FINAL TECHNICAL REPORT

VOLUME I of III

WHTE RIVER FALLS FISH PASSAGE PROJECT

TYGH VALLEY, OREGON

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FINAL REPORT

WHITE RIVER FALLS PASSAGE PROJECT
Tygh Valley, Oregon

BY

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U.S.D.A., Mt. Hood National Forest
Ott Water Engineers, Inc.
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PREFACE

The White River Falls Fish Passage Project was funded by the Bonneville Power Administration in FY 1983 and FY 1984.

A project feasibility was conducted cooperatively among the Oregon Department of Fish and Wildlife (ODFW;), the U.S. Department of Agriculture, Forest Service, Mount Hood National Forest (USDA FS), and Ott Water Engineers, Inc. (OTT).

The publication of this feasibility study culminates Phase I of the White River Falls Fish Passage Project and will be followed by a decision on the project by the Oregon Fish and Wildlife Commission. Recommendations of ODFW staff will be presented to the Commission following a series of public meetings during June and July, 1985.

The Bonneville Power Administration (BPA) will initiate Phase II with the environmental review of the preferred passage alternative in June 1985. The review wiil comply with the National Environmental Protection Act (NEPA) and the Council of Environmental Quality guidelines for the U.S. Department of Energy. Agency consultation and public involvement are expected to occur from July 1985 through January 1986, respectively. Implementation of Phase II of the project is contingent on an approval by the Oregon Fish and Wildlife Commission.

Approximately $2.3 million has been approved for appropriation in FY 1986 for the final design and construction of a trap and haul facility at White River Falls.

PHASE 1 - TECHNICAL REPORT

The feasibility study is presented in three volumes. Volume I is the Final Technical Report and presents the results of the detailed analyses. Volumes II and III are the Appendices and contain the baseline data and methods of analysis.

Copies of these volumes may be obtained from:

U.S. Department of Energy
Bonneville Power Administration
Division of Fish and Wildlife - PJ
P.O. Box 3621
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EXECUTIVE SUMMARY

The potential to increase anadromous fish production in the Deschutes River basin by providing passage over White River Falls has been discussed for many years. In a Deschutes River basin report published by the Oregon Water Resources Division in 1961, the Oregon Department of Fish and Wildlife (ODFW) identified the basin as having a high potential to produce anadromous fish. The U.S. Department of Interior, Bureau of Reclamation developed various estimates of production potential in two reports published in 1974 and 1981. In 1982 the ODFW formally recommended to the Northwest Power Planning Council (Council) that a feasibility study be conducted for providing fish passage over White River Falls.

The Council's 1982 Columbia River Basin Fish and Wildlife Program identifies the fish passage opportunity at White River Falls under Measure 704(d)(l), Table 2. Passage around White River Falls, a 55 m (180 ft) high series of natural falls, could provide new spawning and rearing habitat for anadromous fish.

The feasibility study indicates that 262 km (164 mi) of stream habitat with some potential for anadromous fish would be accessible with little or no work to minor barriers following passage above the falls. Major stream alterations are not included in present project development plans. Under the terms of the Northwest Regional Power Planning and Conservation Act (P.L. 96-501) and the Council's Fish and Wildlife Program, the White River Falls Fish Passage Project constitutes an enhancement opportunity to compensate for other losses to anadromous fish runs in the Columbia River basin that are directly associated with hydropower development.

Ott Water Engineers, Inc. (OTT), the U.S. Department of Agriculture, Forest Service, Mount Hood National Forest (USDA FS), and the Oregon Department of Fish and Wildlife (ODFW) were independently contracted by Bonneville Power Administration (BPA) to cooperatively conduct Phase I, the feasibility study for the White River Falls Fish Passage Project. Phase 1 consists of several studies: an inventory of fish habitat, an estimate of potential anadromous fish production, an analysis of potential impacts on resident fish, and an analysis of passage alternatives. From this information, a benefit/cost analysis was conducted.

Results of the feasibility study are presented in three volumes. The technical report is contained in Volume I; the appendices are presented in Volumes II and III. The appendices contain the detailed data base and calculations. The technical report discusses the methodologies, summarizes the results, and presents the recommendations for project development.

WHITE RIVER BASIN DESCRIPTION

The White River is a major tributary of the Deschutes River in north-central Oregon and drains 1,080 km2 (417 mi^2). Figure S-l shows the White River drainage and project location. The White River heads on the southeastern slopes of Mount Hood in White River Glacier. White River Falls (the falls) is located 3.4 km (2 mi) above its confluence with the Deschutes River. The town of Maupin, Oregon, lies a few miles south of the project area.

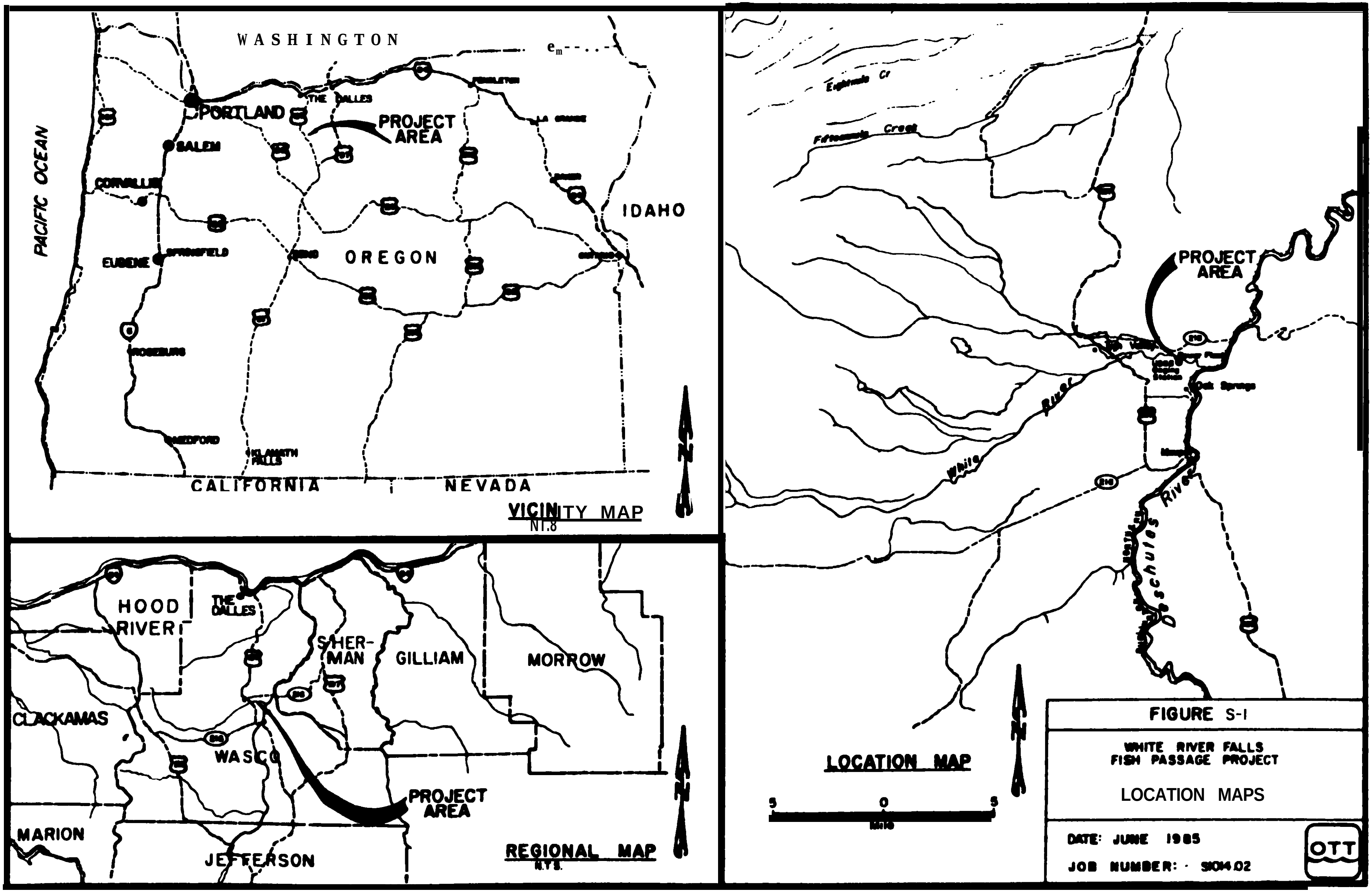
WASHINGTON
PORTLAND
THE DALLES
PROJECT AREA
SALEM
CORVALLIS
EUGENE
SPRINGFIELD
PACIFIC OCEAN
OREGON
IDAHO
ROSEBURG
MEDFORD
KLAMATH FALLS
CALIFORNIA
NEVADA
VICINITY MAP
HOOD RIVER
THE DALLES
SHERMAN
GILLIAM
MORROW
CLACKAMAS
WASCO
PROJECT AREA
MARION
JEFFERSON
REGIONAL MAP
N.T.S.
Eightmile Cr
Fifteenmile Creek
PROJECT AREA
White River
Oak Springs
Deschutes River
LOCATION MAP
5
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FIGURE S-1
WHITE RIVER FALLS
FISH PASSAGE PROJECT
LOCATION MAPS
DATE: JUNE 1985
JOB NUMBER: 31014.02
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'Three natural waterfalls comprise White River Falls. The two upper falls have a total drop of 43 m (140 ft). The lower falls has a drop approximately 5 m (15 ft) and is about 338 m (1,110 ft) below the two upper falls. The cumulative drop between the headwater and tailwater of White River Falls is 55 m (180 ft).

FISHERIES

The feasibility study addressed the species and stock of anadromous fish for introduction, the number of anadromous fish the White River basin would support, and the potential impacts on resident fish by an introduction of anadromous fish.

SPECIES/STOCK SELECTION

The ODFW identified summer steelhead and spring chinook as the most suitable species for introduction. This selection was based upon the species found in surrounding watersheds and the type of stream habitat upstream of White River Falls. The ODFW recommendation assumes that the most adaptable species for the White River would be local Deschutes River stock and species. These fish would probably have better survival rates than fish from other basins and surplus fish from Deschutes River hatcheries may be available for use in White River.

POTENTIAL PRODUCTION

Estimates of the potential production of anadromous fish in the White River basin were essential to evaluate project feasibility. The analysis of potential production, or the numbers of anadromous fish that the basin could support, were based on habitat inventory of streams in the basin, study of the effects of glacial silt, and measurement of stream habitat and resident trout abundance.

Stream Inventory

The USDA FS and ODFW surveyed stream habitat conditions in the White River basin in 1983 and 1984. Data on stream gradient pool-riffle ratios, and steamflow were used to group stream sections into reaches with similar characteristics. In addition, irrigation diversions and fish habitat enhancement opportunities were identified.

The White River basin has 322 km (201 mi) of streams that have potential to support anadromous fish above White River Falls (Table S-l). Generally, habitat quality is fair to good; however, only 89 km (56 mi) of stream would be easily accessible at low flows. Migration barriers other than White River Falls may limit access to approximately 233 km (146 mi) or 73 percent of the stream length. If adults migrate during low flows, improvements at log jams, falls less than 1.8 m (6 ft) high, and low head irrigation diversion structures would benefit upstream passage at these minor barriers and would make an additional 173 km (108 mi) of stream accessible (Figure S-2). The remaining areas (60 km), inaccessible at high or low flows, are above major barriers and would require costly site improvements to provide passage. Several streams above major barriers were recommended as sanctuaries for native rainbow trout.

Table S-l. Stream habitat presently accessible and accessible with passage enhancement in the White River basin above White River Falls.

Stream	Accessible a/	Passage Enhancement b/ Minor c/	Major d/	Total Habitat
White River	50.9	14.7	0	65.6
Tygh	4.5	15.7	8.6 e/	28.8
Jordan	0	1.4	20.5 e/	21.9
Badger	0	30.2	10.7 e/	40.9
Little Badger	0	9.1	2.9	12.0
Threemile	0	23.8	0	23.8
Rock	13.3	0	9.6 e/	22.9
Cate	13.1	7.5	0	20.6
So. Fork Cate	3.4	0	0	3.4
McCubbins Gulch	0	0	7.7	7.7
Boulder	1.6	16.0	0	17.6
Forest	0	2.6	0	2.6
Clear	2.2	16.6	0	18.8
Frog	0	12.5	0	12.5
Barlow	0	10.2	0	10.2
Buck	0	1.6	0	1.6
Bonney	0	1.1	0	1.1
Iron	0	4.3	0	4.3
Alpine	0	0.6	0	0.6
Mineral	0	4.9	0	4.9
Total	89.0 (56 mi)	172.8 (108 mi)	60.0 (37 mi)	321.8 km (201 mi)

a/ Kilometers of habitat presently accessible above White River Falls.

b/ Additional kilometers of habitat with passage at minor and major barriers.

c/ Removal or alteration of all relatively minor obstructions (generally requiring low investment) such as log jams, small falls (0.3-1.8 m) and low head irrigation diversion structures, up to the first major barrier.

d/ Removal or alteration of all remaining migration barriers, including major project sites likely requiring a relatively high level of planning and investment.

e/ Recommended as sanctuaries for native rainbow trout.

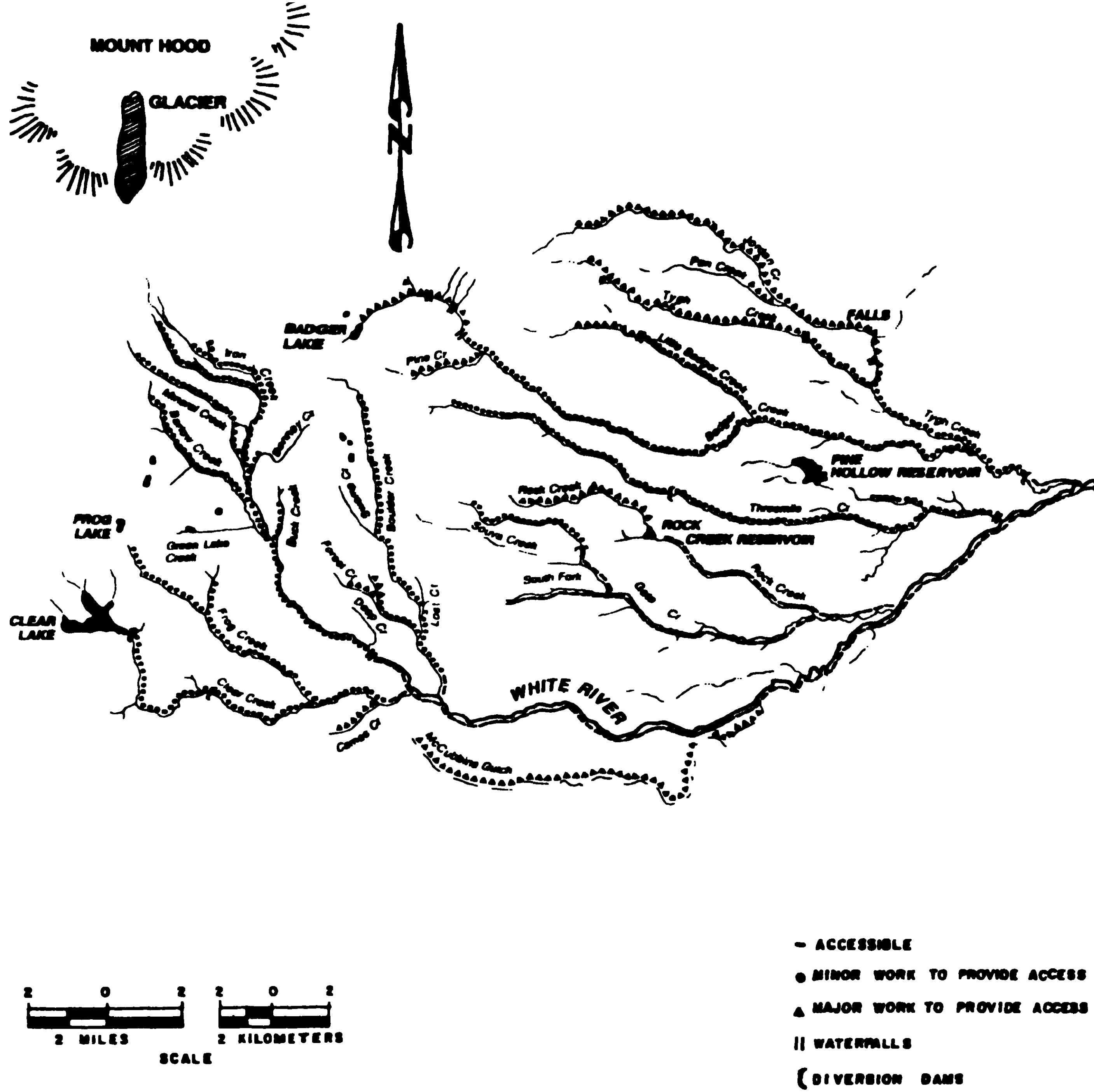

FIGURE S-2

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ACCESSIBLE STREAM HABITAT
PASSAGE ENHANCEMENT LEVELS

DATE JUNE 198[illegible]

The White River basin can be divided into two areas based on habitat conditions. The upper basin contains about 40 percent of the fish habitat in the watershed but only 25 percent of the resident fish production. The lower basin accounts for 75 percent of the resident fish production, although many streams in the lower basin have high water temperatures and low to intermittent flows in the summer.

Stream surface area, pool area, and pool volume of streams in the basin were measured in 1984. The USDA FS and ODFW also estimated the area of spawning gravel (16,000 m^2) below any barriers that appeared suitable for use by anadromous fish upstream of White River Falls. An additional 13,000 m^2 of spawning gravel are available above minor barriers.

Irrigation Diversions

The lower White River and tributaries provide irrigation flows for three principal areas within the basin: Juniper Flat, Tygh Valley, and the Wamic-Smock Prairie area. Several irrigation districts and ditch companies, and many individual irrigators divert stream flows from April through October in a normal water year. Although a minimum instream flow of 60 cfs has been established for the White River for summer months, no minimum stream flow requirements exist for its tributaries. Summer flows in nearly all of the major tributaries (except Barlow Creek) appear to be completely appropriated.

Eighteen ditches in the White River basin would require screens and bypass facilities to protect downstream migrants. Screening of the ditches is essential to develop runs of anadromous fish in the basin. Construction costs (1985 dollars) were estimated at about $58,000 and annual maintenance costs were estimated to be $14,500. ODFW recommends costs for construction of screens , maintenance of screens, and minor modification to diversion dams for upstream passage be included as a cost of the project.

Glacial Silt

The glacial s i t in White River will prevent spawning by spring chinook in the upper 60 percent of the river. However, juvenile chinook will likely move into the upper river from tributaries to rear, which might offset the loss of spawning in the upper mainstem. Glacial silt will probably not affect the production of steelhead.

Steelhead and Chinook Estimates

Estimates of the potential production of steelhead and salmon above the falls were based upon several methods and used data from stream inventories, the glacial silt study,measurements of habitat and resident trout abundance, and the literature. These estimates assume that irrigation ditches will be screened and minor obstructions will be altered to provide passage for migrants.

Nine methods were used to estimate a potential production of 2,100 to 3,500 adult steelhead in the White River basin (Table S-2). The estimates were based on the abundance and biomass of resident trout, on the rearing area in the White River basin, and on steelhead densities and rearing area requirements from selected Northwest streams. The estimates are total production of adult steelhead to the Columbia River prior to in-river fisheries in the Columbia and Deschutes rivers.

Because of intermittent flow in the summer, it was assumed steelhead would use 225 km (86 percent) of the streams below major barriers. Areas above major barriers were not considered usable because the costs to provide upstream passage are high and because these areas are recommended as management areas for native trout. The estimates assumed access to 51 km in the Tygh Creek drainage without which the estimated production would be reduced by 30 percent (400 to 800 adults).

Seven methods were used to estimate a potential production of 1,400 to 2,100 spring chinook adults in the White River basin (Table S-3). Use of 160 km (61 percent) of streams below major barriers in the White River basin, and chinook densities in Northwest streams were used to predict the potential production of chinook. The use of the Tygh Creek drainage by spring chinook will depend on timing of the adult run and effects of high water temperatures on chinook holding in the lower drainage. Without access to 42 km of streams in the Tygh Creek system, the chinook estimates would be reduced by 30 percent (420 to 630 adults).

Enhancement Opportunities

The ODFW and USDA FS biologists found that the potential production of anadromous fish in the White River basin is primarily limited by passage barriers to upstream migration and unscreened irrigation diversions, which were discussed earlier, and by summer water conditions in some of the lower reaches of the basin.

Table S-2. Estimated production of summer steelhead in the White River system below barriers. a/

	Method	Smolts b/	Adults	
			Run Size	Spawning D/ Escapement
1.	Population of resident trout >15 cm	23,166	1,298	649
2.	Numerical densities of age 1 steelhead	77,302	4,328	2,164
3.	Numerical densities of age 0 steelhead	20,340	1,588	794
4.	Population of 1+ resident trout	42,042	2,354	1,177
5.	Rearing area required per smolt	46,209	2,588	1,294
6.	Rearing area required per smolt (20 m2/smolt)	64,215	3,596	1,798
7.	Smolts per area	25,686-38,529	1,438-2,158	719-1,079
8.	Numerical densities of age 0 steelhead from Warm Springs watershed and eastern Oregon rivers	35,427	1,984	992
9.	Numerical densities of age 1 steelhead from Warms Springs and eastern Oregon rivers	64,252	3,598	1,799

a/ Assumed no access above major barriers or above diversion dams on upper Badger, Clear, and Frog creeks. Assumed access to and use of Tygh Creek system above diversion dams on lower Tygh and Badger creeks. Survival figures used: 35% age 0 to age 1 (summer); 60% over winter; 2.8% smolt to spawning adult. Catch to escapement assumed to 1:l.

b/ Reduced by 20% to account for resident rainbow trout (Bjornn 1978).

c/ Estimated harvest: 50% of run harvested in fisheries in the Columbia and Deschutes rivers.

Table S-3. Estimated production of spring chinook in the White River system below barriers except where noted. a/

Method	Migrants	Adults: Run Size	Adults: Spawning Escapement c/
1. Smolt Productivity index (McIntyre 1983)- entire watershed	86,753	3,036	1.518
2. Comparison to Warm Springs Rirer - frainage area (entire watrshed) b/	53,471	2.220	1.110
3. Comparison to Warm Springs - September flow (entire watershed) b/	37,500	1,400	700
4. Comparison to Warm Springs - spawning gravel b/			
a. No restrictions on use	65,836	2,458	1,229
b. Limited use of lower Tygh, Passage at dams	58,350	2,178	1,089
C. No use of Tygh system	45,464	1.697	848
5. Use of spawning gravel based on Warm Springs data			
a. No restrictions on use	50,715	1.776	888
b. Limited use of lower Tygh	44,940	1.574	787
C. No use of Tygh	34.965	1.190	595
6. Rearing densities of Warm Springs			
a. No restrictions	42.743	1.496	748
b. No use of Tygh	33.980	1.224	612
7. Rearing densites of Warm Springs (for upper watershea, and densities of John Day (for lower watershed) - assumes use of Tygh	67,279	2.354	1.177

a/ Assumed no access above major barriers or above diversion dams on upper Badger and Clear creeks. Assumed no use of intermittent tributaries. Survival figures used: 3.5% egg to migrant; 1.75% migrant to spawning adult: 60% over winter. Catch to escapement assumed at 1:l.

b/ Estimated harvest: 50% of run harvested in fisheries in the Columbia and Descnutes rivers.

c/ Mean run sizes of Warm Springs River chinook were prorated using average runs of 75,000 migrants and 2.800 adults.

Summer Water Conditions

Low flows and high water temperatures in summer may limit anadromous fish production in 60 km of six tributaries in the lower White River basin. Natural low flow and peak irrigation demands occur simultaneously, resulting in low stream flow and contributing to high water temperatures.

Rehabilitation of riparian zones in 10 percent of the basin would reduce water temperatures and increase summer flows. Enhancement of fish habitat may increase fish production in some streams, but these measures are not critical to a successful introduction of salmon and steelhead.

RESIDENT FISH

Salmonids present in the White River basin above White River Falls include rainbow trout, Eastern brook trout, and mountain whitefish. Other species in the basin are sculpins, longnose dace, and largemouth bass.

Rainbow trout are widely distributed in the basin. Brook trout occur only in the upper reaches of Boulder, Barlow, Clear, and Frog creeks above White River Falls. Of the other species, only sculpins were widely distributed.

The genetic structure of rainbow trout from White River above the falls is significantly different from rainbow and steelhead trout in the Deschutes River. The rainbow trout from White River are also unique among trout populations east of the Cascades Range. The rainbow trout in White River exhibit little genetic variation and appear to have a high degree of genetic segregation. Based on samples from nine areas, three groups of rainbow trout were identified in the White River basin above the falls and they do not appear to have been influenced greatly by stocking of hatchery trout in the basin. Sanctuaries to protect these stocks from genetic impacts by introduced steelhead could be designated above existing barriers or by installing barriers. Protection of trout in these areas would not seriously reduce the potential production of salmon or steelhead.

Oak Springs Hatchery Contamination

The Oak Springs Hatchery and resident fish in the upper White River basin are currently free of IHN and IPN viruses. Protection of Oak Springs Hatchery from viral contamination is a major consideration in the White River Falls Fish Passage Project. Contamination could occur if viruses are introduced into Clear and Frog creeks because water from these creeks is diverted into the Clear Creek ditch which overflows into the hatchery water supply. This would be avoided by diverting water in the Clear Creek ditch away from the hatchery.

PASSAGE AT WHITE RIVER FALLS

DOWNSTREAM PASSAGE

In 1983 and 1984, ODFW conducted tests to estimate survival rates of juvenile salmonids passing over White River Falls.

Results of tests conducted during high flows (300 to 600 cfs) indicated juvenile steelhead had 100 percent survival and juvenile chinook averaged 90 percent survival after passage over White River Falls. Results from tests at low flows (100 to 300 cfs) indicated a 72 percent survival for juvenile chinook. Steelhead were not released at low flows.

UPSTREAM PASSAGE

In 1983, OTT evaluated 12 passage schemes for applicability, economic feasibility, construction design, and operation requirements. Of the 12 alternatives, four were selected by BPA, ODFW, USDA FS, and OTT for further study. The four alternatives that were designed by OTT included: (1) a fishway from the lower falls; (2) a fishway from the proposed powerhouse; (3) a trap and haul at the lower falls; and (4) a trap and haul at the proposed powerhouse.

The four alternatives are compared in Table S-4 and Figure S-3. Alternative 4 was selected by ODFW as the preferred adult passage alternative.

Alternative Selection

In Alternative 4, a fish trapping facility would be constructed adjacent to the powerhouse proposed by the Northern Wasco County People's Utility District (XWCPUD), downstream of the lower falls. A barrier dam would be constructed across the White River, slightly upstream of the powerhouse tailrace to direct fish toward the fishway entrances (Figure S-4). The barrier dam would have an 80-foot long, ogee-type spillway which would include a swimming barrier along its downstream face.

Fish would be directed into the trapping facility via a four-pool half Ice Harbor ladder. Two entrances would provide a flexible operation of the trap. Attraction and operation flow to both entrances would be gravity fed through a 36-inch pipe from an intake at the dam. Part of this flow would be distributed into the fishway through vertical vanes from the diffusion chamber. Flow would also be routed through branch pipes and valves to the holding pool, fish elevator pump, and fish elevation facilities as required.

The fish trap facility would have a capacity of 30 fish per loading cycle. Figure S-5 shows the details of the fish trap. Access to the loading chute by the tank truck would be across the lower powerhouse deck. The proposed transformer at NWCPUD'S powerhouse would have to be relocated to provide truck access to the loading chute.

The powerhouse access road would be used in hauling the fish upstream of the proposed diversion weir and intake structure. The minimum one-way haul distance to the river, just above the intake structure, is approximately l-1/2 miles. Fish could also be hauled further upstream.

TABLE S-4
MAJOR FEATURES OF PASSAGE ALTERNATIVES

Design Component Alternative	Passage Type	Facility Entrance	Location Exit	Fish Ladder Design	Trap Facility Design	Other Features
Alternative 1 Fishway From falls three	Fish Ladder	Base of falls three on north bank	Upstream of falls one, north bank	° 1880-ft long vertical slot fishway ° 24 pools, each 10'Lx6'W ° Avg. pool velocity - 1 fps ° Elevation change - 180 ft ° 50 to 70 cfs flow	Not Applicable	° Falls three natural barrier to direct migrants ° Folded ladder sections at 3 locations ° Pool depth: 4 to 6 ft
Alternative 2 Fishway From Proposed Powerhouse	Fish Ladder	Tailrace of proposed power-house on south bank	Upstream of falls one, at hydro diversion on north bank	° 3000-ft long vertical slot fishway ° Fish conduit in barrier dam ° Fish ladder like Alt. 1 ° Pool velocities 1 to 2 fps ° Elevation change - 187 ft ° ≤ 100 to 120 cfs flow	Not Applicable	° Barrier dam to direct migrants and house fish ladder crossing
Alternative 3 Trap and Haul from falls three	Trap & Haul	Base of falls three on north bank	Hauled upstream minimum 1 mile	° Fishway with half Ice Harbor baffles to trap facility ° 32 pools in fish ladder, each 10'Lx6'W ° Elevation change - 33 ft ° 50 cfs flow	° Located 32 ft above entrance ° V-trap & holding pool with aeration flow ° Fish crowder & elevator winches to loading chute & truck	° Falls three natural barrier to migrants ° Ladder leads fish to trap facility ° New road to haul fish upstream
The Preferred Alternative 4 Trap & Haul From Proposed Powerhouse	Trap & Haul	Tailrace of proposed powerhouse	Hauled upstream minimum 1 1/2 mi	° Fishway from entrances (2) to facility with half Ice Harbor baffles ° 4 pools ° Fish trap facility like Alt. 3 ° 100 cfs flow	° Fish entrances upstream of tailrace and down-stream of barrier dam ° Facilities adjacent to proposed powerhouse ° Components and opera-tion of trap like Alt. 3	° Barrier dam to direct migrants ° Truck access to facility by proposed powerhouse road

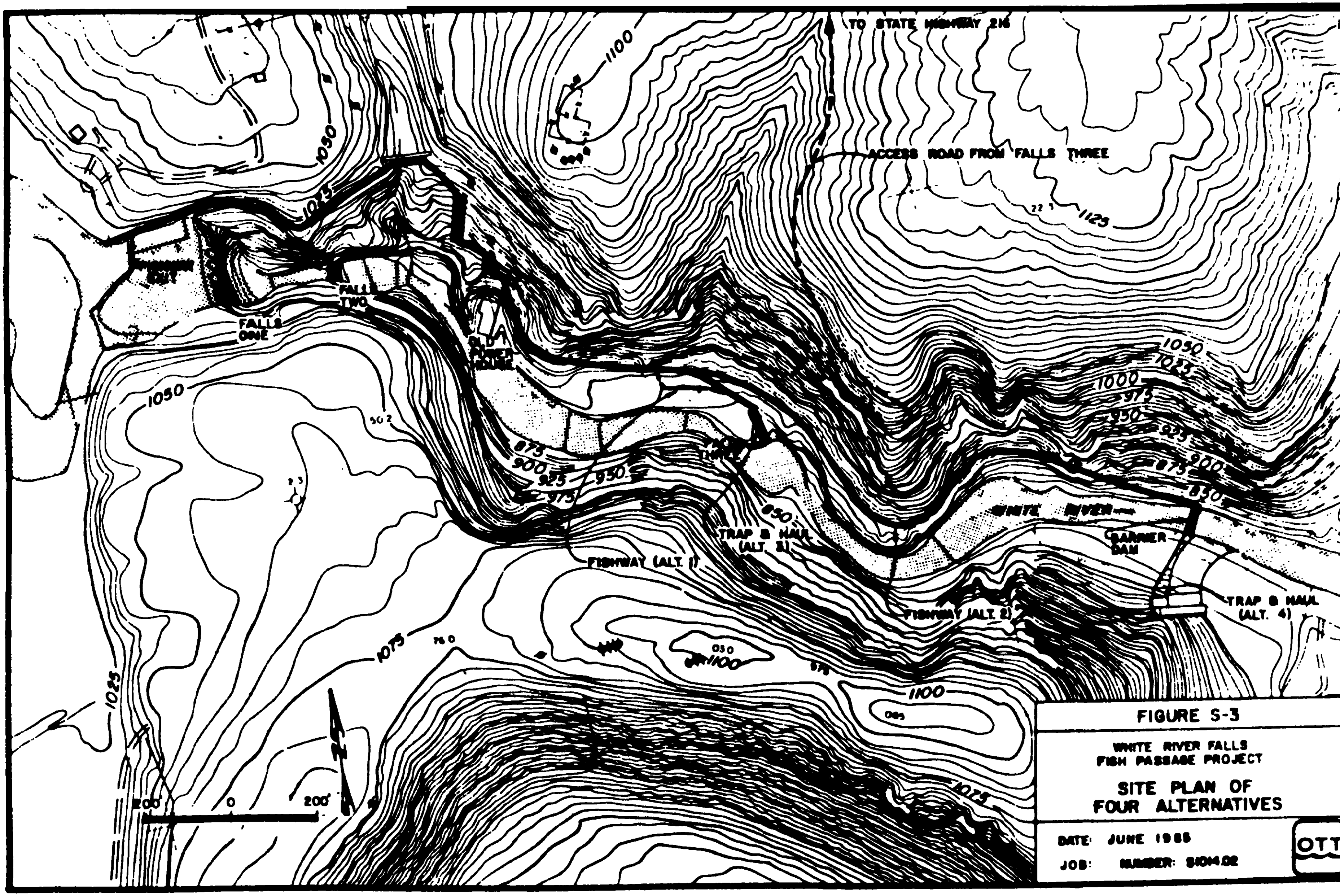

FIGURE S-3

WHITE RIVER FALLS
FISH PASSAGE PROJECT

SITE PLAN OF
FOUR ALTERNATIVES

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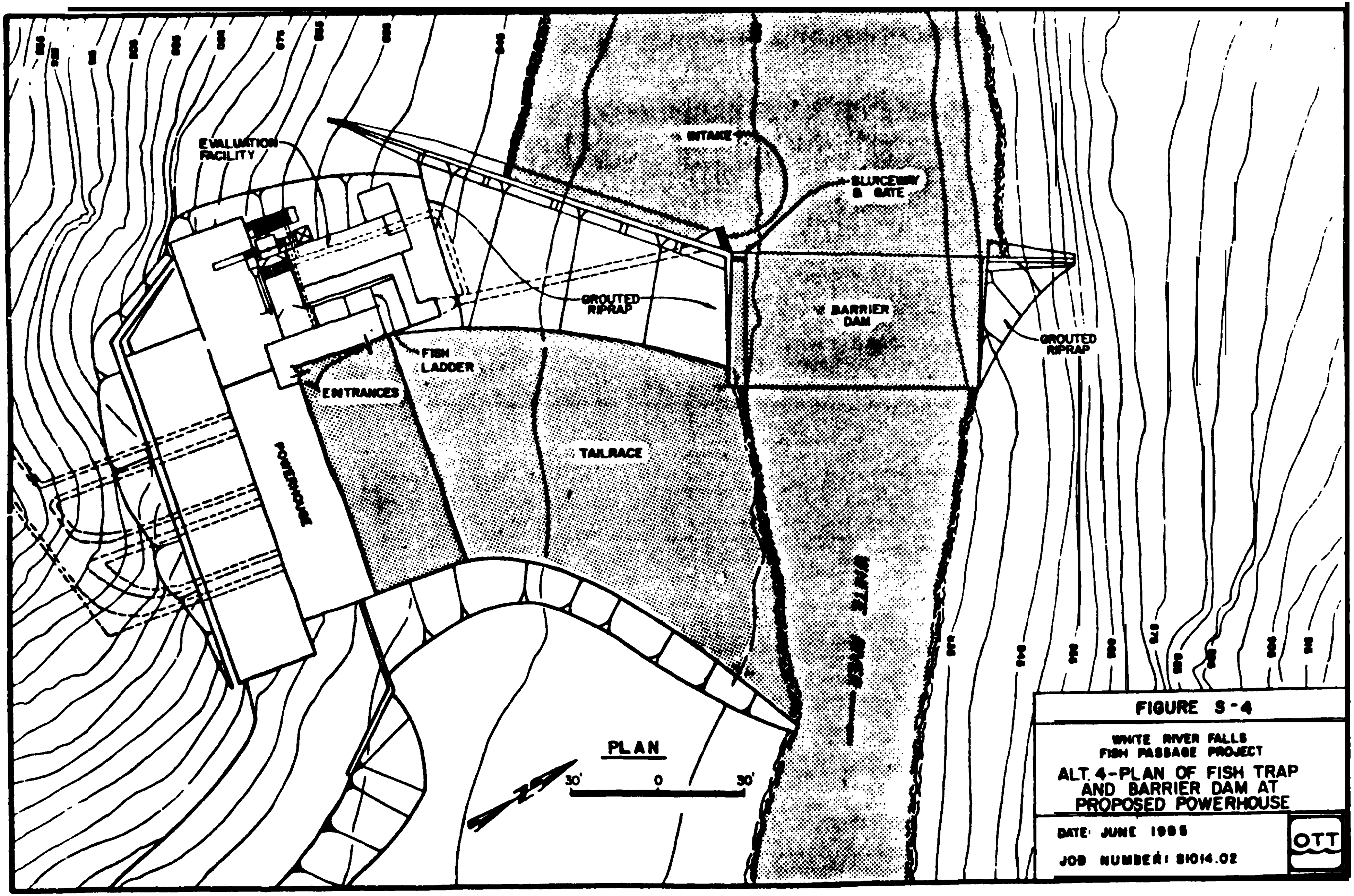

FIGURE S-4

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. 4-PLAN OF FISH TRAP AND BARRIER DAM AT PROPOSED POWERHOUSE

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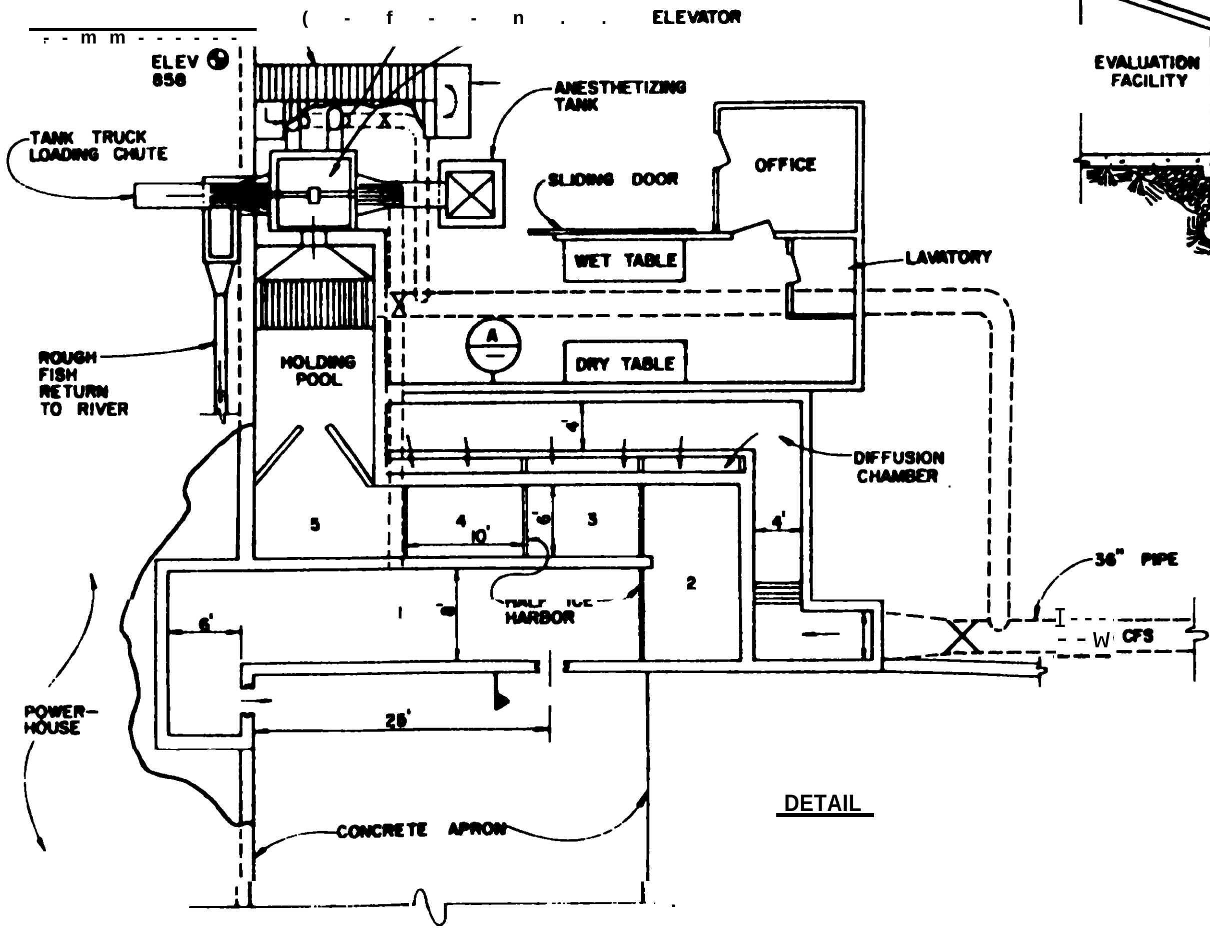

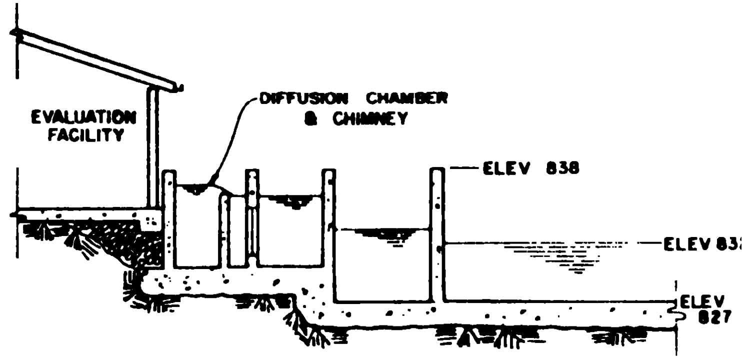

SECTION A

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FIGURE S -5

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. 4 -DETAILS OF FISH TRAP
AT PROPOSED POWERHOUSE

DATE: JUNE 1985

JOB NUMBER: S1014.02

OTT

Fish evaluation facilities, if included, would be located adjacent to the fish trap holding tank as shown in Figure S-5. Electrical power to run the trap facility is available through NWCPUD'S distribution system.

Cost Estimates

Based on a 50-year project life and BPA 3 percent discount rate, a present value analysis was performed. Capital costs, annual costs, and replacement costs were estimated for each of the final alternatives (Table S-S). Total capital costs include construction-related labor, materials, and design services.

Annual costs were based upon labor and maintenance requirements. The trap and haul alternatives (Alternatives 3 and 4) require, one full-time employee to maintain and operate the trapping facilities, and to haul the fish over the 6-month period of upstream migration. The fish ladder alternatives require one half-time employee for regular facility maintenance. Additional power costs and repairs are included. Replacement costs for the trap and haul alternatives were estimated for various equipment items including trucks, pumps, and winches. Other costs include construction and maintenance of irrigation ditch screens and fish rearing for initial introductions.

The alternatives are listed in order of decreasing costs of the total project.

Alternative 2 - $5,987,000
Alternative 1 - $4,715,000
Alternative 4 - $4,296,000
Alternative 3 - $4,048,000

In summary, the fish ladder alternatives (1 & 2) had an estimated cost difference of $1.3 million while the trap and haul alternatives (3 & 4) differed by $0.2 million. The conceptual alternatives which included hydropower development (2 & 4) were more costly than their counterpart alternatives without ‘hydropower considerations.

TABLE S-5

Estimated Capital, Annual, and Replacement Costs for Project Alternatives
(1984 Dollars)

	Cost (Thousand $) By Alternative			
	#1	#2	#3	#4
Capital Cost	$4,200	$5,395	$2,724	$2,983
Annual Cost	20	23	48	48
Replacement Cost	0	0	Refer to Chapter III, Volume 1	
Total Project Cost	$4,715	$5,987	$4,048	$4,296

BENEFIT/COST ANALYSIS

Benefits of passing spring chinook and summer steelhead over White River Falls were determined by combining the estimated production of these fish in White River with the most recent monetary values for these fish. The analysis of benefits incorporated the most reasonable assumptions reflecting a consensus of biologists from Federal agencies, state agencies, and the private sector biologists.

It was determined that at full capacity (with only minor enhancement) the White River watershed could produce harvestable runs of about 963 adult spring chinook and about 1,400 adult steelhead. Since all harvested steelhead are taken in a single fishery, the sport fishery, a single value could be placed on each unit of the catch. Spring chinook, however, are divided among three fisheries: the sport fishery, the commercial fishery, and the Indian ceremonial fishery. Therefore, monetary values had to be assigned to all three segments of the harvest. Monetary values for the respective summer steelhead and spring chinook fisheries are given below:

Species	Net Economic Value
Summer steelhead	$144.00
Spring chinook (sport-caught)	143.00
Spring chinook (commercial)	34.80
Spring chinook (Indian ceremonial)	34.80

In the computation of project benefits, certain assumptions were applied:

(1) Full capacity excludes major passage modifications upstream of White River Falls.

(2) At full capacity, the White River basin could be expected to produce 963 harvestable spring chinook salmon with 55 percent harvested in the sport fishery and 45 percent harvested in the combined commercial and Indian ceremonial fisheries.

(3) At full capacity, the basin could be expected to produce 1,400 harvestable summer steelhead, all taken in the sport fishery.

(4) A 1:l catch-to-escapement ratio is estimated for both target species.

(5) A gradual increase in realized benefits (harvested adult fish) would be expected over time with full benefit from year 3 to year 11 for spring chinook and from year 3 to year 8 for summer steelhead.

(6) A project life of 50 years was used.

(7) A discount rate of 3 percent was used.

(8) Standard compound interest formulas were employed and took into account the rate of growth of benefits to full capacity and a year 3 time frame for realization of first benefit.

The aggregate project benefits are compared to total project costs for each of the four project alternatives in Table S-6.

IMPACTS ON HYDROPOWER DEVELOPMENT

THE NWCPUD has submitted to the Federal Energy Regulatory Commission a license application for redevelopment of hydropower at White River Falls. The powerhouse would be situated approximately 4500 m downstream of the lower falls.

Selection of a suitable fish passage alternative requires the consideration of the proposed hydropower project. Alternative 4 would be well suited to the hydropower project . Alternatives 1 and 2 would require the hydropower project to bypass additional flows to effectively operate the fish ladders. Subsequently, the power production would be decreased. Alternatives 3 and 4 would not require bypass flows in excess of the minimum instream flow requirement.

ODFW RECOMMENDATIONS

The cooperating agencies (ODFW, USDA FS, and Confederated Tribes of the Warm Springs Indians) have been involved in the direction and recommendation of the White River Falls Fish Passage Project.

The following recommendations have been proposed by ODFW:

(1) Hold several public meetings to review results of the project and to answer questions about the project.

(2) Use indigenous stocks of spring chinook and summer steelhead stocks from the Deschutes and the Warm Spring rivers for introduction in the White River basin.

Table S-6. Summary of total project costs for all four project alternatives, project benefits, and benefit/cost ratios.

Alternative	Total Project Cost	Project Benefit	Benefit/Cost
1. Fishway from falls three	$4,715,000	$6,091,000	1.29
2. Fishway from powerhouse	5,987,000	6,091,000	1.02
3. Fish trap at falls three	4,048,000	6,091,000	1.50
4. Preferred alternative: fish trap at powerhouse	4,296,000	6,091,000	1.42

Results of tests conducted during high flows (300 to 600 cfs) indicated juvenile steelhead had 100 percent survival and juvenile chinook averaged 90 percent survival after passage over White River Falls. Results from tests at low flows (100 to 300 cfs) indicated a 72 percent survival for juvenile chinook Steelhead were not released at low flows.

UPSTREAM PASSAGE

In 1983, OTT evaluated 12 passage schemes for applicability, economic feasibility, construction design, and operation requirements. Of the 12 alternatives, four were selected by BPA, ODFW, USDA FS, and OTT for further study. The four alternatives that were designed by OTT included: (1) a fishway from the lower falls; (2) a fishway from the proposed powerhouse; (3) a trap and haul at the lower falls; and (4) a trap and haul at the proposed powerhouse.

The four alternatives are compared in Table S-4 and Figure S-3. Alternative 4 was selected by ODFw as the preferred adult passage alternative.

Alternative Selection

In Alternative 4, a fish trapping facility would be constructed adjacent to the powerhouse proposed by the Northern Wasco County People's Utility District (NWCPUD),Downstream of the lower falls. A barrier dam would be constructed across the White River, slightly upstream of the powerhouse tailrace to direct fish toward the fishway entrances (Figure S-4). The barrier dam would have an 80-foot long, ogee-type spillway which would include a swimming tarrier along its downstream face.

Fish would be directed into the trapping facility via a four-pool half Ice Harbor ladder. Two entrances would provide a flexible operation of the trap. Attraction and operation flow to both entrances would be gravity fed through a 36-inch pipe from an intake at the dam. Part of this flow would be distributed into the fishway through verical vanes from the diffusion chamber. Flow would also be routed through branch pipes and valves to the holding pool, fish elevator pump, and fish elevation facilities as required.

The fish trap facility would have a capacity of 30 fish per loading cycle. Figure S-S shows the details of the fish trap. Access to the ioading chute by the tank truck would be across the lower powerhouse deck. The proposed transformer at NWCPUD'S powerhouse would have to be relocated to provide truck access to the loading chute.

The powerhouse access road would be used in hauling the fish upstream of the proposed diversion weir and intake structure. The minimum one-way haul distance to the river, just above the intake structure, is approximately l-1/2 miles. Fish could also be hauled further upstream.

(3) Divert Clear Creek ditch flows from Oak Springs hatchery to prevent possible contamination of the hatchery with diseases from introduced salmon and steelhead.

(4) The preferred alternative for passage of adult salmon and steelhead at White River Falls is a trap and haul facility located at the proposed powerhouse.

(5) Continue to consider passage Alternatives to a free-fali passage for juvenile migrants over the falls. Will depend on the timing of juvenile outmigrants and on the distribution of migrants in the river channel above the falls.

(6) Wild trout management areas should be designated in tributaries of the basin prior to the introduction of anadromous fish. The native trout could be protected above existing barriers to upstream migration and by constructing new barriers. The areas should provide enough protection to maintain viable populations of native trout.

(7) Screen 18 irrigation ditches in the basin to protect juvenile migrants of salmon and steelhead. Screen design and construction should not affect water use. Provide passage at diversion dams in lower Tygh and Badger creeks to ensure access to these highly productive streams. Methods for providing access to the creeks will depend on the timing of the adult run. Construction of screens, maintenance of screens, and modifications to diversion dams are included as costs of the project.

(8) Develop guidelines for fish habitat enhancement in the basin. Enhancement measures are not critical to the successful introduction of salmon and steelhead.

INTRODUCTION

Runs of salmon and steelhead in the Columbia River basin in Oregon have been reduced largely because of Columbia River dams since the construction of Bonneville Dam in 1932. With the passage of the Pacific Northwest Electric Power Planning and Conservation Act (Pacific Northwest Power Act) of 1980, the Sorthwest Power Planning Council adopted the Columbia River Basin Fish and Wildlife Program in 1982. The Fish and Wildlife Program includes measures to enhance anadromous fish runs in the Columbia basin to mitigate for losses at Columbia River dams. The White River Falls Fish Passage Project is included in Section 704(d)(l) of the 1984 Fish and Wildlife Program. The project is an enhancement measure that would provide passage for anadromous fish over White River Falls (the tails) which is located 3.4 km above the confluence of the White and Deschutes rivers. Access above the falis would open approsimately 262 km (164 mi) of stream habitat for anadromous salmonids; 60 km (37 mi) of additional habitat would require major improvements for access. Development of runs of salmon and steelhead in White River would enhance sport and Indian fisheries in the Deschutes River and compensate, in part, for the unmitigated losses in the Columbia River.

The potential to increase anadromous fish production in the Deschutes River basin by introduction of anadromous fish into the White River watershed has been discussed for many years. In a report on the Deschutes River basin published in 1961 by the Oregon Water Resources Division, the Oregon Department of Fish and Wildlife (ODFW) identified the basin as having a high potential to produce anadromous fish. In a 1974 appraisal report the U.S. Department of Interior (LSDI) Bureau of Reclamation concluded that up to 8,600 summer steelhead, 4,660 spring chinook, and 1,400 fall chinook could be supported by the White River watershed. These estimates assumed that extensive water projects would be built in the watershed. These estimates are now considered optimistic. Estimates contained in original recommendations of fisheries agencies and Tribes to the Northwest Power Planning Council indicated that from 500 to 1,600 steelhead trout and 400 chinook saimon could be produced in the White River watershed if passage over the falls were provided. These estimates were derived from a USDI Bureau of Reclamation appraisal report (1981) on the lower Deschutes River basin and appear to be conservative.

When this study began it was obvious that passage of anadromous fish over White River Falls would involve a large capital outlay. It was equally obvious that the potential for enhancement of anadromous fish in the region by providing passage at White River Falls was poorly understood,

In 1985, a 2-year study of the feasibility of developing runs of anadromous salmonids in the White River basin was completed. The study was funded by the Eonneville Power Administration (BPA) and was conducted cooperatively by Oregon Department of Fish and Wildlife (ODFW), Ott Water Engineers, Inc. (OTT), and the United States Department of Agriculture, Forest Service, Mt. Hood National Forest (USDA FS).

PROJECT GOAL AND OBJECTIVES

The goal of the White River Falls Fish Passage Project is to develop runs of anadromous fish in the White River basin. The project is divided into two phases. Phase I is a 2-year feasibility study completed in 1985 and Phase II is the introduction and evaluation of anadromous fish pending favorable review of Phase I. Only Phase I is discussed in this report.

Phase I studies included three objectives:

Objective 1. Determine which species and stocks would best utilize the habitat and estimate the number of anadromous fish that White River will support.

Studies were conducted to describe current habitat conditions in the White River basin above White River Falls and to evaluate the potential to produce anadromous fish. The USDA FS and ODFW jointly conducted an inventory of spawning and rearing habitats, irrigation diversions, and enhancement opportunities for anadromous fish in the White River drainage in 1983 and 1384. In 1484, ODFW recommended anadromous stocks and species for introduction and estimated the number of anadromous fish White River could support.

Objective 2. Evaluate aduit and juvenile passage problems in White River.

Survival of juvenile fish at White River Falls was estimated by releasing juvenile chinook and steelhead above the falls during high and low flow periods and recapturing them below the falls in 1983 and 1984. Four alternatives to provide upstream passage for adult salmon and steelhead were developed to a predesign level by OTT with recommendations from ODFW. The cost of adult passage and the estimated run size of anadromous fish were used to determine the benefit/cost ratio of the preferred alternative.

Objective 3. Estimate potential impacts on resident fish which may occur from the introduciton of anadromous fish.

Possible effects of the introduction of anadromous fish on resident fish and on nearby Oak Springs Hatchery were evaluated. This included an inventory of resident species, a genetic study of native rainbow, and the identification of fish diseases in the basin.

REPORT ORGANIZATION

Phase I, the feasibility study, is provided in three volumes, entitled White River Falls Fish Passage Project. Volume I presents the project summary, a basin description, a discussion of the potential production of anadromous fish, a discussion of the passage alternatives for fish at White River Falls, and project recommendations.

Volumes II and III are bound separately and contain appendices of habitat survey data, potential production, and fish population data, upstream passage designs, and benefit/cost calculations.

COORDINATION

EPA prepared three separatecontracts with ODFW, USDA FS, and OTT to independently but cooperatively prepare specific sections of the feasibility study.

The feasibility study was conducted in consultation with the Bureau of Land Management (BLM) , the Confederated Tribes of the Warm Springs Indians, Norhtern Wasco County People's Utility District (NWCPUD), and private landowners.

CHAPTER I

WHITE RIVER BASIN DESCRIPTION

STUDY AREA

White River drainage is located in north-central Oregon and is bounded on the east by the Deschutes River, on the west by the Cascade Range, on the north by Hood River and Fifteenmile Creek, and on the south by the Warm Springs River (Figure 1). The mainstem of White River heads on the southeastern slopes of Mt. Hood in White River Glacier and flows 80 km east to its confluence with the Deschutes River, 4 km above Sherars Falls. White River comprises 50 percent of the stream surface area in White River basin and is the only stream affected by glacial flow. The mainstem of White River seasonally carries a heavy load of silt because of its glacial source.

White River is the second largest tributary in the lower 161 km of the Deschutes River with a drainage area of 1,080 km^2. Access for anadromous fish to White River is blocked by White River Falls, a series of three natural waterfalls located 3.4 km upstream from the mouth. The two upper falls lie within 92 m of each other and have a total drop of approximately 43 m (Figure 2), The lower falls is approximately 338 m downstream of the middle falls and has a drop of approximately 4.6 m (Figure 2). The total drop between the headwater of the upper falls and the tailwater of the lower falls is approximately 55 m.

LAND USE

The White River basin is a mixture of public and private lands. The USDA FS, ODFW, and BLM administer the public lands (Figure 3) which constitutes approximately 75 percent of the basin.

Land use within the White River basin mainly consists of agriculture, timber production, and recreation. Present agriculture in the basin is centered on production of livestock, hay, and dryland and irrigated grains. Irrigated land provides important pasture and winter feed for livestock. Cattle are grazed on major segments of public and private lands.

Water for irrigation is important in the agricultural use of lands within White River basin and most of the water used for irrigation is from tributaries of White River. The principal irrigated lands are Juniper Flat (south of White River), Tygh Valley, and the Wamic-Smock Prairie area which includes part of the White River Wildlife Management Area (ODFW).

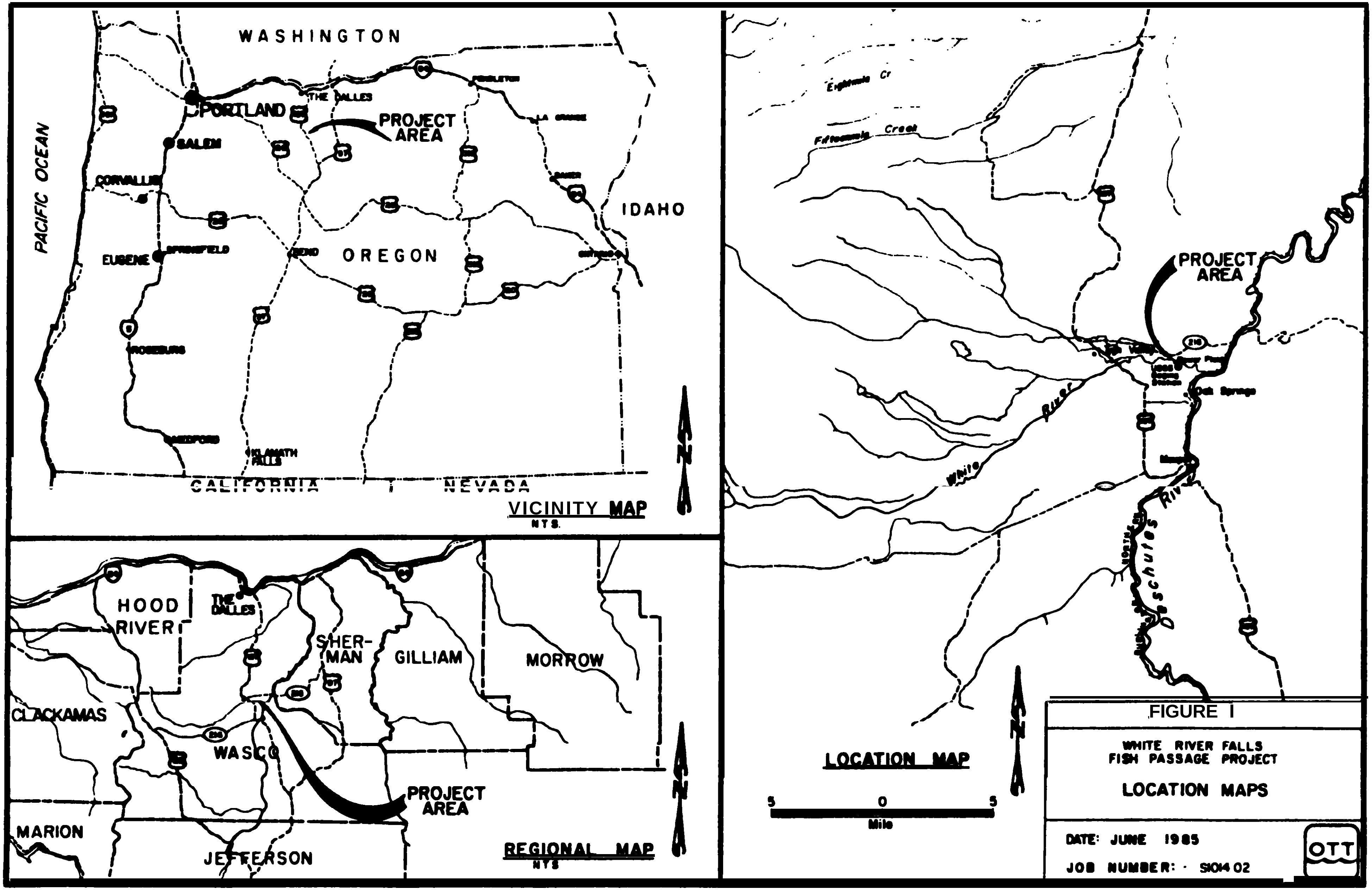

FIGURE I

WHITE RIVER FALLS FISH PASSAGE PROJECT

LOCATION MAPS

DATE: JUNE 1985

JOB NUMBER: S1014.02

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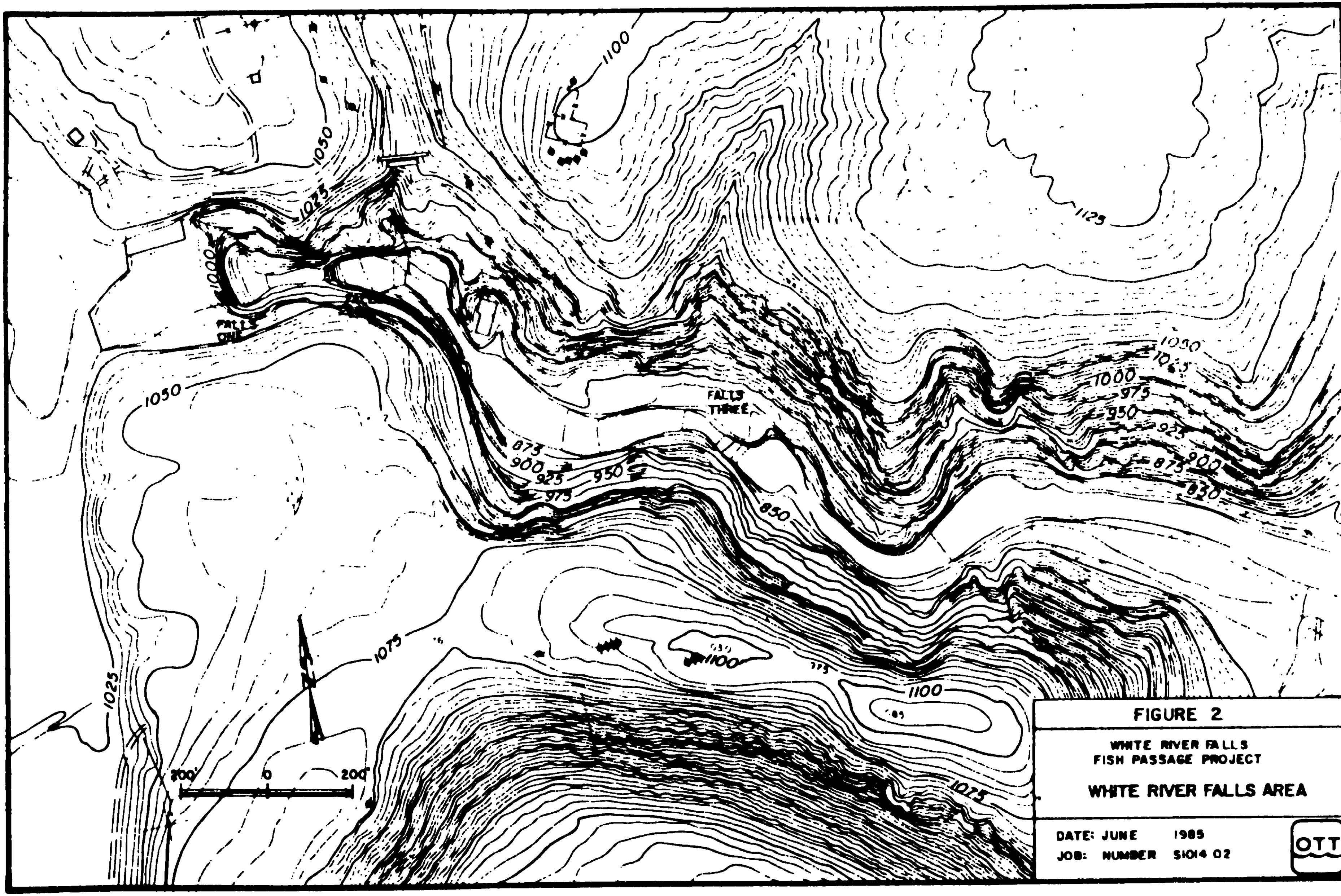

FIGURE 2

WHITE RIVER FALLS
FISH PASSAGE PROJECT

WHITE RIVER FALLS AREA

DATE: JUNE 1985
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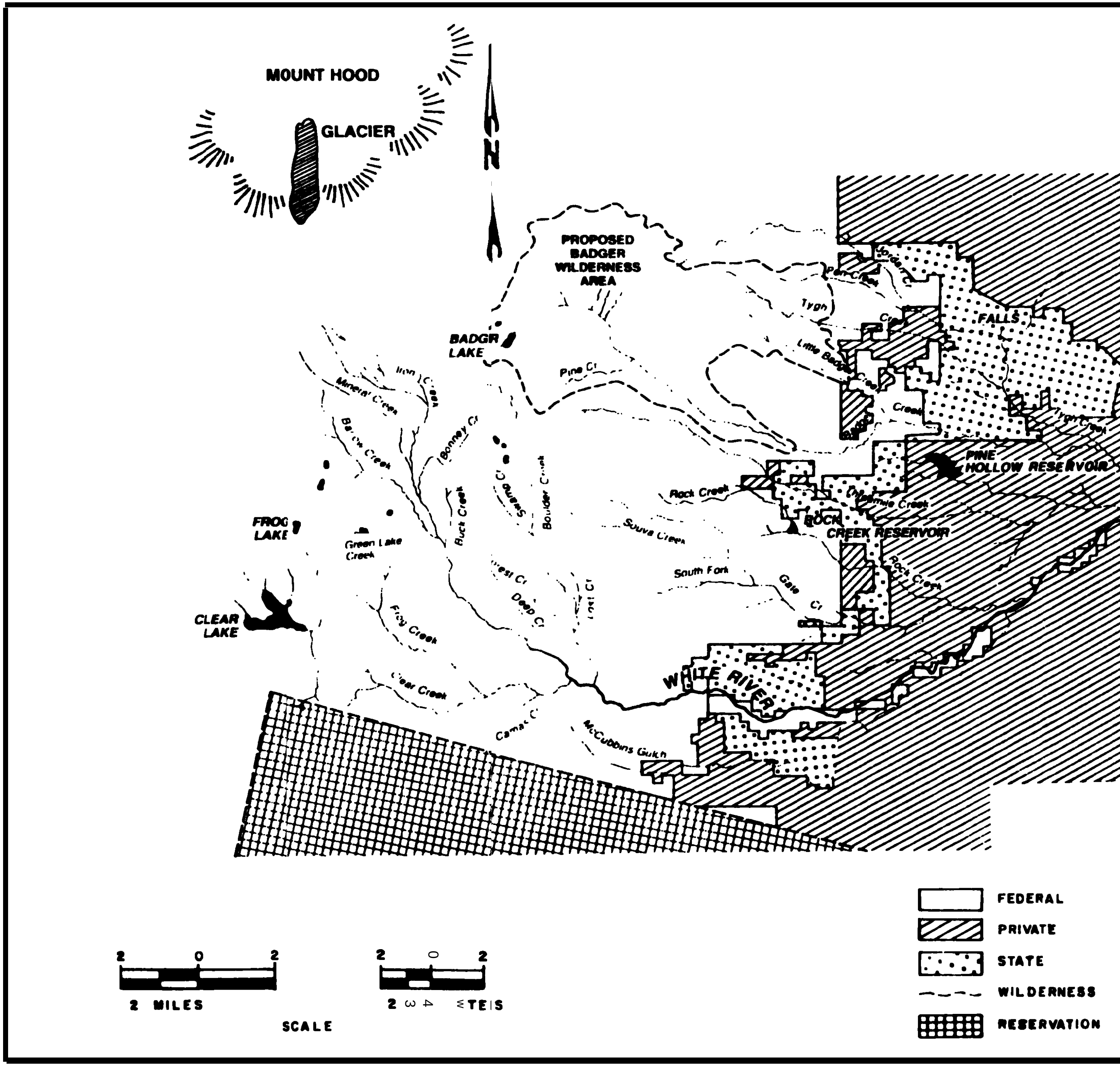

FIGURE 3

WHITE RIVER FALLS
FISH PASSAGE PROJECT

LAND OWNERSHIP IN THE
WHITE RIVER BASIN

DATE JUNE 1985

The White River Management Area (approximately 28,000 acres) is managed primarily as winter range for deer and elk. Yanagement of the area includes irrigation of 800 acres of pasture and farming of 700 acres in summer fallow grain. Other management practices include livestock grazing, controlled burning, winter feeding, rangeland seeding, and timber management.

The White River drains portions of both Bear Springs and Barlow Ranger Districts of the Mt. Hood Sational Forest. The dominant land use of the area is timber management. Other principal uses include recreation, grazing, and fish and wildlife management. The newly created 24,000 acre Badger Creek Wilderness Area is also in the White River basin. The Mt. Hood National Forest's Plan, currently being drafted, will make some further land use designations and establish standards and guidelines for management.

Introduction of anadromous fish into White River probably will not change land management practices to a great degree. The introduction of anadromous fish may result in increased emphasis on protection of riparian areas and water quality, particularly on public lands. It may also result in accelerated efforts within the basin to restore riparian vegetation, stabilize streambanks, and rehabilitate damaged fish habitat.

CHAPTER II

FISHERIES

Two important objectives of the feasibility study were: (1) to select the species and stocks of anadromous fish for introduction into White River basin and to estimate the number of fish the basin will support; and (2) to estimate the potential impacts of an introduction of anadromous fish on resident fish. The amounts of stream habitat accessible to anadromous fish above the main falls, the locations of irrigation diversions, and the effects of glacial silt on the spawning and rearing potential of the mainstem provided baseline data to complete the first objective. The first objective also included estimates of the number of steelhead and salmon the basin could support that were based on resident trout and fish habitat data in the basin. Opportunities to enhance the potential production of anadromous fish were also identified in the basin under the first objective. For the second objective, data on species composition, distribution, abundance, and diseases of resident fish in White River basin were collected to estimate potential impacts of an anadromous fish introduction on resident fish and on Oak Springs Hatchery.

SPECIES/STOCK SELECTION

Spring chinook and summer steelhead are the best species that would most fully utilize the habitat in the White River basin. These species are indigenous to the Deschutes and Warm Springs rivers as well as to other streams in the Columbia River basin above The Dalles Dam.

Deschutes River stocks would be the best choice for introduction. Steelhead and salmon from local stocks are generally more adaptable to habitat conditions in neighboring basins and would probably have better survival than fish from other stocks (McIntyre 1983a). Advantages in survival of fish from local stocks include disease resistance; optimum age, size, and migration timing of juveniles; and optimum migration timing of the adult runs. In addition, various statutes and policies have been adopted in Oregon to guide stock transfers that give priority to local stocks. The availability of stocks and species for introduction was also considered. Surplus fish from Round Butte Hatchery (ODFW) and Warm Springs National Fish Hatchery (U.S. Fish and Wildlife Service) may be available for use in White River.

Although a few areas in White River may have potential for fall chinook, it is questionable whether they would use White River because there is no documented use of the adjacent Warm Springs River by the Deschutes run of fall chinook. Although this potential should be investigated in the future, fall chinook should not be used at this time to establish project benefits.

Areas in the White River basin may also have potential for coho and sockeye salmon but introduction of these species was not considered because they are not native to the Deschutes River basin. Coho salmon would likely use the same habitat as chinook which would result in a reduction in the production of spring chinook, the preferred species. The potential for sockeye salmon in the basin is very limited.

POTENTIAL PRODUCTION

One of the main objectives of the feasibility study was to estimate the number of anadromous fish the White River basin could support (the potential production of the basin). The data required to estimate the production were gathered in a habitat inventory of streams in the basin, a study of the effects of glacial silt, and in measurements of stream habitat and resident trout abundance.

Stream Inventory

Streams in the White River basin were surveyed and sampled in 1983 and 1984 by fisheries personnel from USDA FS and ODFW (see Volumes II and III). Data from 1983 stream surveys were supplemented with a previous survey by BLM (1980) to stratify streams into reaches of similar habitat (Figure 4). Habitat and fish populations in these stream reaches were sampled in 1984 by ODFW. Other data collected during the stream inventory were an estimate of accessible habitat for anadromous fish, the locations of irrigation diversions, identification of opportunities for enhancing fish habitat, and measurements of water temperatures and stream flows. In general, the data gathered in the stream inventory were used as baseline data to estimate potential production of anadromous fish.

The White River basin has 322 km of streams that have some potential to support anadromous fish (Table 1, Figure 5). Stream surface area, pool area, and pool volume were measured in all streams (Tables 2-5). USDA FS and ODFW also identified and estimated the area of spawning gravel in the basin that appeared suitable for use by anadromous fish (Tables 2-5).

The use of some streams by steelhead and salmon would be limited by upstream passage and summer water conditions. Of the 322 km of stream habitat that were surveyed in the basin above White River Falls, 89 km were considered to be easily accessible at low flows (Tables 1 and 3, Figure 5). An additional 173 km of habitat would be accessible at high flows but upstream passage during low flows might require work to minor barriers (Tables 1 and 4, Figure 5). Access to an additional 60 km of streams could be provided at major barriers. However, because of limited benefits and high costs these projects would be low priority (Tables 1 and 5, Figure 5). Streams above major barriers were also recommended as sanctuaries for native rainbow trout.

Fish habitat quality in White River basin is generally fair to good. The basin can be divided into three areas based on habitat conditions. These are: (1) mainstem White River; (2) the upper basin tributaries (streams entering White River above km 28.0); and (3) the lower basin tributaries (those entering below km 28.0). The mainstem of White River, which comprises 44 percent of the flowing water, is the only stream affected by glacial silt. The glacial silt reduces the quality of spawning gravel for anadromous fish in the upper half of the mainstem (see the Glacial Silt section for a more thorough discussion of glacial silt effects). The impacts of glacial silt is probably offset by the availability of spawning gravel in the clear water tributaries of the upper basin.

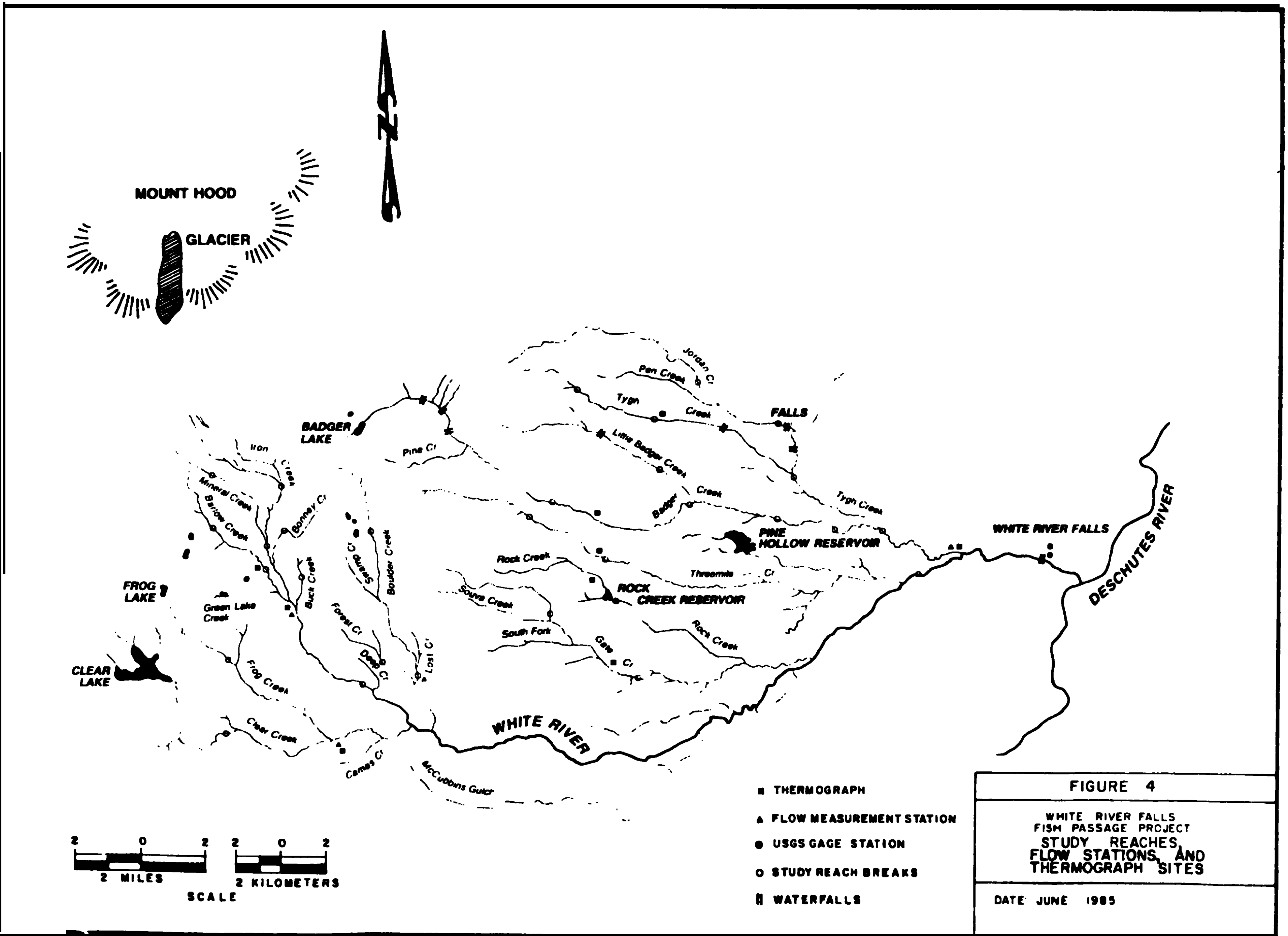

FIGURE 4

WHITE RIVER FALLS
FISH PASSAGE PROJECT
STUDY REACHES, FLOW STATIONS, AND THERMOGRAPH SITES

DATE: JUNE 1985

Table 1. Stream habitat presently accessible and accessible with passage enhancement in the White River basin above White River Falls.

Stream	Accessible a/	Passage Enhancement b/ Minor c/	Major d/	Total Habitat
White River	50.9	14.7	0	65.6
tygh	4.5	15.7	8.6 e/	28.8
Jordan	0	1.4	20.5 e/	21.9
Badger	0	30.2	10.7 e/	40.9
Little Badger	0	9.1	2.9	12.0
Threemile	0	23.8	0	23.8
Rock	13.3	0	9.6 e/	22.9
Gate	13.1	7.5	0	20.6
So. Fork Gate	3.4	0	0	3.4
McCubbins Gulch	0	0	7.7	7.7
Bouider	1.6	16.0	0	17.6
Forest	0	2.6	0	2.6
Clear	2.2	16.6	0	18.8
Frog	0	12.5	0	12.5
Barlow	0	10.2	0	10.2
Buck	0	1.6	0	1.6
Bonney	0	1.1	0	1.1
Iron	0	4.3	0	4.3
Alpine	0	0.6	0	0.6
Mineral	0	4.9	0	4.9
Total	89.0 (56 mi)	172.8 (108 mi)	60.0 (37 mi)	321.8 km (201 mi)

a/ Kilometers of habitat presently accessible above White River Falls.
b/ Additional kilometers of habitat with passage at minor and major barriers.
c/ Removal or alteration of all relatively minor obstructions (generally requiring low investment) such as Log jams, small falls (0.3-1.8 m) and low head irrigation diversion structures, up to the first major barrier.
d/ Removal or alteration of all remaining migration barriers, including major project sites likely requiring a relatively high level of planning and investment.
e/ Recommended as sanctuaries for native rainbow trout.

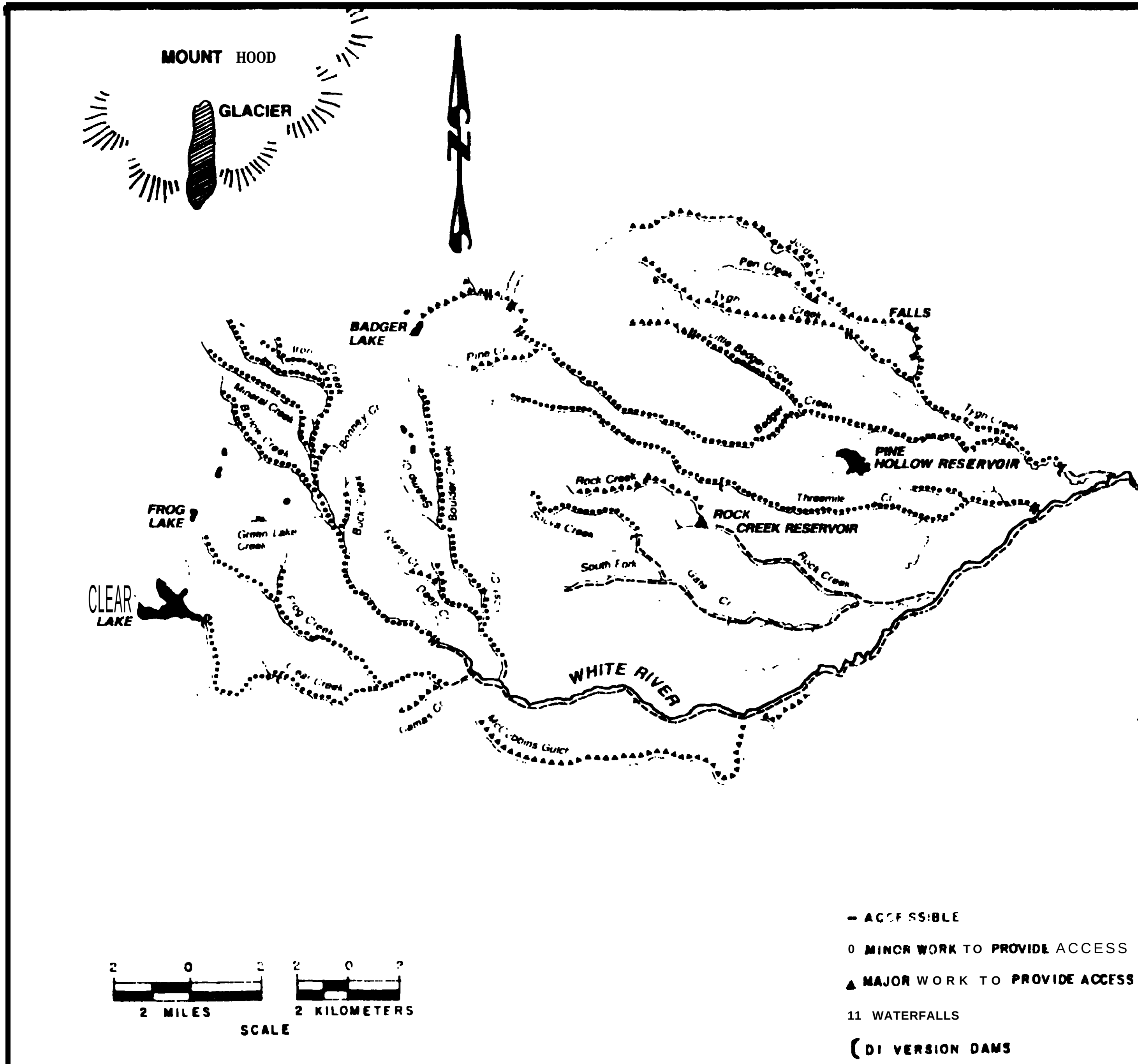

FIGURE 5

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ACCESSIBLE STREAM HABITAT & PASSAGE ENHANCEMENT LEVELS

DATE JUNE 1985

Table 2. Total stream habitat with potential for anadromous fish in the White River basin above White River Falls.

Stream	Length		Surface area	Pool area	Pool volume	Spawning area
White River	41.0 mi.	65.6 km	900,301 m2	394,285 m2	170,444 m3	14,045 m2
Tygh	18.0 mi.	28.8 km	148,152 m2	77,878 m2	16,525 m3	5,575 m2
Jordon	13.7 mi.	21.9 km	81,647 m2	36,834 m2	11,013 m3	1.409 m2
Badger	25.6 mi.	40.9 km	234,705 m2	75,819 m2	20,370 m3	2,288 m2
Little Badger	7.5 mi.	12.0 km	31,472 m2	13,084 m2	1,759 m3	293 m2
Threemile	14.9 mi.	23.8 km	65,751 m2	35,493 m2	12,846 m3	1,626 m2
Rock	14.3 mi.	22.9 km	58,691 m2	33,968 m2	5,806 m3	369 m2
Gate	12.9 mi.	20.6 km	52,889 m2	42,270 m2	6,038 m3	855 m2
S. Fork Gate	2.1 mi	3.4 km	5,257 m2	3,415 m2	342 m3	74 m2
McCubbins Gulch	4.8 mi	7.7 km	25,486 m2	1,112 mt	305 m3	94 m2
Boulder	11.0 mi.	17.6 km	73,668 m2	45.578 m2	17,325 m3	2,495 m2
Forest	1.6 mi.	2.6 km	5,452 m2	3,023 m2	363 m3	96 m2
Clear	11.8 mi.	18.8 km	168.830 m2	111,810 m2	39,366 m3	1,455 m2
Frog	7.8 mi.	12.5 km	94,976 m2	75,475 m2	15,542 m3	295 m2
Barlow	6.4 mi.	10.2 km	39,605 m2	20,933 m2	4,311 m3	797 m2
Buck	1.0 mi.	1.6 km	9,070 m2	3,017 m2	392 m3	161 m2
Bonney	0.7 mi.	1.1 km	5,087 m2	2,153 m2	280 m3	92 m2
Iron	2.7 mi.	4.3 km	12,361 m2	4,079 m2	1,344 m3	49 m2
Alpine	0.4 mi.	0.6 km	1,280 m2	552 m2	194 m3	25 m2
Mineral	3.1 mi.	4.9 km	15,203 m2	3.041 m2	1,655 m3	14 m2
TOTAL	201.3 mi.	321.8 km	2,029,883 m2	983,819 m2	326,220 m3	32,107 m2

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Table 3. Accessible habitat in the White River basin with no passage enhancement above White River Falls.

Stream	Length (km)	Total Area (m2)	Pool Area (m^2)	Pool Volume (m3)	Spawning area (m^2)
White River	50.9	760,609	373,031	163,902	13,884
Tygh	4.5	39,044	46,441	6,814	1,253
Jordan	0	--	--	--	--
Badger	0				--
L. Badger	0				--
Threemile	0	--	--	--	--
Rock	13.3	31,683	19,218	4,036	239
Gate	13.1	21,601	21,065	2,739	426
S.Fk.Gate	3.4	5,257	3,415	342	74
McCubbins Gulch	0	--	--	--	--
Boulder	1.6	8,046	6,436	1,223	272
Forest	0	--	--	--	--
Clear	2.2	19,417	9,825	4,028	48
Frog	0	--	--	--	--
Barlow	0	--	--	--	--
Buck	0	--	--	--	
Bonney	0	--	--	--	--
Iron	0	--	--	--	--
Alpine	0	--	--	--	--
Mineral	0			--	--
TOTAL	89.0 (56 mi)	885,657	458,869	183,084	16,196

Table 4. Additional habitat that would be accessible with minor passage enhancement in the White River basin. (Table displays habitat above minor barriers, for totals refer to Table 1.)

Stream	Length (km)	Total Area (m2)	Pool Area (m2)	Pool Volume (m3)	Spawning area (m^2)
White River	14.7	139,692	21,254	6,542	161
Tygh	15.7	95,960	46,441	8,972	3,450
Jordan	9.84	6,224	660	139	188
Badger	30.2	189,636	61,754	15,850	1,830
L. Badger	9.1	26,281	12,211	1,619	226
Threemile	23.8	65,751	35,493	12,846	1,626
Rock	0	--	--	--	--
Gate	7.5	31,288	21,205	3,299	429
S. Fk. Gate	0	--	--	--	--
McCubbins Gulch	0	--	--	--	--
Boulder	16.0	65,622	39,142	16,102	2,223
Forest	2.6	5,452	3,023	363	96
Clear	16.6	149,413	101,985	35,338	1,407
Frog	12.5	94,976	75,475	15,542	295
Barlow	10.2	39,605	20,933	4,311	797
Buck	1.6	9,070	3,017	392	161
Bonney	1.1	5,087	2,153	280	92
Tron	4.3	12,361	4,079	1,344	49
Alpine	0.6	1,280	552	194	25
Mineral	4.9	15,203	3,041	1,655	14
TOTAL	172.8 (108 mi)	952,901	452,418	124,788	13,069

Table 5. Additional habitat that would be accessible with major passage enhancement in the White River basin.

Stream	Length (km)	Total Area (m^2)	Pool Area (m^2)	Pool Volume (m^3)	Spawning area (m^2)
White River	0	--	--	--	--
Tygh	8.6	13,148	5,558	739	872
Jordan	20.5	75,423	36,174	10,874	1,221
Badger	10.7	45,069	14,065	4,520	458
L. Badger	2.9	5,191	873	140	67
Threemile	0	--	--	--	--
Rock	9.6	27,008	14,750	1,770	130
Gate	0	--	--	--	--
S.Fk.Gate	0	--	--	--	--
McCubbins Gulch	7.7	25,486	1,112	305	94
Boulder	0	--	--	--	--
Forest	0	--	--	--	--
Clear	0	--	--	--	--
Frog	0	--	--	--	--
Barlow	0	--	--	--	--
Buck	0	--	--	--	--
Bonney	0	--	--	--	--
Iron	0	--	--	--	--
Alpine	0	--	--	--	--
Mineral	0	--	--	--	--
TOTAL	60.0 (37 mi)	191,325	72,532	18,348	2,842

The mainstem of White River provides almost 66 km of fish habitat, the quality of which varies greatly, from poor in the upper reaches to good in the lower reach. The upper White River has unstable streambanks, lacks structure, and has poor pool and spawning habitat. The lower river has structure provided by boulders and bedrock, and flushes sediment to maintain quality habitat. This is due to the good base flow (about 100 cfs low water average) from its numerous tributaries. The lower White River has summer water temperatures near the high end of salmonid preference.

The upper tributaries are typified by good base flows, cooler water temperatures, and lower productivity than those of the lower basin. The lower productivity is probably a result of lower dissolved solids, cooler water temperatures, and higher elevations. The upper tributaries are fed by wetlands, have extensive off channel rearing habitat, and almost 5,500 square meters of spawning gravels. The upper basin is generally forested, resulting in high shading and large quantities of LWD providing the principal structure for fish habitat. Frog, Barlow, Clear, and Boulder creeks are the major tributaries of the upper basin. All have diversions that are currently blocks to upstream migration.

The tributaries of the lower basin are lower in elevation, have greater fluctuations in flow conditions, and have less forested land. This has resulted in higher water temperatures for many of these tributaries. These high water temperatures limit the carrying capacity of the lower reaches of these tributaries. The lower basin has higher total dissolved solid and a greater corresponding productivity than the upper basin. The lower basin streams are generally higher gradient and have less off channel rearing than the upper basin. These streams rely heavily on LWD for structure. For a variety of reasons LWD input in some areas (Rocky Burn, etc.) has been interrupted and this lack of or scarcity has resulted in lower quality and quantity of rearing pools.

Irrigation Diversions

Eighteen ditches in the White River basin would require screens and bypass facilities to protect downstream migrants (Figure 6). Screening of the ditches is essential to develop runs of anadromous fish in the basin. Construction costs for screening all ditches would be about $58,000 with annual maintenance costs of about $14,500. The range of construction costs for individual detches was $2,000 to $11,000. Construction costs include materials and labor and are based on ODFW doing the work. Costs would probably be higher if work was done by a private contractor.

The Whdite River watershed currently has seven irrigation districts and ditch companies and many single users (Table 6). The normal irrigation season is April through October. Only White River has an established minimum stream flow (6C cfs in slummer). Summer flows of major tributaries, with the exception of Barlow Creek, are either completely appropriated or over-appropriated.

Oregon statutes that require screening of irrigation diversions greater than 30 cfs and passage at diversion dams have not been enforced in the White River basin. Introduction of anadromous fish in the basin would require screening of ditches to protect juvenile migrants and may require modification to diversion dams to provide upstream passage. ODFW recommends that the costs for construction of screens, maintenance of screens, and modification to diversion dams be included as a cost of the project. Water diversions on National Forest system lands are administered under special use permits and these permits would need to be amended to provide these changes.

Glacial Silt

One of the tasks of the feasibility study was to determine the effect of glacial silt on the potential of the mainstem of the White River to produce anadromous fish. In the White River basin approximately 50 percent of the surface area and 40 percent of the spawning gravel is in the mainstem. Because the river heads in White River Glacier on Mt. Hood, it is seasonally very turbid and laden with silt. The silt load generally occurs from August through September as White River Glacier melts.

Evaluation of the effects of glacial silt included: (1) sampling of gravel with a freeze-ore sampler in lower and upper White River, and in Barlow Creek (control); (2) sampling of resident fish at two sites in the mainstem when the river was turbid and at one site in Barlow Creek; and (3) sampling of food availability (insect drift) and food consumption by trout (stomach samples) in lower and upper White River when the glacier was melting.

The principal effect of glacial silt in the White River is a reduction of spawning area for spring chinook in the upper portion of the mainstem. Glacial silt would probably prevent chinook from successfully spawning in the upper 60 percent of the river. Substrate in the upper river is affected by silt deposition and bedload movement as the glacier melts. This period extends into September, the month of peak spawning of spring chinook. It is assumed that steelhead will successfully spawn in the upper river because the glacial sediment is flushed from the river during high flows of winter and spring. Gravel beds sampled in the upper White River were of poor quality with a fredle index (Lotspeich and Everest 1981) of about 2 (Figure 7).

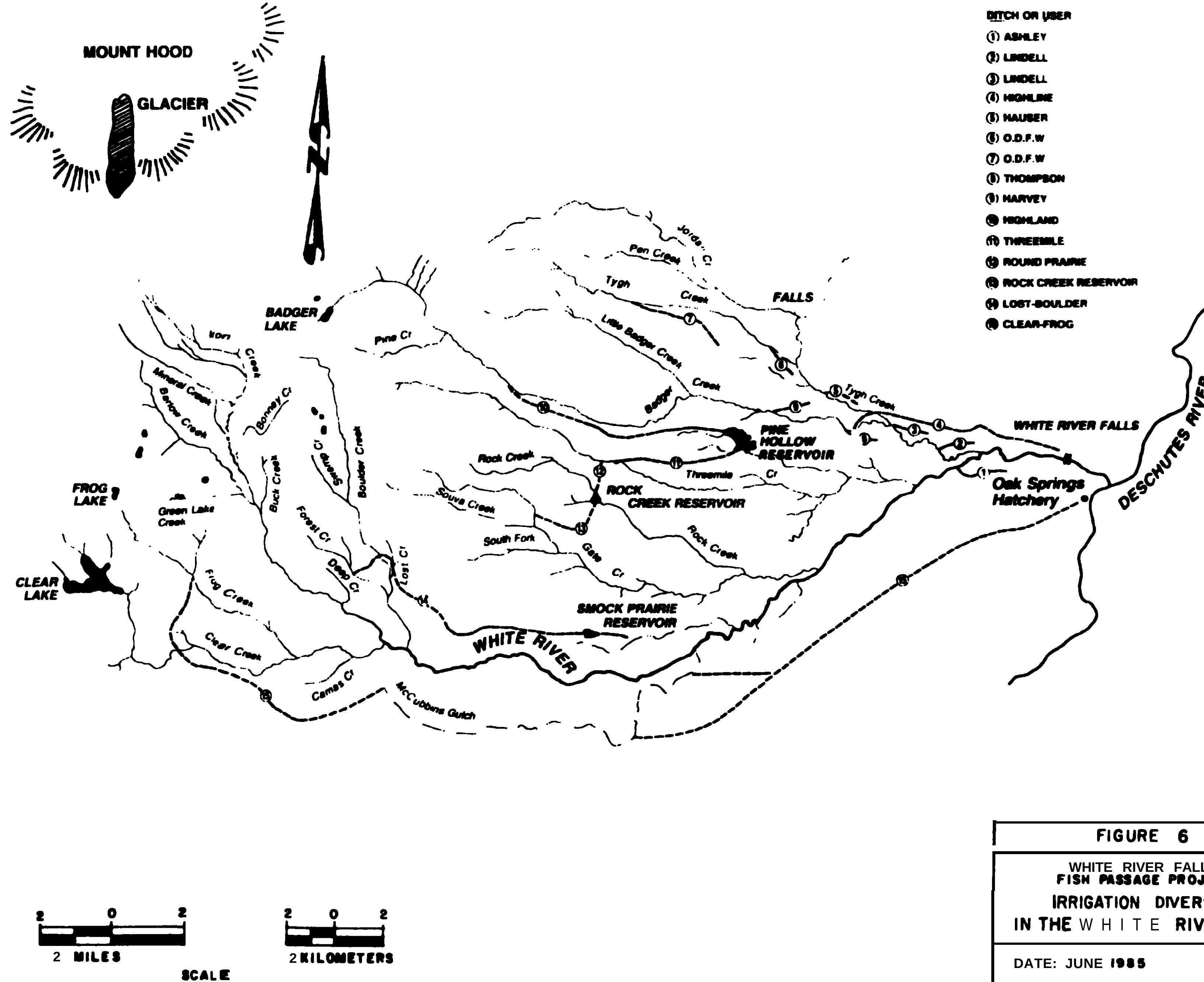


FIGURE 6

WHITE RIVER FALLS FISH PASSAGE PROJECT

IRRIGATION DIVERSIONS IN THE WHITE RIVER SYSTEM

DATE: JUNE 1985

Table 6. Water withdrawals from streams in the White River system estimated in summer 1983.

Stream location (km)	Ditch system or principal user	Type	Water withdrawal (cfs) a/
White River			
3.7-9.0		Pumps (5)	13.0
9.0	Ashley	Ditch	4.0
Tygh Creek			
2.1		Pump	0.1
4.5	Lindell	Ditch	2.0
4.5		Pump	1.6
7.7	Lindell	Ditch	3.3
9.3	Highline	Ditch	4.5
9.7		Pump	0.8
1l.4		Pump	1.5
11.7	Hauser	Ditch	1.5
12.2-14.3		Pumps (5)	1.5
15.7	ODFW	Ditch	1.5
24.3	ODFW	Ditch	2.5
Badger Creek			
1.8	Highline	Ditch	6.0
2.1	Thompson	Ditch	2.1
2.4		Pump	0.1
7.0	Harvey	Ditch	5.0
24.5	Highland	Ditch	18.0
Threemile Creek			
19.2	Threemile	Ditch	2.5
20.0	Round Prairie	Ditch	1.5
Rock Creek			
13.3	Rock Creek Reservoir	Ditch	3.5
Gate Creek			
3.1		Pump	0.1
13.8	Rock Creek Reservoir	Ditch	1.0
Boulder Creek			
5.0	Lost-Boulder	Ditch	25.0
Forest Creek			
2.6	Lost-Boulder	Ditch	6.0

Table 6. (continued)

Stream location (km)	Ditch system or principal user	Type	Water withdrawal (cfs) a/
Clear Creek			
12.5	Clear	Ditch	25.0
Frog Creek			
7.4	Clear	Ditch	12.0

a/ Approximate discharge rates for pumps based on type and head.

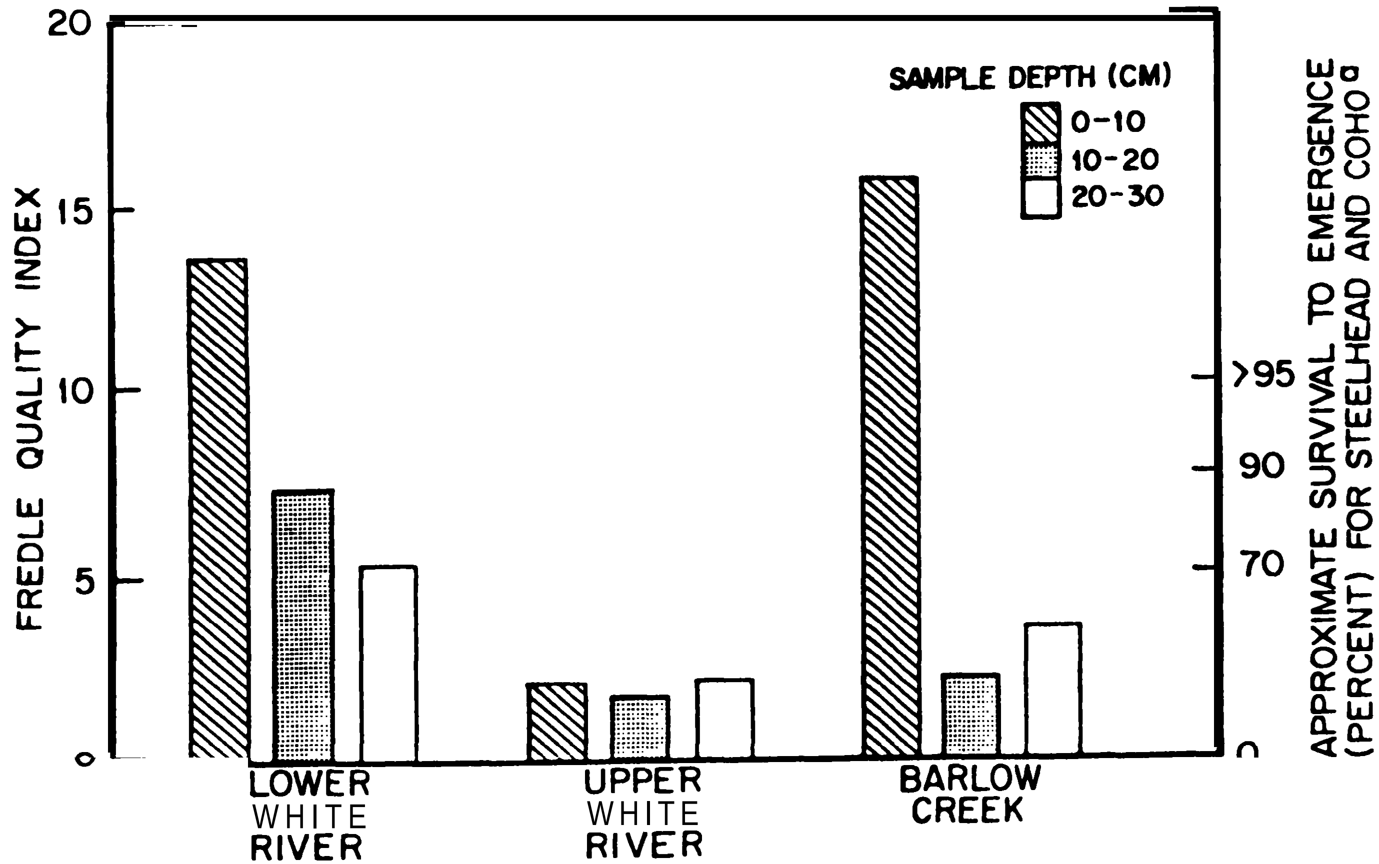


FIGURE 7

WHITE RIVER FALLS
FISH PASSAGE PROJECT

QUALITY OF SPAWNING GRAVEL, SEPTEMBER 1984

DATE: JUNE 1985

Survival of eggs in upper White River would probably be low because generally an index that is greater than 5 to 7 indicates good quality gravel and high survival of eggs. Although the percentage of fine sediments in upper White River would be reduced when the redds were dug, subsequent silt deposition would likely bury redds and still result in low egg survival. The suspended sediment transport in the upper White River has been measured at 30,750 tons/month and bedload transport has been estimated at 15,400 tons/month during September and October (United States Department of the Interior, Bureau of Reclamation, unpublished data). Suspended sediment transport of the White River in Washington, a glacial river on the north slopes of Mt. Rainier with salmon and steelhead, averaged about 11,000 tons/month in September and October with a bedload of just 4 percent of the suspended sediment transport (Nelson 1979).

Gravel beds sampled in Barlow Creek and lower White River were good quality (Figure 7) and survival of eggs to emergent fry is expected to be good. A low fredle index in Figure 7 in the lower depths of the substrate of Barlow Creek is attributed to the influence of the White River floodplain at the mouth of the creek. The suspended sediment transport in lower White River during September and October is approximately 2 percent (540 tons/month) of that measured in the upper White River (United States Geological Survey, unpublished data). The sediment transport in lower White River increases substantially (59,422 tons/month) in November and December and is associated with greater discharge from increased rainfall. Increased sediment load during winter months could reduce egg survival in the lower river. However, because the increased sediment transport generally occurs during high flows, much of the sediment is flushed from the lower river.

Resident fish reared in the mainstem in August and September despite the high turbidity and sedimentation caused by the glacier. Catch rates of fish from the lower mainstem indicated there was no apparent migration from the lower river into clear water tritutaries or into the Deschutes caused by the turbid water (Table 7). In fact, the lower mainstem appears to be an important rearing area for native rainbow in the summer (Figure 8). Catch of rainbow in upper White River, however, generally decreased in August and September whereas the catch of rainbow in Barlow Creek increased (Table 8). This suggests some movement of rainbow from upper White River into clear water tributaries or into Lower White River. As pointed out earlier, glacial silt and turbidity is iess severe in lower than in upper White River which may account fcr the differences in movement in the two sections.

Condition factors of rainbow trout sampled in White River and analysis of stomach contents of rainbow trout indicated that trout in the mainstem are feeding well despite high turbidity during August and September (Table 8). Trout in upper White River appeared to feed primarily on terrestrial insects which contrasts with lower White River where most food items were aquatic insects (Figure 9). The production of aquatic insects is probably very low in upper White River during late summer because of silt deposition and scouring of the substrate by bedlead transport. Stomach samples of juvenile chinook in the Stikine River, a glacial stream in British Columbia and Alaska, indicated terrestrial organisms were a major food item, particularly in August (McCsart and Walser 1982).

Table 7. Recapture of* tagged salmonids in lower White River, 1984.

Date	Native Rainbow			Hatchery Rainbow			Whitefish		
	Catch	Recap-ture	Recap-true (%)	Catch	Recap-ture	Recap-ture (%)	Catch	Recap-ture-	Recap-ture (%)`
19 Jul.	41	--	--	77	--	--	5	--	--
09 Aug.	101	8	7.9	48	11	22.9	3	0	0
27 Aug.	135	21	15.6	38	7	18.4	8	0	0
10 Sep.	141	29	20.6	43	15	34.9	7	0	0
25 Sep.	196	60	30.6	54	27	50.0	16	2	12.5
05 Oct.	145	62	42.8	47	29	61.7	27	4	14.8
08 Oct.	112	49	43.8	53	39	73.6	29	12	41.4
01 Nov.	71	40	56.3	46	29	63.0	18	5	27.8

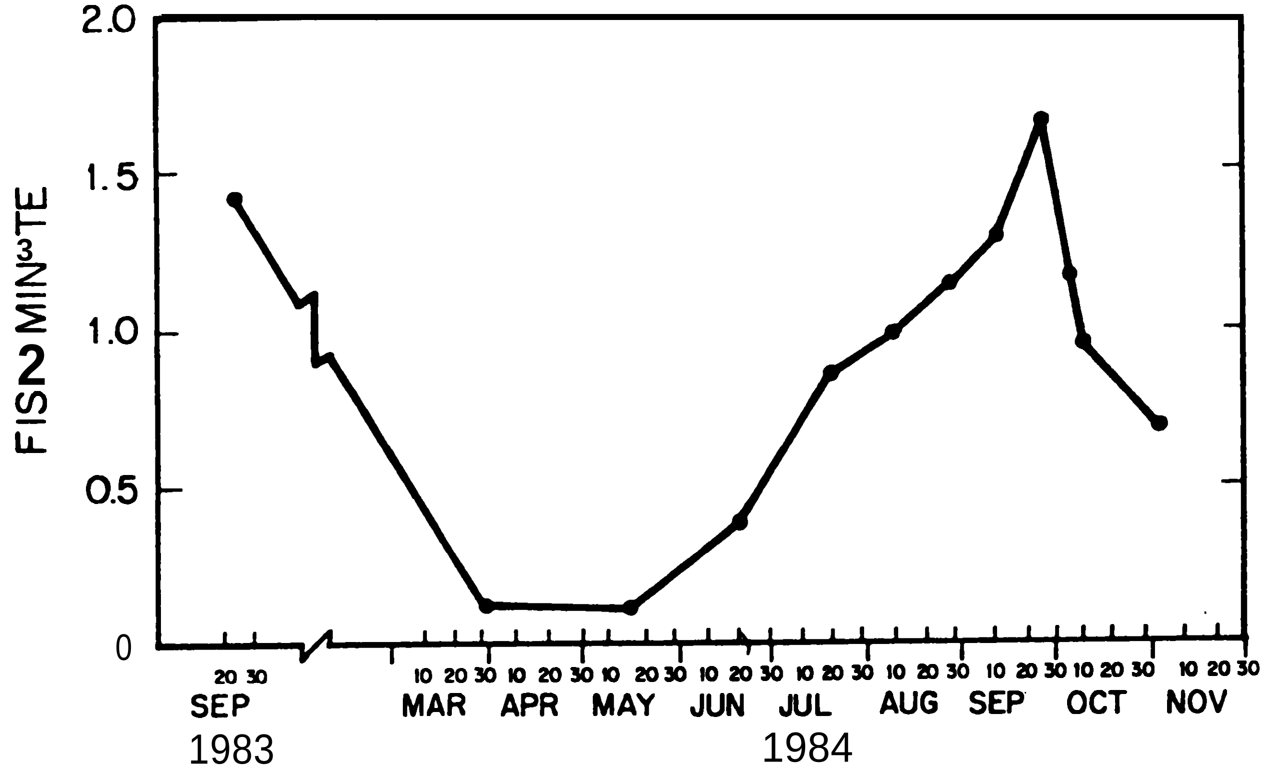


FIGURE 8

WHITE RIVER FALLS
FISH PASSAGE PROJECT

CATCH RATE OF NATIVE RAINBOW TROUT BY ELECTROFISHING ABOVI THE FALLS

DATE: JUNE 1985

Table 8. Sampling of resident rainbow trout in two sites in White River and in one site in Barlow Creek, 1984.

	White River-Hwy 197			White River-Barlow Crossing			Barlow Creek		
Date	Catch rate	Mean fork length (cm)	K a/	Catch rate	Mean fork length (cm)	K a/	Catch rate	Mean fork length (cm)	K a/
OS-09 Aug.	0.65	22.3	1.297	1.27	12.4	1.052	0.70	8.6	1.095
14 Aug.	--	--	--	0.77	10.8	1.075	0.56	6.8	1.129
27-28 Aug.	1.04	20.6	1.304	1.00	10.7	1.072	0.78	7.1	0.941
10-11 Sep.	0.83	18.0	1.267	0.62	12.6	1.042	0.69	7.C	0.585
25-26 Sep.	1.48	17.9	1.242	0.37	8.2	1.128	1.21	5.4	0.912
08-10 Oct.	0.94	20.2	1.285	1.29	10.2	1.001	1.03	7.3	0.866

a/ $K = \left[\frac{(wt/l^3) \times 100}{n}\right]$

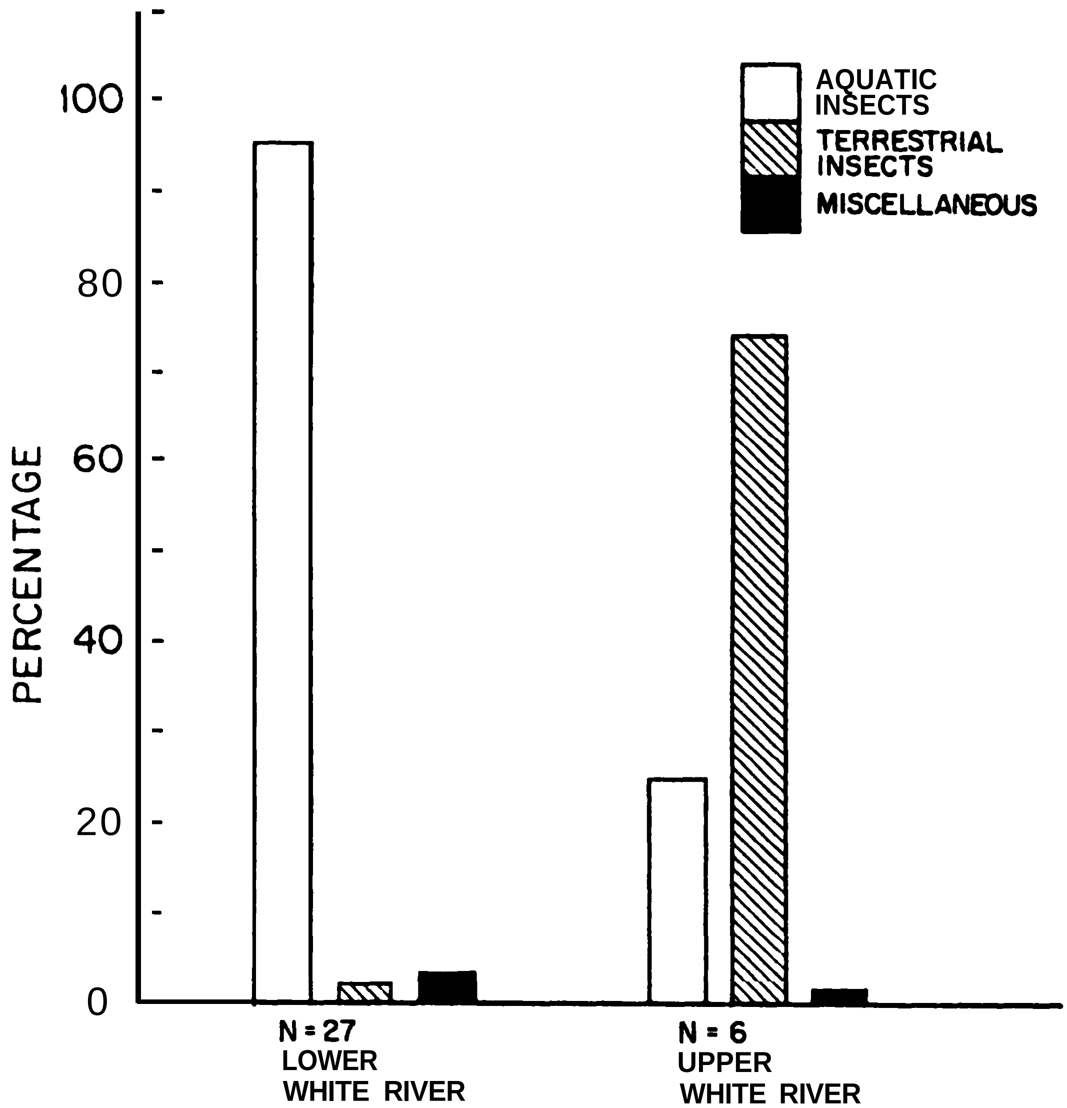


FIGURE 9

WHITE RIVER FALLS
FISH PASSAGE PROJECT

COMPARISON (% BY WEIGHT) OF FOOD ITEMS IN STOMACHS OF RAINBOW TROUT, 1984

DATE: JUNE 1985

Anadromous salmonids are found in glacial streams in Alaska (Kissner 1982), British Columbia (McCart and Walder 1982), and Washington (Bauserfeld, Washington Department of Fisheries, unpublished data). Kissner (1982) reports that growth of juvenile chinook salmon was greater in clear water rivers than in glacial rivers, but that glacial water (mainstems) supported greater densities of rearing juveniles. Meehan and Siniff (1962) reported that juvenile chinook and coho in the glacial Taku River in Alaska exhibited a general increase in condition factors in May and June during periods when water turbidity and water flows were high.

Although glacial silt would prevent spring chinook from successfully spawning *in the* upper river, some juveniles will emigrate from clear water tributaries and rear in the upper mainstem, which might offset the loss of spawning in the upper river. Glacial silt in the mainstem will probably not affect the production of steelhead.

Steelhead and Chinook Estimates

A review of the literature and discussions with biologists in the Northwest indicated there were no standard methods for estimating the potential production of anadromous fish in a watershed, particularly in a watershed with no history of anadromous runs. Consequently, estimates of the number of steelhead and chinook that could be produced in White River basin above White River Falls were based on several methods utilizing data from stream inventories, the glacial silt study, measurements of habitat and resident trout abundance, and the literature.

All methods used to estimate potential production of steelhead and chinook were based on the assumption that irrigation diversion ditches would be screened to protect downstream migrants. Successful introduction of steelhead and salmon would not be possible without a screening program in the basin. It was also assumed that juvenile steelhead and salmon would rear in the mainstem of White River despite the glacial silt. It was assumed glacial silt would not affect spawning by steelhead but would prevent salmon from spawning in the upper portion of the river. The estimated number of steelhead smolts was reduced by 20 percent to account for competition for food and space with resident trout in the basin (Bjornn 1978). It was assumed that interaction between salmon and trout would be limited because of differences in time of spawning and subsequent size differences of the juvenile fish (Everest and Chapman 1972).

Steelhead

Nine methods were used to make the estimate of steelhead production and were based on number and biomass of resident trout, on the rearing area in the White River basin, and on steelhead densities and rearing area requirements in Northwest streams (the methods are discussed in more detail in this section under Methods).

Potential production of steelhead in the White River system ranged from 1,298 to 5,328 (Table 9). After evaluating the methods and the data base from which they were calculated, ODFW biologists narrowed the range of potential production to 2,100 to 3,500 adults. The estimated production of adults is the run size to the Columbia River prior to any in-river harvest.

Table 9. Estimated production of summer steelhesd in tne 'White River system below barriers. a/

Method	Smoltsb/	Adults Run Size	Adults Spawning c/ Escapement
1. Population of resident trout >15 cm	23,166	1.298	649
2. Numerical densities of age 1 steelhead	77.302	4.328	2,164
3. Numerical densities of age 0 steelhead	28,348	1.588	794
4. Population of l+ resident trout	42.042	2.354	1,177
5. Rearing area required per smolt	46.239	2.588	1,294
6. Rearing area required per smolt (20 m2/smolt)	64.215	3.596	1,798
7. Smolts per area	25.686-38,529	1.438-2,158	719-1,079
8. Numerical densities of age 0 steelhead from Warm Springs and eastern Oregon rivers	35,427	1.984	992
9. Numerical densities of age 1 steelhead from Warm Springs and eastern Oregon rivers	64,252	3.598	1,799

a/ Assumed no access above major barriers or above diversion dams on upper Badger. Clear. and Frog creeks. Assumed access to and use of Tygh Creek system above diversion dams on lower Tygh and Badger creeks. Survival figures used: 35% age 0 to age 1 (Sumner); 60% over winter: 2.8% smolt to spawning adult. Catch to escapement assumed at 1:l.

b/ reduced by 20% to account for resident rainbow trout (Bjornn 1978).

c Estimated harvest: 50% of run harvested in fisheries in the Columbia and Deschutes rivers.

The steelhead estimates were based on the use of 225 km (70 percent) of the 322 km of streams that were surveyed in the basin (Figure 10). Of the 89 km below minor barriers, 19 km were considered to be unusable by steelhead because these areas had no flow in the summer. The steelhead estimates were also based on the use of 155 km of the 173 km of accessible streams above minor barriers. Areas above major barriers on tributaries were not included in the estimates because of high costs of providing fish passage and limited benefits. These areas are also recommended as wild trout management areas to protect native stocks of resident rainbow trout. The stream sections used to make the steelhead estimates were: White River below the confluence of Iron Creek; Tygh, Jordan, and Little Badger creeks below waterfalls; Badger Creek below Highland Ditch; Threemile, Rock (below the reservoir), and Gate creeks (estimates in these streams were adjusted downward because they are intermittent); Clear and Frog creeks below irrigation diversions; and Boulder, Barlow, Mineral, Iron, Buck, and Bonney creeks (Figure 10). These stream sections were believed to have the greatest potential for steelhead.

The estimates of steelhead production given above assumed access to the Tygh Creek system over six irrigation diversion dams. The Tygh Creek system is very productive, accounting for about 50 percent of the resident trout abundance in tributaries of White River. Without passage at the six dams on lower Tygh and Badger creeks (Figure ll), access to 51 km of streams would be blocked and the estimated production of steelhead adults in the White River basin would be reduced by 30 percent (630 to 1,050 adults). The steelhead estimates also assumed access to 13.5 km in Little Badger and Threemile creeks that have potential as sanctuaries for wild rainbow trout. If barriers to upstream passage are installed on these creeks to protect rainbow trout, the estimated production of steelhead in the White River basin would be reduced by 5 percent.

Passage at three other diversion dams in Badger, Clear, and Frog creeks would provide access to an additional 17 km of streams and result in a 10 percent increase in the production of steelhead adults (Table 10). Passage of five waterfalis (major barriers) on tributary streams would provide another 15 percent increase in production of adult steelhead (Table 10); however, these falls would require extensive work in remote locations to provide fish passage (Figure 11). The areas above major barriers have potential as sanctuaries for native stocks of rainbow trout in the basin. Passage for fish above Rock Creek Reservoir was not considered feasible because of cost of upstream and downstream passage at the dam.

Whether modifications of diversion dams in the basin are needed will depend on the timing of the adult run and when irrigators install the diversion dams. Passage at minor natural barriers in the basin may be difficult at low flows and the need to modify these barriers will depend on the timing of the adult run.

Chinook

Seven methods were used to make the estimate of potential production of chinook and were based on rearing and spawning areas in the White River basin, and on chinook densities in other Northwest streams (the methods are described in more detail in this section under Methods).

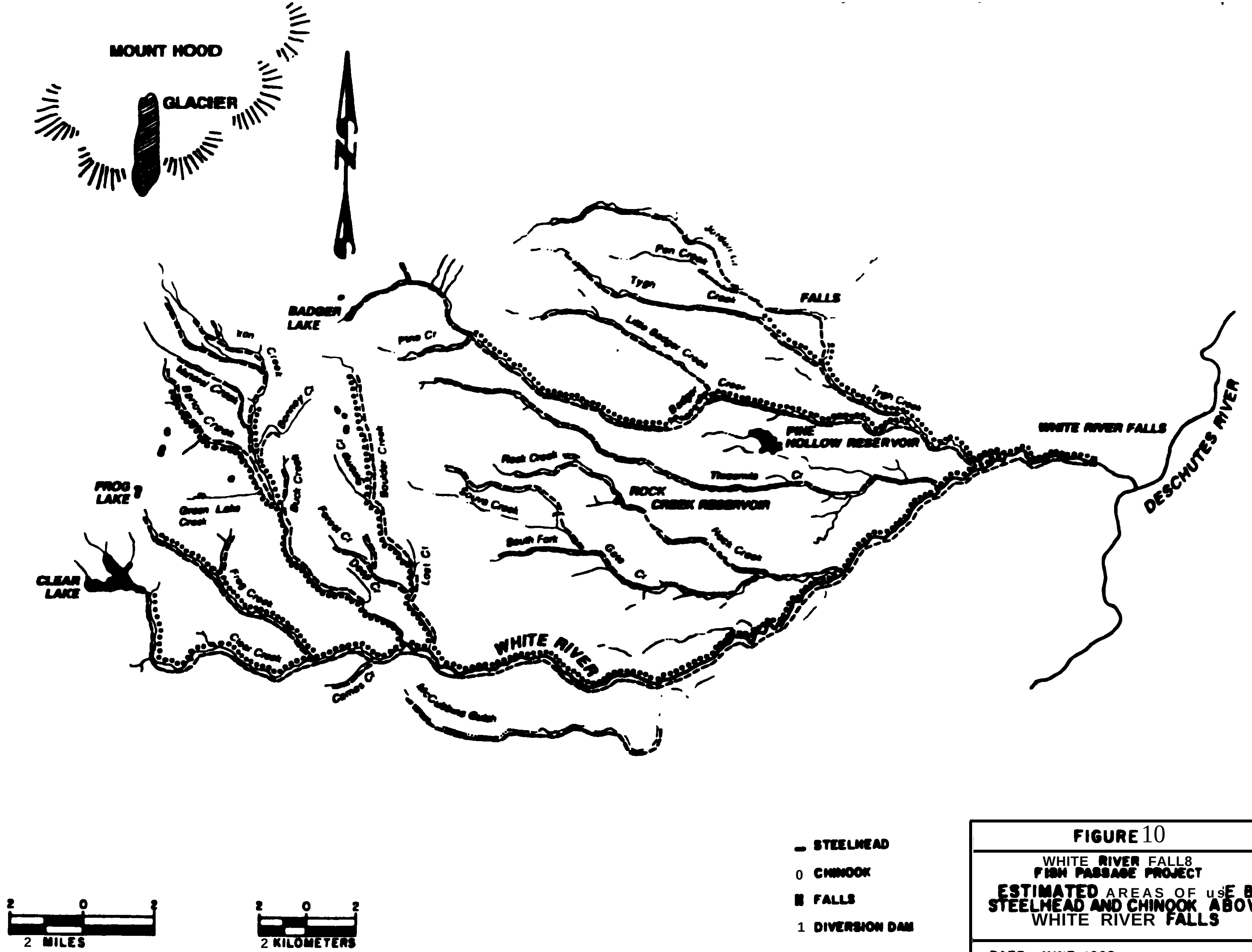
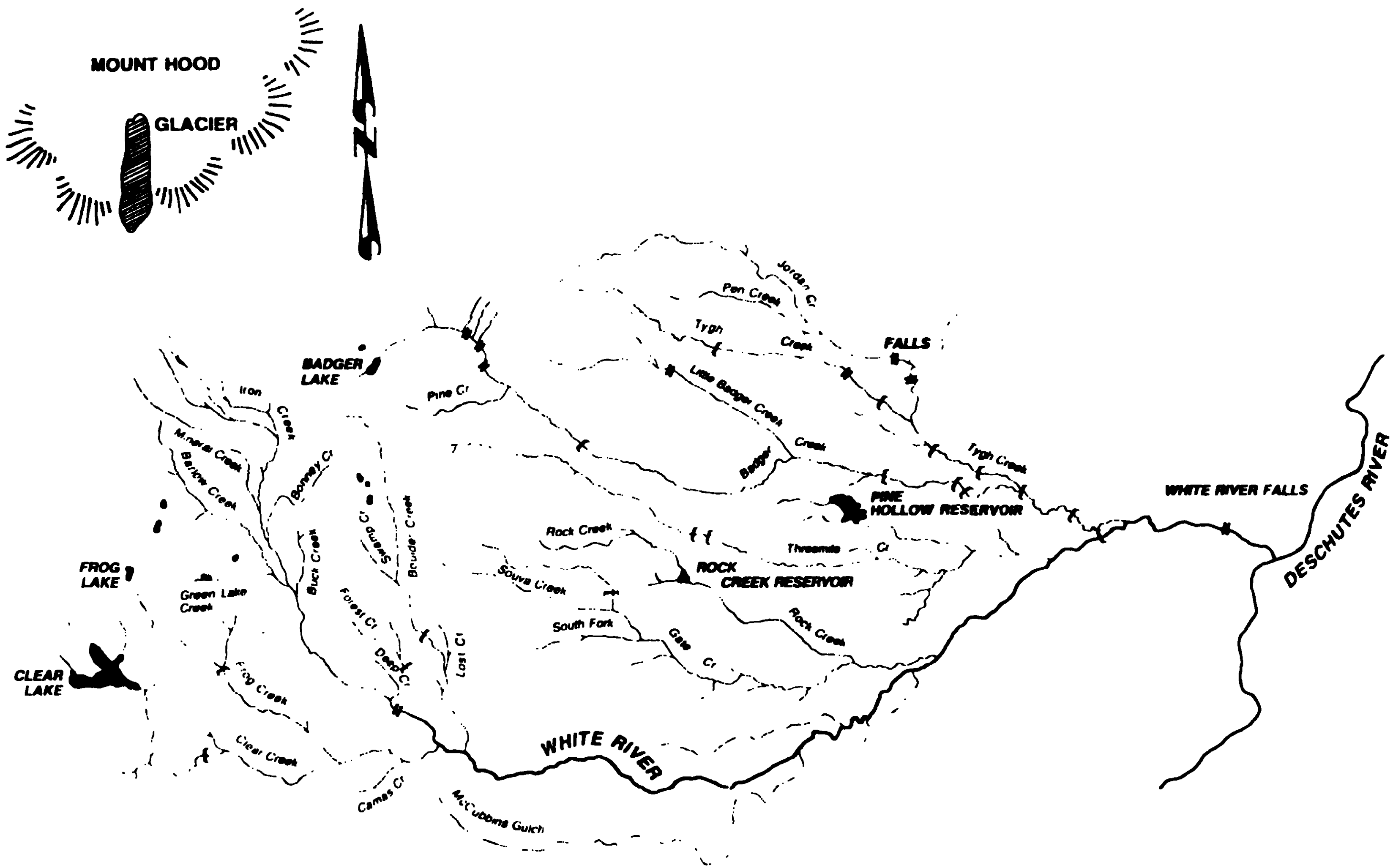


FIGURE 10

WHITE RIVER FALL8
FISH PASSAGE PROJECT

ESTIMATED AREAS OF USE BY STEELHEAD AND CHINOOK ABOVE WHITE RIVER FALLS

DATE: JUNE 1985



11 WATERFALLS

(DIVERSION DAM

2 0 2 2 0 2

2 MILES 2 KILOMETERS

SCALE

FIGURE 11

WHITE RIVER FALLS
FISH PASSAGE PROJECT

IMPASSABLE WATERFALLS AND IRRIGATION DIVERSION DAMS

DATE: JUNE 1985

Table 10. Additional production of adult steelhead above barriers in the White River watershed above White River Falls.

Barrier	Adult Potential: Method 2 a/	Adult Potential: Method 5 b/
Falls:		
Tygh Creek Falls	90	54
Jordan Creek Falls (2)	662	166
Badger Creek Falls (3)	190 c/	64 c/
Little Badger Creek Falls	0	0
Falls Total	942	284
Diversion Dams: d/		
Highland Ditch (Badger Creek)	222	74
Clear Creek Ditch	124	174
Frog Creek Ditch	58	120
Diversion Dams Total	404	368
Rock Creek Reservoir	146	60

a/ Estimated by numerical densities of age 1 steelhead in Eastern Oregon streams (matching age 1 biomass densities of steelhead streams and White River streams).
b/ Estimated by rearing area requirement for smolts (20 m2/smolt).
c/ Contingent on passage at Highland Ditch Dam.
d/ These diversion dams are operated throughout winter and are potential barriers for adult steelhead.

Potential production of spring chinook in the White River system ranged from 1,190 to 3,036 adults (Table 11). After evaluating the methods and the data base from which they were calculated, ODFW biologists narrowed the range of potential production to 1,400 to 2,100 adults. The estimated production of adults is the total run size prior to a harvest.

The chinock estimates Were based on the use of 160 km (50 percent) of the 322 km of streams that were surveyed in the basin (Figure 10) Summer water temperatures and late summer flows were used to determine streams that would probably be used by chinook. Cf the 89 km of streams below minor barriers, 59 km were considered to be usable by chinook. The chinook estimates were also based on the use of 101 km of the 173 km of accessible streams above minor barriers. Areas above major barriers or. the tributaries were not included in calculating the estimates. The stream sections used to make the chinook estimates were: White River below Iron Creek (km 66) for rearing and below km 28 for spawning; Tygh and Jordan creeks below waterfalls; Badger Creek below Highland Ditch; Clear and Frog creeks below irrigation diversions; and boulder, Barlow, and Mineral creeks (Figure 10). These stream sections were believed to have the greatest potential for chinook.

Variation in the estimates of chinook production given above is due in part to the uncertain use of the Tygh Creek system by spring chinook. Use of the Tygh system will depend on migration timing of adults and on effects of high water temperatures on chinook holding in lower Tygh and Badger creeks from mid-July to September. wihtout access to 42 km of streams in the Tygh Creek system, the estimated production of chinook adults in the White River basin would be reduced by 30 percent (420-630 adults).

passage at two other diversion dams on Badger and Clear creeks would provide access to an additional 12 km of streams and would result in a 7 percent increase in the production of chinook adults (Table 12). Passage at four waterfalls (major barriers) on tributary streams could provide another 12 percent increase in production of adult chinook (Table 12); however, these falls would require extensive work in r-emote locations to provide fish passage (Figure il).

In areas of the White River system where salmon and steeihead are likely to be sympatric (Figure 10), the predicted density of salmon and steelhead in the White River is within the range of densities that have been measured in Northwest streams with sympatric populations (Table 13).

Methods

Resident fish POPULATIONS and several habitat parameters were measured in 1984 to provide the necessary data base to estimate the potential production of anadromous fish in the White River basin. Eighteen streams in the White River watershed were divided into 45 reaches (Figure 4) based on general stream characteristics such as gradient, pool-riffle ratio, and change in flow (confluence of tributaries). Reach designations were based on data from 1983 stream surveys of ODFW and USDA FS, and a previous survey by BLM (1980) .

Table 11. Estimated production of spring chinook in the White River system below barriers. Exceptions are noted. a/

Method	Miarants	Adults Run Size	Spawning c/ Escapemetn
1. Smolt Productivity Index (entire watershed)	86.753	3,036	1,518
2. Comparison to Warm Springs River - drainage area (entire watershed) D/	59,471	2.220	1.110
3 Comparison to Warm Springs - September flow (entire watershed) b/	37,500	1,400	700
4 Comparison to Warm Springs - spawning gravel b/			
a. No restrictions on use	65,836	2,458	1,229
b. Limited use of lower Tygh, passage at dams	58,350	2,178	1,089
c. No use of Tygh system	45,464	1,697	848
5 Potential use of spawning gravel based on Warm Springs data			
a. No restrictions on use	50,715	1,776	888
b. Limited use of lower Tygh	44,940	1,574	787
c. No use of Tygh	34,965	1,224	612
6 Rearing densities of Warm Springs			
a. No restrictions	42,743	1,496	748
b. No use of Tygh	33,980	1,190	595
7. Rearing densities of Warm Springs and John Day rivers)	67,279	2,354	1,177

a/ Assumed no access above major barriers or above diversion dams on upper Badger and Clear creeks. Assumed no use of intermittent tributaries. Survival figures used: 3.5% egg to migrant: 1.75% migrant to spawning adult: 60% over winter. Catch escapement assumed at 1:l.

b/ Estimated harvest: 50% of run harvested in fisheries in the ocean and in the Columbia and Deschutes rivers.

c/ Mean run sizes of Warm Springs River chinook were prorated using average runs of 75,000 migrants and 2,000 adults.

Table 12. Additional production of adult chinook above barriers in the White River watershed above White River Falls.

Barrier	Adult Potential	
	Method 5 a/	Method 6 b/
Falls:		
Tygh Creek Falls	34	26
Jordan Creek Falls (2)	82	78
Badger Creek Falls (several)	18	30
Falls Total	134	134
Diversion Dams:		
Highland Ditch (Badger Creek)	22	36
Clear Creek Ditch	4	82
Diversion Dams Total	26	118

a/ Estimated by potential use of spawning gravel based on Warm Springs River data.

b/ Estimated by rearing densities of the Warm Springs River.

Table 13. Numerical densities (fish/m21 of sympatric populations of summer steelhead (StS) and spring chinook (ChS) estimated for White River and measured in seven Columbia basin rivers. a/

Stream	Density (fish/m2)		
	sts (age l+)	ChS (age 0)	Total
White River predicted estimate	0.10	0.08	0.18
Warm Springs River b/	0.05	0.05	0.10
John Day River: c/			
Granite Creek	0.05	0.16	0.21
Bull Run Creek	0.10	0.31	0.41
Middle Fork	0.10 d/	0.09	0.19
Wind River e/	0.12 f/	0.09	0.21
Wenatchee River g/	0.04	0.08	0.12
Entiat River B/	0.08	0.06	0.14
Salmon River-Idaho h/	0.11	0.26	0.37
Clearwater River-Idaho (5 streams) i/	0.08	0.25	0.33

a/ Data were from **streams** and years that were believed to have adequate spawning escapement.
b/ Cates, unpublished data, USFWS, Vancouver, WA.
c/ Burck, et al. 1979, 1980; Lindsay, et al. 1981.
d/ Age 0 and age 1 rainbow-steelhead.
e/ Crawford, et al. 1984.
f/ Summer and winter steelhead.
g/ Mullan, unpublished data, USFWS, Leavenworth, WA.
h/ Sekulich, 1980.
i/ Gamblin, 1984.

within each stream reach, 1 to 4 sites were selected that typified the habitat of the reach. Sites were selected away from campgrounds and road crossings to avoid areas where fishing pressure may have affected fish abundance. A total of 88 sites were sampled throughout the basin.

Except in lower White River, fish abundance was estimated with multiple-pass removal methods (Zippin 1958; Seber and Whale 1970) by using backpack electrofishers and blocking nets at upstream and downstream boundaries of the sites. In larger streams, a Dirago 1000 electrofishing unit mounted in a small pram was used to capture fish. Abundance of salmonids in a section of lower White River (km 5.8 to km 9.0) was estimated with a modified Schnabel procedure (Ricker 1975) by using electrofishing gear mounted in a drift boat to capture fish. Biomass of fish was estimated from population estimates and mean weights.

Stream width, stream depth, and width of undercut banks were measured by transect methods (Platts et al. 1983). At each transect, the width of stream in pool, riffle, slow run, pocket water, fast run, backwater, and side channel (Irving et al. 1983) was measured. These data are presented in Volume III, Append ix B .

Surface area of each site was calculated by multiplying the sum of the transect widths by the transect spacing. Mean surface area, fish abundance, and biomass in sites within a reach were espanded by the proportion of the mean length of sites within a reach to the total length of the reach to calculate estimates for the reach. Reach estimates were summed to estimate surface area, abundance, and biomass in streams in the watershed. Estimates of surface area in Threemile, Rock, and Gate creeks were adjusted downward because lower sections of the streams are intermittent. Stream sections in Tygh, Threemile, Rock, and Gate creeks where we did not find fish were excluded from the expansions.

Three general areas of the White River system are referred to in this sect ion . (1) mainstem of White River; (2) lower tributaries; and (3) upper tributaries. Lower White River is that section of the mainstem from White River Fails to km 10. Lower tributaries are Tygh, Jordan, Badger, Little Badger, Threemi le, Rock, and Gate creeks. Upper tributaries are Boulder, Clear, Frog, Barlow, Iron, Mineral, Buck, and Bonney creeks.

Steelhead potential

Of the nine methods used to make the final estimates, no single method was considered to provide the best estimate of potential production of steelhead above White River Falls. All estimates assumed use of Tygh and Badger creeks. A smolt to adult survival rate of 2.8 percent based on escapement data for hatchery steelhead in the Deschutes River was used to estimate spawning escapement. A catch to escapement ratio of 1:l was used to estimate total steelhead production. The estimated number of steelhead smolts from White River was reduced by 20 percent to account for competition for food and space with resident fish in the basin (Bjornn 1978).

1. Population of resident trout >15 cm. The estimated number of resident trout >15 cm in White River basin in 1984 was used as an estimate of potential production of steelhead smolts. Steelhead smolts in the Deschutes and Warm Springs rivers range from 14 to 22 cm with a 7-year mean of about 18 cm. The estimate of potential based on this method would likely be conservative if resident trout that are older and larger than steelhead smolts are occupying habitat that could be used by juvenile steelhead. The method is also based on abundance of trout in late summer whereas many of the trout >15 cm would have migrated in the previous spring if they had been steelhead.

2. Numerical densities of age 1 steelhead. Biomass (gm/m2) of age 1 and older resident trout in White River streams were matched with biomass of age 1 and older steelhead from streams in Oregon (Maciolek 1979; National Marine Fisheries Service, unpublished data; U.S. Fish and Wildlife Service, unpublished data); Washington (Crawford et al. 1984; U.S. Fish and Wildlife Service, unpublished data); and Idaho (Reiser and Bjornn 1979; Gamblin 1984). Surface areas (m2) of White River streams were multiplied by the numerical densities (fish/m2) of age 1 and older steelhead from streams where steelhead biomass was similar to that of rainbow in White River. Because this was a summer estimate, a 60 percent over-winter survival (Maciolek and Needham 1952; Reimers 1957) was then used to estimate the number of smolts in the following spring.

   The biomass of resident fish in White River basin is an estimate of carrying capacity of the watershed under existing conditions. Sample sites for estimating biomass were selected that typify the habitat of the watershed. It was assumed that trout abundance was not below normal because of low water flows, poor spawning success, fishing pressure, unusual land use practices (such as stream dredging), or other causes. It was also assumed that both resident trout and juvenile steelhead have similar rearing requirements. A smolt migration of age 2 fish was chosen because of its predominance in the Deschutes River (Fessler et al. 1976) and in the John Day River (personal communication on November 28, 1984, with Leslie Lutz, Oregon Department of Fish and Wildlife, Corvallis, Oregon).

   This method uses biomass of fish rather than fish abundance in the White River basin to estimate potential, and is probably a closer estimate of steelhead potential than Method 1. The abundance of resident trout in a stream is likely lower than the abundance of steelhead would be because habitat used by resident trout larger than steelhead smolts would be used by a higher number of juvenile steelhead. In this method, it was assumed the biomass represented by older and larger rainbow would be replaced with an increased number of juvenile steelhead. The White River system appears to be a productive watershed based on densities of resident trout when compared to steelhead streams in Oregon, Washington, and Idaho.

3. Numerical densities of age 0 steelhead. The methodology of this estimate was similar to that of Method 2 except that biomass of age 0 resident trout was used. Because this is a summer estimate of age 0 steelhead, survival was estimated at 35 percent to age 1 (Bjornn 1978; Marshall et al. 1980) and 60 percent over-winter to age 2. This method is likely less accurate because two survival rates were needed to predict the number of steelhead smolts White River would support. Also, abundance of age 0 trout is more difficult to estimate than abundance of age 1 and older trout because the small fish are difficult to capture with electrofishing gear. Consequently, estimates by this method are probably conservative.

4. Population of age 1 resident trout. The methodoiogy of this estimate was similar to that of Method 1 except that age 1 resident trout were used. The abundance of age 1 resident trout was estimated by subtracting the abundance of older trout >15 cm from the abundance of age 1 and older trout >8.1 cm. The length of resident trout at various ages was estimated from scale analysis of resident fish in the White River basin. Production of smolts was then estimated by using a 60 percent over-winter survival rate from age 1. Potential production estimated by this method may be somewhat conservative because older resident trout in the basin would likely have migrated as smolts the previous spring. These older trout may be occupying habitat that could be used to rear more yearling fish.

5. Rearing area required per smolt. Rearing area required per smolt was estimated at 20 m2/smolt (Reiser and Bjornn 1979) in the tributaries and at 40 m2/smolt in White River. Estimated surface area of streams in White River basin was divided by these area requirements to obtain an estimate of potential smolt production. The mainstem value is an average of the Reiser and Bjornn value and the observed area of 60 m^2 per resident fish >15 cm in White River. Information on rearing area requirements of juvenile steelhead is generally lacking in the iiterature, particularly in larger streams.

6. Rearing area required per smolt (20 m2/smolt). The methodology of this estimate was the same as Method 5 except 20 m2/smolt was used for the entire watershed to estimate potential production of steelhead smolts. This method may be somewhat liberal because 56 percent of the surface area in the basin is in the mainstem, which may have a higher area requirement per smolt.

7. Smolts per unit of area. Smolt densities of 0.02 and 0.03 smolts/m^2 from British Columbia (Marshall et al. 1980) and Washington (Johnson 1983) were multiplied by the estimated stream area of White River basin to estimate potential production of steelhead smolts.

8. Numerical densities of age 0 steelhead from Warm Springs and eastern Oregon rivers. Estimated densities (fish/ml) of age 0 steelhead

from the Warm Springs River were multiplied by the surface area of the mainstem and the upper tributaries of White River; estimated densities of age 0 steelhead from five eastern Oregon river systems were multiplied by the estimated stream area of the lower tributaries. T'ne density of age 0 steelhead in the Warm Springs tributaries was estimated at 0.08 fish/m^2 (U.S. Fish and Wildlife Service, unpublished data). The density of age 0 steelhead in the eastern Oregon streams was approximately 0.28 fish/m^2 (Maciolek 1979; National Marine Fisheries Service, unpublished data). Data were from streams believed to have adequate spawning escapement. Survival rates of 35 percent age 0 to age 1 and 60 percent over-winter were used to estimate potential smolt production.

The streams in the upper White River watershed are similar to streams in the Warm Springs basin while streams in the lower White River basin are generally simiiar to streams sampled in the eastern Oregon study. Although the density of age 0 steelhead in the Warm Springs is likely conservative for the upper tributaries of White River, it may be liberal for the mainstem. The density from the eastern Oregon rivers is probably iibera1 for t'ne upper reaches of the lower tributaries. Overall, this estimate may be conservative because White River appears to be more productive than the Warm Springs River. Totai dissolved solids and fish densities were higher in the White River than in the Warm Springs River. Also, the density of steelhead in the Warm Springs tributaries was estimated from limited data (U.S. Fish and Wildlife Service, unpublished data) and is generally higher in other Northwest streams.

9. Numerical densities of age 1 steelhead from Warm Springs and eastern Oregon rivers. The methodology of this estimate was the same as that of Method 8 except that age 1 fish were used. The estimated density of age 1 and older steelhead was 0.05 fish/m^2 in the Warm Springs tributaries and 0.18 fish/m^2 in the eastern Oregon streams. An over-winter survival of 60 percent was used to estimate the number of steelhead smolts.

   This estimate may be somewhat liberal because the density used for the lower watershed (0.18 fish/m^2) appears to be slightly higher than the density of age 1 and older resident trout measured in the lower tributaries (0.15 fish/m^2).

Several methods that were investigated but were not used to estimate steelhead production were: (1) a habitat quality index (Binns and Eiserman 1979; Gamblin 1984); (2) a coastal British Columbia steelhead model (Slaney 1981); (3) a carrying capacity study of juvenile salmonids in northern California streams (Burns 1971); (4) the Washington Department of Game methodologies for setting steelhead escapement goals (Johnson 1983); (5) the USDA FS smolt habitat capability index of the Malheur, Mt. Hood, Cmatilla, and Wallowa-Whitman Sational Forests; (6) returning adults per unit of stream surface area (ODFW 1977); and (7) spawning area required per pair of spawners (Reiser and Bjornn 1979).

Chinook

Of the seven methods used to make the final estimates, no one method was considered to provide the most accurate estimate of potential production of chinook above White River Falls. A smolt to adult survival rate of 1.75 percent was based on data from the Warm Springs River and represents the spawning escapement to the Warm Springs River. A catch to escapement ratio of 1:l was used to estimate total production of spring chinook in White River. A survival rate of 3.5 percent egg to juvenile migrant was also based on data from the Warm Springs River and includes fall and spring migrants.

Some of the methods for estimating chinook production included different levels of use of the Tygh Creek system by chinook. Use of the Tygh system would depend on migration timing of adults and on the effects of high water temperature on chinook holding in lower Tygh and Badger creeks from mid-July to September. Access to the Tygh system would be difficult because of low flows if adult spring chinook did not migrate to the spawning areas until late August as apparently is the case in the Warm Springs River (Confederated Tribes of the Warm Springs Indians, unpublished data).

1. <u>Smolt Productivity Index</u>. McIntyre (1983b) developed a relationship between smolt production (Sm) and mean daily flow in September (cfs) based on data from the Warm Springs, John Day, Lemhi, and Yakima rivers and from Lookingglass Creek:

   $$Sm = 102{,}186.65 \ln (cfs/57) + 7330$$

   In White River, a mean September flow of 124 cfs (1970-1984) measured at the U.S. Geological Survey gaging station near the mouth of White River was used in the model to estimate potential Smolt production.

   Elements in the model were identified that did not take into account some aspects of juvenile life history and the effects of irrigation withdrawals on flow. The model has not been tested. Some assumptions in using the model are that September flow limits production, that streams have the same inherent productivity, and that streams used in the model were seeded to capacity.

2-4. <u>Comparisons to the Warm Springs River</u>. Direct comparisons to the Warm Springs River basin were used to estimate the potential production of migrants and adults in the White River basin. Mean run sizes of 75,000 migrants (combined fall and spring migrants) and 2,800 adults in the Warm Springs basin were prorated by the proportion of drainage area, September flows, and spawning gravel in White River. The estimated production of spring chinook from the Warm Springs River was based on data from years believed to have a good escapement of spring chinook.

Drainage areas are 1,362 km^2 for the 'Warm Springs River and 1,080 km2 for the White River. September flow used in the comparisons were 248 cfs (1976-1982) in the Warm Springs River and 124 cfs (1970-1984) in White River. Spawning gravel in the principal spawning areas of the Warm Springs River was estimated at 11,000 m^2 (telephone conversation on December 11, 1984, with Brian Cates, U.S. Fish and Wildlife Service, Vancouver, WA). Spawning gravel in White River was estimated for three areas based on possible use by spring chinook: (a) no restrictions (9,818 m^2) on the use of Tygh and Badger creeks despite maximum water temperatures that exceed 25°C, low flows, and six diversion dams in the lower reaches of the creeks; (b) limited use (8,720 m^2) of lower Tygh and Badger creeks because of warm water temperatures and low flows, but access is provided to the system; (c) no use (6,715 m^2) of the Tygh Creek system. Only spawning gravel in the lower reaches of White River below km 28.0 was used because of glacial silt deposition in the upper river.

Assumptions of these methods are that the chinook production is related to the variable used for comparison and that the inherent capacities of the White and Warm Springs rivers to produce chinook are comparable, However, most of the streams in White River basin have total dissolved solids 100-150 percent higher than those measured in the Warm Springs River indicating White River is more productive, The mainstem of White River is glacial which could reduce the rearing potential whereas the Warm Springs River is spring fed. The flows of the Warm Springs River and its tributaries are generally more stable than those of White River.

5. Potential use of spawning gravel. Spawning gravel area and redd counts in the spawning areas of the Warm Springs River basin were used to calculate a density of 5 redds/lOO m^2. The density was based on redd counts in 1977, 1978, and 1982 when spawning escapements were adequate to fully seed the Warm Springs River. The area of spawning gravel in White River was multiplied by the redd density. Life history data for Warm Springs River chinook (Jonasson and Lindsay 1983) were used with the predicted redd production of White River to estimate production of juvenile and adult chinook.

Although the ability to accurately classify and measure usable spawning gravel is questionable, this method is based on the use of gravel in the Warm Springs River by chinook spawners. Inaccuracy in assessing spawning gravel is inherent in most surveys, therefore, data on spawning gravel in White and Warm Springs rivers should have similar biases. The use of a redd density to estimate potential utilization of gravel by spawners is more accurate than the use of gravel area required per spawner because the redd density would reflect the selection of usable gravel by spawners as well as territorial behavior of spawners.

The estimate may be somewhat conservative because the redd density from the Warm Springs River was based on an average from three streams. Redd densities *were* higher in the two more important spawning streams than in the average because of the low density in the third stream. In addition, the predicted number of redds in White River streams was used to predict a density of redds per stream length (3.9 redds/km) which was similar to densities in the John Day River of 3.8 redds/km and 4.0 redds/km in 1978 and 1979, respectively (Burck et al. 1980). However, spawning escapements in the John Day River were probably inadequate in these years. Consequently, the estimated production of chinook by Method 5 may be conservative.

6. Rearing densities of the Warm Springs. Numerical densities from the tributaries of the Warm Springs River (U.S. Fish and Wildlife Service, unpublished data) were multiplied by the estimated rearing area of the White River basin (1,424,761 m^2). Because this was a summer estimate, a 60 percent over-winter survival was used to estimate the number of smolts in the following spring.

   Density estimates in the Warm Springs River are based on limited data and are low compared to other streams in the Pacific Northwest. Consequently, the production estimate in White River based on this method is likely conservative. This would be especially true with full use of the Tygh Creek system which appears more productive than the Warm Springs River. However, use of the lower reaches of Tygh and Badger creeks may be limited because of high water temperatures from July to September.

   Data from the John Day River indicated survival of juvenile spring chinook from July to April of the following years was 25 to 29 percent (Lindsay et al. 1981), lower than the 60 percent used in this method. Approximately 55 percent of the juvenile chinook migration in the Warm Springs River occurs from October through December and these fall migrants over-winter in the Deschutes. Assuming a similar fall migration from White River, survival of White River chinook over the winter could be higher than that of John Day chinook.

7. Rearing densities of the Warm Springs and John Day rivers. The methodology was similar to Method 6 except use of the Tygh system was assumed and a density of 0.19 fish/m^2 (Burck et al. 1979, 1980; Lindsay et al. 1981) was used in that system. The 0.05 fish/m^2 from the Warm Springs River was used in the remainder of the White River basin.

   This method accounts for higher productivity of the Tygh system but it assumes access for adult chinook and successful rearing of juveniles in the lower reaches of Tygh and Badger creeks. Because of these assumptions, the estimate may be liberal.

Several methods that were investigated but were not used to estimate chinook production were: (1) a habitat quality index (Binns and Eiserman 1979; Gamblin 1984); (2) a carrying capacity study of spring chinook streams in central Idaho (Sekulich 1980); (3) the USDA FS smolt habitat capability index of the Malheur, Mt. Hood, Umatilla, and Wallowa-Whitman National Forests; (4) returning adults per unit of stream surface area (ODFW 1977); and (5) spawning area required per pair of spawners (Reiser and Bjornn 1979).

Enhancement Opportunities

Although habitat in the White River basin is generally fair-good and will support a successful introduction, production of anadromous and resident fish could be increased by habitat enhancement. Habitat projects have been in progress in the Rocky Burn and will continue whether or not anadromous fish are introduced into White River. Fish and habitat management plans for the White River will include identification of the enhancement opportunities and a tentative schedule for their completion.

The three principal factors that would limit production of anadromous fish in the White River system above White River Falls are: (1) passage barriers to upstream migration (falls, dams, etc.); (2) unscreened irrigation diversions; and (3) low flows and high water temperatures in the lower reaches of Tygh, Jordan, Badger, Gate, Rock, and Threemile creeks.

Passage for adult steelhead and salmon at barriers in the basin and the effects on estimated production of steelhead and salmon were discussed in the previous section. The need to screen irrigation diversions to protect downstream migrants was also discussed earlier and is necessary for successful introductions of steelhead and salmon.

Low flows and high water temperatures in summer may limit salmonid production in 60 km of lower Tygh, Badger, Jordan, Threemile, Rock, and Gate creeks (Tables 14 and 15). The estimated flow in Tygh Creek contributes only about 6 percent of the flow recorded at the USGS gaging station near the mouth of White River from July through September (Table 14). During the rest of the year the flow in Tygh Creek contributes approximately 21 percent of the flow in White River near the mouth. Naturally low flows in the six tributary streams are further reduced by irrigation withdrawals during August and September. In 1983 the flow from July through September was approximately 8 cfs in lower Tygh Creek and the estimated irrigation withdrawals on lower Tygh and Badger Creeks were 30 cfs. Low flows in the tributaries limit upstream and, to some extent, downstream passage, and also limit the potential of rearing areas, holding areas, and spawning gravel for anadromous fish. Low flows also contribute to increased water temperatures.

Water temperatures of 25°C and greater were recorded on the lower reaches of several streams in the basin (Table 15). Deleterious effects of warm water temperatures on growth of juvenile salmonids may be partially offset if the fish have daily relief from maximum water temperatures (Reiser and Bjornn 1979). Diurnal fluctuations in water temperatures of 10°C in lower Tygh Creek appear to reduce the adverse effects of warm daytime temperatures. High densities of resident rainbow trout were measured for many of the lower tributaaries. An analysis of scales taken from these fish indicates they did not ceaase growth during the summer despite warm water temperatures.

Enhancement measures that increase summer rearing habitat and lower water temperatures in the tributaries would increase the production of anadromous fish in White River basin. Small impoundments could be constructed on some tributaries and used to augment summer flows in the streams. Rehabilitation of the riparian zone would also reduce water temperatures and increase summer flows. A preliminary estimate by ODFW indicates that rehabilitation of the riparian zone is needed in about 10 percent of the basin.

While these enhancement meaures would provide the best opportunities for increasing produciton of anadromous fish in White River tasin, other projects would also provide benefits. Enhancement measures such as log weirs to increase pooi habitat, boulders to provide additional cover, and additions of spawning gravel may increase product ion in some streams. Other opportunities would be the use of sections of certain irrigation ditches (Clear and Lost-Boulder) and the use of off-channel ponds to rear juvenile fish.

RESIDENT FISH

introduction of anadromous fish into White River above the falls will likely reduce resident fish populations. After 13 years of planting steelhead fry in Big Springs Creek (Idaho), the population of resident rainbow trout decreased 80 percent from its initial abundance (Bjornn 1978). A similar reduction in resident trout populations is possible in White River primarily because of competition with steelhead. Juvenile rainbow and steelhead are expected to use the same habitat and would compete for food and space. Introduction of anadromous fish into White River basin could also reduce resident populations and affect Oak Springs Hatchery through introduction of fish disease.

Data on res udebt f usg in the White River basin were ccl lected in 1983 and 1984 to determine the potential impacts of the introduction of anadromous fish on res ident specie. Data collected on resident fist. were: species composition, distribution, and abundance ; an analysis of scales from resident trout; and an analys is of the genetic characteristics of native rainbow.

Rainbow trout , Eastern trook trout mountain whitefish, sculpins, longnose dace, and largemouth bass were found in White River basin above the main falls. The most widely distributed species in the basin is rainbow trout (Figure 12). Brook trout are found only in the upper watershed in Boulder, barlow, Clear, and frog Creeks and in upper White River. Sculpins were second only to rainbow trout in distribution (Figure 13).

Trout and whitefish composed 49 percent of the number and 82 percent of the biomass of resident fish sampled in White Riverabove the fails (Figure 14). Whereas sculpins represented 48 percent of the number of fish in the watershed,they composed just 17 percent of the biomass. Largemouth bass were sampled at only cne site in Threemile Creek in 1984. The abundance of largemouth tass was overestimated when the site data were expanded to estimate the population of the reach. Their relative abundance in the basin is low, less than whitefish or hatchery rainbow trout.

Analysis of scales from native trout indicated a predominance of age 1 and age 2 trout in the watershed. Analysis of scales from rainbow trout >30 cm from lower White River indicated first spawning at age 3 (61 percent) and age 4 (31 percent). Although based on a small sample (n=21), scale analysis suggests continued growth of trout after they mature. This is contrary to data on rainbow trout in the Deschutes River that shows little growth after maturity (Fessler and Lichens 1978). The growth of rainbow trout in the lower mainstem was significantly greater than the growth of trout in all other locations. Rainbow trout collected from the lower White River showed a substantial increase in growth which corresponded to their migration into the lower river from July to October.

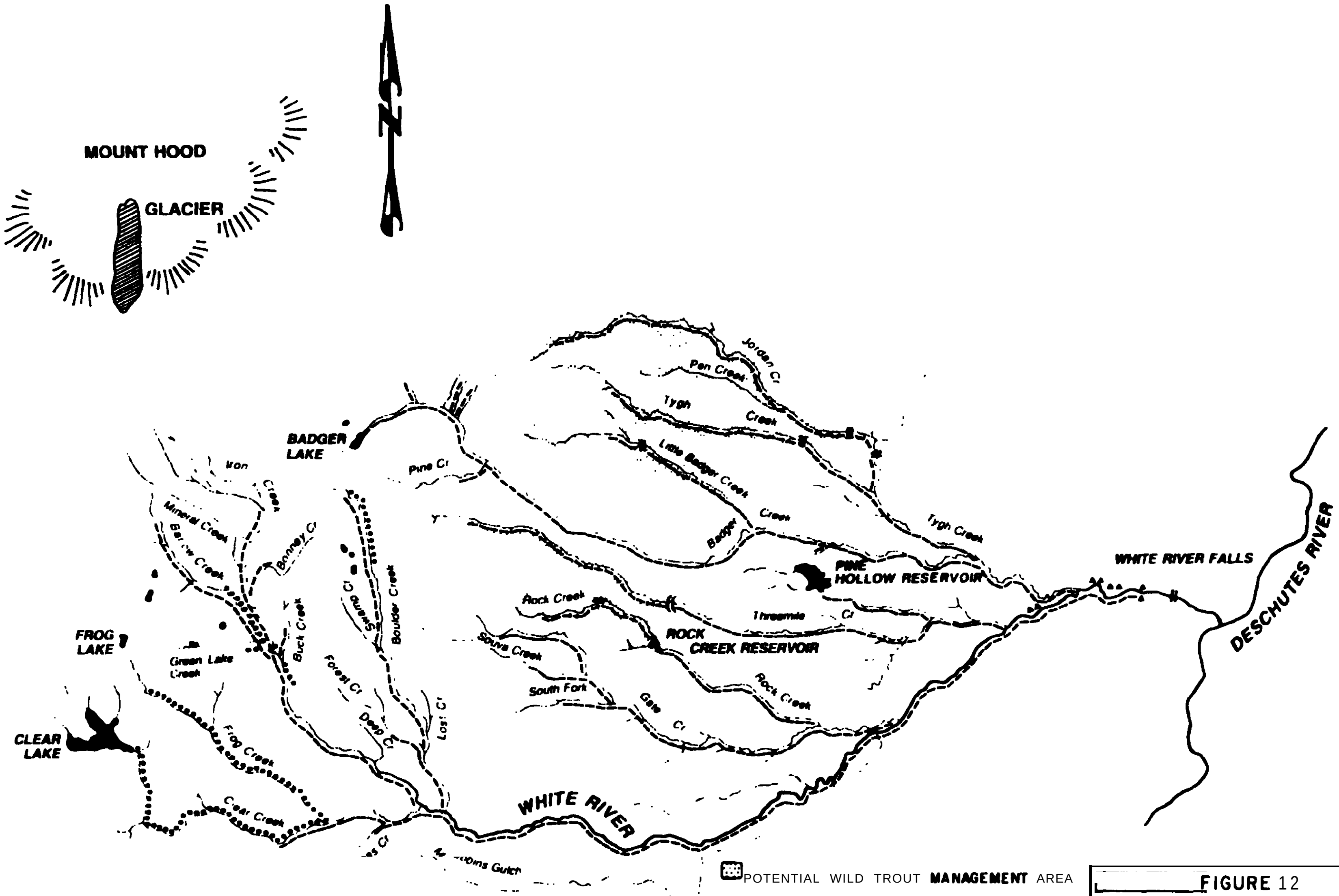
Table 14. Flows at stations in upper White River-and three tributaries (measured with a flow meter) and at the USGS gaging station in lower White River.

Stream	Year	Period	Average flow (cfs)
Tygh Creek (km 1.3)	1983	July-September	8
		October-December	67
	1984	January-March	166
		April-June	67
		July-September	10
Boulder Creek (km 3.5)	1983	July-September	2
		October-December	12
	1984	January-March	--
		April-June	51
		July-September	4
Clear Creek (km 6.0)	1983	July-September	22
		October-December	32
	1984	January-March	--
		April-June	43
		July-September	23
White River - upper (km 59.0)	1983	July-September	75
		October-December	115
	1984	January-March	239
		April-June	248
		July-September	93
White River - lower (km 3.2)	1983	July-September	157
		October-December	241
	1984	January-March	801
		April-June	528
		July-September	166

Table 15. Mean monthly water temperatures (ranges in parentheses) recorded by thermographs in White River basin.

Stream, location (km)	1983 Jul-Sep	1983 Oct-Dec	1984 Jan-Mar	1984 Apr-Jun	1984 Jul-Sep	1984 Oct-Nov
White River						
3.2	13.1(4.7-19.2)	5.1(0.6-13.1)	3.8(0.0-8.8)	9.8(5.3-18.5)	15.1(6.7-22.0)	6.1(2.2-13.0)
59.0	9.3(1.5-16.0)	3.1(0.0-9.8)	1.6(0.0-5.7)	4.8(0.9-13.0)	9.5(5.5-18.0)	3.9(0.5-12.0)
Tygh Creek						
1.3	16.8(8.3-28.3) a/	7.1(0.6-17.0)	4.0(0.0-10.6)	10.6(3.0-23.1)	17.7(6.1-27.8)	6.8(1.7-16.1)
25.4	----	----	----	----	11.6(6.8-15.4)	----
Badger Creek						
18.6	----	----	----	----	12.6(7.2-17.5)	----
Threemile Creek						
19.3	----	----	----	----	12.0(4.9-20.0)	----
Rock Creek						
14.9	----	----	----	----	17.0(7.0-28.6)	----
Gate Creek						
10.0	----	----	----	----	14.9(5.8-22.0)	----
Clear Creek						
6.2	----	----	----	----	9.4(5.4-12.8)	----
Barlow Creek						
5.0	----	----	----	----	9.7(6.4-15.1)	----

a/ August and September only



POTENTIAL WILD TROUT **MANAGEMENT** AREA

-- RAINBOW TROUT

●● **BROOK** TROUT

▲▲ WHITEFISH

4 WATERRLLS

(**DIVERSION** M Y

2 0 2 MILES

2 0 2 KILOMETERS

SCALE

FIGURE 12

WHITE RIVER FALLS FISH PASSAGE PROJECT

DIST. OF RESIDENT SALMONIDS ABOVE THE FALLS AND POTENTIAL SANCTUARIES

DATE: JUNE 1985

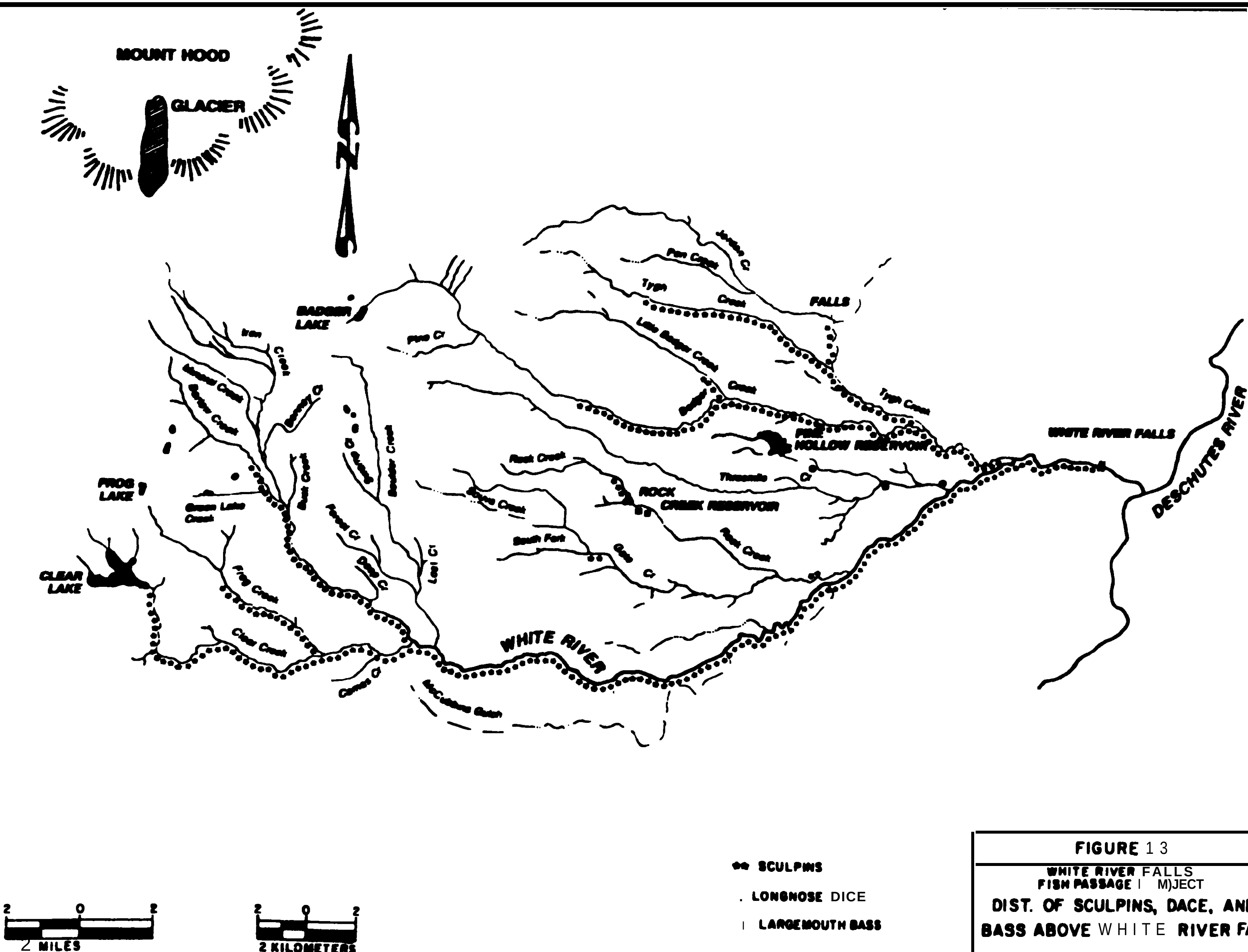


FIGURE 13

WHITE RIVER FALLS
FISH PASSAGE I M)JECT

DIST. OF SCULPINS, DACE, AND BASS ABOVE WHITE RIVER FALLS

DATE: JUNE 1985

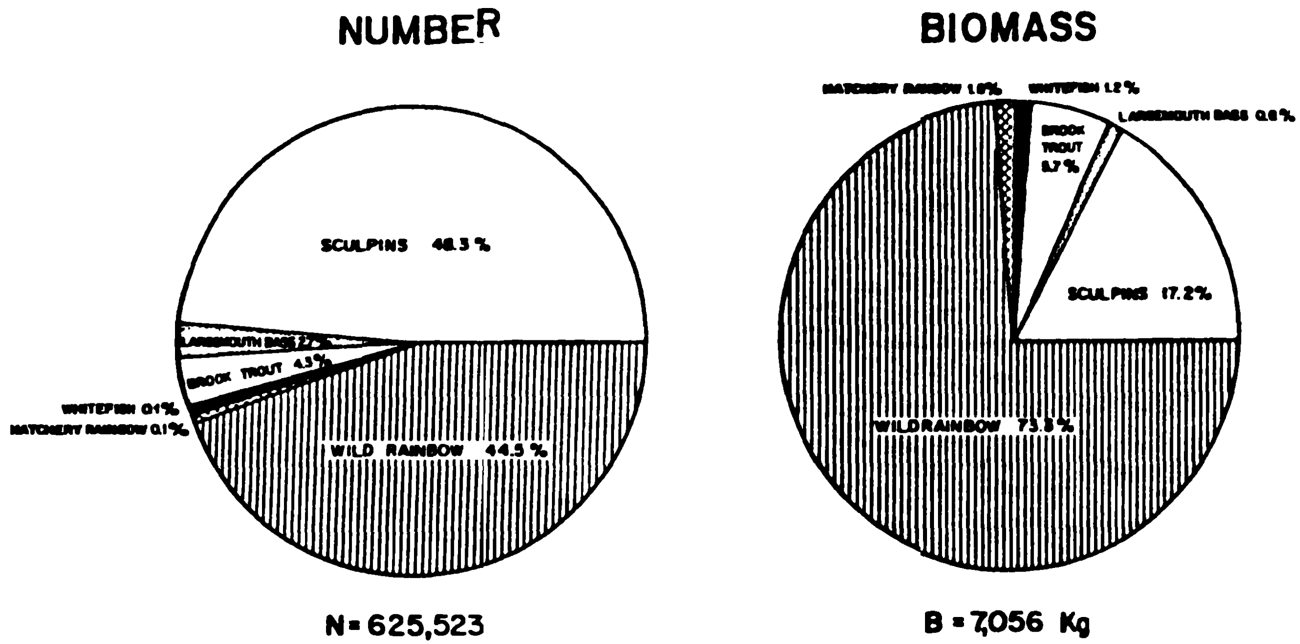


FIGURE 14

WHITE RIVER FALLS
FISH PASSAGE PROJECT

SPECIES COMPOSITION (%) OF RESIDENT FISH IN THE WHITE RIVER WATERSHED, 1984

DATE: JUNE 1985

The genetic structure of fish analyzed by electrophoresis from nine areas in White River watershed and from two locations in the Deschutes River indicated that White River rainbow trout are significantly different from populations of rainbow and steelhead trout from the mainstem of the Deschutes River (Currens 1985). The rainbow trout above White River Falls are also unique among rainbow trout populations from interior streams east of the Cascades because the White River rainbow have very low frequencies of a certain allele (LDH4-76).

Genetic distances were calculated between all possible pairs of rainbow trout populations in sample areas. Identical populations have a genetic distance of 0, whereas populations with completely different gene pools have a genetic distance of 1. Based on samples from nine areas in the basin, three groups of rainbow trout occupy the White River drainage (Figure 15). Rainbow trout in Barlow, Little Badger, and Threemile creeks are significantiy different from rainbow in the other streams. A previously unreported allele in rainbow trout is unique to this group. Rainbow trout in the lower White River, upper Jordan Creek, and Rock Creek are significantly different from rainbow in Gate and Tygh creeks. The analysis of genetic distances indicated there was a high degree of local isolation of the White River populations. Statistical tests of genetic variation also indicated there were significant differences in the genetic segregation of White River populations.

Observed differences between populations in the White and Deschutes rivers are probably not attributed to the influence of hatchery rainbow that have been previously stocked in the White River system. The uniqueness of the White River populations among inland rainbow trout populations because of lack of genetic variation is also probably not due to an influence of hatchery rainbow which generally exhibit a greater genetic variation. The three populations of trout in White River that exhibited greater variation (Lower White River, Lower Tygh Creek, and Rock Creek) have had more opportunity for interaction with hatchery fish.

Resident trout were collected and analyzed at the Fish Disease Laboratory in Corvallis, Oregon, to determine what fish diseases are present in the White River watershed. Neither infectious hematopoietic necrosis (IHN) commonly found in Deschutes River stocks nor infectious pancreatic necrosis (IPN) viruses were found in fish from White River in 1983 and 1984. The level and types of parasites identified in samples from White River are commonly seen in wild fish populations. Results in 1984 (Table 16) are similar to those in 1983 except that no fish were collected from the sample areas where bacterial kidney disease (BKD) was found in 1983.

Ceratomyxa Shasta was not detected in highly susceptible rainbow trout exposed to White River water in 1984 (Table 17). In an ancillary experiment, wild rainbow trout from White River were highly susceptible to C. Shasta when held for 3 weeks in the Deschutes River (Table 17). Both experiments show that C. Shasta found in the Deschutes River is not present in the White River basin.

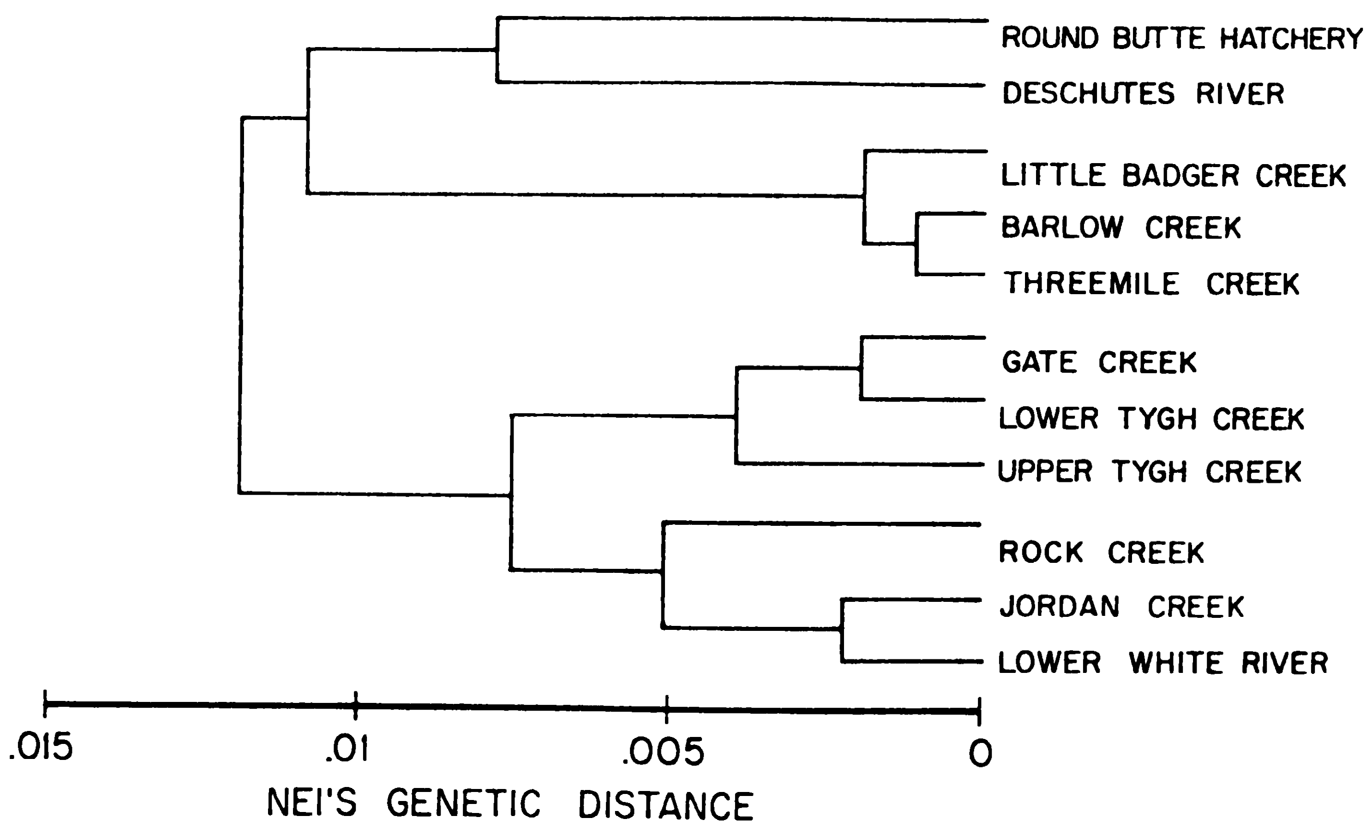


FIGURE 15

WHITE RIVER FALLS
FISH PASSAGE PROJECT

PHENOGRAM OF GENETIC SIMILARITY FOR RAINBOW & STEELHEAD TROUT IN THE WHITE & DESCHUTES RIVERS

DATE JUNE 1985

Table 16. Parasites and bacterial pathogens found in rainbow and brook trout in White River, 1983 and 1984.

Year	Location	Pathogens observed
1983	Badger Lake	Gyrodactylus, copepods, strigeids
	Jordan Creek	Microsporidians
	Tygh Creek	Crepidostomum, strigeids
	White River (lower)	Hexamita, microsporidians, Myxosoma squamalis, Nanophyetus salmincola
	Threemile Creek	Gyrodactylus, N. salmincola, Crepidostomum
	Gate Creek	Gyrodactylus, Crepidostomum, Lactobacillus, motile aeromonad
	Rock Creek	Crepidostomum
	Boulder Creek	Bacterial kidney disease, Gyrodactylus, Trycophrya, Crepidostomum, nematodes
	Clear Lake	Bacterial kidney disease, Cytophaga psychrophila (cold water disease), Chloromyxum, Crepidostomum
	Clear Creek	Bacterial kidney disease, Hexamita, Chloromyxum, Crepidostomum, nematodes
	Barlow Creek	Bacterial kidney disease, Chloromyxum, M. squamalis, Gyrodactylus, Crepidostomum, nematodes
1984	Tygh-Jordan	Epistylis, Scyphidia, trematodes, Crepidostomum, N. salmincola (metacercariae), Aeromonas, Gyrodactylus
	White River (lower)	M. squamalis, myxosporidians (trophozoites), Epistylis, Gyrodactylus, nematode, Crepidostomum, Scyphidia

Table 17. Infection frequencies from Ceratomyxa Shasta in rainbow trout exposed to waters of the Deschutes and White rivers, 1984.

Exposure site	Stock	Exposure dates	Approximate mean water temp. (°C)	Number exposed	Infection frequency (%)
Deschutes River (km 75)	Roaring River	25 May-20 June	13	19	95
	Wild White R.	24 May-20 June	13	80	93
White River (km 5.6)	Roaring River	25 May-20 June	11	50	0

Impacts on Resident Fish

Based on genetic studies, White River contains unique stocks of rainbow trout. Because stocks of trout in the basin are unique, it is important that viable populations of these rainbow are protected. Competition for food and space, and disease from introductions of salmon and steelhead could reduce the abundance of these trout stocks. To protect these unique stocks, wild trout management areas could be provided for populations of native trout without seriously reducing the potential production of salmon or steelhead. Additional genetic analysis of rainbow trout in the basin could be conducted prior to an introduction of anadromous fish to determine the best wild trout management areas that will adequately protect viable populations of the native stocks. Stocks in upper Tygh, Jordan, and Rock creeks could easily be protected because suitable areas lie above existing migration barriers (Figure 12). Stocks in Little Badger and Threemile creeks could be protected by installing barriers in the upper reaches of the creeks. Final designation of wild trout management areas will be done in cooperation with the appropriate management agencies. The estimates of steelhead production in the White River basin included about 9.C km of Little Badger Creek and 4.5 km of Threemile Creek that would not be open for steelhead if barriers were installed to protect rainbow trout. Removal of these two areas would reduce the estimated production of steelhead adults in the basin by 5 percent (105-175 adults). Stream areas in upper Tygh, Jordan, and Rock creeks were not included in the estimates of steelhead production. The production of chinook in the basin would not be affected by designations of trout mangement areas.

The White River basin is not managed exclusively for wild rainbow trout. Hatchery rainbow trout are stocked in lakes, reservoirs, and streams in the basin. much of the resident trout fishery in streams in the White River basin is in lower and middle White River and in Badger Creek in the Bonney Crossing area (personal communication on 21 February 1985 with James Newton, ODFW, The Dalles, Oregon). These fisheries are supported in large part, by stocking of hatchery rainbow trout. Stocking of White River and Badger Creek with hatchery trout could continue in the spring and early summer without affecting steelhead smolts. The remainder of the basin supports a fishery on resident trout 15 to 25 cm and this fishery would not be greatly affected if resident trout were displaced by steelhead as it would partially be replaced with a fishery on juvenile steelhead. Harvest of juvenile steelhead would probably not decrease the production of steelhead in the basin because much of the basin has limited road access to streams on public lands and limited access to streams on private land. Any loss of resident trout fisheries might be offset by allowing a steelhead fishery on adults in the mainstem White River after steelhead have become established. The extent of a steelhead fishery in White River would depend, in part, on the seasonal timing of the adult run into the mainstem.

Oak Springs Hatchery Contamination

Protection of the Oak Springs Hatchery from contamination by IHN and IPN viruses is a major consideration in the White River Falls project. Oak Springs Hatchery and resident fish in White River above the falls are free of IHN and IPN viruses. Salmon and steelhead from the Deschutes River that are introduced into White River above the falls would likely be carriers of IHN or IPN. The potential for viral contamination of Oak Springs Hatchery is from surface water and groundwater connections between the hatchery water supply and the White River watershed.

The water supply for Oak Springs Hatchery is from springs in the Deschutes River canyon on the east end of Juniper Flat. Wastewater from the Clear Creek ditch overflows into the hatchery water supply. Irrigation water for the Clear Creek ditch is diverted from Clear and Frog creeks (Figure 6).

The probability of contaminating Oak Springs Hatchery through groundwater (springs) is likely to be quite small. The concentration of viruses in Clear and Frog creeks would be extremely low. The portion of stream water that becomes groundwater is small, and the amount of groundwater (White River source) that actually reaches Oak Springs Hatchery is even smaller. Consequently, the potentiai concentration of viruses in Oak Springs Hatchery is diluted, and the probability of contaminating the hatchery with virus is small.

In contrast, the surface water connection between the White River and Oak Springs Hatchery water supply is not diluted as is the groundwater. Fish spawning in Clear or Frog creeks above the diversions would use water that is transported in the Clear Creek Ditch, which overflows into the hatchery water supply. The actual concentration of viruses in the irrigation ditches, although low, is never diluted; only the volume of water carrying the viruses would be decreased by irrigation withdrawals. Since no dilution occurs, the potential for contamination by surface waters is much higher than by groundwater.

A number of potential solutions were identified to prevent contamination of Oak Springs Hatchery by surface water. The two most reasonable approaches include: (1) construct a barrier on Clear Creek downstream of the confluence of Clear and Frog creeks; and (2) divert the waste flow from the Clear Creek ditch away from Oak Springs Hatchery.

Of the two approaches, diversion of surface flows from Oak Springs Hatchery is the most direct and the most cost effective. This could be accomplished by collecting the flow at a low diversion structure at the waste pond overflow and piping the overflow along the west slope of the Deschutes Canyon to the Deschutes River. The cost of the first approach, construction of a barrier dam, would be substantially greater and would remove 11.5 km of good fish habitat for anadromous fish.

Because of the apparently low potential for contamination by groundwater, the ODFW is willing to accept the risk posed by groundwater. It will be necessary, however, to divert surface flows from the Clear Creek ditch prior to the introduction of salmon and steelhead into White River basin.

CHAPTER III

PASSAGE AT WHITE RIVER FALLS

Passage at White River Falls for upstream and downstream migrants was studied in 1983 and 1984 by ODFW and OTT. The concern for downstream migrants is survivial of juvenile fish at the upper and middle falls, a drop of approximately 43 m (140 ft). The concern for upstream passage is to determine a passage method that is cost-effective, reliable, and able to pass only rarget species. The following sections discuss passage of downstream and *upstream migrants.

White River Falls has a drop of 55 m over a distance of 430 m from the upper falls to the lower falls. For reference, the upper, middle, and lower falls are numbered falls one, two, and three, respectively. At the head of falls one is an old concrete diversion weir which extends the width of White River and was used to divert water into a penstock for hydropower. A powerhouse below falls two was operated by Pacific Power & Light Company from 1910 to 96.3 A new powerhouse has been proposed by NWCPUD and would be located 274 m below falls three.

SOUNSTREAM PASSAGE

Survival of juvenile salmonids over White River Falls was measured during high and low flow periods in 1983 and 1984. The test group was released above the falls, and the control group was released below the falls. Both groups were recaptured in a floating scoop trap below the control release site.

Results of tests conducted during high flows (300 to 600 cfs) in 1983 and 1984 indicated juvenile steelhead had 100 percent survival and juvenile chinook averaged 40 percent survival after passing over White River Falls. Results from tests at low flows (100 to 300 cfs) in 1983 and 1984 indicated a 72 percent survival for juvenile chinook. So steelhead were released at low flows.

Survival rates of test fish over the falls varied between 1983 and 1384, and among release sites above the falls. Survival of spring chinook at high flows in 1984 was 80 percent compared to 100 percent in 1983 (Table 18). Higher survival in 1983 may have been due to a greater flow in the main channel over the falls. The old penstock in the north channel above the falls was plugged with debris in the spring 1983 which increased flow in the main channel. In 1984, the penstock was open and there was less flow in the main channel.

Spring chinook released at low flows in October had an 88 percent survival Over the falls in 1954, compared with a 57 percent survival in 1983 (Table 18). The apparent increase in survival in 1984 may have been due to the release of healthier and larger fish. The fall release of test fish infected with BKD in 1983 may have decreased survival over White River Falls. A comparison of size of fish at release with size at recapture in 1983 suggested that smaller fish either survived over the falls at a lower rate or did not aigrate as well as larger fish.

Table 18. Survival of juvenile chinook and steelhead released above White River Falls during high and low flow periods in 1983 and 1984.

		Survival (%)	
Species	Flow	1983	1984
Chinook	High	100	80
	Low	57	88
Steelhead	High	100	100
	Low	--	--

KAnderson:paw(WP-PJS-518ON)

Survival of juvenile fish over White River Falls appears to be high enough to make facilities for downstream passage unnecessary at this time. This would reduce the cost of the project because construction and maintenance of juvenile facilities would be expensive. However, variability in study results suggests the need for juvenile passage facilities at the falls will depend on the timing of the juvenile outmigration of introduced fish and on the distribution of migrants in the river channel above the falls.

UPSTREAM PASSAGE

Providing passage for adult fish over White River Falls is complicated by steep canyon walls and lack of access. Hydropower is proposed at the site and includes an intake upstream of falls one and a powerhouse downstream of falls three.

Twelve preliminary alternatives for upstream passage at White River Falls were objectively identified by OTT at the outset of the project. Those alternatives and the evaluation process are presented in Volume III. Of the 12 alternatives, four were selected for further study and developed to the "conceptual" level of design. The four alternatives are: (1) a fishway from falls three; (2) a fishway from the proposed powerhouse; (3) a trap and haul at falls three; and (4) a trap and haul at the proposed powerhouse. The fourth alternative, a trap and haul at the proposed powerhouse, was selected as the preferred method of passage for adults at White River Falls.

Alternative Designs

A description of the four alternatives that were developed to a predesign level are discussed in this section. A more detailed description of the alternatives is presented in Volume III.

Alternative 1 -- Fishway from Falls Three

Alternative 1 is a fishway from falls three as shown in Figures 16, 17, 18, and 19. The 549 m (1800 ft) long fishway would be constructed along the left (north) bank of White River. Fish would enter the fishway at falls three and exit from the headworks adjacent to the existing diversion weir. The vertical drop between entrance and exit of the fishway is approximately 55 m (180 ft).

The fishway would be the vertical slot type with 3.05 m (10 ft) long by 1.8 m (6 ft) wide pools. Maximum water surface drop between pools would be 0.3 m (1 ft). The total depth of flow would vary between 1.2 m (4 ft), at 25 cfs and 1.8 m (6 ft) at 42 cfs. The jet velocity at the fishway entrance and pool slots would be between 4 and 8 fps. Average velocity in the fishway pool would be approximately 1 foot per second (fps). The vertical slots would self-regulate flow under the fluctuating head of 0.6 m (2 ft).

The fish ladder entrance would be placed adjacent to the lower falls which creates a natural barrier to fish. To help fish find the ladder entrance, approximately 25 cfs of attraction flow would be added to the fishway flow

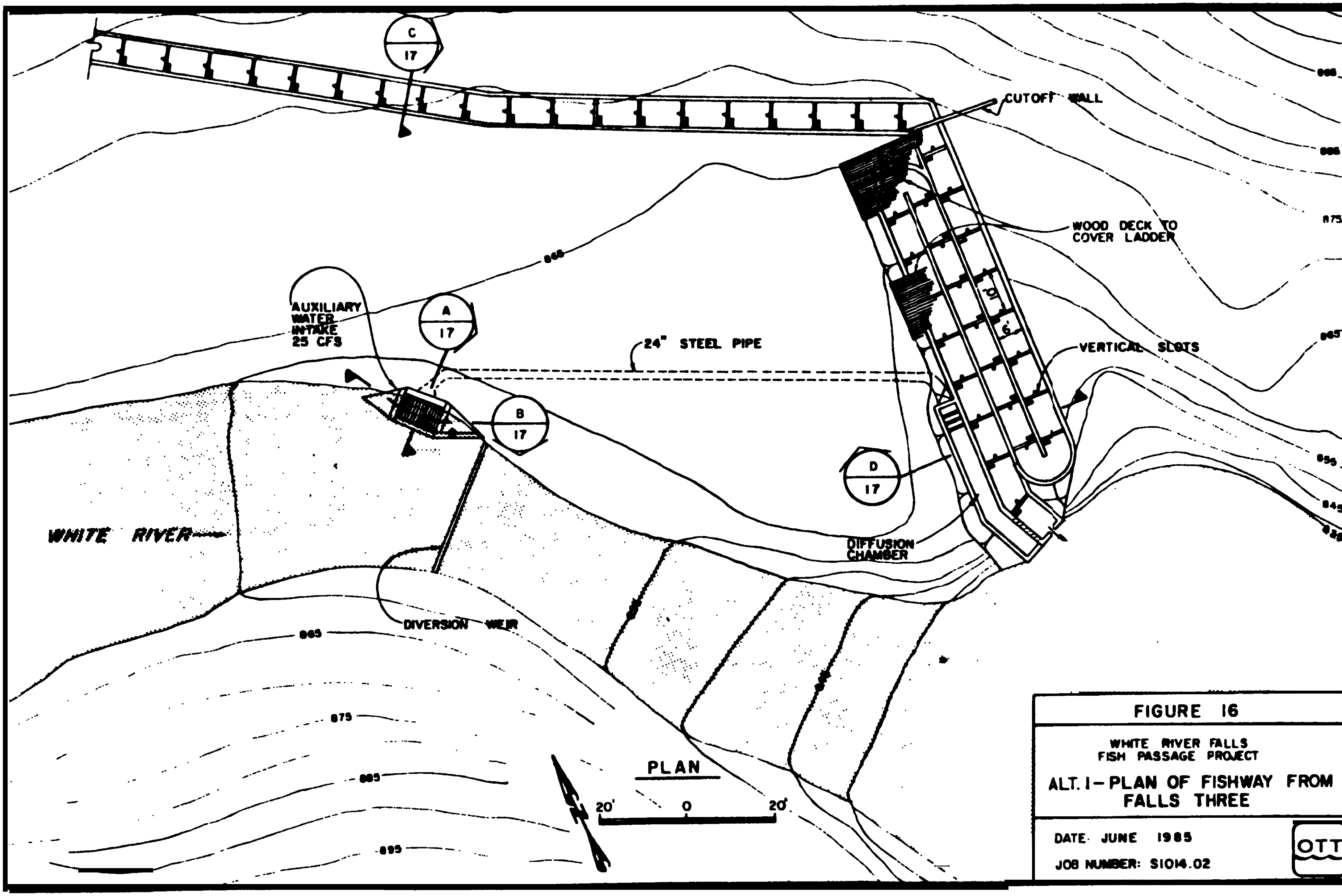


FIGURE 16

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. I – PLAN OF FISHWAY FROM FALLS THREE

DATE JUNE 1985

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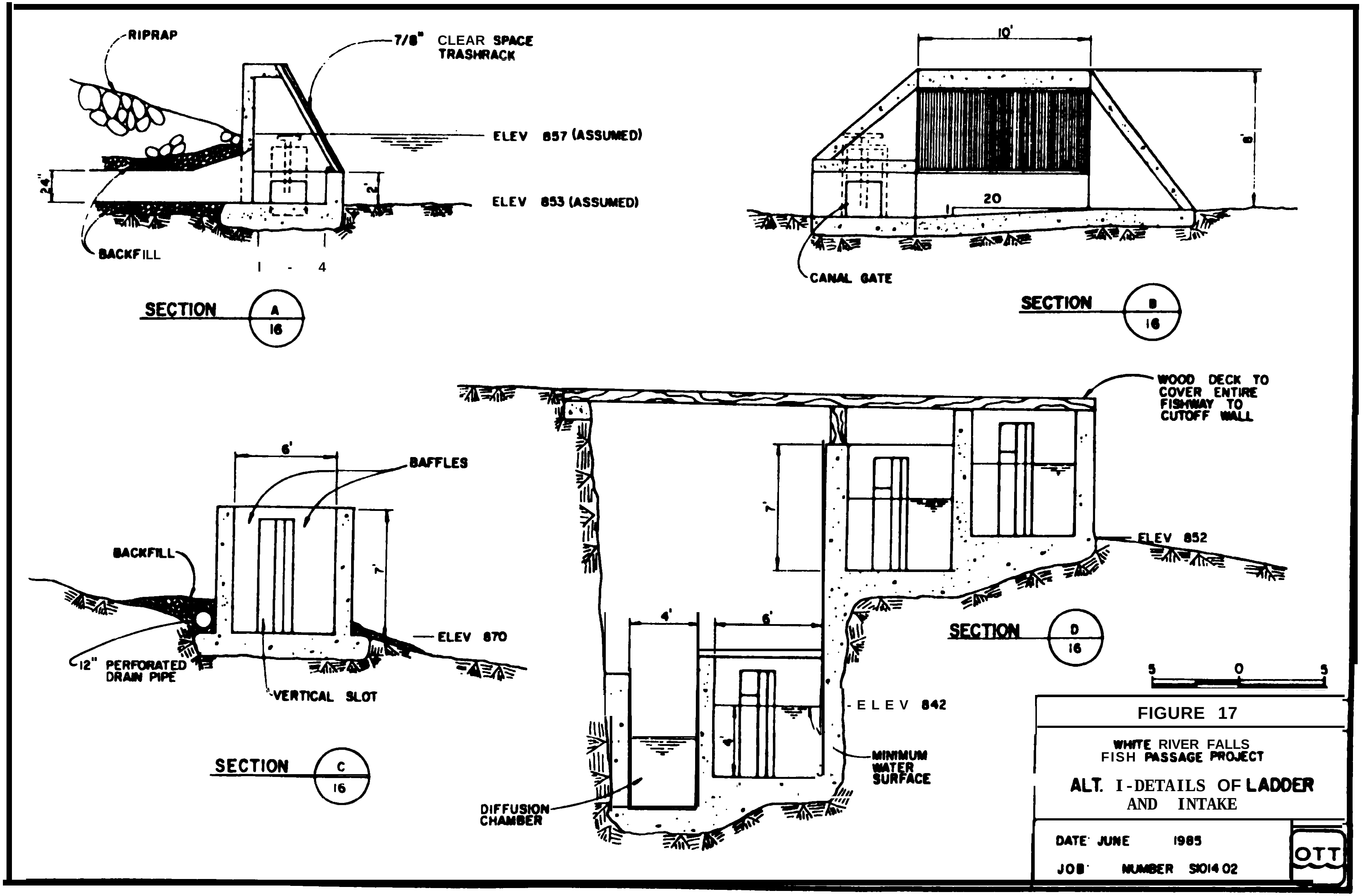

FIGURE 17

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. I-DETAILS OF LADDER AND INTAKE

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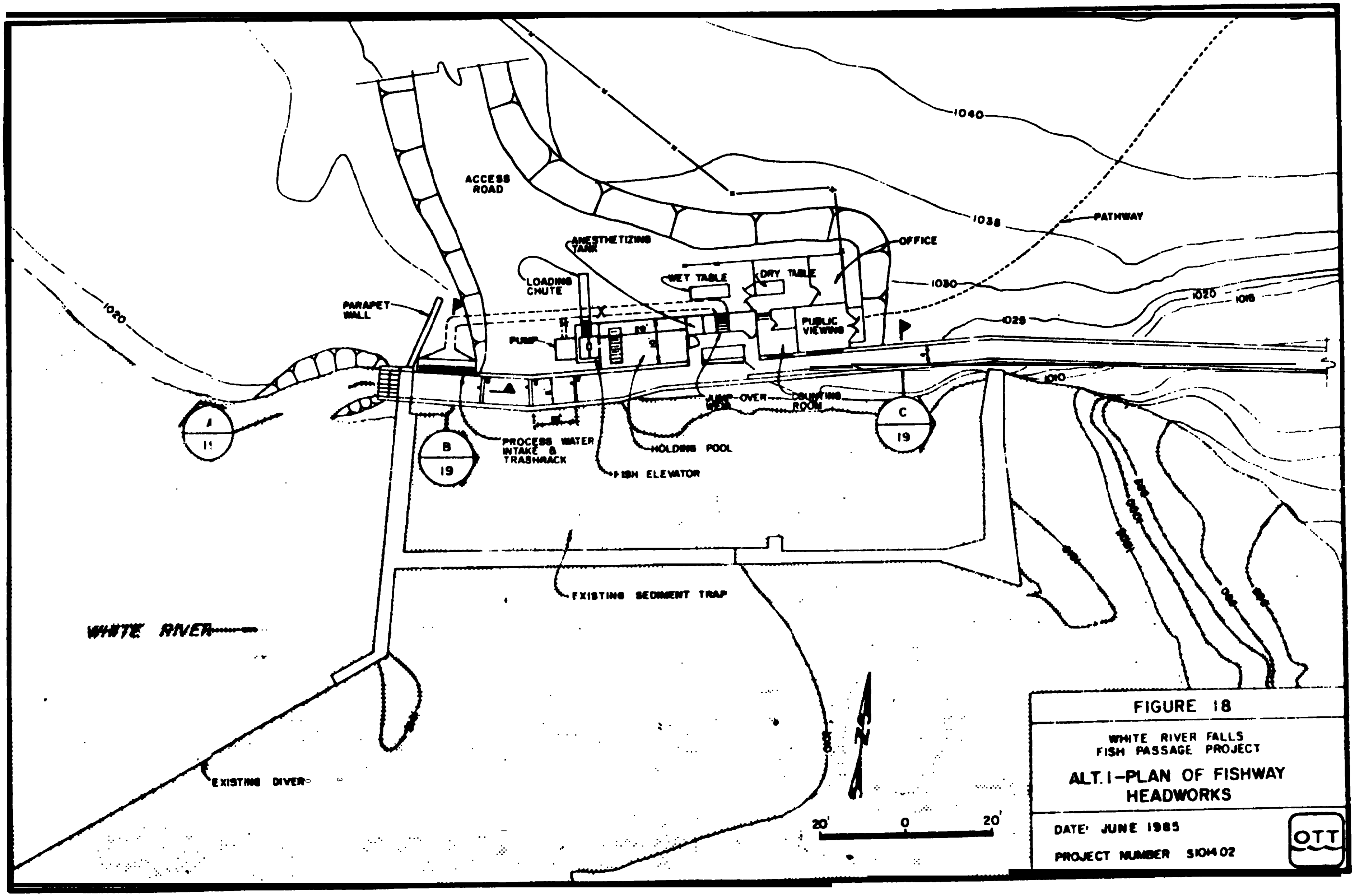
ACCESS ROAD
ANESTHETIZING TANK
LOADING CHUTE
WET TABLE
DRY TABLE
OFFICE
PATHWAY
PUBLIC VIEWING
PARAPET WALL
PUMP
JUMP OVER WEIR
COUNTING ROOM
PROCESS WATER INTAKE & TRASHRACK
HOLDING POOL
FISH ELEVATOR
EXISTING SEDIMENT TRAP
WHITE RIVER
EXISTING DIVER
1040
1038
1030
1020
1016
1028
1010
1020
A
B
19
C
19
20'
0
20'
FIGURE 18
WHITE RIVER FALLS
FISH PASSAGE PROJECT
ALT. I-PLAN OF FISHWAY
HEADWORKS
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PROJECT NUMBER 51014.02
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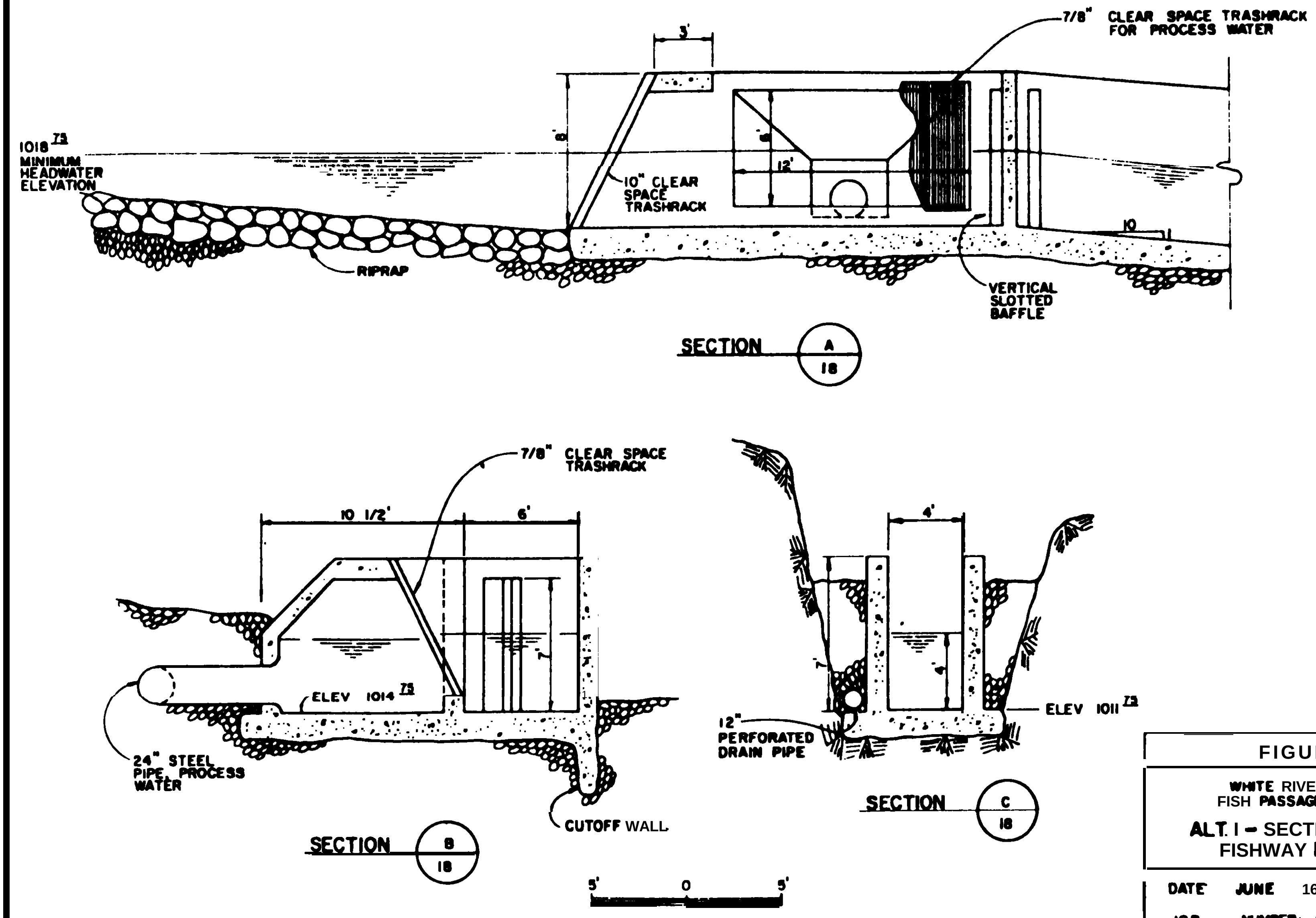

FIGURE 19

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. I - SECTIONS THROUGH FISHWAY HEADWORKS.

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JOB NUMBER SI014 02

OTT

through a diffusion chamber at the entrance. Vertical vanes would guide the flow and prevent fish from entering the diffusion chamber. The attraction flow would be gravity fed from an auxiliary water intake above the falls and flow rate would be controlled by a valve.

Special switchbacks in the fishway at three locations will be required to maintain the uniform hydraulic gradient because of steep cliffs. The first of these, as shown in Figure 16, is at falls three near the fishway entrance. It would contain 24 pools in three rows and would be covered by a wooden deck. The wooden deck would keep debris and bedload out of the structure during flooding at high flows. The remaining two switchback structures would be located above the of powerhouse.

The fishway exit would be located upstream of falls one, just above the existing diversion weir. Any planned evaluation facilities would also be located there. The fishway would be constructed entirely of reinforced concrete including cast-in-place slabs and precast slotted baffled walls. The side walls would be cast-in-place concrete.

Alternative 2 -- Fishway from Proposed Powerhouse

Alternative 2 is a fishway from the proposed powerhouse 274 m (900 feet) below falls three as shown in Figures 20, 21, 22, and 23. The 915 m (3,000 ft) long fishway would be constructed along the left (north) bank of the White River. The fishway entrance would be in the tailrace of the proposed powerhouse below a concrete barrier dam crossing the river. The exit would be above falls one above the proposed hydropower diversion weir. The vertical drop between entrance and exit of the fishway is approximately 57 m (187 ft).

A concrete barrier dam would be constructed in the river upstream of the proposed powerhouse tailrace. The barrier would be designed to prevent fish from passing upstream while directing them to enter the fishway. The central 24 m (80 ft) long spiilway would be an ogee-type with a swimming barrier on the downstream face. The adjacent right and left bank sections of the dam would be 36.3 m (119 ft) and 9.15 m (30 ft) long, respectively, and would be buttressed reinforced concrete retaining walls. The downstream face of the retaining walls would be protected with grouted riprap. The walls would vary uniformly in height with sloping footings and top. The central spillway would be designed to pass the lo-year flood while the right and left bank sections would contain the 100-year flood.

The intake structure located in the barrier wall would provide up to 65 cfs of auxiliary water to the fishway intake by gravity flow. The flow rate, controlled by a valve, would enter the fishway through a diffusion chamber at the fishway entrance pool. The auxiliary water would help to create adequate momentum to attract fish to the two fishway entrances. As seen in Figure 22, the entrance at the powerhouse face would pass fish when the adjacent turbine is not operating. The second entrance, placed below the boil from turbine units, would pass fish when all units are operating.

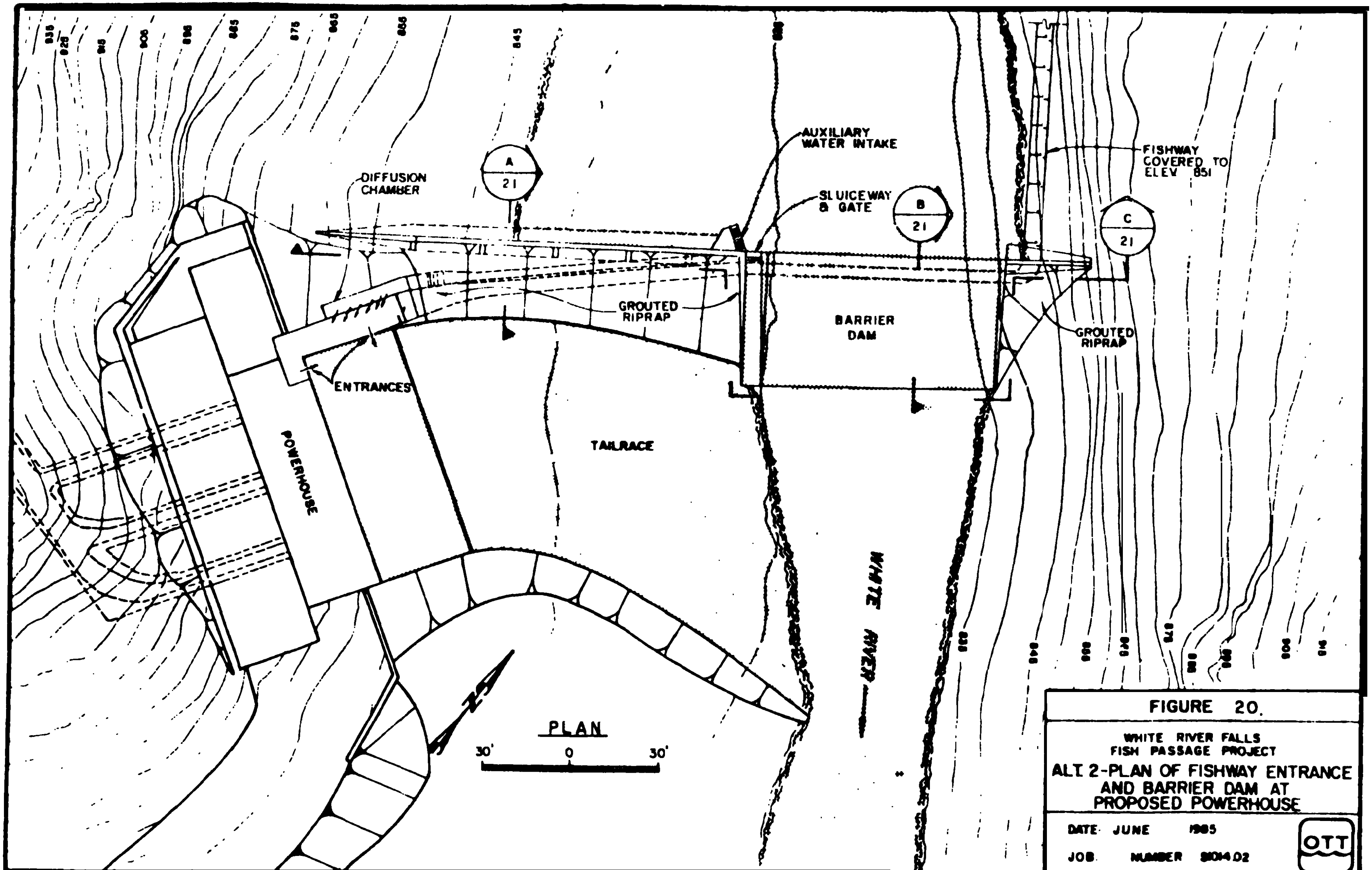

FIGURE 20.

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. 2-PLAN OF FISHWAY ENTRANCE AND BARRIER DAM AT PROPOSED POWERHOUSE

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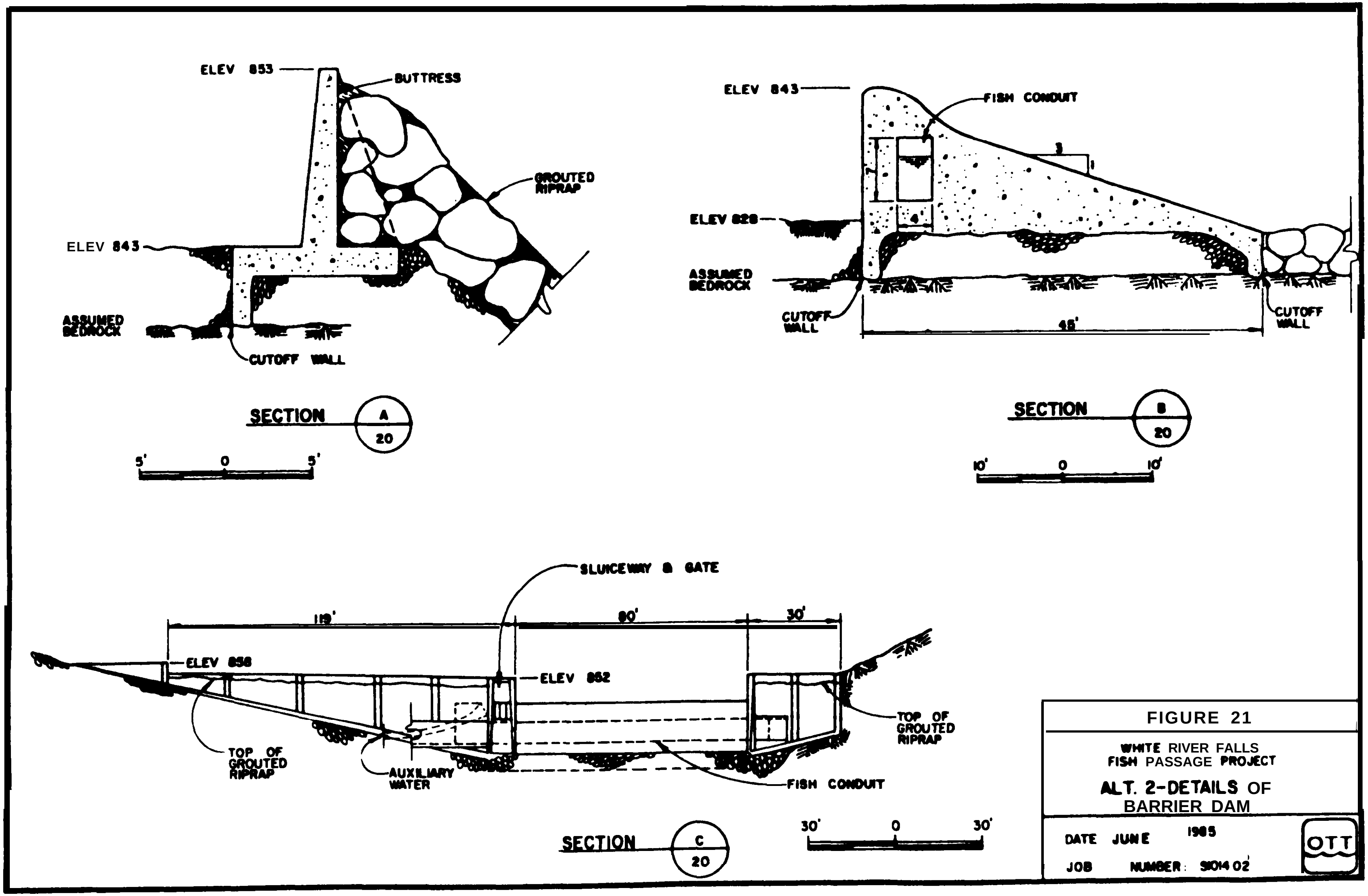

FIGURE 21

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. 2-DETAILS OF
BARRIER DAM

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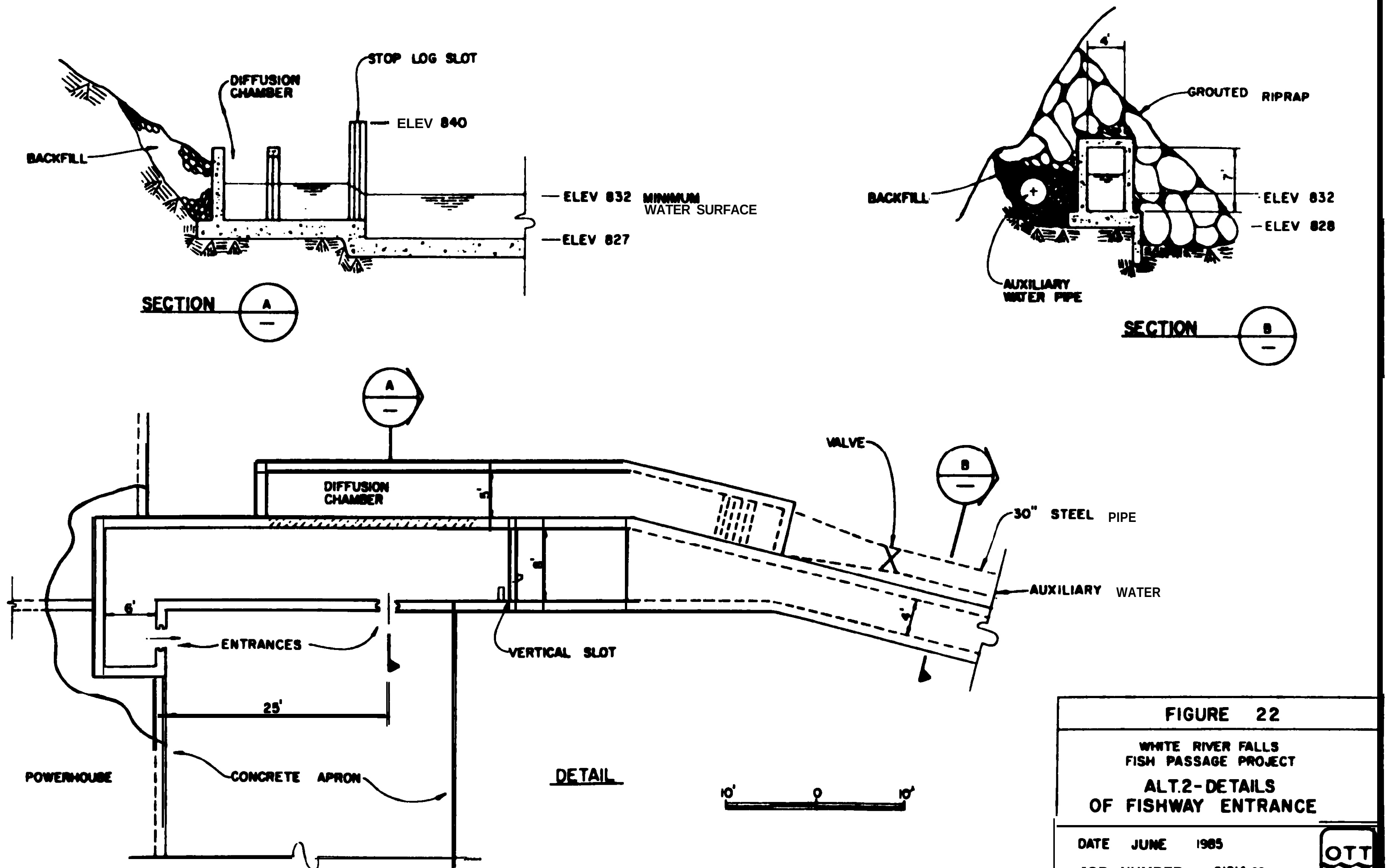

FIGURE 22

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT.2-DETAILS
OF FISHWAY ENTRANCE

DATE JUNE 1985

JOB NUMBER: S1014 02

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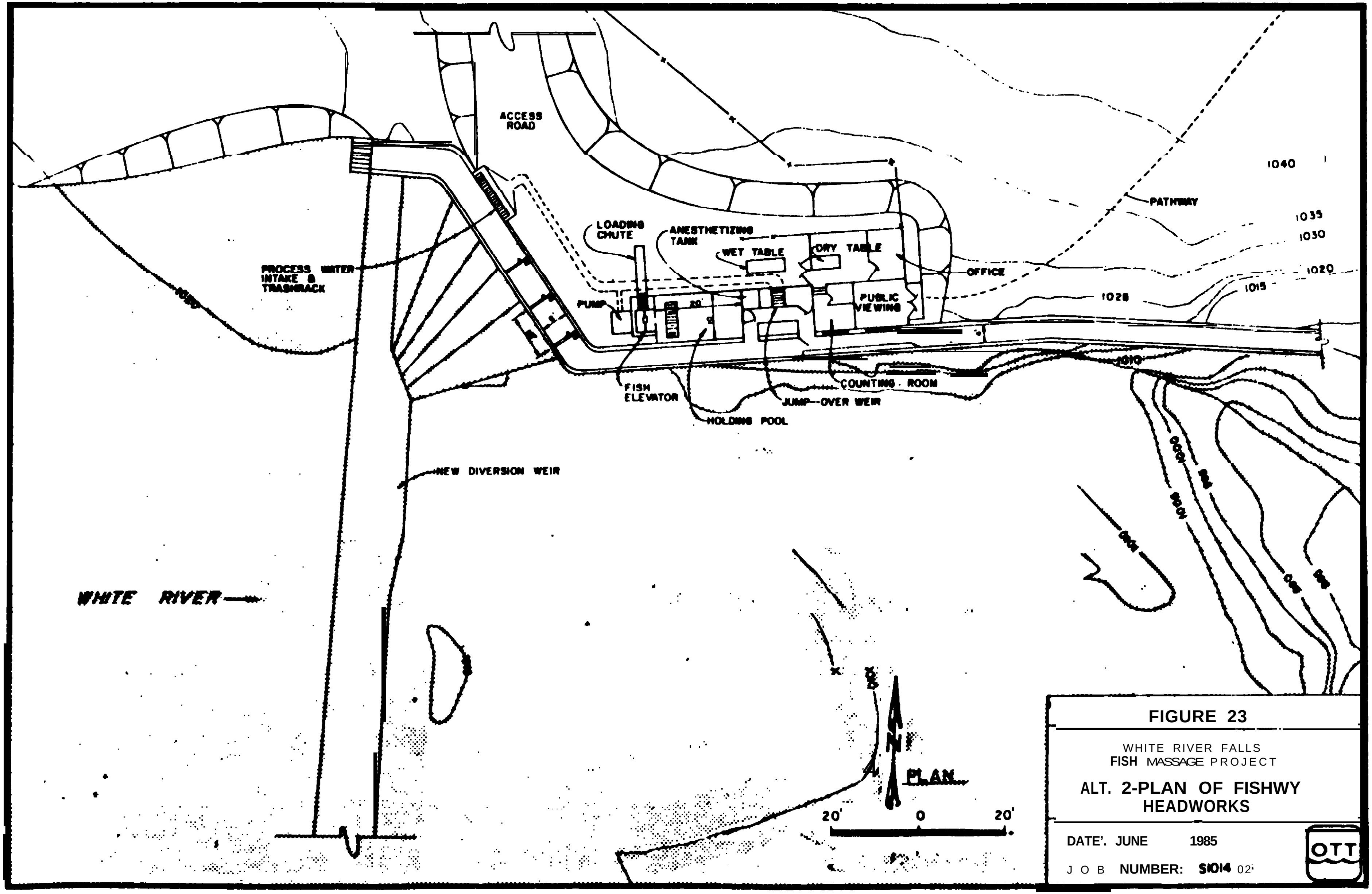

FIGURE 23

WHITE RIVER FALLS
FISH MASSAGE PROJECT

ALT. 2-PLAN OF FISHWY HEADWORKS

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Due to the site restrictions and steep terrain on the right bank of the White River, the fish ladder would cross to the left bank of the river inside a concrete conduit within the barrier dam. The conduit would be 1.2 m (4 ft) wide by 2.1 m (7 ft) high and would be designed to flow partially full at less than 2 fps. After crossing the river, the fishway would follow the left bank until it intersected the same route as the fishway from falls three (Alternative 1).

The fishway would be a vertical-slot type with the same characteristics as the Alternative 1 fishway. The fishway exit would be located above the proposed hydropower diversion weir upstream of falls one. Fish evaluation facilities could be located near the fishway exit on the left bank upstream of falls one. Access to the fishway, from the exit to the barrier dam, would be provided by a pathway adjacent to the fishway. The fishway entrance adjacent to the powerhouse on the south side of the river would be reached using the powerhouse access road.

Alternative 3 -- Trap and Haul at Falls Three

Alternative 3 is a trap and haul system as shown in Figures 24, 25, and 26 located at the left bank of falls three. A switch-backed ladder would be required to transport the fish 9.75 m (32 ft) from the base of the falls to the trap facility above the falls.

The trap entrance, as seen in Figure 24, would be similar in appearance to the switchback entrance used for the Alternative 1 fishway. In this case, however, the baffles between pools would be half Ice Harbor weirs. The half Ice Harbor weirs would maintain a relatively constant water surface elevation at the trap facility regardless of the water surface fluctuations in the river at the trap entrance. The pools would be 3.05 m (10 ft) long and 1.8 m (6 ft) wide with a depth of approximately 1.8 m at 25 cfs. The half Ice Harbor weir would be fashioned with a bottom orifice, 548 cm (18 in) high by 457 cm (15 in) wide, which would pass both fish and bedload. Fish generally prefer the orifice to jumping over the weir. Maximum water surface drop between pools would be 0.3 m (1 ft). Flow velocity through the orifices and the ladder entrance slot would be between 4 and 8 fps.

As in the Alternative 1 fishway, the lower falls will serve as a natural barrier to prevent migrating fish from moving beyond the ladder entrance. Approximately 20 cfs of auxiliary water will be diverted at the intake above falls three and flow to a diffusion chamber at the ladder entrance. As discussed earlier, the auxiliary water will help attract fish away from the falls and to the ladder.

The fish trapping facility would be located above the falls at the end of the 32-pool fishway. The trapping facility would consist of a vee trap, a holding pool, fish crowder, and a fish elevator with loading chutes. A pump station would provide flow to the holding pool and elevator shaft. The pump station would contain two gravity fed propeller pumps; each capable of pumping 25 cfs. One pump would serve as backup in case of mechanical failure.

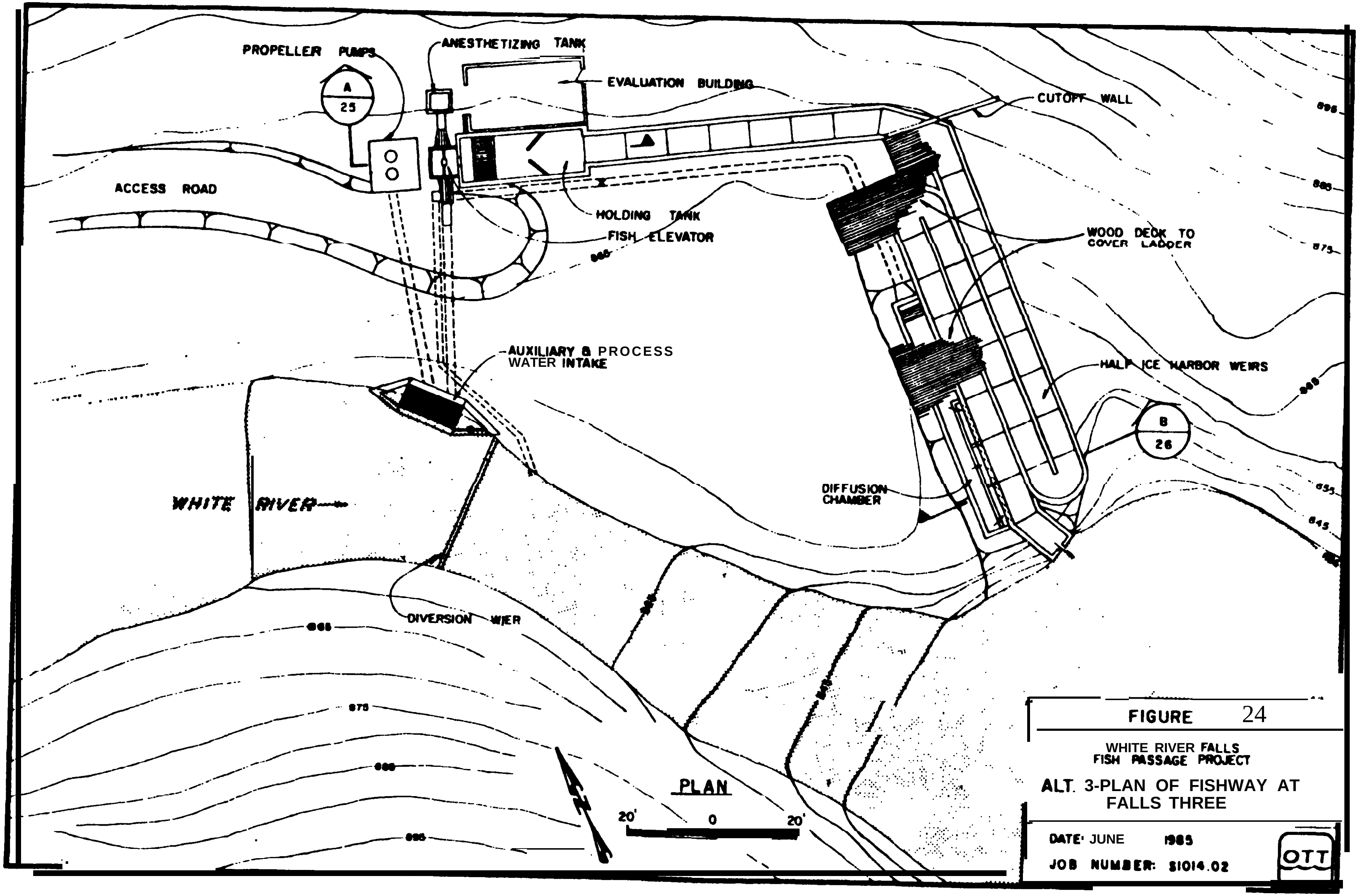

FIGURE 24

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. 3-PLAN OF FISHWAY AT FALLS THREE

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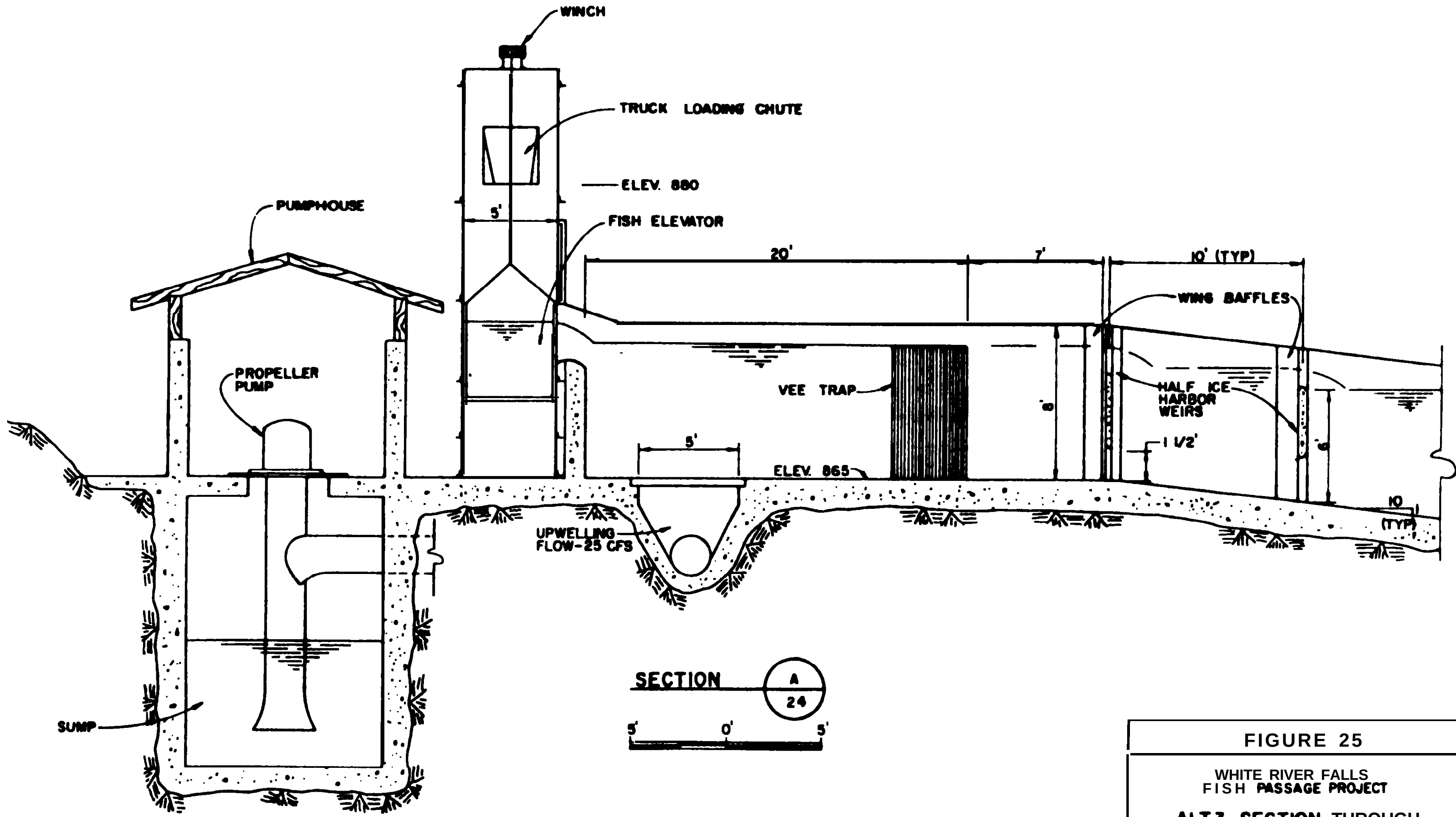

FIGURE 25

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT.3-SECTION THROUGH FISH TRAP ENTRANCE

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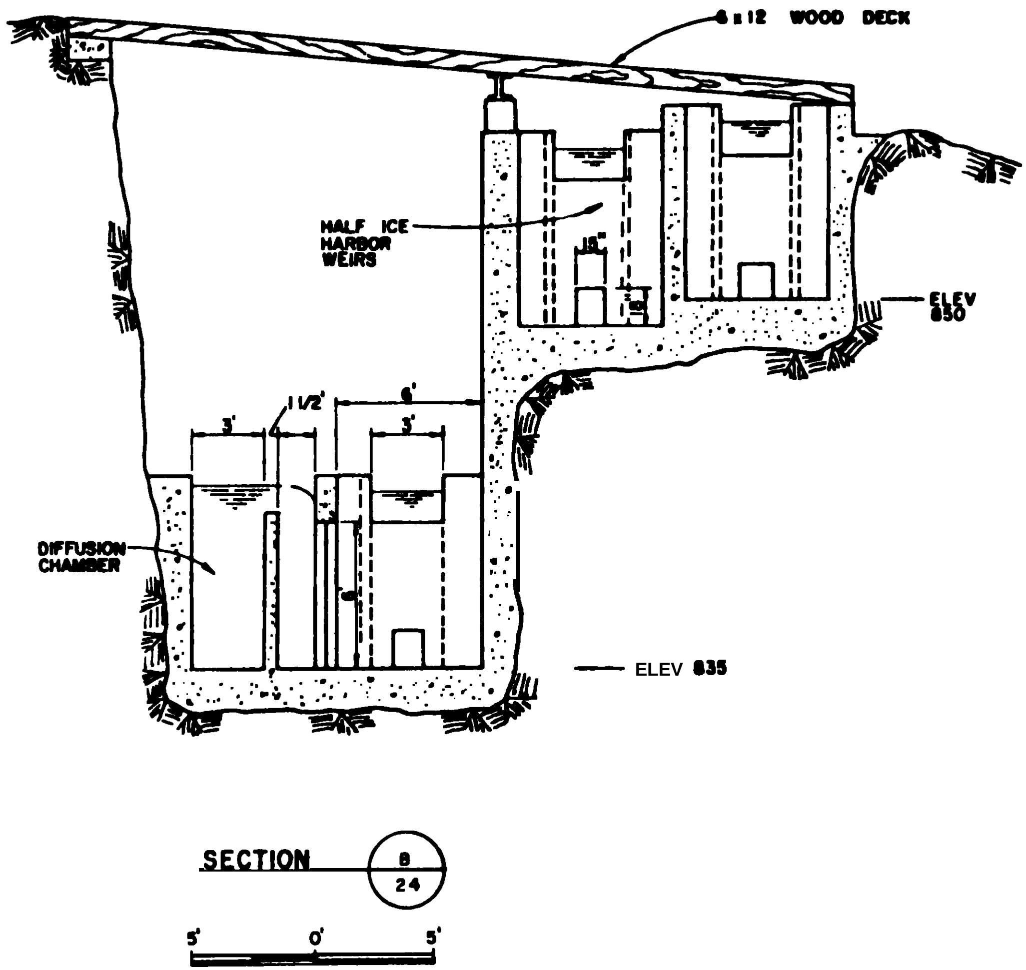

FIGURE 26

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. 3-SECTION THROUGH
FISH TRAP ENTRANCE

DATE: JUNE 1985
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The trap and holding pool would be 3.05 m (10 ft) wide and 8.2 m (27 ft) long. The vee trap would funnel fish into the holding pool while 25 cfs of upwelling flow keeps the holding pool water fresh and aerated. This flow would exit through the trap and continue down the ladder. An elevator at the end of the holding tank would contain a 1.5 m (5 ft) square punched aluminum fish hoisting brail.

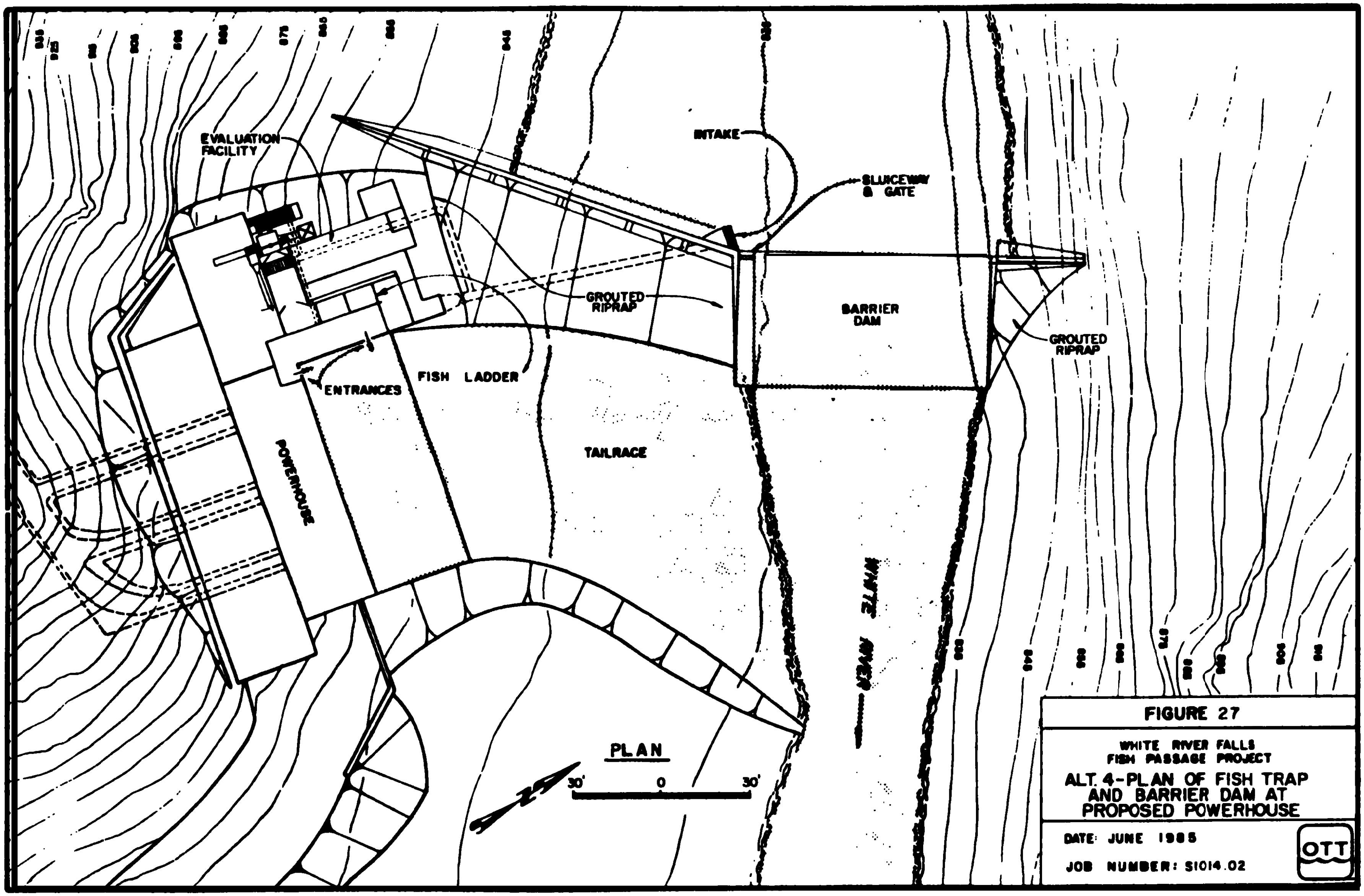
The fish trap facility would have a capacity of up to 30 fish per loading cycle. When the desired number of fish have moved through the vee trap into the holding tank, the operator would turn a valve to divert part of the 25 cfs of upwelling flow into the fish elevator shaft. This new flow pattern would attract fish "upstream'* into the elevator. The operator then would activate the crowder to force the fish to the elevator. The crowder would be a vertical punched aluminum plate which would extend from side to side and top to bottom of the holding tank. The crowder plate would move on rails from the vee trap toward the elevator. After fish are in the elevator, the operator would close a slide gate at the side of the elevator, the water level would rise and the brail would be winched to the truck-loading chute. When the brail reaches the loading chute the fish would exit through an opening in the side of the elevator and slide down the chute into a fish hauling truck parked below. The operator would return rough fish not wanted in the load to the river through a pipe from the loading chute. Once the truck is loaded, the driver would haul fish on a gravel surfaced access road and release them in the river upstream of the existing diversion weir or further upstream in the watershed.

The 3.7 m (12 ft) wide gravel surfaced access road would traverse the north side of the canyon adjacent to the trap facility. From there, the road would continue north to State Highway 216. The minimum length of the fish haul would be approximately 1.6 km (1 mi). The fish could also be hauled further upstream on existing public roads.

The trap and haul system would require electrical power at the trap facility to operate the pumps, crowder, and winch. This power could be supplied from the existing Tygh Valley substation, less than 0.2 km away. Fish evaluation facilities, should they be included, would be located adjacent to the trap holding tank.

Alternative 4 -- Trap and Haul at Proposed Powerhouse

Alternative 4 is a trap and haul system at the proposed powerhouse 274 m (900 feet) below falls three as shown in Figures 27 and 28. The trap facilities would be located adjacent to the proposed powerhouse below a concrete barrier dam crossing the river. A four pool half Ice Harbor ladder would be required to pass fish from the tailrace entrances to the trap facility. The concrete barrier dam would be the same as described in Alternative 2, although there would be no need to cross the river with a f ishway. The dam would be located just upstream of the proposed powerhouse tailrace to prevent fish from passing upstream and missing the trap facility entrance.


EVALUATION FACILITY
INTAKE
SLUICEWAY & GATE
GROUTED RIPRAP
BARRIER DAM
GROUTED RIPRAP
FISH LADDER
ENTRANCES
POWERHOUSE
TAILRACE
WHITE RIVER
PLAN
30' 0 30'
FIGURE 27
WHITE RIVER FALLS
FISH PASSAGE PROJECT
ALT. 4-PLAN OF FISH TRAP AND BARRIER DAM AT PROPOSED POWERHOUSE
DATE: JUNE 1985
JOB NUMBER: S1014.02
OTT

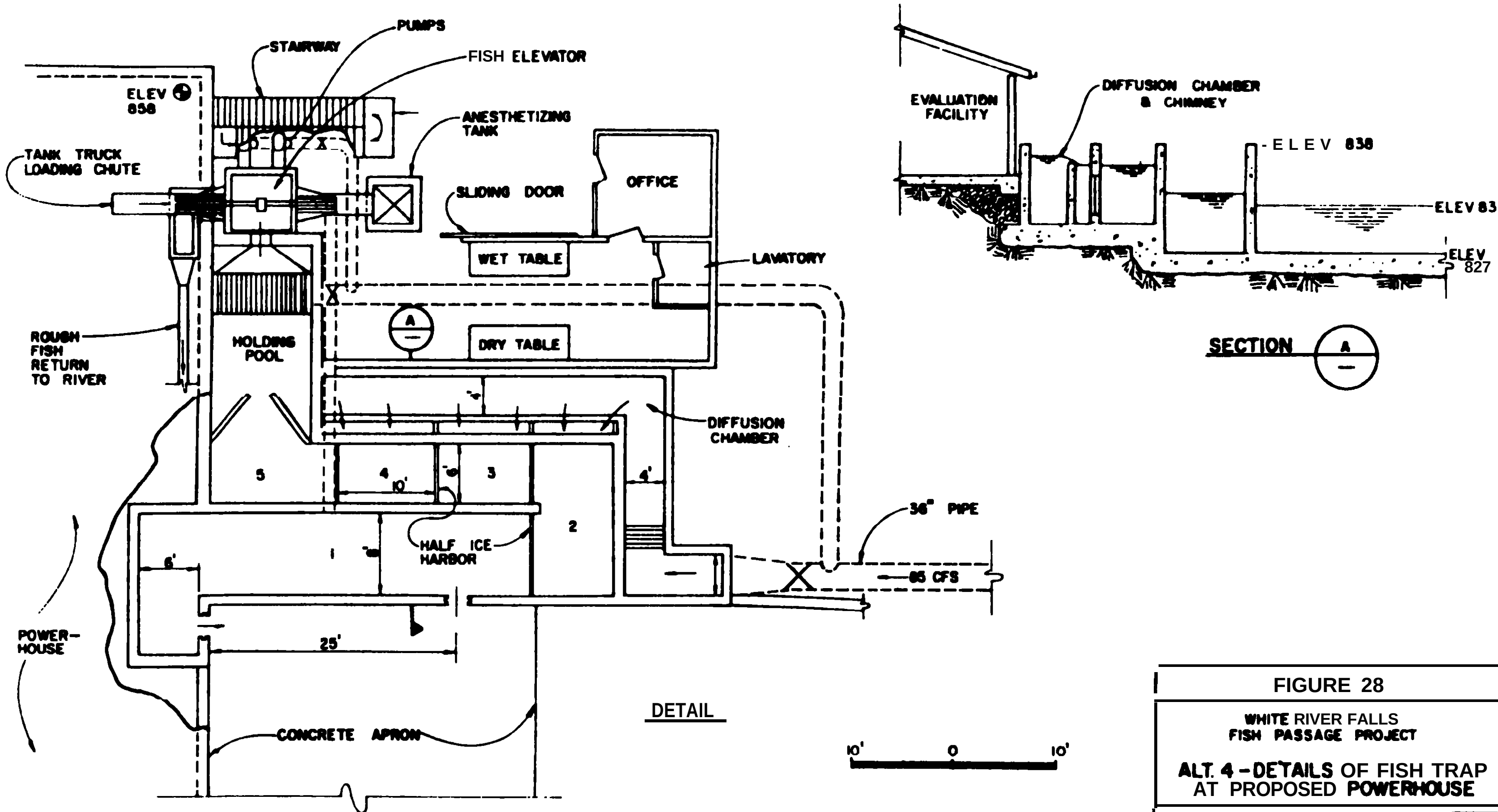


FIGURE 28

WHITE RIVER FALLS
FISH PASSAGE PROJECT

ALT. 4 - DETAILS OF FISH TRAP AT PROPOSED POWERHOUSE

DATE: JUNE 1985
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OTT

As discussed in Alternative 2, two entrances would provide a flexible operation of the trap. Attraction and operation flow to both entrances would be gravity fed from an intake at the dam. Part of this flow would be distributed to the fishway through vertical vanes from the diffusion chamber. Flow would also be routed through branch pipes and valves to the holding pool, fish elevator pump, and fish elevator as required.

Though oriented differently, the general physical and operational characteristics of the fish trap would be the same as those described for Alternative 3. Fish truck access to the loading chute would be across the lower powerhouse deck. The proposed transformer, at NWCPUD'S powerhouse, would have to be relocated to provide truck access to the loading chute.

The powerhouse access road would be used to haul the fish upstream of the proposed diversion weir and intake structure. The minimum one-way haul distance to the river, just above the intake structure, is approximately 2.4 km (1.5 mi). Fish could also be hauled further upstream. Fish evaluation facilities would be located adjacent to the fish trap holding tank as shown in Figure 28. Electrical power for the trap facility is available through NWCPUD'S distribution system.

Alternative Selection

Through discussions with BPA and OTT, Alternative 4, a trap and haul located at the proposed powerhouse site, was selected by ODFW as the preferred passage alternative.

Alternative 4 was selected because (1) it is capable of successfully passing anticipated salmon and steelhead runs; (2) the cost is comparable with other alternatives; (3) it is compatible with proposed hydropower at White River Falls; and (4) it will allow selective passage of target species of fish into the White River basin above the falls.

Each of the four alternatives is capable of successfully passing the anticipated fish runs in White River. Similar designs in the Northwest have provided passage over barriers for 50 years. The cost of each passage alternative, considering both capital and annual costs, is not significantly different among the alternatives; this is shown in the following section.

The four aiternatives are not equal, however, with respect to compatibility with hydropower and selective passage of only target species. If hydropower is redeveloped at White River Falls, according to NWCPUD’s proposed plan, Alternatives 1 and 3 would be poor choices. Fish would congregate at the powerhouse tailrace and few would readily reach the trap or ladder entrances upstream at falls three. Methods to help fish pass the tailrace, such as louvers, have not been effective in the past. If the proposed powerhouse is built below falls three, Alternatives 2 and 4 are the only reasonable choices.

As presented in the previous section, Alternative 4 is “integrated” with the proposed powerhouse. When final engineering design begins, the plans will be modified such that the trap facility will operate, in an optimum fashion, without the powerhouse. At the writing of this report, it is anticipated that construction of fish facilities at White River Falls will occur well in advance of hydropower. It should be understood that a fish trap at White River Falls will operate equally well if its construction is: (1) at the same time as the hydropower plant; (2) well before the hydropower plant; or (3) if the hydropower plant is never constructed.

The issue of selective passage of only target species of anadromous fish is important because squawfish, suckers, shiners, and other nongame species present in the Deschutes River, and probably in White River below the falls, are not present above the falls. Also, abundance of whitefish above the falls is low and they appear to inhabit mainly the first 10 km of White River above the falls. If fish are allowed to pass above the falls as in the ladder alternative (Alternative 2), new species of fish would enter the watershed above the falls, and the whitefish abundance may increase. This might decrease the production of anadromous fish because of competition for food and space. Handling fish at the ladder would add an annual cost for labor that makes Alternative 2 economically unattractive. Fish handling is part of a trap operation and selecting target species amounts to sorting fish as they enter the hauling truck.

Cost Estimates

Capital costs of each alternative are listed by major item and provided in Tables 19 to 22. The annual costs of each alternative were estimated for labor, maintenance, and operation (Tables 19 to 22). The trap and haul alternatives are estimated to require one full-time employee to operate the trap, haul fish, and maintain irrigation diversion screens in the upper watershed. Fish ladder alternatives are assumed to require one half-time employee for regular maintenance of the facilities. Annual costs in excess of labor for all alternatives would include power costs, repairs, and like items.

During normal operation of trap and haul facilities, some equipment items must be replaced. These items include trucks, pumps, and winches. The assumed replacement times and costs are included in Tables 21 and 22. Fish ladder alternatives do not have equipment that is expected to require replacement; therefore, no replacement costs are included in project costs.

A present value analysis was performed for each alternative to make all costs comparable. The annual and replacement costs were reduced to single present value amounts using standard engineering economic procedures. The assumptions in the analysis were a 50-year project life and a 3 percent discount rate. This cost information is a best estimate based on the level of analysis completed to date.

Table 19. Capital and annual costs for construction, engineering, operation, and maintenance for Alternative 1, fishway from falls-three

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
MOBILIZATION & DEMOBILIZATION	LS	---	$ 25,000	$ 25,000
DEWATERING				
Falls Three	LS	---	150,000	150,000
Headworks	LS	---	6,000	6,000
Pumps & Maint.	LS	---	15,000	15.000
		Total		$ 171,000
EARTHWORK				
Excavation, Rock	CY	7,230	25	181,000
Backfill	CY	600	15	9,000
Riprap	CY	80	25	2,000
Hauling	CY	2,000	7	14,000
		Total		$ 206,000
REINFORCED CONCRETE				
Slabs	CY	2,050	250	512,000
Walls	CY	2,140	350	749,000
		Total		$1,261,000
DRAINS				
Perforated Pipe	LF	1,800	17	31,000
Drains	LS	---	10,000	10,000
		Total		$ 41,000
METALS				
Trashracks	LS	---	3,000	3,000
Diffusers	LS	---	4,000	4,000
Piping	LS	---	17,000	17,000
Valves & Gates	LS	---	20,000	20,000
		Total		$ 44,000
ACCESS ROAD	LS	---	230,000	$ 230,000
WOOD DECK	LS	---	24,000	$ 24,000
CIVIL SITE WORK	LS	---	50,000	$ 50,000
Subtotal				2,052,000
10% Contractor O&P				205,000
20% Contingency				451,000
		Total		$2,708,000

TABLE 13. (continued)

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
ENGINEERING SERVICES				
Permits				35,000
Design				
Basic Services				270,000
Surveying				40,000
Geotechnical Investigation				80,000
Testing				25,000
Inspection				120,000
		Total		$ 570,000
OTHER PROJECT COSTS				
Fish Rearing				250,000
Irrigation Diversion Screening				58,000
Hatchery Water Supply Protection				50,000
		Total		$ 358,000
FEASIBILITY STUDY COSTS				564,000
TOTAL CAPTTAL COSTS				$4,200,000
Annual COSTS				
l/2 FTE @ #30,000/yr.				$ 15,000
Maintenance, Yearly				5,000
		Total		$ 20,000
PRESENT VALCE				
PV of Annual Costs (3%, 50 years)				515,000
TOTAL PROJECT COST				$4,715,000

Table 20. Capital and annual costs for construction, engineering, operation, and maintenance for Alternative 2, fishway from powerhouse

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
MOBILIZATION & DEMOBILIZATION	LS	a - -	$ 25,000	$ 25,000
DEWATERING				
Barrier Dam	LS	- - -	94,000	94,000
Headworks	LS	- - -	6,000	6,000
Pumps & Maint.	LS	- - -	10,000	10,000
		Total		$ 110,000
EARTHWORK				
Excavation, Common	CY	1,060	15	16,000
Excavation, Rock	CY	10,700	25	267,500
Backfill	CY	1,030	15	15,500
Riprap, Grouted	CY	900	70	63,000
Riprap	CY	305	25	8,000
Hauling	CY	3,000	7	21,000
		Total		$ 391,000
REINFORCED CONCRETE				
Slabs	CY	4,120	250	1,030,000
Walls	CY	3,120	350	1,092,000
		Total		$2,122,000
DRAINS				
Perforated Pipe	LF	3,100	17	53,000
Drains	LS	---	18,000	18,000
		Total		$ 71,000
METALS				
Trashracks	LS	---	3,000	3,000
Diffusers	LS	---	4,500	4,500
Piping	LS	---	13,500	13,500
Valve	LS	1	10,000	10,000
Sluice Gate	LS	1	15,000	15,000
		Total		$ 46,000
CIVIL SITE WORK	LS	---	60,000	$ 60,000
Subtotal				2,825,OOO
10% Contractor O&P				282,000
20% Contingency				621,000
		Total		$3,728,000

Table 20. (continued)

ITEM	UNIT	QUANTITY	CNIT COST	TOTAL COST
ESGINEERING SERVICES				
Permits				35,000
Design				
Basic Services				385,000
Surveying				50,000
Geotechnical Investigation				100,000
Testing				25,000
Inspection				150,000
		Total		$ 745,000
OTHER PROJECT COSTS				
Fish Rearing				250,000
Irrigation Diversion Screening				58,000
Hatchery Water Supply Protection				50,000
		Total		$ 358,000
FEASIBILITY STUDY COSTS				564,000
TOTAL CAPITAL COSTS				$5,395,000
ANNUAL COSTS				
l/2 FTE @ $30,000/yr.				15,000
MAINTENANCE, Yearly				8,000
		Total		$ 23,000
PRESEST VALUE				
PV of Annual Costs (3%, 50 years)				$ 592,000
TOTAL PROJECT COST				$5,987,000

Table 21. Capital and annual costs for construction, engineering, operation, and maintenance for Alternative 3, fish trap at falls-three

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
MOBILIZATION & DEMOMOBILIZATION	LS	---	$ 25,000	$ 25,000
DEWATERISG				
Cofferdams	LS	---	150,000	150,000
Pumps & Maint.	LS	---	10,000	10,000
		Total		$ 160,000
EARTHWORK				
Excavation, Rock	CY	2,000	25	50,000
Backfill	CY	250	15	4,000
Hauling	CY	1,000	7	7,000
		Total		$ 61,000
REISFORCED CONCRETE				
Slabs	CY	370	250	92,000
Walls	CY	480	350	168,000
		Total		$ 260,000
METALS				
Trashracks	LS	---	2,000	2,000
Diffusers	LS	---	6,000	6,000
Piping	LS	---	45,000	45,000
Valves & Gates	LS	---	41,000	41,000
Vee Trap	LS	---	5,000	5,000
Crowder	LS	---	10,000	10,000
Elevator	LS	---	15,000	15,000
		Total		$ 124,000
EQUIPMENT				
Generator	LS	1	15,000	15,000
Winches	LS	2	5,000	10,000
Truck	LS	1	80,000	80,000
Pumps	LS	2	30,000	60,000
		Total		$ 165,000
ACCESS ROAD	LS	---	230,000	$ 230,000
WOOD DECK	LS	---	24,000	$ 24,000
CIVIL SITE WORK	LS	---	25,000	$ 25,000
Subtotal				1,074,000
10% Contractor O&P				107,000
20% Contingency				236,000
		Total		$1,417,000

TABLE 21. (continued)

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
ENGINEERING SERVICES				
Permits				35,000
Design				
Basic Services				155,000
Surveying				40,000
Geotechnical Investigation				60,000
Testing				20,000
Inspection				75,000
		Total		$ 385,000
OTHER PROJECT COSTS				
Fish Rearing				250,000
Irrigation Diversion Screening				58,000
Hatchery Water Supply Protection				50,000
		Total		358,000
FEASIBILITY STUDY COSTS				564,000
TOTAL CAPITAL COSTS				$2,724,000
REPLACEMENT COSTS				
Tractor - Replace @ Year 10, 20, 30, & 40				$ 40,000
Winches - Replace @ Year 10, 20, 30, & 40				10,000
Pumps - Replace @ Year 25				30,000
		Total		$ 80,000
ANNUAL COSTS				
Truck Maintenance/Year				$ 9,700
Labor, 1.0 FTE @ $30,000/Year				$ 30,000
Maintenance/Yearly				8,000
		Total		$ 47,700
PRESENT VALUE				
PV of Replacement Costs				115,000
PV of Annual Costs				1,209,000
TOTAL PROJECT COST				$4,048,000

Table 22. Capital and annual costs for construction, engineering, operation, and maintenance for Alternative 4, fish trap at powerhouse

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
MOBILIZATION & DEMOBILIZATION	LS	---	$ 25,000	$ 25,000
DEWATERING				
Cofferdams	LS	---	89,000	89,000
Pumps 6 Maint.	LS	---	10,000	10,000
		Total		$ 99,000
EARTHWORK				
Excavation, Common	CY	1,060	15	16,000
Excavation, Rock	CY	3,300	25	82,000
Backfill	CY	600	15	9,000
Riprap, Grouted	CY	900	70	63,000
Riprap	CY	260	25	6,000
		Total		$ 176,000
REINFORCED CONCRETE				$ 543,000
Slabs	CY	370	250	382,000
Walls	CY	480	350	161,000
		Total		$ 543,000
METALS				
Trashracks	LS	---	2,000	2,000
Diffusers	LS	---	7,000	7,000
Piping	LS	---	32,000	32,000
Valves & Gates	LS	---	56,000	56,000
Vee Trap	LS	---	5,000	5,000
Crowder	LS	---	10,000	10,000
Elevator	LS	---	25,000	25,000
Stairway	LS	---	14,000	14,000
		Total		$ 151,000
EQUIPMENT				
Generator	LS	1	15,000	15,000
Winches	LS	2	5,000	10,000
Truck	LS	1	80,000	80,000
Pumps	LS	2	15,000	30,000
		Total		$ 135,000
ACCESS ROAD	LS	1	130,000	$ 130,000
CIVIL SITE WORK	LS	---	25,000	$ 25,000
Subtotal				$1,284,500
10% Contractor O&P				128,000
20% Contingency				283,000
		Total		$1,695,00

Table 22. (continued)

ITEM	UNIT	QUANTITY	UNIT COST	TOTAL COST
ENGINEERING SERVICES				
Permits				3S ,000
Design				
Basic Services				155,000
Surveying				20,000
Geotechnical Investigation				60,000
Testing				20,000
Inspection				75,000
		Total		$ 365,000
OTHER PROJECT COSTS				
Fish Rearing				250,000
Irrigation Diversion Screening				58,000
Hatchery Water Supply Protection				50,000
		Total		358,000
FEASIBILITY STUDY COST				564,000
TOTAL CAPITAL COSTS				$2,983,500
REPLACEMENT COSTS				
Tractor - Replace @ Year 10, 20, 30, & 40				40,000
Winches - Replace @ Year 10, 20, 30, & 40				10,000
Pumps - Replace 1 @ Year 25				7,500
		Total		$ 57,500
ANNUAL COSTS				
Truck Maintenance/Year				$ 9,700
Labor, 1.5 FTE @ $30,000/Year				45,000
Maintenance/Year				8,000
			Total	$ 62,700
PRESENT VALUE				
PV of Replacement Costs				104,000
PV of Annual Costs				1,209,000
TOTAL PROJECT COST				$4,296,000

BENEFIT ANALYSIS

Measures to mitigate, restore, or enhance the Columbia basin anadromous fishery are not necessarily subject to a favorable benefit/cost determination (P.L. 96-501); however, the objective of achieving "sound biological objectives at minimum economic cost" is recognized by that legislation. Furthermore, priorities for implementation of various measures of the Fish and Wildlife Program, especially expensive ones, will likely be determined to a significant degree through a consideration of the relationship of benefits to costs.

The analysis of benefits for this project proceeded in a stepwise manner. The steps are as follows:

(1) Identification of the specific benefit to be analyzed.

(2) Identification of the factors limiting or constraining the benefit after project completion and quantification of the productive capacity of the system for the target benefit.

(3) Identification of the time frame for realization of first benefit.

(4) Estimation of the rate of increase in benefit to full capacity or "steady state".

(5) Projection of exploitation rates and the distribution of harvest among users.

(6) Identification of an appropriate dollar value per unit.

(7) Choice of a project life.

(8) Choice of an appropriate discount rate.

(9) Computation of the present worth offuture benefits.

The outcome of analysis according to this stepwise process are summarized below. A more complete description of specific rational and criteria is given in Appendix D, Volume III.

(1) Target benefit -- Adult anadromous fish made available to the rombined fishery. For this project, spring chinook and summer steelhead are to be the enhanced stocks.

(2) Factors limiting production at full capacity -- quantity and quality of accessible and usable rearing habitat for outmigrant-sized fish. A range of outmigrant-sized juvenile production potential was narrowed to a single value for each species for calculation purposes. Estimated adult returns for the calculation of benefits, were 963 spring chinook and 1,405 summer steelhead.

(3) time to first benefit -- year 3 for spring chinook and year 3 for summer steelhead.

(4) Rate of increase in benefits to "steady state" -- for spring chinook, 50 percent of full benefit from year 3 through year 6, 75 percent of full benefit from year 7 through year 10, and 100 percent of full benefit from year 11 through year 50 (end of project life); for summer steelhead, 30 percent for year 3, 50 percent for years 4 and 5, 75 percent for years 6 and 7, and 100 percent from year 8 through year 50 (end of project life).

(5) Exploitation rates and distribution of the catch -- 1:l for interim enhanced fisheries for both species. All of the summer steelhead exploitation is assumed to be allocated to the sport fishery. For spring chinook, assumed exploitation apportionment is 10 percent to commercial fisheries, 55 percent sport fisheries, and 35 percent Indian ceremonial and subsistence harvest.

(6) Dollar values per unit -- values per unit were obtained from Meyer (1984). These values are:

Species	Net Economic Value
Summer steelhead	$144.00
Spring chinook (sport-caught)	143.00
Spring chinook (commercial)	34.80
Spring chinook (Indian ceremonial)	34.80*

*Estimates of prices paid by Warm Springs Confederated Tribes for ceremonial fish suggest that net economic value very closely approximates the net commercial value for the same fish. Therefore, identical values are used in this analysis.

(7) Project life -- 50 years.

(8) Discount rate -- 3 percent. Three percent is the risk-free rate of time preference used by BPA for project analyses and assumes that the risk of underestimating benefits is at least as great as the risk of overestimating project benefits. The use of 3 percent is consistent with the assumptions used in estimating benefits from potential production of anadromous fish, from the catch to escapement ratios, and from the rate of increase in benefits to full production.

(9) Computation of benefits -- methods employed use standard compound interest formulas taking into account the rate of growth of benefits to full capacity and the time frame for realization of first benefit.

Results of calculations indicate present values of net economic benefits to the combined fishery over a SO-year project life of $4,236,000 for summer steelhead trout and $1,855,000 for spring chinook salmon. The combined present value of the project is projected to be $6,091,000. The actual calculations are summarized in Volume III of this report. Aggregate project benefits are compared to total project costs for each of the four project alternatives in Table 23.

Table 23. Summary of total project costs for all four project alternatives, project benefits, and benefit/cost ratios.

Alternative	Total Project Cost	Project Benefit	Benefit/Cost
1. Fishway from falls three	$4,715,000	$6,091,000	1.29
2. Fishway from powerhouse	5,987,000	6,091,000	1.02
3. Fish trap at falls three	4,048,000	6,091,000	1.50
4. Preferred alternative: fish trap at powerhouse	4,296,000	6,091,000	1.42

Benefits of implementation of a preferred alternative for passage of anadromous fish over White River Falls were computed using the best available information. This information is considerably more "current" than that commonly used by others in computation of benefits for projects where Columbia River drainage anadromous fish are concerned. By using current information, and subbasin-specific assumptions for particular stocks of fish, several of the multipliers were necessarily different than those "basinwide average*' or outdated multipliers commonly used by others. Consequently, the dollar benefits and benefit/cost ratio generated for this project should be compared only with caution to those for many other projects.

Differences in multipliers from those commonly used in other analyses include the following:

(1) Use of a 1:l catch-to-escapement ratio for summer steelhead instead of 2:l. This ratio depends on the river system and race of fish; 2:1 may be applicable in other river systems.

(2) Use of 1:l catch-to-escapement ratio for spring chinook instead of 3:l. This ratio depends on the river system and race of fish; 3:1 may be applicable in other river systems.

(3) Assigning 45 percent of the harvest of spring chinook to the commercial and Indian ceremonial fisheries instead of 43 percent. This reduces the comparable benefit for spring chinook by a few percent.

(4) Use of (newer) net economic values for summer steelhead of $144 per sport-caught fish instead of the older (1982) values of $214.

(5) Use of (newer) net economic values for spring chinook of $143 per sport-caught fish instead of older (1982) values of $295.

Because of these differences in commonly used multipliers, great care should be exercised when comparing this project to other projects in the Columbia basin. It is especially important to use consistent net economic values per unit and to apply basin-specific catch-to-escapement and harvest allocation multipliers to the greatest extent possible.

IMPACTS ON HYDROPOWER DEVELOPMENT

In 1983, NWCPUD, filed a FERC Major License Application, number 3139, for redevelopment of hydropower at White River Falls. A power generating plant below falls two was operated by Pacific Power & Light Company until 1963. NWCPUD'S proposed powerhouse is located approximately 610 m (2,000 ft) downstream of the original powerhouse (NWCPUD 1982).

During FERC liicense application preparation,NWCPUD was aware that passage for adult anadromous fish may be provided around White River Falls. Though construction of the hydropower project is not certain at the writing of this report, it does appear to be compatible with the preferred alternative, Alternat ive 4. if the powerplant is not constructed (or delayed to a much later date), the passage facilities wili still be effective, though design would be modified somewhat.

The preferred passage alternative is also the alternative best suited to NWCPUD'S hydropower development. Fish ladder alternatives would require approximately 25 cfs, beyond the required minimum instream flow, making it unavailable for power production. The fish trap alternatives do not require this. Further, if the trap at falls three (Alternative 3) was selected, NWCPUD would be required to keep adult fish out of their powerhouse tailrace. This is a virtually impossible task that would certainly be costly for both BPA and NWCPUD.

If the powerplant is constructed at the proposed location and fish passage is provided at White River Falls, both BPA and NWCPUD would benefit from shared costs on many items. Operational plans for the passage facility and powerplant during periods of low flow will be critical to the success of both facilities. Finally, screening downstream migrants from powerplant flow will be necessary if hydropower is developed at White River Falls.

CHAPTER IV

RECOMMENDATIONS

The cooperating agencies (ODFW, USDA FS, and Confederated Tribes of the Warm Springs Indians) have been involved in the feasibility study of the White River project. Through the progression toward a final decision on the project, the management agencies (ODFW, USDA FS, Confederated Tribes of the Warm Springs Indians, BLM) will be involved in the process. NWCPUD and private landowners will also be involved.

The following are recommendations of the ODFW staff. However, these recommendations <u>do not</u> necessarily reflect the final recommendations of the Oregon Fish and Wildlife Commission who, after a public review process, will decide whether to introduce anadromous fish into White River.

PUBLIC REVIEW

A public review of the project will include distribution of a project summary of results and recommendations, and several public meetings to solicit comments on the introduction. This process will probably take place June 1985.

ANADROMOUS FISH SPECIES AND STOCK SELECTION

Anadromous fish should be introduced into White River above the falls to help mitigate for losses at Columbia River dams.

Spring chinook and summer steelhead are the best species for introduction in the White River basin. Indigenous stocks of summer steelhead and spring chinook from the Deschutes and Warm Springs rivers should be used in White River. Fish for introduction should be surplus to the present production allocation and should not affect existing hatchery programs.

OAK SPRINGS HATCHERY

Water in the Clear Creek ditch that overflows into the water supply of Oak Springs Hatchery must be diverted away from the hatchery. This measure needs to be taken to prevent disease contamination of Oak Springs Hatchery. Contamination of the hatchery by disease is a possibility if anadromous fish are introduced in White River basin, specifically with introduction of anadromous fish in upper Clear and Frog creeks which are diverted into the Clear Creek irrigation ditch.

PASSAGE ALTERNATIVES

A trap and haul facility located at the site of the proposed powerhouse of NWCPUD (Alternative 4) is the preferred alternative for adult fish passage at White River Falls. The trap would be located 274 m below the lower falls on the south side of White River.

Eecause of the variability in study results in 1983 and 1984 owing to release location and flow, the option of providing passage for juveniles at the falls must be maintained. Whether juvenile facilities will be needed will depend on the timing of juvenile outmigrations of the introduced populations and on the distribution of migrants in the river channel above the falls. Screening or a juvenile trap will be required at the intake of the proposed SWCPUD Penstock if the plant is constructed.

RESIDEST FISH

Eecause the White River basin contains genetically unique stocks of rainbow trout, areas for management of resident native trout will be designated in cooperatin with appropriate management agencies prior to introduction of anadromous fish. Resident fish populations can easily be maintained above impassable waterfalls on Tygh and Jordan creeks and in Rock Creek above the reservoir. Stocks in Little Eadger and Threemile creeks could be protected by installing barriers to prevent anadromous fish passage into the upper areas. Removal of these areas from introduction of anadromous fish would not seriously reduce the potential production of salmon or steelhead in the White River basin.

Supplemental stocking of hatchery trout to support fisheries in White River and Badger Creek could be continued without affecting anadromous fish. The fishery on resident trout in the remainder of the basin would likely also harves t juvenile steelhead. In some streams the 15-25 cm trout may be displaced by steelhead and the trout fishery would then be replaced by a fishery on juvenile steelhead. Restrictions on this harvest would probably be unnecessary because the fishery in the basin is currently limited by road access to streams on public land and by access to streams on private land. Coordination between agencies on future access and recreation development will probably be necessary.

IRRIGATION DIVERSONS

Screening of up to 18 irrigation ditches in White River will be necessary to protect salmon and steelhead migrants. Screen design and construction should not impact present water use.

Modification of diversion dams in lower Tygh and Badger creeks may be necessary to ensure adult access to these important systems. Passage at other diversion dams would enhance production of anadromous fish. Mofi ications, if needed, will not affect water usage in any way.

ODFW recommends construction of screens, maintenance of screens, and modif ication to diversion dams as a cost of the project.

HABITAT IMPROVEMENT

Development of cooperative guidelines for fish and habitat management in the White River basin should include identification of habitat enhancement opportunities. These guidelines should be developed by management agencies following a decision on the introduction of anadromous fish in the White River basin.

REFERENCES

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