.	3-5
Photograph 3.2-8. Aspiri beach, El. 1869.8.	3-5
Photograph 3.2-9. South of Aspiri beach, El. 1869.6.	3-5
Photograph 3.2-10. Starr beach, El. 1870.1.	3-6
Photograph 3.5-1. Wenatchee River, looking upstream (westward), immediately downstream of Lake Wenatchee and upstream of the State Highway 207 Bridge.	3-57
Photograph 3.5-2. Potential location of impoundment structure on Wenatchee River, looking upstream.	3-57
Photograph 3.5-3. North shore overbank.	3-58
Photograph 3.5-4. South shore overbank.	3-58
Photograph 3.5-5. Week Falls rubber dam; inflated with water over crest.	3-59
Photograph 3.5-6. Weeks Falls rubber dam; deflated.	3-59
Photograph 3.5-7. Typical Portadam river crossing. (Photo courtesy Portadam, Inc.)	3-64
Photograph 3.5-8. Portadam at MWH Wynoochee Hydro Project on the Wynoochee River near Montesano, WA.	3-64
Photograph 5.1-1. Shows septic tank that is located very close to the shoreline and could be impacted by any of the five alternatives.	5-7
Photograph 5.1-2. Site 45CH208 upstream from proposed impoundment structure.	5-15
Photograph 5.1-3. View south of abandoned Wenatchee River Bridge pilings from the north bank of the Wenatchee River.	5-16
Photograph 5.2-1. Estimated 1872.4 ft. Water Elevation at the Glacier View Campground Boat Launch.	5-20
Photograph 5.2-2. Estimated 1872.4 ft. Water Elevation at the Lake Wenatchee State Park Campground Boat Launch.	5-20
Photograph 5.2-3. Water line at Camp Zanika Beach approximates OHW Alternative while base of survey rod depicts approximate El. 1872.4.	5-22
Photograph 5.2-4. Base of survey rod depicts approximate water elevation for the 1872.4 Alternative at Lake Wenatchee State Park Beach.	5-23
Photograph 6.3-1. Little Wenatchee River near upper extent of lake backwater effect; the river contains extensive amounts of spawning gravel. Photos taken during November 2002 field reconnaissance.	6-5
Photograph 6.3-2. White River at FS Road 6500, looking downstream (left photo) and White River above lake influence zone. Photos taken during November 2002 field reconnaissance.	6-6
Photograph 6.3-3. Lake Wenatchee looking upstream within outlet channel near proposed site of rubber weir (upper photo) and upstream view of Wenatchee River just below lake outlet at control riffle, from Highway 207 bridge (right photo). Photos taken during November 2002 field reconnaissance.	6-6

Photograph 6.3-4. Wenatchee River at Plain, looking downstream of Highway 209, and within Tumwater Canyon section above Leavenworth, Washington. Photos taken during November 2002 field reconnaissance. 6-7

Photograph 6.3-5. Upstream (left photo) and downstream (right photo) views of Wenatchee River near Peshastin, Washington. Photos taken during November 2002 field reconnaissance. 6-7

APPENDICES

Appendix A – Project Team Members / Scope of Work