Value Engineering

FINAL REPORT

PROJECT:

Elwha River Restoration, Glines Dam Removal

DATE: December 15, 1995

Workshop Study conducted within a certified Module I course by SAMI LLC

UNITED STATES
DEPARTMENT OF THE INTERIOR
Bureau of Reclamation
Module 1 Workshop

Technical Service Center
Denver Office

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VALUE ENGINEERING WORKBOOK

PROJECT:

Elwha River Restoration, Dam Removal

VE TEAM MEMBERS

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TEAMLIST.MEM

DESCRIPTION OF PRESENT DESIGN

Elwha River Restoration, Dam Removal

Elwha River Restoration Project, Dam Removal Plan:

This project is a part of the Elwha River Restoration Project that would remove Elwha and Glines Canyon Dams as proposed by the Dam Removal Task Group, to restore the Elwha River ecosystem and native anadromous fisheries.

Both Glines Canyon Dams and Elwha are located on the Elwha River, within the Olympic Peninsula of northwestern Washington. Elwha Dam was completed in 1913 at river mile 4.9, and includes a 108-foot-high concrete gravity section, gated spillways on both abutments, and a powerhouse with four generating units rated at 14.8 MW. Glines Canyon Dam was completed in 1927 at river mile 13.4, and includes a 210-foot-high concrete thin arch section, a gated spillway on the left abutment, a thrust block on the right abutment, and a powerhouse with a single generating unit rated at 13.3 MW. Elwha Dam impounds Lake Aldwell, having a surface area of 267 acres and a storage capacity of 8,100 acre-feet at elevation 197.0. Glines Canyon Dam impounds Lake Mills, having a surface area of 415 acres and a storage capacity of 40,500 acre-feet at elevation 590.33. Both dams are currently owned and operated by James River Corporation.

Dam removal plans should meet the following requirements:

Remove Glines Canyon Dam safely.
Accommodate river flows during dam removal, through diversion channels and notches.
Facilitate sediment management schemes, through controlled releases and planned construction schedules.
Address environmental and cultural issues.
Provide structures for historical preservation at Glines Canyon Dam, allowing public viewing of the site from structures on both abutments and retaining the historic powerhouse.
Achieve reasonable costs, by limiting structure removal at Glines Canyon Dam and by selecting construction methods that will facilitate economy without sacrificing safety.

DESCRIPTION OF PRESENT DESIGN

Elwha River Restoration, Dam Removal

The design process for development of the dam removal plans consisted of the following steps:

Review existing information, including previous studies performed by others for the Draft Staff Report (March 1993) and The Elwha Report (January 1994).

Develop reasonable dam removal alternatives by considering previous designs, existing site conditions, project objectives, and current construction practices.

Identify and address issues that could impact construction, including streamflow diversion, sediment management, safety, and environmental concerns.

Develop a construction sequence to minimize potential flood impacts, improve efficiency, and accommodate periodic shutdowns for salmon runs and potential flood flows.

Prepare feasibility-level cost estimates for removal of each dam, based on the preferred dam removal alternatives and assumed demolition methods.

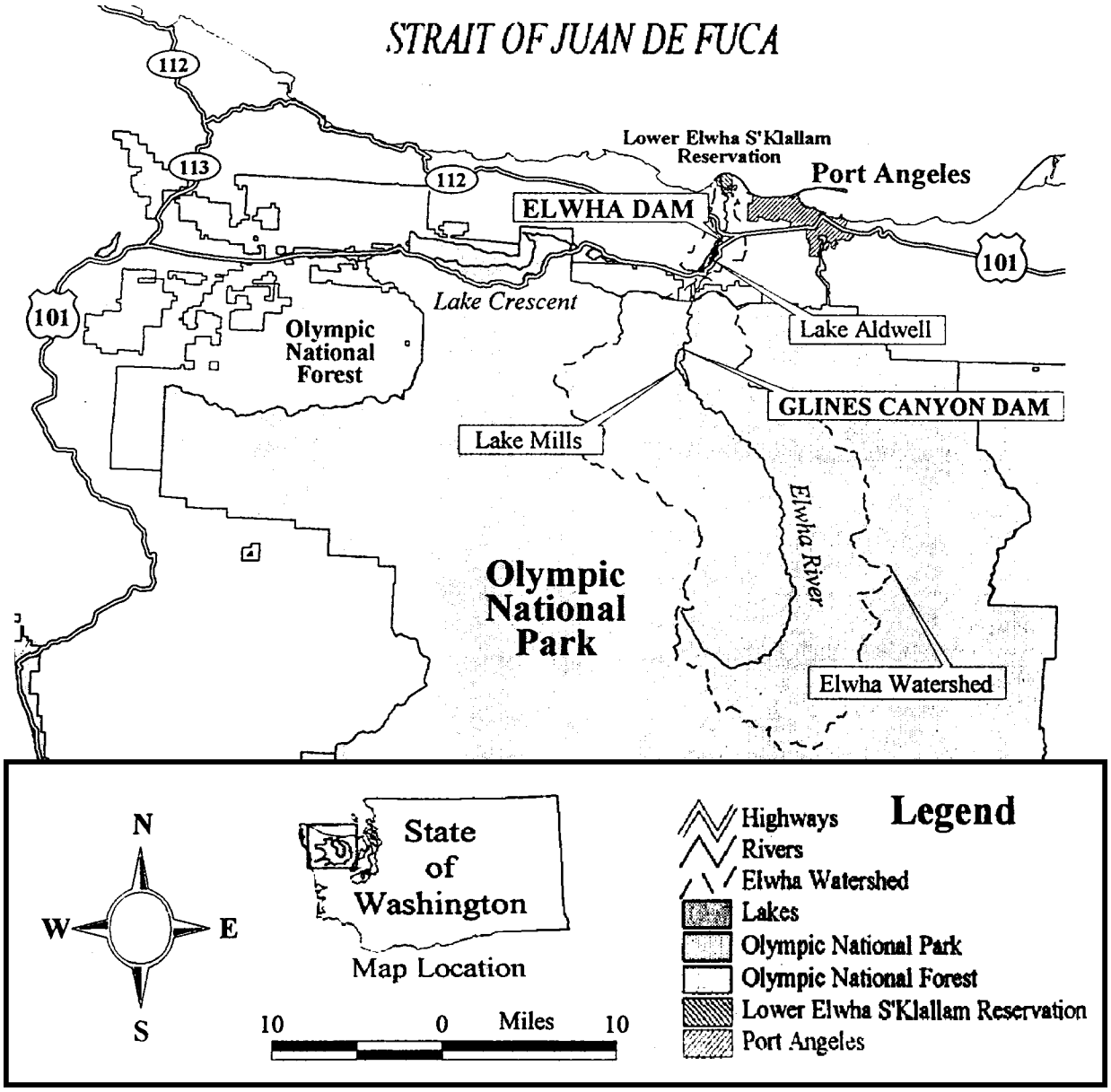
Document design studies by preparing a technical memorandum and feasibility drawings.

The total field cost of dam removal is currently estimated at $20,200,000, including an allowance of 20 percent for contingencies. Costs for engineering and construction management would add about 20 percent to the overall project cost. A construction period of about 2 years is anticipated to be required, with a recommended notice-to-proceed date of November 1, 1996.

Additional construction requirements associated with dam removal include hazardous waste collection and disposal, removal of transmission lines, and road improvements. The Fish and Wildlife Service (FWS) has prepared a separate report on the proposed collection and disposal of hazardous waste at both damsites, with an estimated cost to the project of $1,200,000. Removal of 14 miles of transmission lines and poles was estimated to cost $238,000 (plus contingencies) in 1990. Improvements necessary to rehabilitate the Olympic Hot Springs Road are included in this project.

PRESDESC.DES

GENERAL LOCATION AND VICINITY MAP



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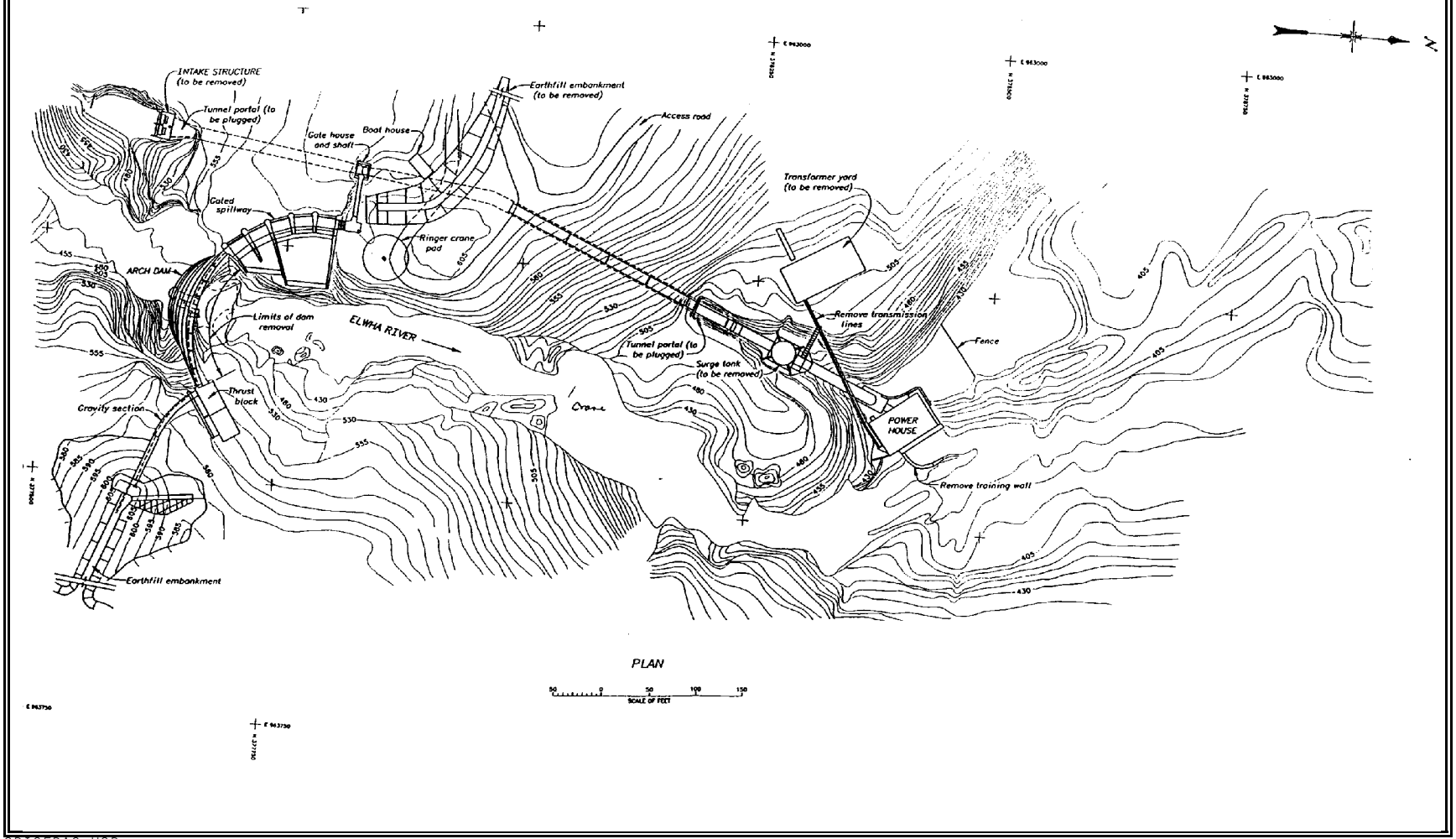
ORIGINAL CONCEPT - GLINES CANYON DAM



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SPECIAL CRITERIA

USERS:
Glines Dam is located on the Elwha River which is fished by the S'Klallam people.
CODES:
Comply with Toxic Waste and Safety Codes.
RESTRICTIONS:
Steep embankments
Confined construction site
DESIGN HISTORY: (RESPONSIBILITIES, COMMITMENTS, STATUS, ETC.
This project is the outgrowth of controversy surrounding the relicensing of the Glines Canyon Dam hydroelectric powerplant. Congress enacted Public Law 102-495 to restore the Elwha River anadromous fisheries and ecosystem to the pre-dam conditions. A programmatic environmental impact statement has been issued. Specific restoration activities will be dealt with in an "implementation" Environmental Impact Statement. The Congress has not appropriated funds to implement restoration activities.

SPECCRIT.TAB

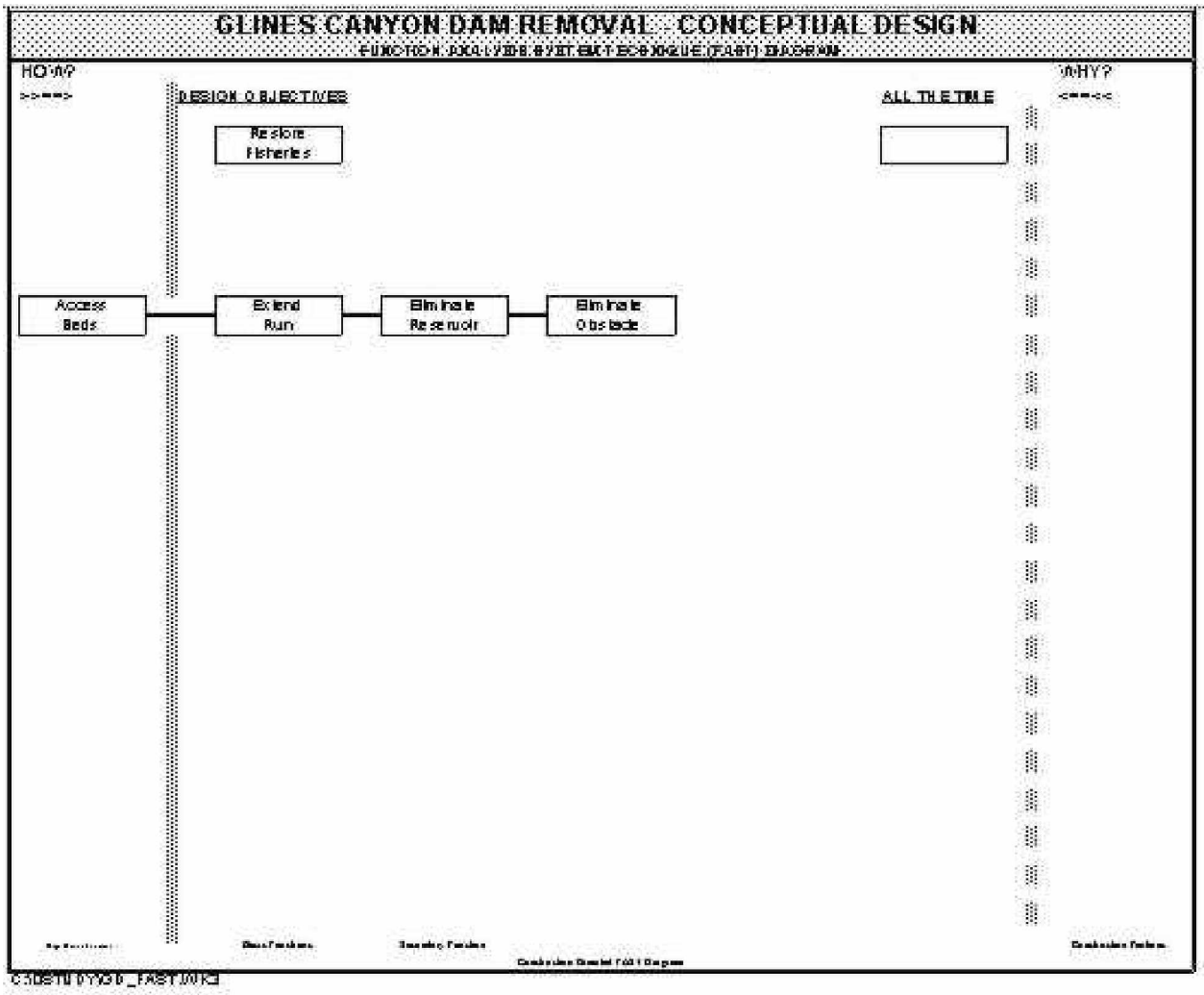
FUNCTION ANALYSIS

PROJECT: **Elwha River Restoration, Dam Removal**

STUDY ITEM: **Preferred design alternative**

COMPONENT	VERB (ACTIVE)	NOUN (MEASURABLE)
Dam Structure	Contain Generate Eliminate Eliminate	Reservoir Power Reservoir Obstruction
Fish Beds	Access Restore	Beds Fisheries

FUNCANAL.TAB



Function Analysis System Technique (FAST)

The VE Study Team used the function analysis process to generate a Function Analysis System Technique (FAST) diagram designed to show the present conceptual design preferred alternative from a functional point of view. The function analysis and resulting FAST diagram aided the VE Study Team in identifying design features that are critical to meeting requirements that support the critical functions, and those that meet noncritical design objectives.

Glines Canyon Dam

VALUE ENGINEERING STUDY

COST MODEL

COMPONENT	PERCENT PROJECT COST	PROJECT COST PROPORTION
Put your data here. Don't delete	(0.0%)	
Mobilization	(24.8%)	
Site Access	(0.1%)	
Dam Removal	(75.0%)	
Crane Pad	(0.2%)	
Diamond-Wire H Sawcut	(22.0%)	
Diamond-Wire V Sawcut	(10.9%)	
Track Drill/Blast	(30.7%)	
Conc Demo Abutments	(0.1%)	
Remove Concrete	(6.5%)	
Rem Trashrack/valve/oper	(0.2%)	
Fndtn Support @ Abut	(0.1%)	
Remove Intake	(1.4%)	
Remove Surge Tower	(1.9%)	
Remove Txfrmr Yard	(0.8%)	
Restore/Shape/Seed	(0.3%)	

COST MODEL AND ESTIMATE INFORMATION

The study team cost model is based on the conceptual design estimates provided by the design team for the preferred project design. This cost model is developed by the VE team and is used to focus on features with the greatest potential for savings and to highlight areas of value mismatch.

Unit prices are reviewed by the Estimating Section, Engineering Services Group, D-8170, to ensure reliability and applicability.

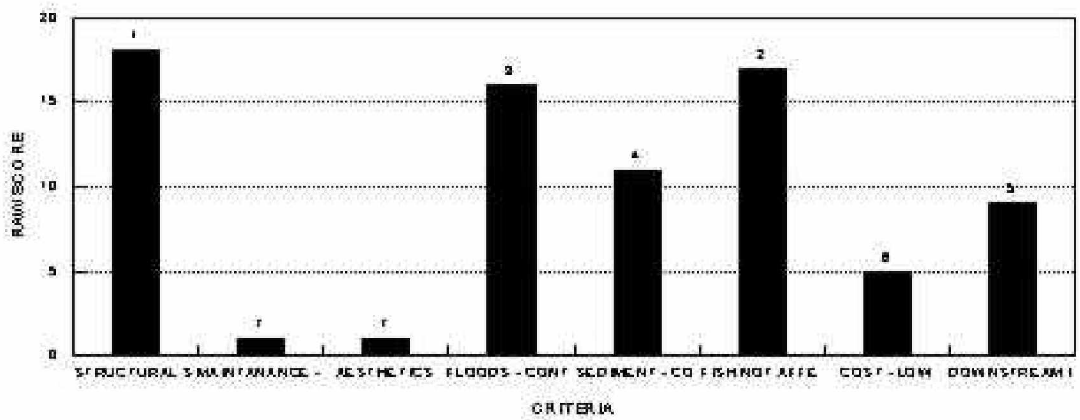
Cost savings and the original design concept estimates are of the same general level of development. It is recognized that these costs may vary as final designs are pursued.

CRITERIA WEIGHTING PROCESS

PROJECT: ELWHA RIVER RESTORATION

COMPONENT: GLINES DAM | FUNCTION: REMOVE OBSTACLES

CRITERIA	RAW SCORE (WEIGHT)	RANK
A. STRUCTURAL SAFETY	18	1
B. MAINTANANCE - LOW	1	7
C. AESTHETICS	1	7
D. FLOODS - CONTROLLED	16	3
E. SEDIMENT - CONTROLLED	11	4
F. FISH NOT AFFECTED	17	2
G. COST - LOW	5	6
H. DOWNSTREAM IMPACT	9	5



How important

4 - Major preference
3 - Medium preference
2 - Minor preference
1 - Letter/Letter - no preference each scores one point

	B	C	D	E	F	G	H
A	A 4	A 4	A 1	A 2	A 3	A 3	A H 1
B		B C 1	D 4	E 4	F 4	G 2	H 3
C			D 4	E 3	F 4	G 2	H 3
D				D E 1	D 2	D 3	D 2
E					F 3	E 2	E H 1
F						F 4	F 2
G							G H 1

(Each row: letter = other, number = number)

Note: Drop Criteria with a Raw Score of 1
(Criteria which gets dropped may be considered in Advantages/Disadvantages Analysis.)

CADSTUDY\GLINES\WT.WK3

VALUE ENGINEERING - DISPOSITION OF IDEAS

PROJECT: Elwha River Restoration, Dam Removal

OTHER VE ELEMENTS CONSIDERED AS POTENTIAL PROPOSALS	
IDEA	**DISPOSITION**
Blast dam in stages.	Not cost effective, no flood control.
Cut vertical slot to base.	Affect fish, structure unstable, no flood control.
Blast/cut dam to sediment level with fish ladder.	No flood control, affect fish.
Cut narrow slot to base with tunnel.	Affect fish, structure unstable, no flood control.

VALUE ENGINEERING - DISPOSITION OF IDEAS

PROJECT: Elwha River Restoration, Dam Removal

OTHER VE ELEMENTS CONSIDERED AS POTENTIAL PROPOSALS	
IDEA	**DISPOSITION**
A tunnel would be cut through the dam at the streambed level. The tunnel would be approximately 27 feet long and at least 10 feet in diameter. Prior to daylighting through to the upstream side, the sediment would be removed to a distance of approximately 200 feet upstream of the dam. The bulkhead would be constructed and lowered from a barge to cover the upstream portal. The impounded water will drained through a bulkhead with gates. After drainage is complete the hole would be enlarged to the extent necessary to safely pass the 500-year/6-hour storm event. Concrete from the tunnel construction would be used for sediment bank stabilization upstream of the dam.	Submitted as Proposal No. 1.

VALUE ENGINEERING - DISPOSITION OF IDEAS

PROJECT: Elwha River Restoration, Dam Removal

OTHER VE ELEMENTS CONSIDERED AS POTENTIAL PROPOSALS	
IDEA	**DISPOSITION**
This proposal requires the removal of sediment around the upstream face of the sluice gate area which is approximately 5 to 7 feet below the current sediment pool elevation, and for a distance of approximately 100 feet upstream of the dam. A 20-foot by 20-foot bulkhead would be lowered from a barge to the sluice gate elevation. A 10-foot-diameter, 27-foot-long tunnel would be sawed/controlled blasted to the bulkhead from the downstream face. Dewatering to elevation 537.8 would proceed as planned in the original concept. When the initial opening to the bulkhead is complete, the bulkhead gate would be gradually opened to drain the remaining impounded water. The tunnel would then be enlarged to the allow passage of the 500-year/6-hour storm event. The removed concrete would be used to construct an engineered river grade downstream from the sluice gate elevation at approximate elevation 445. The river upstream of the dam would be shaped and riprapped for	Submitted as Proposal No. 2.

VALUE ENGINEERING - DISPOSITION OF IDEAS

PROJECT: Elwha River Restoration, Dam Removal

OTHER VE ELEMENTS CONSIDERED AS POTENTIAL PROPOSALS	
IDEA	**DISPOSITION**
Sediment would be removed to an approximate elevation of 410 (approximate apron elevation), and to an approximate distance of 100 feet upstream. The impounded pool would be dewatered to elevation 537.8 through the penstock inlet. Excavation of a 27-foot-long tunnel approximately 10 feet in diameter from the downstream face would begin. Excavation would be completed through a combination of sawing and controlled blasting. The excavation would continue upstream until a safe distance from the upstream face where water head would be approximately 120 feet. The final tunnel section is removed by a controlled blasted. After the reservoir recedes, and a base flow is established, additional excavation is completed to enlarge the tunnel. Concrete waste material could be used as riprap for the shaped channel constructed upstream of the dam face for a distance of 200 feet.	Submitted as Proposal No. 3.

VEIDEAS.TAB

VE PROPOSAL DESCRIPTION

PROJECT: Elwha River Restoration, Glines Dam Removal

PROPOSAL NO. 1. TUNNEL THROUGH DAM AT BASE WITH BULKHEAD

BACKGROUND

The current proposal calls for the complete removal of Glines Dam. The dam would be removed using a combination of controlled blasting and diamond-wire sawcutting. The concrete would be removed in block form. The dam would be dewatered through the existing dam penstock to elevation 537.8, and then dewatering would occur through a series of alternate "notches."

VE PROPOSAL

A tunnel would be cut through the dam at the streambed level. The tunnel would be approximately 27 feet long and at least 10 feet in diameter. Prior to daylighting through to the upstream side, the sediment would be removed to a distance of approximately 200 feet upstream of the dam. The bulkhead would be constructed and lowered from a barge to cover the upstream portal. The impounded water will drained through a bulkhead with gates. After drainage is complete the hole would be enlarged to the extent necessary to safely pass the 500-year/6-hour storm event. Concrete from the tunnel construction would be used for sediment bank stabilization upstream of the dam.

VALUE ENGINEERING PROPOSAL NO. 1

PROJECT: Elwha River Restoration, Dam Removal	
COMPONENT: Glines Canyon Dam	**FUNCTION:** Eliminate Obstacles

ORIGINAL CONCEPT	VE CONCEPT
The current proposal calls for the complete removal of Glines Dam. The dam would be removed using a combination of controlled blasting and diamond-wire sawcutting. The concrete would be removed in block form. The dam would be dewatered through the existing dam penstock to elevation 537.8, and then dewatering would occur through a series of alternate "notches".	A tunnel would be cut through the dam at the streambed level. The tunnel would be approximately 27 feet long and at least 10 feet in diameter. Prior to daylighting through to the upstream side, the sediment would be removed to a distance of approximately 200 feet upstream of the dam. The bulkhead would be constructed and lowered from a barge to cover the upstream portal. The impounded water will drained through a bulkhead with gates. After drainage is complete, the hole would be enlarged to the extent necessary to safely pass the 500-year/6-hour storm event. Concrete from the tunnel construction would be used for sediment bank stabilization upstream of the dam.

COST ITEMS	NONRECURRING*	LIFE CYCLE*
ORIGINAL CONCEPT	$ 9,289,000 1/	
VE CONCEPT (-)	$ 2,455,000	
SAVINGS	$ 6,834,000	
NUMBER OF UNITS (X)		
TOTAL SAVINGS	$ 12,834,000 2/	
VE STUDY COSTS (-)		
IMPLEMENTATION COSTS(-)		
NET SAVINGS	**$ 12,834,000**	

* CHOOSE ONE METHOD-USE NONRECURRING IF LIFE CYCLE COSTING DOES NOT APPLY.

1/ Remainder of original concept cost ($9,700,000) is made up of cost items common to both proposals.

2/ An additional $ 6,000,000 savings results from power generation for 18 months during downstream construction at Elwha Dam.

IMPLEMENTATION OF PROPOSAL NO. 1

CRITICAL ITEMS TO CONSIDER:

Will contracts allow continued powerplant operation for income.

Some flood risk exists during construction while enlarging tunnel opening.

Prior to enlargement, tunnel can provide some flood control/mitigation.

PROBLEMS AND HOW THEY CAN BE OVERCOME:

Structural analysis must indicate proposed tunnel location and size is feasible.

PROCEDURES: (WHO DOES WHAT)

Principal designer needs to conduct and evaluate structural analysis to determine feasibility and size.

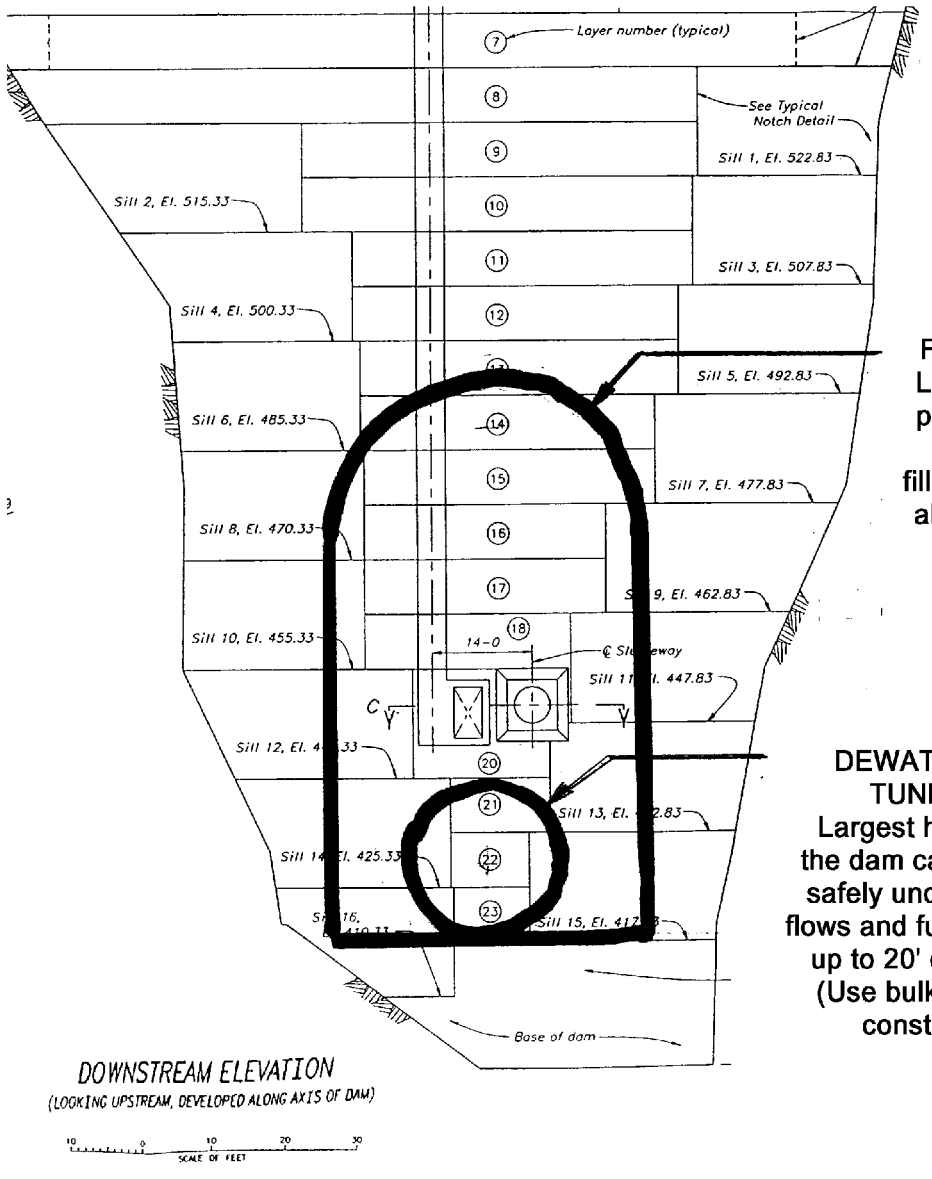
SUMMATION OF BENEFITS AND DRAWBACKS OF THE VE PROPOSAL:

Benefits:
1) Controlled releases for water/sediment.
2) Less concrete disposal.
3) Reduces heavy equipment needs.
4) Shorter construction schedule.
5) Power generation still possible during construction.
6) Potential exists for flood control/mitigation.
7) Less weather dependent.
8) More of the historically significant structures remain.
9) Good potential savings while meeting objective.

Disadvantages:
1) Requires additional engineering stability analysis.
2) Requires upstream sediment removal.
3) Increased flood risk during construction.
4) Structural analysis may indicate that the tunnel size is impractical.

1-IMPLEM.TAB

VE PROPOSAL NO. 1 – Dam Elevation



DOWNSTREAM ELEVATION
(LOOKING UPSTREAM, DEVELOPED ALONG AXIS OF DAM)

SCALE OF FEET

FINAL TUNNEL
Large enough to pass a 500 Year flood without filling the reservoir above the tunnel

DEWATERING TUNNEL
Largest hole that the dam can survive safely under storm flows and full reservoir up to 20' diameter. (Use bulkhead to construct.)

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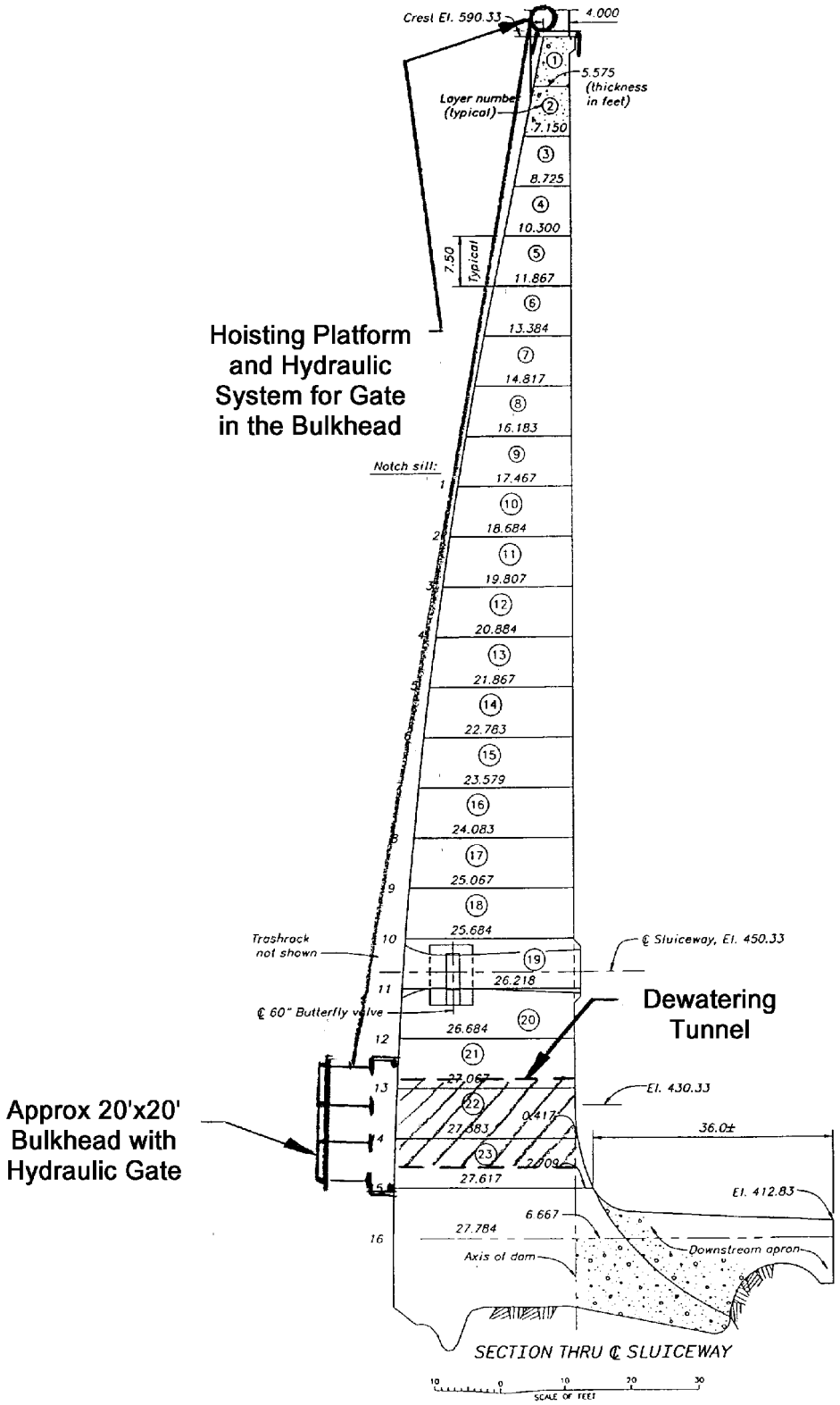
VE PROPOSAL NO. 1 – Dam Section



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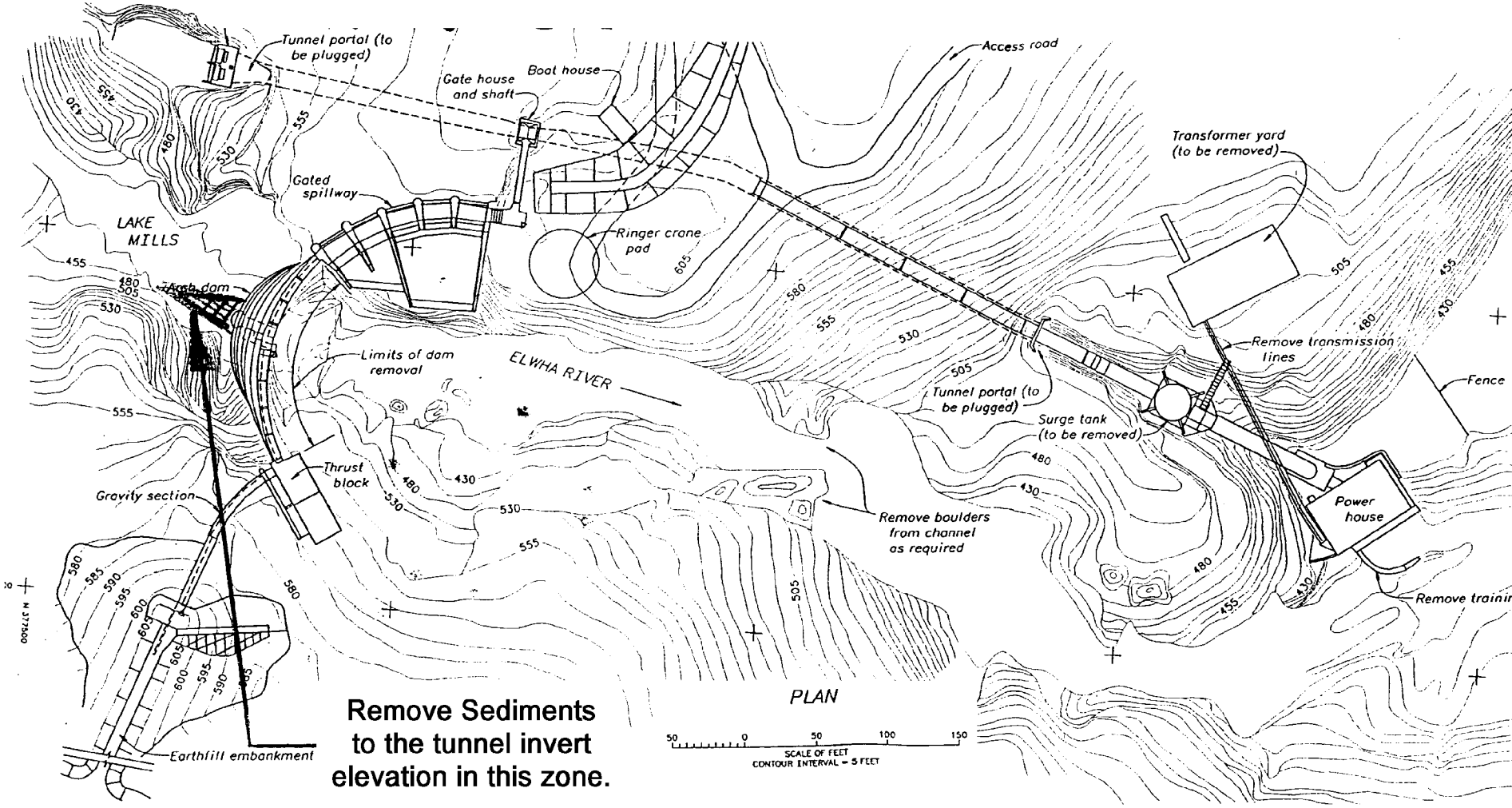
VE PROPOSAL NO. 1 – General Plan



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VE PROPOSAL DESCRIPTION

PROJECT: Elwha River Restoration, Glines Dam Removal

PROPOSAL NO. 2. TUNNEL THROUGH DAM AT SLUICE GATE ELEVATION WITH BULKHEAD

BACKGROUND

The current proposal calls for the complete removal of Glines Dam. The dam would be removed using a combination of controlled blasting and diamond-wire sawcutting. The concrete would be removed in block form. The dam would be dewatered through the existing dam penstock to elevation 537.8, and then dewatering would occur through a series of alternate "notches."

VE PROPOSAL

This proposal requires the removal of sediment around the upstream face of the sluice gate area which is approximately 5 to 7 feet below the current sediment pool elevation and for a distance of approximately 100 feet upstream of the dam. A 20-foot by 20-foot bulkhead would be lowered from a barge to the sluice gate elevation. A 10-foot-diameter, 27-foot-long tunnel would be sawed/controlled blasted to the bulkhead from the downstream face. Dewatering to elevation 537.8 would proceed as planned in the original concept. When the initial opening to the bulkhead is complete, the bulkhead gate would be gradually opened to drain the remaining impounded water. The tunnel would then be enlarged to the allow passage of the 500-year/6-hour storm event. The removed concrete would be used to construct an engineered river grade downstream from the sluice gate elevation at approximate elevation 445. The river upstream of the dam would be shaped and riprapped for approximately 200 feet through the sediment.

VE PROPOSAL COST ESTIMATE

No cost estimate was prepared for this proposal due to a lack of time.

IMPLEMENTATION OF PROPOSAL NO. 2

CRITICAL ITEMS TO CONSIDER:

Engineered river gradient needed to access downstream portal.

Structural analysis of tunnel.

PROBLEMS AND HOW THEY CAN BE OVERCOME:

Design of engineered river bed; use construction spoil concrete, making natural, rising pools.

Finite element analysis must indicate stability for desired tunnel size.

PROCEDURES: (WHO DOES WHAT)

Principal designer needs to conduct and evaluate structural analysis to determine tunnel feasibility and size.

Hydraulic division needs to evaluate and design an engineered river bed.

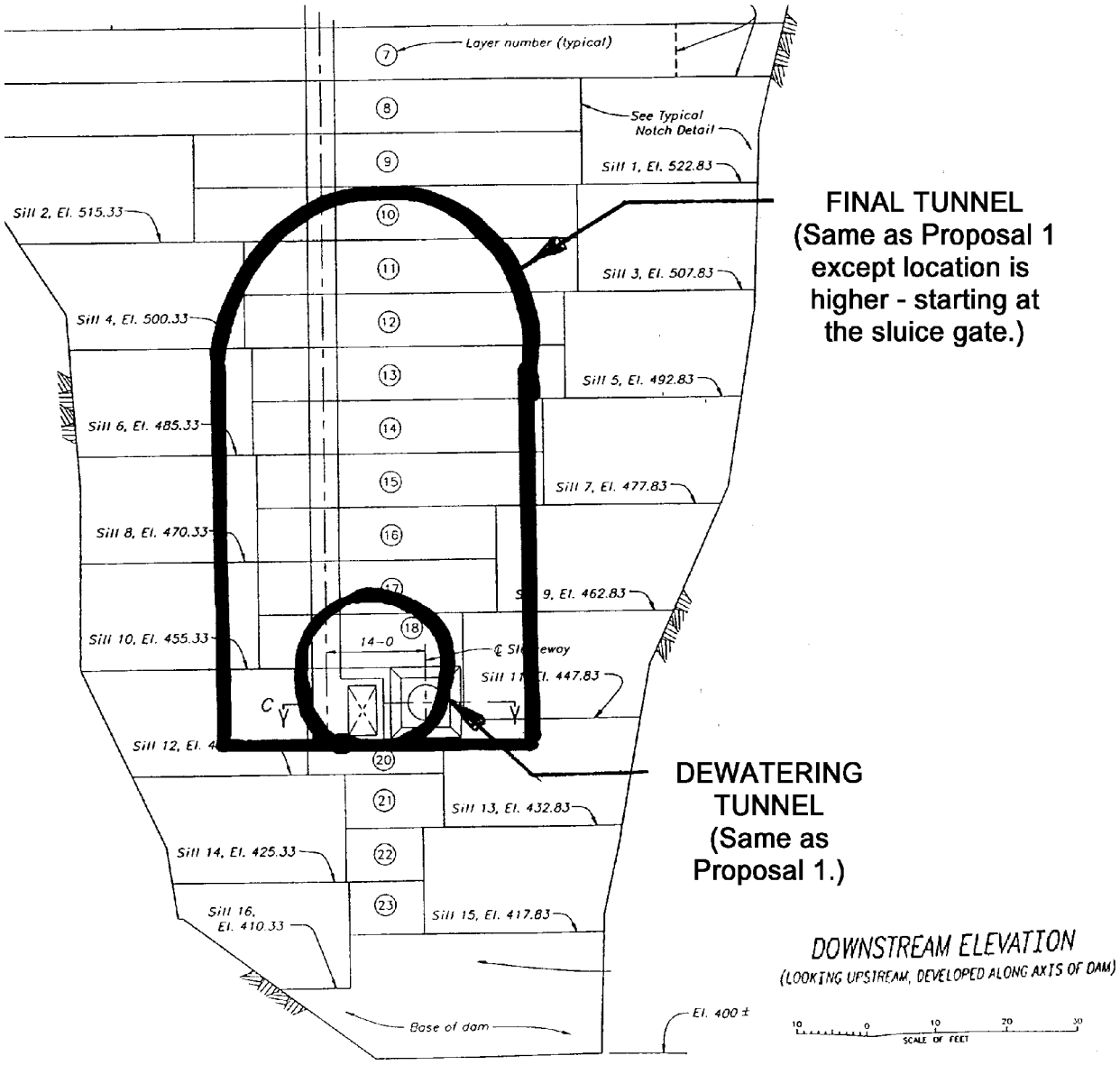
SUMMATION OF BENEFITS AND DRAWBACKS OF THE VE PROPOSAL:

Benefits:
1) Controlled releases for water/sediment.
2) Less concrete disposal.
3) Reduces heavy equipment needs.
4) Shorter construction schedule.
5) Power generation still possible during construction.
6) Potential exists for flood control/mitigation.
7) Less weather dependent.
8) More of the historically significant structures remain.
9) Decreased sediment transport after reservoir tap.
10) Lower cost while meeting objective.

Disadvantages:
1) Requires additional engineering stability analysis.
2) Requires upstream sediment removal.
3) More flood risk during construction.
4) Requires engineered river gradient downstream.
5) May reduce structural strength of dam.
6) Structural analysis may indicate that the tunnel size is impractical.

2-IMPLEM.TAB

VE PROPOSAL NO. 2 – Dam Elevation



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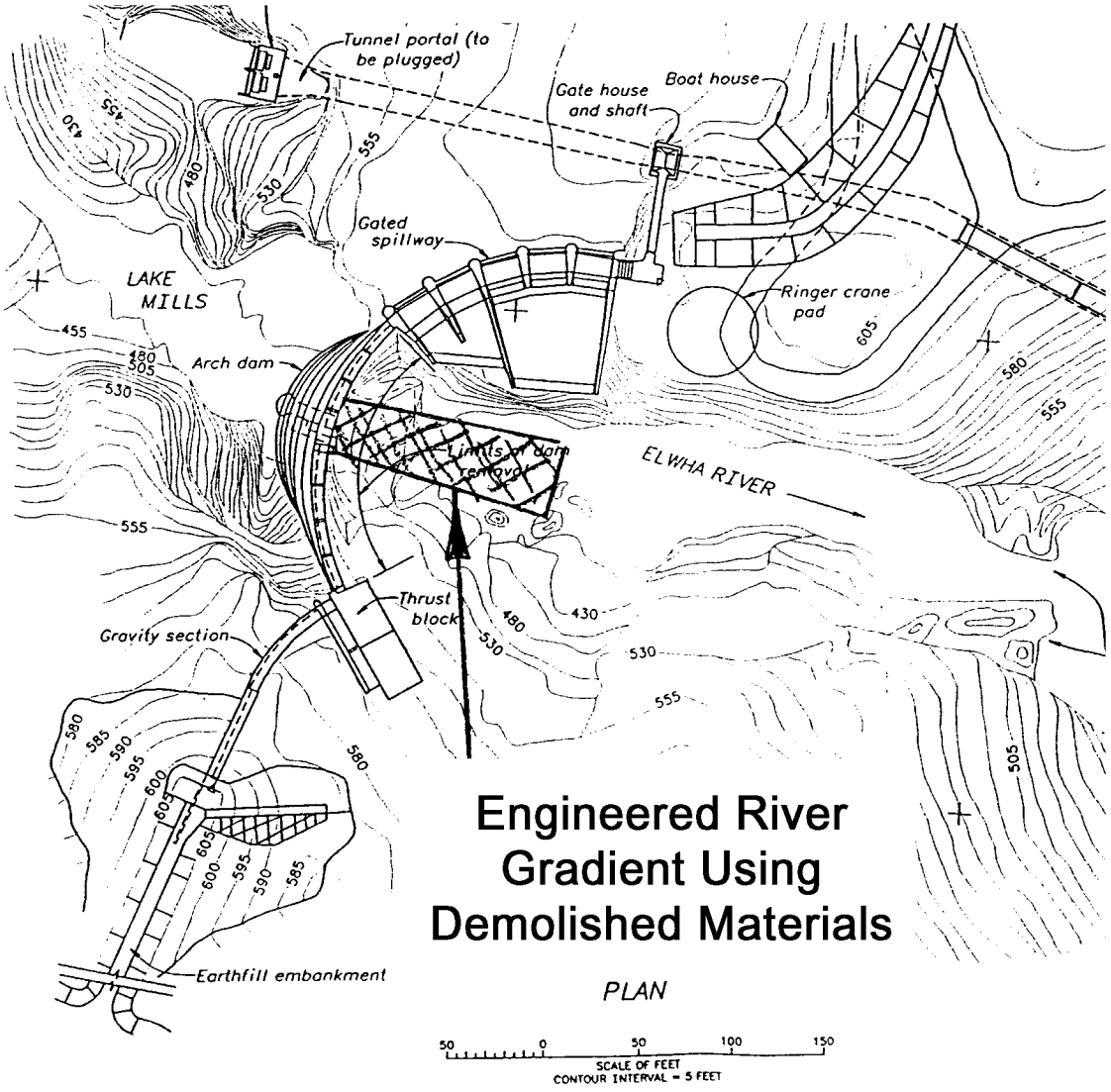
VE PROPOSAL NO. 2 – General Plan



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VE PROPOSAL DESCRIPTION

PROJECT : Elwha River Restoration, Glines Dam Removal

PROPOSAL NO. 3. TUNNEL THROUGH DAM AT BASE WITHOUT BULKHEAD

BACKGROUND

The current proposal calls for the complete removal of Glines Dam. The dam would be removed using a combination of controlled blasting and diamond-wire sawcutting. The concrete would be removed in block form. The dam would be dewatered through the existing dam penstock to elevation 537.8, and then dewatering would occur through a series of alternate "notches."

VE PROPOSAL

Sediment would be removed to an approximate elevation of 410 feet (approximate apron elevation), and to an approximate distance of 100 feet upstream. The impounded pool would be dewatered to El. 537.8 through the penstock inlet. Excavation of a 27-foot-long tunnel approximately 10 feet in diameter from the downstream face would begin. Excavation would be completed through a combination of sawing and controlled blasting. The excavation would continue upstream until a safe distance from the upstream face where water head would be approximately 120 feet. The final tunnel section is removed by a controlled blast. After the reservoir recedes, and a base flow is established, additional excavation will be completed to enlarge the tunnel. Concrete waste material could be used as riprap for the shaped channel constructed upstream of the dam face for a distance of 200 feet.

VE PROPOSAL

No cost estimate was prepared for this proposal due to a lack of time.

IMPLEMENTATION OF PROPOSAL NO. 3

CRITICAL ITEMS TO CONSIDER:

Structural analysis on tunnel location and size.

Difficult to determine proper thickness of tunnel "daylight" face for reservoir tap.

Completion of construction prior to flood events.

PROBLEMS AND HOW THEY CAN BE OVERCOME:

Structural analysis must indicate proposed tunnel location and size is feasible.

Hydraulic study needed to determine effects of flooding during construction.

PROCEDURES: (WHO DOES WHAT)

Principal designer needs to conduct and evaluate structural analysis to determine feasibility and size.

Hydraulic division should conduct flood study and effect on construction methods.

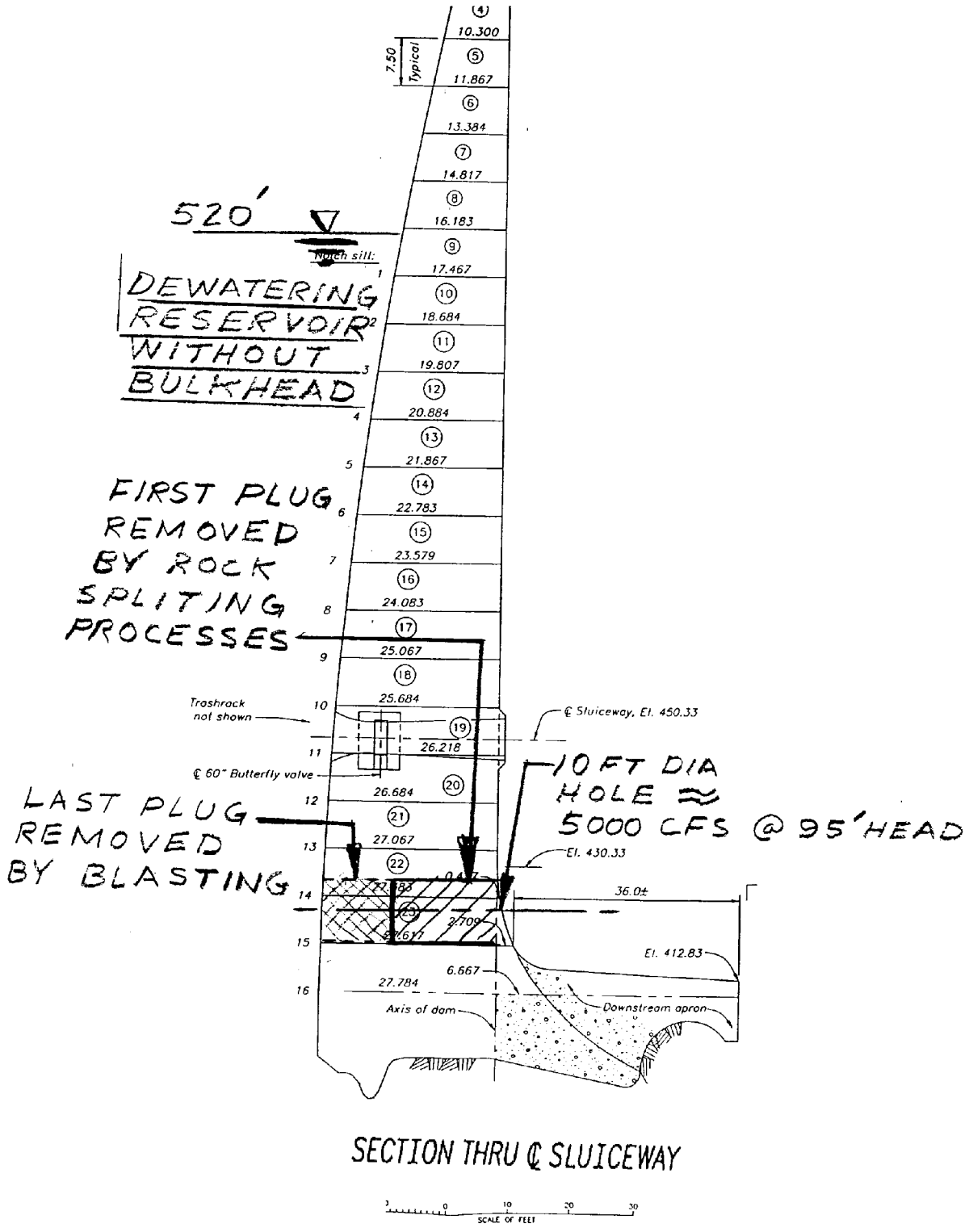
SUMMATION OF BENEFITS AND DRAWBACKS OF THE VE PROPOSAL:

Benefits:
1) No bulkhead expenses.
2) Less concrete disposal.
3) Reduces heavy equipment needs.
4) Shorter construction schedule.
5) Power generation still possible.
6) Potential exists for flood control/mitigation.
7) Less weather dependent.
8) More historically significant structures remain.
9) Construction schedule is quick and efficient.

Disadvantages:
1) Requires additional engineering stability analysis.
2) Requires upstream sediment removal.
3) More flood risk during construction.
4) Uncontrolled releases of water/sediment during reservoir tap.
5) Structural analysis may indicate impractical tunnel size.

3-IMPLEM.TAB

VE PROPOSAL NO. 3 – Dam Section



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CONSULTATION RECORD

CONSULTANT (Name,Title, Company)	CONTACT INFO (Telephone, address)	MAIN TOPIC DISCUSSED AND INFORMATION RECEIVED
Joe Lawrence	(303) 236-9120 Extension 231	Cost estimate for bulkheads and dredging.
Tom Hepler	(303) 236-9129 Extension 231	General project information.
Steve Higenbotham	(303) 236-9129 Extension 557	General project information.

CONSULT.REC

SUPPORTING DOCUMENTATION