US Army Corps
of Engineers
Walla Walla District

Lower Granite Sedimentation Study

DRAFT

Preliminary Evaluation and Progress Report

December 1992

CENPD-PE-PF (CENPD-PE-TE/9 Aug 93) (1105) 2nd End
Mr. Weaver/kb/(503)326-3826
SUBJECT: Lower Granite Reservoir Dam - Induced Flooding at Lewiston, Idaho

CDR, North Pacific Division, Corps of Engineers, P.O. Box 2870, Portland, Or 97208-2870 4-NOV 1993

FOR Commander, Walla Walla District (ATTN: CENPW-PL)

1. In accordance with the 1st End., HQUSACE has determined that further studies of flood protection at Lewiston, ID should be conducted under Section 216 of the 1970 FCA. Based on guidance in EC 11-2-161 (FY 1995 Budget EC), para A-2.3a(1)(b) for Review of Completed Projects, an initial appraisal or reconnaissance report should be prepared using O&M funding as an initial effort. The initial appraisal report should be limited to $20,000 cost and determine potential Federal interest, including the preliminary economic feasibility of a project with the changed sediment conditions in the reservoir. Also, you should identify a non-Federal sponsor(s) who is willing and capable of meeting study and project cost sharing requirements under WRDA 1986. Any follow-on GI reconnaissance study would have to be budgeted and compete for "new start" funds as described in paragraph A-2.3a(2)(a) of the budget EC.

2. If you have any questions, please contact Mr. Jerry Weaver, Plan Formulation Division, at (503) 326-3826.

FOR THE COMMANDER:

/signed/ DA Geiger
for ROBERT P. FLANAGAN, P.E.
Director, Planning and Engineering

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CF (w/o encl):
CENPD-CO
CENPD-PM-CP
CENPD-PE-TE
CENPD-PE-EC

CECW-EP-W (CENPD-PE-TE/PF/9 Aug 93) (1130) 1st End
SCHELL/cms/202-272-8889
SUBJECT: Position Paper and Request for Guidance in Report Preparation - Lower Granite Reservoir Dam - Induced Flooding at Lewiston, Idaho

HQ, US Army Corps of Engineers, Washington, DC 20314-1000

FOR Commander, North Pacific Division, ATTN: CENPD-PE-TE/PF

1. With the conditions cited in the Position Paper, it appears that neither a deficiency report nor major rehabilitation report as suggested would be appropriate. Standing authorities are contained in Section 216 of the 1970 Flood Control Act. Section 216 authorizes studies to review the operation of completed Federal projects and recommend project modifications "when found advisable due to significantly changed physical or economic conditions...and for improving the quality of the environment in the overall public interest". These studies are conducted in the two phase study process in the same manner as feasibility studies.

2. Unless there is a current agreement or contract in existence that requires a certain level of protection, the level of protection should be determined with the investigation of alternatives during the Section 216 study process.

3. Caution should be exercised in any contact (as inferred in your paragraph 6) with the impacted communities to discuss protection level until the appropriate time within the study process as outlined in ER 1105-2-100.

FOR THE DIRECTOR OF CIVIL WORKS:

/signed/
PAUL D. BARBER, P.E.
Chief, Engineering Division
Directorate of Civil Works

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DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION, CORPS OF ENGINEERS
P.O. BOX 2870
PORTLAND, OREGON 97208-2870

Reply to
Attention of:

CENPD-PE-TE/PF (1130)

9- AUG 1993

MEMORANDUM FOR CDR USACE (CECW-P) 20 MASS AVE NW, WASH DC 20314-1000

SUBJECT: Position Paper and Request for Guidance in Report Preparation - Lower Granite Reservoir Dam-Induced Flooding at Lewiston, Idaho

1. The Lower Granite Dam impounds the Snake River and Clearwater River at about River Mile 107 on the Snake River. The two rivers enter the Reservoir in the vicinity of Lewiston, Idaho and Clarkston, Washington. Lewiston and Clarkston are near the upstream limits of the Reservoir. The Reservoir is the most upstream in the lower Snake River system as other planned dams were not constructed. The Reservoir collects sediments from all upstream river basins at a significant rate which would not have occurred if upstream dams had been built as envisioned. The water surface elevation at Standard Project Flood (SPF) flows is increasing, since project construction, at a rate of about 0.25 feet per year. Sediment accumulation is choking the river channel to the point that the SPF will overtop the sub dams (levees) that the Corps constructed long before the anticipated economic life of the project is reached. It is the opinion of North Pacific Division and Walla Walla District that the extreme risk to life and property requires maintaining at least Standard Project Flood protection on this project.

2. During the design of the project a decision was made to set the dam height at an elevation that would maximize power revenues and enhance navigation. The Asotin Dam was expected to be constructed, which would aid in the control of sediments. Selected pages of the Design Memorandum are enclosed that give greater insights to those decisions.

3. The water surface elevation established by dam height selection required the taking of lands and relocating the City of Lewiston or protecting the City with sub-dams (levees). The most cost-effective solution, given that upstream dams were anticipated, was levee construction at Lewiston. As required by the real estate guidance at the time and still prevailing (ER 405-1-12), the level of protection or risk allowed was established at SPF levels. The area where project-induced flooding is increased by up to 10 feet if protection is compromised is the central business and industrial area of Lewiston, Idaho.

Much of the new development has been encouraged by the project and the Corps developed slackwater navigation. Potential flooded areas are shown on Plates 1 and 2. Loss of life can be expected and the developed areas will experience severe damage if the levees are overtopped. The exact extent of loss of life is unknown, but the protective system was not designed for overtopping and a catastrophic failure is anticipated if the levees are compromised. The risk for loss of life is much greater behind these levees than in a gradually sloping reservoir so this is in the upper range of risk that the Corps normally allows in a real estate taking action.

4. During Design Memorandum preparation it was recognized that sedimentation could create a problem until authorized upstream dams were constructed. A sediment monitoring program was established and Walla Walla District has documented the sediment build-up and increasing flood risk since construction. It has been obvious for some time that upstream dam construction will not occur in any near-term timeframe and that an action will need to be taken to restore and preserve flood protection.

5. We are requesting your recommendation on the type of report to prepare. A Design Deficiency can be claimed, as adequate provisions for sedimentation were not included for the condition of no upstream dams. A post-project modification report and a major rehabilitation report may also offer suitable vehicles to obtain funds.

6. We require your concurrence in our position to continue protection to Lewiston at SPF levels for three (3) reasons. The first of these reasons is that the level cited in ER 405-1-12 was set by your discretionary authority. The second reason is that most reports require detailed economic analysis to aid in supporting priorities for funding. A detailed analysis can be foregone if the basis for funding is maintaining an SPF risk level. The third reason for

requesting concurrence now is to allow Walla Walla District to go on record with the impacted communities on the level of risk the Corps may impose on them in the future. Risk levels associated with less than SPF protection will be resisted by the impacted communities.

7. We would like to proceed with a least-cost engineering analysis with risk established at SPF levels as the basis for completing a Design Deficiency Report.

FOR THE COMMANDER:

2 Encls

\signed\ W.E. Daughat
for ROBERT P. FLANAGAN, P.E.
Director of Planning and Engineering

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DESIGN MEMORANDUM NO. 2

UPPER POOL DETERMINATION

LOWER GRANITE LOCK AND DAM
LOWER SNAKE RIVER PROJECT
OREGON, WASHINGTON AND IDAHO

U. S. ARMY ENGINEER DISTRICT, WALLA WALLA

CORPS OF ENGINEERS

12 APR 1963

SECTION 11 - DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

11.01. Discussion.

a. Lower Granite Pool Elevation. - As noted throughout this report, the choice of a pool for Lower Granite is greatly complicated by the Towns of Lewiston, Clarkston, and Asotin. Pool elevation 738 affords the most desirable solution to the many factors affecting pool selection. It results in normal and maximum lock lifts of 100 and 105 feet, which are comparable to the lifts at the other Lower Snake River dams. It provides an acceptable navigation channel up the Clearwater to the Memorial Highway Bridge without channel excavation. Small pleasure boats, of course, can navigate both rivers to points of lesser water depths. The 738 pool will be some three or four feet higher than average ground elevations behind the levees, but seepage through the levees and drainage from behind the levees will be controlled so that natural ground-water elevations will not be raised.

Economic analyses favor a 745 pool elev[illegible]tion in combination with the 146.5 Asotin site (see Chart 20), but [illegible]at pool would require a maximum lock lift of 112 feet at Lower Granite, and the water surface at Lewiston would average 10 feet above the main street. This constantly higher water surface would greatly complicate the maintenance of present ground-water levels.

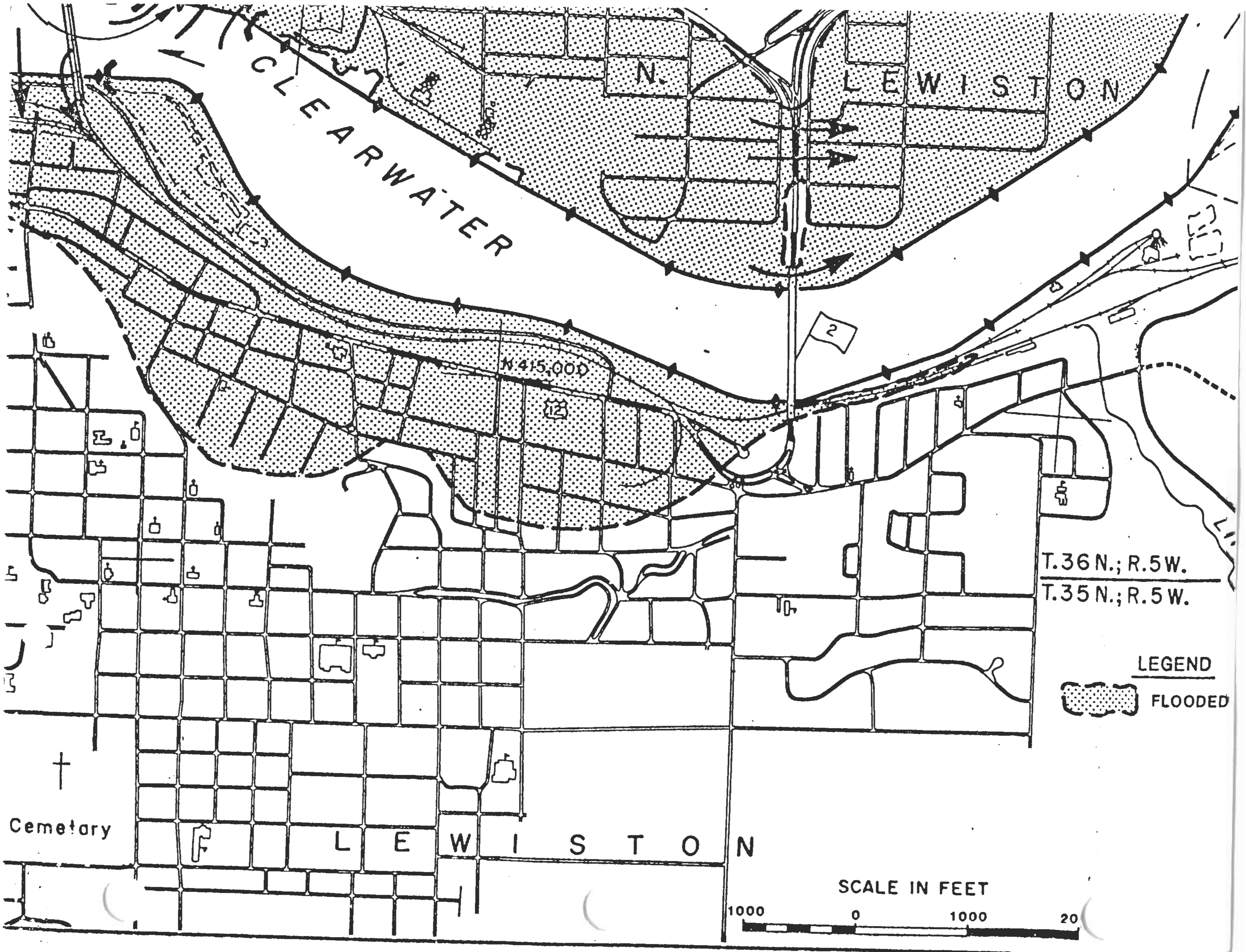
The 730 pool is economically the least desirable, and due to backwater effect, it would result in levees in the Lewiston area only three feet lower than those required for the 738 pool. Further, water depths for harbor facilities would be insufficient without dredging.

b. Asotin Site Selection. - The economic analysis illustrated on Chart 20 indicates that a dam at Snake River Mile 146.5 would provide highest net benefits, of the three sites studied, with Lower Granite pool at elevation 741 or higher, and also shows a loss in annual net benefits of approximately $100,000 for pool elevation 738. Not included in the economic analysis illustrated by Chart 20 is a $70,000 loss in annual net benefits chargeable to the upper site due to pondage requirements. See discussion in paragraph 9.04g. With Lower Granite pool at elevation 741 or less, a dam at river mile 143.8 appears to be the economical choice. The discussion in the foregoing paragraph supports selection of pool elevation 738 for the Lower Granite project, and since loss in annual net benefits are not excessive at that elevation, factors other than economic influence selection of a site for Asotin Dam. The main disadvantage to a dam at either river mile 143.8 or 145.2 would be inundation of the Town of Asotin, the county seat of Asotin County, with its accompanying disruption and loss of propert to the tax roll. For these comparative estimates, the cost of inundation of Asotin is based upon real estate purchase. If relocation was proposed similar to Arlington and Boardman on the John Day pool the cost could be considerably higher. The indicated economic savings do not warrant inundation and/or relocation of the Town. Although the dam is tentatively sited at river mile 146.5, the possibility exists that future studies may justify moving the dam upstream, with even less potential disruption to the Town of Asotin.

c. Public Meetings. - At a meeting with the Lewiston Chamber of Commerce on 13 December 1962, and at public meetings held at Lewiston on 25 January 1963, at Clarkston on 26 January 1963, and at Asotin on 7 February 1963, information was presented in support of a 738 pool elevation for Lower Granite project and location of Asotin Dam at Snake River Mile 146.5. Specific questions from the people of the area were answered, but no opposition to the proposed project was expressed at the meetings.

11.02. Conclusions. - Based on the investigations and analyses presented in this report, it is concluded that establishing Lower Granite normal maximum pool at elevation 738 will most acceptably develop the available water resources at the Lower Granite site and will not result in undue hardships to the communities of Lewiston, Idaho, and Clarkston and Asotin, Washington. It is further concluded that locating Asotin Dam in the vicinity of Snake River Mile 146.5 will match Lower Granite pool elevation 738 and will cause minimum disruption to the Town of Asotin. Finally, Lower Granite pool elevation 738 will not hamper potential development of the lower reaches of Clearwater River.

11.03. Recommendations. - It is recommended that maximum normal pool elevation 738 be approved for the Lower Granite project as a basis for preparation of the general design memorandum, and that Snake River Mile 146.5 be tentatively approved as the location for Asotin Dam.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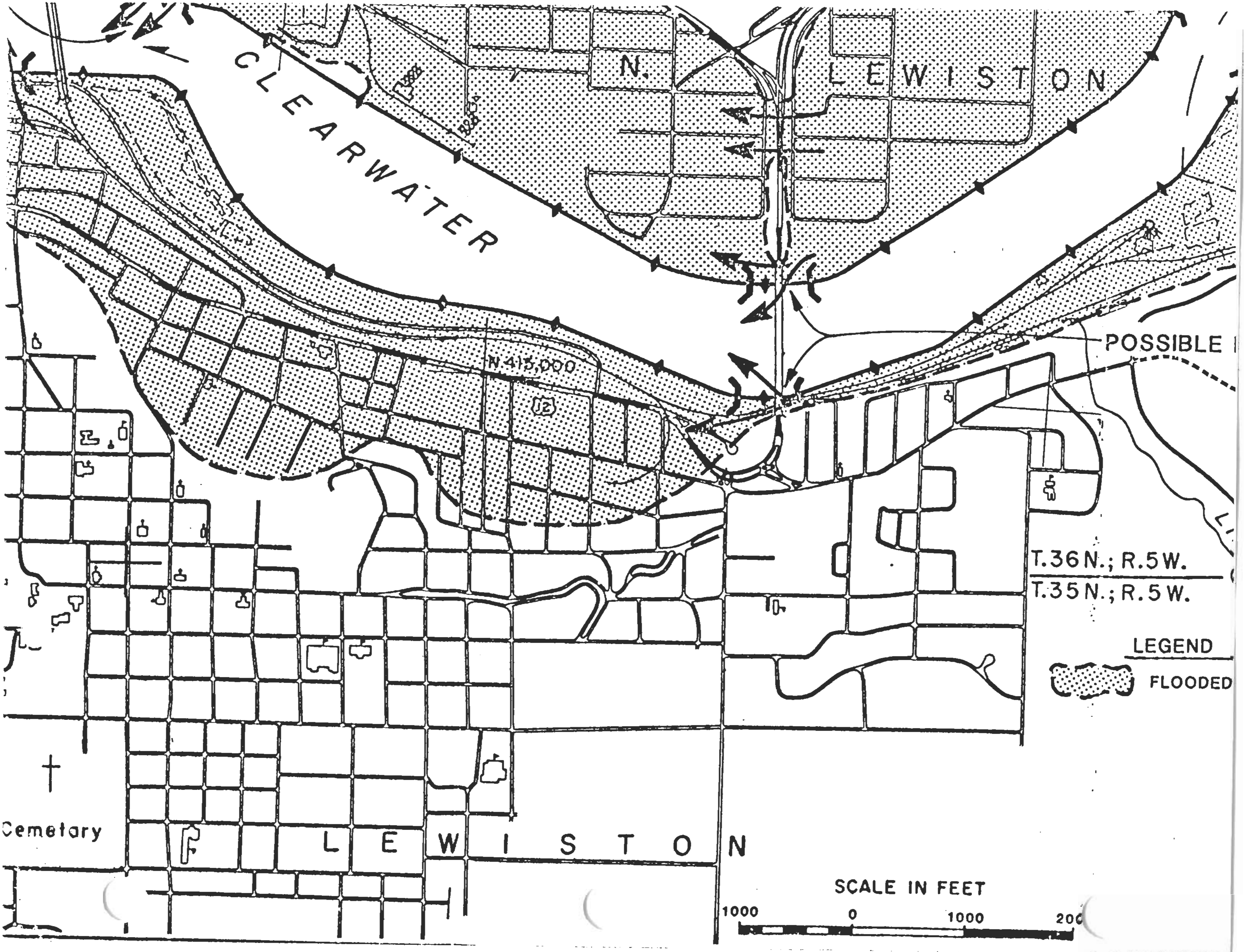
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CENPW-PL-PF (1110-2-1150a) 30 September 1993

MEMORANDUM FOR Plan Formulation Branch Files

SUBJECT: Lower Granite Sedimentation Study and Environmental Impact Statement (EIS) Team Meeting

1. A Lower Granite Sedimentation Study Team meeting was held 23 September 1993 in the Planning Division Conference Room.

2. Fiscal year 1994 funding is $0. Until funding is received all work will cease on 30 September 1993.

3. Chris Sneider could not attend the team meeting. He reported earlier that he will be meeting with Cost Engineering and finishing his portion of the report by 30 September.

4. Chris Pinney could not attend the team meeting, but reported earlier that Dr. Bennett will be finishing the final report of the 7 year reservoir testing program in FY 94. His estimate for this work is $56,800. Environmental Resources Branch coordination is estimated to be about $10,000.

5. Les Cunningham will coordinate with Environmental Resources concerning his planned monitoring of six specific sites for Dr. Bennett's work.

6. The next major sediment survey of Lower Granite Reservoir is scheduled for 1995.

7. System Operation Review studies all assume that dredging of sediments in the Lower Granite Reservoir will begin in FY 95. We can only assume that if dredging does begin in FY 95, placement of the dredge material will be on the high uplands. Past decisions by State and Federal agencies indicate that no in-water placement of dredge material will occur until the environmental impact statement is completed.

8. HQUSACE is reviewing a position paper that requested guidance in report preparation for this study. Concurrence is requested to continue protection to Lewiston, Idaho, at Standard Project Flood levels and to proceed with a least-cost engineering analysis with risk established at SPF level as the basis for competing a Design Deficiency Report. The response from HQUSACE through Division may result in a totally new direction for this study.

9. All study work is on hold due to funding and definition of study direction.

/signed/
Gareth Clausen
Technical Manager

CF:
C, CENPW-PL-PH
C, CENPW-PL-PE
C, CENPW-EN-DB
CENPW-PL-PF (Graham, SCS)

Team Members:

CENPW-PL-ER	(Barila, Pinney, Miller)
CENPW-EN-GB-SC	(Sneider)
CENPW-PL-H	(Cunningham)
CENPW-OP-PO	(Bluhm)
CENPW-ENB	(Coulombe)
CENPW-RE	(Buerstatte)
CENPW-PL-PG	(Fredericks, Trafton)

CONVERSATION RECORD	Time:	Date: 2 July 1993

___ Visit ___ Conference _X_ Telephone

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Name	Int
~~LAWS~~	
~~FITZSIMMONS~~	
ROEDIGER	
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Person(s) Contacted
Jerry Weaver
CENPD-PL-PF (503) 326-3826

SUBJECT
Lower Granite Sedimentation Study -
Standard Project Flood Protection Level

SUMMARY

1. Division staff have been discussing the District's position and concerns about maintaining the Lower Granite Project (backwater levees) to provide Standard Project Flood (SPF) protection for the City of Lewiston, Idaho. Also of concern is the need for an economic risk based analysis of providing other levels (less than SPF) of protection for overtopping of the Corps backwater levees. A sub-issue is the Corps' responsibility to maintain the level of protection as the project was designed. A plan of action includes the following:

Mr. John Oliver will be preparing a Position Paper on maintaining Standard Project Flood protection for the City of Lewiston, Idaho without the need for economic and risk analysis of various levels of protection.

A draft will be provided for CENPW review and comment the week of 6 - 9 July 1993.

CENPD will forward this position paper to the ASA for consideration.

In the interim Jerry Weaver said we are to continue our studies and schedule to complete feasibility level analyses and the environmental impact statement.

2. CENPD Economics is concerned that this approach won't work. It has been HQUSACE's position that economic analysis for various levels of protection is needed for any financial decision.

ACTION REQUIRED

Anticipate the arrival of the draft position paper for review.

Name Gareth Clausen	/signed/	Date 6 July 1993

ACTION TAKEN

None at this time.

Name	Title	Date

To: Plan Formulation Files

Thru: Gareth Clausen, Study Manager
Acting Chief, Plan Formulation Branch

From: Paul C. Fredericks, NPW-PL-PF

Date: June 21, 1993

Subject: Lower Granite Sedimentation Study

1. This is a recap of an informal meeting I had with Ed Woodruff, NPD-PE-EC and JerryWeaver, NPD-PE-PF at the Division office on June 17. A planned meeting involving others from NPW and NPD was canceled June 16, while I was in transit, due to unavailability of NPD representatives.

2. Ed and Jerry began by stressing that HQUSACE and Sec. Army's Office are insisting on seeing economic analysis in all funding decisions regardless of whether other considerations, e.g., legal liability or legislative direction, require Corps implementation. Several examples were cited, including Columbia River in-lieu Indian fishing sites. I said I understood and that our Chief of Planning was sensitive to this situation. I also said that in the Lewiston levee situation, the District needs to be able to defend a study that will probably show that something other than SPF is optimum in terms of damages prevented and could show that SPF isn't economically justified by damages prevented. They seemed to appreciate this concern.

3. We discussed the history of this study; the Division asking for economic analysis of alternative levels of flood protection and the District citing legal responsibility for providing SPF obviating the need to study other levels. I said that the District thought that the opinion of District Counsel of 19 April 1990 resolved the issue in favor of SPF protection and that is why the December 1992 Progress Report did not included consideration of alternative levels of protection. I mentioned that a draft Preliminary Evaluation and Economic Analysis report in February 1989 contained a very quick and dirty economic analysis and it showed most, if not all, alternatives justified with 100-year protection as optimum, and that revisions to time-to-levee overtopping relationships in March 1990 altered that analysis such that only 100-year protection was justified. I further mentioned that the overtopping event damages in the 1989 very rough estimate were $600 million and the recent estimate for SOR (which I would consider sub-reconnaissance) was $300 million. I was reluctant to cite the 1989 and 1990 analysis because of its preliminary nature but thought Ed and Jerry needed an indication of where economic analysis might lead.

Regarding analysis of alternative levels of protection, I said the District was coming around to their position on the requirement to make such analysis (per study manager Gareth Clausen's discussions with Matt Laws), on the other hand I brought up the draft Quarterly Review meeting notes wherein the resolution of study of alternatives, at least with respect to risk analysis, was that risk analysis was intended for the without project condition only.

5. We discussed risk and uncertainty and I pointed out that the guidance they were directing us to follow is for the formulation of new projects and explicitly requires application of risk and uncertainty parameters to a number of factors in flood damage estimation. I explained that the data we used for the SOR analysis is not to the level of detail needed to comply with the draft EC on risk analysis that they referred us to. Ed and Jerry seem to want risk analysis in a more generic sense as applied to several key variables rather than the whole gamut.

6. We then started discussing the possibility of a 2 stage approach to economic analysis. The first stage would consist of risk analysis applied to the without-project condition and SPF protection, using as much existing information as possible, e.g., SOR damage analysis. We would then have an indication of whether or not SPF was justified by damages prevented but not what the optimum level of protection should be. This information, along with the argument for SPF would be presented to higher authority and we would get feedback on the need for and scope of studies of alternate levels of protection. In the initial stage we would apply risk analysis to several key variables (to be identified in consultation between District and Division staff). I said I thought this was a reasonable approach and the damage information we have could be used, supplemented as needed for the risk analysis. I cautioned that I couldn't say how much work Hydrology would have to do for the first stage. I also said that many of the considerations NPD asked for in their 4th endorsement would have to be set aside in order to do this initial stage of economic analysis expeditiously. Jerry agreed, although he would consider this a deferral of those considerations to the next stage of study.

7. Jerry will organize a meeting of appropriate NPD staff to discuss this 2 stage approach to include Tom Davis, John Oliver, Doug Speers and Ed Woodruff and/or Ken Boire. Jerry thought the earliest that could take place would be the week of 28 June. There would then be a meeting of NPD and NPW technical staff (here !) to discuss particulars of the first stage of study (or the overall study if the 2 stage approach isn't acceptable). Important aspects of this meeting would be agreement on the depth of detail and variables to which risk analysis would be applied.

cc: Gina Trafton, NPW-PL-PF
Les Cunningham, NPW-PL-H

CENPW-PL-H (1110-2-1150a) 28 May 1993

MEMORANDUM FOR Plan Formulation Branch Files

SUBJECT: Lower Granite Sedimentation Study, Minutes of the 25 May 1993 Planning Quarterly Review Meeting

1. A Quarterly Review meeting with Division staff was conducted on 25 May 1993, in the Main Conference Room. One of the issues discussed was the direction and study process for the Lower Granite Sedimentation Study.

2. It was re-emphasized that this study is not a 216 GI study. However, the 18 March 1993 4th Endorsement specifically states: "However, a risk-based analysis will need to be developed for this level (and other levels) of flood protection prior to proceeding with a feasibility study." Because of the confusion, it was noted that all must take care in using terminology, i.e. feasibility study versus feasibility level studies.

3. The product of the sedimentation study will be a decision document that will present the case to move the study from a non-routine program to a routine program. We must demonstrate to Headquarters that dredging to maintain the Lower Granite Project is an appropriate investment decision.

4. Presenting risk should demonstrate the problem and urgency.

5. Division staff indicated they would review the study process and their request for a risk analysis.

6. Mr. Flanagan suggested a special meeting to discuss and come to an understanding of the study process and what is needed and expected of CENPW and CENPD. We agreed. I will discuss such a meeting forum and format with Mr. Weaver and leave it to CENPD to schedule this meeting.

\signed\

GARETH M. CLAUSEN
Plan Formulation Branch

CONVERSATION RECORD	Time:	[.e: 22 April 1993

___ Visit ___ Conference _X_ Telephone

ROUTING

Laws

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PL-PF Files

Person(s) Contacted
Karl Foley, Washington Level Review (703) 355-2480

SUBJECT
Lower Granite Sedimentation Study,

SUMMARY

1. I gave Karl a brief explanation of the Lower Granite Project, Lewiston Levees, and our dilemma regarding Standard Project Flood protection for the City of Lewiston.

2. First thought this would likely fall under the 216 authority. However, feasibility reports are painfully slow to get through the system. His initial reaction was that if we could get this classified as a "design deficiency" that would be the best way to go.

3. Two important factors:

a. The Corps owns, operates, and maintains the Lewiston Levees. From a laymen's point of view we would have the responsibility to maintain the design of our project.

b. Potential overtopping is a safety problem that needs to be resolved.

4. He spoke of other projects throughout the country having questions regarding design deficiency, dam safety, and incomplete development of the total planned project. In some cases plan formulation and economics were done and others the problems were corrected. The Yazo River project dragging on for years is still uncertain.

5. As we talked more about the project, authorized for navigation, irrigation, and surplus hydropower, not flood control, he realized that we have a difficult, complicated, situation. I told him we may elevate this issue to the Headquarters level. He agreed.

ACTION REQUIRED

Name	Signature	Date
Gareth Clausen	\signed\	22 April 1993

ACTION TAKEN

None at this time

Name	Title	Date

CONVERSATION RECORD	Time:	Date: 22 April 1993

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Person(s) Contacted
Richard Carlton, CENPW-RE

SUBJECT
Lower Granite Sedimentation Study, ER 405-1-12, Real Estate Handbook

SUMMARY

1. One of the principle arguments we have for providing no less than Standard Project Flood protection to the City of Lewiston is ER 405-1-12, REAL ESTATE HANDBOOK, SECTION IV. RESERVOIR PROJECTS;

2-12. Application of Joint Policy by Corps of Engineers. - - - - - -
c. Levees in Lieu of Acquisition.
(1) Where construction of levees or flood walls and necessary associated facilities for protection of land and properties located within potential flowage limits of a reservoir is proposed in lieu of acquisition of fee title or easements over such properties, the protective structures shall meet the following minimum functional requirements:
(2) **In urban communities or other areas of highly concentrated developments where overtopping of levees would result in major hazards to life or unusually severe property damage under anticipated future conditions, levee grades and designs shall be adequate to withstand without failure the occurrence of the standard project flood,** assuming the reservoir is filled to highest level that is reasonably likely to prevail at the beginning of such a flood.

2. Richard contacted his counterpart in Division regarding Real Estate's position regarding this section of the ER. Division RE had reviewed our progress report and indicated they were familiar with the issue.

3. Richard said that Division stated the ER is applicable to new construction not existing projects.

4. I find Division's statement disturbing when told: The purpose of real estate guidance is to protect the rights of abutting land owners at the time of construction **and in the future for the life of the project.**

ACTION REQUIRED

Name	Signature	Date
Gareth Clausen	\signed\	22 April 1993

ACTION TAKEN

None at this time

Name	Title	Date

Rec'd
21 April 1993

CENPW-PL-H (1110-2-1150a) 15 April 1993

MEMORANDUM FOR Chief, Plan Formulation Branch,
ATTN: Mr. Gareth Clausen, Lower Granite Study Manager

SUBJECT: Lower Granite Sedimentation Study: Division Comments and Cost Estimate for Reconnaissance-Level Risk-Based Analysis

1. In response to the Draft Preliminary Evaluation and Progress Report, Division has returned a number of comments and recommendations which variously appear to either recommend or actually direct us to do some or all of the following:

a. Stop our present study of alternatives to provide Standard Project Flood (SPF) protection for the life of the Lower Granite Project.

b. Change the Sedimentation Study to a Flood Damage Reduction Study which evaluates the levees as if they were a separate flood control project with the focus being on economic justification.

c. Follow the guidelines (presently in development) for selection of an NED plan from among the possible alternatives for levee raises, dredging plans, etc., based on risk and uncertainty.

d. Evaluate the before-project (no levee) and after-project condition at the SPF and possibly other flood levels.

e. Re-evaluate the SPF.

f. Evaluate the effect of proposed drawdown plans on the various alternatives.

g. Reduce the scope of recommendation "c" by pre-selecting the "most likely alternative" and showing that at least this one alternative would be economically feasible and in the interest of the government.

h. Perform a risk-based economic analysis before proceeding with a feasibility study.

2. The above comments and recommendations appear rather confusing, particularly items "f" and "g" above which derive from a 2 April 1993 "Conversation Record." The pre-selection of a single alternative appears incompatible with the recommended procedure for a risk-based selection process. This procedure

requires the simultaneous evaluation of an array of alternative solutions, such as levee raise, dredging, drawdown, etc., each of which incrementally covers the possible range of alternatives, with confidence limits defined for each major parameter and probabilities of failure and economic consequences assigned to each increment.

The Division objective is to induce the District to abandon the effort to maintain the original design level of protection and focus on alternative solutions from a purely economic prospective.

3. Previous major changes in study direction, as a result of similar directives from Division, have resulted in considerable additional study effort and failure to properly document previous study results. Since a major division of the present study is nearly complete, it would probably be prudent to make sure that present studies are completed and properly documented before making a major change in the study direction. With regard to the latest comments, perhaps the following steps should be considered.

a. Respond to specific Division comments, make needed corrections, and publish the preliminary evaluation and progress report which was submitted for review on 28 January.

b. Complete the cost estimates for alternatives covered in the existing sedimentation study and publish the results by updating the "Preliminary Evaluation and Progress Report" to include the latest hydrology write-up and the cost information.

c. Resolve the question of whether this study should be a Lewiston-Clarkston Vicinity **Flood Damage Reduction Study** or a Lower Granite **Project Deficiency Study.**

d. Recognize that whichever course is pursued, the interdependence between the Lower Granite Project and the upstream levees (which presently provide the operating head) for the dam cannot be ignored. How does the concept of project life affect our analysis? At what point in time do we assume sediment will no longer continue to accumulate in the river? If the levees will fail every 10 years after 150 years of sediment accumulation, does this need to be factored into an economic risk analysis?

e. Change direction of the study only after the previous studies have been documented and the critical question of study direction has been resolved.

4. Cost estimate for alternatives which provide an economic evaluation of lower levels of protection than the SPF.

Two approaches can be made:

a. Choose one dredge/levee raise option and evaluate only one element of risk: the risk of experiencing a flood peak of a given frequency. This approach largely bypasses the risk-based selection process as presently presented.

b. Perform the alternative-selection process on a risk-based economic analysis.

\signed\

DAVID L. REESE
Chief, Hydrology Branch

2 Encls
1. Cost Estimate for Single Alternative
2. Cost for Full Risk-Based Analysis

COST ESTIMATE FOR SINGLE ALTERNATIVE
(Hydrology Branch Only)

The easiest study would be a levee-raise only evaluation. However an option which combined a moderate dredging program combined with a levee raise might be the most economical.

1. Task 1. **Prepare a detailed plan of study.**

GS-12 5 days @ 520/day	$2,600
GS-13 1 day @ 560/day	$ 560
Attend Study Team Meetings GS-12 4 hrs	$ 250
Division Coordination mtgs. GS-12 1 day	$ 520
GS-13 1 day	$ 560
Per diem	$ 150

2. Task 2. **Perform technical evaluations.**

a. Extend cross sections to include potential flooded areas behind levees.

Survey Crew. 12 ranges @ 1600/range	$19,200
Office Computations. 2 days @ 480/day	960

b. Base Case: Evaluate levee-raise only case.

1. Code HEC-2 overbanks 5 days — $2,600
   Debug model 10 days — $5,200

2. Set up 5 separate HEC-2 models @ 20yr intervals in future based on HEC-6 output

   GS-12 5 days — $2,600

3. Run 2,10,50,100,500,SPF Floods with levee (5 separate runs)
   GS-12 1 day — $520

4. Run same series (assuming 4 levee heights, 5 time periods) with overtopping and levee failure scenarios. (20 runs, 120 profiles)
   GS-12 40 days — $20,800

5. Plot backwater profiles with and without levee failure for above runs
   GS-12 20 days — $ 2,600

6. Prepare flood boundary maps
   GS-11 20 days @ 415/day — $ 8,300

3. Task 3. **Prepare Hydrology Write-Up For Report.**

1. GS-12 30 days — $15,000
   Branch Chief Review 2 days — $ 1,200

2. Responses to Division Review
   GS-12 8 days — $ 5,000

TOTAL TIME 4 to 6 months — TOTAL COST $80,990

COST FOR FULL RISK-BASED ANALYSIS1.
(Hydrology Branch Only)

1. Task 1. **Prepare a detailed plan of study & study coordination.**

GS-12 20 days @520/day			$10,800
Branch Chief Assistance	GS-13	4 days @560/day	$2,400
Attend Study Team Meetings	GS-12	2 days	$1,040
3 Division Coordination mtgs.	GS-12	3 days	$1,560
	GS-13	1 day	$ 560
Per diem @75/day			$ 300

2. Task 2. **Perform technical evaluations.**

a. Extend cross sections to include potential flooded areas behind levees.

Survey Crew. 12 ranges @ 1600/range	$19,200
Office Computations. 2 days	$ 960

b. Evaluate uncertainty in frequency computations
GS-12, 2 days — $1,040

c. Re-evaluate uncertainty in water-surface profile computations.
GS-12 5 days — $2,600

d. Base Case: Evaluate levee-raise only case.

1. Code HEC-2 overbanks 5 days — $2,600
Debug model 10 days — $5,200

2. Set up 5 separate HEC-2 models @ 20y intervals in future based on HEC-6 output
GS-12 5 days — $2,600

3. Run 2,10,50,100,500,SPF Floods with levee (5 separate runs)
GS-12 1 day — $ 520

4. Run same series (assuming 4 levee heights, 5 time periods) with overtopping and levee failure scenarios. (20 runs, 120 profiles)
GS-12 40 days — $20,800

5. Plot backwater profiles with and without levee failure for above runs
GS-12 5 days — $ 2,600

6. Prepare flood boundary maps
GS-11 20 days @415/day — $ 8,300

7. Evaluate risk and uncertainty
GS-12 20 days — $10,400

Encl 2

e. Case 2. Reasonable dredging plan (800 kcy/yr?) along with levee raise.

1. Perform HEC-6 runs to obtaining geometry every 20 years. GS-12 30 days	$15,600
2. Perform uncertainty analysis on Sediment inflow data by rerunning model with low and high sediment concentrations. GS-12 30 days	$15,600
3. Set up 15 separate HEC-2 models @ 20yr intervals in future based on HEC-6 output GS-12 15 days	$7,800
4. Run 2,10,50,100,500,SPF Floods with levee assuming low, high, and average sediment inflow (15 separate runs) GS-12 1 day	$ 520
5. Run average series (assuming 4 levee heights 5 time periods) with overtopping and levee failure scenarios. (20 runs, 120 profiles) GS-12 40 days	$20,800
6. Plot backwater profiles with and without levee failure for 20 runs. GS-12 20 days	$10,400
7. Prepare flood boundary maps GS-11 20 days @415/day	$ 8,300
8. Prepare input for risk and uncertainty analysis GS-12 20 days	$10,400

f. Two additional cases assuming (500 kcy/yr and 1200 kcy/yr) to define effect of dredge-volume variation.

2 additional cases total GS-12 176 days	$90,320

3. Task 3. **Prepare Hydrology Write-Up For Report**

1. GS-12 30 days		$15,600
Branch Chief Review 2 days		$ 1,120
2. Responses to Division Review GS-12 10 days		$ 5,200
TOTAL TIME: 2 engineers 12 months	TOTAL COST	$295,140

CENPD-PE-PF (CENPD-PL-PF/1 Feb 90) (1105) 4th End
Mr. Weaver/kb/(503)326-3826
SUBJECT: Lower Granite Sedimentation Study

CDR, North Pacific Division, Corps of Engineers, P.O. Box 2870, Portland, Or 97208-2870 18 MAR 1993

FOR Commander, Walla Walla District (ATTN: CENPW-PL)

1. Reference: draft circular 1105-2-XXXX, subj: Risk Analysis Framework for Evaluation of Hydrology/Hydraulics and Economics in Flood Damage Reduction Studies, 31 July 92.

2. We have reviewed the subject Progress Report and find that it generally provides a good status of work which has been accomplished for the sedimentation study. As noted in your endorsement, and in the chain of correspondence to date, there has been a question of Federal liability of not maintaining Standard Project Flood (SPF) level of protection for the Lewiston levee system. As discussed briefly below and in the enclosed CENPD staff comments, we do not believe there is a problem with formulating alternative plans which provide SPF protection. However, a risk-based analysis will need to be developed for this level (and other levels) of flood protection prior to proceeding with a feasibility study.

3. In accordance with the reference circular, a risk-based analysis (i.e. reconnaissance level) must be developed for the subject study. In order to determine the appropriate level of flood protection which should be provided/restored via potential modification of the Lower Granite project, decision makers need to know the risks involved, as well as the associated costs and flood damages prevented, for alternative plans which address various levels of protection including the SPF. Therefore, the analysis should identify and assess key variables that are critical to project formulation, such as variance in the SPF discharge, rates of sedimentation, etc.

4. To facilitate your preparation of the risk-based analysis, we are enclosing CENPD staff comments which resulted from our review of the Progress Report. Also, we are enclosing for your use and information a marked-up copy of the report showing miscellaneous minor comments. If you have any questions concerning the comments, needed study direction or wish to schedule a meeting between our joint staffs, please contact Mr. Jerry Weaver, Plan Formulation Division, at (503) 326-3826.

FOR THE COMMANDER:

\signed\

Encl

ROBERT P. FLANAGAN, P.E.
Director, Planning and
Engineering

CF: CENPD-PM-CP

CENPD Staff Review Comments
Lower Granite Sedimentation Study
(Draft Preliminary Evaluation and Progress Report)
12 March 1993

1. **Risk-based Analysis** - We note that paragraph 9 of your 3rd endorsement states that "Risk and uncertainty analyses for varying flood frequency with varying freeboard is not appropriate" based on the position paper in appendix "A" of the report. However, reference guidance provided via CECW-PD memorandum, subject: Risk Analysis for Flood Damage Reduction Studies, 29 July 1992, requires that "... all flood damage reduction studies will adopt a risk-based analysis framework". Therefore, a risk-based analysis must be developed for the Lower Granite Sedimentation Study. Your analysis should be conducted at a reconnaissance level of detail and include identification and assessment of key variables that are critical to project formulation and making decisions on the SPF level of protection. That assessment should include a description of the added risk for loss of life and increased property damage associated with the leveed system that is now in place in lieu of the more gentle flooding, or non-flooding, condition that may have occurred without the Lower Granite Project in place. Beyond the description of the with- and without-project in place, the likely project costs and expected damages prevented with SPF protection for the present levee system needs to be presented on a risk and uncertainty basis (e.g. variances in rates of sedimentation, discharge variances , accuracy of first floor elevations, content and structure values, etc.). The analysis should also determine the risk associated with providing levels of protection less than the SPF. You should formulate alternatives to address the SPF (as currently planned), but also determine the consequence(s) of providing lesser levels of flood protection. In other words, what are the likely project costs and expected damages prevented with project dredging, drawdown and levee modification strategies which provide less than SPF protection? We suggest that two to three levels of protection, down to the 100-year flood, be examined.

The reconnaissance-level, risk-based analysis discussed above will be needed for CENPD review and approval, prior to initiating a feasibility study. Accordingly, the schedule in the Progress Report (Table 2) should be revised to show completion of this reconnaissance-level analysis, before undertaking the more detailed study. A copy of the revised schedule, along with an estimate of any changes to the annual study funding requirements (shown in paragraph 7.04 of the report) should be provided to CENPD-PE-PF.

2. **Project Formulation/Related Studies** - As you know, drawdown of Lower Granite Reservoir to as low as the natural streambed, is being investigated under the ongoing System Configuration Study (SCS). The results of the Phase I SCS (report scheduled

for completion in November 1993) may be important for completing the formulation and evaluation of alternative flood control plans for Lower Granite Sedimentation reconnaissance-level study (e.g. implementation of drawdown could affect the location and quantity of sediment in the reservoir). The Progress Report contains a good discussion of the estimated effects of drawdown in combination with other plans being considered, and your plan of study (section 7) appropriately includes this option for evaluation.

Also, it is noted that, in theory at least, the System Operational Review (SOR) study is including in its analysis the possibility that flood control rule curves at Dworshak and Brownlee projects could be revised to benefit fishery operations. Any such change in reservoir operating policy could result in a corresponding increase in the SPF discharge. The Lower Granite Sedimentation study should consider these potential changes.

3. **Hydrologic Studies** - Future hydrologic studies should include at least a cursory review of the derivation of the SPF discharge that is used as the basis of design. The Hydromet Branch of the National Weather Service is now finalizing a new report on probable maximum precipitation in northwest states. This may have a bearing on the SPF flow.

In Appendix C, the discussion of failures and forecasting capability is limited to spring flood conditions only. There should also be a discussion of winter rain-flood conditions, as well. This is likely to be limited to the Clearwater reach only, but may be critical in that forecasting lead time is short.

4. **Dredging Studies/Costs** - While the ultimate recommended plan cannot be predicted at this time, most of the alternatives under consideration appear to involve a considerable amount of dredging and would exceed available, practical placement site capacity over the project life. The costs for this dredging will tend to get higher in the future, as reasonable placement sites are used up and more restrictions and greater haul distances and handling requirements are placed on disposal options. Therefore, consideration should be given to minimizing dredging requirements, if this measure is included in the selected plan.

Based on studies and experience elsewhere, the timing and other restrictions placed on dredging and in-water placement seem to be excessive. Placement of the clean sediments should have minimal adverse effects, and benthic communities should rapidly recover unless the required substrate is drastically altered. The District's monitoring efforts and studies to identify potential opportunities for beneficial use of dredged material to improve habitat value, will hopefully demonstrate that in-water placement is environmentally acceptable.

As recognized on pages 6-14 and 6-15 of the Progress Report, it appears that it would be advantageous to extend the work window into the late summer months. The District should pursue extending the work window into a more favorable time frame to reduce dredging risks and delays due to winter weather and to allow more time to accomplish work. Also, the report does indicate that dredging would be required for navigation purposes (access to port facilities, etc.). The extent of dredging for navigation should be identified as it would be cost shared as a different purpose than for flood control.

The extent of dredging with some of the alternatives is not clear from the descriptions or plates provided in the report. For example, the "dredging only" alternative described on page 4-3 indicates that removal of approximately 10 mcy from the confluence would regain the 5 feet of levee freeboard and maintain it to the year 2074. The report then describes additional annual dredging to reach an eventual total of 116 mcy.

The discussion of levee failure on page 3-3 refers to Plate 4 to see the anticipated levee break locations, but instead this plate shows disposal test sites used for the sedimentation study.

Section 5 of the report, on costs, indicates the dredging requirement would be the same (800,000 cy/year) for the dredging only and the dredging plus 3-foot levee raise alternatives. It seems that dredging requirements should be less with the increased levee height. Also, the estimated annual cost may be understated for the project life since the costs for future work will likely increase as discussed above.

The discussion of dredging at Chief Looking Glass Park on page 2-7 states that future dredging "was canceled when it was determined that an EIS would be necessary for future contract work". The necessity to fulfill NEPA requirements should not be used as a basis upon which to eliminate an alternative(s) in future studies.

The estimated costs for upland disposal at Dry Creek and other upland sites (Appendix E) appear to be low, and would tend to increase and possibly become infeasible or cost prohibitive over time. The estimate properly includes both loading and offloading time and cost, but does not appear to include time/cost for mooring and connecting/disconnecting to the pipeline for pumping dredged materials ashore. Also, there is no discussion of whether a mooring barge or stationary structure would be needed for the connection to pump ashore. The costs of the mooring and connection system and pipeline do not appear to have been included in the estimate.

The dredging disposal plan calls for a containment dike which will eventually reach a height of 245 feet at Dry Creek, and even higher dikes at other sites. There appears to be an additional lift requirement of 35 to 104 feet from the reservoir pool elevation of 736 feet NGVD for the alternatives identified in Appendix E. The pumping distance from shore is not identified, but appears to be around 3,000 feet. It is unlikely that a hopper dredge, even with a booster pump(s), will be able to pump into the disposal site at these heights and that distance. Adding more boosters would increase the pumping capability, but at significantly increased cost and reduced efficiency. At some point, it would likely be necessary to stockpile the material, and/or transfer it to be hauled up into the land disposal site. Consequently, dredging and disposal costs would likely increase significantly in the future if this alternative is used. In addition, the cost estimate does not appear to reflect real estate requirements, including acquisition costs, nor does the report indicate who would be responsible for providing the disposal sites.

5. **Environmental Studies/ Comments** - On page 7-3 of the Progress Report there is a statement than an EIS is not required by law, which is wrong. NEPA requires a determination be made if a Federal action will have significant impact on the environment. If it does, an EIS is necessary. If it is not known whether the Federal action will be significant, an Environmental Assessment must be prepared to determine if an EIS is required. Among other things, an assessment of the impacts of various plans (and selected plan) on the recently listed species under the Endangered Species Act would be needed. Also, NEPA stands for National Environmental Policy Act, not the National Environmental Protection Agency as stated in this section.

6. **Power Losses** - The use of power values (based on displacement of thermal resources, energy value only, in the PSW regions), to estimate power losses with and without levee failure, is appropriate for the reasons discussed on page 3-11 of the Progress Report. However, do not include a PNW new coal-fired plant in this determination.

DEPARTMENT OF THE ARMY
NORTH PACIFIC DIVISION, CORPS OF ENGINEERS
P.O. BOX 2870
PORTLAND, OREGON 97208-2870

REPLY TO
ATTENTION OF:

1 Feb 90

CENPD-PL-PF

Jim

MEMORANDUM FOR Commander, Walla Walla District

SUBJECT: Lower Granite Sedimentation Study

1. Reference CENPD-PL-PF 5th End, dated 2 Dec 88, subject as above.

2. The reference requested a reconnaissance-level analysis which addresses benefits and costs of SPF protection and which considers other factors such as risk, uncertainty, freeboard requirements, etc. This evaluation was to be used in establishing budget priorities and support for funding requests of ongoing studies and interim measures for addressing sedimentation problems. It would also assist preparation of a final plan of study, which I note has not yet been submitted for approval.

3. Considering that this information has not been provided, and in light of continuing funding requests for studies and interim measures, you are requested to present an overview of the study in a progress review meeting at CENPD. This comprehensive review should address status of the study, results of investigations and remedial actions to date, plans for completing the study, milestones, future funding needs for the study and interim measures, and other pertinent information which will enable our full understanding of where we are headed.

4. This meeting should be scheduled to occur after budget hearings but not later than the end of March 1990. Please contact Mr. Witt Anderson regarding scheduling and details of the meeting.

\signed\

PAT M. STEVENS IV
Brigadier General, USA
Commanding

PFH/15 S-58
DAG 14

CENPW-PL-PF (CENPD-PL-PF/1Feb 90) (1110-2-1150a) 1st End
Mr. McMichael/sg/ 522-6632
SUBJECT: Lower Granite Sedimentation Study

DA, Walla Walla District, Corps of Engineers, Walla Walla, WA 99362-9265 12 February 1990

FOR Commander, North Pacific Division, ATTN: CENPD-PL

1. Enclosed for your review are 10 copies of the draft Preliminary Evaluation and Economics Analysis Report for the subject study. Copies of the revised plan of study will be submitted to you by 1 March 1990.

2. It should be noted that the hydraulic and hydrologic analysis for this report was completed in April 1989. Significant new information has been developed in the interim which may affect some of the conclusions. A summary of significant new findings will accompany the plan of study.

3. Arrangements have been made with Mr. Witt Anderson to hold the progress review meeting at CENPD on 28 March 1990.

FOR THE COMMANDER:

\signed\

Encl (10 cys)

L. V. ARMACOST, P.E.
Chief, Planning Division

CENPD-PL-PF (CENPD-PL-PF/1 Feb 90) 2nd End Mr. Ramirez/rm/FTS 8-423-3827
SUBJECT: Lower Granite Sedimentation Study

CDR, North Pacific Division, Corps of Engineers, P.O. Box 2870, Portland, OR 97208-2870 25 APR 1990

FOR Commander, Walla Walla District

1. The subject report has been reviewed and CENPD comments are provided for your consideration. These comments are based on the added information provided by your staff in the In-Progress Review Meeting held at CENPD on 28 March 1990.

2. There are still several issues which need resolution prior to completion of this report. Based on the results of the economic impact of the changed hydrology, the need to proceed with this study at this time is open to question. However, in order for that determination to be made, the "knottier" question of Federal liability associated with maintaining SPF protection must be answered. We suggest that a legal determination be made by the district counsel on this question and that it be forwarded to CENPD counsel for an opinion as quickly as possible.

3. The status of this report leaves some questions open which need to be resolved. The comments which we are providing in this correspondence should be incorporated into the report and it should be forwarded to CENPD for action. It will then become the document used to make the decision on how to proceed with the overall Lower Granite Sedimentation Study. Depending on the resolution of the liability question, a NED analysis may be required which may result in a recommendation for some protection below SPF.

4. Any question regarding enclosed comments can be addressed to Mr. Al Ramirez at (503) 326-3827.

\signed\

2 Encls
1. wd all cys
Added 1 encl

MICHAEL K. COLLMEYER
Colonel, Corps of Engineers
Acting Commander

CENPD-PL-PF 19 April 1990

CENPD Staff Comments on Lower Granite Sedimentation Study
Preliminary Evaluation and Economic Analysis

1. One major point raised at the In-Progress Review Meeting was the urgency for providing protection with adequate freeboard at Lewiston/Clarkston at this time. The subject report conveys no sense of urgency to the reviewer. This should be addressed in the report.

2. The Hydrology presented at the In-Progress Review Meeting is totally different than what is in the report. The report information needs to be revised to reflect the new information.

3. Water surface profiles presented at the meeting were based on zero flow through the powerhouse. This assumption needs to be explained and justified. What effect does this assumption have on water surfaces for floods less than SPF?

4. The description of the without-project condition needs to be clarified. It is not clear whether continued dredging is part of that condition nor is it clear how much flood protection is provided by the navigation dredging. The inconsistencies which create this problem are found in the report problem description and the project damage calculations in Table 1. Damages seem to be based on interim dredging maintaining current levee freeboard until 1991, while Table 1, Lewiston Levee Failure Analysis, assumes failure from the base year of 1985.

5. As a result of the above changes in the problem description, we believe the estimated benefits will be reduced to about 1/8 the amount claimed in the draft report. Many of the alternatives reported are not likely to be justified. The economics will need to be reevaluated.

6. We question your assessment of the effectiveness of in-stream structures on sedimentation. Their effectiveness has been proven in CENPP projects, for instance. Why are we not able to apply them in this instance?

7. Risk and uncertainty are not adequately handled in the report. There is no evaluation of the risks associated with delaying decisions. The risk of varying flood frequency with varying freeboard needs to be evaluated..

8. The alternatives presented in the report are either/or alternatives. We expect that an alternative which combines portions of several of the alternatives presented is going to be the NED plan. Combination levee raise with dredging alternatives should be included in this report.

Encl. to CENPD-PL-P
2nd End, 25 Apr 90,

9. There is no section in the report which summarizes the comparisons shown in the report tables. Recommend that a Comparison of Alternatives section be included in the report which includes a summary table of costs and benefits.

10. The report does not contain a schedule developed for the Sedimentation Study completion. This schedule now needs to include activities such as Dioxin testing. Recommend that this schedule be made part of the report.

11. Page 3, Para. 3, Problem Description, last Para. What is the authority used to dredge recreation sites?

Jhw 2/3 PF DAG 22

CENPW-PL-PF (CENPD-PL-PF/1 Feb 90) (1110-2-1150a) 3rd End
Mr. Clausen/ss/522-6592
SUBJECT: Lower Granite Sedimentation Study

DA, Walla Walla District, Corps of Engineers, Walla Walla, WA 99362-9265 14 January 1993

FOR Commander, North Pacific Division, ATTN: CENPD-PL

1. Enclosed for your review are 10 copies of a revised draft Preliminary Evaluation and Progress Report for the subject study.

2. It should be noted that project plan and cost analyses for this progress report are based on existing information and data. Similar analyses at the feasibility level are in-progress for the upcoming feasibility report and environmental impact statement.

3. Completion of this Preliminary Evaluation and Progress Report was delayed due to allocation of District resources for the Lower Granite and Little Goose Projects 1992 Reservoir Drawdown Test.

4. The question of Federal liability associated with maintaining Standard Project Flood (SPF) protection is still unsettled. This progress report and further studies will be based on the conclusion of the position paper (Appendix A) that the Corps has a legal liability to provide and maintain levee protection against any increased or incremental risk caused by the construction and operation of the Lower Granite Project.

5. The urgency for providing protection with adequate freeboard at Lewiston/Clarkston at this time (1992) has been temporarily moderated due to interim dredging and drought conditions. The urgency remains for continued monitoring, completion of the feasibility report/EIS, and development of a long-term management plan. Ongoing dredging will be a requirement in the Lewiston/Clarkston area.

6. The most current hydrology is presented in Appendix C of the progress report.

7. A description of the without-project condition described in the report assumes no future dredging and therefore, accumulation of sediment will cause the flows of more frequent floods to overtop the levees causing catastrophic failure.

8. Analysis of sediment deposition and relocation (disposal) shows that any sediment deposited in the upper 20 miles of the reservoir (confluence to rivermile 120) significantly effects the backwater during the SPF. In-stream structures do move sediment and are effective for localized control of sediment deposition, especially around port facilities and navigation channels. However, during a flood condition such structures would effectively choke the flood channel and further raise backwater levels at the Lewiston levees.

9. Risk and uncertainty analyses for varying flood frequency with varying freeboard is not appropriate based on the premise that the Corps is to provide and maintain levee protection against any increased or incremental risk caused by the construction and operation of the Lower Granite Project.

10. Five basic alternatives described in the report include alternatives that combine levee raise with dredging. We anticipate the development of more alternatives that may reflect additional modifiers, like reservoir drawdown and land treatment. These will be defined in the scoping process of the EIS development.

11. This progress report does not summarize or compare alternatives by cost. Costs and environmental factors will be coalesced in the EIS process to identify a recommended plan.

12. Your review comments are requested by 1 March 1993. Questions should be directed to Mr. Gareth Clausen, (509) 522-6592.

FOR THE COMMANDER:

\signed\

3 Encls
wd encl 1-2
Added 1 encl (10 cys)

MATHEW M. LAWS, III, P.E.
Chief, Planning Division

LOWER GRANITE LOCK AND DAM
SEDIMENTATION REMOVAL FOR FLOOD CONTROL
PRELIMINARY EVALUATION AND PROGRESS REPORT

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SECTION 10 - REFERENCES (Continued)

GLOSSARY OF TERMS, ABBREVIATIONS AND ACRONYMS

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PLATES

APPENDIXES

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APPENDIXES (Continued)

LOWER GRANITE LOCK AND DAM
SEDIMENTATION REMOVAL FOR FLOOD CONTROL
DRAFT PRELIMINARY EVALUATION AND PROGRESS REPORT

EXECUTIVE SUMMARY

Sediment accumulation in Lower Granite Reservoir has reduced, and continues to reduce, the designed capability of the Lewiston levee system for flood protection and authorized navigation. About 2.3 million tons of sediment enter the reservoir annually, reducing levee freeboard at a rate of 3-inches-per-year. The 5-foot (ft) levee freeboard for the design flood has decreased, since project completion in 1975, to less than 3 ft in 1986. Interim dredging, and a series of low flow years, has stabilized the problem since 1986, but a long-term solution is needed. Without corrective action, the Standard Project Flood (SPF) could overtop the levees in the year 2004.

The U.S. Geological Survey (USGS) and the U.S. Army Corps of Engineers (Corps) have documented sediment inflow and deposition characteristics. Chemical analyses of depositions in the Snake River and Clearwater River confluence area indicated heavy metal and organic concentrations typical of uncontaminated sediments.

Sedimentation was considered during the Lewiston levee design, but a decision on a long-term solution was delayed for lack of data until after levee construction. Preliminary studies, completed in 1984, led to interim dredging and detailed studies to identify a long-term plan. Dredging occurred for interim flood control in 1986, 1988, 1989, and 1992, and for navigation in 1982, 1983, 1984, and 1987. No dredging was done in 1990 or 1991.

The feasibility study (a multi-year task) seeks the least cost, most environmentally sound method of regaining, and maintaining, adequate flood protection and navigation for the future. Flood protection alternatives being investigated include dredging, levee modifications, instream structures, land treatment, and reservoir operation changes. Disposal alternatives being investigated include in-water disposal, island construction, fill material for construction of Wawawai Canyon Road, and several upland disposal sites.

Due to the sensitive nature of the aquatic environment in Lower Granite Reservoir, an advisory Interagency Working Group (IWG) was formed. The resulting agency concurrence with in-water disposal, on a test basis, in lieu of upland disposal was a significant achievement because upland disposal is much more costly. A multi-year prototype disposal test with environmental monitoring is the key element of this feasibility study, and is expected to provide

data necessary to determine acceptability of in-water disposal as a long-term solution. Agencies are primarily concerned about the effect of disposal on anadromous fish. The final phase of the prototype disposal test, involving deep water disposal, was postponed in 1990 and 1991 due to lack of funding for interim dredging. The final dredging and test disposal phase was completed in 1992.

In-water disposal test site monitoring is currently scheduled for completion in 1994 (2 years after the final dredge disposal placement in 1992). Design, economic, and environmental studies for the feasibility report and environmental impact statement will continue concurrently. The draft feasibility report and environmental impact statement (EIS) are tentatively scheduled for completion in 1994. Tentative date for the signing of a record of decision is December 1994.

The Corps, Walla Walla District, intends to continue interim dredging for flood control and navigation, as needed and as funds allow, until necessary studies are completed and a permanent long-term solution is approved and implemented.

This preliminary evaluation/progress report justifies the urgency for completion of feasibility studies and EIS, presents history and background (up to this point in time), identifies potential long-term alternatives, presents the plan of study for completing the feasibility report and EIS, and presents findings to date.

LOWER GRANITE LOCK AND DAM
SEDIMENTATION REMOVAL FOR FLOOD CONTROL
DRAFT PRELIMINARY EVALUATION AND PROGRESS REPORT

SECTION 1 - INTRODUCTION

1.01. STUDY AUTHORITY.

The Lower Granite project was authorized by Public Law 14, 79th Congress, 1st Session, and approved March 2, 1945. The portion of the act applicable to this study reads as follows:

> "...Snake River, Oregon, Washington, and Idaho: The construction of such dams as are necessary, and open channel improvement for the purposes of providing slackwater navigation and irrigation in accordance with the plan submitted in House Document Numbered 704, Seventy-fifth Congress, with such modifications as do not change the requirement to provide slackwater navigation as the Secretary of War may find advisable after consultation with the Secretary of the Interior and such other agencies as may be concerned: Provided, that surplus electric energy generated at the dams authorized in this item shall be delivered to the Secretary of the Interior for disposition in accordance with existing laws relating to the disposition of power at Bonneville Dam...."

1.02. STUDY PURPOSE AND SCOPE.

a. Interim Progress Report Purpose.

The purpose of this progress report is to document progress leading up to the scheduled feasibility report/EIS. The feasibility report/EIS will recommend a long-term plan to provide acceptable flood protection for Lewiston, Idaho.

b. Feasibility Report, EIS Purpose.

The purpose of the feasibility report will be to identify the least costly, environmentally soundest, and most socially acceptable plan to:

- Regain the 5-ft design freeboard for the SPF of 420,000 cubic feet-per-second (cfs) at the Lewiston, Idaho levee system;

- Maintain the 5-ft design freeboard through the 100-yr project life of Lower Granite Lock and Dam (1974 - 2074).

- Identify potential environmental benefits or enhancements, and particularly, the beneficial uses of dredged sediment.

c. Interim Progress Report Scope.

All analyses and evaluations in this interim report are preliminary in nature and, for comparative purposes, are based essentially on studies completed through July, 1992.

The scope is also predicated on an opinion of the Office of Council that was presented in a Draft Position Paper, dated April 19, 1990, (appendix A). This position paper stated that the Corps has the responsibility to provide and maintain levee protection against any increased or incremental risk caused by the construction and operation of the Lower Granite Project. It also addresses a standing Corps policy which ensures that the Lewiston Levee system will withstand without failure the SPF.

d. Prior Reports.

(1) U.S. Army Corps of Engineers, December, 1987. *Final Environmental Assessment* (EA) issued for proposed 1988 Lower Granite Reservoir Interim Flood Control Dredging (first year of in-water disposal). This EA considers the effects of a dredging project on the lower Clearwater River, and the Snake River adjacent to the confluence of the Clearwater River. It addresses dredging 800,000 cubic yards (yd^3) of material, with in-water disposal downstream at designated disposal areas [near river mile (RM) 120].

(2) U.S. Army Corps of Engineers, August, 1986. *Lower Granite Lock and Dam, Snake River, Washington and Idaho, Sedimentation Feasibility Study, Phase I - Reconnaissance Level Analysis.* This study is designed to make a broad economic, environmental, social, and cultural evaluation of possible alternatives for use in developing a long-term flood control plan for the Lewiston-Clarkston area.

(3) U.S. Army Corps of Engineers, September, 1985. *Environmental Assessment for January - March.* This EA considers the effects of a maintenance dredging project on the Snake River at Clarkston, Washington, and Lewiston, Idaho. It addresses dredging 800,000 yd^3 of material, with upland disposal at Wilma Habitat Management Unit (HMU).

(4) U.S. Army Corps of Engineers, Walla Walla District, June, 1985. *Lower Granite Project Sedimentation Study - FY 86 Interim Dredging.* This report presents a general evaluation of several dredging and disposal plans, and selects the best plan for 1986 dredging with respect to hydraulic efficiency and cost.

(5) U.S. Army Corps of Engineers, February, 1984. *Lower Granite Project, Snake River, Washington, Sedimentation Study - Interim Report.* This report summarizes sediment investigations to date, using the Hydrologic Engineering Center (HEC) -6 model. It also outlines additional studies planned for the future.

(6) U.S. Army Corps of Engineers, October, 1981. *Lewiston-Clarkston Dredging and Disposal Report.* This report was prepared to give a general evaluation and overview of the dredging requirements, and disposal of dredged materials, for the Snake and Clearwater Rivers in the vicinity of Lewiston, Idaho and Clarkston, Washington.

(7) U.S. Army Corps of Engineers, July, 1975. *Design Memorandum 39, Lake Sedimentation Ranges.* This design memorandum (DM) addressed the need to establish 60 additional sedimentation study ranges in addition to the 11 already established study ranges at Lower Granite Lake. The report was modified in July, 1982, to include an addition of four sediment ranges on Asotin Creek, a tributary that flows into Lower Granite Reservoir.

(8) U.S. Army Corps of Engineers, Hydrologic Engineering Center, December, 1975. *Special Projects Memorandum 453, Sediment Study for Lower Granite Reservoir.* This memorandum analyzes sediment movement on the Snake River from RM 130 to RM 146.79, and on the Clearwater River from RM 0 to RM 7.83.

(9) U.S. Army Corps of Engineers, August, 1972. *DM 29.1, East Lewiston Levee (with endorsements).* This DM presents information pertinent to the design and construction of a levee along the south bank of the Clearwater River to protect eastern area of Lewiston. The DM was supplemented in March, 1980, and presented a plan that would reduce the threat of flooding by improving means of removing debris, mud, and gravel from the Lindsay Creek intake structure.

(10) U.S. Army Corps of Engineers, April, 1972. *DM 29.2, West Lewiston Levee (with endorsements).* The purpose of this DM is to present information pertinent to the design and construction of a levee along the east (right) bank of the Snake River and the south (left) bank of the Clearwater River to protect the western area of Lewiston.

(11) U.S. Army Corps of Engineers, August, 1972. *DM 29.3, North Lewiston Levee (with endorsements)*. The purpose of this DM is to present information pertinent to the design and construction of a levee along the north bank of the Clearwater River for the protection of North Lewiston.

(12) U.S. Army Corps of Engineers, Hydrologic Engineering Center, October 1971. *Special Projects Memorandum 359, Sediment Study on Clearwater River*. This memorandum analyzes sediment movement from the mouth of the Clearwater River to RM 4.3. It establishes possible aggradation and the its influence on navigation depths and the water surface profile of the levee design flood.

LOWER GRANITE LOCK AND DAM
SEDIMENTATION REMOVAL FOR FLOOD CONTROL
DRAFT PRELIMINARY EVALUATION AND PROGRESS REPORT

SECTION 2 - BACKGROUND/HISTORY

2.01. LOWER GRANITE PROJECT DESCRIPTION.

Lower Granite Project is the most upstream of four locks and dams that were authorized by Congress, in 1945, for navigation and power generation on the lower Snake River below Lewiston, Idaho. The Lower Granite Project includes a levee system that protects Lewiston and North Lewiston, Idaho, from inundation by waters impounded behind the dam. Lock and dam construction was completed in 1975. Pool raise occurred in 1975, providing slackwater navigation to the cities of Lewiston, Idaho, and Clarkston, Washington, in addition to power production and recreation. Lower Granite Dam is located 32 miles (mi) west of Lewiston and 107.5 mi upstream from the confluence of the Snake and Columbia Rivers. Structures include a single-lift navigation lock, spillway, powerhouse, non-overflow sections, and fish passage facilities.

The majority of the project is located in Washington State. The upper 8 mi of the Snake River portion of the reservoir forms the border between the states of Idaho and Washington. The Clearwater River arm of the reservoir is located in Idaho. Pertinent project data can be found in appendix B. Plates 1 and 2 show the project location, vicinity, and general plan of the Lower Granite Project.

The reservoir, Lower Granite Lake, extends 39 mi up the Snake River from Lower Granite Dam to Asotin, Washington, and 4.6 mi up the Clearwater River from its confluence with the Snake River at Lewiston. The water surface is maintained between 733 and 738 feet mean sea level (fmsl) at the confluence of the Snake and Clearwater Rivers. The normal reservoir elevation (el) of 738 is called the control point elevation. It is taken at the intersection of the left bank of the Clearwater River and the right bank of the Snake River. The location of the control point elevation, and the confluence are synonymous throughout this report. The terms reservoir, lake, pool, Lower Granite Reservoir, and Lower Granite Lake are also synonymous in this report.

2.02. LEWISTON, IDAHO LEVEE SYSTEM.

a. General.

The Lewiston Levees are not a separate flood control project but, rather are a part of the Lower Granite Project (plate 3). Design

Memorandum No. 3, paragraph 1.06.a. (Project Purpose), states:

> "Congressional authority for the Lower Granite project does not cite flood control as a project purpose. However, the construction of an extensive system of backwater levees in Lewiston and Clarkston will provide the areas behind the levees with flood protection up to and including the Standard Project Flood."

Without this system of backwater protection levees, large areas of industrial, commercial, and residential lands in the Lewiston, Idaho, area would have been inundated by the Lower Granite Reservoir. About nine mi of levees were constructed along the banks of the Snake and Clearwater Rivers, essentially encompassing the entire length of the waterfront of Lewiston and North Lewiston, Idaho. Levees are shown on plate 3.

b. Lewiston Levee Design.

Design of the Lewiston Levees provided a minimum of 5 ft of freeboard during the SPF, and 420,000 cfs from the control point elevation of 738.0.

All levee sections are engineered embankments founded on impervious gravel and consisting of an impervious cutoff to bedrock, an impervious core with a sand-gravel filter, gravel fill, and riprap protection (see plate 3). Random fill is placed on the levee backside at variable slopes for beautification. The levee system includes a series of collector ponds and pumping plants for interior drainage.

c. Lewiston, Idaho, Floodplain.

The estimated flooded area, assuming a levee breach at the SPF discharge, would be about 1.6 square mi (mi^2), or 1,025 acres. The total area is broken down as follows:

■ Area behind North Lewiston Levee	300 acres
■ East Lewiston Levee	300
■ West Lewiston Levee	425
Total Floodplain Area:	1,025 acres

2.03. LEVEE RECREATION AND AESTHETICS.

Subsequent to levee construction, the Corps initiated extensive landscape architectural development of the levees, as a pilot project for levee beautification efforts. Levee beautification was intended as an integral feature of the Lewiston Levees. The work included the sculpturing of the topography, as well as the development of ponds, lawns, tree and shrub plantings, park furniture, interpretive displays, and paved trails. The area is now known as the Lewiston Levee Parkway. A paved trail, extending along levees and adjacent portions of project lands, was designated as the Clearwater and Snake River National Recreation Trail by the Secretary of the Interior in 1988. The 16 mi of trails connect several interpretive centers, boat ramps, Hells Gate State Park, Kiwanis Park, and Swallows Park.

2.04. RESERVOIR SEDIMENTATION.

a. Sedimentation Surveys.

The USGS measured and analyzed sediment inflow during the period from 1972 to 1979. Sediment ranges have also been established to determine the sediment distribution in Lower Granite Reservoir, and to monitor sediment inflow since the USGS measurement period.

b. Sediment Inflow and Deposition Rates.

Estimates of total sediment deposited in Lower Granite Reservoir, since project completion (1974 through 1986), range from 22 to 38 million yd^3 (myd^3). About 80 percent of the sediment inflow is from the Snake River, while about 20 percent is from the Clearwater River.

The USGS estimated that, on the average, about 2.34 million tons of sediment annually enters the reservoir from above the Spalding (Clearwater River) and Anatone (Snake River) gages. This equates to about 3.4 myd^3/yr. The USGS estimate does not include sediment inflow from the 3.5 percent of drainage area contributing to the reservoir below the gages. Assuming an 85- percent trap efficiency in the reservoir, the USGS inflow estimate translates to approximately 2 million tons of sediment deposition annually. This compares to about 3.2 myd^3/yr deposition, based on sediment range resurveys.

About half of the incoming sediment volume (1.5 myd^3/yr) is deposited in areas above RM 120 that impact the freeboard available at the Lewiston levee system, and also impact navigation to the port facilities in Lewiston and Clarkston. The remaining half is deposited in areas less critical to levee freeboard maintenance, or remains in suspension and passes through the reservoir.

2.05. HISTORICAL DREDGING FOR NAVIGATION AND FLOOD CONTROL.

a. Interim Dredging and Disposal Test Sites.

Hydrologic analysis of the sediment deposition shows that, without an interim dredging program, the annual reduction of freeboard on the Lewiston levee system poses an unacceptable risk. The analyses also show that there is a significant chance that dredging, for the purpose of maintaining navigational access to the port facilities, would be needed during the interim period.

The reduction in levee freeboard documented in the February, 1984 interim report, combined with the limited options for interim actions, mandated a program of interim dredging to preclude further reduction in flood protection prior to selection of a long-term solution.

Due to the sensitive nature of the aquatic environment in Lower Granite Reservoir, an advisory IWG was formed. This group concurred with in-water disposal, on a test basis, in lieu of upland disposal. This would be a multi-year prototype disposal test program with environmental monitoring. Three test sites were constructed, at about RM 120 (near Kelly Bar in Lower Granite Reservoir), with dredge material producing a mid-depth plateau (1988), an island (Centennial Island, 1989), and a deep-water site (1992) for study and evaluation. The mid-depth and Centennial Island sites are located along the left bank at Kelly Bar, which was the location of a ranch and orchard prior to the filling of the reservoir. The deep-water site is located just downstream of RM 119. Disposal sites are shown on plate 4.

Centennial Island is about 1,000 ft long, varies from 75- to 250-ft wide, and is about 5 ft above high pool. The larger surface area, greater depth variation, and increased shorelines provided by the island produce the most complex and varied aquatic habitat types possible with sand and silt substrates. The island provided the best opportunity for creating a statistically measurable fish response to habitat changes in a relatively short period. Without island development, some data essential to adequately understanding aquatic responses could not be obtained. It also allowed the investigation of potential beneficial uses.

Since 1988, continuous monitoring of fish and benthic communities has been performed by the U.S. Fish and Wildlife Service (USFWS), and the Idaho Cooperative Fish and Wildlife Research Unit at the University of Idaho. Monitoring is currently in progress, and is planned through 1994.

b. Dredging Activities in 1982.

Approximately 256,175 yd^3 of sediment were removed from the reservoir on the Clearwater River in the Port of Lewiston, Idaho area. The purpose of the hydraulic dredging was to maintain navigation. Sediments were disposed, on land, at the Port of Lewiston.

c. Dredging Activities in 1983.

Approximately 5,000 yd^3 of sediment were removed from the Snake River in the Port of Clarkston, Washington area, to maintain navigation access. Land disposal occurred at the Port of Clarkston. Dredging was initiated and financed by the Port of Clarkston.

d. Dredging Activities in 1984.

Approximately 15,000 yd^3 of sediment were removed from the reservoir near the Port of Clarkston, with land disposal at the Port of Clarkston. Dredging was initiated and financed by the Port of Clarkston.

e. Flood Control Dredging Activities in 1986.

Flood control maintenance dredging removed about 771,002 yd^3 of material from the south shore of the Snake River in front of the Port of Clarkston. The material was disposed of, on land, at the Wilma disposal site located just downstream from the Port of Wilma.

f. Dredging Activities in 1987.

The 1987 dredging was initially planned to include the removal of 1,190,000 yd^3 of sediment for both navigation and flood control. However, due to funding limitations, only the removal of the portion needed to maintain navigation depths at the Port of Lewiston was actually accomplished. About 378,980 yd^3 were removed and disposed of on non-Federal lands, through agreements with the Port of Lewiston.

g. Flood Control Dredging Activities in 1988.

An EA, dated December, 1987, was prepared for the 1988 interim flood control dredging. It documented the initiation of the in-water disposal test as part of the Feasibility Report/EIS. This was followed by a supplement to the Lower Granite EIS for the interim navigation and freeboard maintenance dredging, dated October, 1988. The Record of Decision was signed by the North Pacific Division Commander in December, 1988.

The in-water disposal test was initiated in 1988, even though a final plan of study for the overall feasibility study of long-term solutions had not yet been approved. The in-water disposal test sought to define the potential environmental effects and possible benefits of in-water disposal, in accordance with national environmental policy and applicable regulations.

A total of 915,970 yd^3 of sediment were removed downstream from the Port of Clarkston area, primarily to maintain freeboard. The material was disposed of below RM 120 to construct a shallow water test disposal site, and initiate disposal in the deep in-water test disposal site.

h. Flood Control Dredging Activities in 1989.

Freeboard maintenance dredging in the Snake River, downstream of the Port of Clarkston, was accomplished with mechanical dredging (clamshell) equipment. A total of 993,445 yd^3 of sediment were excavated from the vicinity of Red Wolf Bridge downstream to the Port of Wilma, and used to construct the island site test site. The dredged material was mostly sand, with pockets of silty sand and silt.

Two test pits were excavated in the gravel bar north of the Port of Clarkston. The purpose of the two test pits was to determine potential production rates if, at some future time, it was decided to excavate in the gravel bar material, and take samples for physical gradations and chemical analysis. The excavated material was then placed on the riverward side of the island to help stabilize it, and protect it against erosion caused by wind and wave action. A total of 8,118 yd^3 of material was excavated.

i. Dredging Activities in 1992.

The 1992 dredging operation was the final dredging for the deep in-water disposal test site below RM 120. Contract volumes removed from the confluence area and the Port of Lewiston were 520,695 yd^3 and 50,771 yd^3, respectively. A total of 571,466 yd^3 of material were placed at the deep in-water disposal test site near River Mile 119.

2.06. HISTORICAL DREDGING AT RECREATION SITES.

a. Chief Looking Glass Park.

Chief Looking Glass Park is on the left bank of the Snake River at Asotin, Washington. Sediment removal was accomplished almost annually at the park, using dragline or clamshell rental equipment. After 1980, a Mud Cat hydraulic dredge was used. Excavated sediment has been deposited on the eastern breakwater, trucked to a disposal site west of the boat basin, and some of the material was used as topsoil at various project locations. The known sediment removal events are as follows:

- August 1975 - Under 500 yd^3.
- June 1979 - About 2,000 yd^3.
- August 1980 - Under 500 yd^3.
- Annually, from 1981 to 1986 - Between 150 to 200 yd^3 each year.

The last sediment removal work was apparently completed in 1987, when perhaps 25 yd^3 of sediment were excavated. Sediment removal in 1988, and subsequent years, was canceled when it was determined that an EIS would be necessary for future contract work.

b. Swallows Park and Greenbelt.

Swallows Park and Greenbelt is located on the left bank of the Snake River at Clarkston, Washington. Sediment removal was accomplished very infrequently at the park. Excavated material was deposited in a diked containment area on a nearby island, and later hauled by truck, as fill material in reclaiming unused quarries and rock processing sites. The known sediment removal events are as follows:

- May 1979 - quantities unknown, but probably under 1,000 yd^3.
- August 1980 - quantities unknown, but probably under 1,000 yd^3.
- October and November 1981 - 1,367 yd^3.

There has been no dredging or excavation since 1981.

c. Hells Gate Marina, Hells Gate State Park.

The marina is located on the right bank of the Snake River upstream from Lewiston, Idaho. Sediment removal has been accomplished at the marina almost annually. The quantity removed each year varies, but is generally in the range of 2,000 to 6,000 yd^3. The work was normally done using a Mud Cat hydraulic dredge. In 1980, sediment removal was performed by rental dragline equipment and, in 1992, removal was done by the Idaho Department of Parks and Recreation during the 1992 Reservoir Drawdown Test. Excavated material has either been trucked and pumped to a diked disposal site south of the basin or, in 1980, to an upland site east of the park maintenance area. The known sediment removal events are as follows:

- May 1979 - Quantity unknown.
- August 1980 - Quantity unknown.
- May to August 1981 - 10,400 yd^3. Sediment removal inside the marina, as well as at the entrance, was performed following a high runoff year.
- July to November 1982 - 4,508 yd^3.

- September 1983 to February 1984 - About 3,500 yd^3.
- July 1984 - About 4,500 yd^3.
- June to August 1985 - About 3,500 yd^3.
- July to August 1986 - About 3,500 yd^3.
- 1987 - Under 1,000 yd^3.
- July to August 1988 - About 2,000 yd^3.
- 1990 - About 1,500 yd^3.
- March 1992 - About 8,000 yd^3. Sediment was removed from the marina with trucks and loaders during the 1992 Lower Granite Reservoir Drawdown Test.

2.07. HYDROLOGIC AND SEDIMENT STUDIES - HISTORY AND BACKGROUND.

a. Sediment Investigations.

All sedimentation studies have been conducted using the Corps' Hydrologic Engineering Center model, HEC-6, Scour and Deposition in Rivers and Reservoirs. HEC-6 is a one-dimensional numerical model of river mechanics that computes scour and deposition by simulating the interaction between the hydraulics of the flow and the rate of sediment transport. This model was designed as a tool for the analysis of long-term river and reservoir behavior, rather than the response of streams to short-term floods.

Channel and reservoir geometry is always changing following high run-off events and dredging events where sediment has been deposited or removed from the reservoir. Because the geometry is dynamic, HEC-6 analyses are done periodically to determine the effect on the water surface profile during the SPF. Analyses of several long-term dredging and disposal solutions are made.

The following is a list of sedimentation investigations that have been performed, and the year in which they were performed:

- 1975 - The initial lake sedimentation ranges were established by DM 39 (July, 1975). The purpose of these ranges was to measure sediment inflow and distribution, and the scope of the sedimentation problem. Additional ranges have been added, particularly in the confluence area, in recent years.

- 1983 - A sedimentation study was conducted in 1982 and 1983 to determine future sedimentation effects on navigation and the Lewiston levee system. (Corps, 1984). WHAT IS THIS REFERENCE?????

" 1984 - Sediment ranges were surveyed, and 24 additional ranges were established.

- 1986 - Sediment ranges were resurveyed, and verified with field tests. Based on the accuracy of the sediment ranges, the HEC-6 model was calibrated for actual conditions. This year was established as the base year for all subsequent HEC-6 analyses.

- 1987 - Condition surveys were performed at the proposed dredging and in-water disposal sites for 1988. Sediment ranges on Asotin Creek and the Snake River were resurveyed to study the effects of sedimentation on the Asotin Creek water surface profile. Channel cross sections on the Snake River between RM 140.2 and 141.5 were resurveyed to evaluate the effectiveness of this reach as a sediment trap.

- 1988 - An acoustical sub-bottom survey was performed in an attempt to accurately determine the depth of sediment deposition since the project was completed in 1975. However, the survey yielded little useful information due to interference by gas bubbles in the sediment. The gas originates from decomposing organic material in sediment deposited after the creation of the reservoir. Direct measurements were made using a sediment spud. Sediment ranges and disposal sites were resurveyed, and 1-ft contour maps were developed that covered the disposal sites. Sediment density and core samples were taken.

- 1989 - Sediment ranges were resurveyed in the areas affected by dredging. Disposal sites were resurveyed, and 1-ft contour maps were developed. Sediment samples were collected to monitor changes in grain size and sediment depth at disposal sites. Consolidation tests were run to estimate the rate of consolidation of natural sediment. Also, the USGS measured the sediment discharge of six of the larger ungaged tributaries on the Snake and Clearwater Rivers downstream of existing gage stations.

- 1990 - Sediment disposal sites and ranges through the 1989 test pits were resurveyed, and sediment samples were collected to monitor changes in grain size and sediment depth at disposal sites. Additional samples were collected as part of a test for dioxins and furans.

- 1991 - Sediment disposal sites and ranges through the 1989 test pits were resurveyed, and sediment samples were collected to monitor changes in grain size and sediment depth at disposal sites.

- 1992 - Sediment ranges were resurveyed, both before and after drawdown surveys were performed, in areas of expected erosion or deposition (from the confluence of the Snake and Clearwater Rivers, down to Port of Wilma and the disposal site). Sediment depths were measured on several exposed areas of the reservoir during the drawdown, including the mid-depth disposal site, Alpowa Creek delta, and Silcott Island channel. Suspended and bedload sediment transport was measured during the drawdown at several sites.

b. Disposal Monitoring.

Stability and spread of disposal material at the in-water test sites is monitored on an annual basis. Core samples are taken in the disposal areas to monitor the deposition of new sediment, as well as to identify the extent of lateral drift of deposited material following each disposal event. Sediment samples (core and grab) were taken at the disposal sites and six other reference sites, in order to monitor possible physical changes. Monitoring is expected to continue through 1993.

c. Erosion and Sedimentation

The Soil Conservation Service (SCS) conducted a field evaluation, in 1988, to determine the nature of erosion from cropland that contributes to the reduction of channel capacity in Lower Granite Reservoir. It assessed how much erosion reduction on dry cropland above the reservoir could be achieved through the implementation of the 1985 Food Security Act.

2.08. ENVIRONMENTAL STUDIES - HISTORY AND BACKGROUND.

a. General.

The 1986 and 1987 IWG, and other technical meetings, led to the development of four sets of hypotheses regarding dredging and disposal activities, and various other aspects of the aquatic environment.

b. Reservoir Monitoring Fish Community Activity.

A comprehensive, deliberate test of the potential effects, and possible benefits, of in-water disposal was designed by environmental experts from both the Corps and other agencies, working through the IWG. Their report of the conceptual model and proposed studies was published, by the Corps, Walla Walla District, in a document entitled *"Lower Granite Reservoir In-Water Disposal Test: Proposed Monitoring Program,"*, dated December, 1987 (Webb *et al.*).

Following the interim dredging event in 1988, Dr. David Bennett, from the University of Idaho, began reservoir testing activities. He has been working continuously since that time, and is scheduled to continue through 1994. The focus of his investigations is the fish community, benthic organisms, predator and prey interactions, and other aquatic parameters associated with dredging and in-water disposal actions.

Deep-water disposal testing is primarily intended to demonstrate that in-water disposal probably has insignificant impact (no net loss). Shallow and mid-depth disposal, and island construction testing seeks to evaluate the potential for beneficial use.

c. Reservoir Hydroacoustic Surveys.

BioSonics, Inc. conducted four seasonal hydroacoustic surveys on Lower Granite Reservoir from May, 1989 to February, 1990. The overall objective was to provide baseline information on fish distribution and abundance in various habitats throughout the entire reservoir. Each survey consisted of 60 orthogonal transects, extending from Lower Granite Lock and Dam to the Red Wolf Bridge at Clarkston, Washington. Information on species composition was provided by the netting efforts of the concurrent fish community activity monitoring by the Idaho Cooperative Fish and Wildlife Research Unit, and was incorporated into the acoustic estimates of abundance. BioSonic's final report is dated April 25, 1992.

d. Reservoir Dredge/Disposal Simulation Model.

In July, 1987, Environmental and Social Systems Analysts (ESSA) was contracted to facilitate the implementation of the Adaptive Environmental Assessment and Management (AEAM) process, and develop the ecological monitoring program for the in-water disposal test. To accomplish these requirements, two workshops were conducted. The first workshop focused on developing a conceptual model of the biophysical system in the Lower Granite Reservoir. This conceptual model formed the basis for synthesizing current system understanding and identifying the potential for positive and negative effects on key system indicators [Valued Ecosystem Components (VEC)]. Following development of the conceptual model, a set of four hypotheses was developed. At the second workshop, the hypotheses were clarified and a disposal design, monitoring program, and priorities were developed. These were further refined at two technical meetings held after the second IWG workshop.

e. History of Water Quality Studies.

(1) Sediment.

Sediment sampling and data collection of both sediment and gravel bar material near port facilities, and at the Snake and Clearwater confluence area, was performed. Analysis was done for a variety of heavy metals, pesticides, and organic concentrations. Findings to date are discussed in section 6. The following items indicate the dates and locations of sediment sampling and data collection:

- April 1981, Clearwater River, Port of Lewiston
- January 1982, Snake/Clearwater confluence
- September 1984, Snake River, Port of Clarkston
- November 1985, Clearwater River, Port of Lewiston
- April 1986, Clearwater River, Port of Lewiston
- March 1987, Snake/Clearwater confluence
- May 1987, Snake/Clearwater confluence and reservoir

- July 1988, Snake River, Port of Clarkston/Port of Wilma
- March 1989, Snake River, Port of Clarkston/Port of Wilma
- October 1990, Snake/Clearwater confluence
- March 1992, Snake/Clearwater confluence down to Silcott Island - associated with the physical drawdown test

(2) Dredge Monitoring.

During the dredging activity near the confluence of the Snake and Clearwater Rivers from January to March 1986, water quality in the Snake River was monitored to assess the magnitude of impacts caused by dredging and potential disposal activities.

(3) Disposal Monitoring.

Species composition, abundance, and physical habitat data collected over the period from 1984 to 1986 were used to project the effects of sediment dredging and in-water disposal on fishes in the Lower Granite Reservoir.

During January and February 1988, the first in-water disposal was conducted. As no in-water disposal operation had been attempted prior to this work in Lower Granite, a water quality testing program was initiated to monitor the water column loading which occurred at the disposal site, and to determine the transport of material outside of the disposal area. The objectives of the monitoring were to determine: (1) the spatial extent of the turbidity plume generated from in-water disposal; (2) the peak concentrations of suspended solids in the plume; (3) the change with time of turbidity below the disposal site; (4) the mixing effects of the disposal; (5) the release of orthophosphate and ammonia; and (5) the effect of disposal on ambient dissolved oxygen.

During the dredging and in-water disposal activity which took place from January to March, 1989, material disposal and rehandling was monitored at the island site to quantify water column loading and transport of material outside of the disposal area. The objectives of disposal and rehandling monitoring were to determine the spatial extent of the generated turbidity plume, water column mixing effects, and effects on ambient dissolved oxygen. Disposal monitoring included determination of the peak concentrations of suspended solids in the plume, and the change with time of turbidity below the disposal site. Rehandling monitoring included heavy metal, pesticide, and nutrient determinations. In addition, reservoir-wide water quality monitoring was initiated to determine the large-scale impacts, if any, of turbidity generated by the dredge/disposal activity.

(4) Dioxin Testing in 1992.

Battelle/Marine Sciences Laboratory conducted a study to measure the concentration of dioxins in sediment to be dredged from the Lower Granite Reservoir near Lewiston, Idaho, and to compare those measurements to concentrations found at reference sites. This study was done in preparation for the 1992 drawdown test.

The area dredged in 1992 is immediately adjacent to, and downstream from, an effluent discharge pipe belonging to the Potlatch Corporation's pulp mill. Information provided by the Environmental Protection Agency (EPA) indicated the need to test for dioxins and furans in sediments of water adjacent to and downstream of pulp mill effluents. Nine of thirty-three sampling stations were analyzed for dioxins and furans.

f. 1992 Reservoir Drawdown Test.

A test of the reservoir drawdown concept was completed in March, 1992, using the Lower Granite and Little Goose projects. The test was primarily designed to provide information regarding the physical effects of such an operation. Information on a variety of physical features was gathered. Environmental data, including effects on water quality and aquatic organisms, was also obtained at this time. Analysis and evaluation of data collected is ongoing. A draft report is scheduled to be completed in 1992 with a final report following analysis of collected data. Studies of reservoir drawdown alternatives are ongoing in the Corps' Columbia River Salmon Mitigation Analysis - System Configuration Studies.

LOWER GRANITE LOCK AND DAM
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SECTION 3 - FUTURE CONDITIONS WITHOUT REMEDIAL ACTION

3.01. PROBLEM SUMMARY.

a. Present Level of Flood Protection.

Sediment accumulation in Lower Granite Reservoir is degrading the level of flood protection provided by the levee system to the area around the city of Lewiston, Idaho. Only 3 ft of the originally designed 5 ft of levee freeboard remains for the SPF. The level of flood protection has been stable since 1986 because of interim dredging and less than average hydrologic conditions. A minimum of about 800,000 yd^3 of sediment needs to be dredged annually from the confluence area in order to maintain this current level of available freeboard.

b. Rate of Sediment Deposition.

Since the pool was raised in 1975, the sediment deposition in Lower Granite Reservoir has reduced levee freeboard by an average of about 0.25 ft/yr. Approximately 3.2 myd^3 of sediment will continue to be deposited throughout the reservoir on an annual basis.

c. Impact of Sediment Deposition.

(1) Flood Protection.

Current projections indicate that, without corrective action, the SPF could overtop (no freeboard) the existing levees by the year 2004. Without long-term remedial action, the accumulation of sediment will cause the flows of lesser floods to overtop the Lewiston levee system, causing catastrophic failure.

(2) Navigation.

Sedimentation impacts navigation to the Ports of Lewiston and Clarkston. Currently, up to 400,000 yd^3 of sediment on the Clearwater River, and 80,000 yd^3 on the Snake River, require removal every third year in order to maintain authorized navigation. Removal of this material would partially satisfy the annual requirements for maintenance of flood protection.

3.02. CONDITIONS WITHOUT REMEDIAL ACTION.

a. General.

Without further action (dredging sediment or levee construction), levee failure will eventually occur. Periodic dredging for navigation could delay, but may not prevent, levee failure at the SPF.

Levee failure would have an immediate impact on the city of Lewiston, and an extended period of impact (during the time to rebuild damaged levees) on navigation, hydropower generation, anadromous fish, and recreation.

Failure scenarios were evaluated and are described in appendix C.

b. Failure Assumptions.

Because of sediment buildup over time, and subsequent loss of levee freeboard, failure was assumed when the calculated water surface encroached on the selected freeboard for any flood discharge.

The description of failure levels is based on the Lower Granite Reservoir control point elevation of 738.0. This control point elevation is taken at the intersection of the left bank of the Clearwater River and the right bank of the Snake River. References to the confluence and location of the control point elevation are synonymous in the context of this report.

Failure at three freeboard levels were analyzed:

- 5 ft of freeboard - El 738.0 at the confluence; (Design freeboard at the reservoir control point)
- 3 ft of freeboard - El 740.0 at the confluence;
- 0 ft of freeboard - El 743.0 at the confluence.

Levee failure was assumed to be caused by a combination of overtopping by wind-wave action and erosion.

Levees along the left and right banks of the Clearwater River are assumed to fail under the same flood conditions. However, unless the levees are overtopped, simultaneous failure of both levees would not necessarily occur.

c. Failure at the Camas Prairie Railroad Bridge (CPRR).

The levee break locations for failure at the CPRR bridge, and the associated flooded area, are shown on plate 3.

The West Lewiston Levee section is level, at el 743, and is between the CPRR Bridge and the Highway 12 bridge. This levee section is at the confluence. The weakest point is likely to be at the CPRR Bridge. During a flood, the backwater profile shows that freeboard is minimal at this point. Compaction under, and around, the bridge is likely to be less than at other locations, due to adjacent structures and minimal clearance under the bridge.

It was assumed that wind-wave action severe enough to breach the levee at one point would cause severe damage over a considerable length of levee. This length was estimated to be equivalent to 2,000 ft of levee to the south, and 1,000 ft of levee to the north. Failure was assumed to occur when freeboard requirements were exceeded. Failure at the CPRR Bridge would result in level ponding of flood waters behind the levee, at the level of the river.

d. Failure at the Potlatch Forest Industries Plant (PFI).

Levee failure near the PFI plant is the most likely point of failure, since the freeboard is minimal near this point. Failure at this location would result in maximum flood damages to the city of Lewiston. The levee break locations, for levee failure at the PFI plant and the associated flooded area, are shown on plate 4.

On the left bank, most of the PFI plant would be inundated. The water would then surge through downtown Lewiston, where it would overtop and breach the West Lewiston Levee just above the confluence, but downstream of the CPRR bridge. High velocity flow would erode the backside of the levee near the Memorial Bridge (Highway 12), which crosses the Clearwater River.

If the failure point could be anticipated, it might be possible to block the underpass at Memorial Bridge, cut the levee upstream, and confine the damage to the PFI plant. Anticipating this failure point, and creating a flood relief point (shown on plate 4), is not included in the analyses of this report. However, emergency project operation procedures call for this action in the event of a major flood.

On the right bank, water would flow through residential areas, over Highway 12, and into business and storage areas around the Port of Lewiston. High velocity discharges would concentrate in the narrow underpass at Memorial Bridge (Highway 12), eroding the levee from the unprotected back side. The discharges would then flow into the Port of Lewiston, and overtop and breach the North Lewiston Levee near the CPRR Bridge, opposite the sewage treatment plant.

Assuming a worst case situation, about 4,000 ft of levee would have to be rebuilt (1,000 ft on each side at the initial failure points, 500 ft on each side under the Memorial Bridge, and at the overtopping points near the confluence).

e. Reservoir Operation and Sequence of Levee Repairs.

The Lower Granite Regulation Manual allows for forebay lowering up to 3 days prior to the anticipation of flows exceeding 300,000 cfs (50-year flood). The pool may be lowered to el 725, and even further, as flows increase up to the SPF (420,000 cfs below the confluence).

The sequence of events prior to, and following, levee failure would begin by lowering the Lower Granite Reservoir on, or about, 5 May (the hypothetical date is two days before the SPF hydrograph reaches 300,000 cfs). Reservoir elevation at Lower Granite Dam would be at about el 725, until a failure occurs at the peak of the hydrograph (17 May). Spillway gates would remain open, allowing the pool to gradually drop until it was low enough for the reconstruction of levees to begin (by 15 July). Reservoir levels would be maintained at about el 712 between 17 May and 30 July, and lowered to about el 710, from 30 July until reconstruction of the levees occurs (by 15 January of the following year). Elevations would be similar to levels seen during the March 1992 drawdown test.

3.03. EFFECTS OF POST-LEVEE FAILURE.

a. General.

Although both the flooding event and levee failure would cause significant damages, more impact would occur during the reservoir drawdown phase that facilitates levee repairs. The reservoir would be drafted to el 710 for about eight months, in order to make levee repairs.

The structural effects of such a drawdown were evaluated in the *1992 Columbia River Salmon Flow Measures Options Analysis/EIS*. Physical effects were evaluated during the March 1992 reservoir drawdown test. The reservoir was drafted down to elevation 705, at a controlled rate of 2-ft/day, for 14 days. The four main aspects monitored during the drawdown test were: (1) Project and reservoir facilities and structures; (2) Water Resources; (3) Biological resources; and (4) Cultural resources and recreation.

The preliminary findings of this test are representative of the effects of reservoir drawdown following a levee failure. Sections and preliminary findings in the draft test report (draft report released for public review in November, 1992) are paraphrased in the following sections, and describe potential effects.

b. Project and Reservoir Facilities and Structures.

A potential rapid lowering of the reservoir level, after levee failure, would lower the factor of safety for slope stability, because ground-water drainage will increase pore water pressure and decrease slope stability. This could cause the embankment section of Lower Granite Lock and Dam to be unstable. Slope stability and streambank erosion could cause significant undermining of exposed (water surface below riprap protection) railroad and highway embankments, as well as the remaining sections of undamaged levees.

Potential scour from higher flows experienced in 1992 could undermine the Red Wolf Bridge piers. The piers are founded on dense gravels, three at el 712 and one at el 706. Potential scour could occur with estimated river velocities of 7- to 10-ft-per-second. Protection for the supporting piers could be the placement of riprap, sheet pile, and grout, or geotextile fabrics and grout. The choice, and level, of protection would depend on surveys and analysis of river flows around the piers.

The upstream floating guidewall at the Lower Granite navigation lock would have to be disconnected and relocated to prevent major damage from occurring anytime the reservoir water surface was below el 725.

There was no apparent damage to the Lower Granite Dam embankment sections, or the Lewiston levee system, during the 1992 drawdown test. These embankments are engineered embankments designed to withstand more stress than those composed of natural materials. Weather during the test was mild, with little wind or rain, and resulted in very little erosion because of wave action below riprap sections of the embankments.

An extended drawdown for levee repair would expose all embankments to higher levels of wind and wave erosion. River flows would be much greater after a flood event than actual flows during the 1992 drawdown test period. A greater amount of erosion and scour would be expected.

During the 1992 test, turbines operated within safety criteria for bearing temperatures and shaft runout. However, an increase in shaft runout was noted as the head dropped below design criteria. A significant increase in vibration was observed as the tailwater elevation at Lower Granite (Little Goose Reservoir) was dropped below normal minimum operating pool. Long-term implications during an extended drawdown for levee repair (from May through January), will require more detailed analyses of data obtained during the drawdown test.

Although there were no failures of road or railroad embankments during the test, cracking and undulating of the embankment occurred throughout an 11-mi stretch of Road 9000, which runs along the north shore of Lower .pa

Granite Reservoir. Cracking also occurred in the CPRR bed. Road 9000 was closed as a result of cracking, and realignment of tracks on the railroad bed were made continually during the test.

The majority of embankment failure and sloughing that occurred were in isolated areas, and on natural embankments. These situations did not cause significant damage to any facilities or structures. Sediment movement toward the reservoir resulted in the displacement of some pilings.

Red Wolf Marina, in Clarkston, Washington, sustained damage to docks and associated structures as a result of drainage eroding accumulated sediments.

Levee interior drainage collector ponds drained through culverts as designed.

c. Water Resources.

(1) Water Velocities.

Drafting of Lower Granite Reservoir would result in a downstream shift of the head of the reservoir. Natural river conditions would exist at the confluence of the Snake and Clearwater Rivers.

(2) Turbidity and Sediment Transport.

A large increase in sediment transport was measured in the confluence area during the 1992 drawdown test. More than 1 myd^3 of sediment was eroded in the confluence area between the Southway Bridge and Red Wolf Bridge. Much of this material was redeposited a short distance downstream. Turbidity increased, but this increase during the test may have been minimal compared to turbidity levels following a SPF. Wind and wave action, during an extended drawdown for levee repair, would add to localized turbidity along the shorelines. The potential also exists for an increase in overall reservoir turbidity.

(3) Water Quality.

If levees failed, flooding of the PFI plant effluent ponds would result in the movement of large amounts of untreated effluent and accumulated sludge into the river. This may introduce high concentrations of dioxins into the reservoir, as dioxins have recently been detected in the effluent, receiving waters, and fish tissue. In any case, a greatly increased loading of biochemical oxygen demand, chemical oxygen demand, tannins, lignins, and other waste products would occur. The above would potentially be one of the greatest long-term effects.

At the confluence, the PFI effluent discharge would be exposed during a drawdown for levee repair. The discharge was exposed during the 1992 drawdown test.

Of even more concern, flooding of the downtown Lewiston area would likely release other toxic materials from buoyed storage tanks, breaks in utility and transport lines, and industrial storage areas.

(4) Dissolved Gas Supersaturation.

Increased flow over Lower Granite spillway would increase gas saturation below the dam and in Little Goose Reservoir. Gas saturation is dependent on flow, volume, and tailrace to forebay elevation, and it increases with the duration of spill. Saturation readings, after a 4-hr test in June, 1991, were as high as 138 percent. During 1992 drawdown tests, readings up to 135 percent were recorded. It is conceivable that during a drawdown period after levee failure, gas saturation levels could increase to 120 percent, and up to 140 percent below Lower Granite Dam. This would definitely affect fish health and condition.

d. Biological Resources.

(1) Resident Fish.

The primary concern of a reservoir drawdown, applicable to resident fish, would be the dewatering of spawning and rearing habitat. Benthic and plankton production required for fish growth would be reduced. Analysis of data from the drawdown test is ongoing. Fish and aquatic organisms (crayfish, mussels, clams) in embankment ponds or shallow water embayments, that were unable to follow the water levels as they dropped were severely impacted. Several instances of resident fish kills were documented.

(2) Anadromous Fish.

Post-levee failure would lower the reservoir and reduce the outmigration transit time, through the reservoir, for salmon smolts. Higher velocities would potentially increase smolt survival. However, a lower reservoir would render the juvenile collection system at Lower Granite Dam inoperable, and more juvenile fish mortality would occur from higher gas supersaturation levels below Lower Granite Lock and Dam.

There would be increased predation in Lower Granite Reservoir on subyearling fish from predator concentration, and increased downstream turbine and predation mortality for fish typically transported from Lower Granite Lock and Dam.

Dewatering of the normal shallow zone would reduce the shallow-water rearing habitat, for subyearling chinook, in Lower Granite Reservoir.

The adult fish ladders and auxiliary pump systems at Lower Granite Dam are operable with forebay elevations down to 710. Initial observations of tailrace flow patterns during the 1992 spill tests indicated that delay of fish during substantial spills, even with some powerhouse flow, could be considerable. However, this is a very preliminary observation, and will be reevaluated in further drawdown analyses.

(3) Terrestrial Ecology.

Actual flood events would probably have a negligible effect on wildlife, since the impacted areas are primarily of a residential and industrial character. Impacts to wildlife would occur later, due to consequences from a reservoir drawdown needed for levee repair. A reservoir lowered for the estimated 8 months for levee repair, would result in a temporary loss of riparian habitat and the few wetland areas created by the normal pool levels. This would impact all species dependent on these areas.

At developed HMU's, such as Chief Timothy, the irrigation supply would be cut off. Installation of a considerable length of intake pipe would be needed to reach the river. Additional pumps (to overcome the increased lift) would probably be required, as well. If lake bottom conditions prevent early restoration of irrigation to intensive habitat sites, permanent habitat loss could occur. It would take several years to replace these essential mitigation features. Additional losses may occur in areas where riparian vegetation has established naturally.

A negative impact on Canada Geese would occur, primarily due to increased exposure of broods to predation when crossing exposed riverbanks to reach brooding pasture (mainly on the Chief Timothy and Moses HMU's, and the Granite-Goose Pasture). It is also possible that some pasture sites traditionally used may be eliminated, or reduced, due to the steepness of the exposed riverbank. These same conditions would also impact upland game bird broods (pheasant, chukar, quail) through increased exposure to predation in their attempts to access the river for drinking water.

It is difficult to estimate the effect of a lowered pool elevation on the use of the reservoir as a resting site by wintering waterfowl. The area around Chief Timothy (upstream to the confluence with the Clearwater River) receives heavy use by wintering waterfowl. The number of birds using the reservoir usually peaks around late December to early January, just prior to the time when the reservoir would be brought to normal full pool.

A few wintering bald eagles are also known to utilize the reservoir. It is possible that the levee break scenario would result in an increase in the availability of fish, which is the preferred prey of wintering eagles.

e. Cultural Resource Effects.

Portions of exposed cultural sites would be subject to erosion, vandalism, breakdown, and movement of material. Fourteen previously identified sites were exposed during the 1992 drawdown test. Additional sites were identified, and public collecting at certain sites was a problem.

f. Recreation and Aesthetic Effects.

All boat ramps, moorage facilities, and swimming areas below Asotin, Washington would be unusable during a reservoir drawdown for levee reconstruction, as was the case during the 1992 Drawdown Test. Developed recreation areas would continue to be usable, but visitation would drop dramatically as access to the water became difficult. Aesthetic considerations, such as the presence of extensive mud flats would also discourage some visitors. Eight irrigation intakes at project recreation areas would be above water, and irrigation from the reservoir would not be available, thus possibly harming lawns and plantings.

Large areas of lake bottom and debris would be exposed. The river through Lewiston and Clarkston would recede into the former channel and take on a riverine character, and the old reservoir bottom would be exposed. The largest areas exposed would be near Silcott Island (Chief Timothy State Park), and the shoreline at the confluence.

g. Air Quality.

The lowered reservoir would produce odors from newly exposed sediments and, when dry, could produce blowing dust. There would be no significant air quality impact.

h. Social Impact.

The flooding of downtown Lewiston would, very likely, lead to a loss of life, although uncertainty in defining social attitudes make the risk to life difficult to evaluate. The Federal Emergency Management Agency (FEMA) Flood Insurance Study for the city of Lewiston, dated 21 July 1981, and the Flood Insurance Rate Maps published in January of 1982, both state that "these dikes contain the 100- and 500-yr flooding on both rivers." The study also states that "no flood plain ordinances or protection measures are in effect in .pa
Lewiston." The study did identify a narrow band of land along Lindsay Creek

(in the east part of the city) which is subject to flooding at the 100-year level, but the levee pumping system is expected to handle the inflow adequately at the levees to prevent flooding of Lewiston.

Given the history of the levee documents, the Lewiston community probably has a reasonable expectation of adequate flood protection, and certainly many businesses have located in the downtown area based on that expectation. This expectation is probably reinforced by their experience with typical spring runoff. An extreme flood event, however, develops rapidly with perhaps only a few hours notice. A rise of 50,000 cfs within a 3- to 5-day period is not unusual. Although this would seem to allow adequate time for evacuation, the time could be considerably shortened.

Since the spring runoff is an annual event which normally occurs with little detectable change in the confluence water surface elevation, it is unlikely that the general population would be mentally prepared for a rapid evacuation.

Failure, once in progress, could result in rapid flooding (probably one or two hours) of the downtown area, with depths of up to 18 feet. It is almost certain that there would be loss of life.

Without remedial action, flooding will occur eventually. It is also certain that flooding would result in great economic disruption. The downtown area and the PFI plant directly, or indirectly, are responsible for a large portion of the Lewiston job base. Because the flooding would occur suddenly and with little warning, businessmen and homeowners alike, would have little time to prepare. Further, the flood hydrograph would not recede sufficiently to reenter portions of the flooded area for about 2 months.

i. <u>Economic Effects</u>.

Damages and losses are shown to illustrate the magnitude of the economic effects of a levee failure at Lewiston, Idaho. The data is from the System Operations Review (SOR) update of discharge-damage relationships in areas where Columbia River Basin system reservoirs provide flood control; in this instance, Dworshak Dam and Reservoir.

(1) <u>Floodplain Damages</u>.

The most damaging levee failure scenario, failure at Clearwater River mile 3.0, was evaluated for SOR. Estimated property damage was $280 million, and included damages in the following categories: (1) commercial structures and contents; (2) industrial structures and contents;

(3) residential structures and contents; (4) streets; (5) utilities; (6) railroads; and (7) emergency expenses. Losses to barge transportation and hydropower productions are discussed in the following paragraphs.

(2) Transportation.

An extended reservoir drawdown would result in insufficient clearance over the navigation lock sill resulting in the suspension of barge traffic in the interim. Preliminary navigation losses were computed as the increase in transportation cost for shipping commodities during the extended drawdown for rebuilding of the levees. This period is estimated to be from May to January. A preliminary estimate of navigation losses is about $7.1 million.

(3) Agriculture.

Minimal effect to agriculture in the Lower Granite Project vicinity is anticipated.

(4) Power Losses.

Power generation at Lower Granite Lock and Dam was computed with, and without, levee failure. The assumed period of analysis is from May to January. Flow conditions are assumed to be above normal, because failure would most likely occur during a year of historic high flows. As a result, the analysis of the value of power generation was made on the assumption that all generation from Lower Granite Dam would be exported to the Pacific Southwest (PSW). Two options for the value of power were considered: (1) displacement of thermal resources of the PSW; and (2) displacement of a new coal-fired plant in the Pacific Northwest (PNW). In both cases, because of the uncertainty of when a failure might actually occur, fuel cost escalation was not included. The value of thermal resource displacement in the PSW comes from other studies (Galloway Dam), and the displacement value of a new coal plant in the PNW is the value for the fiscal year (FY) 1989 budget, at the 1 October 1987 cost level.

The analysis was based on the assumption that, under both normal and post-levee failure conditions, the project would be operated run-of-river, with the number of units online being determined by the flow in the river. Results of the analysis are as follows:

Generation	Without levee failure	With Levee Failure	Net Loss
(kilowatt hours)			
Total	2,266,120,000	1,647,830,000	618,290,000
Marketable	2,039,510,000	1,483,050,000	556,460,000
Value			
PSW Displacement	$27,378,000	$18,713,000	$8,665,000
PNW Displacement	$39,566,000	$28,771,000	$10,795,000

j. Summary of Economic Losses.

Economic losses tabulated below illustrate the magnitude of the economic effects of a levee failure at Lewiston, Idaho.

Floodplain Damages	$280,000,000
Navigation Losses	7,100,000
Agriculture	minimal
Hydropower PSW Displacement	8,700,000
PNW Displacement	10,800,000
Total	$306,600,000

SECTION 4 - POTENTIAL ALTERNATIVES AND OPTIONS

4.01. GENERAL.

a. Plan Formulation.

Alternative plans to maintain flow capacity in the upper reaches of the reservoir have been formulated in numerous reconnaissance reports, interim reports, and sedimentation studies of Lower Granite Reservoir. The primary component of Federal planning is the process of developing and evaluating alternatives which meet the needs and desires of the nation, while responding to state and local concerns.

The potential alternatives presented in this progress report are typical remedial plans which illustrate the variety and the potential cost of a long-term plan. The four basic alternatives to be discussed are: (1) Raise Levee 12 Ft - No Dredging; (2) Dredging Only - No Levee Raise; (3) Dredging With 7-Ft Levee Raise; (4) Dredging With a 5-Ft Levee Raise; and (5) Dredging With 3-Ft Levee Raise. These are representative of the most current alternatives under consideration. Various options, if added to an alternative, would modify costs, as well as dredging and disposal sequencing (*i.e.*, drawdown options.

Formulation of a recommended long-term remedial action plan that combines alternatives and options will be done in the feasibility report and through the EIS scoping and review processes.

The formulation of alternatives in this interim progress report, and the upcoming feasibility report, is based on water resource planning regulations, and the Federal planning process described in appendix D.

b. Dredging Window.

The window for dredging, December 15 through March 15, is consistent with the in-water work window evaluated in the *Lower Granite Environmental Impact Statement Final Supplement No. 1 - Interim Navigation and Flood Protection Dredging (EISFS)*. This time period minimizes the risk to valued environmental resources during dredging, while still providing sufficient time to accomplishing the task in an economical manner.

c. Analysis of Alternatives.

A dynamic balance exists between sediment moving in a natural stream, size and gradation of sediment material in the stream's boundaries, and the hydraulics of flow. The creation of Lower Granite Lake in 1974, and the subsequent dredging needed to maintain the navigation channel and maintain flow capacity for flood protection, has changed the natural stream balance. Prediction of the behavior of shallow reservoirs and rivers (Lower Granite Lake) requires the inclusion of the interaction between flow hydraulics and sediment transport, as well as related changes in boundary geometry and roughness. A combination of flow hydraulics, sediment deposition, and changing geometry forms an ever-changing dynamic system. The Snake and Clearwater Rivers will continue to carry sediment into Lower Granite Reservoir until a riverine condition is established that produces the dynamic balance of a natural stream. Eventually, this amassed sediment will completely fill Lower Granite Reservoir. Therefore, any proposed alternative which maintains the Lewiston Levee freeboard is temporary, and will only be effective for a limited period of time.

The analysis period for all alternatives is the 100-yr project life of Lower Granite Lock and Dam which began in 1974, and ends in 2074. This period was chosen only because the typical service life of major lock and dam facilities is 100 yrs. The basic alternatives described in this section were formulated based on providing the design freeboard to the year 2074 (100-year life of Lower Granite Lock and Dam).

Reduction of sediment inflow (land treatment) and the periodic drawdown of Lower Granite Reservoir, are actions that would enhance and extend the effectiveness of each alternative beyond the year 2074. Evaluation and the combination of these options will be done in the feasibility report and EIS scoping process.

Alternatives that include dredging and disposal within Lower Granite Reservoir were analyzed using HEC-6, Scour and Deposition in Rivers and Reservoirs. HEC-6 simulates the ability of a stream to transport sediment. It does not predict watershed sediment yield. The base year for HEC-6 modeling purposes was established in 1986, because sediment range surveys conducted that year were calibrated for actual conditions.

In-water disposal, as described for each alternative, means a given volume placed below the water surface. Placement in deep-water, mid-depth, or island creation (shallow-depth) is to be determined based on the evaluation of data gathered from the disposal test sites.

4.02. RAISE LEVEE 12-FT, NO DREDGING.

This alternative assumes that no dredging would be done in the Snake or Clearwater Rivers throughout the remaining project life of Lower Granite Lock and Dam (from the present to the year 2074).

In order to maintain at least 5 ft of freeboard at the reservoir control point elevation (at the confluence) through the year 2074, the levee would have to be raised and extended to achieve a minimum raise of 12 ft at the CPRR lift bridge on the Clearwater River.

4.03. DREDGING ONLY, NO LEVEE RAISE.

a. Dredging.

Initial dredging would excavate a rectangular template varying from 750- to 1000-ft wide, with the bottom set at the existing thalweg. This area would extend from the confluence (RM 139.3) to approximately Silcott Island (RM 131.8). Removal of approximately 10 myd^3 of material from the confluence area would regain the 5 ft of design levee freeboard, and maintain 5 ft of freeboard to the year 2074. This would include excavation of roughly 5 myd^3 of sediment, and 5 myd^3 of original riverbed gravels.

The general dredging plan would be to start dredging 0.9 myd^3/yr, by excavating the channel down to the rectangular template and working downstream. Overdredging of the original bed material would be done to facilitate future dredging needed to clean the template. At the end of 9 years, the SPF freeboard would be about 5 ft, and the excavated template would extend downstream to Red Wolf Bridge. After the initial 9-yr period, dredging would proceed by removing sediment deposited in the previously excavated template and extending the template farther downstream. The excavated template would extend to just above Silcott Island by the year 2074.

Average annual volume to be dredged would increase to about 1.3 myd^3 for a period of 79 yrs. The total volume dredged and disposed would be about 116 myd^3.

b. Disposal.

Disposal would be at upland areas along Lower Granite Reservoir, or at disposal sites (to be identified in future studies) downstream of Lower Granite Lock and Dam. A preliminary upland disposal analysis is shown in appendix E.

There would be no in-water disposal in Lower Granite Reservoir for this alternative. Upland disposal would be done by the following assumed plan:

Upland Disposal Sites

Site Name	Capacity	Distance	Site Life
Lower Granite Project: Upland			
Dry Creek	40.0 myd^3	3.9 mi	32 yrs
LB1	16.1 myd^3	4.0 mi	13 yrs
LB2	10.9 myd^3	7.5 mi	9 yrs
Page Creek	30.9 myd^3	9.0 mi	24 yrs
Subtotal	97.9 myd^3		

4.04. DREDGING WITH A 7-FT LEVEE RAISE.

This alternative combines a dredging plan and a 7-ft levee raise. The dredging process would remove an average of 0.53 myd^3, in-water disposal. Increasing levee height alone would not be sufficient to restore design freeboard for the life of the project. Periodic dredging would have to be done over the long term, in conjunction with a levee raise, to handle future sedimentation.

a. Dredging.

An initial 9-yr dredging plan (for removal of 0.53 myd^3/yr) would excavate a 750-ft bottom-width trapezoidal design template into the original channel bed gravels. Overdredging of 2- to 3-ft would be required, during the initial dredging, to assure that subsequent dredging would restore the geometry of the design template without excavating original materials. The channel, excavated to the design template, would extend from just below Memorial Bridge (on the Clearwater River) and just below the Highway 12 bridge (on the Snake River) to the Port of Wilma.

After the initial 9-yr construction of the design template, future dredging of 0.53 myd^3/yr would be done, in an effort to clean and extend the design template.

b. Disposal.

In-water disposal within Lower Granite Reservoir is assumed for this alternative. The present strategy, introduced by Dr. Dave Bennett, is the creation of shallow water feeding for the rearing habitat of chinook salmon. This would start at Offield Landing, near Lower Granite Dam, and progressively fill upstream, at sites specifically identified for optimum habitat development. The estimated total capacity of the deep in-water disposal area is about 86 myd^3.

c. Levee Raise.

This alternative would raise all levees by 7 ft. The East Lewiston levee would have to be extended about 1,200 ft upstream. The CPRR bridge, the Highway 12 bridge, and Memorial Bridge (across the Clearwater River) would have to be raised 6, 2, and 7 ft, respectively. Also, three pumping stations would require additional pumps, motors, and discharge lines. Utilities in some areas would have to be upgraded. Port and marina facilities would have to be modified, and there would be major disruptions to the Lewiston park system.

4.05. DREDGING WITH A 5-FT LEVEE RAISE.

This alternative combines a dredging plan, in-water displosal, and a 5-ft levee raise. The dredging plan would remove an average of 0.89 myd^3/yr. As with the above alternative, increasing levee height alone would not be sufficient to restore design freeboard for the life of the project. Periodic dredging would have to be done over the long term, in conjunction with a levee raise, to handle future sedimentation.

a. Dredging.

This alternative also includes dredging a design template into the original channel bed gravels. Annual dredging volume would be about 0.89 myd^3/yr. After the initial construction of the design template, future dredging of 0.89 myd^3/yr would be done in order to clean and extend the design template.

b. Disposal.

In-water disposal within Lower Granite Reservoir is assumed for this alternative, and would progressively fill in an upstream direction at sites specifically identified for aquatic habitat development.

c. Levee Raise.

The East Lewiston levee would have to be extended upstream, and the bridges must be raised. Also, pumping stations would require modification. Utilities in some areas would have to be upgraded, and port and marina facilities would have to be modified. There would be major disruptions to the Lewiston park system.

4.06. DREDGING WITH A 3-FT LEVEE RAISE.

This alternative combines a dredging plan, a combination of in-water disposal and upland disposal, and a 3-ft levee raise. The dredging plan would remove an average of 1.18 yd^3/yr. As with the above alternative, increasing levee height alone would not be sufficient to restore design freeboard over the life of the project. Periodic dredging would have to be done over the long term, in conjunction with a levee raise, to handle future sedimentation.

a. Dredging.

The initial dredging plan would excavate a 750-ft bottom-width trapezoidal design template into the original channel bed gravels. Overdredging of 2- to 3-ft would be required, during the initial dredging, to assure that subsequent dredging would restore the geometry of the design template without excavating original materials. The channel, excavated to the design template, would extend from just below Memorial Bridge (on the Clearwater River) and just below the Highway 12 bridge (on the Snake River) to the Port of Wilma.

After the initial 9-yr construction of the design template, future dredging of 1.18 myd^3/yr would be done in order to clean and extend the design template.

b. Disposal.

If this alternate is selected, in-water disposal would be used for about 66 years, and upland disposal would be used for about 22 years. The annual dredging requirement is estimated to be about 1.18 myd^3/yr.

In-Water and Upland Disposal Sites

Site Name	Capacity	Distance	Site Life
Lower Granite Project: In-water	86.0 myd^3	25.0 mi	66 yrs
Lower Granite Project: Upland Dry Creek	40.0 myd^3	3.9 mi	32 yrs

c. Levee Raise.

Preliminary studies examined various levee-raise formats, including steel sheet pile walls, crib walls, and reinforced earth systems. The August 1986 reconnaissance report examined four 3-ft levee raise options. These options were: 1) Raise the embankment, with recovery of the aesthetic treatment of the levee system; 2) Interlocking steel piles with caps; 3) Pre-cast interlocking concrete panels; and 4) Cast-in-place concrete panels.

Pre-cast interlocking concrete panels were found to be the most acceptable from both economic and aesthetic views. Access points would have to include special designs. Existing bridge abutments would also require special considerations.

4.07. IN-WATER DISPOSAL OPTIONS, LOWER GRANITE RESERVOIR.

In-water disposal in Lower Granite Reservoir will extend from RM 120 to Lower Granite Dam, a distance of about 12 mi. Minimum and maximum haul distances, from the confluence of the Snake and Clearwater Rivers, would be from 20- to 30-statute mi, respectively.

The total capacity of in-water disposal is estimated to be about 86 myd^3. For each reach of the pool, this volume would be distributed between deep water, mid-depth, shallow, and island construction. Actual in-water placement will be determined by further studies and benefit evaluation of the disposal test sites.

Shallow water habitat and island construction would require rehandling of dredge material.

4.08. UPLAND DISPOSAL OPTIONS, LOWER GRANITE PROJECT AREA.

a. General.

Future years of upland disposal depend on the identification of suitable disposal sites for containment of dredged sediment. Due to the high-walled canyon character of the Snake River, limited land resources are currently available for upland disposal.

A reconnaissance-level investigation of upland disposal sites within the Lower Granite Project Area was done in 1989 (appendix E).

b. Dry Creek Site.

This site is the closest upland disposal site to the dredge areas at the confluence. A retention dam would be constructed in the Dry Creek drainage, and sediment would be pumped into the storage area with a pipeline operation. The site is about 4 mi from the confluence. The containment dike would be about 245 ft high, with a storage capacity of about 40 myd^3.

c. LB1 and LB2 Sites.

Site LB1 is in a minor canyon that drains into the Snake River near Dry Creek. The site is about 4 mi from the confluence. The containment dike would be about 266-ft high, with a storage capacity of about 16.1 myd^3.

Site LB2 is in a minor canyon that drains into the Snake River near Silcott Island. The site is about 9 mi from the confluence. The containment dike would be about 200 ft high, with a storage capacity of about 10.9 myd^3.

d. Page Creek Site.

Page Creek site is a tributary canyon, off Alpowa Creek, near Silcott Island. The site is about 9 mi from the confluence. The containment dike would be about 211 ft high, with a storage capacity of about 30.9 myd^3.

e. Wilma HMU.

The Wilma HMU disposal site (Corps property) is located on the right bank of the Snake River near River Mile 135, and just downstream of the Port of Wilma. Negotiations are in progress for a land exchange that would transfer Wilma HMU land to the Port of Wilma. The port's plan is to complete the filling of the disposal areas and to use the land for industrial development. Disposal capacity is estimated to be between 0.5 to 1.0 myd^3.

f. Stockpiling for Upland Disposal Options.

Dredged material could be stored at in-water stockpile sites to reduce dredge scow turnaround time. Tentative temporary stockpile sites include the Port of Wilma and the Port of Clarkston. Rehandling would be required to move the stored material from in-water disposal on to land, where trucks or scrapers, conveyor belts, or hydraulic pumping could transport it to the final disposal site(s).

With direct transfer from water-transport equipment to the stockpile site on land, dredging duration could be reduced.

g. Upland Disposal Above In-Water Disposal.

In-water disposal sites along the shoreline of Lower Granite Reservoir could be expanded above water, at the natural angle of repose, to meet the canyon walls.

4.09. DOWNSTREAM DISPOSAL SITES BEYOND LOWER GRANITE PROJECT.

Downstream disposal sites were considered because of limited upland disposal opportunities within the Lower Granite Project area. The inflow of sediment into Lower Granite Reservoir will continue past the 100-year project life analysis year of 2074. Beyond that year, all disposal opportunities within the Lower Granite Project will diminish, and other sites may be needed.

Most proposed downstream in-water sites would be located over original river bars inundated by the pool behind each dam. River bends and shoreline configurations appear to be conducive to natural bar development.

Potential downstream disposal sites, estimated capacity, and the distance from the Snake and Clearwater River confluence are tabulated below:

Potential Downstream Disposal Sites

Project and Site Name	Capacity	Distance
Little Goose Pool:		
In-water Corral	11.9 myd^3	67 mi
Lower Monumental Pool:		
In-water Cistern	20.5 myd^3	97 mi
Ice Harbor Pool: In-water		
Simmons	10.6 myd^3	112 mi
Votaw	6.7 myd^3	118 mi
Page	7.2 myd^3	118 mi
McNary Pool: Upland		
Martindale	2.8 myd^3	132 mi
Tri Cities	1.3 myd^3	144 mi
McNary Pool: In-Water		
Tri Cities	2.7 - 7.1 myd^3	144 mi
Barren	7.9 myd^3	148 mi
Juniper Canyon	47.0 myd^3	159 mi

4.10. RESERVOIR DRAWDOWN (OPTION WITH ALTERNATIVES).

The annual drawdown of Lower Granite Reservoir can be considered as a means of reducing the height of levee raise alternatives, or the volume of annual dredging. Implementation of such a drawdown is under investigation in mitigation analysis studies, and in the analysis of physical data collected during the 1992 Lower Granite Drawdown Test. To be effective in moving sediment, an annual two-month drawdown period would be needed during the peak of the runoff hydrograph. A reservoir drawdown would temporarily increase flow velocities in the upper reservoir, by carrying the suspended sediment farther into the reservoir, shifting a portion of the deposited sediment farther downstream, and carrying more fine suspended sediment through the reservoir. This alternative may have limited effectiveness in resuspending material already deposited along the reservoir shoreline and at port berthing areas.

4.11. LAND TREATMENT (NON-STRUCTURAL OPTION).

Land treatment programs could be implemented to potentially reduce future sediment inflow by dealing with sediment at its point of origin. The effectiveness of various programs is, however, difficult to predict. Because of the ownership of the erodible lands, and the portion of erosion that is not treatable, only limited reductions in sediment inflow are realistic. Implementing erosion control programs might reduce the magnitude and costs of other actions required, particularly maintenance dredging for each alternative. Actual frequency of dredging, and the volume that must be dredged to maintain freeboard, will vary depending on hydrologic conditions in the basin during the spring freshet, hydrologic conditions during unseasonalably high runoff volumes, and successful efforts to control soil erosion through implementation of the Food Security Act of 1985. These are highly variable and unpredictable. Control of soil erosion is dependent on farmer participation, crop rotation, and the efficiency of measures taken to control erosion.

4.12. WAWAWAI ROAD FILL.

The CPRR, roadways, State Route 193, and County Road 900 parallel the right bank of the Snake River from North Lewiston to Wawawai Canyon. The roadway turns and continues up the canyon away from the river, and the railroad continues to Lower Granite Lock and Dam along the shoreline. Local interests desire continuation of a roadway along the shoreline. An extensive amount of rock excavation would be necessary to extend the roadway from Wawawai Canyon to Lower Granite Lock and Dam.

An alternative to expensive rock excavation would be to place dredge material, from the confluence dredging, as fill for the roadway (near RM 110). The primary concern is the suitability of dredge material for roadfill. Stability analyses, cross section design, length of time to construct, and costs will be determined in future studies.

4.13. NON-STRUCTURAL EMERGENCY ALTERNATIVES.

a. Emergency Isolation of Flood Prone Areas.

During a flood, it would be prudent to concentrate emergency flood-fighting efforts on the highest valued areas, which are located along the south side of the Clearwater River. If failure occurred on the left bank near the PFI plant, it may be possible to isolate the area above Memorial Bridge from the area below, by blocking the narrow opening under the south side of the bridge. The levee just upstream could then be cut to allow flood water to drain back into the river. This process is outlined in the existing project operating procedures.

b. Emergency Levee Raise.

An emergency levee raise would require about 2 weeks to raise levees 3 ft (the amount that could be achieved without blocking bridges, *etc.*). Since the low chords of the bridges are only several feet above the levee top, special treatment would be required to assure adequate compaction and a watertight seal around the bridge stringers. There is considerable development on top of the levees, such as landscaping, a visitors center, and paved jogging trails. It would require an imminent disaster to warrant destruction of these developments. It is probable that a very high discharge with imminent loss of control, combined with forecasts of even higher flows, would be required before a decision would be made to run the risk of a false alarm, wasted effort, and considerable damage to the levee landscaping.

SECTION 5 - COSTS

5.01. GENERAL.

Costs presented in this progress report are meant to be illustrative, by showing the magnitude of cost for typical alternatives that would be included in a long-term remedial action plan. Costs shown are based on technical information developed in past reconnaissance and interim reports. Life-cycle costs were not updated for this progress report.

Mitigation measures for upland disposal actions must still be determined through the habitat evaluation process. Costs will be quantified in the scheduled feasibility report.

5.02. COMPARABLE ACTION PLAN COSTS.

a. Dredging Only, Upland Disposal - Dry Creek Disposal Site.

A plan that combines dredging only with upland disposal is described in appendix E. The plan described calls for annual dredging of 800,000 yd^3/yr, and disposed upland in Dry Creek Canyon. The analysis concludes that the minimum cost of upland disposal at the Dry Creek Site would be about \$5.08/yd^3, based on a compacted sand containment dike. The annual cost would be about \$4 million annually (May 1988 price levels), based on the dredging and disposal of 800,000 yd^3/yr.

If a rockfill containment dike becomes necessary, the annual cost of this plan would rise to about \$5 million (May 1988 price levels), based on the dredging and disposal of 800,000 yd^3/yr.

b. Levee Raise Alternatives.

Construction cost for the pre-cast interlocking concrete panels needed for a 3-ft levee raise is estimated to be about \$21 million (1988 price level). The amortized cost would be about \$1.8 million, annually.

The estimated construction cost of a 7-ft levee raise is about \$41 million (1986 price level).

c. Dredging With Upland Disposal and a 3-Ft Levee Raise.

The cost of this remedial action plan would include the costs for annual dredging of 800,000 yd^3 and upland disposal, as well as the annual cost of the 3-ft levee raise alternatives described above. Total annual cost would be about $5.8 million or $6.8 million (1988 price levels) for the sand dike option or the rockfill dike option, respectively. These are representative costs for this long-term remedial action plan.

5.03. COST ANALYSIS FOR THE FEASIBILITY REPORT/EIS.

a. Construction Costs.

Comparative construction cost estimates will be prepared for each alternative. These will rank and evaluate each alternative, and combinations of alternatives, to formulate a recommended remedial action plan.

Construction unit prices will be based on similar work, and past dredging contracts, at the current price levels.

b. Project Costs.

Project costs will include engineering and design costs, estimated on the specific construction work to be accomplished. Non-specific cost estimates for engineering and design, as well as construction management, will be estimated at 10- and 11-percent of direct construction costs, respectively.

c. Investment Costs.

The investment cost of each alternative will include the appropriate interest during operation, and/or interest during construction.

Dredging costs are considered an operation expense. Therefore, interest during operation will be computed as simple interest, at year end, on the expense incurred that year. The interest rate will be the current Federal discount interest rate (8.5 percent in FY 1992).

Alternatives that include capital improvements, such as a levee raise, can take several years to construct. Therefore, costs are incurred without producing immediate benefits. Interest during construction will be computed on capital improvements as compound interest over the period of construction at the current Federal discount interest rate (8.5 percent in FY 1992).

d. Annual Costs.

The average annual cost is the annual cost equivalent that reflects the time value of money.

Future economic analysis of dredging and disposal alternatives will be evaluated over a period of 88 years. This period will be used because all alternatives are evaluated using HEC-6 modeling over the period from 1986 to 2074. The annual cost analysis will be at October price levels for the analysis year, annualized over a period of 88 years at the current Federal discount rate (8.5 percent in FY 1992).

Annual costs will also include the estimated cost of annual operation, maintenance, and replacement (where applicable).

LOWER GRANITE LOCK AND DAM
SEDIMENTATION REMOVAL FOR FLOOD CONTROL
DRAFT PRELIMINARY EVALUATION AND PROGRESS REPORT

SECTION 6 - FINDINGS TO DATE

6.01. RESERVOIR SEDIMENTATION, FINDINGS TO DATE.

a. Sediment Inflow and Deposition Rates.

Estimates of total sediment deposited in Lower Granite Reservoir since project completion through 1986, range from 22 to 38 myd^3. The USGS measured yearly sediment inflows ranging from 62,300 to 68,413 tons between 1972 and 1979. The average annual inflow rate is 2.3 million tons or about 3.4 myd^3. Assuming an 85-percent trap efficiency, the USGS inflow estimate translates to approximately 2 million tons of sediment deposition annually. About 80 percent of the sediment inflow is from the Snake River, while about 20 percent is from the Clearwater River. The USGS measurements are summarized in table 1. Studies are ongoing to verify the rate of inflow and the deposition patterns.

b. Sediment Deposition.

About half of the incoming sediment volume is deposited in areas above RM 120. This impacts both the freeboard available at the Lewiston levee system and navigation to the port facilities in Lewiston and Clarkston. The remaining half is deposited in areas less critical to levee freeboard maintenance, or remains in suspension and passes through the reservoir.

The USGS measured the sediment discharge of six of the larger ungaged tributaries on the Snake and Clearwater Rivers downstream of existing gage stations during Water Year 1989. Field data collection of suspended sediment and water discharge was concentrated on Asotin, Alpowa, and Tammany Creeks. Discharge during the measuring period was lower than normal.

The SCS conducted a field evaluation to determine the nature of the erosion and sedimentation conditions that contribute to the reduction of channel capacity in Lower Granite Reservoir. It assessed how much erosion reduction on dry cropland above the reservoir could be achieved through the implementation of the 1985 Food Security Act. Results indicate that implementing land treatment programs could potentially reduce future sediment inflow if the sediment could be managed/controlled at its point of origin. The effectiveness of various programs is difficult to predict. Because of the ownership of the erodible lands, and the portion of erosion that is not treatable, only limited reductions in sediment inflow are considered realistic. The cumulative effects of implementing conservation methods and erosion control programs may reduce the magnitude and costs of other actions required, particularly maintenance dredging.

c. Sedimentation Studies.

A sedimentation study was conducted in 1982 and 1983 to determine future sedimentation effects on navigation and the Lewiston levee system. The study illustrated the need for immediate (interim) corrective action, as well as a long-term solution to the sedimentation challenge. The analysis utilized a roughly calibrated HEC-6 computer program that modeled the sediment transport through the reservoir. Backwater computations, based on the sediment transport results, indicated that the SPF could overtop the levees, by up to 2 ft, by the year 2035. Even more significant was the conjecture that the HEC-6 model may be underestimating the magnitude of the problem, and a series of high-flow years could substantially shorten this time frame.

Preliminary results of density sampling conducted in the fall of 1988 tend to support the accuracy of USGS sediment inflow data. Over 60 sediment density samples were taken that year in the Lower Clearwater Snake Rivers. These samples revealed a much lower sediment density than had previously been estimated, with a very high gas (voids) content. Density sampling in 1988 documented an average sediment density figure of 50.5 pounds (lb)/cubic foot (ft^3), which is much lower than the approximately 90 lb/ft^3 figure previously assumed.

6.02. PAST DREDGING EXPERIENCE AND FINDINGS.

Dredged material could be transported to deep water sites by barge, pipeline (fixed or floating), or a combination of the two options. A preliminary review of a proposal to transport dredged materials 17 mi to in-water disposal sites concluded that the concept of transporting dredged material by pipeline, on a permanent basis and at such a long distance, is not practical with equipment currently available.

6.03. DISPOSAL TEST SITES, FINDINGS TO DATE.

a. Consolidation Monitoring.

Core samples, collected in 1988 and 1989, were tested to serve as a basis for estimating future consolidation under natural sedimentation loads, and under loads imposed by in-water disposal of dredged material. Due to the high water content of the samples, the consolidation curves deviated from the shape normally expected for foundation soil tests. It is not known how this will effect the ability to project long-term consolidation of this material, but it is likely to complicate the evaluation.

b. In-Water Disposal Test Site.

The mid-depth disposal test site was constructed to evaluate the potential benefits to fishery resources. Material placed in the test site is primarily sand, with pockets of silty sand and silt.

The material placed at the mid-depth site has significant structure. Elevation variations between peaks and valleys of more than 10 ft is not uncommon. The undulating surface was visible during the 1992 Reservoir Drawdown Test.

There was little drifting of material downstream of the mid-depth site. Samples, taken within one month of disposal, showed that approximately 1/8- to 1/4-inch of new sediment, in the form of silt, had been deposited over the disposal area. Changes in the structure created by the disposal are more likely to result from future sediment deposition than from erosion.

Dredge material was placed at the deep in-water disposal site in 1988 and again in 1992. Analysis of surveys taken on 28 February 1992 suggest that sand, or other fine material released from the split-bottom barges, drifted considerably farther downstream and upstream than was observed in previous disposal operations. The drift limits have not been pinpointed exactly by this set of surveys because the drift apparently extends beyond the limits of previous detailed surveys and, also, because natural sediment deposition around the base of the fill (since 1989) is not distinguishable from the dredge material.

c. Island Disposal Test Site (Centennial Island).

Centennial Island was created in 1989. It is about 1,000 ft long, varies from 75 to 250 ft wide, and is about 5 ft above high pool. The larger surface area, greater depth variation, and increased shorelines provided by the island produce the most complex and varied physical habitat types possible. The island provides the best opportunity for a statistically measurable fish response to habitat changes, in a relatively short period. Without island development, some data essential to adequately understanding aquatic responses could not be obtained. It also allowed the investigation of potentially beneficial uses to fishery and aquatic invertebrate resources.

6.04. ENVIRONMENTAL STUDIES - FINDINGS TO DATE.

a. The IWG.

The 1986 and 1987 IWG meetings led to the development of a flowchart-based conceptual model of the reservoir biophysical relationships. This identified four sets of hypotheses relating dredging and disposal activities to various aspects of the aquatic environment. The conceptual model and impact hypotheses were used to structure an initial version of a disposal simulation model. These processes are documented in the report entitled *"Lower Granite Reservoir In-Water Disposal Test: Proposed Monitoring Program"*, dated December, 1987.

b. Possible Effects on the Aquatic Environment.

The in-water disposal test is designed to test the defined linkages within each set of impact hypotheses on the revised list of VEC's identified by the Interagency Working Group. The VEC's are spring/summer and fall chinook salmon, steelhead trout, resident game fish (white sturgeon and smallmouth bass), sportfish catch, and wildlife (*e.g.*, waterfowl).

A primary benefit associated with in-water disposal is the creation of additional shallow water habitat (10- to 20-ft depth) in the lower reservoir. Quantity and quality of this habitat is limited in the lower reservoir. The major species that may benefit from this habitat is juvenile fall chinook, which use open shallow areas for resting and feeding while migrating downstream.

Adult spring/summer chinook generally move quickly through the reservoir toward their spawning streams. The impact of the dredging and disposal activity, including the created habitat, is expected to be minimal. Adult chinook salmon generally do not feed during their time in the reservoir. Steelhead feed to a minimal extent. Some proportion of adult steelhead that pass the Lower Granite Dam in September and October winter over in the reservoir prior to spawning the following spring. The annual proportion of fish that remain in the reservoir, and their habitat requirements, are unknown at this time.

Juvenile spring/summer chinook and steelhead are normally smolting to some degree as they move through the reservoir. They tend to have passage times on the order of three days to a week (data range 1 - 40 days). During this time, they would normally be feeding on material from both benthic and terrestrial sources. Juvenile fall chinook are not normally as physiologically advanced as the spring/summer chinook and steelhead juveniles. They prefer sites with lower velocity, and may spend several weeks feeding there, as they move downstream through the reservoir.

Juvenile salmonids are commonly associated with more open substrate areas, located in shallow water (15 ft or less), during their migration. During peak migration, they can be found throughout the reservoir, but their numbers are proportionately greater in the top 10 to 20 ft of the water column.

Disposal activity may have mixed effects on resident fish within the reservoir. Most efforts center around the creation or elimination of spawning habitat for resident species that prey on juvenile salmonids as they migrate through the reservoir. These are predominately northern squawfish, smallmouth bass, and channel catfish. Shallow water disposal will increase resident spawning habitats. This will have a negative effect on the amount of migrating salmonid smolts surviving passage through Lower Granite Dam and Reservoir. Decreasing resident spawning habitat could potentially affect sport fishing. Catfish populations are more likely to be limited by the amount of shallow water habitat (less than 5 ft deep) that would be available for spawning and juvenile rearing. White sturgeon, that generally spawn in the Hells Canyon reach of the Snake River, use the upper reservoir of Lower Granite for feeding and the rearing of juveniles. Originally, it was thought that deepwater sites were the most critical to sturgeon, but not enough data was available to quantify any importance value. More recent data, from the University of Idaho, suggests that the Lower Granite population of sturgeon move seasonally between low/mid depths and deep depths. Higher water velocities downstream from the confluence of the Snake and Clearwater Rivers appear to be preferred by sturgeon, and may initiate movement.

Apart from depth, velocity, and food supply, the other determinant of habitat that may be important is the amount of cover provided by macrophytes, or relief of the substrate. In general, spring/summer chinook may use some cover to decrease the potential for predation. Conversely, fall chinook are thought to prefer open areas, away from hiding areas used by predators. Necessary cover can be provided not only by macrophytes, but also by the structure of the bottom. The undulating surface of the underwater shoals, produced when the slug of sediment material is released from a bottom-dumping transport scow, may improve the structure of the bottom. If the disposal site has a usable gravel or rocky surface prior to the disposal event, then the deposition of new material may be counterproductive to maintaining habitat integrity.

Benthic organisms in Lower Granite Reservoir are primarily larval insects, crayfish and other smaller forms of freshwater crustaceans (amphipods), mollusks, and oligochaete worms that inhabit the bottom surface and provide food for valued salmonids, as well as their resident predator species. Some forms of benthic organisms prefer sandy/silty embedded mud habitats in the 12- to 20-ft depth range for refuge (*i.e.*, crustaceans, insects), while other forms use the gravel and cobble habitats for refuge, foraging, and wintering over (*e.g.*, crayfish). The top of the underwater shoals are being constructed, by disposal, to a depth of 12- to 20-ft. Disposal is likely to displace site-specific benthic organisms for the short-term, by covering the original habitat. This may prove to be either a benefit or a cost, depending on the tradeoff between the quality of the original and the created habitat. One example would be replacing a limited productive deep-water site (composed of high silt sedimentation) with a shallow water bench and island. This would exhibit a high degree of shoreline, composed of a more diverse array of sand-to-gravel habitats. It is a generally accepted fact that most deep- and mid-water benthic communities should recover fully within 1 to 2 years following a more traditional disposal activity.

Little is known about either zooplankton dynamics or their importance to early life stages of salmonid and resident fish in Lower Granite Reservoir. Based on the primary productivity exhibited by phytoplankton abundance (thought to nourish reservoir zooplankton), it was generally viewed by workshop participants associated with the Interagency Working Group that the availability of zooplankton to young fish, and the benthic community, was not limiting.

c. Reservoir Monitoring of Fish Community.

Data on species composition, abundance, and physical habitat was collected during the period from 1985 to 1986 (Bennett and Shrier, 1986). This was used to project the effects of sediment dredging and in-water disposal on fishes in the Lower Granite Reservoir. The results of this preliminary analysis indicate that disposal of dredged material in Lower Granite Reservoir could be conducted with no significant impacts to biotic communities in areas with low habitat diversity. Sediment disposal at sites with higher habitat diversity could alter the structure and dynamics of the biological communities. However, habitat conditions could be enhanced in selected areas, and dredged material could contribute to increased habitat diversity. A fish and benthic community abundance study at proposed in-water disposal sites was conducted in 1987 (Bennett *et al.*, 1988).

A comprehensive, deliberate test of the potential effects and possible benefits of in-water disposal was designed by environmental experts from both Corps and non-Corps agencies, working through the Interagency Working Group. The three in-water disposal test events were initiated in 1988, continued in 1989, and completed in 1992. Three in-water display options have been employed, including a mid-depth plateau, an island, and deep-water disposal. Statistical design is based on the comparison of control areas of like size.

Since 1988, continuous monitoring of fish and benthic communities at the disposal and reference sites has been performed by the University of Idaho (Bennett *et al.*, 1990, 1991, and in preparation 1992). Monitoring is currently in progress, and is planned to continue through 1994.

(1) In-Water Pre-Disposal Test Data.

Dr. David Bennett, from the University of Idaho, provided a brief overview of his pre-disposal findings (Bennett and Shrier, 1986, and Bennett *et al.*, 1988) at the July, 1988 IWG meeting. The presentation included physical characterization (morphometry, velocity, substrate composition), benthic community descriptions, and fish abundance findings at both the reference and disposal sites. The following is a summary of the significant points:

- Substantial differences in bathymetry exist between mid-depth and deep-water sites. Mid-depth sites varied in depth from 30 to 50 ft, with typically flat bottoms. All sites were structurally "simple" systems. Deep sites generally had flat bottoms, and depths that varied from 8 to 120 ft. The structure at one deep station was abundant, but scarce at another.

- The factors affecting velocity characteristics in Lower Granite Reservoir were a function of reservoir location. A model developed to predict channel and on-site velocities indicated that the variables of the river mile/cross sectional area and total inflow were more significant in predicting upstream channel velocity, while the variables of the river mile/cross sectional area and pool elevation were most significant in predicting downstream velocity. Onsite velocities were less predictable than channel velocities.

- The University of Idaho found no relationship between river mile and substrate particle size at deep and mid-depth stations. Particles smaller than sand [less than 0.061 millimeters (mm)], and sand, dominated the sediment. Organic matter ranged from 7- to 15-percent.

- Differences in both benthic structure and the benthos standing crop did not demonstrate significant differences among mid- and deep-water sites. Mean densities of benthos were highest in the summer and lowest in the spring. Two shallow stations exhibited low benthos abundance, but indices of diversity and evenness generally were higher at these stations. Juvenile salmonids fed actively on a variety of organisms, but especially dipteran fly larvae. Seasonal differences in abundance in the benthic community were observed. As in previous surveys of the benthic community in Lower Granite Reservoir, oligochaetes worms and chironomid fly larvae accounted for 99 percent of the number of organisms. Highest numbers, and standing crops, were collected in the summer. Benthic community structure was generally more diverse at mid-depth, rather than at deep stations.

- Changes in the abundance of chinook salmon demonstrated a high correlation to differences in physical characteristics. During the period between mid-March through the end of June, anadromous salmonid smolt activity is high throughout the reservoir. From May through October, resident fishes spawn and rear, while chinook salmon migrate through Lower Granite. In the fall, adult steelhead trout pass through the reservoir. The University of Idaho found, from field sampling and examining dam counts, that fish activity is lowest in Lower Granite Reservoir from late December through mid-March.

The University recommended that a 2- to 2.5-month window (from late December to mid-March) would minimize resource conflicts. Dr. Bennett indicated that these results reflected capture by all gear types, and that sampling efficiency was not a factor. Smolts migrating through Lower Granite Reservoir during 1987 were preyed upon by channel catfish, northern squawfish, and smallmouth bass. Squawfish and bass consumed predominately chinook salmon, whereas channel catfish consumed mostly steelhead trout. This may reflect open-water foraging by channel catfish, and shoreline foraging by smallmouth bass and squawfish. A variety of food items were consumed in Lower Granite Reservoir in 1987, especially crayfish and zooplankton.

- Abundance of wild steelhead trout also had a high correlation to their physical characteristics. Somewhat lower correlations were observed for hatchery steelhead trout. Based on University of Idaho catches, residualization of steelhead was high in Lower Granite during 1987.

- Fish abundance and diversity varied among sampling stations, and seasons, in 1987. Overall, white sturgeon abundance was low, especially at mid-depth stations. Northern squawfish abundance was generally low, especially the predatory-sized age class (greater than 250 mm). With the exception of steelhead, nongame fish (redside shiners, northern squawfish, suckers, and carp) dominated the fish community. Largescale suckers dominated the fish community biomass at all sites. Game fish abundance at mid-depth sites was considerably higher than at deep sites. Fish activity varied by season. In the spring, higher numbers of fish were recorded at night, as compared to the summer, when highest number were recorded during the day. Fish distribution at deep sites was generally in the upper third of the water column.

- The shallow water site studied in the lower reservoir is an important station for all fish species, except juvenile fall chinook salmon, which prefer upstream areas with finer substrate and more open level slopes. More than 96 percent of the total fish (23 species) collected by the University of Idaho in 1987 were caught at shallow stations. The remaining 4 percent were captured at deep stations. Juvenile and adult salmonids were collected at all stations. Largescale sucker, northern squawfish, chiselmouth, and peamouth were highly abundant, and seasonal averages of nongame fish abundance showed a progressive downstream decrease.

(2) <u>In-Water Post-Disposal Test Data</u>.

The 1988 effort was somewhat experimental, in terms of the identification of effective sampling techniques. Dr. Bennett hoped to identify those techniques that would provide a return commensurate with the effort expended. Experimental in-water disposal was conducted in 1988 and 1989, with construction of an underwater bench and island at mid-depth (20 to 60 ft), and some additional disposal at deep (greater than 60 ft) sites. Initial results indicate:

- Purse seines are not effective at fill sites, because the seine embeds itself in the material and cannot be moved.

- Trawling is an effective means of sampling, except where complicated by the roughness of the bottom.

- Gill nets are the only effective method of sampling in deep water. Trawling may be effective after a larger site is created.

- The researchers are employing a new benthic dredge that provides good penetration with limited avoidance. Additionally, the sampling program for benthos exceeds that outlined in the monitoring program, and should provide greater statistical reliability. The program also provides for seasonal coverage.

Initial findings related to fish abundance indicate:

- A large number of sturgeon have been captured at the deep-water fill site. Using a marking system, researchers have determined that recaptures are limited. It appears there are a lot more fish present than originally estimated.

- The monitoring projects have shown that shallow water habitat serves as foraging and "holding" areas for juvenile anadromous salmonids and, also, as spawning and rearing habitat for resident game fishes. Deep habitats supported fewer fishes. These were primarily nongame catostomid and cyprinid fishes, although white sturgeon inhabited the deeper waters. Mid-depth habitats supported a benthic community higher in diversity and the abundance of game fishes than deep habitat, but generally was lower in abundance than shallow habitat. The mid-depth reference site at RM 111.8 appears to be a major staging area for both spring and summer chinook salmon. The major difference between reference and disposal stations was the paucity of fishes in the 4- to 8-inch, and larger than 12-inch, size classes at the disposal stations. This suggests that spawning and/or rearing habitat at the disposal stations may not yet be suitable for certain species. However, only one year of monitoring data is currently available.

- The sites appear to have similar benthic characteristics. As a result, benthos may not be a good surrogate for use in evaluation.

Results to date have indicated that catch rates of salmonid fishes and juvenile salmonid predators at disposal sites were similar to catch rates at the reference sites (Bennett *et al*., 1989, 1991). Catch rates of larval and juvenile predators have not been elevated, relative to those at reference sites. These results are only representative of an early ecological succession stage occurring during the first year of monitoring. Because of this, long-term conclusions cannot be drawn. Successional processes in the developing ecology of habitat creation or manipulation will occur with time. Data resulting from years 2 through 5 of the monitoring program will refine the year 1 findings, and help in establish a trend analysis for management.

d. Reservoir Hydroacoustic Surveys.

Four seasonal hydroacoustic surveys were conducted from May, 1989 to February, 1990. Acoustic estimates were categorized into three species groups: predators, others, and salmonids. Data analysis resulted in acoustic estimates of 33,603 predators and 108,334 others. Estimates on the salmonid population were 434,165, 183,892, 18,162, and 131,958 for May, June, October, and February, respectively.

The densities of downstream migrants were highest near the surface, but extended over a considerable depth range. Distribution tended to be near the shore in the upper reservoir, but more uniform in the lower reservoir, especially at night. Species groups, other than the downstream migrant group, showed strong distributions, both near the shores and the bottom, throughout the reservoir.

The preciseness of the estimates on fish population was good, especially at night. The major error in the estimates was the distribution, both near the shores and the bottom, of the fish population.

The techniques used in this study appear to be highly effective for salmonid population estimation. However, modifications would be required to address questions of transit time. The experience gained in this study, combined with other recent developments in hydroacoustic technology, greatly increase the utility of hydroacoustics for similar studies of the fish distribution, abundance, and behavior in reservoir habitats. These techniques offer the potential to significantly increase understanding of downstream migrant behavior and predator interaction.

e. Reservoir Dredge/Disposal Simulation Model.

In July, 1987, ESSA was contracted to facilitate implementation of the AEAM process, and develop the ecological monitoring program for the in-water disposal test. A biophysical relationship framework of the Lower

Granite Reservoir was developed through the Interagency Working Group process. It was called the Conceptual Model. This framework guided the development of the Lower Granite Reservoir Simulation Model.

The initial version of the Simulation Model is a computer generated synthesis incorporating the significant components of the reservoir and their interactions in relation to juvenile salmonid survival, based on modification in the predacious resident fish habitat. The biological components of the simulation are comprised of resident predator species and their prey, the salmon smolt stocks.

The physical components of the model simulate the natural sedimentation process on an annual basis, and over a number of user-described depth ranges. Superimposed on this, dredged material disposal operations may also modify the area within depth categories, alter finescale bathymetric features (bumpiness), and possibly introduce new material types (such as gravels) to the bottom.

It is now apparent that this model may have uses beyond sediment and disposal analyses. Application and updating of the model for sediment, disposal, and other analyses, such as drawdown scenarios, is in progress. Subsequent revisions of the Simulation Model will be calibrated to make more accurate quantitative predictions about how the ecological processes controlling each significant component will interact to affect the overall behavior of the system in terms of valued salmonid and resident fish population dynamics exposed to habitat manipulation by dredge removal/disposal and entire reservoir drawdown. More recent information, collected by the University of Idaho, suggests that a greater emphasis needs to be placed on the quantification of possible impacts to: 1) white sturgeon rearing and feeding; and 2) trophic relationships and, in particular, the importance of crayfish. These additions to the Simulation Model will also be required to analyze the removal process of dredging activity upstream from RM 120, as well as the disposal process of dredge spoil downstream from RM 120.

f. <u>Water Quality Studies</u>.

The Corps, Walla Walla District, presented findings from water quality samples taken during the 1988 dredging operation at the July, 1988 IWG meeting. Overall, it appears that in-water disposal has limited immediate impacts on the water column. Suspended solids concentrations were high only in the immediate area of the disposal, and only in the bottom water layer. Although reductions in dissolved oxygen occurred, they did not cause impacts in the area sampled. Nutrient loading appears to be minimal, with the possible exception of ammonia during the first event.

(1) Sediment.

Chemical analyses of sediment in the Snake and Clearwater confluence area indicate that heavy metal and organic concentrations are typical of sediments in this region.

(2) Dredge Monitoring.

During the dredging activity near the confluence in January through March of 1986, water quality in the Snake River was monitored in order to assess the magnitude of the impacts caused by dredging and potential disposal activities. Turbidity created by the dredge barge was negligible at a point about 300 ft downstream. The excess of turbidity was very slight and within the normal daily fluctuations of the ambient levels. Turbidity downstream of the retention ponds increased with the length of the project, as expected, due to decreased retention capacity of the holding ponds. Plume studies indicated the effluent was fairly well mixed into the water column after leaving the discharge pipe.

(3) Disposal Monitoring.

During January and February of 1988, dredging and in-water disposal were conducted. As no in-water disposal operation had been attempted prior to this work at Lower Granite, a program was initiated to monitor the water column loading occurring at the disposal site, and to determine the transport of material outside of the disposal area. The objectives of the monitoring were to determine the spatial extent of the turbidity plume generated from in-water disposal, the peak concentrations of suspended solids in the plume, the change with time of turbidity below the disposal site, the mixing effects of the disposal, the release of orthophosphate and ammonia, and the effect of disposal on ambient dissolved oxygen. Sampling was also conducted to ensure compliance with water quality certification standards.

During the dredging and in-water disposal activity in January to March 1989, material disposal and rehandling was monitored at the island site to quantify water column loading and transport of material outside of the disposal area. In-water disposal appears to have limited immediate impacts upon the water column. Suspended solids concentrations were high only in the immediate area of disposal, and the greatest concentrations were found in the bottom water layer. The rehandling operation (to build Centennial Island) appeared to have minimal suspended solids and turbidity effects on the water column. Minor water column loading of heavy metals, dichlorodiphenyltrichloroethane (DDT) and breakdown products, and nutrients occurred in the immediate area downstream of the rehandling operations. Concentrations were well below U.S. EPA chronic freshwater quality criteria, and should not be harmful to aquatic life. In-water disposal and rehandling appeared to have no effect on reservoir transparency and turbidity outside of the immediate area of disposal. Additional monitoring of in-water events has occurred.

(4) Contaminant Investigations.

Chemical analysis of both the sediment and the gravel bar material downstream of the Snake and Clearwater confluence area indicates that heavy metal, pesticide, and organic concentrations are typical of sediments in this region.

(5) Dioxin Testing in 1992.

The Battelle/Marine Sciences Laboratory conducted a study to measure the concentration of dioxins in sediment that was to be dredged from Lower Granite Reservoir near Lewiston, Idaho. Some chlorinated dioxin congeners were detected in all 9 of the 33 sampling stations analyzed. The Concentrations were similar to background concentrations. No samples showed concentrations of 2,3,7,8 tetrachlorodibenzodiooxin (TCDD).

g. USFWS Evaluation Report.

The scope of work was intended to cover both qualitative and quantitative impacts on fish and wildlife, recommend mitigative actions, and identify opportunities for enhancement of fish and wildlife resources. At this point, the report lacks the required quantitative information. The report has not been reviewed by other agencies, and should be reviewed before it is used.

6.05. ALTERNATIVE AND OPTION FINDINGS TO DATE.

a. Alternatives Eliminated from Detailed Study.

As a result of input from the IWG and others, the scope of the feasibility level study has been expanded to seriously consider all alternatives identified in the reconnaissance level analysis, except for the removal of Lower Granite Dam and the construction of an upstream sediment storage facility.

Instream structures placed within the reservoir, or channel modifications (*e.g.*, underwater foils or other river training devices), may be effective for localized control of sediment deposition, especially around port facilities. They may provide navigation channel depths and sediment transport through a specific reach. However, backwater profiles could be raised by such modifications. They should not significantly impact maintenance dredging costs.

It is anticipated that these structures will be inefficient for transporting sediment to below RM 120 (20 mi) and probably not a feasible long-term solution to the sediment problem. The plan formulation process may identify a preferred solution that leaves a localized sedimentation problem. Such a problem would be best handled with in-water structures. However, because some dredging is likely with any alternative plan, and dredging of all material in the confluence is equally effective for maintaining levee free-board requirements, it is unlikely that in-water structures will be justified unless they reduce long-term dredging requirements.

b. Dredging Window.

(1) Winter Dredging Window, December through March.

The December through March dredging time period is consistent with the in-water work window evaluated in the *Lower Granite Environmental Impact Statement Final Supplement No. 1 - Interim Navigation and Flood Protection Dredging (EISFS)*. This dredging time period minimizes the risk to valued environmental resources, while still providing sufficient time to accomplish dredging in an economical manner.

The December through March in-water work window necessitates a long-range outlook, and an annual dredging program focused on the average sediment inflow. If dredging is deferred until a large sediment inflow occurs, the Corps would require a correspondingly longer in-water work window. Due to the potential negative impacts of an extended window on fishery resources, it appears more prudent to concentrate on alternatives that include an annual program.

In reality, an annual dredging program would achieve gains in levee freeboard at the design discharge during some years, but in other years those gains could be lost. The spring and summer run-off period, following the winter dredging, may bring in enough sediment to completely negate any improvement made during the previous dredging operation.

The peak fishing effort (steelhead) in the confluence area occurs in December. The Idaho Interagency Working Group was concerned about angler safety, with respect to the wake produced by barges moving between the dredging and disposal areas. There have been no complaints by anglers, or other recreational boaters, during previous dredging operations in the Lower Granite Reservoir.

(2) Summer Dredging Window.

A late summer dredging window was suggested by the Corps for the summer of 1988, but was not implemented due to concerns for adult fish migrating upstream. A late summer dredging period was desirable for several reasons, including better weather, more efficient working conditions, and a more favorable period for budgeting purposes. The following are the most important considerations:

- The late summer dredging period arrives just after high spring and summer flows bring in their annual sediment load. During an unusually high flow year, the sediment may significantly reduce the levee freeboard, interfere with shipping lanes, or even close down one or more port areas. A summer window allows an immediate response and correction of those conditions that would otherwise persist until the next scheduled dredging period.

- Late summer is the period of reliable, uniform, low flows. In contrast, the winter dredging period is subject to unpredictable winter freshets, which result in increased sediment resuspension during dredging, downstream drift during disposal, and refilling of the dredged site. This makes the accurate determination of dredged quantities difficult and reduces the effectiveness of the dredging effort. Negative effects include the interference with adult summer-run steelhead, and summer/fall chinook upstream migration.

c. Interim Dredging.

Until a long-term remedial action plan is established, necessary interim dredging would involve dredging sediments, and may include original river bed material.

Dredging in gravel bar material during the interim dredging period was not recognized during the original design of the in-water disposal test because it was projected that hydraulic equipment would be used. Based on dredging experience and test pit excavations, it is now apparent that a dredging template of mixed sediment and gravel bar material is the most likely dredging format for the long-term remedial action plan. The removal of gravel bar material would be necessitated by excavation to a specific template.

The subgroup members to the IWG, which advised the Corps on the Sedimentation Study, could not identify any significant environmental problems associated with the dredging of gravel bar materials, to date.

d. Dredging and Levee Raise Alternatives.

Based on past contracts, the equipment and method of dredging is predicated on the disposal site. Contractors have indicated that pipeline dredging is economical for disposal sites within 3 mi of the dredging operation. Disposal sites beyond that would dictate the use of a clamshell dredge and scows, for transportation. Installation of a semipermanent staging or stockpiling facility, in-water or upland, within 3 mi of dredging, will be considered for distant disposal sites.

Based on past reports and HEC-6 modeling results, five representative alternatives will be presented during the EIS scoping process. Disposal, reservoir drawdown, and land treatment options will be evaluated for each alternative. The following represent the range of levee raise and dredging possibilities:

- Raise Levee 12 Ft, No Dredging
- Dredging Only, No Levee Raise
- Dredging With 7-Ft Levee Raise
- Dredging With 5-Ft Levee Raise
- Dredging With 3-Ft Levee Raise

e. Disposal Alternatives and Options.

(1) In-Water Disposal Options, Lower Granite Reservoir.

In-water disposal within Lower Granite Reservoir will most likely be a combination of deep-water disposal, mid-depth and shallow-depth disposal, and the creation of islands, beaches, or sand dunes. The combination and configuration of in-water disposal will be evaluated during the EIS scoping process.

(2) Upland Disposal, Lower Granite Project.

Future years of upland disposal depend on the identification of suitable disposal sites for containment of dredged sediment. Due to the high-walled canyon character of the Snake River, limited land resources are currently available for upland disposal.

Based on past estimating, and communication with dredging contractors, costs increase dramatically for pumping dredge material more than 100 ft vertically.

Pumping, or hauling, sediment up to perched lands above the reservoir presents a problem if the lands are fee-owned sites allocated to wildlife management. Since mitigation requirements under the Lower Snake River Fish and Wildlife Compensation Plan have not yet been met for many terrestrial species, the burial of productive areas with sand and silt (similar to that done at the Wilma disposal site in 1986), may render the areas useless to wildlife. This may require acquisition of additional off-project lands, in order to replace lost habitat and meet mitigation requirements. Currently, no authorization for acquisition of additional lands exists.

Roller compacted concrete retention dams, select sand containment dikes, and rockfill containment dikes were considered. Preliminary studies indicate that the select sand containment dike option is less expensive, but due to concerns regarding sloughing, the rockfill dike may be preferable.

(3) Downstream Disposal Sites.

Downstream disposal sites are considered for use in the extended long-term (beyond the assumed project life of year 2074). Also, upland disposal sites within the Lower Granite Project are limited, and it may be necessary to utilize disposal sites downstream of Lower Granite Dam.

Potential downstream in-water disposal sites are identified in all reservoirs below the Lower Granite Project. The most downstream sites are in Lake Wallula (McNary Project). The farthest, 159 statute mi from the Snake and Clearwater confluence, is along the left bank near Juniper Canyon. All sites for waterfront development (with the exception of in-water and upland disposal at Kennewick and Pasco, Washington) would be developed for mid-depth, shallow-depth, the creation of islands, and primitive beach area.

The upcoming EIS will be the first extensive evaluation of these sites for beneficial habitat.

The total combined disposal volume, downstream from the Lower Granite Project, is estimated at about 123 myd^3.

f. Reservoir Drawdown (Option with Alternatives).

Annual drawdown of Lower Granite Reservoir, to the spillway crest of Lower Granite Dam, can be considered as a means of reducing the levee raise alternative and/or annual dredging. Implementation of such a drawdown is under investigation in the mitigation analysis studies, and the analysis of physical data collected during the 1992 Lower Granite Drawdown Test.

Some sediment could be moved by an annual, 2-month drawdown period during the peak of the runoff hydrograph, when the pool would be near a free flow condition, with all spillway gates open. The technical advisory group, with the SOR and the SCS process, is also considering a 4.5-month drawdown period. A drawdown would temporarily increase flow velocities in the upper reservoir, carry the suspended sediment farther into the pool, shift a portion of the deposited sediment farther downstream, and carry more fine suspended sediment through the reservoir. The estimated effects of a drawdown, in combination with several of the previously described alternatives, are detailed below.

- If reservoir drawdowns to spillway crest were conducted annually, the proposed 12-ft levee raise alternative could be reduced to a 5-ft levee raise. This conclusion is based on direct HEC-6 modeling results.

- The dredging-only alternative requirements, with annual reservoir drawdown, could be reduced by about 50 percent (from 1.3 myd^3/yr to about 0.7 myd^3/yr. Additional mathematical modeling is necessary to confirm this theory.

- It may be possible to eliminate the 7-ft levee raise with annual reservoir drawdown, while still retaining a modified dredging plan, by concentrating on the reach downstream of Red Wolf Bridge. Annual dredging quantities would likely remain at a level of 0.53 myd^3/yr. Reservoir testing indicates that this area is the most productive netting area for sturgeon.

- If there is an annual reservoir drawdown, it is likely that the 3-ft levee raise would not be necessary. However, annual dredging would be a requirement. A determination of the annual dredging requirement will need additional studies.

- If there is an annual reservoir drawdown and no dredging, a 5-ft levee raise would be needed. This conclusion is based on direct HEC-6 modeling results.

g. Land Treatment (Non-Structural Option).

Implementing land treatment programs could potentially reduce future sediment inflow. The effectiveness of various programs is difficult to predict. Because of the ownership of the erodible lands, and the portion of erosion that is not treatable, only limited reductions in sediment inflow are considered realistic. The magnitude and costs of other actions required, particularly maintenance dredging, might be reduced by implementing erosion control programs.

The Corps agrees with the SCS's view that sedimentation problems would be obviated if the sediment could be dealt with at its point of origin.

h. <u>Wawawai Road Fill</u>.

The Port of Whitman County would like to see the road from Wawawai Canyon to Lower Granite Dam constructed along the Snake River shoreline. Construction of this road is under consideration in other studies as a mitigation measure for loss of navigation, because of the possible annual drawdown of Lower Granite Reservoir. However, it may be less costly to use dredged sand from the confluence to construct the fill embankment for this road. The suitability of this material for such construction will be evaluated in the upcoming feasibility report.

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SECTION 7 - PLAN OF STUDY

7.01. GENERAL.

The plan of study discussed in this section is for Fiscal Year (FY) 1993 through FY 1996. The problem description, present and future conditions, impacts, prior studies and agency coordination, and interim dredging were discussed in previous sections of this progress report.

The objective of the study is to assess the economic, engineering, environmental, and social aspects, as well as impacts of various alternatives for recovering and maintaining the designed levee flood protection at Lewiston, Idaho. Study purpose and scope were discussed in section 1.

7.02. PROPOSED STUDIES.

a. Alternatives.

The following alternatives have been identified as potential solutions, and will be considered singularly, as well as in combination, during the remainder of this study.

(1) Dredging Alternatives.

Dredging alternatives would include initial excavation to a design template, and dredging at regular intervals to maintain various levels of protection over the life of the project. This may involve dredging original bed materials that were in place before the reservoir was raised, in addition to the removal of constantly accumulating sediments. The transport of accumulated sediment will also be examined.

(2) Disposal Alternatives.

(a) Upland Disposal.

Upland disposal of dredged sediment, on land and at sites within the Lower Granite Project area, will be evaluated.

(b) In-Water Disposal.

In-water disposal within Lower Granite Reservoir would be located in deep water downstream of RM 120, or placed along the shorelines to create mid-depth and shallow-depth habitat. Creation of islands will be considered.

(c) Downstream Disposal.

In-water and upland disposal sites downstream of Lower Granite Dam will be investigated to identify potential disposal options for the distant future.

(3) Reservoir Drawdown.

An annual reservoir drawdown could significantly change flow conditions and, therefore, transport incoming sediment through critical areas and scour previously deposited sediments. Effects on turbidity, navigation, and aesthetics will be evaluated.

(4) Levee Raise.

Raise the levees to provide an adequate level of freeboard protection. Levee raises of 12, 7, 5, and 3 ft will be evaluated.

(5) No Action Alternative.

Determine the future rate of sediment deposition, and its impact on navigation and flood control without corrective action.

(6) Land Treatment.

Determine the impact, to other alternatives, of reducing sediment inflow by land treatment at the sediment source.

b. Engineering Studies.

(1) Hydrologic and Sedimentation Studies.

Studies are ongoing, and will continue to verify the rate of sediment inflow and deposition patterns. Sedimentation studies, using the HEC-6 computer program to model sediment transport through the reservoir and make backwater computations, will be ongoing.

The various alternatives and option combinations will be evaluated to determine impacts on sediment deposition, and the resulting impact on levee freeboard. The sediment studies will determine the dimensions, frequencies, durations, quantities, and locations needed by each alternative for it to maintain various levels of protection for the life of the project. SPF profiles will be provided for each alternative.

The SCS conducted a field evaluation to determine the nature of the erosion and sedimentation conditions that contribute to the reduction of channel capacity in Lower Granite Reservoir. It is a preliminary report, and assesses the potential erosion reduction through implementation of the 1985 Food Security Act. The report should be updated to evaluate Conservation Reserve Program (CRP) signups, update the projection of sediment delivery, and include the effects of other US Department of Agriculture (USDA) programs.

(2) Design and Cost Estimates.

Design and cost estimates are planned as an extension of work completed in reconnaissance level analyses. Seasonal, equipment-type, disposal location, and potential operational restrictions will be considered, where applicable. Disposal site development and maintenance will also be considered, where applicable. Levee raise alternatives will consider various heights, including modifications of improvements such as roads, bridges, railroads, interior drainage facilities, barge-loading facilities, and levee beautification features.

c. Environmental Studies.

(1) In-House Studies.

Environmental studies will identify and evaluate both the short- and long-term effects, on the environment, of implementing each alternative plan. One specific issue that needs to be addressed is the long-term effect on the aquatic environment. The effort will result in an EIS. Development of the EIS is not only required by law, but is the instrument for presenting alternative economics, environmental impacts (both positive and negative) of alternatives. It also documents public input and comment on proposed alternatives and plans.

(2) EIS Development.

The Corps of Engineers will carry out its responsibility for the Lower Granite Sedimentation Study, as directed by legislative and executive authorities, by the following actions:

- Considering carefully, and seeking to balance the environmental and development needs of the region, in full compliance with the National Environmental Protection Agency (NEPA) and other authorities promulgated by Congress and the Executive Branch.

- Examining and evaluating environmental values fully, along with economic, engineering, and social factors, when studying alternative means of meeting the flood control needs of Lewiston, Idaho and Clarkston, Washington.

- Utilizing the best available interdisciplinary environmental knowledge and insight in the planning, development, and management of the Lower Granite waters and related land resources.

- Considering all practicable and justifiable means and measures for solving water resource problems, with a view toward selecting the solution that best satisfies identified regional needs, while at the same time protecting the quality of the environment.

- Encouraging broad public participation, early in the planning process, to define environmental problems and elicit public expression of needs and expectations. Local, state, and other Federal agencies are contacted early for their views and provided with timely information on the social, economic, engineering, and environmental considerations involved, before making recommendations on dredging and disposal options.

- Identifying, early in planning studies, significant environmental resources and values that would likely be impacted, favorably as well as adversely, by alternatives being considered. All plans formulated will avoid, to the fullest extent possible, any adverse impacts on these resources. Any significant adverse impacts that cannot be avoided will be mitigated to the extent justified.

(3) USFWS Coordination.

The USFWS will complete an evaluation of the effects of alternatives on fish and wildlife. Initial efforts will focus on the effects resulting from the implementation of each action, in an effort to aid in refining the alternatives.

(4) Habitat Evaluation Procedures.

Mitigation measures for the Lower Snake River Compensation Plan have not yet been met for many terrestrial species. The burial of productive areas with sand and silt may render the areas useless to wildlife. Studies are necessary to determine potential acquisition of additional off-project lands, in order to replace lost habitat and meet mitigation requirements. Currently, no authorization for acquisition of additional lands exists.

(5) Reservoir Monitoring Fish Community Activity.

Since 1988, continuous monitoring of fish and benthic communities has been conducted by the USFWS, and the Idaho Cooperative Fish and Wildlife Research Unit from the University of Idaho. Disposal, in 1992, basically completed the in-water disposal test sites. Each test site, following disposal, must be monitored to provide a minimum of two years of data collection to adequately assess the potential for long-term impacts. Monitoring is currently in progress, and is planned to continue through 1994.

(6) Reservoir Dredge/Disposal Simulation Model.

In July of 1987, ESSA was contracted to facilitate implementation of the AEAM process and develop the ecological monitoring program for the in-water disposal test.

The Lower Granite Reservoir Simulation Model is a computer program that synthesizes information about different components of the reservoir and their interactions, and makes quantitative predictions about how the processes controlling each component will interact to affect the overall behavior of the system.

It is now apparent this model may have uses beyond sediment and disposal analyses. Application and updating of the model for sediment, disposal, and other analyses (such as drawdown) are in progress and will continue in FY 1993 and FY 1994. The model may provide a basis for adapting future data collection efforts and managing future disposal.

d. Social and Cultural Studies.

Studies will assess the impacts of the various alternatives and plans on aesthetics, social acceptance, and cultural resources. Work will be coordinated with appropriate Federal and state agencies, Indian tribes, and other interested groups.

7.03. AGENCY AND PUBLIC INVOLVEMENT.

Participation in the study by environmental concerns is essentially continuous through the IWG. Involvement by other groups is planned in accordance with the NEPA process. An EIS scoping meeting is scheduled for FY 1994. Public meetings are scheduled for FY 1996, to comment on the draft EIS.

7.04. FUNDING SUMMARY.

Total study costs are estimated at $3.1 million. Costs tabulated below include funding for all study activities leading up to the final report and EIS. Funding requirements for hydrology studies and interim dredging are not shown since they are budgeted separately. Costs and funding requirements (projected) by FY are:

FY 1987	$ 385,000	
FY 1988	358,000	
FY 1989	409,000	
FY 1990	217,000	
FY 1991	246,000	
FY 1992	402,000	
FY 1993	450,000	(Projected)
FY 1994	520,000	(Projected)
FY 1995	110,000	(Projected)
FY 1996	50,000	(Projected)
TOTAL	$3,147,000	

7.05. PLAN OF STUDY SCHEDULE.

The completion schedule for the plan of study is shown in table 2.

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Ongoing hydrologic studies will continue to verify the rate of sediment inflow and deposition patterns. Sedimentation studies, using the HEC-6 computer program to model the sediment transport through the reservoir and make backwater computations, will continue beyond the completion of the scheduled feasibility report and EIS. These studies are necessary to monitor the continually changing reservoir conditions.

Environmental decisions made for the scheduled EIS will need to be reconsidered in the future. The long-term effects of the recommended plan on the environment can only be forecasted. Both positive and negative impacts should be reaffirmed in the future.

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SECTION 9 - COORDINATION

9.01. PUBLIC INVOLVEMENT.

Participation in the study by environmental concerns is essentially continuous through the multi-agency task force identified below. Involvement by other groups is planned in accordance with the NEPA process. Public information briefings are planned to update local residents and communities on status, to provide an opportunity for comment on interim findings and recommendations, and to comment on the EIS supplement.

9.02. AGENCY INVOLVEMENT.

a. IWG.

Due to the strong negative reaction of resource agencies to the reconnaissance-level report recommendation to implement dredging as a permanent solution, and the sensitive nature of the fisheries and related aquatic habitat in Lower Granite Reservoir, a multi-agency task force called the Interagency Working Group was formed in late 1986. The IWG was formed to advise the Corps of Engineers regarding environmental aspects of the study. The IWG includes the following agencies, organizations, and tribes:

- American Waterways Operators, Inc.
- Columbia River Inter-Tribal Fish Commission (CRITFC)
- Columbia River Towboat Association
- Confederated Tribes and Bands of the Yakima Indian Nation
- EPA
- USFWS
- Idaho Department of Fish and Game
- Idaho Department of Health and Welfare
- National Marine Fisheries Service (NMFS)
- Nez Perce Tribe of Idaho
- Oregon Department of Environmental Quality
- Oregon Department of Fish and Wildlife
- SCS
- Washington Department of Ecology (Ecology)
- Washington Department of Fisheries
- Washington Department of Game

As a result of input from the IWG and others, the scope of the feasibility-level study has been expanded to seriously consider all alternatives identified in the reconnaissance-level analysis, except for the removal of Lower Granite Dam and an upstream sediment storage facility. The environmental agencies were unwilling to commit to implementing any alternatives on more than an interim basis, unless the Corps satisfies all of the following:

- Document that the sedimentation problem is real, and that the impacts of doing nothing are unacceptable.

- Document that any recommended alternative will effectively resolve the problem.

- Document that any recommended alternative will not have adverse impacts on the environment, particularly the anadromous fishery.

- Document that any recommended alternative will not cause a net loss of environmental resources.

The Corps, Walla Walla District, purpose in organizing and cooperating with the IWG was to:

- Provide a simple structure for coordinating with the many and diverse agencies interested in the problem and potential solutions.

- Obtain agency input on the selection and design of environmental studies necessary to sufficiently document anticipated impacts.

- Secure agency cooperation for implementing a reasonable solution.

- Ensure that actions proposed by the feasibility study will minimize detrimental effects on the valued natural resources.

The major concern of the resource agencies was the proposed dredging and disposal of sediment within the reservoir. The basis of concern is the uniqueness of Lower Granite Reservoir as a freshwater reservoir, with a substantial anadromous fish run. The agencies believe that few, or no, precedents exist for dredging and disposal within such an environment. To adequately address the uncertain environmental effects of long-term disposal in the reservoir, the Corps, Walla Walla District, has worked with the task force to develop a 5-yr test program for an evaluation of the effects and potential benefits from in-water disposal of dredged material. That program forms a major portion of this study.

The IWG represents a significant effort to more fully involve other agencies in the planning process. An independent facilitator was contracted due to the necessity of reestablishing and maintaining credibility with the environmental agencies. The Interagency Working Group played a major role in the development of the in-water disposal test, and coordination with the group is largely responsible for the state water quality certification of the disposal test dredging.

b. IWG History of Proceedings.

The first coordination meeting held with the agencies and tribes associated with the Lower Granite Sedimentation Study occurred in January 1985. This meeting was held as a followup to a November, 1984 CENPW letter to involved agencies and tribes, by asking for input to the reconnaissance study due in spring 1985, and the feasibility study in spring 1986. It specifically addressed activities for the proposed 1986 dredging effort. Key topics at that meeting included discussion of:

- loss of shallow water habitat
- potential sediment contamination
- dredging and disposal window
- adequate fishery evaluation
- all alternatives identified
- water quality (plume, migratory block/delay)

In February, 1985, contract action was initiated for a fishery evaluation of Lower Granite Reservoir (through Dr. David Bennett, University of Idaho). Dr. Bennett began monitoring activities in April, 1985 to November, 1986 (Bennett and Shirer, 1986).

Agency involvement accelerated during this time period, due in part to the response to the Corps, Walla Walla District, actions involving the use of the Wilma Wildlife HMU as an upland disposal site for the January to March, 1986 dredging event. The need for long-term planning for the life of the sedimentation study was recognized, and because of the sensitivity of environmental issues involved, an Interagency Working Group was established to evaluate impacts, beneficial uses, scoping for long-term solutions, and other environmental guidance on all alternatives identified. In April, 1986, a coordination meeting was held to address the following issues:

- need for dredging
- need for SPF
- selection of alternatives
- coordination for 1987 dredging
- recommended formation of Interagency Working Group

Comments to the draft reconnaissance study distributed in 1986 raised strong objections to the conclusions in the report, largely due to the limited consideration of environmental issues in the evaluation of alternatives. The District expanded the scope of the proposed feasibility-level study, to include consideration of all alternatives identified in the reconnaissance-level analysis, except for the removal of Lower Granite Dam and the construction of an upstream sediment storage facility.

A December, 1986 IWG meeting reviewed the following:

- 15 issues/problems, and the level of priority for each
- role of the IWG
- project review
- in-water disposal plan
- biological investigations
- ecosystem approach to evaluation

In January, 1987, the Interagency Working Group met to discuss the conceptual model approach (ecosystem model), developed by Waterways Experiment Station personnel under a Dredging Operations Technical Support request. An IWG meeting in February of 1987, focused on the role of the IWG, the history and status of sedimentation, and study alternatives. At this meeting, a subgroup was established to handle the technical issues of scopes of work, proposals, and other actions. The subgroup was comprised of a representative from the USFWS, NMFS, Washington Department of Fisheries, the Yakima Tribe, and the Corps. The first subgroup meeting was held in March, 1987, to begin discussion on the proposed in-water disposal test.

In April, 1987, Dr. Bennett began a year-long evaluation of fish and benthic community abundance at proposed in-water disposal sites. This effort was to characterize the physical habitat, and assess seasonal dynamics of fish and benthos prior to in-water disposal. The study also included a fish and habitat evaluation of shallow-water habitats within the reservoir (Bennett *et al.*, 1988).

Two multiple-day workshops with the IWG and other technical experts were held in July and August, 1987, to provide input toward the development of hypothesis testing and test design for the in-water disposal test (Sonntag *et al.*, 1987, and Webb *et al.*, 1987). In September, 1987, the IWG met to review the in-water test schedule, design development for the in-water events, and criteria for evaluating test results. Two additional meetings were held with the subgroup during this time period.

Dr. Bennett began the first year of disposal monitoring in April, 1988, following the first in-water disposal event in January to March, 1988 (the creation of a submerged plateau). Several reference sites, and upper reservoir shallow water sites, were included in his study (Bennett *et al.*, 1990).

The IWG met in July, 1988, to review the status of all ongoing studies and to discuss future in-water disposal test actions.

In September, 1988, Dr. Bennett presented the results of the in-water disposal monitoring, and the potential to enhance fish habitat in Lower Granite Reservoir at the Effects of Dredging on Anadromous Fishes on the Pacific Coast Workshop (Bennett *et al.*, 1990a.).

In January, 1989, a 2-day scoping meeting with the subgroup, and other technical representatives, was held to review the first year's monitoring results, and the design for the second year. Statistical design concerns, and the development of the scope of work for year two, were the main topics focussed on at the meeting. Later in January, a 2-day technical workshop was held to develop the bounds for the conceptual model. This was followed by two concurrent subgroup sessions; one focusing on habitat and benthos, and the other on fish populations (Webb and Robinson, 1989).

In April, 1989, Dr. Bennett began the second year of aquatic monitoring following the second in-water disposal event, the creation of the island (Bennett *et al.*, 1991). A contract was initiated with BioSonics, Inc. to conduct hydroacoustic mobile surveys to evaluate the distribution and abundance of fish in Lower Granite Reservoir. Dr. Bennett was to provide the groundtruthing to the hydroacoustics estimates generated by BioSonics, Inc. (Thorne *et al.*, 1992).

The IWG next met in June, 1989, to review the in-water disposal test study, and to get a status update on all other sedimentation studies underway.

The subgroup, and other technical representatives, met in December, 1989, to discuss the monitoring program for year three, as well as other related study questions (Webb, 1990).

Dr. Bennett began the third year of monitoring in April, 1990. Dredging did not occur in 1990, due to limited funding. However, for continuity of the data base, Dr. Bennett was contracted to continue with the ongoing monitoring effort (Bennett *et al.*, in preparation). Dr. Bennett presented further findings of the monitoring study, and the potential for fish habitat enhancement, at the Beneficial Uses of Dredged Material Workshop in May, 1990 (see Bennett *et al.*, 1990b.).

No dredging or disposal events occurred in 1990.

Efforts in 1990 focused on the development of the conceptual model into the simulation model (Robinson and Webb, 1990a. and 1990b.; and Robinson, 1991).

The fourth year of monitoring for the in-water disposal test began in April, 1991. Again, no dredging or disposal events occurred in 1991. Dr. Bennett continued monitoring activities to provide continuity with the efforts of the previous year. Additional focus was placed on sturgeon distribution and abundance, and fall chinook distribution and rearing. A December meeting was held with the Interagency Working Group to review studies to date, to overview the upcoming 1992 dredging and disposal activities, and to discuss the upcoming EIS scoping effort for the long-term management plan for the sedimentation study.

From January to February, 1992, the third disposal event occurred (deep-water site). Dr. Bennett commenced the fifth year of monitoring. This year of data will be of particular interest (and probable complexity), due to the 1992 drawdown test at Lower Granite Dam in March, 1992. The drawdown test appeared to significantly alter some aspects of the aquatic community that Dr. Bennett had been studying since 1987, particularly that of the resident and benthic communities. Dr. Bennett conducted intensive surveys prior to, during, and following the drawdown, in addition to monitoring activities scheduled under the sedimentation studies (Bennett *et al.*, in preparation).

The subgroup met in September, 1992, to discuss the simulation model and its application to the alternatives to be developed during the EIS scoping effort. The full IWG met to discuss the EIS effort in December, 1992.

9.03. AGENCY CORRESPONDENCE.

The following summarizes agency correspondence regarding this study, but particularly the disposal test portion.

a. Columbia Basin Fish and Wildlife Authority (CBFWA).

In a November, 1988 letter, the CBFWA advised the Corps that the Fish Passage Advisory Committee had concluded that dredging and in-water disposal, beyond March 15, was not justified for constructing the island test disposal site. They also requested that priority be placed on the island and mid-depth disposal tests versus the deep-water test.

b. CRITFC.

In an August 1, 1989 letter addressing a public notice on proposed 1990 Lower Granite Interim Navigation and Freeboard Maintenance Dredging, CRITFC recommended the CBFWA in-water work window presented above. The CRITFC expressed concern that the use of original riverbed material did not represent expected conditions, and would influence the long-term test results. They recommended dredging sand and finer materials only. The CRITFC also questioned the need for annual dredging. The CRITFC was not opposed to interim dredging and disposal activities as long as these activities were consistent with the biological monitoring and evaluation program.

c. EPA.

In a December 6, 1988 letter, the EPA commented on the Final Supplemental EIS for the Lower Granite Interim Navigation and Flood Protection Dredging. They stressed that the acceptability of the interim 5-year monitoring plan design, including interim dredging, hinges upon completion of the monitoring program, as defined by Webb *et al.*, 1987. They also suggested that the results of the program will contribute toward a long-term solution.

In a July 27, 1989 letter addressing a public notice on proposed 1990 Lower Granite Interim Navigation and Freeboard Maintenance Dredging, the EPA expected monitoring of the disposal test sites to continue in spite of funding constraints. The EPA warned that the 1990 dredging event would complete the test site construction, and that further in-water disposal to maintain freeboard should not be assumed. Investigation of other alternatives should now begin in earnest to avoid potential confrontations in the future.

d. Latah Soil Conservation District.

In a September 21, 1988 letter, the Latah Soil Conservation District requested written support of the implementation of the Middle Potlatch Creek Water Quality Project. The project could potentially reduce the amount of sediment entering Lower Granite Reservoir, and may reduce long-term sediment removal requirements. The Corps response was supportive.

e. NMFS.

In a July 28, 1989 letter addressing a public notice on proposed 1990 Lower Granite Interim Navigation and Freeboard Maintenance Dredging, NMFS questioned the suitability of dredging original riverbed materials and the need for dredging in 1990. The NMFS argued that original riverbed material is not representative of accumulating sediments and is, therefore, not appropriate in assessing a long-term plan. They also stated that their acceptance of the interim dredging and in-water disposal program was contingent upon the conduct of the monitoring program to evaluate impacts, and that they would oppose in-water disposal in Lower Granite Reservoir that was not directly related to the monitoring effort.

f. Ecology.

In a September 28, 1987 letter providing water quality certification for the 1988 dredging effort, Ecology stated that the certification was, among other conditions, contingent upon a monitoring plan, and was subject to a limitation on in-water activities.

In an October 5, 1988 letter providing water quality certification for the 1989 dredging effort, Ecology stated that the certification was, among other conditions, contingent upon the continuation of the studies deemed necessary by the IWG to evaluate the short-term and potential long-term effects of in-water disposal of dredged material in Lower Granite Reservoir. Ecology also limited dredging and disposal to the December 15 through March 15 window, except that the movement of vessels associated with the dredging operation was restricted to the hours of darkness.

In a September 6, 1989 letter providing water quality certification for the 1990 dredging effort, Ecology stated that the certification was, among other conditions, contingent upon the continuation of the studies deemed necessary by the IWG to evaluate the short-term and potential long-term effects of in-water disposal of dredged material in Lower Granite Reservoir. The certification was also contingent upon no additional sources of material or potential contaminants being discharged or affecting the sediments within the dredge limits. They also limited dredging and disposal to the December 15 through March 15 window, except that dredging and related work shall not impact water quality to the impairment of local sport fishing.

In a September 6, 1989 letter on the Corps Section 404 permit for the 1990 dredging effort, Ecology acknowledged that the water quality certification was not an appropriate mechanism to control navigation, *i.e.*, limit barge traffic to night-time hours to prevent use conflicts with sport fishermen. Ecology asked the Corps, and its contractor, to minimize conflicts with the sports fisheries. Ecology encouraged the Corps to utilize the island test site as a test wildlife enhancement project, by developing habitat versus the proposal to allow the island to establish on its own with minimal plantings to prevent erosion. Ecology was not opposed to dredging original bed material provided evaluations were adequate. Ecology suggested that consideration be given to dredging a sediment trap, or sump, which would facilitate the use of large clamshell equipment and concentrate the area extent of dredging.

In a October 11, 1991 letter on the Corps Section 404 permit for the 1992 dredging effort, Ecology recommended the use of the same type of dredging equipment used in the 1990 effort. Ecology noted that the water quality certification is contingent upon the continuation of studies deemed necessary by the IWG to evaluate the short-term and potential long-term effects of the in-water disposal of dredged material in the Lower Granite Reservoir.

g. <u>State of Washington Department of Fisheries</u>.

In an August 1, 1989 letter addressing a public notice on proposed 1990 Lower Granite Interim Navigation and Freeboard Maintenance Dredging, the Department of Fisheries stated that while they approved of the in-water disposal as part of the monitoring and evaluation program, the test program should not be used to justify continued dredging. Dredging, for the sake of dredging, was not the intent of the program. They also stated a need for further investigation of sturgeon habitat preference and utilization before authorizing continued deep-water disposal. They considered the removal of original river bed material as premature. Their approval of the dredging was contingent upon continued Corps funding of the monitoring and evaluation portion of the test program, and the adaptive management concept.

In an October 16, 1991 letter addressing a public notice on proposed 1992 Lower Granite Interim Navigation and Freeboard Maintenance Dredging, the Department of Fisheries reaffirmed their previous concerns.

h. <u>State of Washington Department of Wildlife</u>.

In a September 6, 1988 letter, the Department of Wildlife objected to extending the construction window beyond January 1 through March 1.

In a July 25, 1989 letter addressing a public notice on proposed 1990 Lower Granite Interim Navigation and Freeboard Maintenance Dredging, the Department of Wildlife expressed concern about the impacts of dredging activities, including barging, on recreational fishing, and recommended that December activities be restricted to night work. They also requested that cover, other than grasses, be established on the island test site.

i. <u>SCS</u>.

In a July 26, 1989 letter addressing a public notice on proposed 1990 Lower Granite Interim Navigation and Freeboard Maintenance Dredging, the SCS strongly recommended that the long-term solution, including the EIS, should address the application of land treatment programs on basin cropland, in combination with other alternatives.

j. USFWS Evaluation Report.

Following the completion of the Draft 1986 Reconnaissance-Level Sedimentation Study, the Corps, Walla Walla District signed an interagency agreement with the U.S. Fish and Wildlife Service to prepare a fish and wildlife impact evaluation. The U.S. Fish and Wildlife Service was asked to investigate possible environmental consequences of three actions: 1) levee raises; 2) dredging and associated disposal activities; and 3) reservoir drawdown. The report has not been reviewed by other agencies, and should be reviewed before it is used.

LOWER GRANITE LOCK AND DAM
SEDIMENTATION REMOVAL FOR FLOOD CONTROL
DRAFT PRELIMINARY EVALUATION AND PROGRESS REPORT

SECTION 10 - REFERENCES

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b. Bennett, David H., J.A. Chandler, and L.K. Dunsmoor, 1990. *Lower Granite Reservoir In-Water Disposal Test: Results of the Fishery, Benthic, and Habitat Monitoring Program - Year 1 (1988)*. U.S. Army Corps of Engineers, Walla Walla District, Walla Walla, Washington.

c. Bennett, David H., L.K. Dunsmoor, J.A. Chandler, and T.Y. Barila, 1990a. *Use of dredged material to enhance fish habitat in Lower Granite Reservoir, Idaho-Washington*. In: Simenstad, C.A., ed. Effects of dredging on anadromous Pacific Coast fishes: workshop proceedings, Seattle, September 8-9, 1988. Washington Sea Grant Program, Univ. of Washington. 160 pp.

d. Bennett, David H., T.Y. Barila, J.A. Chandler, and G. Chandler, 1990b. *Use of dredged material to enhance fish habitat in the Lower Snake River, Idaho-Washington.* In preparation for Technical Report, Beneficial Uses of Dredged material, Proceedings of Interagency Workshop, San Diego, CA., May, 1990.

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b. Robinson, Donald C.E., and T.M. Webb, 1990. *A Simulation Model for the Lower Granite Reservoir: A User's Guide.*

c. Robinson, Donald C.E., and T.M. Webb, 1990. *Lower Granite Reservoir In-water Disposal Test, Design of a Simulation Model.*

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10.4. DOCUMENTS ON DREDGING ACTIONS ISSUED BY CORPS OF ENGINEERS, WALLA WALLA DISTRICT, AND OTHERS, SINCE 1984.

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10.5. <u>OTHER DOCUMETNS AND REPORTS</u>.

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n. U.S. Army Corps of Engineers, August, 1972. DM 29.3, *North Lewiston Levee*, with endorsements.

o. (HEC), October, 1971. Special Projects Memorandum No. 359, *Sediment Study on Clearwater River.*

TABLES

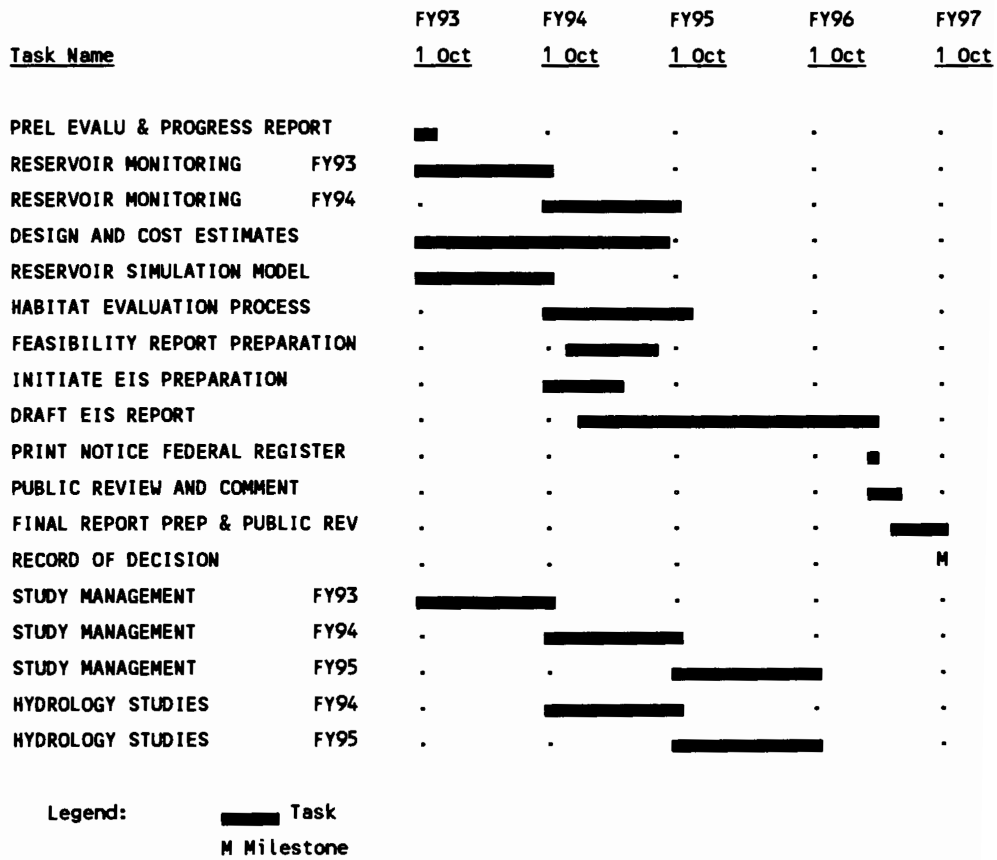
TABLE 1
MEASURED TOTAL SEDIMENT INFLOW INTO LOWER GRANITE RESERVOIR, 1972 THROUGH 1979

Year	Snake River Near Anatone, WA (tons)	Clearwater River at Spalding, ID (tons)	Total into Lower Granite Reservoir (tons)
1972	3,046,900	970,100	4,017,000
1973	252,800	36,300	289,100
1974	5,517,000	1,324,300	6,841,300
1975	2,254,500	480,100	2,734,600
1976	2,324,300	445,200	2,769,500
1977	28,000	34,300	62,300
1978	1,064,100	278,100	1,342,200
1979	453,600	215,200	668,800
Total	14,941,200	3,783,600	18,724,800
Percent of Total Sediment Inflow:			
	80%	20%	100%
Average Annual Sediment Inflow (tons):			
	1,867,600	473,000	2,340,600

Note: source of data is USGS, Idaho District, Water Resources Investigations Open File Report 80-690, Sediment Transport in the Snake and Clearwater Rivers in the Vicinity of lewiston, Idaho, August 1980, Tables 15 and 16.

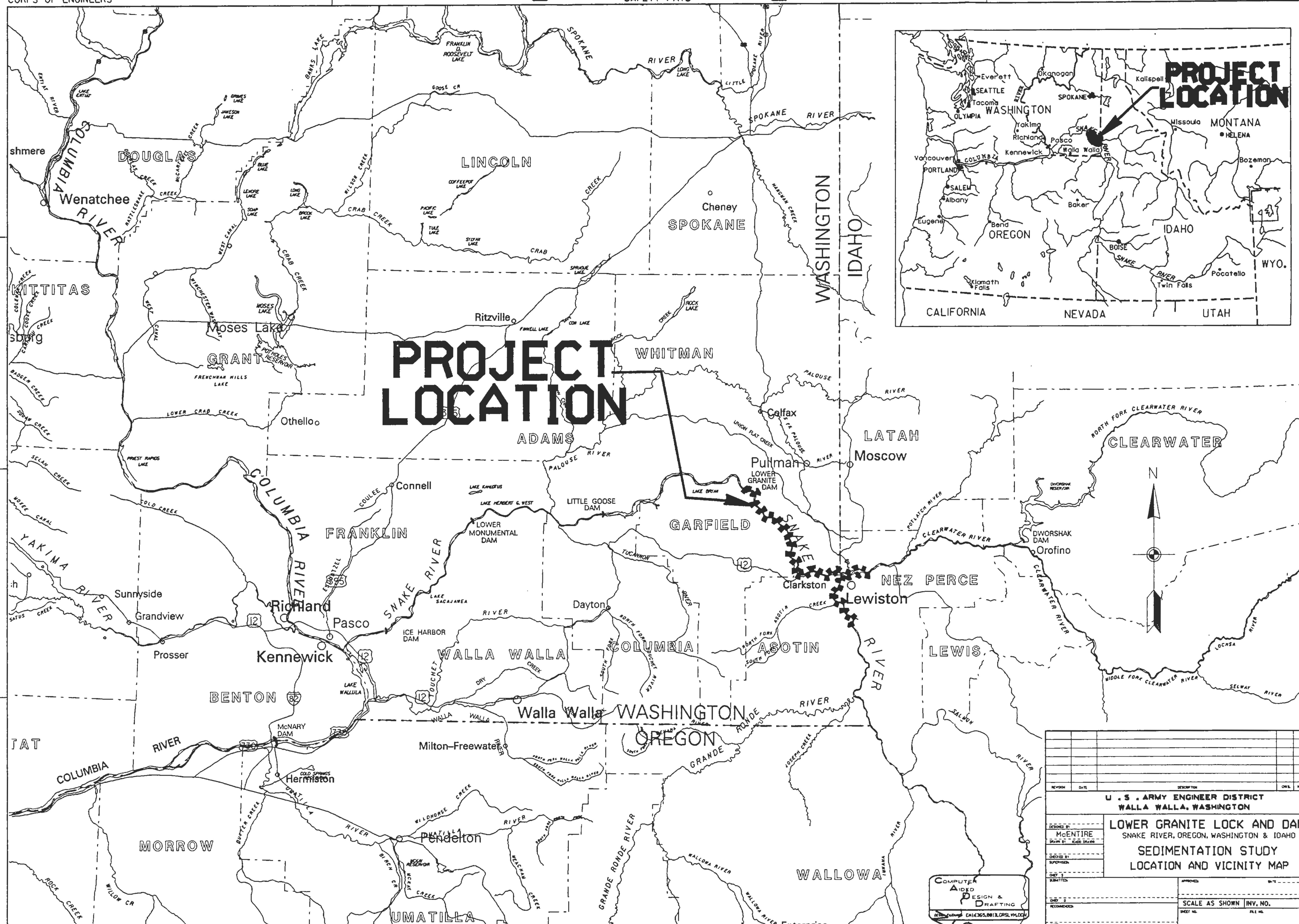
TABLE 2
LOWER GRANITE SEDIMENTATION FEASIBILITY REPORT AND EIS

Completion Schedule



PLATES

CORPS OF ENGINEERS SAFETY PAYS U. S. ARMY



U.S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON & IDAHO
SEDIMENTATION STUDY
LOCATION AND VICINITY MAP

DESIGNED BY McENTIRE

SCALE AS SHOWN INV. NO.

PLATE 1

VALUE ENGINEERING PAYS

REFERENCE FILES ATTACHED REGBOUND.DGN.B REGCITIE.DGN.C LEVELS ON FOR CONTRACT DRWGS REGMAPLG.DGN.MAP SCALE

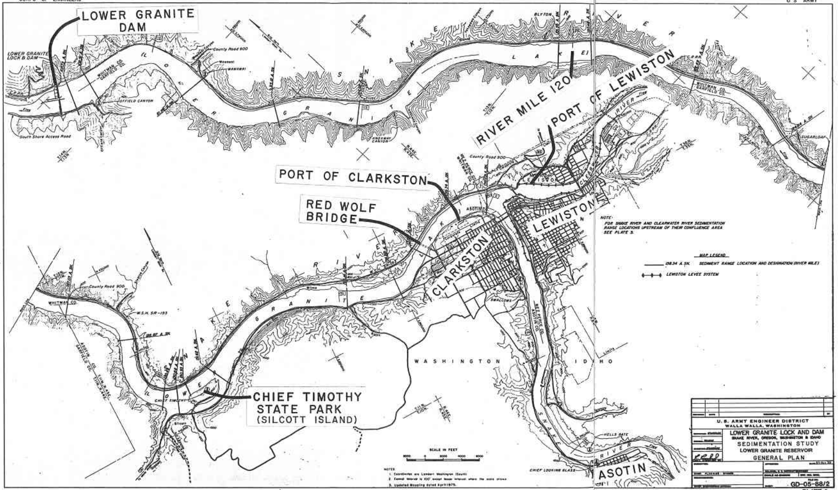
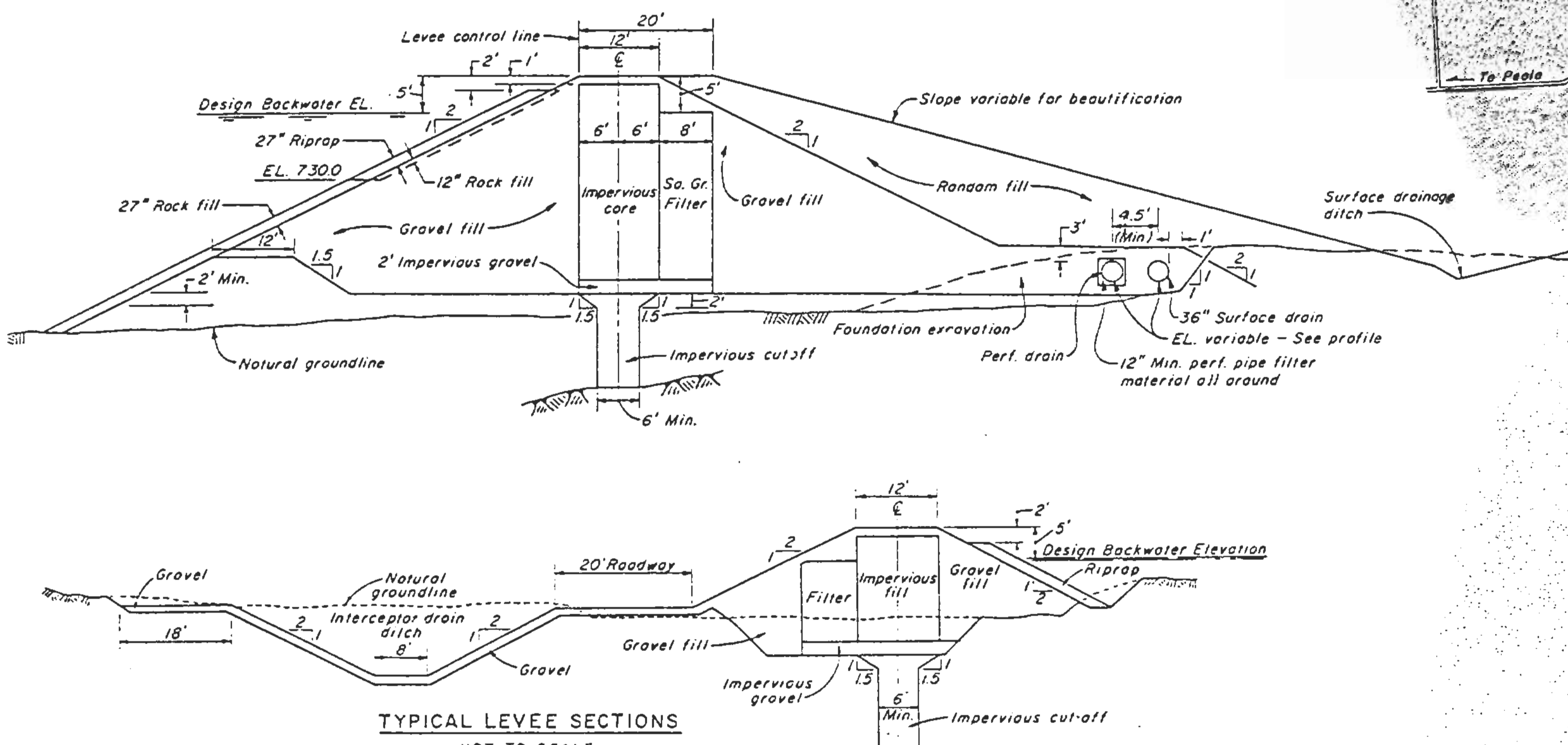
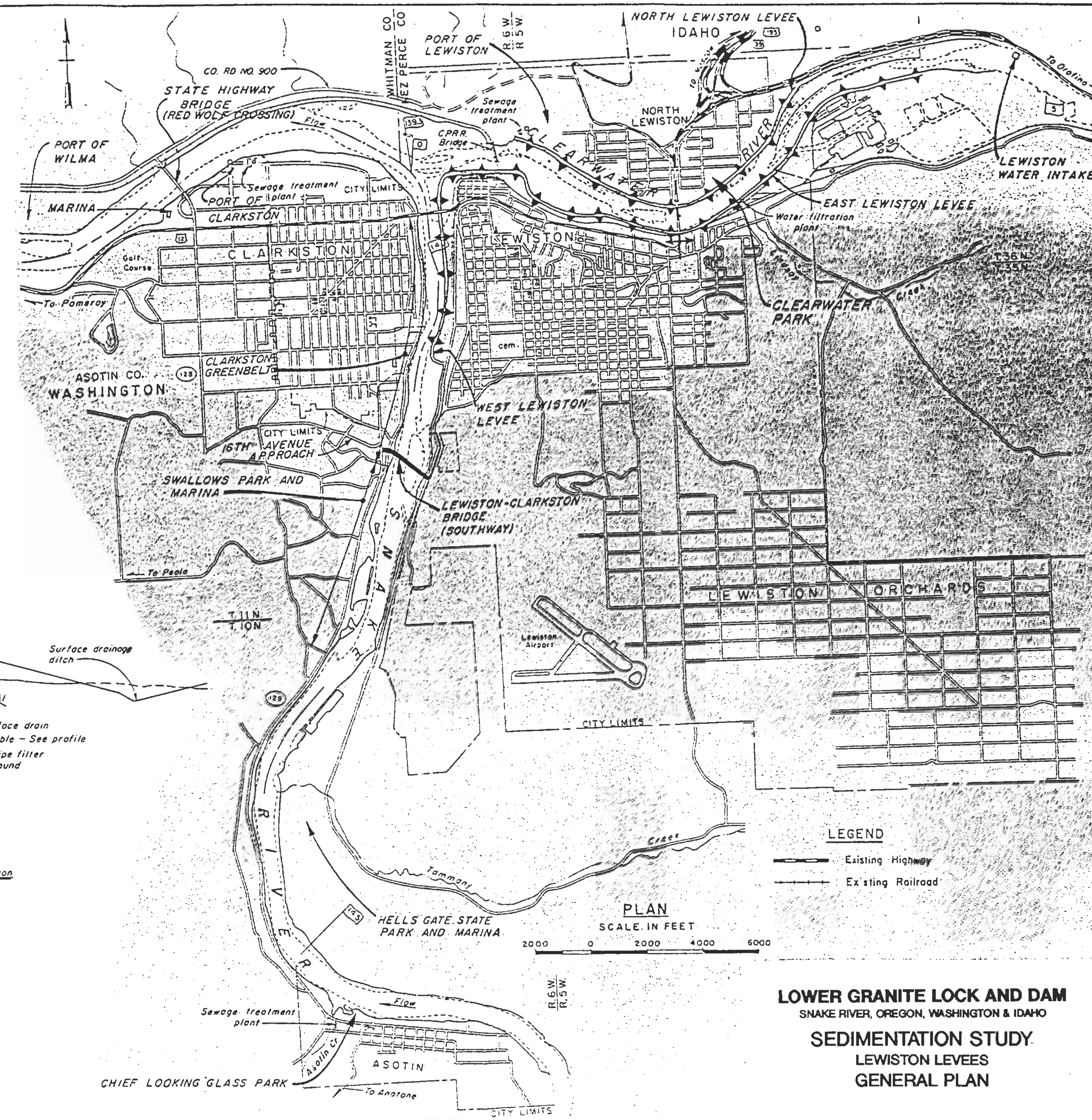

LOWER GRANITE DAM
LOWER GRANITE LOCK & DAM
RIVER MILE 120
PORT OF LEWISTON
PORT OF CLARKSTON
RED WOLF BRIDGE
LEWISTON
CLARKSTON
CHIEF TIMOTHY STATE PARK (SILCOTT ISLAND)
ASOTIN
WASHINGTON
IDAHO
County Road 900
South Shore Access Road
OFFIELD CANYON
KNOXWAY CANYON
SUGARLOAF
HELLS GATE
CHIEF LOOKING GLASS
WHITMAN CO.
GARFIELD CO.
ASOTIN CO.
NEZ PERCE CO.
NOTE: FOR SNAKE RIVER AND CLEARWATER RIVER SEDIMENTATION RANGE LOCATIONS UPSTREAM OF THEIR CONFLUENCE AREA SEE PLATE 3.
MAP LEGEND
SEDIMENT RANGE LOCATION AND DESIGNATION (RIVER MILE)
LEWISTON LEVEE SYSTEM
SCALE IN FEET
NOTES
3. Updated Mapping dated April 1975.
U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON
LOWER GRANITE LOCK AND DAM
SEDIMENTATION STUDY
LOWER GRANITE RESERVOIR
GENERAL PLAN
GD-05-88/2

PLATE 2



TYPICAL LEVEE SECTIONS

NOT TO SCALE



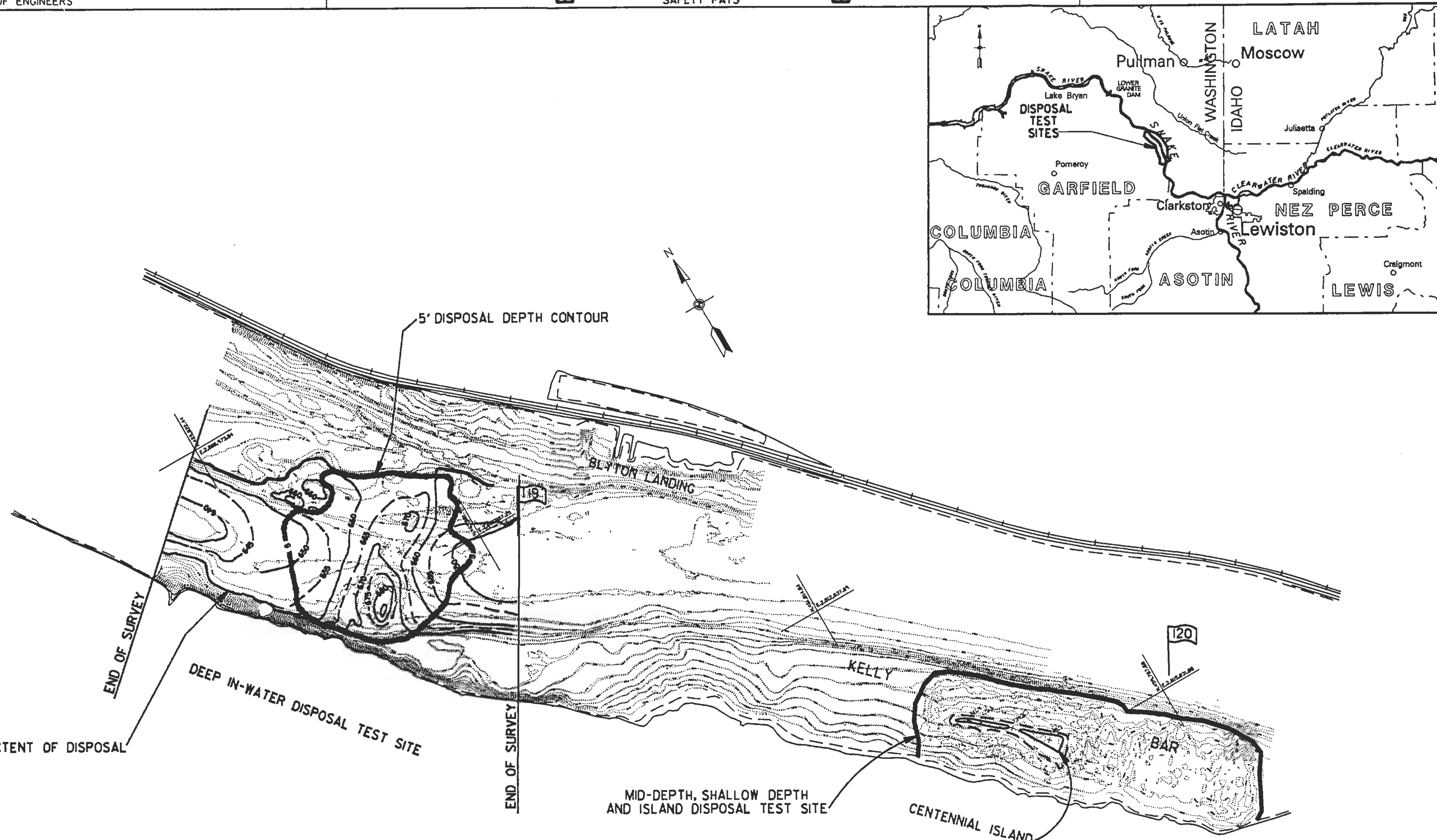
LOWER GRANITE LOCK AND DAM

SNAKE RIVER, OREGON, WASHINGTON & IDAHO

SEDIMENTATION STUDY

LEWISTON LEVEES

GENERAL PLAN



U. S. ARMY ENGINEER DISTRICT
WALLA WALLA, WASHINGTON

McENTIRE

LOWER GRANITE LOCK AND DAM
SNAKE RIVER, OREGON, WASHINGTON & IDAHO
SEDIMENTATION STUDY
DISPOSAL TEST SITES

COMPUTER AIDED DESIGN & DRAFTING

SCALE AS SHOWN | INV. NO.

REFERENCE FILES ATTACHED
CADP685.2D, 685 CADP736.2D, 736 LGSEDCEN.2D, LGS
CADP686.2D, 686 CADP645.2D, 645 WAKBLK3D.2d BORDER
LEVELS ON FOR CONTRACT DRWGS
SCALE
NOT TO SCALE

GLOSSARY OF TERMS, ABBREVIATIONS, AND ACRONYMS

GLOSSARY

Reservoir control point elevation: This is the reference point for control of Lower Granite Reservoir to elevation 738.0 at R.M. 139.5. Reservoir water surface elevations and profiles upstream and downstream are modeled from this point illustrating the "hinge pool" concept of Lower Granite Reservoir. Its location is further defined as the intersection of the left bank of the Clearwater River and the right bank of the Snake River. The Lewiston levee freeboard is also based on the reservoir elevation of 738.0 at this point.

ABBREVIATIONS

cfs	cubic feet per second
el	elevation
fmsl	feet mean sea level
ft	feet
lb	pound
lb/ft^3	pounds per cubic foot
mi^2	square mile
mm	millimeter
myd^3	million cubic yards
myd^3/yr	million cubic yards per year
RM	river mile
yr	year
yd^3	cubic yards

ACRONYMS

AEAM	Adaptive Environmental Assessment and Management
CBFWA	Columbia Basin Fish and Wildlife Authority
Corps	The Corps of Engineers
CPRR	Camas Prairie Railroad
CRITFC	Columbia River Inter-Tribal Fish Commission
CRP	Conservation Reserve Program
DM	Design Memorandum
EA	Environmental Assessment
Ecology	Washington State Department of Ecology
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
ESSA	Environmental and Social Systems Analysts
FEMA	Federal Emergency Management Agency
FY	Fiscal Year
HEC	Hydrologic Engineering Center
HMU	Habitat Management Unit

ACRONYMS (Continued)

IWG	Interagency Working Group
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
PFI	Potlatch Forest Industries
PSW	Pacific Southwest
PNW	Pacific Northwest
SCS	Soil Conservation Service
SOR	System Operation Review
SPF	Standard Project Flood
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VEC	Valued Ecosystem Components

APPENDIX A

DRAFT POSITION PAPER

CENPW-PL-PF (1110-2-1150a) 30 April 1990

MEMORANDUM FOR Commander, North Pacific Division,
ATTN: CENPD-PL

SUBJECT: Lower Granite Sedimentation Study

1. Reference CENPD-PL-PF 2nd End, dated 25 April 1990, subject as above.

2. In response to the suggestion in the referenced letter, a position paper on the Corps of Engineers liability, if the Lewiston Levee system should fail due to sediment accumulation in Lower Granite Reservoir, is enclosed. The position paper concludes that the Corps has a legal liability to provide and maintain levee protection against any increased or incremental risk caused by the construction and operation of the Lower Granite Project. The position paper also addresses standing Corps policy that the Lewiston Levee system will withstand without failure the Standard Project Flood (SPF).

3. Based on the above legal liability and SPF protection policy, I recommend that the subject study proceed with the goal of recovering and maintaining the SPF level of protection in the Lewiston area, provided that sufficient resources (funding) are available, and recommend a solution on a least-cost basis.

Encl

JAMES A. WALTER
LTC, EN
Commanding

CF w/encl:
CENPW-OC
C, CENPW-OP

DRAFT

POSITION PAPER

Corps Liability for Lewiston Levee System Failure
19 April 1990

1. a. Issues have been raised regarding the Corps of Engineers legal liability that would exist if the Lewiston Levee system feature of Lower Granite Lock and Dam should fail due to sediment accumulation in the reservoir.

b. The Lower Snake River Projects, which include the Lower Granite Project, were authorized by P.L. 79-14 for slackwater navigation, irrigation, and hydropower. Flood control was not an authorized project purpose. The Lewiston Levee system was included in the Lower Granite Project as a necessary feature to permit slackwater navigation into the Lewiston area (DM No. 3). The Lewiston Levee system, while it may offer some flood protection to lower downtown Lewiston, is not a separable flood control feature. The Lewiston Levee system was constructed to prevent inundation of lower downtown Lewiston when Lower Granite Pool was raised to accomplish the authorized project purpose of slackwater navigation. Consequently, condemnation of private and municipal property was unnecessary. The Lewiston Levee system is operated and maintained entirely as a Federal responsibility with the exception of the Clearwater Park recreation site. Any failing in this responsibility would lead predictably to flooding and inundation of the property in the lower downtown area and may establish liability under the theory of "Inverse Condemnation."

c. The Corps of Engineers has a legal liability to provide and maintain levee protection against any increased or incremental risk caused by the construction and operation of the Lower Granite Project. The U.S. Code provision, 33 USC 702c, which provides immunity for Federal flood control projects from flood damage liability, would not appear to apply unless it could be clearly established that such damages were the result of floodwaters, such as releases at Dworshak raising the Lower Granite slackwater navigation pool to the elevation of topping the Lewiston Levees or causing their failure. Court decisions indicate that immunity is not conferred upon the Government by the Flood Immunity Statute, 33 USC 702c, where flooding damages occurred from the negligent design of a navigational feature of a Federal project, Graci v. U.S., 456 F.2d 20 (Ca5 1971).

2. a. A second issue was raised regarding a requirement for the Lewiston Levee system to provide the Standard Project Flood (SPF) level of protection as provided in the project Design Memorandum.

b. Lower Granite Project DM No. 3 states that the Lewiston Levee system will provide flood protection up to and including the SPF. Section IV, paragraph 2-12.c.(2) of ER 405-1-12 states that where levees are installed in lieu of land acquisition in urban communities or other areas of highly concentrated developments where overtopping of levees would result in major hazards to life or unusually severe property damage under anticipated future conditions, the levees will withstand without failure the occurrence of the SPF.

c. The areas protected by the Lewiston Levee system are highly concentrated developments where overtopping levees would result in major hazards to life and unusually severe property damage under anticipated future conditions.

d. The DM No. 3 statement and ER 405-1-12 guidelines represent a discretionary decision within the established policy guidelines set by Corps higher authority. The Corps may use its discretionary authority to revise the level of protection, clearly articulating the reasons upon which its judgment was based, provided by the Lewiston Levee system without increasing the Corps legal exposure especially under the the Federal Tort Claims Act because of the "discretionary functions" exemption in the Act.

\signed\

JOHN P. STANFORD
District Counsel

\signed\

CLIFFORD L. FITZSIMMONS
Planning Division

APPENDIX B

PERTINENT PROJECT DATA

LOWER GRANITE LOCK AND DAM
PERTINENT DATA

GENERAL

Location:	
State	Washington
Counties	Garfield and Whitman
River	Snake
River mile	107.5
Township	14 N
Range	43 E
Section	32
Latitude	46° 39′ 37"
Longitude	117° 25′ 37"
River miles from mouth of Snake River	107.5
River miles upstream from Little Goose Dam	37.2
Owner	U.S. Army Corps of Engineers, Walla Walla District
Authorized purpose	Navigation, Hydropower
Other uses	Flood control (maintain levee freeboard at Lewiston), fishery, and recreation
Type of project	Run-of-river
Real estate:	Fee acquisition land above pool elevation 738, acres 9,224

RESERVOIR

Name	Lower Granite Lake 1/
Elevations (feet msl):	
Maximum at dam for spillway design flood	746.5
Normal operating range at confluence gage (RM 139.5)	738-733
Reservoir control point elevation (RM 139.5)	738
Minimum at dam for standard project flood	724
Length, miles:	
Snake River (to Asotin damsite, RM 146.8)	39.3
Clearwater River	4.6
Length of shoreline, miles	91
Average width, miles	0.3
Maximum width, miles	0.6

1/ For the purpose of continuity with existing Lower Granite Lock and Dam documents, the use of the terms "pool" or "reservoir" are used interchangeably. The term "lake" is used to designate a geographical body of water.

RESERVOIR (Continued)

Surface area at El 738 (low flow - flat pool), acres	8,900
Storage below flat pool El 738, acre-feet	483,800
Storage below flat pool El 733, acre-feet	440,200
Storage between El 733 and 738	43,600
Height normal high pool to tailwater El 638 (low flow 30,000 cfs or less), feet	100

LEWISTON LEVEES

Top width, feet	12
Slopes, waterside and landside	1V on 2H
Materials	Gravel and earth fill with impervious core
Top elevation	5 feet above backwater profile for standard project flood 1_/
Embankment length, miles:	
North Lewiston Levee	2.4
East Lewiston Levee	2.1
West Lewiston Levee	4.1
Total Lewiston Levees	8.6
Installed pumping capacity, cfs:	
Lewiston levees	450.4

1_/ Original design criteria for freeboard.

DAM (GENERAL)

Axis (Lambert)	N 32^{o} 00′ E
Length and widths (in feet):	
Dam total length at crest	3,200
North abutment embankment	1,435
South nonoverflow monoliths	32.2
Spillway overall length	512
Spillway to powerhouse nonoverflow	43.4
Powerhouse overall length	656
Spillway to navigation lock nonoverflow	43.4
Navigation lock overall width at foundation	304
Navigation lock overall width at deck	186

DAM (GENERAL) (Continued)

Concrete heights (feet):	
Maximum overall concrete height (Powerhouse sump deck to deck)	254
Maximum nonoverflow monoliths height	
(North)	151
(Central)	166
(South)	181
Maximum lock wall monolith height (Culverts to deck)	191
Deck elevations (feet msl):	
Intake, spillway bridge, nonoverflow sections, and upstream end of navigation lock	751
Downstream end of navigation lock	746
South shore fish ladder	656
Tailrace and fishwater intake	656
North abutment embankment	756

SPILLWAY

Number of bays	8
Overall length, feet (abutment centerlines)	512
Deck elevation, feet msl	751
Ogee crest elevation, feet msl	681
Flip lip elevation, feet msl	630
Control gates	
Type	Tainter
Size	50′ W x 60′ H
Gantry crane (joint use with powerhouse). capacity, tons	100
Stilling basin length, feet	188
Stilling basin elevation, feet msl	580
Maximum design capacity, cfs	850,000

POWERHOUSE

Length overall, feet	656
Spacing, feet:	
Units 1 through 5	90
Unit 6	96
Erection and service bay	110

POWERHOUSE (Continued)

Width overall, transverse section, feet	243.17
Intake deck elevation, feet msl	751
Tailrace deck elevation, feet msl	656
Maximum height (draft tube invert to intake deck), feet	228
Turbines:	
Type	Kaplan, 6-blade
Runner diameter, inches	312
Revolutions per minute	90
Rating, horsepower	212,400
Distributor centerline elevation	599
Generators:	
Rating (nameplates), kilowatts	135,000
Power factor	0.95
Kilo-volt ampere rating	142,100
Units installed complete initially	3
Skeleton units provided initially	3
Total units now installed	6
Plant capacity, nameplate rating, kilowatts	810,000
Crane capacities, tons:	
Intake (joint use with spillway)	100
Bridge	600
Draft tube gantry	50

NAVIGATION LOCK AND CHANNELS

Net clear length, lock chamber, feet	674
Net clear width, lock chamber, feet	86
Upstream gate:	
Type	Submersible tainter
Height, feet	23
Downstream gate:	
Type	Miter
Height, feet	122
Operating water surface elevations in chamber	633-738
Maximum operating lock lift, feet	105
Lift, feet (riverflow 300,000 cfs, practical navigation limit)	88.2
Length of guide walls (from face of gate), feet:	
Upstream (floating)	750
Downstream	700

NAVIGATION LOCK AND CHANNELS (Continued)

Downstream approach channel:	
Width, feet	250
Bottom elevation	617
Minimum tailwater elevation	633.0
Lower lock sill elevation	618.0
Upper lock sill elevation, feet	718.0
Maximum depth over upper sill, feet	20.0
Minimum water depth over sills, feet	15.0

ABUTMENT EMBANKMENT

Embankment elevation	756
Embankment top width, feet	45
Material	Gravel fill with rock facing; impervious silt core
Upstream	Combination sand and gravel filters
Downstream	Gravel and sand filters
Slope, upstream	1V on 2H
Slope, downstream	1V on 2H

FISH FACILITIES

Upstream migrants fish ladder:	
Number of fish ladders	1
Slope:	
Weir 634 - Weir 627	1V on 10H
Weir 728 - Weir 737	1V on 32H
Ladder clear width, feet	20
capacity, cfs	75
Exit channel:	
Location	Between weir 737 and pool in nonoverflow section
Top of trashrack	El. 732
Invert	El. 727
Width, feet	6
Alternate exit channel (pool El below 727):	
Exit pipe to reservoir 18-inch-diameter full plastic pipe down to El. 718 and a half-round plastic pipe	down to El. 710

FISH FACILITIES (Continued)

Operating elevations:	
Design range:	
Pool elevations	733 to 738
Tailwater elevations	633 to 642
Riverflow	Zero to 225,000 cfs
Maximum operating range:	
Pool elevations	732 to 739
Tailwater elevations	633 to 645.4
Riverflow	Zero to 340,000 cfs
Adult fish trap and handling facility	1
Pumps for fishway system attraction water:	
Number	3
Capacity, cfs	3,150
Downstream migrants bypass system:	
Design pool range	733 to 738
Design capacity, cfs	200 to 250
Submersible traveling fish screens	18
Vertical barrier fish screens	18
Orifices from bulkhead and fish screen slots:	
Number	72
Size (diameter in inches)	10
Fingerling collection gallery	1
Fingerling transportation pipe	1
Fingerling holding and sampling facility	1
Fingerling transportation facilities:	
Truck loading facility	1
Barge loading facility	1

HYDROLOGIC DATA

(Based on streamflow data for Snake River near Clarkston, Washington)

Drainage area, square miles	103,200
Period of record	October 1915 - September 1972 December 1972 (discontinued)
Discharges in cfs:	
Instantaneous maximum of record, 29 May 1948	369,000
Instantaneous minimum of record, 2 September 1958	6,660
Average annual flow	50,300
Average annual mean daily peak flow	188,300

HYDROLOGIC DATA (Continued)

Extreme outside period of record:	
Flood of June 1894	409,000
Flood of June 1894, controlled by existing projects	295,000
Standard project flood (controlled by existing projects):	
Snake River below Clearwater River	420,000
Snake River above Clearwater River	295,000
Clearwater River above Snake River	150,000
Spillway design flood:	850,000
500-Year Flood	
Snake River below Confluence	360,000 cfs
Clearwater River above Confluence	142,000 cfs
100-Year Flood	
Snake River below Confluence	319,000 cfs
Clearwater River above Confluence	130,000 cfs
Spillway Design Flood 7-month run-off volume	81,000,000 AF
Average annual runoff volume, 1910 - 1986	37,500,000 AF
Minimum annual runoff volume, 1977	20,430,000 AF
Maximum annual runoff volume, 1974	57,410,000 AF

DRAINAGE BASIN AREAS

Snake River	
At Hells Canyon Dam	73,300 mi^2
At Anatone	92,960 mi^2
At confluence	93,548 mi^2
At Lower Granite Dam	103,500 mi^2
Snake above confluence	93,548 mi^2
Above Hells Canyon Dam	73,300 mi^2
Salmon River	14,007 mi^2
Grande Ronde River	4,130 mi^2
Imnaha River	855 mi^2
Local inflow	1,256 mi^2
Hells Canyon to Anatone	668 mi^2
Anatone to confluence	588 mi^2
Clearwater above confluence	9,659 mi^2
Clearwater at Spalding	9,570 mi^2
Clearwater at Orofino	5,580 mi^2
N. Fork at Dworshak	2,440 mi^2
Local inflow (approximate)	

DRAINAGE BASIN AREAS (Continued)

Lapwai Creek	240 mi^2
Potlatch River	500 mi^2
Other above Peck	20 mi^2
Other below Peck	790 mi^2
Local inflow below Spalding	89 mi^2
Local inflow confluence to Dam	293 mi^2

BASIN AREAS ABOVE CONFLUENCE CONTRIBUTING SEDIMENT

Snake River total		20,248 mi^2
(Salmon River	14,007 mi^2)	
(Grande Ronde	4,130 mi^2)	
(Imnaha River	855 mi^2)	

LOWER GRANITE LOCK AND DAM

BASIN AREAS ABOVE CONFLUENCE CONTRIBUTING SEDIMENT (Continued)

(Local inflow	1,256 mi^2)	
(Snake above Grande Ronde	545 mi^2)	
(Snake below Grande Ronde	711 mi^2)	
Clearwater River not including North Fork		7,219 mi^2

BASIN AREAS ABOVE LOWER GRANITE DAM CONTRIBUTING SEDIMENT

Snake River above Anatone gage		19,660 mi^2
(Salmon River	14,007 mi^2)	
(Grande Ronde	4,130 mi^2)	
(Imnaha River	855 mi^2)	
(Local inflow	1,256 mi^2)	
(Snake above Grande Ronde R.	545 mi^2)	
(Snake below Grande Ronde R.	123 mi^2)	
Clearwater River above Spalding gage		7,130 mi^2
Local inflow		970 mi^2
(Snake, Anatone to confluence	588 mi^2)	
(Clearwater, Spalding to confluence	89 mi^2)	
(Snake, confluence to dam	293 mi^2)	

LOWER GRANITE LOCK AND DAM

PERTINENT DATA (Continued)

WATER SURFACE ELEVATIONS AT CONFLUENCE

Normal water surface prior to reservoir	705 to 710
Note: Flood elevations not known	
Normal water surface control point elevation	738.0
Minimum operating control point elevation (at the confluence)	733.0
Standard Project Flood (design)	
Forebay elevation	724.0
Elevation at confluence	738.0
Spillway Design Flood	
Forebay elevation	746.5
Elevation at confluence	760.0

APPENDIX C

HYDROLOGIC ANALYSIS

CENPW-PL-H (1110-2-1150a) 13 May 1991

MEMORANDUM THRU

Chief, Plan Formulation Branch

Chief, Planning Division

FOR Mr. Gareth Clausen, Study Manager, Plan Formulation Branch

SUBJECT: Lower Granite Sedimentation Study: Preliminary Evaluation and Economic Analysis

1. Attached is an updated draft of the Hydraulic and Hydrologic information contained in the September 1990 version of the subject report. This revision includes the findings of an HEC-6 sediment transport analysis of the Lower Granite Project which resulted in major adjustments to previous projections of sediment buildup and consequent levee-freeboard loss during the remaining life of the project.

2. Questions regarding this material should be directed to Mr. Les Cunningham, ext. 6615.

Encl

DAVID L. REESE
Chief, Hydrology Branch

LOWER GRANITE SEDIMENTATION STUDY
Preliminary Evaluation and Economic Analysis

HYDROLOGIC ANALYSIS

1. BACKGROUND

Lower Granite Dam, located on the Snake River about 32 miles downstream of the City of Lewiston, Idaho, creates a slack-water pool which extends up to, and several miles beyond, the Cities of Lewiston and Clarkston. A series of levees along the riverward side of Lewiston form an integral part of the Lower Granite Project. The levees allow the pool to be held at the authorized maximum pool level (738 ft). Without the levees a large portion of the downtown business district would be inundated during normal operation. The project was designed to safely pass the Standard Project Flood with 5 ft of freeboard remaining on the levees.

Since the Lower Granite Pool was raised in February 1975, over 40 million cubic yards of sediment has deposited in the reservoir. About 6 feet of freeboard was available when the project was completed. The most recent analysis, based on the fall, 1989 sediment range resurvey, indicates that only 3 ft of freeboard would remain at the peak of the Standard Project Flood.

Although the potential for sedimentation problems was recognized early in the design process, most of the study effort concerned the effects of sediment deposited in the reach upstream of the confluence. The removal of the old Washington Water Power Dam on the Clearwater was expected to release sediment stored upstream, while the barge turning basin downstream would collect sediment. Three years of site-specific sediment data, plus additional data some distance downstream was available at the time of project construction. With a design based on limited available data, there was some concern that the proposed profile might prove to be too low. However, the District felt that the lingering uncertainties were not sufficient reason to warrant the expense and visual impact of a higher levee profile which might later prove to be over-designed. Maintenance dredging for navigation was expected to reduce the problem on the Clearwater, and provision was made for the levee profile to be adjusted in the future if additional research and sedimentation data proved this to be necessary. Early planners may have taken some consolation in the knowledge that Asotin Dam (authorized and in the planning stages at the time) would trap most of the sediment on the Snake River.

Concern over the effects of sedimentation on the levee design was documented in correspondence between the District, NPD and OCE concerning Lower Granite Design Memorandum No. 3 (4th-

12th Ind). The 12th Ind., dated 5 Aug 1969, from OCE is of particular interest. "In view of the inconclusiveness of the engineering studies and the possible hazards of loss of life and inordinate property damage inherent in levee failure" several recommendations were made: 1) That provision be made for future raising of the design grade; 2) An average levee freeboard of five feet with the design based on provisions of Engineering Bulletin 54-14 and EM 110-2-1601; 3) The use of conservatively high roughness coefficients; and 4) That a systematic program be developed to obtain data and perform studies to establish the effect of sedimentation on water surface profiles after project completion.

The United States Geological Survey (USGS) began collecting sediment discharge data in 1972 and continued for a period of 8 years. Based on this data, a draft interim sedimentation report was completed in February 1984 which suggested that the design freeboard would soon be exceeded and that the levees could actually be over-topped by two or more feet by the SPF within the life of the project. Additional sediment ranges were surveyed the following summer and the hydraulic and sedimentation data were refined. A recalculation of the SPF profile based on 1986 surveys indicated that the design freeboard had already been exceeded. The survey also suggested that freeboard was being lost at a much higher rate than previous studies had predicted.

2. PURPOSE.

The purpose of this report is to provide hydrologic input for a cursory analysis ~~which addresses the benefits and costs~~ of providing SPF ~~and o~~ther levels of protection over the remaining project life. These amount of freeboard needed and the risk and uncertainties associated with design floods, sedimentation rates, and other pertinent design parameters, are also addressed.

3. ASSUMPTIONS.

In order to complete this study within the time and cost constraints it was necessary to limit the number of scenarios considered, to accept very rough estimates of flood damage, and make some simplifying assumptions. A partial list of these limiting assumptions follows:

a. The area considered was limited to the reaches protected by the Lewiston Levees. For a complete analysis the area should be expanded to include the effects of both upstream and downstream of the levees.

b. The density of deposited sediment was assumed to remain constant (equal to the observed density in 1986) throughout the life of the project.

c. Failure was assumed when the calculated water surface encroached on the selected freeboard for any flood discharge.

Failure at three freeboard levels were analyzed: At 0, 3, and 5 ft. freeboard. Profiles behind the levees after failure were estimated rather than calculated.

d. The estimated profile at the time of failure was used to estimate damages associated with each of the two failure scenarios described in the next section. Changes in the probability of failure resulting from progressive sediment accumulation were calculated. However, increased damage resulting from flood levels above that which would result in levee failure were ignored. Due to quality of information available on real estate values, damage estimates would not be improved by a detailed analysis of variations in inundation depths. Different levels of protection were addressed by delaying maintenance costs until the flood profile for the specified protection level began to encroach on the specified freeboard.

4. PROJECTED RISE IN THE WATER SURFACE PROFILE DURING THE LIFE OF LOWER GRANITE PROJECT.

Starting with the reservoir geometry surveyed in 1986, sediment transport was mathematically modeled for the 88 years remaining in the project life. An annual synthetic hydrograph developed from flow duration statistics was used to model Snake and Clearwater discharge. No dredging or other corrective actions were considered, and the model assumed that flow would be confined within the levees even if it overtopped the existing levee profile.

The rising profiles, calculated at approximately 10-year intervals, are presented on Plate 1. The water surface profiles are compared with the existing top-of-levee profile on the Snake River on Plate 2, and on the Clearwater River on Plate 3. Note that the SPF would overtop the levees sometime between the years 2000 and 2010. By the year 2074 the SPF would overtop the levees by nearly 8 feet.

Apparently due to interim dredging and lower than average sediment inflow, the experienced freeboard loss since 1986 has been less than projected. The calculated 1989 SPF profile was actually about 0.2 ft below the 1986 value. With no corrective dredging and average peak flows the projected profile would have been 0.4 ft above the 1986 level.

5. FAILURE SCENARIOS.

Failure was assumed to be caused by a combination of overtopping by wind-wave action and erosion at two possible locations: 1) At the CPRR Bridge near the confluence, and 2) At River Mile 3.0 on the Clearwater. The former is the most likely point of failure since the freeboard is minimum near this point and levee compaction under and around the bridges is likely to be less than at other locations. Failure at the latter location would result in maximum flood damage. Maps showing the failure locations and areas inundated by failure are found on Plates 4-6. For risk and economic evaluation the levees along the left and right banks of the rivers are assumed to fail under the same flood conditions. However, unless the levees are overtopped, simultaneous failure of both levees would not necessarily occur.

a. **Scenario 1: Failure at the CPRR Bridge.**

West Lewiston Levee is level and at a minimum elevation of 743 from the CPRR bridge to the Highway 12 bridge. The weakest point is likely to be at the CPRR bridge. Freeboard is minimum at this point, and compaction under and around the bridge is likely to be less than at other locations due to adjacent structures and minimal clearance under the bridge. Although this study assumes equal failure frequencies on both sides of the river, failure on the North side of the Bridge (North Lewiston Levee) appears less likely than on the south. The south levee drops down to its minimum freeboard for only a short distance near the CPRR Bridge where it connects to a high basalt cliff. This location also appears to be somewhat sheltered from direct wind-wave attack from the west.

It was assumed that wind-wave action severe enough to breach the levee at one point would cause severe damage over a considerable length of levee. This length was estimated to be equivalent to 2000 ft of levee to the South and 1000 ft of levee to the North. Failure was assumed to occur when freeboard requirements were exceeded. Plate 4 indicates the assumed failure locations and the area which would be inundated with a failure. It should be noted that failure at the CPRR bridge or any other locations near the confluence would result in level ponding of flood waters behind the levee at the level of the river. The profiles could be lowered somewhat particularly at lower discharges by directing some of the flow through the powerhouse. Powerhouse capacity is about 130,000 cfs at maximum head. However at SPF discharge, studies indicate that a drop in the forebay water level produces a greatly diminished response at the confluence.

b. **Scenario 2: Failure at the PFI plant (RM 3.0).**

Freeboard is somewhat greater at River Mile 3.0 and it is less exposed to wind wave action than at the confluence. However, the economic consequences of failure are potentially greater. Although equal probabilities of failure were used for economic analysis, the right bank levee (North Lewiston) appeared more likely to fail since it was on the outside of a bend.

After failure at RM 3.0 on the right bank, water would flow through residential areas, over Highway 12, and into business and storage areas around the Port of Lewiston. High velocity flow would concentrate in the narrow underpass at Memorial Bridge (Highway 12) eroding the levee from the unprotected back side, flow on down into the Port of Lewiston, and then overtop and breach the North Lewiston Levee near the CPRR bridge opposite the sewage treatment plant.

On the left bank most of the Potlatch manufacturing and warehouse storage areas would be inundated. Water would then flow west, surging through the narrow opening under Memorial Bridge and into downtown Lewiston where it would overtop and breach West Lewiston Levee. If the failure point could be anticipated, it might be possible to block the underpass at Memorial Bridge, cut the levee upstream and confine the damage to the Potlatch plant area. Assuming a worst case situation, about 4000 feet of levee could be lost (1000 feet on each side at the initial failure points, 500 feet on each side under the Memorial Bridge, and at the overtopping points near the confluence).

c. Other Impacts of A Major Flood with Levee Failure.

The Lower Granite Regulation Manual allows for forebay lowering up to three days prior the anticipation of flows exceeding 300,000 cfs. The pool may be lowered to 725 and even further as flows increase up to the SPF (420,000 CFS below the confluence). During a year when failure occurs, pool lowering is assumed to begin on 5 May (2 days before the SPF hydrograph reaches 300,000 CFS) and average 725 elevation until failure occurs at the peak of the hydrograph on 17 May. After failure the project gates would remain open, allowing the pool to gradually drop until it was low enough for reconstruction of levees to begin by 15 July. Pool levels average 712 between 17 May and 30 July and remain at 710 from 30 July until reconstruction of the levees is completed on 15 January. Barge traffic would be interrupted due to insufficient clearance over the Navigation Lock sill (717 ft. elevation.) from 5 May until pool raise on 15 January. Although progressively smaller floods could breach the levee later in the project life, detailed analysis of variations in hydrograph shape, timing of floods, and reduced freeboard uncertainties associated with these smaller floods could not be completed within the time constraints of this study.

c. Explanation of Plates Relating to Levee Failure.

Plate 6 indicates the assumed profile for flood flows in the floodplain areas for damage analysis purposes. The profiles assume a single flood profile for any flood which exceeds the indicated freeboard allowance and assumes overbank flows will pond up behind and overtop the downstream levees. In an actual flood the profile would vary depending on the flood discharge, obstruction by debris, and flood fight scenarios.

Plate 7 indicates the effects of progressive sedimentation on the SPF water surface profile at the CPRR bridge. Plate 8 lists the date when the water surface profile would encroach on the listed freeboard for floods of selected frequencies. This information is indicated in graphical format on Plates 9 and 10. Plates 11 through 14 indicate the impact of progressive sediment buildup on the level of protection at the PFI plant.

6. ABILITY TO FORECAST FLOODS.

The National Weather Service River Forecast Center is responsible for flood forecasts, and flood warnings. Forecasts of seasonal peak flows are generally provided as a range of flow, with a 50% chance that the peak flow will fall within the indicated range. The peak flow that can be expected, given the estimated snowpack water volume combined with possible weather scenarios of graded severity (with a probability of occurrence also supplied) is calculated several times during the runoff season. Using the above information, the possibility for an unusually high discharge could be predicted 30 days or more in advance of the hydrograph peak. Daily, or even six-hour forecasts are also provided by the Weather Service. These are based on 3-day precipitation forecasts and 5-day air temperature forecasts combined with estimated snowpack conditions and projected reservoir storage and releases. These projections are considered fairly reliable for three days into the future with the reliability dropping off rapidly thereafter.

Discharge forecasts and operation of the flood control projects on the Snake River basin are based on basin modeling using the SSARR computer model. Two weak points in the present model are the Boise and the North Fork Clearwater River portions of the model. Although Walla Walla District has developed advanced SSARR models using the snow band option for both the North Fork of the Clearwater and Boise rivers, the Clearwater model is not satisfactorily reproducing observed flows and the Boise model also needs additional work.

By April 1 enough of the winter snowpack is in place to allow fairly reliable runoff volume forecasts to be made. Less predictable factors such as soil moisture, temperature, wind speed, and rainfall control how fast the available runoff volume comes off and, consequently, the peak flow and shape of the flood hydrograph. The most critical period with regard to flood forecasting and planning for emergency action occurs after 1 April during reservoir refilling. With only 2 Million Acre-Feet of flood control storage in Dworshak reservoir and an average annual runoff of 2.8 Million Acre-Feet there is not much room for error. Less than optimum operation can, and has occurred, in the past. A case in point is the 1974 spring flood when a rapid increase in air temperature combined with rainfall near the end of the spring snowmelt resulted in premature filling of Dworshak Reservoir and spill during the peak flow. While DM 1 asserted that the largest known flood (1894) could be controlled to a discharge of 295,000 CFS, the 1974 instantaneous peak was close to 316,000 CFS, and the flow at the Spaulding gage on the Clearwater was 131,000 CFS (only 19,000 less than the Clearwater Standard Project Flood). Human error probably increased the peak discharge by at least 28,000 CFS. By coincidence the flow of record at Anatone on the Snake River (195,000 cfs) coincided with loss of control on the Clearwater. It is also of interest to note that Lewiston Levees were under construction at the time, but an unfinished section near the CPRR bridge allowed flow to escape over-bank and completely inundate the sewage treatment lagoons and associated facilities of the city of Lewiston. It seems ironic that the regulated Standard Project Flood is generally determined by assuming the worst meteorological conditions that can reasonably occur while regulation of this flood is generally based on optimum operation of flood control projects.

Peak flows on the Snake River below the Clearwater confluence since Dworshak began operation are shown on Plate 15. Frequency curves for the Clearwater River at Spaulding and the Snake River at Lower Granite Dam are shown on Plates 16 and 17.

7. SELECTION OF THE DESIGN FLOOD: RISKS AND UNCERTAINTIES.

The element of risk was a key consideration in the original design process when selecting the design flood, levee freeboard, and physical design of the project. With regard to selection of the Standard Project Flood as the design level of protection for the Lewiston Levees, DM 1 paragraph 4-1 quotes Engineering Bulletin 52-8 as follows:

(The Standard Project Flood) "represents the flood discharge that should be selected as the design flood . . . where an unusually high degree of protection is justified by hazards to life and high property values within the area to be protected."

It is important to note that the Lewiston Levees were required to allow the Lower Granite Project to produce power at the design head. They are a part of the project, not a separate flood control project. Design Memorandum No. 3, under "Project Purpose," Paragraph 1.06.a states: "Congressional authority for the Lower Granite project does not cite flood control as a project purpose. However, the construction of an extensive system of backwater levees in Lewiston and Clarkston will provide the areas behind the levees with flood protection up to and including the standard project flood."

While the existence of high property values behind the levee can hardly be questioned (The main business and hotel district in Lewiston, with property valued at around one billion dollars lies on low ground behind the Levees), the risk to life is a little harder to evaluate. Since the spring run-off is an annual event which normally occurs with no detectable change in the confluence water surface, it is unlikely that the general population would be mentally prepared for a rapid evacuation and it is also unlikely that the Corps of Engineers or emergency personnel would want to arouse unnecessary fears prior to a known emergency.

The spring run-off period normally starts in April and may last late into July with a gradually rising and falling hydrograph. Even with a forecast of an unusually heavy run-off, it is unlikely that an emergency situation would be anticipated until the flow had reached a discharge level that began to threaten the project's ability to maintain the normal high pool level (738 ft MSL). Based on a review of past hydrographs a rise of 50,000 cfs within a 3 to 5 day period (or 1 ft/day water surface rise) is not unusual. This would seem to allow time for an evacuation but the time could be considerably shortened by operator error at one of the projects, partial blockage of a bridge, or failure due to wind wave action.

Based on experiences with evacuation efforts in other areas of the country it is unlikely that emergency personnel would be able to warn everyone, that all of those warned would believe that an emergency existed, and that it would be possible to prevent some people from returning to retrieve valuables. Failure, once in progress, could result in rapid (probably one or two hours) flooding of the downtown area to depths of up to 18 feet.

8. FREEBOARD REQUIREMENTS.

With regard to freeboard, Lower Granite DM #3, pg 6-4 states that "five feet of elevation above the standard project flood backwater profile would generally serve project requirements as far as inundation and normal wave action are concerned."

Although 5-ft freeboard above the standard project flood has been the adopted level of protection throughout most of the design process, the original computations summarizing all factors involved in this determination have not been found to date.

EM 1110-2-1601, Paragraph 12.a defines freeboard as the vertical distance above the design water surface needed to insure that the desired degree of protection will not be reduced by unaccounted factors. A list of these factors includes erratic hydrologic phenomena, accumulation of silt, trash, and debris, and variation in resistance from the assumed values. Some of the more important known risks and associated levels of uncertainty are listed in TABLE 1 below.

TABLE 1.

Risk Factor	Best Estimate feet	Probable Range feet
1. Wind-Wave Runup	2.8	+1.7 - +3.1
2. SPF Sediment Inflow	0.4	0.0 - +1.0
3. Model Calibration	1.0	-2.0 - +2.0
4. SPF Flow Distribution	0.0	-1.0 - +0.0
5. Project Operation Error	1.7	-0.0 - +6.0
6. Bridge Obstruction	1.5	0.0 - +2.0
7. Superelevation	0.5	-0.5 - +0.5

In keeping with the provisions of Civil Works Engineering Bulletin 54-14, Section 3,c,(5) it would appear reasonable to include in the freeboard an allowance for estimated SPF sedimentation, wind-wave run-up, and an additional allowance for at least one of the several unknown or unexpected factors such as model calibration error, project operation error, or bridge debris blockage. The above combination would result in a freeboard allowance of 4.2 to 4.9 ft. Since one or more of the risk factors could exceed the "best estimate," a minimum freeboard allowance of 5.0 ft appears reasonable.

a. Wind-wave Runup

Extensive wind-wave runup computations were made for Lower Granite Dam and points along the entire upstream length of the reservoir. The design wind of 60 mph was based on wind records near Ice Harbor dam which were increased by 10% for use in Lower Granite Reservoir since no data was available at that location. Table 2 lists the Design wave heights found in the Levee Design Memorandums 29.1, 29.2, and 29.3. These heights were developed using the procedure given in Supplement 2 of John Day DM 7 and represent the wave heights expected to be exceeded 25 times per year on the average. A review of wind records at Lewiston up to 1969 indicated that winds of up to 60 mph have been recorded in June, and up to 70 mph in the winter. Some early (1968) calculations estimated wave runup as high as 3.1 ft within the leveed reach.

The design wind would not necessarily occur at the time when the SPF peak arrived at Lewiston. However, the possibility of such a combination does exist since strong winds are associated with storm conditions which could produce the SPF. Therefore the impact of such an event must be considered in the analysis. A complete review of the basis for wind-wave freeboard allowance would involve consideration of the additional wind data available since project design, and the effect of flow velocities (6 to 10 fps) on fetch calculations.

TABLE 2.

DESIGN WAVE HEIGHTS FOR LEWISTON LEVEES
North Lewiston Levee

Clearwater River Mile	Effective Fetch (Miles)	Wave* Height (Feet)
0.6	0.6	2.8
2.0	0.2	1.7
2.8	0.3	2.1
4.0	0.3	2.1

East and West Lewiston Levees

Clearwater River Mile	Effective Fetch (Miles)	Wave Height (Feet)
0.6	0.6	2.8
2.0	0.2	1.7
Snake River River Mile		
139.5	0.7	2.2
140.5	0.7	2.3

*Boat and barge traffic is expected to produce 2.8 ft. waves more often than wind.

b. Sedimentation

Rates of freeboard loss due to progressive sediment build-up are expected to decrease with time: Starting at 0.25 ft/yr and decreasing to about 0.08 ft/yr by year 2074. (See Plate 7). If no corrective action is taken the total rise in SPF water surface profile during the 100-year project life could be as high as 14 ft.

The amount of freeboard which could be lost during a single flood event could vary considerably depending on soil conditions and other factors at the time of the flood. Plates 18 and 19 indicate the spread of individual instantaneous sediment inflow measurements collected by the USGS during the years 1972-1979. These plates were adapted from graphs on pages 160 and 161 of the USGS report "Sediment Transport in the Snake and Clearwater Rivers in the Vicinity of Lewiston, Idaho." The equation for the "best fit" line was obtained from a previous Corps study and superimposed on the above USGS graphs. Due to time limitations, the "upper" and "lower" limits used on the charts were determined visually. The instantaneous data suggests a spread of almost 2 orders of magnitude for sediment discharge rates on the Clear-water River and about 1 for the Snake River. The actual uncer-tainty is likely to be considerably less when determined on the basis of the variation in sediment discharge relations for an entire runoff event (there is likely to be much more scatter in individual measurements than in flood period totals).

The effects of sediment inflow were mathematically modeled using HEC-6 with both the best-estimate and the estimated maximum (upper bound on Plates 18 and 19) sediment inflow rating curves. The model predicted a freeboard loss of about 0.4 ft if the flood occurred early in the project life. Using the upper-bound curve the freeboard loss approached 0.6 ft. The maximum loss is limited by the transport capacity of the SPF rather than sediment supply. If sediment is allowed to collect in the reservoir a SPF would have little effect on the profile near the end of the project life. hydrograph. Plate 20 indicates estimated effect of the SPF sediment inflow on the Snake River. Clearwater profiles are shown on Plate 21.

c. Roughness Calibration.

Plate 22 indicates the effect of changes in roughness on the water surface profile at the confluence. As indicated by the chart a change of 0.002 in Manning's-n results in a 1 ft rise in water surface. The use of a roughness coefficient of 0.024 would indicate 5 ft of available freeboard at the SPF; while 0.034 would overtop the levee. Various attempts to calibrate Lower Granite roughness at different flows and impoundment conditions have produced values ranging from 0.024 to 0.032. A roughness coefficient of 0.028 downstream and 0.030 upstream of the Clearwater confluence was used for this report unless otherwise noted.

Water-surface profiles were surveyed for a range flows up to 369,000 cfs in 1948 and 1956. These profiles are indicated on Plates 23 and 24 of Lower Granite Design Memorandum No. 1. Plates 23 and 24 in this report show these surveyed profiles compared with calculated profiles using 1975 geometry. Manning's n-values ranging from 0.028 to 0.32 were required to obtain a good fit in each of the indicated reaches. The degree to which excavation in the river bed near the confluence and levee encroachment on the channel for a short distance above the Clearwater confluence (RM 139.29 - 140.51) affects the profile will require further evaluation using pre-project geometry. Pre-project water surface profile data on the Clearwater was of little use in model calibration due to the extensive modifications of the channel during levee construction. Due to the relatively flat pool it may be difficult to obtain useful post project water-surface profile data for calibration purposes. However, additional calibration work would be useful on the Clearwater if data can be obtained during high enough flows.

As indicated on Plates 25-30 a Manning's n of 0.03 produces a conservatively high water surface profile while 0.028 appears to produce a good fit for the critical reach below the confluence. Errors in matching the observed data on the Snake generally were within 2 feet of the model. While the pre-project profiles allow calibration over a wide range of flows they may not accurately indicate post project channel roughness, particularly in the deeper parts of the reservoir. This uncertainty is likely to be on the conservative side since the increased channel depth, reduced bank vegetation, and smoothing by sediment deposits would be likely to reduce the channel roughness. The possibility of increased bed-form roughness during a SPF due to dune formation will need to be investigated.

d. Flow Distribution.

Plates 31 and 32 indicate the correlation between flows on the Snake River and flows on the Clearwater at Spaulding and the Snake River at Anatone during annual peak flow events. The timing of peak flows on the Snake and Clearwater Rivers, may or may not coincide for a particular flood event. Plates 33 through 35 indicate the profile spread that could be expected during a Standard Project event on the Snake River below the confluence combined with either low or high bound curves for flows on the upper Snake or Clearwater rivers combined with roughness coefficients either higher or lower by 0.002 than the adopted values.

e. Project Operation Error.

Operator or forecasting errors can result in higher flows than would normally be expected as discussed earlier in Paragraph 6. Premature filling of either Brownlee or Dworshak prior to the arrival of the flood peak could result in flows approaching the peak reservoir inflow. The 1974 flood on the Clearwater River was a recent example. Such an error would be of little consequence so long as the resulting flow did not exceed the ability of Lower Granite Dam to maintain the design freeboard. At present this flow is about 360,000 cfs, but sediment inflow could reduce this value by about 5000 per year (assuming no dredging). Operator error would become a progressively greater risk with continued loss in channel capacity.

Severe floods resulting from operation error on the upper Snake River system appear to be somewhat less likely than on the Clearwater since there are several upstream flood control projects (Brownlee, Boise River, and Palisades-Jackson Hole) regulate the Snake River. The maximum increase in discharge due to total loss of control on all projects would be in the range of 50 to 100 kcfs based on regulated vs unregulated lower granite frequency curves (See Plate 17). As an example, at the present time a 20-year flood with total loss of control could result in a flood peak of 360 kcfs.

A rise in water surface of 0.06 feet per 1000 cfs discharge increase can be used as a rough approximation of the impact of operation errors near the peak of a standard project flood. As an example: During a Standard Project Flood a 28,000 cfs increase (similar to 1974 flood) would raise the profile about 1.7 feet at the CPRR Bridge. This combined with the additional loss of up to 1 ft due to sediment inflow could bring the water level very close to the top of the levees without any allowance for wind-wave action, bridge obstructions, or errors in hydraulic modeling.

f. Debris Obstruction.

Three bridges cross the Snake and Clearwater rivers in the leveed reach. During a Standard Project Flood the river would be transporting a large quantity of floating debris (trees, logs, parts of houses, etc.). However, a serious condition could develop if a barge tow was to loose power or control or if one or more barges were to break loose from their moorings at the Port of Lewiston near the peak of a Standard Project Flood. The current would likely carry the barge into the center or right side of the channel where it could strike one or more bridge piers, break up, wrap around a pier, or become lodged against two piers. Similar events have happened in the past. Plate 35 shows a barge trapped against the UPRR bridge in June 1974. Barges using the river range in length from 180 to nearly 360 ft and in width from 42 to 63 ft although most range from 42-50 ft wide by 180 to 275 ft long. The scenario investigated assumed that a 200 ft long barge broke loose, became wedged against two piers adjacent to the navigation guide wall, turned on its side and sank, dropping enough of its load of containers to effectively block the full depth of flow as illustrated on Plate 36. The resulting obstruction would block 30% of the flow area at the narrowest part of the river, raise the water surface about 1.5 feet, and increase velocities along both banks. Such an event, combined with errors in project operation, friction loss estimates, or sediment inflow could result in overtopping the levees. Profiles with and without bridge blockage are shown on Plate 37. Blockage by an floating barge (14 ft draft) or during a lower flow would result in correspondingly reduced impacts, but an incident involving the normal maximum tow dimensions (64 by 650 ft.) could create a very serious condition involving levee erosion as well as increased flood depths.

g. Superelevation.

Superelevation of high velocity flows could have a minor, but significant effect on the water surface, particularly at the bend in the river at the upstream failure point (RM 3.0). Using the methods found in EM 1110-2-1601 a maximum of about 0.5 feet superelevation was calculated for flow velocities and channel conditions at this location during a SPF.

9. <u>TEMPORARY MEASURES TO REDUCE POTENTIAL FLOOD DAMAGE.</u>

There are a number of temporary actions that could be considered to reduce the rate of freeboard loss or to reduce potential flood damage should a flood occur when insufficient freeboard exists. Some of these are as follows:

b. Lower Granite Pool to Reduce Upstream Sediment Deposition

b. Continue Interim Dredging

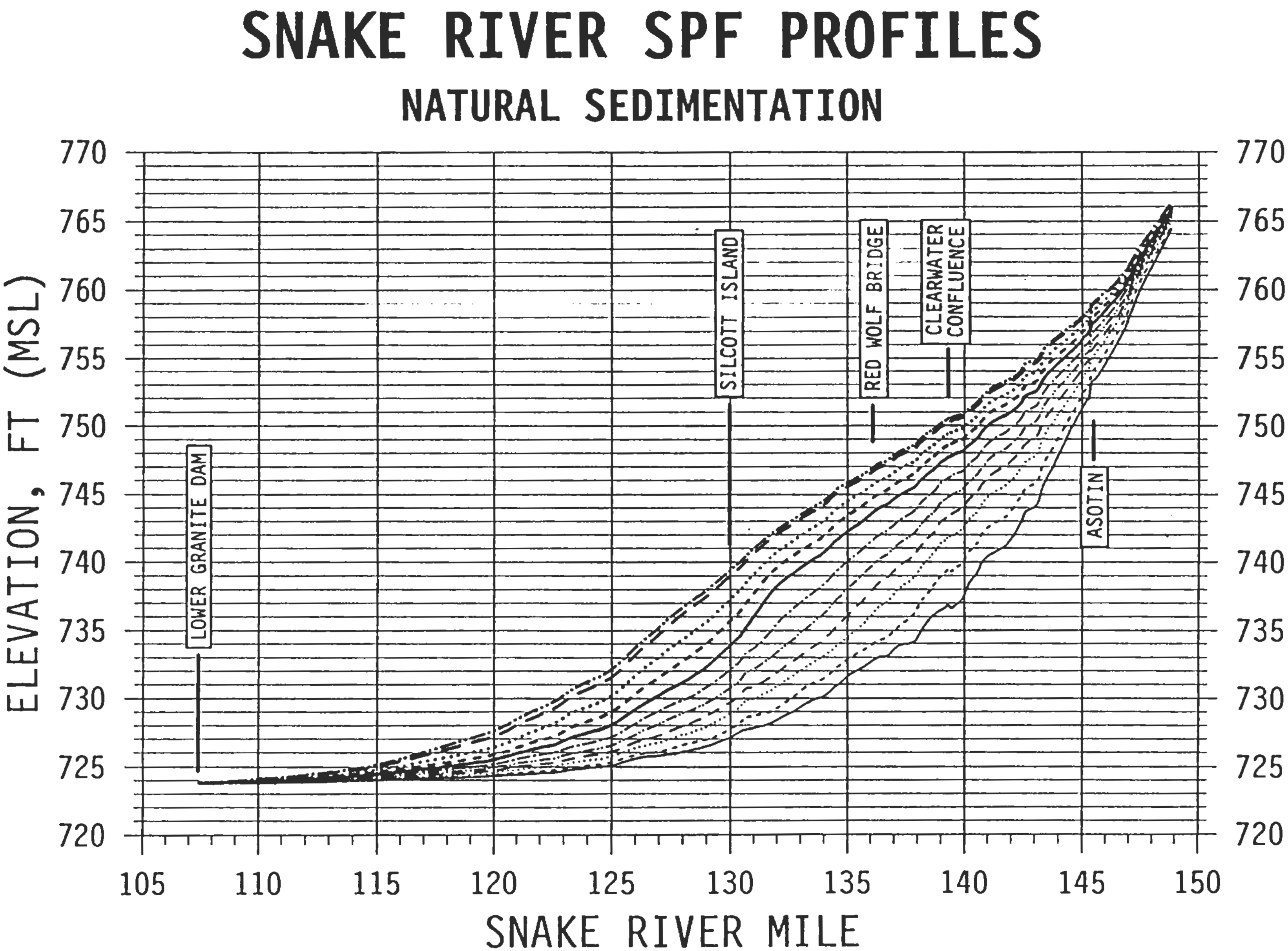
c. Emergency Measures: Evacuation Plans, Flood Proofing, Isolation of Flood Prone Areas, Temporary Levee Raise, Revised Operation of Flood Control Projects.

With respect to emergency measures, a plan for isolation of flood prone areas and an emergency or temporary levee raise deserve some discussion. The Corps has taken a dim view in the past of reliance on emergency measures when permanent structural alternatives are available. This is partly due to the fact that considerable confusion often exists during an emergency, knowledgeable personnel are often unavailable, and emergency procedures are often not followed.

During a flood it would be prudent to concentrate flood fight efforts on the highest valued areas which are located along the south side of the Clearwater River. If failure occurred on the left bank near the PFI plant it might be possible to isolate the area above Memorial bridge from the area below by blocking the narrow opening under the south side of the bridge. The levee just upstream could then be cut to allow flood water to drain back into the river.

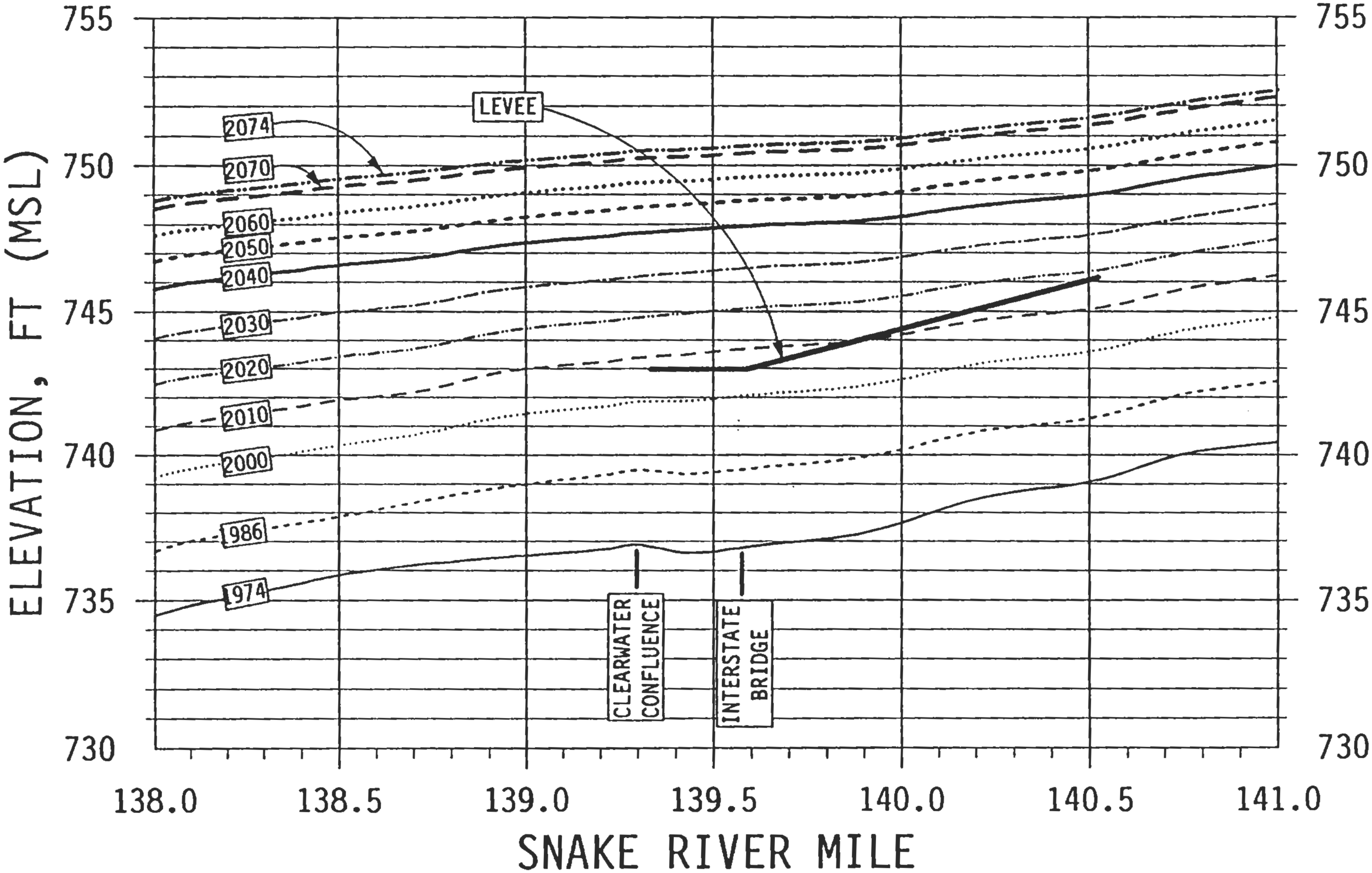
Prevention of downstream failure would consist of maintaining riprap integrity and raising the levee. It has been estimated that it would require about 2 weeks to raise the levee 3 feet (the amount that could be achieved without blocking bridges etc.). Since the low chords of the bridges are only a couple feet above the levee top, special treatment would be required to assure adequate compaction and a watertight seal around the bridge stringers. There is considerable development on top of the levees - landscaping, paved jogging trails, etc. It would require an real emergency to warrant destruction of these developments. It is probable that a very high discharge with imminent loss of control combined with forecasts of even higher flows would be required before a decision would be made to run the risk of a false alarm, wasted effort, and considerable damage to the levee landscaping.

APPENDIX A: CHARTS AND GRAPHS


SNAKE RIVER SPF PROFILES
NATURAL SEDIMENTATION
ELEVATION, FT (MSL)
770
765
760
755
750
745
740
735
730
725
720
LOWER GRANITE DAM
SILCOTT ISLAND
RED WOLF BRIDGE
CLEARWATER CONFLUENCE
ASOTIN
105
110
115
120
125
130
135
140
145
150
SNAKE RIVER MILE

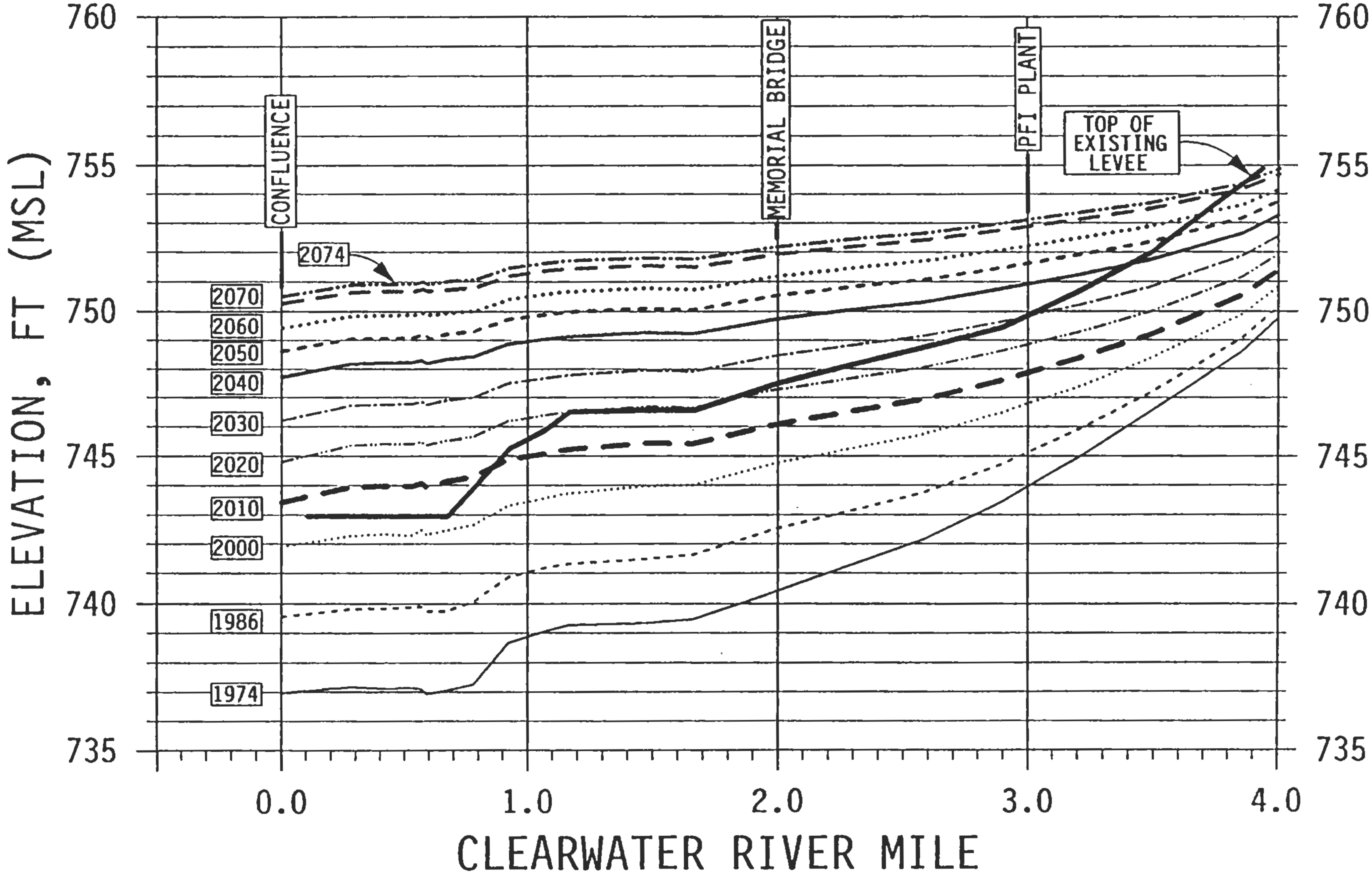
SNAKE RIVER SPF PROFILES

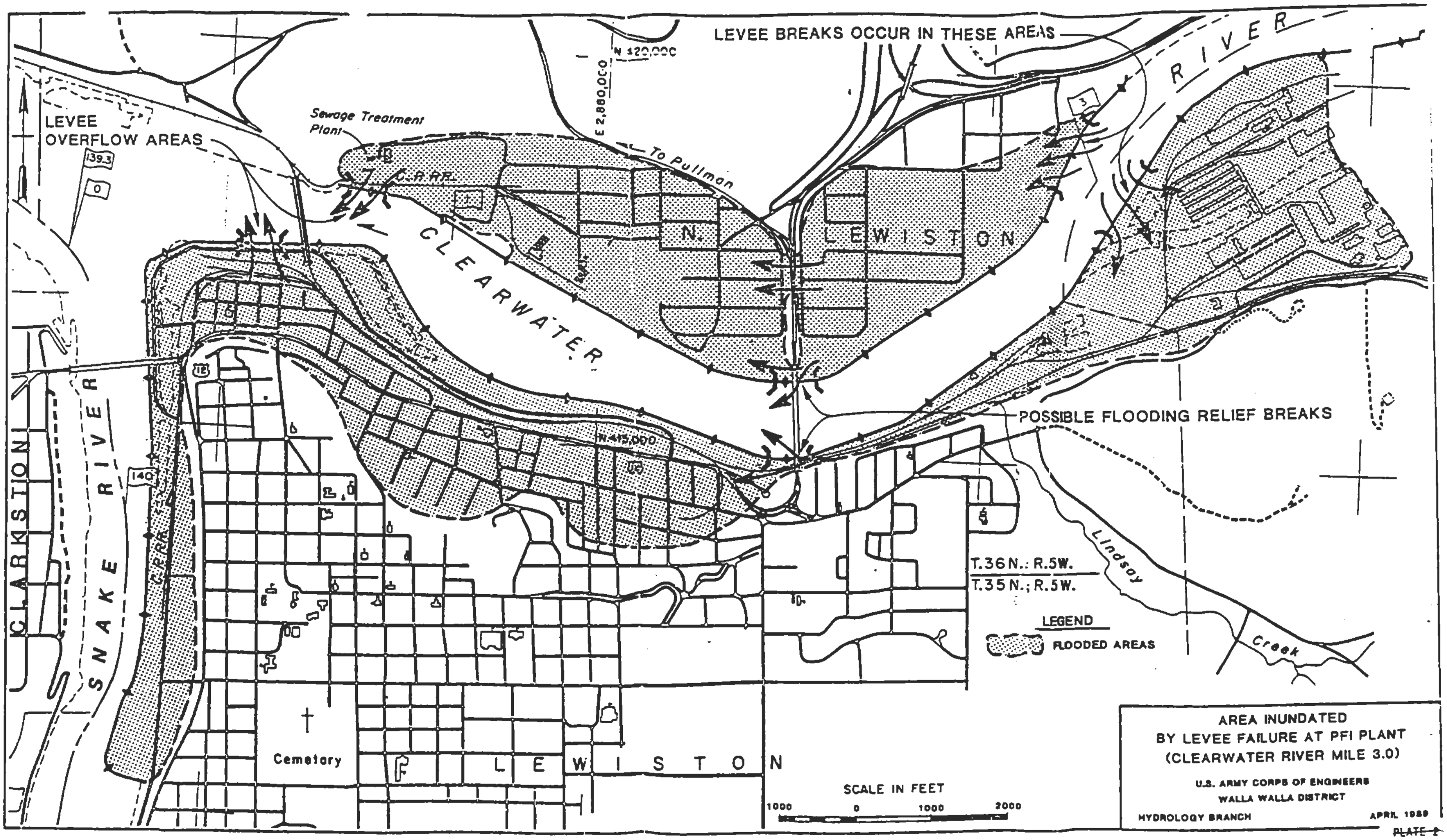
NATURAL SEDIMENTATION



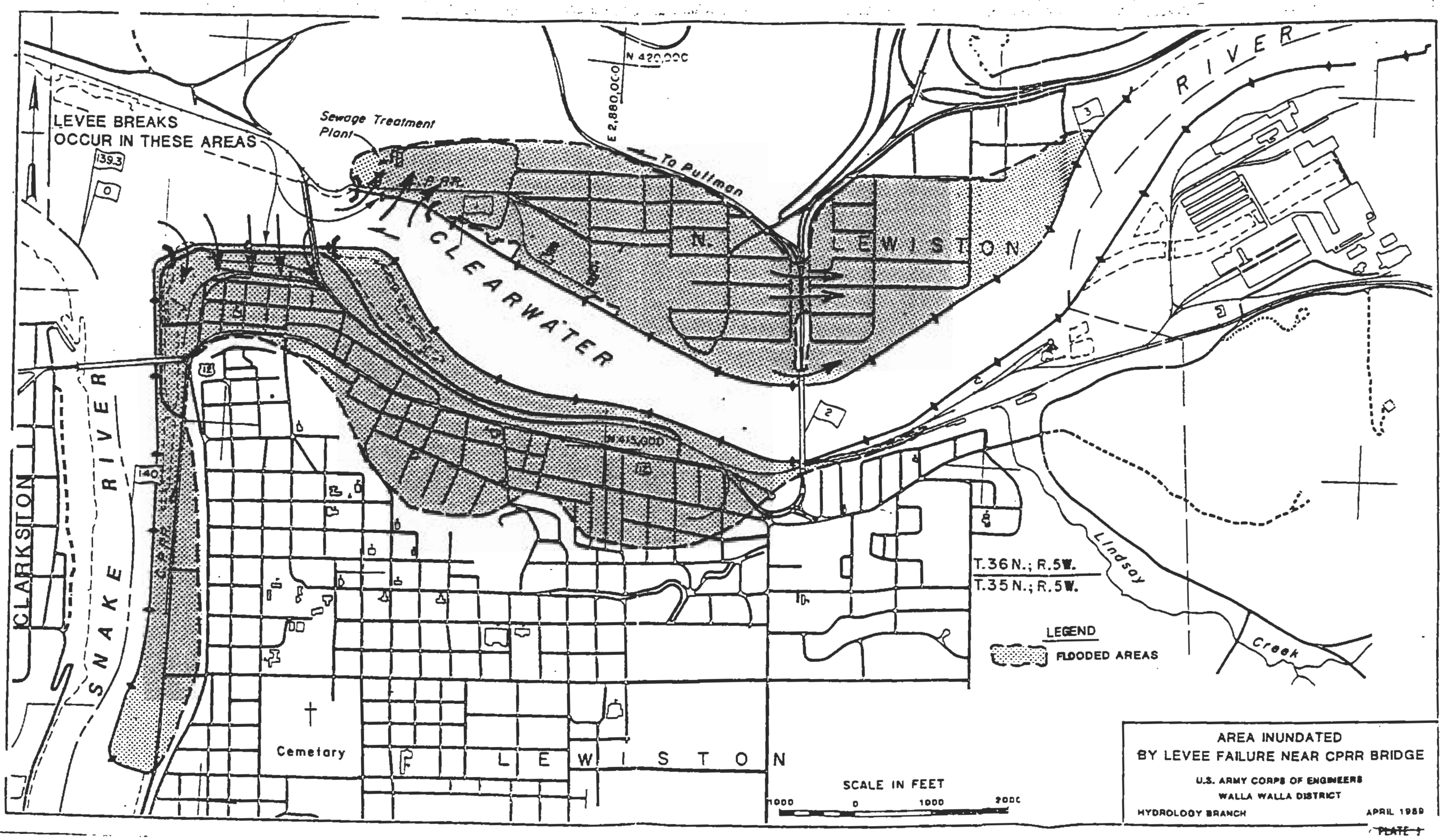
PROJECTED RISE IN CLEARWATER SPF PROFILES

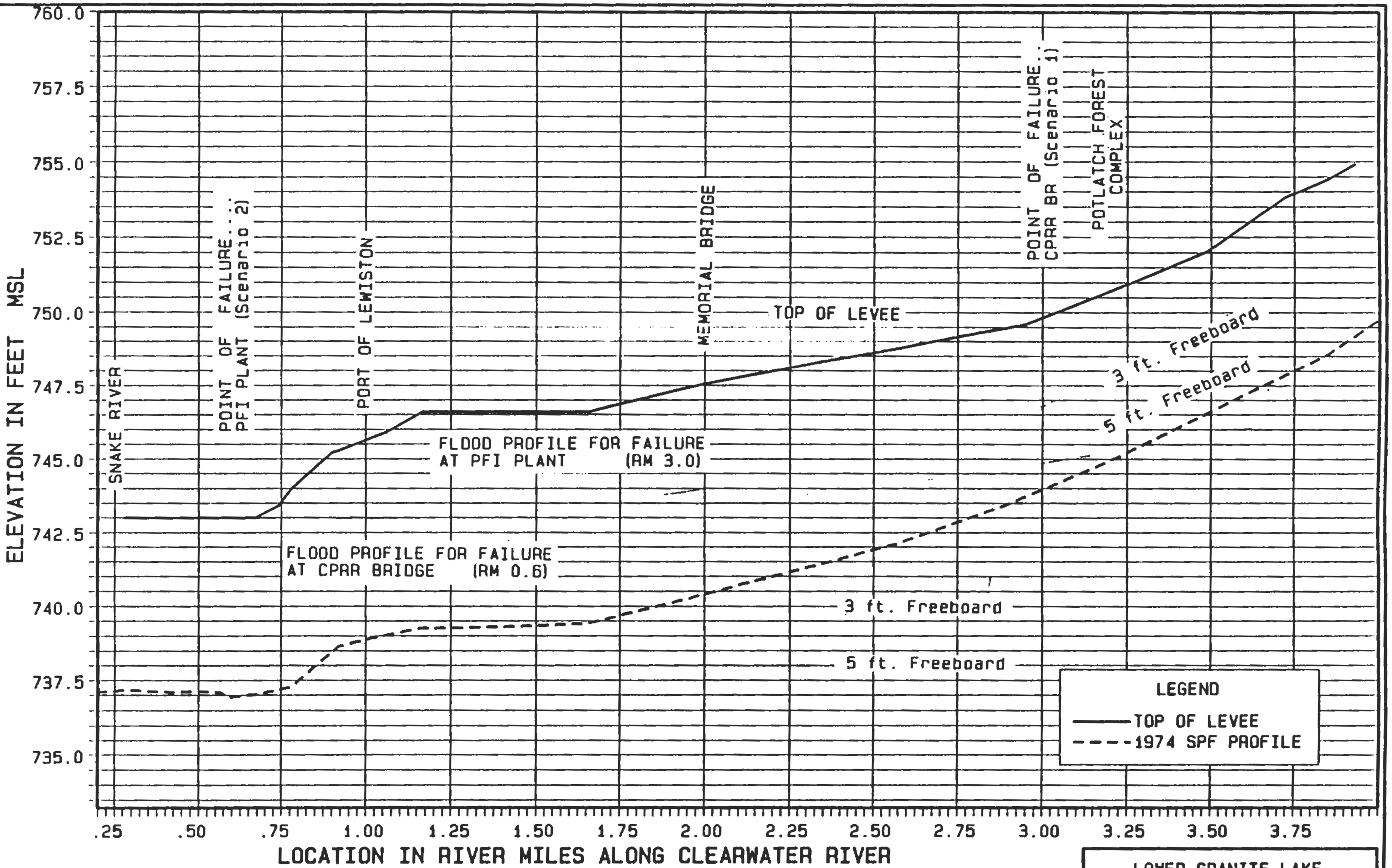
NATURAL SEDIMENTATION WITH LEVEE RAISE





AREA INUNDATED
BY LEVEE FAILURE AT PFI PLANT
(CLEARWATER RIVER MILE 3.0)
U.S. ARMY CORPS OF ENGINEERS
WALLA WALLA DISTRICT
HYDROLOGY BRANCH
APRIL 1989
PLATE 2


LEVEE BREAKS
OCCUR IN THESE AREAS
Sewage Treatment
Plant
To Pullman
N 420,000
E 2,880,000
CLEARWATER
N. LEWISTON
RIVER
SNAKE RIVER
CLARKSTON
T.36 N.; R.5W.
T.35 N.; R.5W.
Lindsay
Creek
LEGEND
FLOODED AREAS
Cemetary
LEWISTON
SCALE IN FEET
1000
0
1000
2000
AREA INUNDATED
BY LEVEE FAILURE NEAR CPRR BRIDGE
U.S. ARMY CORPS OF ENGINEERS
WALLA WALLA DISTRICT
HYDROLOGY BRANCH
APRIL 1989
PLATE 3

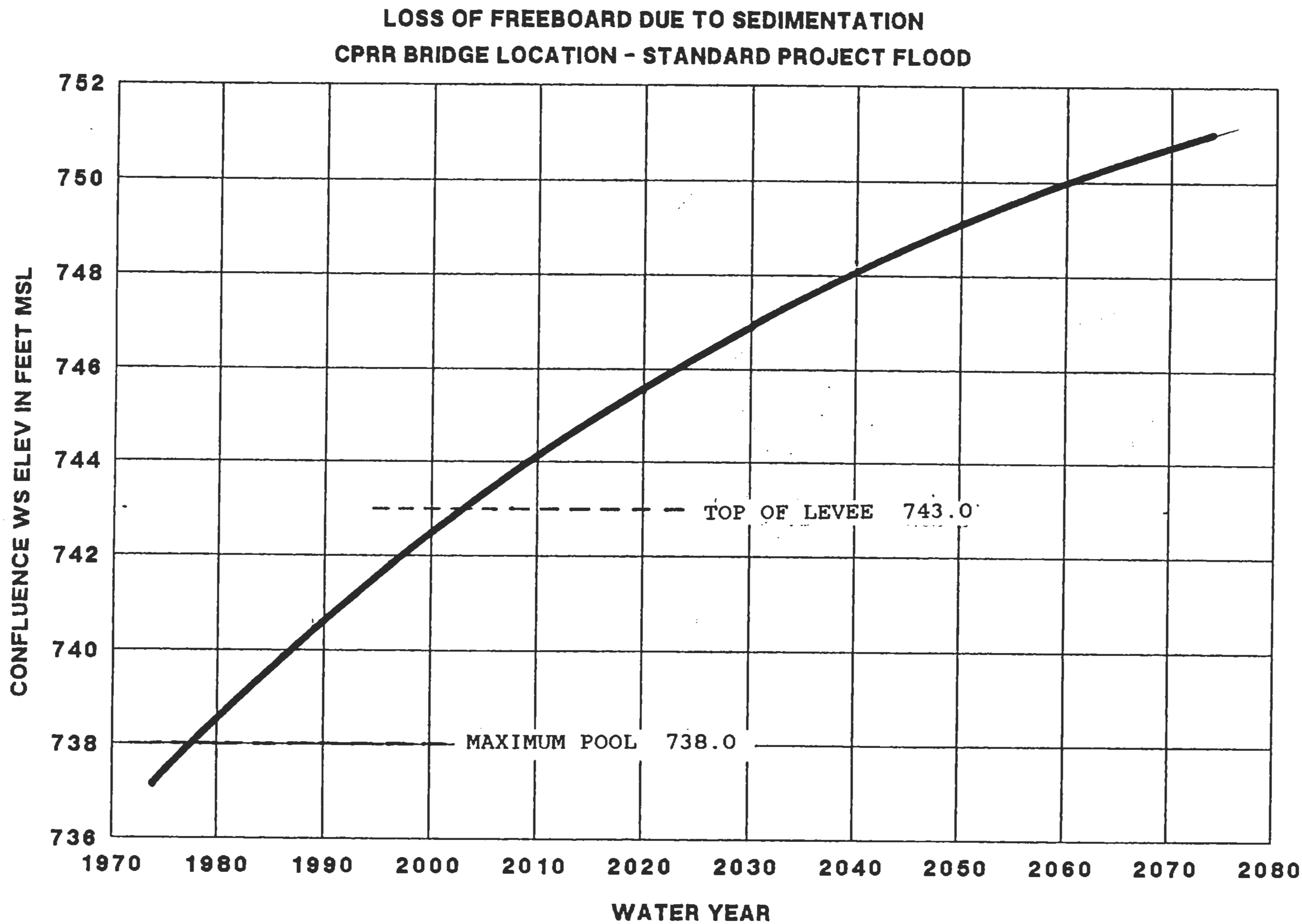


LOWER GRANITE LAKE

FLOOD PROFILES
AFTER LEVEE FAILURE

Hydrology Branch

L. CUNNINGHAM MAY 1991

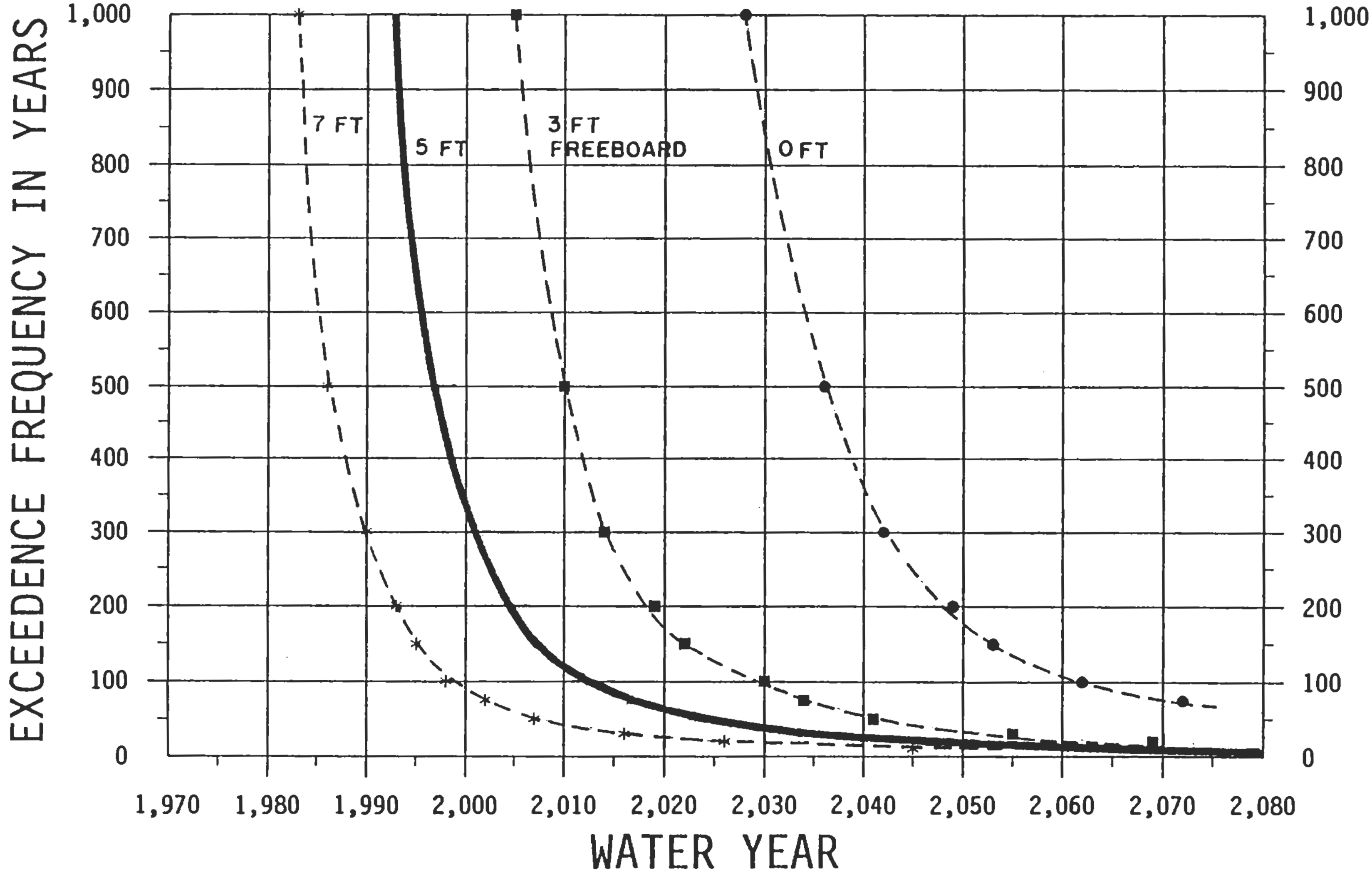

LOSS OF FREEBOARD DUE TO SEDIMENTATION
CPRR BRIDGE LOCATION - STANDARD PROJECT FLOOD
CONFLUENCE WS ELEV IN FEET MSL
752
750
748
746
744
742
740
738
736
TOP OF LEVEE 743.0
MAXIMUM POOL 738.0
1970
1980
1990
2000
2010
2020
2030
2040
2050
2060
2070
2080
WATER YEAR

LEWISTON LEVEE FAILURE AT CPRR BRIDGE LOCATION
YEAR WHEN FLOW WOULD ENCROACH ON FREEBOARD

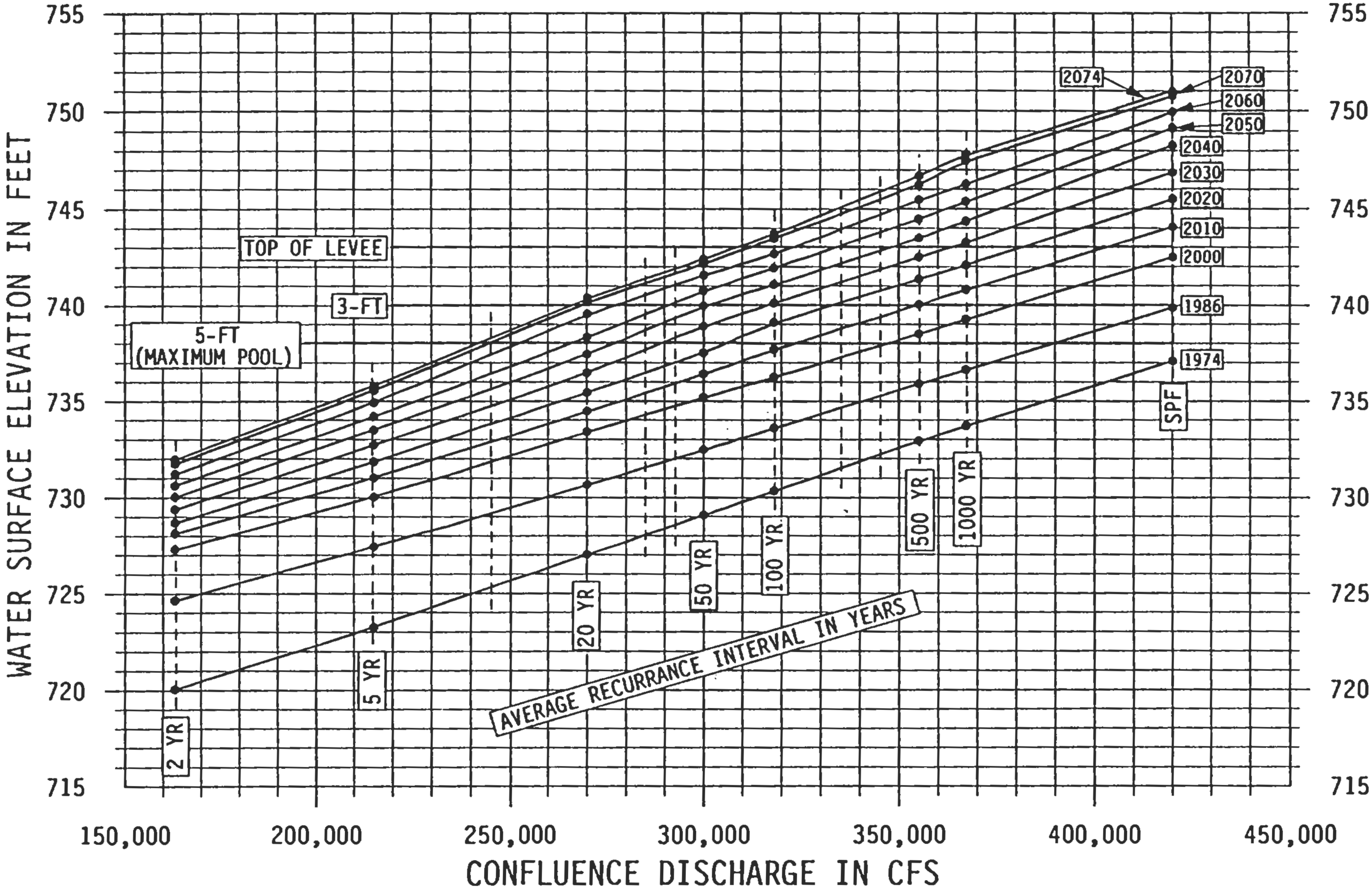
DISCHARGE FREQUENCY	Q	1986 WSEL	1986 FREE-BOARD	YEAR OF ENCROACHMENT 0-FT	3-FT	5-FT	7-FT
2	163000	724.64	18.4				
5	215000	727.46	15.5				2076
10	244000	729.10	13.9			2070	2045
20	270000	730.66	12.3		2069	2047	2026
30	285000	731.60	11.4		2055	2033	2016
50	300000	732.46	10.5		2041	2023	2007
75	310000	733.00	10.0	2072	2034	2017	2002
100	318000	733.60	9.4	2062	2030	2012	1998
150	330000	734.30	8.7	2053	2022	2007	1995
200	335000	734.70	8.3	2049	2019	2005	1993
300	345000	735.25	7.8	2042	2014	2001	1990
500	355000	735.92	7.1	2036	2010	1997	1986
1000	367000	736.64	6.4	2028	2005	1993	1983
SPF	420000	739.88	3.1	2004	1986	1978	1969

LEWISTON LEVEE FAILURE AT CPRR LOCATION

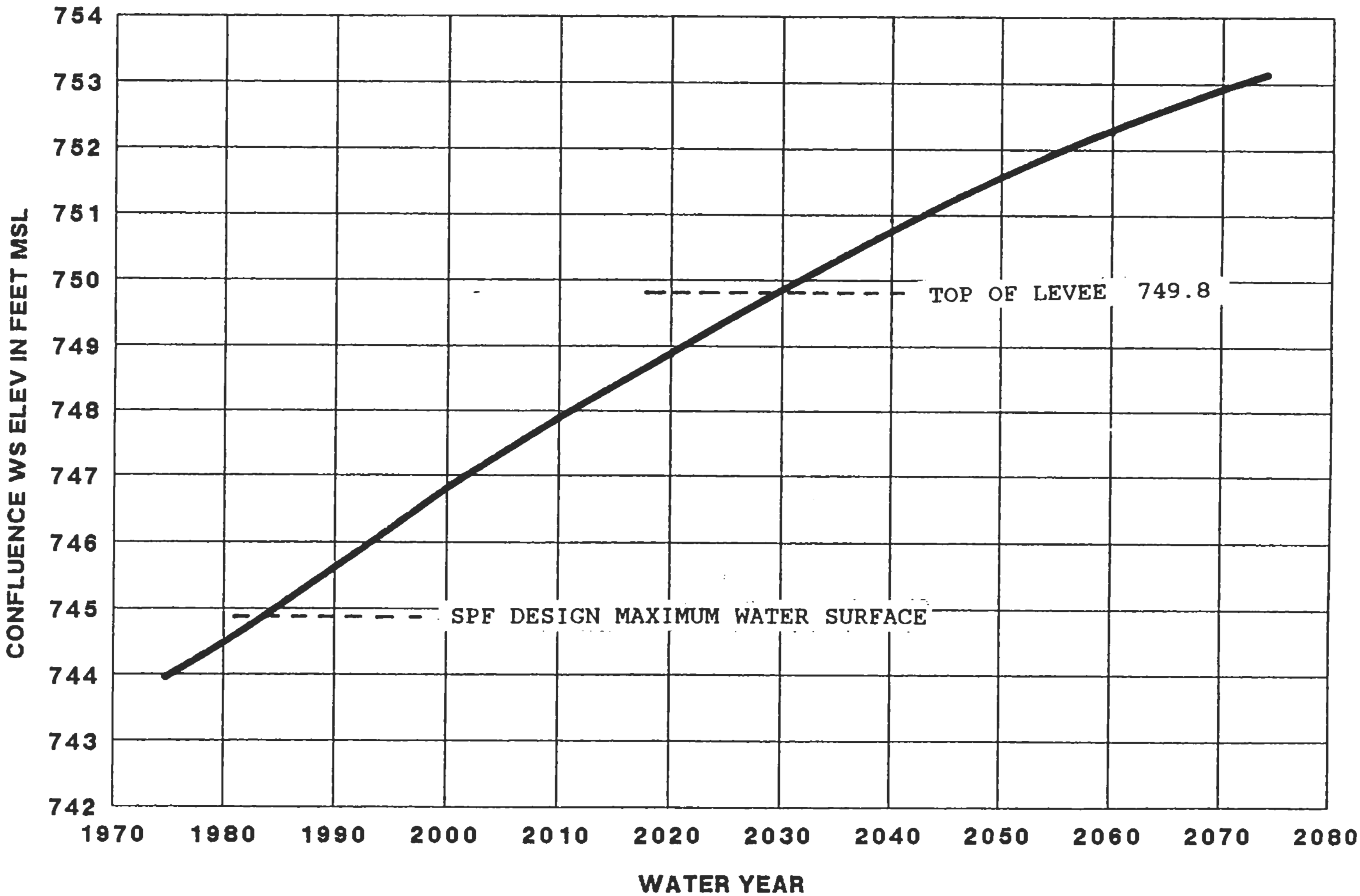
DATE OF FREEBOARD ENCROACHMENT



PROJECTED INCREASE IN PROFILE AT CPRR BRIDGE DUE TO SEDIMENTATION



LOSS OF FREEBOARD DUE TO SEDIMENTATION
PFI PLANT LOCATION - STANDARD PROJECT FLOOD

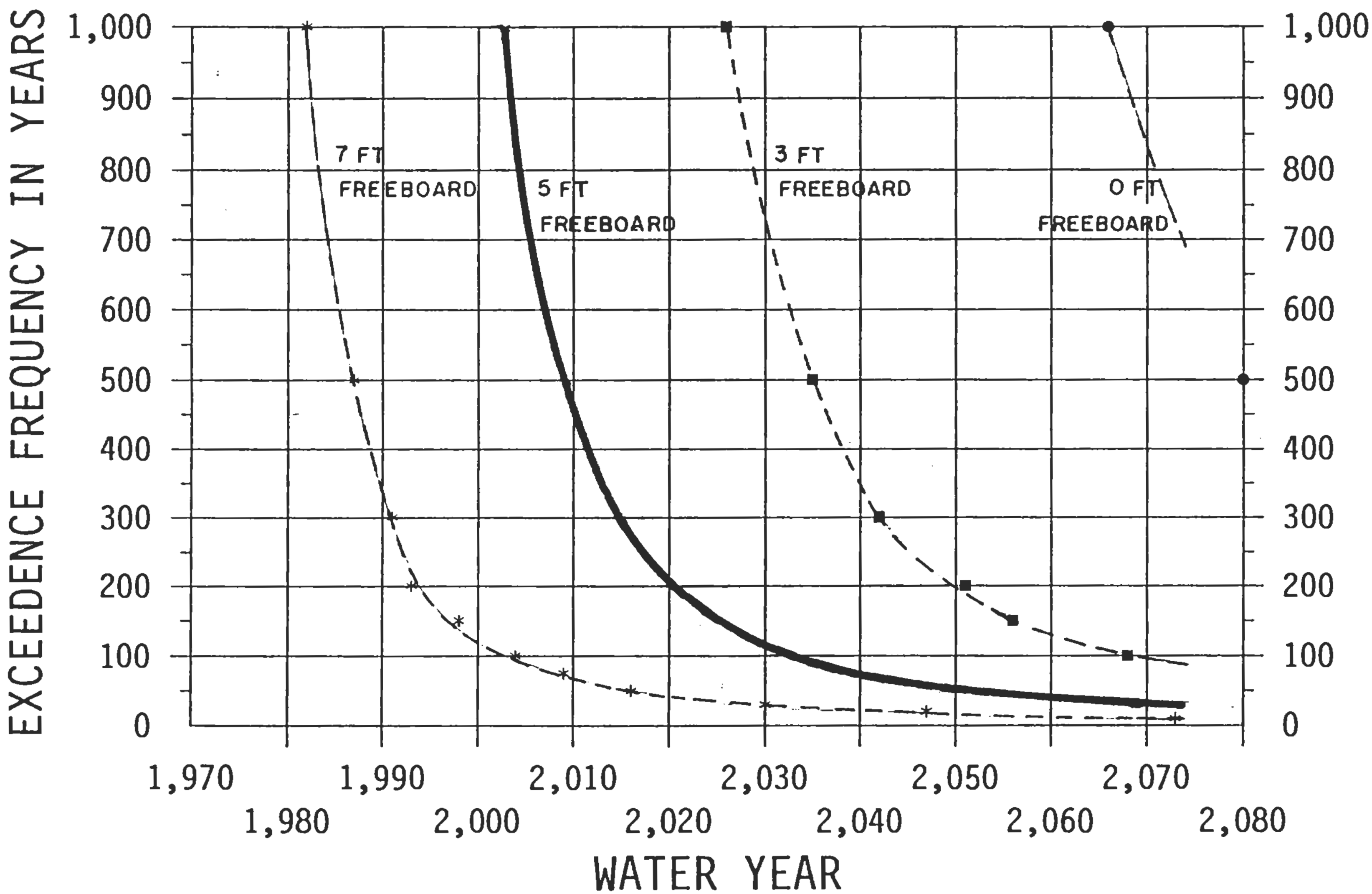


LEWISTON LEVEE FAILURE AT PFI PLANT
YEAR WHEN FLOW WILL ENCROACH ON INDICATED FREEBOARD

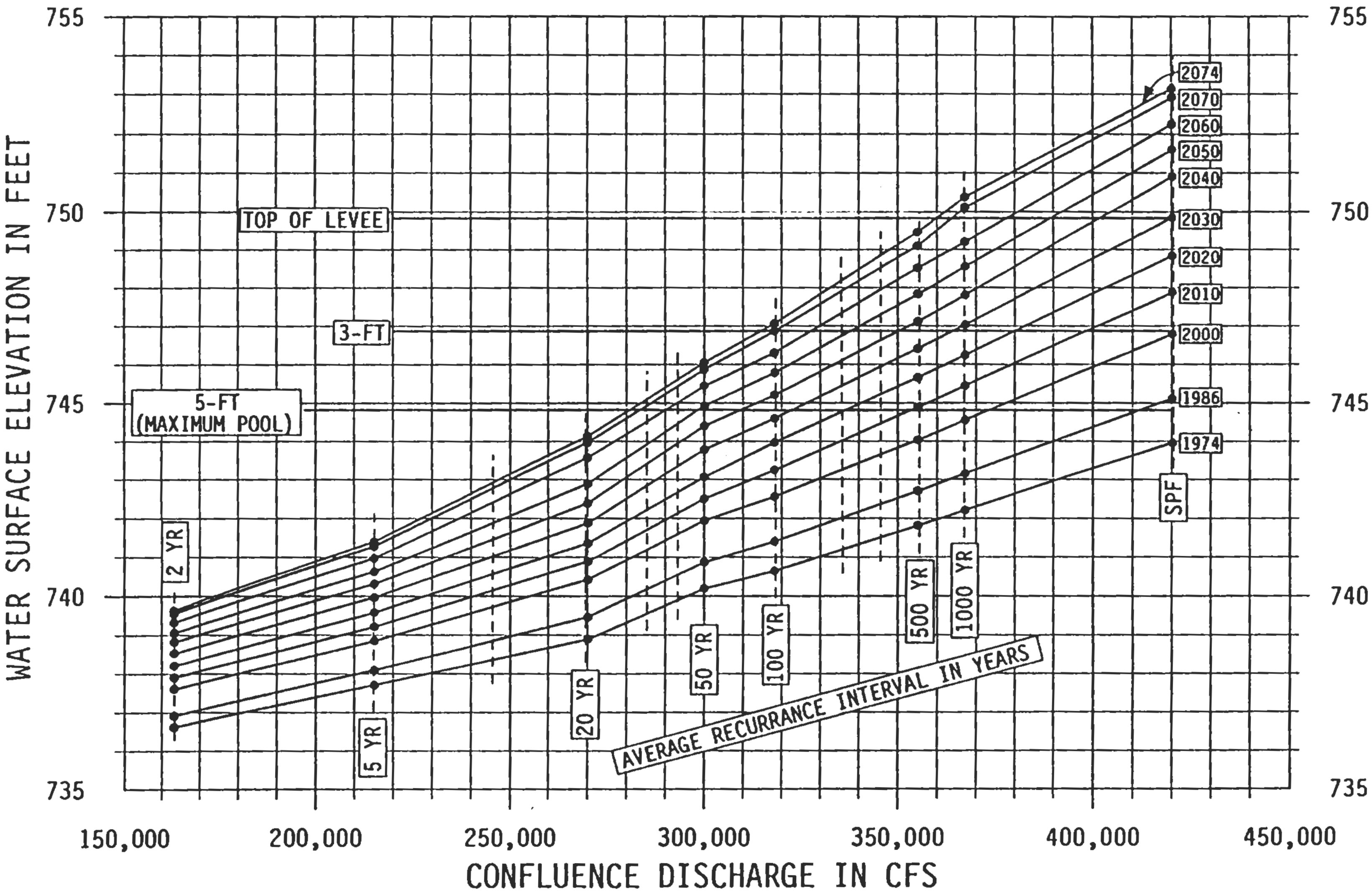
DISCHARGE FREQUENCY	Q	1986 WSEL	1986 FREE-BOARD	YEAR OF ENCROACHMENT 0-FT	3-FT	5-FT	7-FT
2	163000	736.94	12.9				
5	215000	738.12	11.7				
10	244000	738.8	11				2073
20	270000	739.48	10.3				2047
30	285000	740.2	9.6			2069	2030
50	300000	740.89	8.9			2049	2016
75	310000	741.15	8.7			2040	2009
100	318000	741.42	8.4		2068	2034	2004
150	330000	741.8	8		2056	2025	1998
200	335000	742	7.8		2051	2021	1993
300	345000	742.35	7.5		2042	2015	1991
500	355000	742.72	7.1	2080	2035	2009	1987
1000	367000	743.17	6.6	2066	2026	2003	198[illegible]
SPF	420000	745.14	4.7	2029	2000	1983	1962

LEWISTON LEVEE FAILURE AT POTLATCH LOCATION

DATE OF FREEBOARD ENCROACHMENT



PROJECTED INCREASE IN PROFILE AT POTLATCH DUE TO SEDIMENTATION



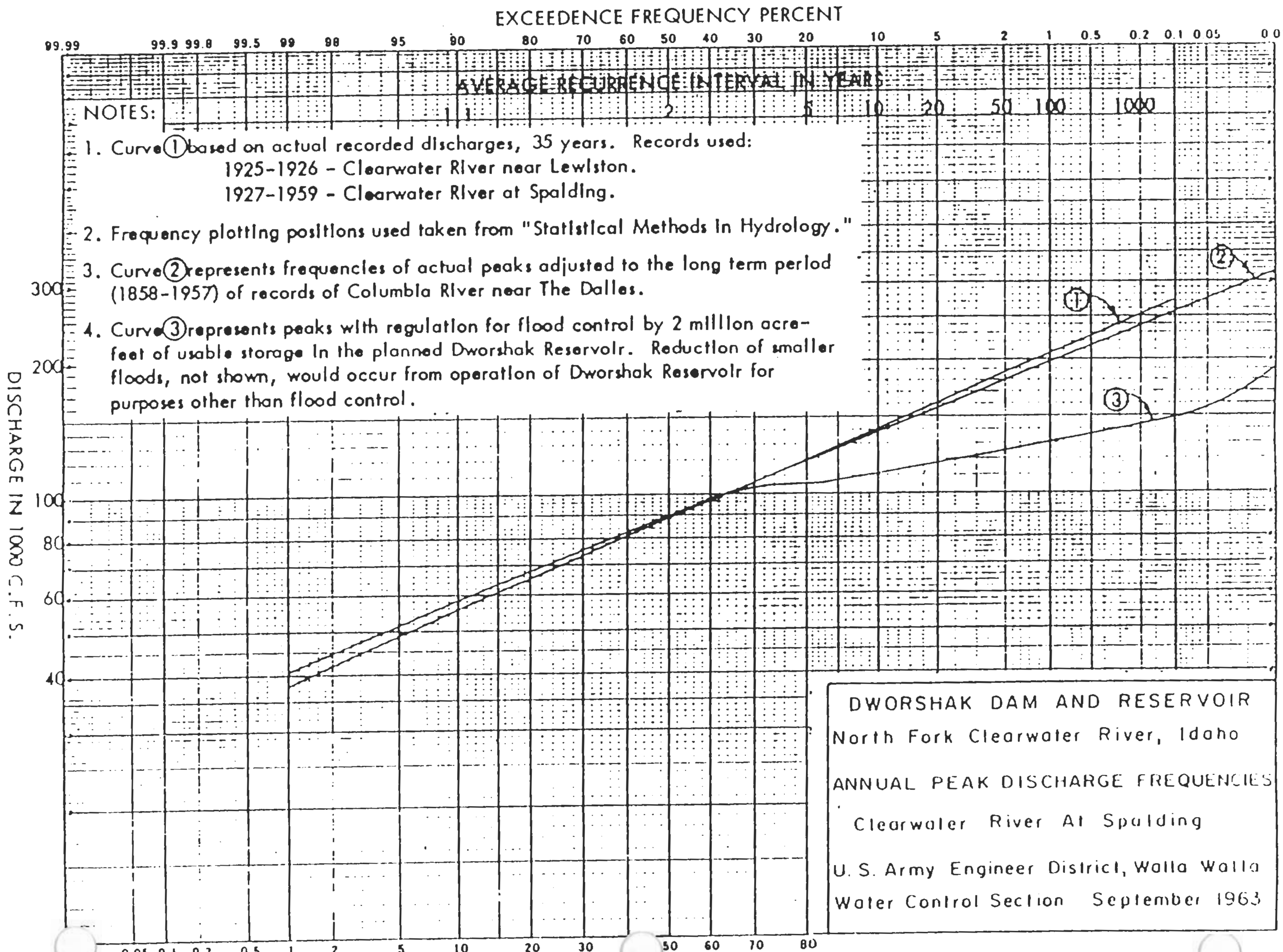
SNAKE AND CLEARWATER RIVERS
INSTANTANEOUS PEAK FLOWS NEAR CONFLUENCE

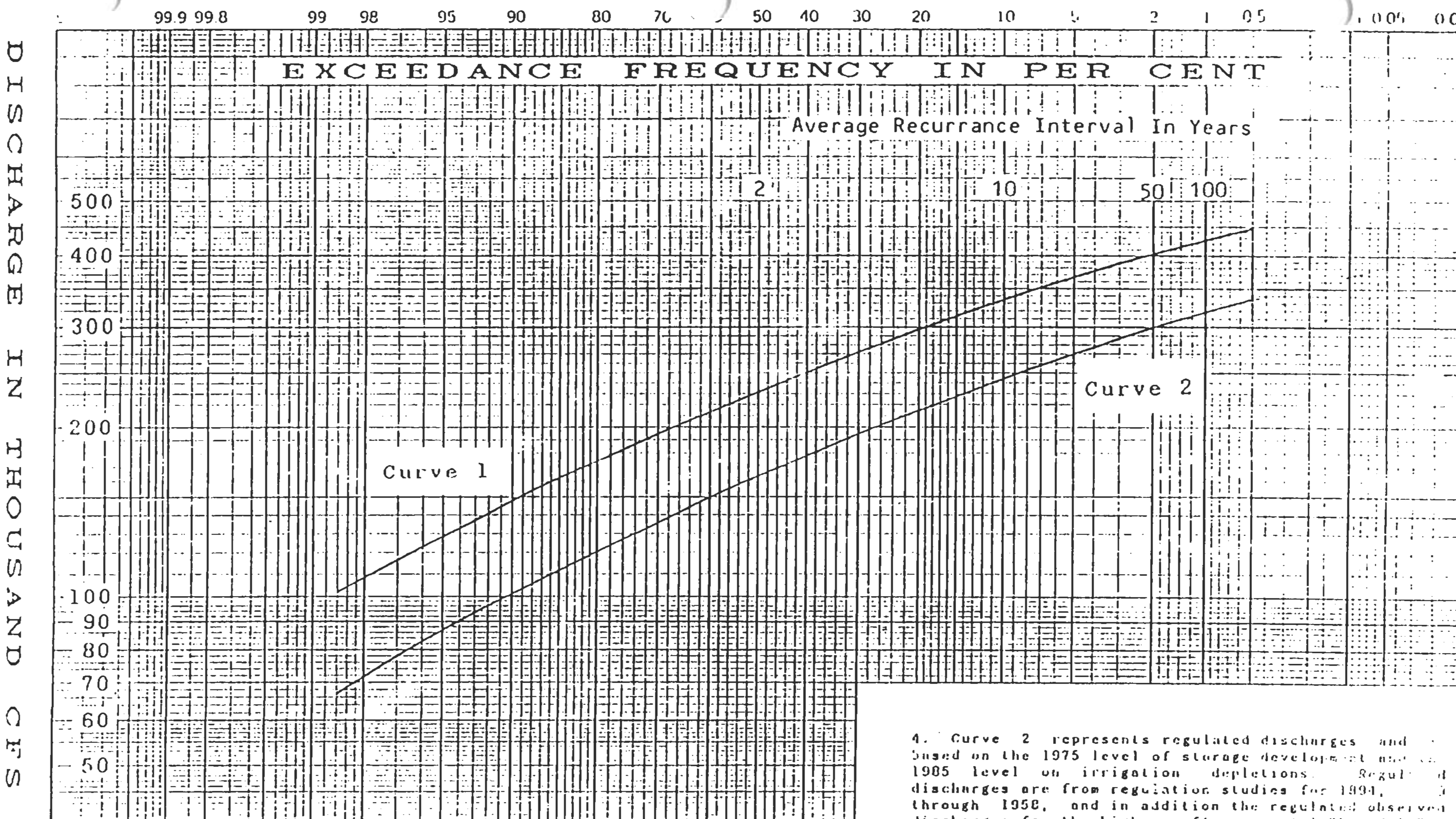
	WATER YEAR	CLEARWATER SPAULDING		SNAKE ANATONE		SNAKE CONFLUENCE
	1988	44600	5/7	53600	5/25	90280*
	1987	52000	5/1	57900	5/13	103880*
	1986	70600	5/30	159000	6/1	219200*
	1985	60800	6/8	82700	4/11	125770**
	1984	81500	5/31	183000	5/31	263650**
	1983	61000	5/29	150000	5/29	209900**
	1982	66300	6/17	148000	6/18	211200**
	1981	66400	6/19	122000	6/10	179940**
	1980	52300	5/26	92400	6/12	132570**
	1979	66900	5/24	82000	5/25	148000**
	1978	58800	6/9	99300	6/9	152770*
	1977	31700	5/2	38000	6/7	65400*
	1976	78700	5/11	124000	5/15	209880*
	1975	79300	6/3	119000	6/8	184800***
	1974	131000	6/16	195000	6/18	316000***
	1973	36900	5/18	63000	5/18	98100***
	1972	94200	6/2	138000	6/3	240000#
AVERAGES	1972-1988	66647		112171		173608
AVERAGES	1972-1979	72188		107288		176869

From gage: Snake River at Clarkston.
* Obtained by selecting the highest sum of 6-hr observed data.
** Obtained by adding the peak flow in one stream with the 6-hr observed flow in the other at the same time and date.
*** Obtained by totaling the peak flow in one stream plus the mean daily in the other on the same date.

Several methods were used to estimated the instantaneous peak flows at the confluence depending on the data available. Since both streams often do not peak on the same date the confluence peak may occasionally occur at a time when neither stream in peaking. The above data does not include local downstream of the gages.

Dworshak regulation began 27 September 1971.


EXCEEDENCE FREQUENCY PERCENT
99.99 99.9 99.8 99.5 99 98 95 90 80 70 60 50 40 30 20 10 5 2 1 0.5 0.2 0.1 0.05 0.01
AVERAGE RECURRENCE INTERVAL IN YEARS
1.1 2 5 10 20 50 100 1000
NOTES:
1. Curve (1) based on actual recorded discharges, 35 years. Records used:
1925-1926 - Clearwater River near Lewiston.
1927-1959 - Clearwater River at Spalding.
2. Frequency plotting positions used taken from "Statistical Methods in Hydrology."
3. Curve (2) represents frequencies of actual peaks adjusted to the long term period (1858-1957) of records of Columbia River near The Dalles.
4. Curve (3) represents peaks with regulation for flood control by 2 million acre-feet of usable storage in the planned Dworshak Reservoir. Reduction of smaller floods, not shown, would occur from operation of Dworshak Reservoir for purposes other than flood control.
DISCHARGE IN 1000 C.F.S.
300 200 100 80 60 40
0.05 0.1 0.2 0.5 1 2 5 10 20 30 50 60 70 80
DWORSHAK DAM AND RESERVOIR
North Fork Clearwater River, Idaho
ANNUAL PEAK DISCHARGE FREQUENCIES
Clearwater River At Spalding
U. S. Army Engineer District, Walla Walla
Water Control Section September 1963



4. Curve 2 represents regulated discharges and based on the 1975 level of storage development and the 1985 level on irrigation depletions. Regulated discharges are from regulation studies for 1894, through 1958, and in addition the regulated observed discharges for the high runoff years of 19[illegible] and 1974. The plotting positions for the regulated event years are for the natural frequency curve. Curve 2 is a graphical fit of the regulated data.

NOTES

1. Drainage area equals 103,200 sq. mi.

2. This is a preliminary graph subject to revision.

3. Curve 1 represents natural discharges and is based on the 1894-1975 station record adjusted for irrigation depletions and storage and extended by correlation with the 1858-1975 Columbia River at The Dalles station record. It includes an expected probability adjustment. The station and adopted skew is -0.5. Natural discharges for the 1894-1975 period of record are plotted based on their ranking within the extended record. The median plotting position method was utilized.

DWORSHAK DAM AND RESERVOIR
North Fork Clearwater River, Idaho

ANNUAL PEAK DISCHARGE FREQUENCIES
Snake River At Lower Granite Dam

U.S. Army Engineer Division, N.P.
NPDEN-WM-HES May 1978

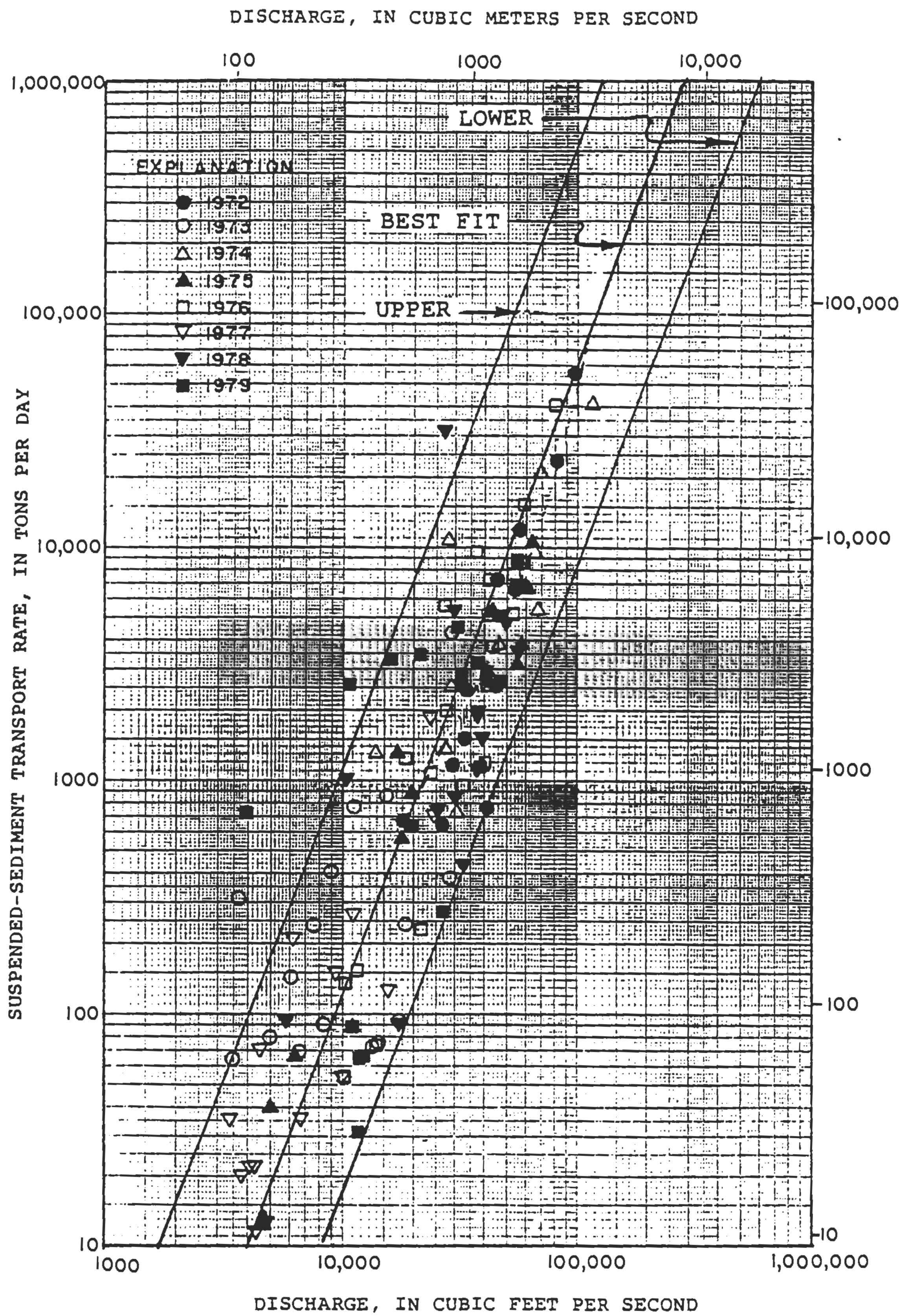


Figure 5.--Suspended-sediment transport rate as a function of stream discharge, Clearwater River at Spalding, Idaho.

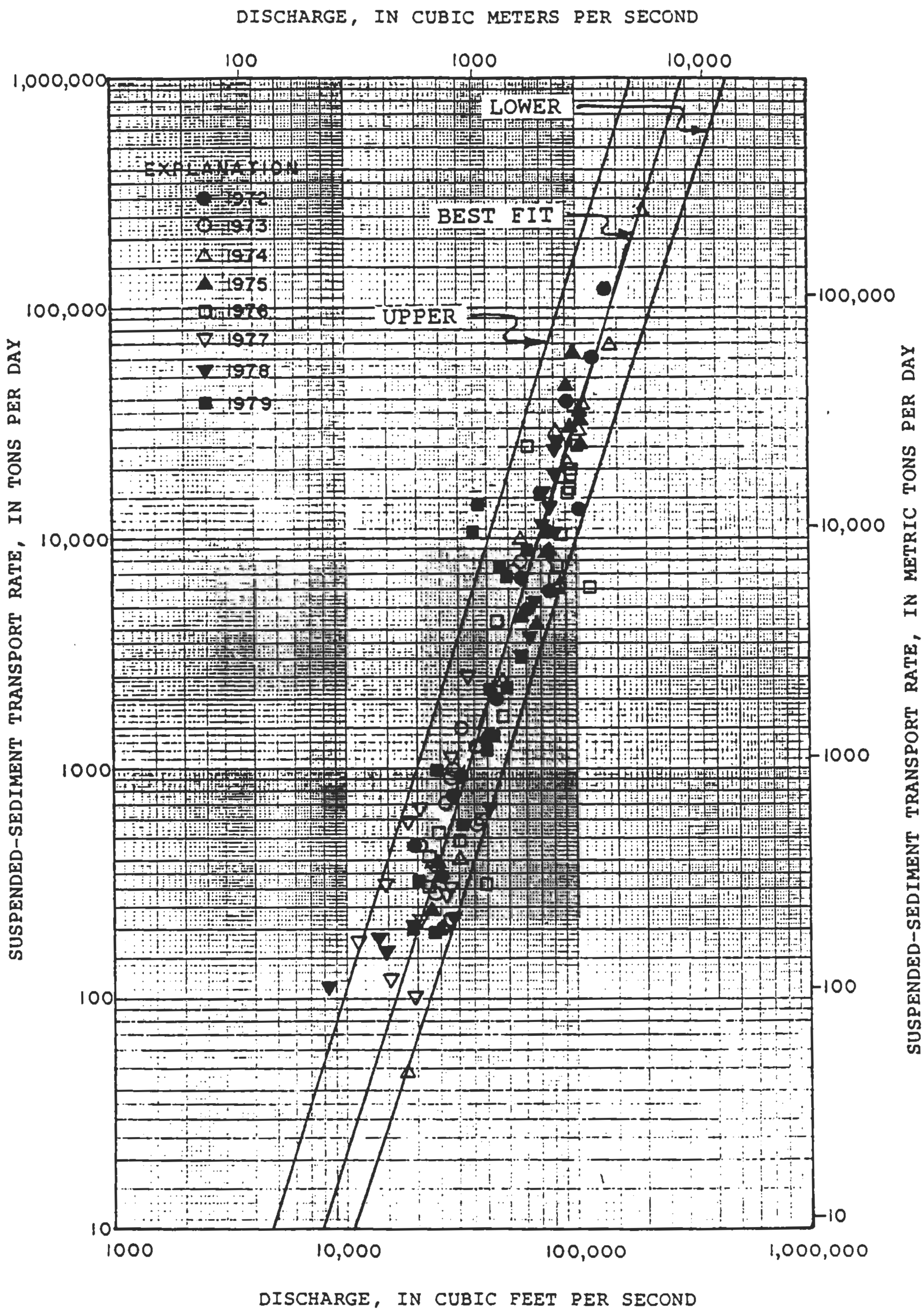
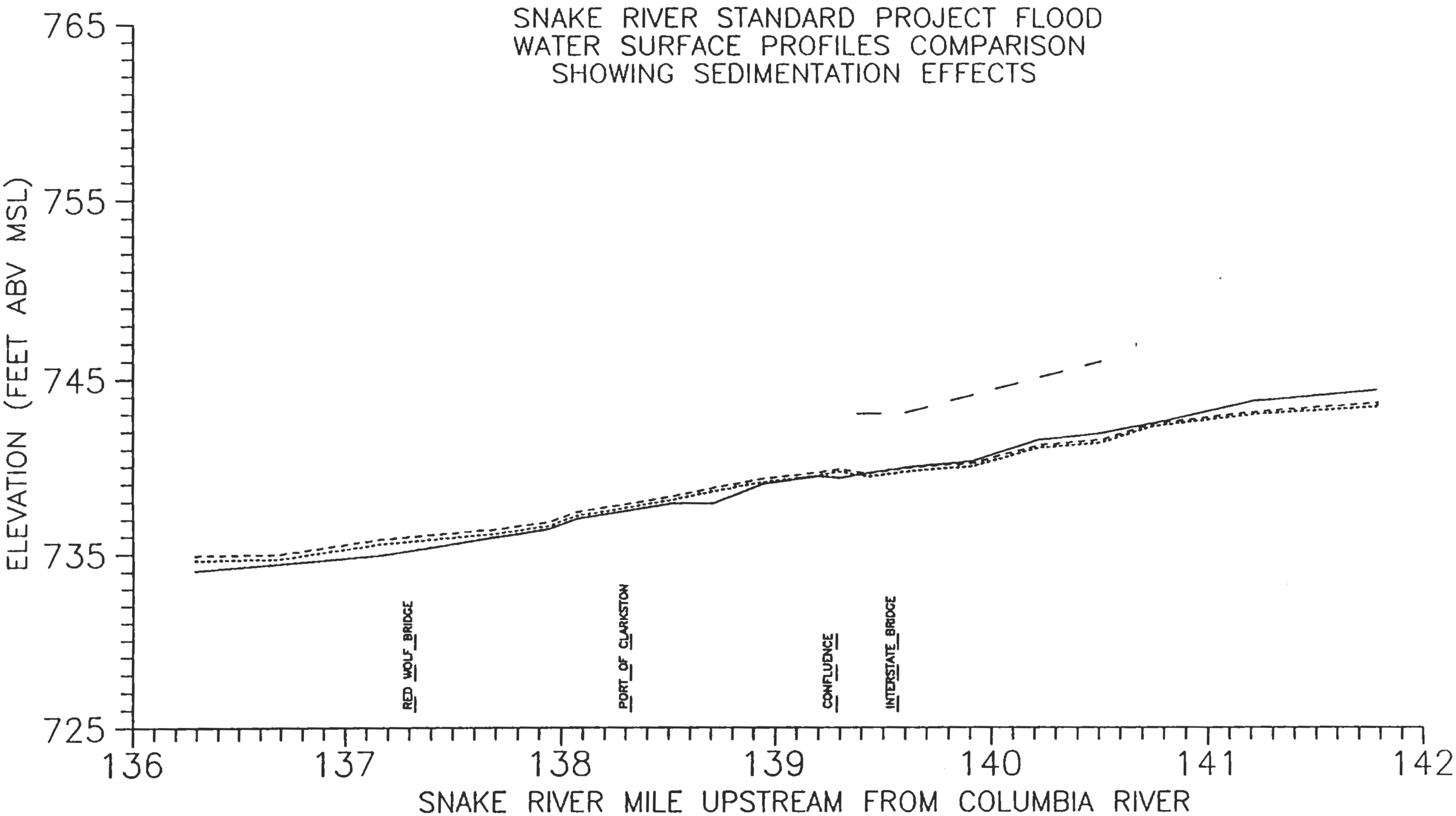


Figure 4.--Suspended-sediment transport rate as a function of stream discharge, Snake River near Anatone, Washington.

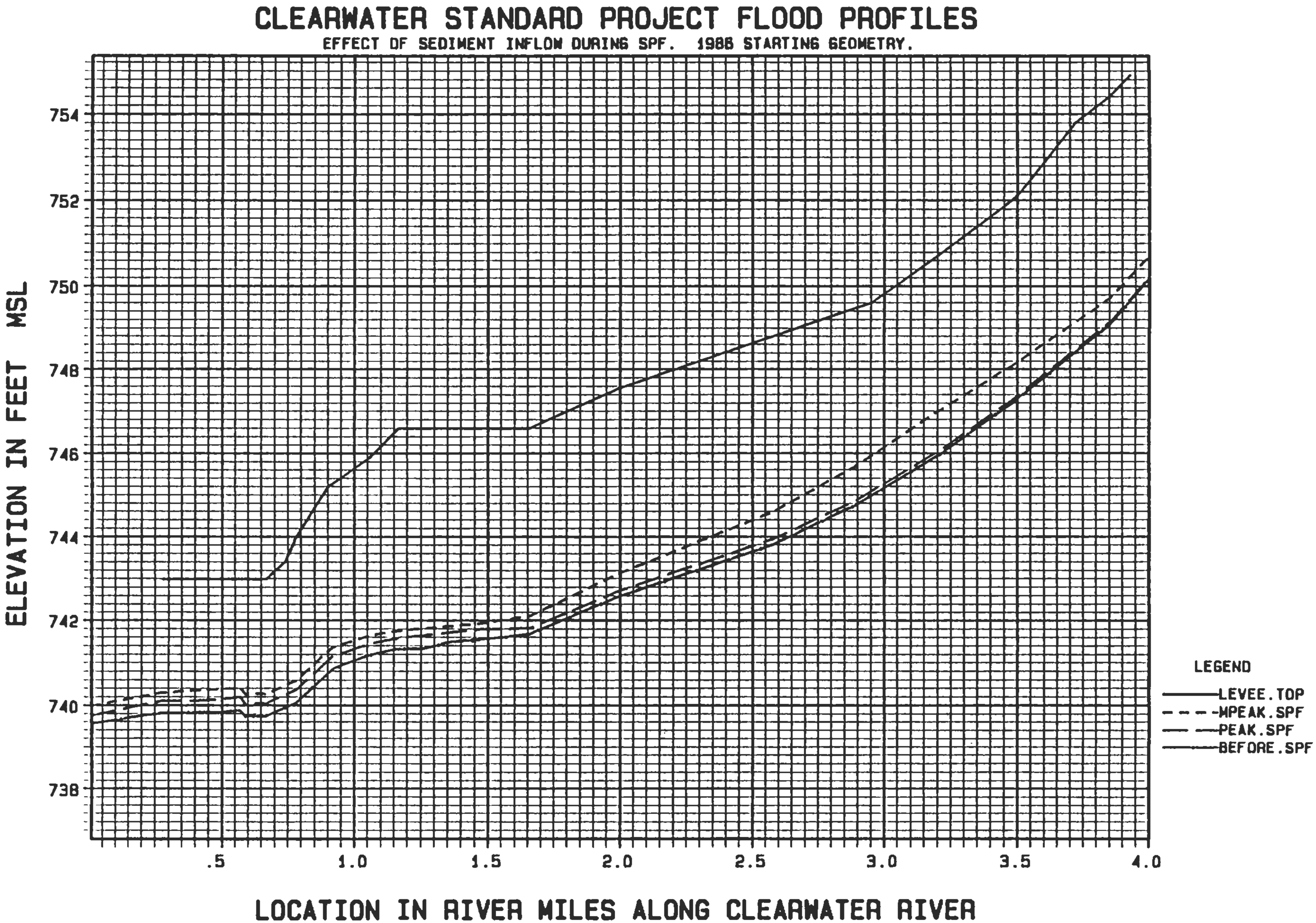
19

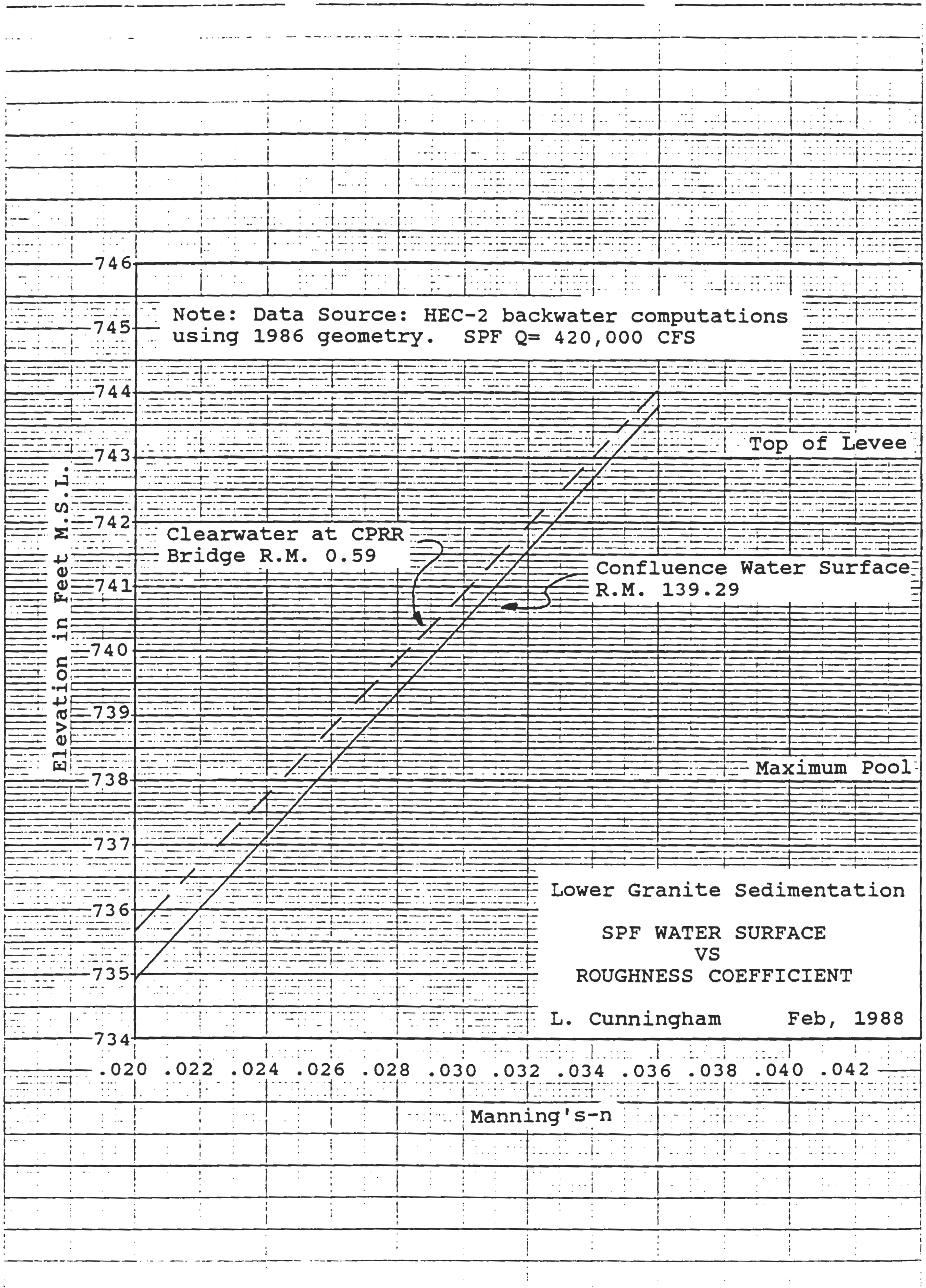


STANDARD PROJECT FLOOD PROFILE AT START OF SIMULATION
STANDARD PROJECT FLOOD PROFILE AT TIME OF FLOOD PEAK
STANDARD PROJECT FLOOD PROFILE AT END OF SIMULATION
WEST LEWISTON LEVEE TOP OF LEVEE PROFILE

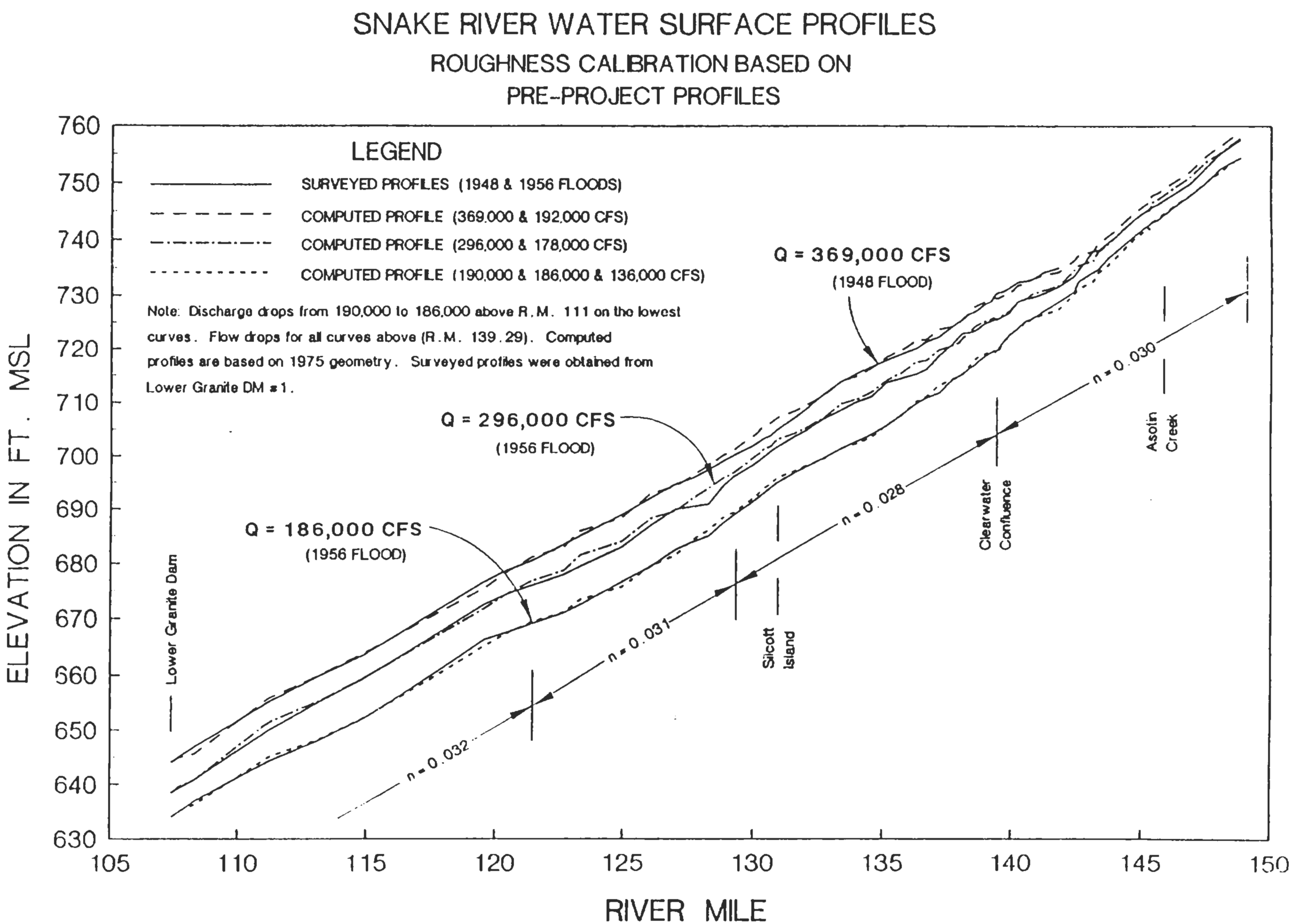
NOTES: 1.TOFFALETI/MEYER-PETER-MULLER TRANSPORT METHOD USED
2.MAXIMUM INFLOWING LOAD CURVE USED

U.S. ARMY ENGINEER DISTRICT
WALLA WALLA – HYDROLOGY BRANCH
GENE SPANGRUDE MAY 1990


CLEARWATER STANDARD PROJECT FLOOD PROFILES
EFFECT OF SEDIMENT INFLOW DURING SPF. 1986 STARTING GEOMETRY.
ELEVATION IN FEET MSL
754
752
750
748
746
744
742
740
738
.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
LOCATION IN RIVER MILES ALONG CLEARWATER RIVER
LEGEND
LEVEE.TOP
MPEAK.SPF
PEAK.SPF
BEFORE.SPF

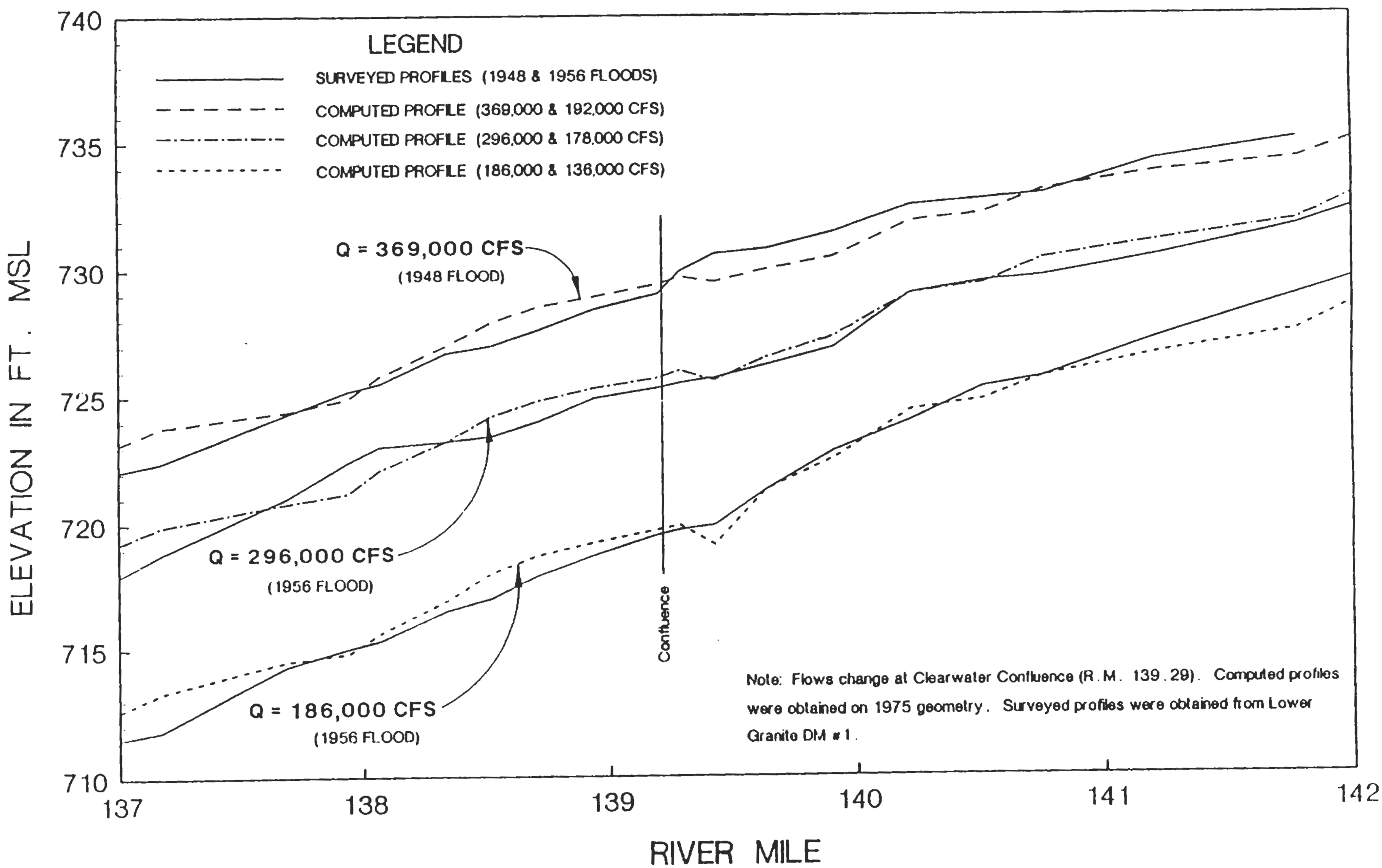


Note: Data Source: HEC-2 backwater computations using 1986 geometry. SPF Q= 420,000 CFS
Elevation in Feet M.S.L.
746
745
744
743
742
741
740
739
738
737
736
735
734
Top of Levee
Clearwater at CPRR Bridge R.M. 0.59
Confluence Water Surface R.M. 139.29
Maximum Pool
Lower Granite Sedimentation
SPF WATER SURFACE
VS
ROUGHNESS COEFFICIENT
L. Cunningham Feb, 1988
.020 .022 .024 .026 .028 .030 .032 .034 .036 .038 .040 .042
Manning's-n

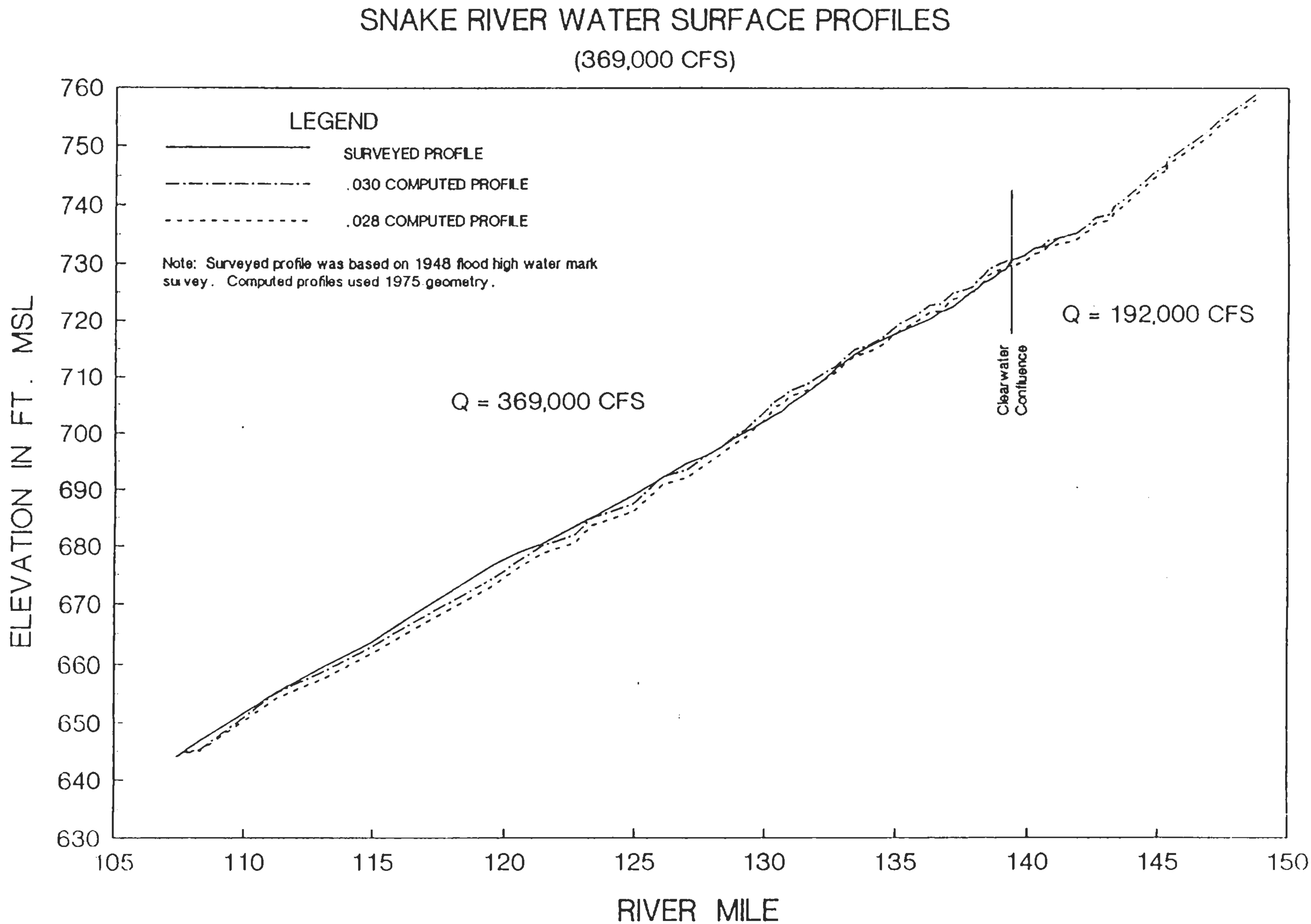

SNAKE RIVER WATER SURFACE PROFILES
ROUGHNESS CALIBRATION BASED ON
PRE-PROJECT PROFILES
LEGEND
SURVEYED PROFILES (1948 & 1956 FLOODS)
COMPUTED PROFILE (369,000 & 192,000 CFS)
COMPUTED PROFILE (296,000 & 178,000 CFS)
COMPUTED PROFILE (190,000 & 186,000 & 136,000 CFS)
Note: Discharge drops from 190,000 to 186,000 above R.M. 111 on the lowest curves. Flow drops for all curves above (R.M. 139.29). Computed profiles are based on 1975 geometry. Surveyed profiles were obtained from Lower Granite DM #1.
Q = 369,000 CFS
(1948 FLOOD)
Q = 296,000 CFS
(1956 FLOOD)
Q = 186,000 CFS
(1956 FLOOD)
Lower Granite Dam
Silcott Island
Clearwater Confluence
Asotin Creek
n = 0.032
n = 0.031
n = 0.028
n = 0.030
ELEVATION IN FT. MSL
RIVER MILE
760
750
740
730
720
710
700
690
680
670
660
650
640
630
105
110
115
120
125
130
135
140
145
150

SNAKE RIVER WATER SURFACE PROFILES

ROUGHNESS CALIBRATION: VICINITY OF CLEARWATER CONFLUENCE



C-42



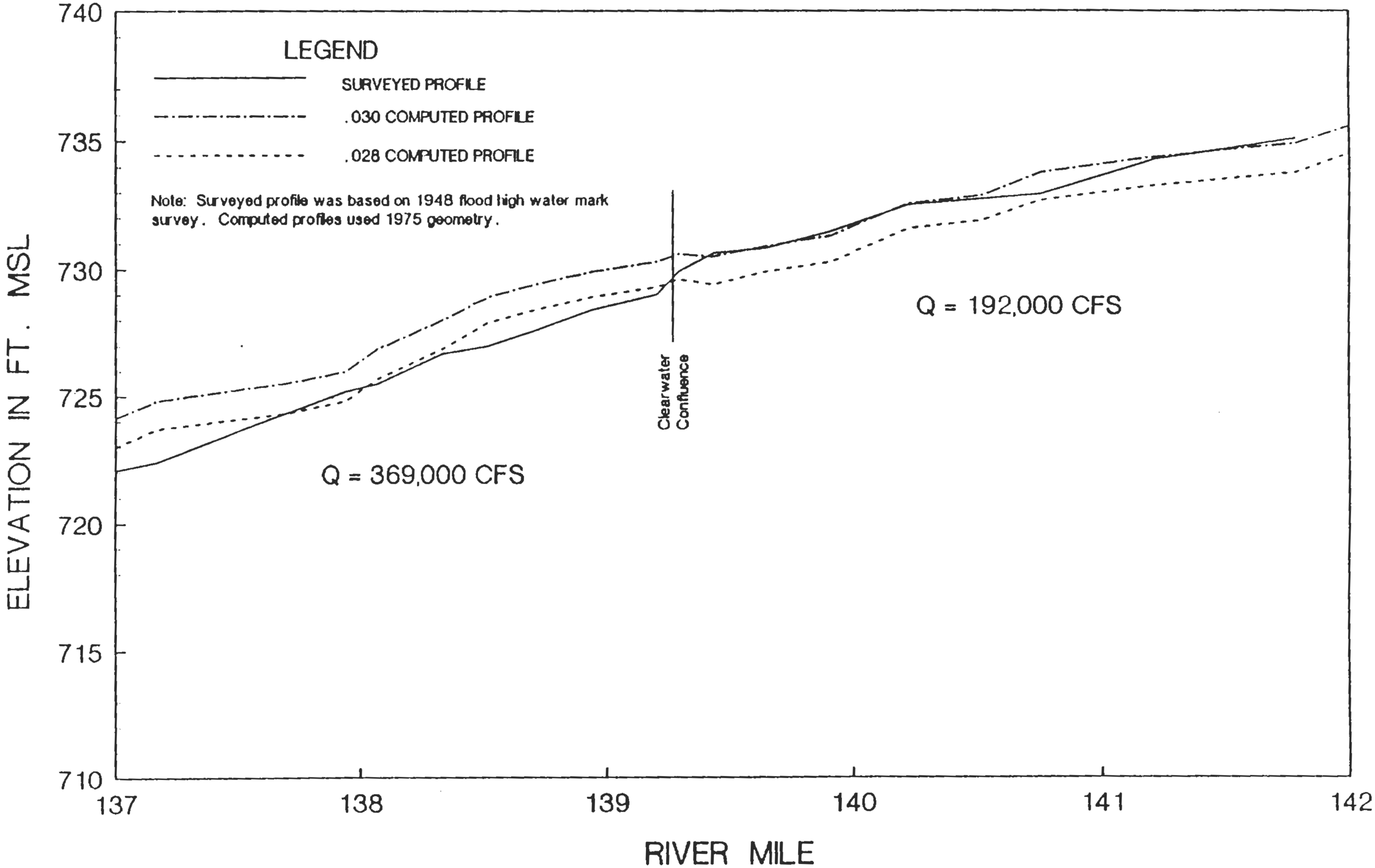
SNAKE RIVER WATER SURFACE PROFILES
(369,000 CFS)
LEGEND
SURVEYED PROFILE
.030 COMPUTED PROFILE
.028 COMPUTED PROFILE
Note: Surveyed profile was based on 1948 flood high water mark survey. Computed profiles used 1975 geometry.
Q = 369,000 CFS
Q = 192,000 CFS
Clearwater Confluence
ELEVATION IN FT. MSL
RIVER MILE
760
750
740
730
720
710
700
690
680
670
660
650
640
630
105
110
115
120
125
130
135
140
145
150

PLATE 24

SNAKE RIVER WATER SURFACE PROFILES

VICINITY OF LEWISTON & CLARKSTON

(369,000 CFS)

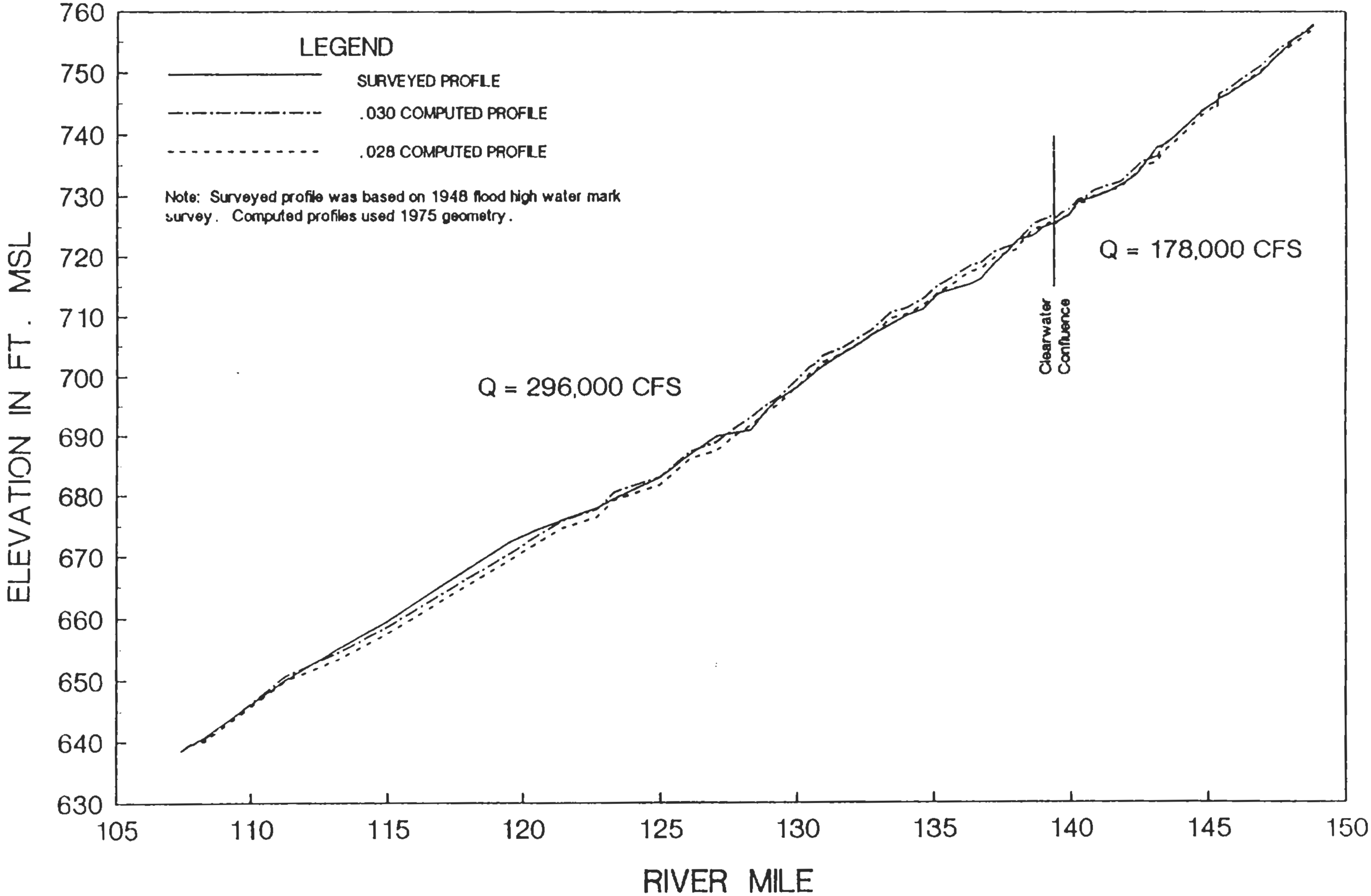


C-44

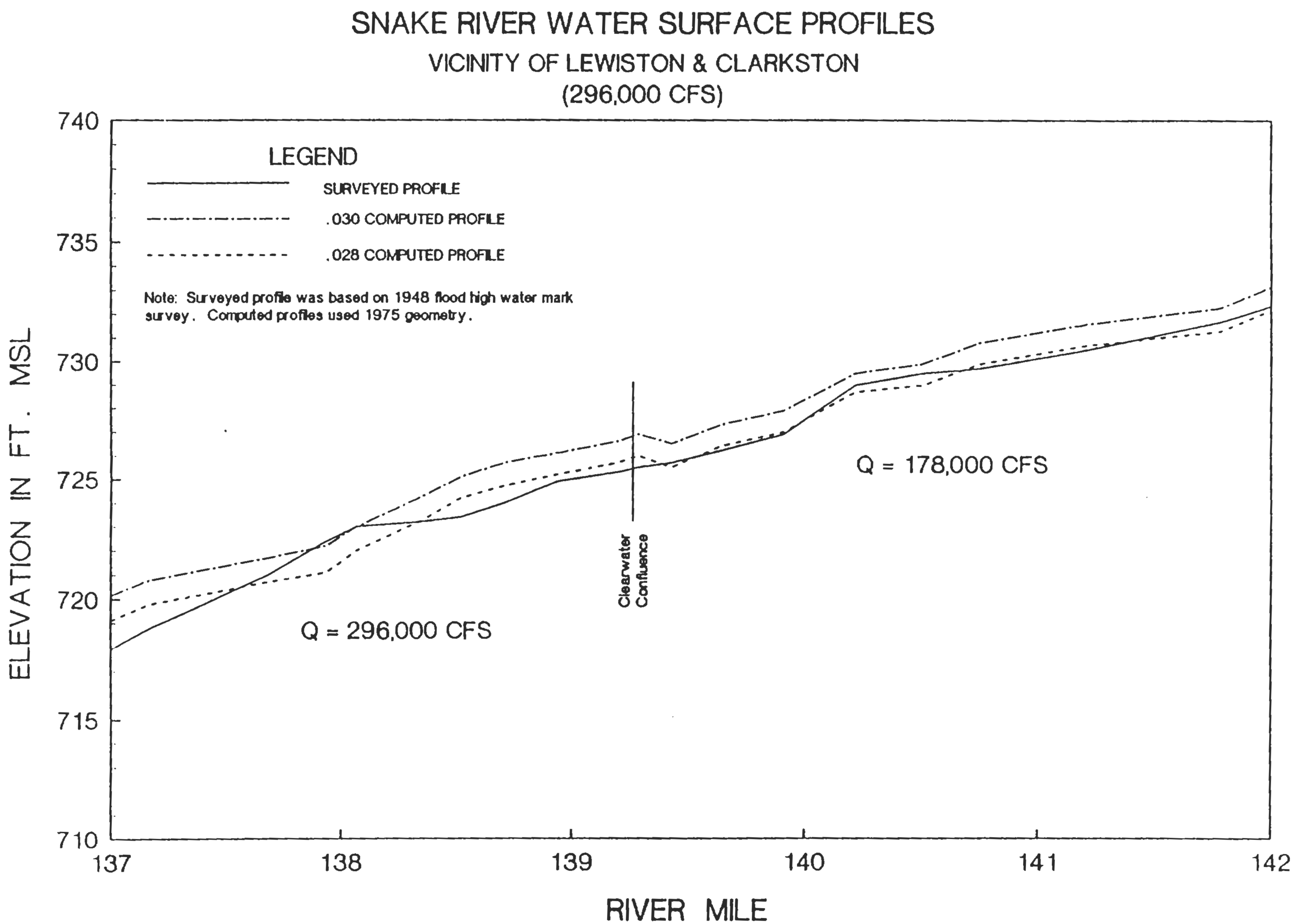
PLATE 25

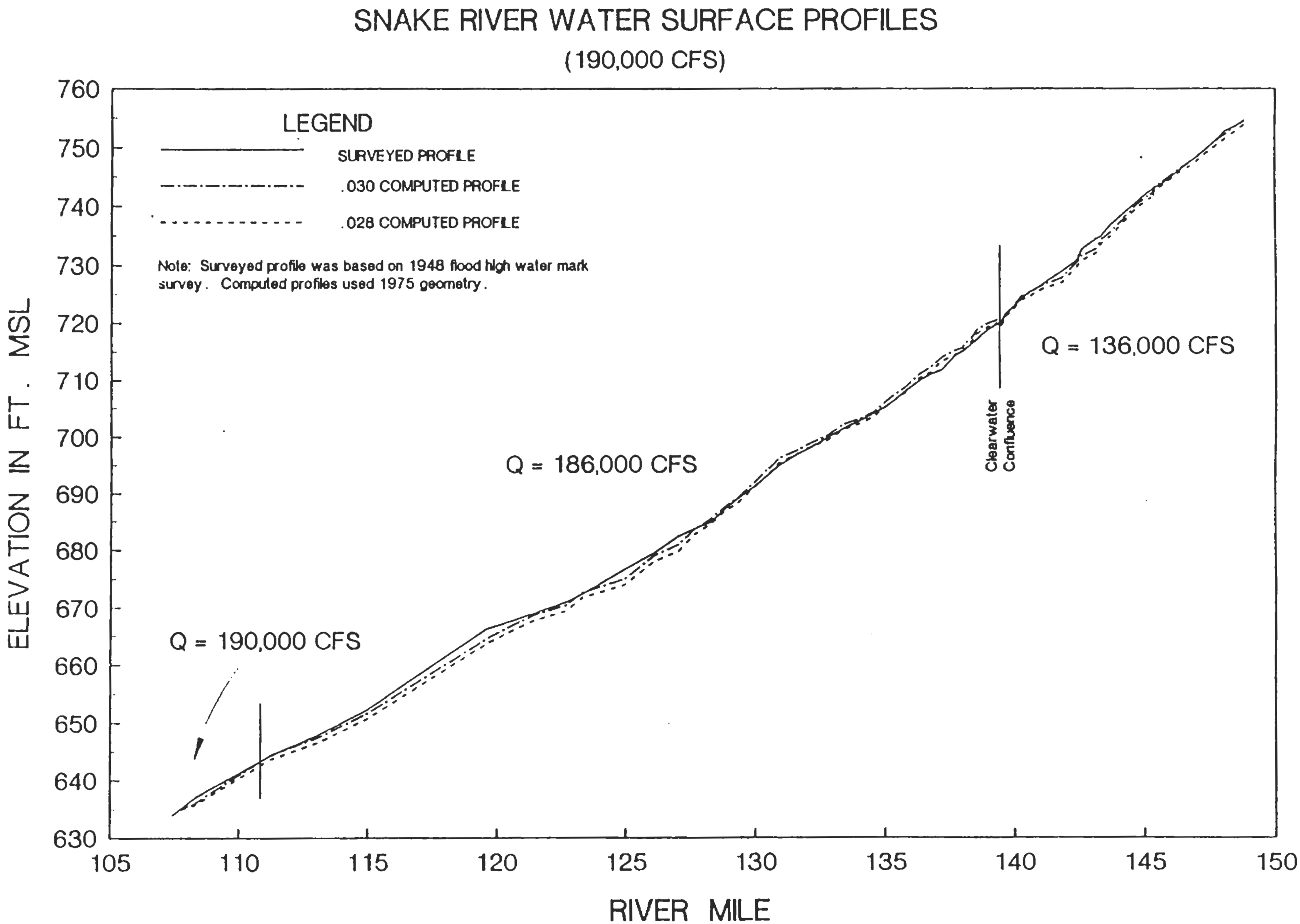
SNAKE RIVER WATER SURFACE PROFILES

(296,000 CFS)



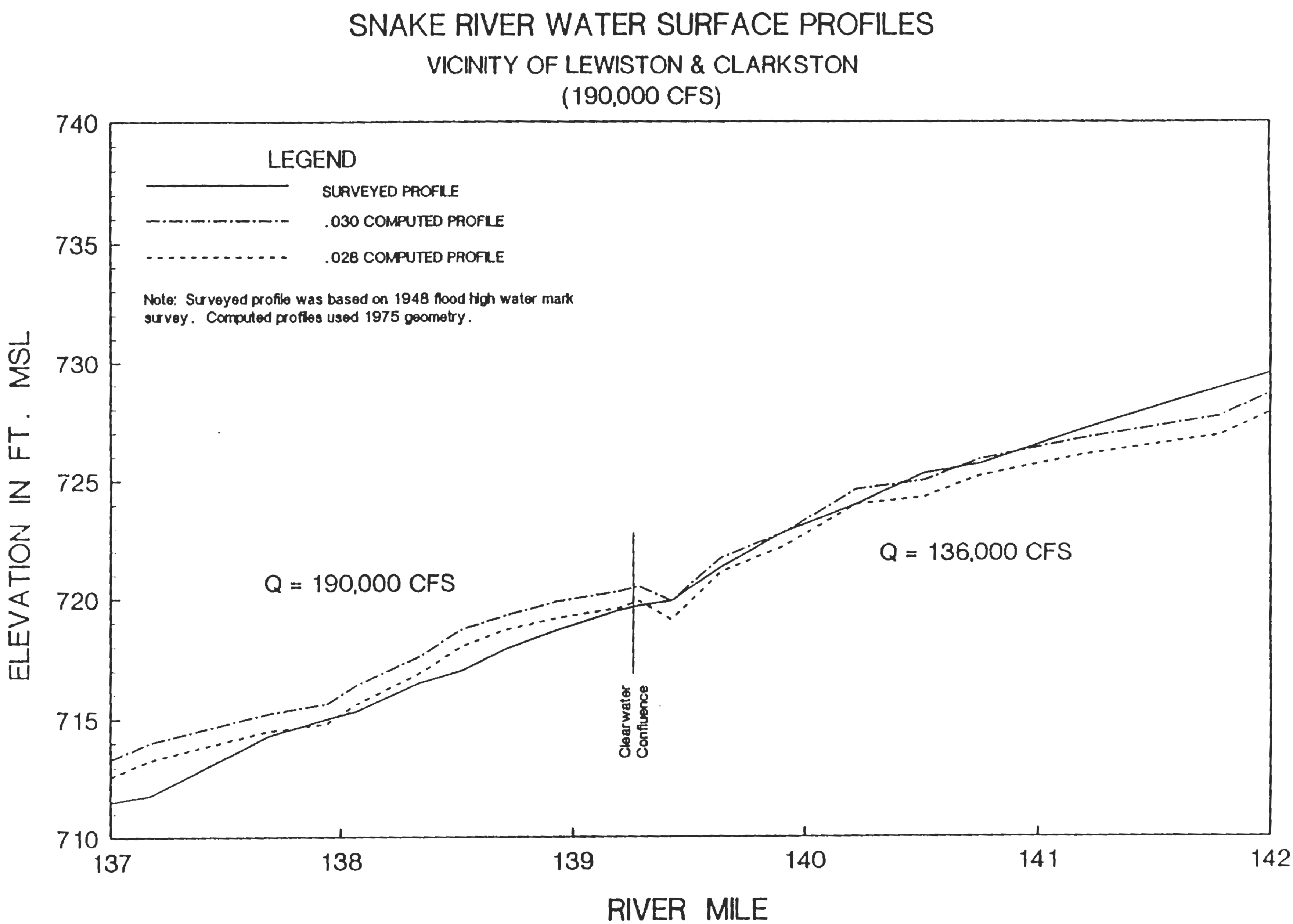
C-45


SNAKE RIVER WATER SURFACE PROFILES
VICINITY OF LEWISTON & CLARKSTON
(296,000 CFS)
LEGEND
SURVEYED PROFILE
.030 COMPUTED PROFILE
.028 COMPUTED PROFILE
Note: Surveyed profile was based on 1948 flood high water mark survey. Computed profiles used 1975 geometry.
ELEVATION IN FT. MSL
740
735
730
725
720
715
710
Clearwater Confluence
Q = 178,000 CFS
Q = 296,000 CFS
137
138
139
140
141
142
RIVER MILE

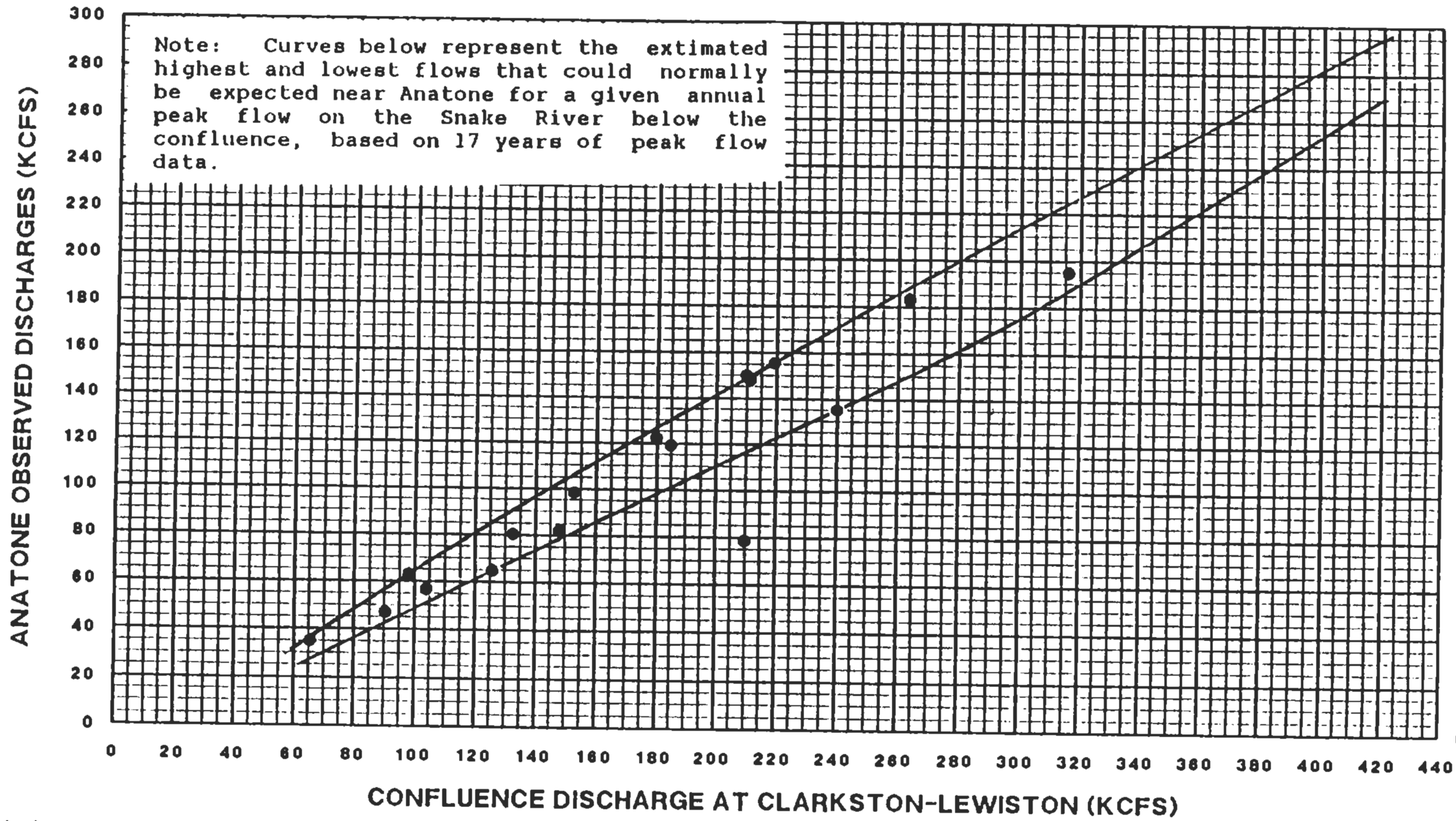


SNAKE RIVER WATER SURFACE PROFILES
(190,000 CFS)
LEGEND
SURVEYED PROFILE
.030 COMPUTED PROFILE
.028 COMPUTED PROFILE
Note: Surveyed profile was based on 1948 flood high water mark survey. Computed profiles used 1975 geometry.
Q = 190,000 CFS
Q = 186,000 CFS
Q = 136,000 CFS
Clearwater Confluence
ELEVATION IN FT. MSL
RIVER MILE
760
750
740
730
720
710
700
690
680
670
660
650
640
630
105
110
115
120
125
130
135
140
145
150

C-47

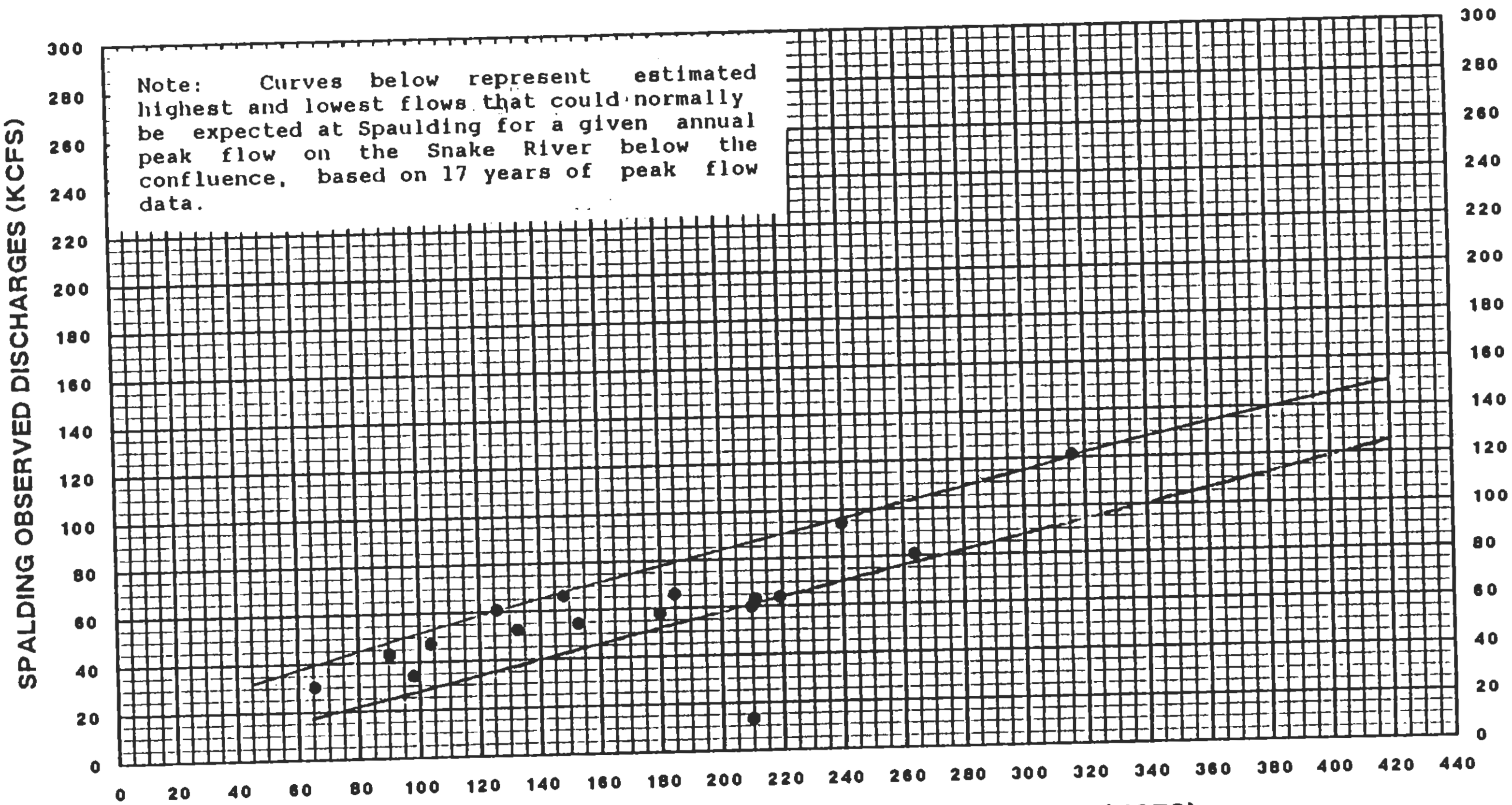

SNAKE RIVER WATER SURFACE PROFILES
VICINITY OF LEWISTON & CLARKSTON
(190,000 CFS)
LEGEND
SURVEYED PROFILE
.030 COMPUTED PROFILE
.028 COMPUTED PROFILE
Note: Surveyed profile was based on 1948 flood high water mark survey. Computed profiles used 1975 geometry.
ELEVATION IN FT. MSL
740
735
730
725
720
715
710
Q = 190,000 CFS
Q = 136,000 CFS
Clearwater Confluence
137
138
139
140
141
142
RIVER MILE

CORRELATION BETWEEN SNAKE RIVER DISCHARGE AND AT CONFLUENCE DISCHARGE DURING INSTANTANEOUS PEAK FLOW AT CONFLUENCE

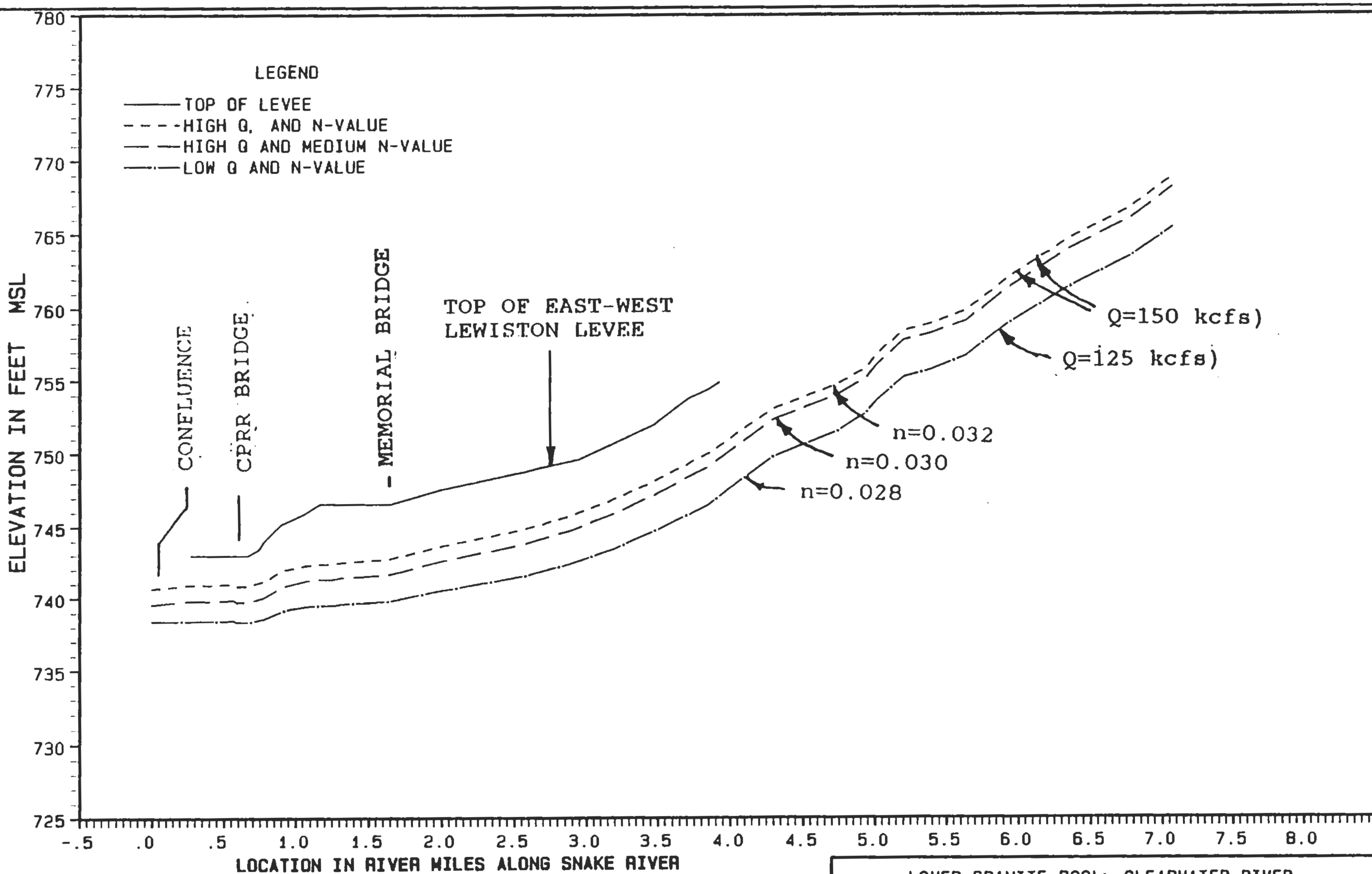


Note: Instantaneous peak at confluence was determined by summary simultaneous observed discharges at USGS gages ANAWQD and SPDIQU from available records of instantaneous peak, 6-hour, or mean daily discharge records. (1972 - 1988)

CORRELATION BETWEEN CLEARWATER AND CONFLUENCE DISCHARGE DURING INSTANTANEOUS PEAK FLOW AT CONFLUENCE



Note: Instantaneous peak at confluence was determined by summary simultaneous observed discharges at USGS gages ANAWQD and SPDIQU from available records of instantaneous peak, 6-hour, or mean daily discharge records. (1972 - 1988)

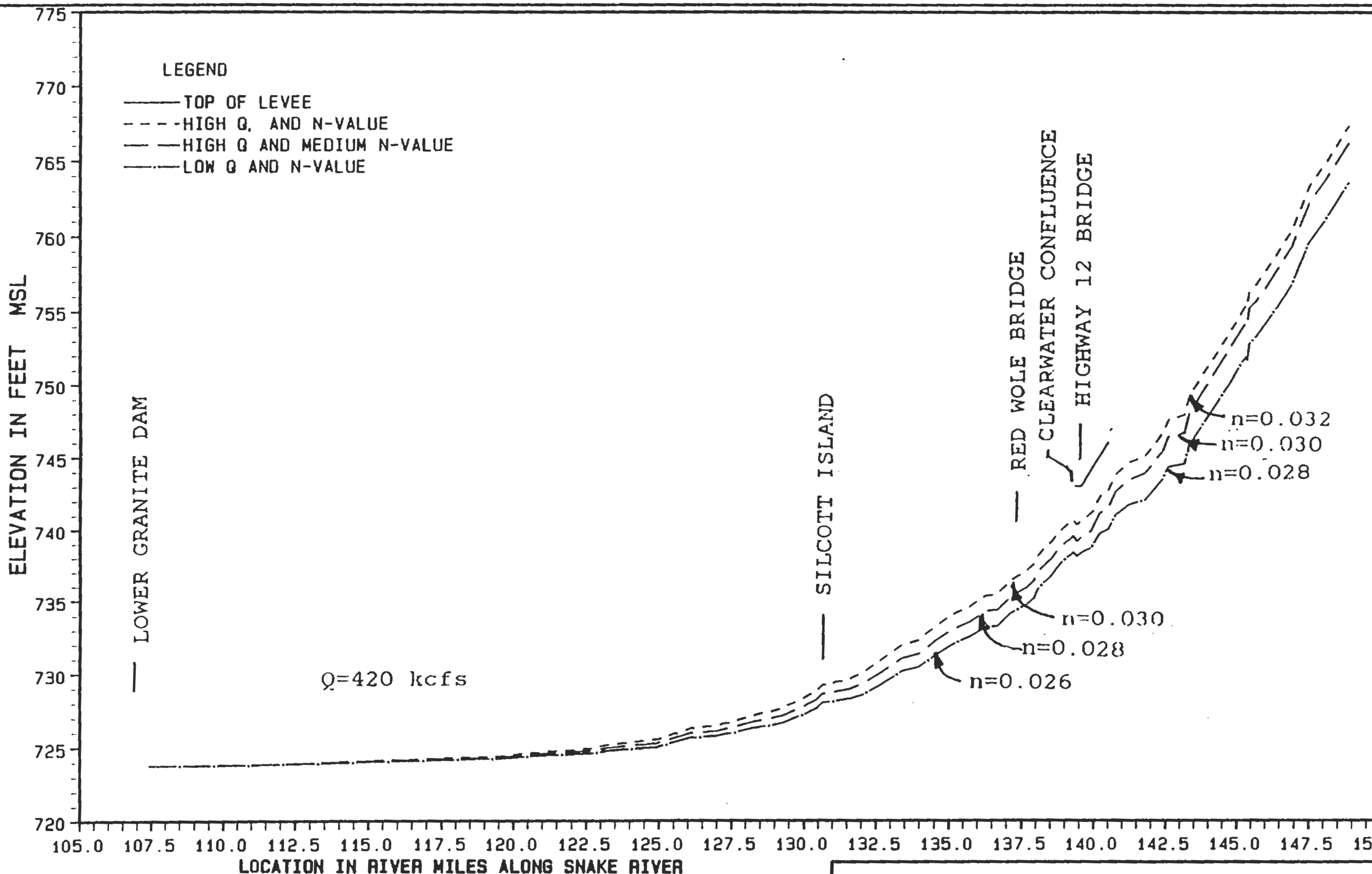


LOWER GRANITE POOL: CLEARWATER RIVER

SENSITIVITY TO FLOW DISTRIBUTION
AND ROUGHNESS COEFFICIENT

Hydrology Branch

LLC MAY 1991



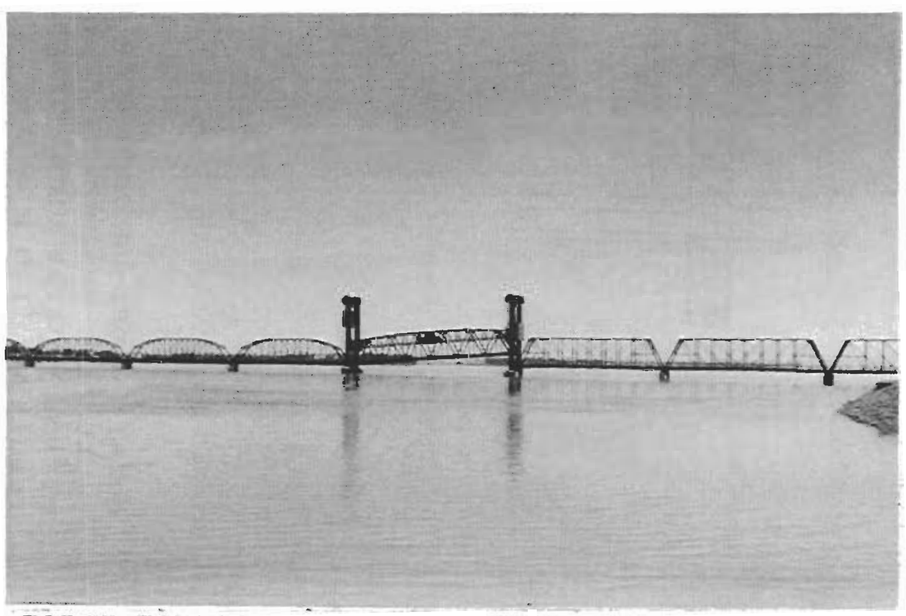
LOWER GRANITE POOL

SENSITIVITY TO FLOW DISTRIBUTION
AND ROUGHNESS COEFFICIENT

Hydrology Branch

LLC MAY 1991

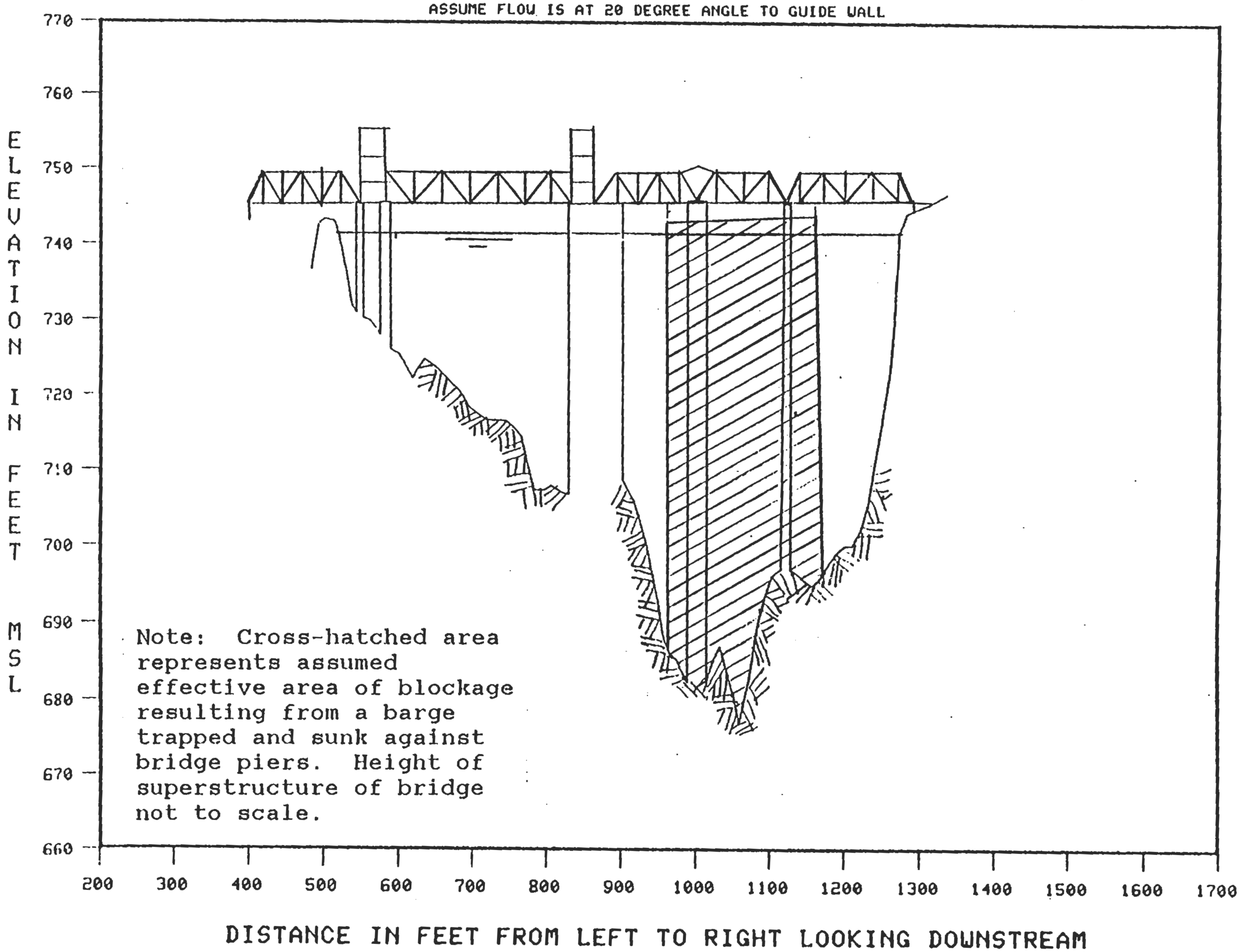
BARGE STUCK UNDER UPRR BRIDGE. 28 JUNE 1974

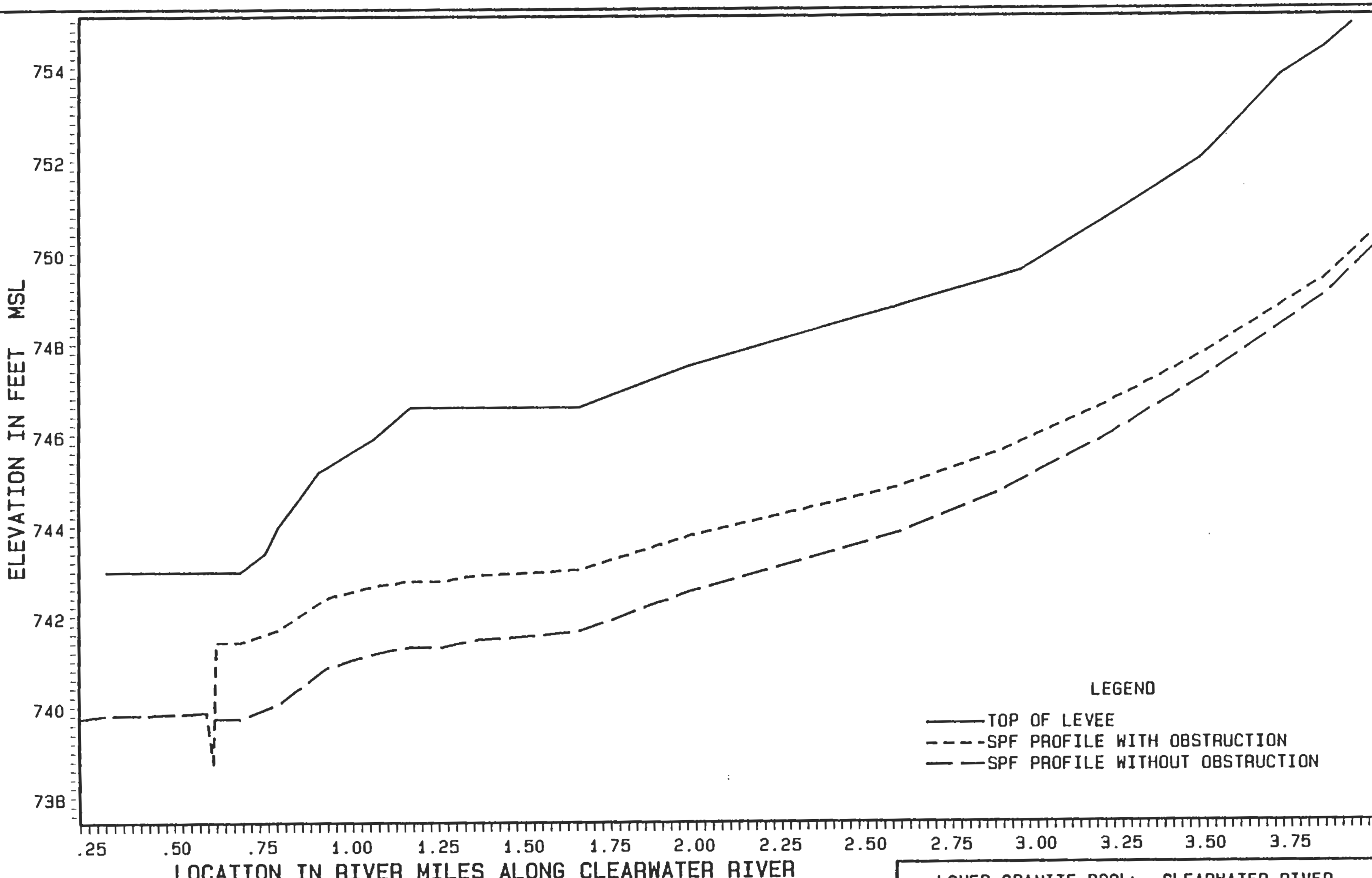


BARGE DAMAGE TO NPRR BRIDGE. 28 JUNE 1974

UPRR BRIDGE ACROSS CLEARWATER RIVER AT LEWISTON, IDAHO

ASSUME FLOW IS AT 20 DEGREE ANGLE TO GUIDE WALL





LOWER GRANITE POOL: CLEARWATER RIVER

EFFECT OF BRIDGE OBSTRUCTION
ON STANDARD PROJECT FLOOD PROFILE

Hydrology Branch

L. CUNNINGHAM MAY 1991

APPENDIX D

FEDERAL PLANNING PROCESS

APPENDIX D

FEDERAL PLANNING PROCESS

1.01. WATER RESOURCES PLANNING REQUIREMENTS.

Alternative plans are formulated to ensure that all reasonable alternatives are evaluated. Appropriate mitigation of adverse effects is to be an integral part of each alternative plan. The alternative of taking no action is to be fully considered.

Activities conducted pursuant to the requirements of the National Environmental Policy Act (NEPA) of 1969 are to be fully integrated with the planning process. In implementing NEPA, Planning Guidance requires compliance with the Water Resources Council Environmental Quality Evaluation Procedures regarding the conservation of fish and wildlife resources, preservation of historic and archaeological resources, and implementation of Section 404 of the Clean Water Act and Sections 102 and 103 of the Marine Protection, Research, and Sanctuaries Act. Section 122 of the River and Harbor and Flood Control Act of 1970, Public Law 91-611, also requires that possible adverse economic, social, and environmental effects relating to any proposed project be fully considered in the planning process, and that the final decisions be made in the best overall public interest.

If the alternative under consideration involves farmland, the Department of Agriculture Final Rule, 7 CFR 658, Farmland Protection Policy, must be considered. The rule requires that, before taking or approving any action that would result in conversion of farmland, all Federal agencies examine the effects of the action and, if there are adverse effects, consider alternatives to lessen them. Agencies are also required to ensure that their programs, to the extent practicable, are compatible with state, local, and private programs, as well as polices to protect farmland.

Throughout the regulations and guidelines, it is emphasized that Federal water resources planning must be responsive to state and local concerns, in accordance with Executive Order 12372 and 33 CFR 384.

Planning Guidance requires public involvement in Civil Works planning studies. The objective of public involvement is to open and maintain channels of communication with the public, in order to give full consideration to public views and information in the planning process.

1.02. PLANNING PROCESS.

The primary component of Federal planning is the process of developing and evaluating alternatives to meet the needs and desires of the nation, while still responding to state and local concerns. The water resources planning process consists of the following major steps:

a. Specification of relevant water resource problems and opportunities associated with the Federal objective.

b. Inventory, forecast, and analysis of water resource conditions within the planning area relevant to the identified problems and opportunities.

c. Formulation of alternative plans.

d. Evaluation of the effects of alternative plans.

e. Comparison of alternative plans.

f. Selection of a recommended plan.

The planning process identifies alternative plans that could be recommended, including no action, and culminates in the selection of the recommended plan. The selection is based on completeness, effectiveness, efficiency, and acceptability.

1.03. PLANNING OBJECTIVE.

The planning objective is to maintain 5 feet (ft) of levee freeboard during the Standard Project Flood (SPF), in order to provide flood protection for the city of Lewiston, Idaho.

1.04. PLANNING CRITERIA.

a. Technical.

Measures should be sound, practicable, technically feasible, economically justified, and environmentally acceptable.

Measures must not create a hazard to life and safety.

Measures must not increase downstream damages.

Recommended improvements should maximize use of existing facilities.

Regardless of the degree of protection planned, consideration will be given to the results of extreme events, as represented by the standard project.

b. Economic.

The recommended plan is the most economical means of meeting the planning objectives.

Tangible benefits exceed project economic costs.

Each separable increment of improvement or purpose should provide incremental benefits at least equal to its incremental cost.

The scope of development maximizes net benefits.

No means are more economical, evaluated on a comparable basis, for accomplishing the same purpose or purposes, which would be precluded from development if the plan were undertaken. This limitation refers only to alternatives that would be physically displaced, or economically precluded from development, if the project were undertaken.

Benefits should be derived from a comparison of projected conditions without Federal action to the projected conditions with the proposed plan.

Plans should consider effects in the areas of employment, tax base, property values, and regional growth potentials.

Intangible benefits should also be evaluated. These include health, safety, and welfare of residents within the study area.

c. Environmental.

Plans should be formulated in a manner which maximizes the beneficial, and minimizes the adverse, effects of the project on manmade resources, natural resources, air, water, and land. Preservation and/or enhancement of environmental resources should be provided.

Unavoidable adverse environmental impacts should be fully noted, quantified when possible, and qualified, in order to facilitate a knowledgeable decision-making process.

The recommended plan should avoid unnecessary, irreversible commitment of resources to future use.

d. Social.

The recommended plan should avoid unnecessary and/or unreasonable risks and hazards to life, health, and safety.

The recommended plan should enhance social, cultural, educational, aesthetic, and historical values.

Plans should minimize and, if possible, avoid destruction or disruption of community cohesion, injurious displacement of people, and disruption of desirable community growth, public facilities, and services.

Human environmental benefits and costs should be considered equal in status to monetary units.

Possible employment effects, as well as tax and property values should be identified.

The recommended plan should be coordinated with local, regional, and state interests.

The recommended plan should comply with Indian treaties, and preserve or enhance the cultural heritage of the tribes.

e. Institutional.

Existing political and social institutions should be able and willing to fulfill the necessary requirements, including cost sharing, to implement the various plans. Local assurances and necessary permits, approvals, and endorsements must be obtainable.

Institutional requirements, imposed by the recommended plan, should be an integral part of the project plan formulation.

Coordination should be carried out with existing Federal, state, and local institutions that are operating in, or have an interest in, the study area.

Areas of responsibility of Federal, state, and local institutions should be defined.

The recommended plan should be institutionally implementable.

1.05. REGULATORY REQUIREMENTS.

The Corps of Engineers has regulatory responsibility for all dredged material disposal activities that occur within the waters of the United States. This authority stems from Section 10 of the River and Harbor Act of 1899, Section 404 of the Clean Water Act, and Section 103 of the Marine Protection, Research, and Sanctuaries Act. Section 404 authorizes the Secretary of the Army to issue permits for the discharge of dredged or fill material into waters of the United States, in accordance with the Section 404(b)(1) Guidelines, and other requirements of Federal law.

Compliance with the guidelines requires the avoidance of "unacceptable adverse effects" to the aquatic environment. The Guidelines specify four conditions of compliance: 1) There is no other practicable alternative that would have less adverse impact on the aquatic environment; 2) the disposal will not result in violation of applicable water quality standards after consideration of dispersion and dilution, toxic effluent standards or marine sanctuary requirements, nor will it jeopardize the continued existence of threatened or endangered species; 3) the disposal will not cause or contribute to significant degradation of the waters of the United States; and 4) all appropriate and practicable steps have been taken to minimize potential adverse impacts of the discharge on the aquatic environment.

Findings for compliance with condition 2) are based, in large part, on Section 401 of the Clean Water Act, which allows the individual states to establish state water quality standards. Washington State has established more stringent standards, in order to reflect a higher priority for environmental protection.

The findings of compliance with condition 3) are to be based, in part, on "evaluation and testing" of the propsoed dredged material.

APPENDIX E

PRELIMINARY UPLAND DISPOSAL ANALYSIS

CENPW-PL-PP (1110a-2-1150a) 26 January 1989

MEMORANDUM THRU C, Planning Div

FOR C, Plan Formulation Branch

Subject: Land Disposal Evaluation, Lower Granite Sedimentation Study

1. Reference is made to your DF dated 19 Nov 1987, subject as above.

2. Enclosed is a report entitled "Lower Granite Sedimentation Study, Upland Disposal Analysis" dated January 1989 as requested in the above referenced DF. As explained in the report, the analysis was limited to the Dry Creek site. This site was chosen for detailed study because of it's close proximity to the confluence dredging as compared to other potential sites and the fact that the site had the greatest potential for storage. On this basis, this site should represent a least cost storage site.

3. If you have any questions about the report, please contact Jerry Roediger, ext. 6597.

Encl
Sedimentation Study

BRIAN J. BEECHIE
Chief, Project Planning Branch

January 1989

Lower Granite Sedimentation Study
Upland Disposal Analysis
Table of Contents

List of Tables

List of Figures

Lower Granite Sedimentation Study
Upland Disposal Analysis

1. INTRODUCTION

As part of the overall Lower Granite sedimentation study, various alternative methods of disposing of the dredged material are being evaluated. The two major disposal methods in the overall study include in-water disposal and on-land disposal. Because of environmental concerns of in-water disposal and it's effect on the fishery, on-land disposal has been identified as a possible viable alternative.

It has been determined in previous studies that there are limited on-land disposal sites adjacent to the river. In light of this, the feasibility of using upland disposal sites located above the reservoir in canyons and open areas was evaluated and is the subject of this report.

A previous study (unpublished report) evaluated the feasibility of developing an upland disposal site using a roller compacted concrete (RCC) retention dam built in three phases. As part of that study, it was estimated that upland disposal would cost over $8.00 / CY at the Dry Creek site. In light of the high cost, further studies were initiated to evaluate the feasibility of using something other than a RCC type containment structure.

2. PURPOSE AND SCOPE

The purpose of this study was to evaluate the average annual unit cost of disposing large volumes of dredged material on-land using select sand or rock fill as a containment dike. A total of four upland disposal sites were identified but only a single site was evaluated for cost. The study is of a reconnaissance level using existing data and information.

3. DESCRIPTION OF DISPOSAL SITES

The location of each of the four sites identified is shown on Figure 1. Storage-Elevation information for each site is included on Tables 1-4. Other pertinent information about each site is presented below:

SITE NAME: Dry Creek

Reservoir Depth at Dike	245 Feet
Storage Capacity	40 Million CY
Life of Site	50 Years /1

SITE NAME: LB1

Reservoir Depth at Dike	266 Feet
Storage Capacity	16.1 Million Cy
Life of Site	20 Years /1

SITE NAME: LB2

Reservoir Depth at Dike	200 Feet
Storage Capacity	10.9 Million CY
Life of Site	13 Years /1

SITE NAME: Page Creek

Reservoir Depth at Dike	211 Feet
Storage Capacity	30.9 Million CY
Life of Site	39 Years /1

1/ Based on 800,000 CY per year.

Reconnaissance level cost estimates were prepared only for the Dry Creek site. This site was chosen because of it's relatively large storage capacity as compared to the other sites and it's close proximity to the confluence area. Only the location, hydrology and storage-capacity information is presented for the LB1, LB2, and the Page Creek Sites.

4. HYDROLOGY

The following hydrologic information was developed for the four disposal sites.

Thunderstorm Standard Project and Probable Maximum Floods

Site Name	Drainage Area (SQ Mi)	PMF Peak Flow (cfs)	PMF Vol (A-F)	SPF Peak Flow (cfs)	SPF VOL (A-F)
Dry Creek	8.7	27,400	5,200	13,500	2,160
LB1	3.5	12,900	2,000	6,400	900
LB2	1.4	6,700	800	3,300	400
Page Creek	20.3	28,000	9,000	13,400	4,600

Annual Frequency Peak Flow Summary
(cfs)

Flood Event	Dry Creek	LB1	LB2	Page Creek
2- Year	60	25	14	75
10- year	350	160	80	410
50- year	1040	470	240	1190
100- Year	1540	690	350	1750
500- Year	3490	1560	800	3850

Annual Frequency Volume Summary
(A-F)

Flood Event	Dry Creek	LB1	LB2	Page Creek
2- Year	13	5	2	30
10- year	69	28	11	158
50- Year	197	80	32	452
100- Year	287	117	47	659
500- Year	623	254	102	1435

5. DISPOSAL SITE DESIGN, DRY CREEK SITE

Two types of containment dikes were evaluated including a compacted select sand section, and a rockfill section. In each case, it was assumed that the containment dike would be constructed in phases over the life of the project. Each increment would provide storage for approximately 5 years of dredging. The compacted select sand containment dike has a 1V on 5H downstream slope, a 10 foot top width, and a 1V on 3H upstream slope as shown on Figure 3. The rockfill containment dike has a 1V on 1.3H downstream slope, a 10 foot top width, and a 1V on 2H upstream slope as shown on figure 4.

Upon filling the disposal area created by the first phase of construction, the containment dike is then raised to accept the disposal for the next dredging period. The first few years were limited to less than the 5 year capacity in order to limit the height of the dike. From then on, it was assumed that the dikes were raised every 5 years. A layout of the Dry Creek disposal site and typical sections of the incrementally constructed containment dikes are shown on figures 2, 3, and 4.

It was assumed that the sediment would be dredged from a sump located at the confluence of the Clearwater River. The sediment would be dredged from the sump and placed behind the containment dike. Three methods of placement were considered as discussed in paragraph 7.

Residual water from the dredging operation and natural run-off from the drainage area will be passed through the project by means of percolation and by means of an outlet works. The outlet works would be designed for uncontrolled automatic operation. The intake tower is rectangular with an inside diameter of 5 feet. Ungated intake ports are uniformly positioned vertically along the tower to allow inflows to enter at various levels. As the level of the sediment in the disposal site rises, the lower level intake ports are blocked off. A debris barrier cap would be placed on the top of the tower for safety and to prevent debris from entering the system. The intake tower is designed to be built in increments as the containment dike is raised. The debris barrier cap is removed prior to raising the tower and replaced after the job is complete.

The outlet conduit is a 5 foot diameter reinforced concrete pipe. The conduit extends from the invert of the intake structure to an impact stilling basin. Open channel flow conditions will exist in the conduit for all discharges. The stilling basin is designed to function up to a maximum design flow of 260 cfs with a head of 250 feet. The outlet works was sized to pass debris up to about 2.5 feet in length.

In order to limit large size debris from entering the disposal site and clogging the outlet system, debris barriers were included at each of the major drainage basin inlets to the disposal area. With these debris barriers, along with the debris barrier at the top of the intake tower, the potential of clogging of the system is minimized .

Because of the inherent nature of the incrementally constructed containment dike, a conventional spillway was not included in the design. In order to protect the containment dike from damage due to basin run-off, the elevation of the top of dike was set to provide storage for 4,000,000 CY (5 years @ 800,000 CY per year) plus 463,000 CY of storage to contain the annual 100 year flood, plus 3 feet of freeboard.
On this basis, all floods up to the 100 year frequency will be completely controlled. In the first year of the five year period, the degree of protection will be much greater than the 100 year protection. As the sediment storage area is filled, the flood protection will be reduced down to the 100 year level at the end of the fifth year. In the event that the dike is over-topped, costs have been included for major repair of the dike and cleaning of the area downstream. This concept was felt justified since the only improvement downstream of the disposal area subject to damage would be a short section of State Highway 12 adjacent to the Snake River.

Within the disposal area, there are three residents, electrical power lines with a substation, and a county road that runs up the canyon. It was assumed that residents and the electrical power lines and substation were relocated. The county road was assumed to be abandoned at no cost because relocation of the road would be impractical and access is provided by existing alternate routes. A plan of the Dry Creek site is included on Figure 2.

6. CONSTRUCTION COST ESTIMATES

Cost estimates for development of the Dry Creek disposal site were prepared at May 1988 price level for both the compacted select sand and rockfill containment dike sections. A 25 % contingency factor was used with combined engineering and design, and supervision and administration estimated to be 15 %. A summary of the total project cost by phase of construction is presented below. Summary cost estimates by general feature for each type of containment dike is included on Tables 5 and 6 respectively. Investment costs are shown below based on an average of a 6 month construction period in determining the interest during construction.

Compacted Select Sand Containment Dike
Phased Construction Costs
($ 1,000)

Year	Total Project Cost	Total Investment Cost
1	4,998	5,106
2	1,333	1,362
3	263	269
5	1,126	1,150
10	875	894
15	526	537
20	495	506
25	322	329
30	233	238
35	205	209
40	185	189
45	192	196

Rock Fill Containment Dike
Phased Construction Costs
($1,000)

Year	Total Project Cost	Total Investment Cost
1	6,025	6,155
2	2,969	3,033
3	2,634	2,691
5	4,235	4,326
10	3,959	4,045
15	3,378	3,451
20	3,579	3,656
25	3,194	3,263
30	3,192	3,261
35	3,035	3,101
40	2,961	3,025
45	3,396	3,469

7. DREDGING COSTS

a. Three methods of dredging and transporting the dredged material from the confluence to the disposal area behind the containment dike were considered. Two of the methods were previously evaluated as part of the Value Engineering Study Number 87-03. The third method was evaluated as part of this study. A brief description of each of the methods and the estimated unit costs are presented below.

(1) Alternative 9, VE 87-03
Description- Hopper dredge and cutterhead
Operation- Hopper dredge dumps material in-water adjacent to Dry Creek site. Cutterhead and booster pump pumps material into disposal area.
Quantity Dredged- 800,000 CY
Required Time- 7.2 weeks
Average Annual Unit Cost- $ 4.14 / CY

(2) Alternative 10, VE 87-03

Description- Hopper Dredge and Cutterhead

Operation- Material is pumped from hopper dredge to a holding pond. Cutterhead and booster pump pumps material into disposal area.

Quantity Dredged- 800,000 CY

Required Time- 15 weeks

Average Annual Unit Cost- $5.39/ CY

(3) Third Method

Description- Hopper dredge and booster pump

Operation- Material is pumped directly by pipe-line with booster pump from the hopper dredge into the disposal area.

Quantity Dredged- 800,000 CY

Required Time- 11 weeks

Average Annual Unit Cost- $4.14/ CY

Unit Costs of the alternatives 9 and 10 as presented in the VE study report are different than what is presented above due to adjustments made to be consistent with this report. The adjustments included removal of costs for development of the disposal site. This report is based on the third dredging method as described above.
A detailed cost estimate of the third method is included on Table 7. The following assumptions were made as part of the estimate.

* Dredge 800,000 CY per year

* All dredging was from a sediment trap to be located at the confluence.

* The sediment trap was assumed already in place.

* A 4,000 CY dredge was used.

* Barge haul distance 3.9 miles.

* All dredging equipment including the pipelines are owned and operated by the dredging contractor.

b. The total cost of dredging 800,000 CY of material and placing it into the disposal site is estimated to be $3,311,000 as shown on Table 7.

8. AVERAGE ANNUAL COST

a. Compacted Select Sand Containment Dike

(1) Site Development

Average annual site development costs were developed based on 8 5/8 % interest, and 50 year project life. The following information shows development of the present worth of the site development costs.

Compacted Select Sand Containment Dike
Present Worth of Phased Construction Cost
Costs in $1,000

Year	Years Hence	Invest. Cost	P.W. Factor	Present Worth
1	0	5,106	1	5,106
2	1	1,362	.92	1253
3	2	269	.85	229
5	4	1,150	.72	828
10	9	894	.47	420
15	14	537	.31	166
20	19	506	.21	106
25	24	329	.14	46
30	29	238	.091	22
35	34	209	.060	13
40	39	189	.040	8
45	44	196	.024	5
			Total	$8,202
			Called	$8,200

Interest and amortization at 8 5/8 % interest and 50 year life is calculated as follows.

Interest and Amortization =(.08765) X ($8,200,000)= $ 718,730
Called $ 719,000

(2) Annual Dredging and Disposal

The average annual cost of dredging and disposal will be $3,311,000 as shown on Table 7. This includes all costs to place the material into the disposal site.

(3) Operation,and Maintenance

The average annual operation and maintenance for the disposal site for cleaning of trash racks etc. is estimated to be $24,000.

(4) Major Repair

(a) The project was designed to control the average annual 100 year flood. In the event of a larger flood, the containment dike will be damaged and a portion of the sediment will be washed out of the disposal area an down across Highway 12. In order to account for this event, a cost for major repair of the project is included. The estimated cost used for repair of the disposal site is as follows:

Major Repair Construction Costs
Costs in $1,000

Flood Frequency	Probability	Cost of Repair
100	.01	$ 0
500	.002	$ 1,400
1000	.001	$ 2,800

(b) Based on 8 5/8 % interest, the average annual major repair cost was estimated to be $ 8,000 as shown below:

Average Annual Major Repair Costs
Costs in $ 1,000

Probability	Repair Cost	Average Cost of Interval	Probability of Interval	Annual Cost
.01	0			
		700	.008	5.6
.002	1,400			
		2,100	.001	2.1
.001	2,800			
			Total $	7.7
			Called	8.0

(5) Summary

Total average annual costs for dredging and disposal behind a compacted select sand containment dike is summarized below:

Interest and Amortization	$ 719,000
Dredging and Transport	3,311,000
Operation and Maintenance	24,000
Major Repairs	8,000
Total Average annual Costs	$ 4,062,000

or

Cost / CY = $ 4,062,000/800,000 CY = $ 5.08 / Cy

b. Rockfill Containment Dike

(1) Site Development

Average annual site development costs were developed based on 8 5/8 % interest, and 50 year project life. The following information shows development of the present worth of the site development costs.

Rockfill Containment Dike
Present Worth of Phased Construction Cost
Costs in $1,000

Year	Years Hence	Invest. Cost	P.W. Factor		Present Worth
1	0	6,155	1		6,155
2	1	3,033	.92		2,790
3	2	2,691	.85		2,287
5	4	4,326	.72		3,115
10	9	4,045	.47		1,901
15	14	3,451	.31		1,070
20	19	3,656	.21		768
25	24	3,263	.14		457
30	29	3,261	.091		297
35	34	3,101	.060		186
40	39	3,025	.040		121
45	44	3,469	.024		83
				Total	$19,230
				Called	$19,200

Interest and amortization at 8 5/8 % interest and 50 year life is calculated as follows.

Interest and Amortization =(.08765)X($19,200,000)= $ 1,682,880
Called $ 1,682,900

(2) Annual Dredging and Disposal

The average annual cost of dredging and disposal will be $3,311,000 as shown on Table 7. This includes all costs to place the material into the disposal site.

(3) Operation,and Maintenance

The average annual operation and maintenance for the disposal site with the rockfill containment dike for cleaning of trashracks was assumed to be the same as for for the compacted sand containment dike or $24,000.

(4) Major Repair

The major repair cost for the rockfill containment dike was assumed to be the same as for the compacted sand containment dike or $8,000.

(5) Summary

Total average annual costs for dredging and disposal behind a rockfill containment dike is summarized below:

Interest and Amortization	$1,682,900
Dredging and Transport	3,311,000
Operation and Maintenance	24,000
Major Repairs	8,000
Total Average annual Costs	$ 5,025,900

or

Cost / CY = $ 5,025,900 / 800,000 CY = $ 6.28 / CY

9. DISCUSSION

The Dry Creek disposal site was chosen for evaluation rather than other large volume alternative sites because of it's close proximity to the confluence dredging. The farther the distance between the dredging location and the disposal site, the higher the cost of transporting the material. The Dry Creek site was considered to give the least cost of upland disposal for dredging being accomplished at the confluence.

In the cost estimate, it was assumed that the county road running up the canyon could be abandoned at no cost. This assumption was made because it was determined that a relocated road was not practical from a cost standpoint and access could be obtained by alternate routes. In order to show the sensitivity of road relocation, for every million dollars cost (including E&D,and S&A) in road relocation, the total average annual cost would be increased by about $ 0.11 /CY.

As discussed, both the compacted select sand and the rockfill containment dikes were evaluated. There is concern about the stability of the compacted select sand containment dike. There is concern that the compacted select sand containment dike would slough as a result of seepage through the dike. It was felt that the rockfill containment dike would perform satisfactorily under the seepage conditions.

10. CONCLUSION

The least cost of upland disposal at the Dry Creek Site, including dredging, transportation, development of disposal site, operation and maintenance, and major repairs is estimated to be about $ 5.08 / CY based on a compacted select sand containment dike. However, further evaluation will be required in order to resolve the question of sloughing of the dike as a result of seepage discussed in paragraph 9. If in the event that the sloughing problem cannot be resolved, a rockfill containment dike would be the next cheapest alternative with a cost of about $ 6.28 /CY.

TABLE I

Dry Creek Site

Area-Capacity-Volume Data

Elevation Feet, msl	Area Sq feet	Volume Cy	Suface Area Acres
771.4	0	0	0
800	280,000	148,296	6.4
840	1,360,000	1,363,111	31.2
880	3,200,000	4,740,889	73.5
920	6,000,000	11,555,704	137.7
960	10,080,000	23,466,815	231.4
1000	15,560,000	42,459,408	357.2

TABLE 2.

LB-1 Site

Area-Capacity-Volume Data

Elevation Feet, msl	Area Sq feet	Volume Cy	Suface Area Acres
774	0	0	0
800	80,000	38,519	1.84
840	240,000	275,556	5.51
880	680,000	957,037	15.61
920	1,200,000	2,349,630	27.55
960	2,160,000	4,838,519	49.59
1000	3,560,000	9,075,556	81.73
1040	5,880,000	16,068,148	134.99

TABLE 3

LB-2 Site

Area-Capacity-Volume Data

Elevation Feet, msl	Area Sq feet	Volume Cy	Suface Area Acres
840	0	0	0
880	280,000	207,407	6.43
920	680,000	918,519	15.61
960	1,320,000	2,400,000	30.3
1000	2,880,000	5,511,111	66.12
1040	4,360,000	10,874,074	100.09

Page Creek Site

Area-Capacity-Volume Data

Elevation Feet, msl	Area Sq feet	Volume Cy	Suface Area Acres
829	0	0	0
840	80,000	16,296	1.84
880	840,000	697,778	19.28
920	2,400,000	3,097,778	55.1
960	4,680,000	8,342,222	107.44
1000	7,440,000	17,320,000	170.8
1040	10,920,000	30,920,000	250.69

TABLE 4

Dry Creek Disposal Site
Compacted Sand Embankment
Summary Cost Estimate 1/
Phased Construction
($1,000)

Construction Year

COST ITEM		1	2	3	5	10	15	20	25	30	35	40	45
Lands and Damages		683	0	0	0	0	0	0	0	0	0	0	0
Relocations		1250	0	0	0	0	0	0	0	0	0	0	0
Outlet Works		957	197	229	315	213	123	106	78	45	41	41	29
Debris Barrier		75	0	0	0	0	0	86	0	0	0	0	0
Embankment		770	962	0	664	548	334	238	202	158	137	120	138
Dredge Pipe Bench		611	0	0	0	0	0	0	0	0	0	0	0
Subtotal		4346	1159	229	979	761	457	430	280	203	178	161	167
E&D, and S&A	15%	652	174	34	147	114	69	65	42	30	27	24	25
Total Project Cost		$4,998	$1,333	$263	$1,126	$875	$526	$495	$322	$233	$205	$185	$192
EDC 2/		108	29	6	24	19	11	11	7	5	4	4	4
Total Investment Cost		$5,106	$1,362	$269	$1,150	$894	$537	$506	$329	$238	$209	$189	$196

1/ Includes 25 % Contingencies
Based on 8 5/8 % interest and an average of 6 month construction Period

2/ Engineering during construction. Based on 8 5/8 %, and 6 month construction period. (f= .0216)

TABLE 5

Dry Creek Disposal Site
Rockfill Containment Dike
Summary Cost Estimate /1
Phased Construction
$1,000

COST ITEM		Construction Year 1	2	3	5	10	15	20	25	30	35	40	45
Lands and Damages		683	0	0	0	0	0	0	0	0	0	0	0
Relocations		1250	0	0	0	0	0	0	0	0	0	0	0
Outlet Works		957	197	2290	311	213	123	106	78	45	41	41	29
Debris Barrier		75	0	0	0	0	0	86	0	0	0	0	0
Embankment		1663	2385	0	3372	3230	2814	2920	2699	2731	2598	2534	2924
Dredge Pipe Bench		611	0	0	0	0	0	0	0	0	0	0	0
Subtotal		$5,239	$2,582	$2,290	$3,683	$3,443	$2,937	$3,112	$2,777	$2,776	$2,639	$2,575	$2,953
E&D, and S&A	15%	786	387	344	552	516	441	467	417	416	396	386	443
Total Project Cost		$6,025	$2,969	$2,634	$4,235	$3,959	$3,378	$3,579	$3,194	$3,192	$3,035	$2,961	$3,396
EDC 2/		130	64	57	91	86	73	77	69	69	66	64	73
Total Investment Cost		$6,155	$3,033	$2,691	$4,326	$4,045	$3,451	$3,656	$3,263	$3,261	$3,101	$3,025	$3,469

1/ Includes 25 % Contingencies

2/ Engineering during construction. Based on 8 5/8 %, and 6 month construction period (i= .0216)

TABLE 6

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

FILENAME: J:HOPDRDG8

E N G I N E E R ' S   E S T I M A T E

PROJECT: CONFLUENCE DREDGING — SHEET OF

ALTERNATIVE DESCRIPTION: EXCAVATE WITH HOPPER DREDGE FOR DISPOSAL ON LAND BY DIRECT PUMPOUT

ESTIMATED BY: RASMUSSEN

DATE: 21-Jun-88

TYPE OF DREDGE: 4,000 CY HOPPER DREDGE
LOCATION OF DISPOSAL SITE: DISPOSAL AREA IN DRY CREEK CANYON BEHIND RETENTION DAM
DISTANCE TO DISPOSAL SITE: 3.9 MILES
TOTAL QUANTITY EXCAVATED: 800,000 CY
AVERAGE DAILY PRODUCTION: 11,412 CY/DAY
TOTAL DREDGING TIME: 2.5 MONTHS

MISC REQUIREMENTS: OVERSPILLING OF HAULING EQUIPMENT ALLOWED BUT LIMITED TO 15 MIN. MATERIAL WILL BE DREDGED FROM A SEDIMENT TRAP PREVIOUSLY CONSTRUCTED NEAR THE CONFLUENCE OF THE TWO RIVERS

ITEM	UNIT	QUANTITY	UNIT PRICE	AMOUNT	REMARKS
DREDGING AND PUMPOUT	CY	800,000	3.22	2,576,000	✓
MOB AND DEMOB & PREP WORK:					
DREDGE	JOB	1	175,000	175,000	✓
BOOSTER AND MISC EQUIPMENT	JOB	1	20,000	20,000	✓
SET UP AND TEAR DOWN PIPELINE	JOB	1	8,000	8,000	✓
DREDGE MOORAGE FACILITY FOR PUMPOUT OPERATIONS	JOB	1	100,000	100,000	✓
TOTAL CONSTRUCTION COST				$2,879,000	
CONTINGENCIES @	15.0%			431,850	
TOTAL CONTRACT COSTS				$3,310,850	✓
USE TOTAL CONTRACT COSTS - - -)				$3,311,000	✓
TOTAL UNIT COST - - -)				$4.14	✓

TABLE 7
Sheet 1 of 1

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

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11 FILENAME: J:HOPDRDG8

| ALTERNATIVE NO. QUANTITY: 800,000 CY |

| ALTERNATIVE DESCRIPTION: EXCAVATE WITH HOPPER DREDGE FOR DISPOSAL ON LAND BY DIRECT PUMPO |

ESTIMATED BY: RASMUSSEN CHECKED BY: R L Porter

LOCATION:

EXCAVATION AREA: -> CONFLUENCE OF SNAKE RIVER AND CLEARWATER RIVER

DISPOSAL AREA: -> DISPOSAL AREA IN DRY CREEK CANYON BEHIND RETENTION DAM

TYPE OF DREDGE: -> 4,000 CY HOPPER DREDGE

MATERIAL HAULED TO DISPOSAL BY: -> HOPPER DREDGE

MISC REQUIREMENTS: -> OVERSPILLING OF HAULING EQUIPMENT ALLOWED BUT LIMITED TO 15 MIN.
-> MATERIAL WILL BE DREDGED FROM A SEDIMENT TRAP PREVIOUSLY
-> CONSTRUCTED NEAR THE CONFLUENCE OF THE TWO RIVERS

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

1. QUANTITIES:

	PUMPOUT TO DISPOSAL AREA IN DRY CREEK CANYON				
NEAT LINE BCY ---->	800,000				
OVERDEPTH BCY ---->					
SHOALING BCY ---->					
TOTAL PAY BCY ------>	800,000				
NON PAY BCY ---->					
TOTAL EXCAVATED BCY ---->	800,000				

2. MISC DATA:

	PUMPOUT TO DISPOSAL AREA IN DRY CREEK CANYON				
SURFACE AREA ---->	2,000,000				
AVERAGE BANK HEIGHT ---->	10.8				
MINIMUM DEPTH IN EXCAVATION AREA:					
Average Water Surface Elev.	736				
Average Bottom Elev.	718				
Minimum Draft:	18				
MINIMUM DEPTH IN DISPOSAL AREA:					
Average Water Surface Elev.	736				
Average Bottom Elev.	717				
Minimum Draft:	19				

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

3. PRODUCTION DATA AND CALCULATIONS FOR EXCAVATION RATE:

	PUMPOUT TO DISPOSAL AREA IN DRY CREEK CANYON	TOTALS
HOPPER DREDGE PRODUCTION RATE DATA:		
Size of Hopper (CY)	4,000	
Size of Pipe (IN)	24	
Type of Material to be Excavated	Sand & Silt	
Estimated Density of Material (mg/l)	1,450	
Economical load (CY)	2,500	
Pumping Rate (CY/MIN)	30.0	
Weather Factor	0.95	
Availability Factor (1)	95.0%	
Dredging Hours per Day	24	24

(1). This accounts for delays due to minor repairs, refueling, servicing and other normal delays.

DREDGE EXCAVATION RATE:		
Quantity Excavated (BCY)	800,000	800,000
Dredge Production @ 100% Efficiency (BCY/HR)	1,800	
Production Adjusted for Effective Time (Availability Factor)	1,710	
Production Adjusted fo Weather (BCY/HR)	1,625	
Daily Production While Pumping (BCY/DAY)	39,000	

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

4. DISPOSAL CYCLE TIME AND EQUIPMENT REQUIREMENTS:

	PUMPOUT TO DISPOSAL AREA IN DRY CREEK CANYON		AVERAGES
HOPPER LOADING DATA:			
Size of Hopper (CY)	4,000		4,000
Does Draft @ Dump Site Control Load?	No		
Average Load Size (CY)	2,100		2,100
CYCLE TIME TO LOAD HOPPER:			
Time to Load Hopper (MIN)	78		
Turning, Etc	12		
Total to Load Hopper (MIN)	90.0		
CYCLE TIME TO HAUL:			
Haul Distance:			
Excavate @ River Mile:	139.0		
Disposal Site @ River Mile:	135.1		
Total Haul Distance (MI)	3.9		3.9
Haul Cycle Time (MIN):			
Travel Time to Disposal @	29.3	8.0 MPH	
Return Time @	29.3	8.0 MPH	
Dumping, or ...			
Pumpout @ 1,320 CY/HR	96.0		
Misc Delays	10.0		
Total Time to Haul One Load:	164.6		
TOTAL CYCLE TIME FOR DREDGE: (MIN)	254.6		

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

5. CALCULATIONS FOR TOTAL CREW AND EQUIPMENT TIME:

	PUMPOUT TO DISPOSAL AREA IN DRY CREEK CANYON
DAILY PRODUCTION AND TIME:	
Number of Dredges to be Used:	1
Average Cycle Time (MIN)	254.6
Number of Loads per Day	5.7
Daily Production (BCY/DAY)	11,970
Time for Dredging and Disposal (DAYS)	66.8

SUMMARY OF TIME REQUIRED:

TOTAL DREDGING DAYS		66.8 DAYS
CLEANUP AND MOVE TIME		1.3 DAYS
ALLOW FOR BARGE TRAFFIC DELAYS		DAYS
ALLOW FOR BREAKDOWNS AND MISC		2.0 DAYS
TOTAL TIME OPERATING		70.1 DAYS
ALLOW FOR LOST TIME DUE TO FOG, EXTREME WIND, EXTREME TEMPERATURES, ETC..	USE	3.0 DAYS

SUMMARY OF TIME AVAILABLE:

AVAILABLE DAYS FOR DREDGING		74.0
DEDUCT FOR:	SUNDAYS	
	HOLIDAYS	2.0
TOTAL REMAINING DAYS		72.0

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

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3. CALCULATIONS FOR TOTAL CREW AND EQUIPMENT TIME (CONTINUED):

TOTAL CREW TIME:

	DAYS	HRS/DAY	TOTAL CREW-HRS
DREDGING	70.1	24	1,682
WEATHER DELAY DAYS, ALLOW 1-SHIFT/DAY	3.0	24	72
TOTAL CREW HOURS			1,754

TOTAL EQUIPMENT TIME: (OPERATING)

	DAYS	HRS/DAY	TOTAL HOURS
DREDGING	70.1	24	1,682
WEATHER DAYS (USE 10% OF CREW TIME)			7
TOTAL EQUIPMENT OPERATING HOURS -			1,689

TOTAL EQUIPMENT TIME: (OWNERSHIP)

TOTAL TIME OPERATING		70.1 DAYS
LOST DAYS DUE TO EXTREME WEATHER		3.0 DAYS
TOTAL TIME ON JOB		73.1 DAYS
NUMBER OF DAYS WORKED PER MONTH	29 DY/MO	
TOTAL MONTHS FOR DREDGING		2.5 MONTHS
USE TOTAL MONTHS FOR OWNERSHIP = = = = = = = = >>		2.5 MONTHS

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

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o. EQUIPMENT COSTS

OPERATING COSTS:

DESCRIPTION	NO. RQD	HOURS	HOURLY RATE	AMOUNT
		1689		
HOPPER DREDGE, 4,000 CY	1	1689	293.10	495,046
CREW BOAT	1	1689	8.00	13,512
D6 DOZER, LGP, OPERATED 1/2 TIME	0.5	1689	37.39	31,576
27" BOOSTER PUMP	1	1689	204.23	344,944
LIGHT PLANT	1	1689	5.29	8,935
PICKUP	1	1689	5.79	9,779
BOOM TRUCK, OPERATED 1/4 TIME TO HANDLE PIPE, ETC	0.25	1689	19.35	8,171
		1689		
		1689		
		1689		
TOTAL OPERATING				$911,963

OWNERSHIP COSTS:

DESCRIPTION	NO. RQD	MONTHS	RATE	AMOUNT
		2.5		
HOPPER DREDGE, 4,000 CY (ownship & cfc)	1	2.5	118,265.00	295,663
CREW BOAT "	1	2.5	1,000.00	2,500
27" BOOSTER PU "	1	2.5	11,408.00	28,520
		2.5		
		2.5		
		2.5		
HOPPER DREDGE, 4,000 CY (taxes, ins, misc)	1	2.5	65,285.00	163,213
CREW BOAT "	1	2.5	200.00	500
27" BOOSTER PUMP "	1	2.5	11,014.00	27,535
		2.5		
		2.5		
		2.5		
		2.5		
TOTAL OWNERSHIP				$517,931

SUMMARY OF EQUIPMENT COSTS:

TOTAL OF OPERATING AND OWNERSHIP COSTS:		$1,429,894
SMALL TOOLS ALLOWANCE @	3.0% OF DIRECT LABOR	126
TOTAL EQUIPMENT COSTS -------)		$1,430,020

TABLE 7.
Sheet 8 of 10

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

/. LABOR COSTS

DIRECT LABOR COSTS:

DESCRIPTION	NO. RQD	HOURS	RATE	AMOUNT
NORMAL CREW:				
CAPTAIN	1	12	21.65	260
MASTER	1	12	18.55	223
CHIEF ENGINEER	1	12	20.55	247
ENGINEER AND BOOSTER OPERATOR	4	12	20.00	960
MATE	2	12	19.58	470
SEAMAN (AB)	2	12	16.90	406
DRAGTENDER	2	12	17.63	423
COOK/STEWARD	1	12	16.25	195
OILER	2	12	16.73	402
SHORE MAN	3	12	16.73	602
SUBTOTAL, DIRECT DAYLY CREW COST:				$4,188
OVERTIME @ 36.00%				1,508
TOTAL DIRECT DAYLY CREW COSTS				$5,696
TAXES AND INSUR. @ 35.0%				1,994
TOTAL - - - - - - - -)				$7,690

FRINGE BENEFITS:

DESCRIPTION	NO. RQD	HOURS	RATE	AMOUNT
CAPTAIN	1	12	4.23	51
MASTER	1	12	4.23	51
CHIEF ENGINEER	1	12	4.23	51
ENGINEER AND BOOSTER OPERATOR	4	12	4.23	203
MATE	2	12	4.23	102
SEAMAN (AB)	2	12	4.23	102
DRAGTENDER	2	12	4.23	102
COOK/STEWARD	1	12	4.23	51
OILER	2	12	4.23	102
SHORE MAN	2	12	4.23	102
TOTAL DAYLY FRINGE BENEFIT COSTS:				$917

SUMMARY OF LABOR COSTS:

TOTAL DAYLY LABOR COSTS - - - - - - - - - - -) $8,607

TOTAL LABOR COSTS FOR: 1754 HOURS @ 24 HOURS/DAY = = = =) $629,028

PROJECT: CONFLUENCE DREDGING
INVITATION NUMBER: PLANNING STUDY

.. SUPPLIES AND MISC COSTS

DESCRIPTION	UNIT	QUANTITY	PRICE	AMOUNT
SUBSISTENCE FOR CREW	DAY	1389	40.00	55,560
PIPE WEAR FOR 2,800 LF AVERAGE LENGTH (27" DIA)	CY	800,000	0.04	32,000
TOTAL SUPPLIES AND MISC COSTS ---------->				$87,560

9. SUMMARY OF DREDGING COSTS:

LOCATION:
EXCAVATION AREA: -> CONFLUENCE OF SNAKE RIVER AND CLEARWATER RIVER
DISPOSAL AREA: -> DISPOSAL AREA IN DRY CREEK CANYON BEHIND RETENTION DAM

TYPE OF DREDGE: -> 4,000 CY HOPPER DREDGE

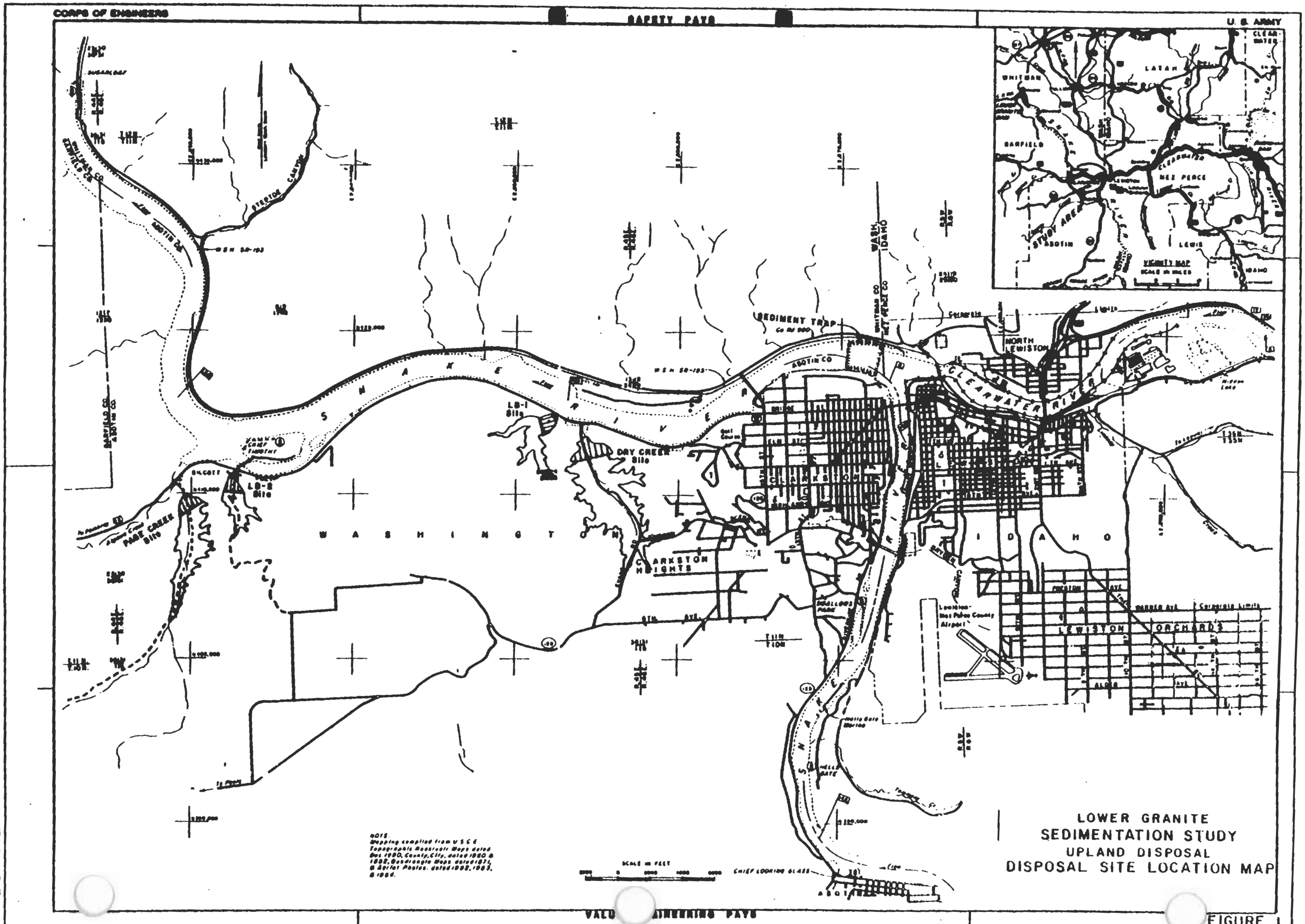
MATERIAL HAULED TO DISPOSAL BY: -> HOPPER DREDGE

MISC REQUIREMENTS: -> OVERSPILLING OF HAULING EQUIPMENT ALLOWED BUT LIMITED TO 15 MIN.
-> CONSTRUCTED NEAR THE CONFLUENCE OF THE TWO RIVERS
-> ERR

HOPPER CAPACITY:	4,000 CY
AVERAGE SIZE OF LOAD	2,100 CY
DREDGE HORSEPOWER	6,300 HP
TOTAL YARDAGE EXCAVATED:	800,000 BCY
AVER DISTANCE TO DISPOSAL SITE:	3.9 MILES
AVERAGE DAILY PRODUCTION:	11,412 BCY/DAY
TOTAL DAYS OPERATING:	70.1 DAYS
TOTAL TIME ON JOB:	2.5 MONTHS

SUMMARY, DIRECT COSTS	COST PER OPERATING DY	COST PER MO ON JOB	TOTAL
EQUIPMENT	$20,400	$572,008	$1,430,020
LABOR	$8,973	$251,611	$629,028
SUPPLIES & MISC	$1,249	$35,024	$87,560
TOTAL DIRECT COSTS			$2,146,608
OVERHEAD AND PROFIT @	20.0%		$429,322
TOTAL COST TO THE GOVERNMENT			$2,575,930
UNIT COST:		$3.22 /CY	

TABLE 7
Sheet 10 of 10



LOWER GRANITE
SEDIMENTATION STUDY
UPLAND DISPOSAL
DISPOSAL SITE LOCATION MAP

FIGURE 1

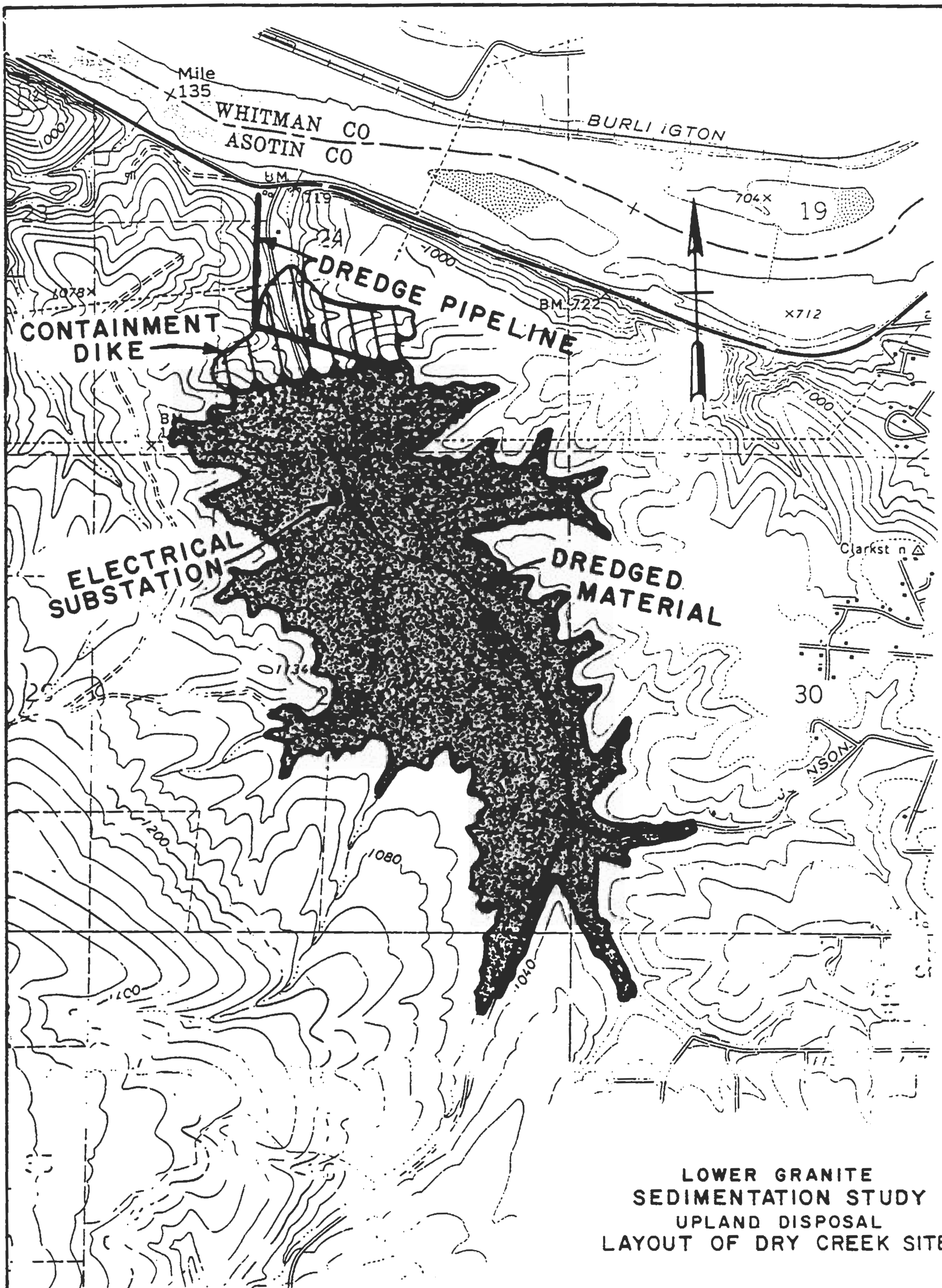
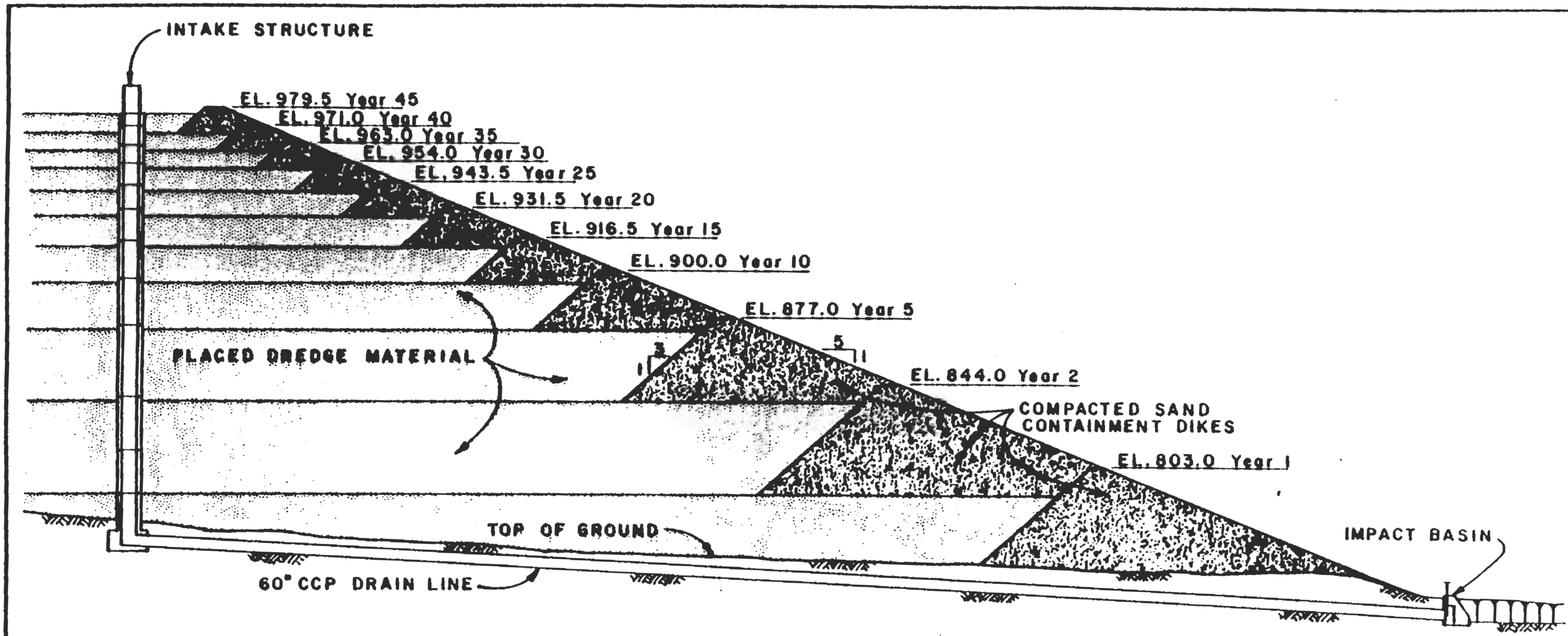

Mile
135
WHITMAN CO
ASOTIN CO
BURLI IGTON
BM
719
704
19
DREDGE PIPELINE
BM 722
712
1078
1000
CONTAINMENT
DIKE
ELECTRICAL
SUBSTATION
DREDGED
MATERIAL
Clarkston
30
1134
1200
1080
1040
LOWER GRANITE
SEDIMENTATION STUDY
UPLAND DISPOSAL
LAYOUT OF DRY CREEK SITE

FIGURE 2

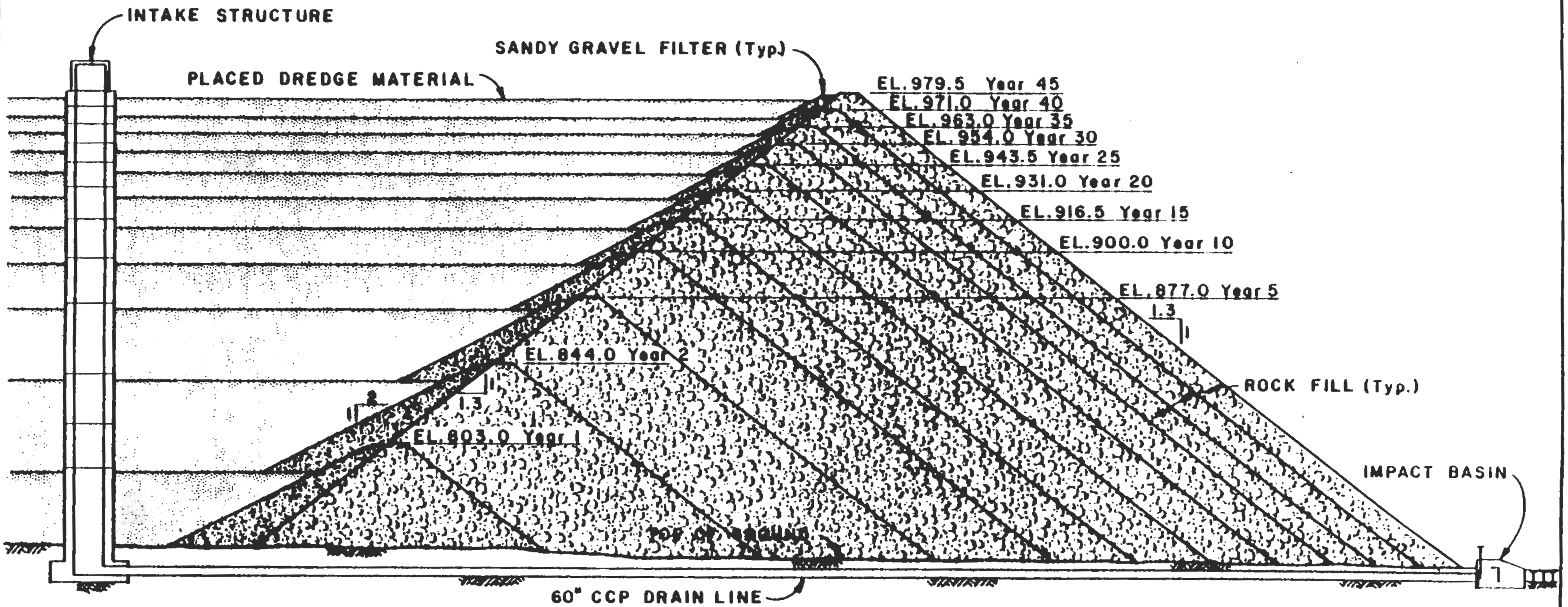


TYPICAL SECTION

NOT TO SCALE

LOWER GRANITE
SEDIMENTATION STUDY
UPLAND DISPOSAL
TYPICAL SEC[illegible]
COMPACTED SAND CONT[illegible]ENT DIKE

FIGURE 3



LOWER GRANITE
SEDIMENTATION STUDY
UPLAND DISPOSAL
TYPICAL SECTION
ROCKFILL CONTAINMENT DIKE

FIGURE 4

FIGURE 4