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Forest Service Handbook 7509.11 – Dams Management Handbook
Chapter 80 - Planning and Design

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Duration: This amendment is effective until superseded or removed.

Superseded Directive: 1, August 8, 1990; Entire Handbook issued, December 1986

Approved by: F. Dale Robertson, Chief

Date approved:

Responsible Staff:

Explanation of changes: Following is an explanation of the changes throughout the directive by section.

POSTING NOTICE: Amendments are numbered consecutively by Handbook number and calendar year. Post document in numerical order of chapters (1109.12, sec. 4.32, ex. 01).Remove entire national text of the Handbook and replace with this amendment. DO NOTREMOVE SUPPLEMENTS OR INTERIM DIRECTIVES. Retain this transmittal as the first page of this document.

Revises and updates entire Handbook. Significant changes in direction are as follows:

05: Moves select definitions from FSM 7500. Modifies definitions to agree with Glossary of Terms for Dam Safety, prepared by the Interagency Committee for Dam Safety (ICODS), and Federal Emergency Management Agency (FEMA).

08: Updates reference list and adds names and addresses of agencies, associations, and groups publishing reference materials related to dams and dam safety.

10: Changes chapter title from Project Files to Records and Files.

40: Changes chapter title from Safety Evaluation/Hazard Potential to Safety Inspections and Hazard Assessments. Replaces the term "safety evaluation" with "safety inspection" throughout.

42: Replaces the term "Hazard - Potential Evaluations "with" Hazard Assessment."

42.3: Adds hazard classification examples.

53: Adds direction on location of copies of emergency action plans.

54: Adds direction on testing emergency action plans.

62: Revises direction to exclude Regional dam or water resources engineer from serving on a dam failure investigation team in cases of potential or apparent conflict of interest.

70: Changes title from Dam Inventory to Management of Special Use and Other Non-Forest Service Projects. Previous direction contained in this chapter is moved to FSM 7514; moves direction from previous chapter 80 to chapter 70.

80: Changes title from Management of Special-Use and Other Non-Forest Service Projects to Planning and Design.

Completes previously reserved FSM 7520 and incorporates it into
FSH 7509.11.

81: Provides guidance and definitions for four phases in the design schedule.

82: Provides guidance for planning and designing channel layout.

83: Provides guidance for assigning hazard classification.

This Handbook is now available electronically in the National Information Center in the same format as the paper copy. Henceforth, amendments to this Handbook will be issued to Forest Service units electronically on a document basis.

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Dams, channels, and other hydraulic structures on National Forest System lands must be planned and designed in accordance with accepted engineering practice. Many sources of information on planning and design exist, including those published by the Army Corps of Engineers, the Bureau of Reclamation, and the Soil Conservation Service. See section 08, References, in the Zero Code, FSM 7505, and FSM 7530 for additional references.

80.2 - Objective

To complete an efficient and effective design for a safe dam, channel, or hydraulic structure.

81 - Scheduling

To efficiently accomplish the design of a hydraulic structure or system of hydraulic structures, schedule the work in a manner that will allow the design to be developed and reviewed in an orderly progression. The design process should begin with many alternatives and progress to the best alternative through a progressive refinement and evaluation of alternatives.

The design schedule may be divided into four main phases:

1. Phase I, feasibility study.

2. Phase II, data collection and evaluation.

3. Phase III, preliminary design.

4. Phase IV, final design.

Although there is some overlapping of work in the various phases, the end of each phase provides a logical opportunity for effective review. Complex projects may be further divided into subphases for control purposes. Simple projects may not require separate review of each phase. The scope of work normally done in each phase of design follows.

81.1 - Phase I, Feasibility Study

In the planning stage, make a study to determine the feasibility of constructing the proposed hydraulic structure in the given watershed.

The reports of a feasibility study may vary from brief reports to formal, comprehensive reports, depending on the type and class of project. Watershed work plans developed for watershed protection and flood prevention projects under Public Law 566 are examples of formal feasibility studies.

Much of the information gathered in a feasibility study may be obtained from record searches; topographic, seismic, and geologic map studies; site reconnaissance; and watershed

reconnaissance. However, such reconnaissance investigations usually must be supplemented by field surveys, hydrologic studies, economic studies, and surface and subsurface investigations.

1. A feasibility study must be made in the detail required to determine, with reasonable assurance, that:

    a. The benefits derived from the project will exceed the cost of installation, operation, and maintenance.

    b. The desired functional objectives of the project can be attained.

    c. The project is environmentally sound.

    d. The project meets the intent of the Forest Plan.

    e. The construction of the project is physically practicable.

    f. The administrative and hazard potential classifications were considered.

2. The required scope and intensity of the study, surveys, and investigations vary with:

    a. The complexity of the proposed structure or system of structures.

    b. The complexity of the site and the watershed with respect to geology, hydrology, and so on.

    c. The importance of the project in terms of size, type, hazard potential, cost, or impact on other programs.

81.2 - Phase II, Data Collection and Evaluation

Collect sufficient basic data by means of surface reconnaissance, surveys, subsurface investigations, materials testing and hydrologic studies (FSM 2530) to furnish an adequate basis for design.

Ensure the data collected are sufficiently accurate to allow reasonable confidence in the assumptions and approximations that must be made to establish and apply design criteria.

To avoid duplication of effort, perform phase I surveys and investigations to the same standards prescribed for phase II surveys and investigations when it is cost effective to do so. If not, use the phase I data to reduce the cost of collecting the phase II data.

It is often necessary to obtain supplementary data after the design has progressed into phases III and IV. When such needs arise the designer (or reviewer) should promptly notify the office concerned.

The scope and intensity of the data collection program varies with the size and complexity of the project, the complexity of the site and of the watershed, the hazard potentials, and the impact on other programs. The designer or reviewer must evaluate all of the data and assess their suitability for use as a basis for design. In making this evaluation, the designer, in collaboration with appropriate specialists, must be guided by published instructions and criteria, and by a general knowledge of good design practice.

Omissions, discrepancies, and inadequacies must be reported to the engineer responsible for data collection as soon as possible. Such reports should contain suggestions for supplementary investigations or other corrective actions to be taken to secure adequate data.

81.3 - Phase III, Preliminary Design

Two or more preliminary designs may be made to allow for the selection of the best alternative for final design.

1. Each preliminary design alternative consists of selecting the general features of the structure including:

    a. The structure type.

    b. The general form and the arrangement of the elements of the structure.

    c. The types and locations of appurtenant mechanical equipment.

    d. The most practical power source, if applicable.

2. Each preliminary design alternative includes hydraulic features that define as a minimum:

    a. The alignment, grades, and cross-sections of channels.
    b. The critical elevations, general dimensions,and capacities of all water-control structures and equipment in the system.

3. Each preliminary design includes structural dimensions that, as a minimum, allow preparation of reasonable estimates of quantities of materials.

4. Each preliminary design includes prescriptions for reservoir clearing that, as a minimum, reflect recommendations in the environmental analysis and consider the effect of debris on spillway function.

81.4 - Phase IV, Final Design

The final design consists of:

1. Checking the adequacy of surveys and investigations and the accuracy of the selected preliminary design alternative.

2. Refining the elements of the preliminary design.

3. Completing the structural design.

4. Preparation of construction drawings, specifications, bid schedules, engineer's estimate of costs and construction schedule.

5. Review by the appropriate level of the organization or other agencies, if applicable.

6. Preparation of the final design summary.

7. Preparation of the operation and maintenance plans. (FSM 7515).

82 - Channel Planning, Investigation, and Design

Channel work shall be performed by personnel having up-to-date skills and training appropriate for the work. For modifications and changes to natural channels, up-to-date training is required in river mechanics, fluvial geomorphology, or related hydrologic areas of knowledge. This is a rapidly advancing branch of science, but one that is not commonly taught in engineering schools. For all channels, up-to-date training in channel hydraulics and earth work engineering are required.

Contact the Forest Service Stream Systems Technology Center in Ft. Collins, Colorado, a unit of the Rocky Mountain Forest and Range Experiment Station for current state-of-the-art courses, handbooks, and publications on channels, sediment transport, and related topics. Contact agencies such as the Soil Conservation Service and Bureau of Reclamation for current state-of-the-art information in channel hydraulics and earthwork engineering.

82.1 - Layout

Align the channel to optimize economy of construction and operation and minimize environmental impacts. Design the channel to safely release excess flow where:

1. Natural flow is intercepted by the channel.

2. The channel grade decreases.

3. Sedimentation is likely to occur.

82.2 - Planning and Design

Design linings, depth, width, and slope of channels so they are appropriate for the site conditions and design capacity.

83 - Hazard Classification

Assign a hazard classification in accordance with FSM 7511 and chapter 40 of this handbook. The hazard classification will affect the degree of precision required in a design and the need for a conservative, low risk design.