DEPARTMENT OF ECOLOGY
Water Resources Program / Dam Safety Office
PO Box 47600, Olympia, WA 98504-7600

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To: Project Engineers, Project Managers

From: Marty Walther, Dam Safety Engineer

Subject: Dam Safety Engineering Reports

The following information may be helpful to you in compiling the engineering documents for your new dam or dam modification project. Guidance for dam engineering design reports is provided in *Dam Safety Guidelines, Part II, Project Planning and Approval*, in Section 3.3. A copy of this section from *Guidelines Part II* is attached.

If you have limited experience submitting engineering reports to the Dam Safety Office, we have attached a suggested table of contents that provides a framework for compiling the information requested in *Guidelines Part II*, Section 3.3. A condensed table of contents is shown on the following page, with an annotated version on subsequent pages to provide more details about each section of the report.

This suggested table of contents adds to the guidance in our Dam Safety Guidelines on the content and level of detail needed to convey the professional judgment behind the engineering designs for dams and spillways. Although we have provided this guidance, you are free to use another format that you or your firm prefers for these types of engineering reports.

Some items or topics listed here will not apply to your particular project. You may revise both the content and the format of the engineering reports as appropriate for your specific projects. Also, note that the details under each heading will vary based on the size and complexity of the project. For small, low hazard dams, brief descriptions might be warranted, whereas for larger, more complex structures, more detailed descriptions may be needed.

Early and open communication helps all of us. If you have any questions, please do not hesitate to call or e-mail.

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_____ Dam / Stormwater Pond
Dam Safety Engineering Report

Table of Contents

_____ Dam / Stormwater Pond
Dam Safety Engineering Report

Table of Contents (Annotated)

Spillway and Outlet Design (continued)

Secondary Spillway

Dimensions, materials, key elevations for drop inlet spillways; stage-discharge table/curve; flow surges and air venting; spillway outfall.

Emergency Spillway

Dimensions, lining materials, key elevations for open channels; stage-discharge table/curve; flow velocities and erosion resistance; spillway outfall.

Outlet Works

Dimensions, materials, key elevations for low outlet pipes; control valves; stage-discharge table/curve; reservoir drawdown table/curve.

Geotechnical Analysis and Design

Usually a separate geologic/geotechnical report by a geotechnical sub-consultant. See Dam Safety Guidelines for further guidance.

References

Project Data Sheet (*see below*)

Appendices

Dam and reservoir

Maps, drawings, tables

- *Map(s) showing project location and pond/reservoir area.*
- *Plan, section and profile views of the embankment.*
- *Stage-surface area-storage volume table for pond or reservoir, 1 foot intervals or smaller, plus key elevations for water levels (WQ pool, 100-year storm), spillways (overflow elevations), dam crest.*

Dam failure analysis

Maps

- *Map(s) showing inundation area and/or downstream hazard locations. Include flood wave travel times and flood depths or elevations at key locations.*

Dam breach hydrographs

Piping failure

- *Calculations of dam breach dimensions, timing and discharge.*
- *Summary statistics from dam breach hydrograph (see below).*
- *Graph of dam breach hydrograph.*

Overtopping failure

- *Calculations of dam breach dimensions, timing and discharge.*
- *Summary statistics from dam breach hydrograph (see below).*
- *Graph of dam breach hydrograph.*

Dam failure analysis (*continued*)

Flood path

- *Hydraulic profile of downstream channel.*
- *Channel cross-sections at selected locations.*
- *Network for computer model.*

Flood routing

Piping failure

- *Hydrographs for selected locations.*
- *Flood wave travel times and peak discharges at selected locations.*
- *Comparisons to 100-year natural flood discharges at selected locations.*

Overtopping failure

- *Hydrographs for selected locations.*
- *Flood wave travel times and peak discharges at selected locations.*
- *Comparisons to 100-year natural flood discharges at selected locations.*

Water surface elevations

Piping failure

- *Inundation depths, elevations and top widths for selected locations*.
- *HEC-RAS standard output table.*

Overtopping failure

- *Inundation depths, elevations and top widths for selected locations.*
- *HEC-RAS standard output table.*

Design step for hydrologic analysis

- *Design step worksheet, either photocopied or spreadsheet version.*
- *Incremental damage analysis; flood hydrographs and flood elevations with and without dam failure; selected design step*.

Hydrologic analysis

Maps and drawings

- *Map(s) showing topography, drainage areas, hydraulic features.*
- *Map(s) showing watershed soils, land uses.*
- *Map and line diagram of inflows and outflows for off-stream reservoir or lagoon.*

Watershed hydrology

- *Network for hydrologic model.*
- *Time and rainfall parameters.*
- *Runoff parameters.*
- *Time of concentration.*
- *Infiltration and CN computations.*
- *Design storm precipitation.*
- *Storm, interflow and loss hyetographs.*

Hydrologic analysis (*continued*)

Inflows and outflows for off-stream reservoir or lagoon

- *Parameters for inflow conveyance facilities – pipeline or channel location, length, bed slope, key dimensions and elevations, cross-section geometry, flow capacity.*
- *Parameters for outflow conveyance facilities – pipeline or channel location, length, bed slope, key dimensions and elevations, cross-section geometry, flow capacity.*
- *Parameters for inflow or outflow pumping facilities – pump station location and pump configurations, pump parameters (Hp, GPM, TDH; copy of pump curve).*
- *For wastewater inflows, summary of key water quality parameters; list NPDES or State Discharge Permit number.*

Spillway and reservoir parameters

- *Stage-discharge table and curve for combined spillways.*
- *Required reservoir freeboard.*
- *Stage-surface area-storage volume table for reservoir, at same intervals as stage-discharge curve.*

Results from computerized analysis

- *Network and summary input data for hydrologic model.*
- *Summary results.*
- *Reservoir freeboard during IDF.*
- *Reservoir inflow and outflow hydrographs.*
- *Runoff hydrographs for representative sub-basins.*

Spillway and outlet design

Principal (Flow Control) Spillway

- *Plan, section and profile views of the spillway and outfall.*
- *Stage-discharge calculations, table and curve.*
- *Reservoir drawdown calculations, table and curve.*

Secondary Spillway (*items for drop inlet spillway*)

- *Plan, section and profile views of the spillway and outfall.*
- *Stage-discharge calculations, table and curve.*
- *Flow surge and air vent calculations.*

Emergency Spillway (*items for open channel spillway*)

- *Plan, section and profile views of the spillway and outfall.*
- *Stage-discharge calculations, table and curve.*
- *Calculations of flow velocities and adequacy of erosion resistance.*

Outlet Works

- *Plan, section and profile views of the outlet pipe and outfall.*
- *Stage-discharge calculations, table and curve.*
- *Pump parameters – Hp, GPM, TDH; copy of pump curve.*
- *Reservoir drawdown calculations, table and curve.*

Summary statistics from dam breach hydrographs:

Piping failure:	Peak discharge	=	_____ cfs
	(negligible inflow during failure)		
	Time to peak discharge	=	_____ hours
	Time for breach development	=	_____ hours
	Time to drain the reservoir	=	_____ hours
	Reservoir volume	=	_____ acre-feet
Overtopping failure:	Peak discharge	=	_____ cfs
	includes inflow	=	_____ cfs
	Time to peak discharge	=	_____ hours
	Time for breach development	=	_____ hours
	Time to drain the reservoir	=	_____ hours
	Reservoir volume	=	_____ acre-feet
	Flood hydrograph volume	=	_____ acre-feet

Project Data Sheet

Template formats for project data sheets are shown on the following pages. Each project data sheet is two to three pages long. Two formats are presented for you to select from. The first format was developed with many of our existing dams in mind, typically used for purposes such as irrigation water supply, flood control, recreation, or wastewater treatment. The second format was developed with new storm ponds in mind, typically used for stormwater management, or in some cases specifically for flood control.

You should format and edit the project data sheet to best describe your specific project. In particular, the slashes "/" indicate where you must choose between two or more possible choices. (The exception here is for spillway profile slopes given in units of ft/ft.) If the abbreviations are too confusing, please feel free to call or email for clarification. The blanks generally need some numerical information (except for creek or river names in the downstream flood path, or the watershed or stream name for off-stream reservoirs or storm ponds).

Feel free to delete items that do not apply to your dam and to rearrange items as appropriate. For example, if your principal spillway is an open channel rather than a drop inlet structure, simply use the text for the open channel within the Principal Spillway section. If your dam has just one overflow spillway, simply use whichever text applies in a section titled Overflow Spillway and delete the unneeded text. If your dam has a separate low outlet pipeline in addition to principal, secondary and emergency spillways, simply add an Outlet Works section to the second format data sheet on a third page.

Some additional comments follow after the Project Data Sheet templates.

_____ Dam

Project Data Sheet

(*1st format*)

General

State I.D. No.	[Dam Safety file no.]
Owner and Operator	[company name]
Location	T __ N, R __ E/W, Section ___
	___ miles N/S/E/W of (major city/town)
Construction Completed	19___ / 20___
Purpose	Irrig water supply / Flood control / Rec.
Public Water System WFI No.	[delete if not applicable]
NPDES / State Discharge Permit No.	[delete if not applicable]
Downstream Hazard Potential	High/Significant/Low, Hazard Class ___
Downstream Flood Path	_____ Creek to _____ River
	to _____ Lake/River/Floodplain

Reservoir

Watershed	[stream name]
Drainage Area	___ acres / square miles
Normal / WQ Pool Operating Elevation	_____ feet
Surface Area at Normal / WQ Pool	____ acres
Active Storage at Normal / WQ Pool	____ acre-feet
Spillway Overflow Elevation	_____ feet
Surface Area at Spillway Overflow	____ acres
Active Storage at Spillway Overflow	____ acre-feet
Dam Crest Elevation	_____ feet
Surface Area at Dam Crest	____ acres
Active Storage at Dam Crest	____ acre-feet

Dam Embankment

Type	[type and internal seepage/drainage controls]
Structural Height	____ feet
Hydraulic Height	____ feet
Crest Elevation	____ feet
Elevation Datum	Spillway / MH lid / [other] = ____ feet
Crest Length	____ feet
Crest Width	____ feet
Upstream Slope	____ H:1V
Downstream Slope	____ H:1V

_____ Dam

Project Data Sheet

(*1st format*)

Principal Spillway

Type	[Concrete/material] drop inlet
Location	Center of dam / right/left abut / natural grnd
Discharge Capacity	____ cfs at water level ____ feet
	____ cfs at water level ____ feet
Overflow Elevation	____ feet
Riser Diameter / Dimensions	____ feet x ____ feet
Overflow Weir Length	____ feet
Discharge Conduit – section	____ inch diameter [material] pipe
Discharge Conduit – profile	____ feet long: ____ ft at slope _____ ft/ft, then ____ feet at slope ____ ft/ft (__ H:1V)

Emergency Spillway

Type	[material]-lined open channel
Location	Center of dam / right/left abut / natural grnd
Discharge Capacity	____ cfs at water level ____ feet
	____ cfs at water level ____ feet
Overflow Elevation	____ feet
Overflow Control Section	Base width ___ feet, side slopes ___ H:1V
Discharge Channel – section	Base width ___ feet, side slopes ___ H:1V
Discharge Channel – profile	____ feet long: ____ ft at slope _____ ft/ft, then ____ feet at slope ____ ft/ft (__ H:1V)
Inflow Design Flood – Storm	Step _, _% PMP; Shrt/Intm/Long, hi int/vol
Inflow Design Flood – Precipitation	2/6/24 hr = ___ inch, 6/18/72 hr = ___ inch (as calculated per Technical Note 3, 1993/2009)

Outlet Works

Type	____ inch diameter [material] pipe
Location	Principal spillway / center of dam / R/L abut
Discharge Capacity	____ cfs at water level ____ feet
	____ cfs at water level ____ feet
Flow Controls	Upstream – [**req'd:** valve, gate, orifice, etc.]
	Downstream – [valve, gate, orifice, etc.]
Intake Elevation	____ feet (pipe invert / centroid)
Outlet Conduit – profile	____ feet long, slope _____ ft/ft
Drawdown Capacity	____ feet/day at water level ____ feet
(max drawdown at minimal inflow)	____ feet/day at water level ____ feet

_____ Dam

Project Data Sheet

(*2nd format*)

General

State I.D. No.	[Dam Safety file no.]
Owner and Operator	[company name]
Location	T __ N, R __ E/W, Section ___ ___ miles N/S/E/W of (major city/town)
Construction Completed	20___
Purpose	Stormwater management / Flood control
NPDES / State Discharge Permit No.	[delete if not applicable]
Downstream Hazard Potential	High/Significant/Low, Hazard Class ___
Downstream Flood Path	_____ Creek to _____ River to _____ Lake/River/Floodplain

Reservoir

Watershed	[stream] / Offstream within _____ drainage
Drainage Area	___ acres / square miles
WQ Pool Operating Elevation	_____ feet
Surface Area at WQ Pool	____ acres
Inactive Storage at WQ Pool	____ acre-feet
Spillway Overflow Elevation	_____ feet
Surface Area at Spillway Overflow	____ acres
Combined Storage at Spillway Overflow	____ acre-feet
Dam Crest Elevation	_____ feet
Surface Area at Dam Crest	____ acres
Combined Storage at Dam Crest	____ acre-feet

Dam Embankment

Type	[type and internal seepage/drainage controls]
Structural Height	____ feet
Hydraulic Height	____ feet
Crest Elevation	____ feet
Elevation Datum	Spillway / MH lid / [other] = ____ feet
Crest Length	____ feet
Crest Width	____ feet
Upstream Slope	____ H:1V
Downstream Slope	____ H:1V

_____ Dam

Project Data Sheet

(*2nd format*)

Principal Spillway

Type	[Concrete/material] flow control structure with interior baffle wall / [material] riser
Location	Center of dam / right/left abutment
Discharge Capacity	____ cfs at water level ____ feet ____ cfs at water level ____ feet
Riser Diameter / Dimensions	____ feet x ____ feet
Interior Riser Diameter	____ feet
Low Outlet Overflow Elevation	____ feet
Intake Conduit – section	____ inch diameter [material] pipe
Discharge Conduit – section	____ inch diameter [material] pipe
Discharge Conduit – profile	____ feet long: ____ ft at slope _____ ft/ft, then ____ feet at slope ____ ft/ft (__ H:1V)
Drawdown Capacity (max drawdown at minimal inflow)	____ feet/day at water level ____ feet ____ feet/day at water level ____ feet

Secondary Spillway

Type	[Concrete/material] drop inlet
Location	Principal spillway / center of dam / R/L abut
Discharge Capacity	____ cfs at water level ____ feet ____ cfs at water level ____ feet
Overflow Elevation	____ feet
Riser Diameter / Dimensions	____ feet x ____ feet
Overflow Weir Length	____ feet
Discharge Conduit – section	____ inch diameter [material] pipe
Discharge Conduit – profile	____ feet long: ____ ft at slope _____ ft/ft, then ____ feet at slope ____ ft/ft (__ H:1V)

Emergency Spillway

Type	[material]-lined open channel
Location	Center of dam / right/left abut / natural grnd
Discharge Capacity	____ cfs at water level ____ feet ____ cfs at water level ____ feet
Overflow Elevation	____ feet
Overflow Control Section	Base width ___ feet, side slopes ___ H:1V
Discharge Channel – section	Base width ___ feet, side slopes ___ H:1V
Discharge Channel – profile	____ feet long: ____ ft at slope _____ ft/ft, then ____ feet at slope ____ ft/ft (__ H:1V)
Inflow Design Flood – Storm	Step _, _% PMP; Shrt/Intm/Long, hi int/vol
Inflow Design Flood – Precipitation	2/6/24 hr = ___ inch, 6/18/72 hr = ___ inch (as calculated per Technical Note 3, 1993/2009)

Most new dams are homogeneous earthfill embankments, or homogeneous earthfill with toe drain. A new dam more than 15 feet high that requires internal drainage would be described as homogeneous earthfill with chimney [and/or other] drain. An earth dam with a low-permeability core section and higher-permeability outer shell sections would be described as zoned earthfill [with chimney and/or other drain, if applicable].

In most cases, the Inflow Design Flood storm will be one of the following: Short duration; Intermediate; Long high-intensity; Long high-volume; or Long duration. The 2009 update to Technical Note 3 replaced the Long high-intensity and Long high-volume storms with just one Long duration storm, and revised all of the time-distribution hyetographs. It will be helpful to identify which version of Technical Note 3 was used in the IDF calculations.

As stated previously, if the abbreviations or other items in the data sheet templates are too confusing, please feel free to call or e-mail for a clarification.

Acknowledgements

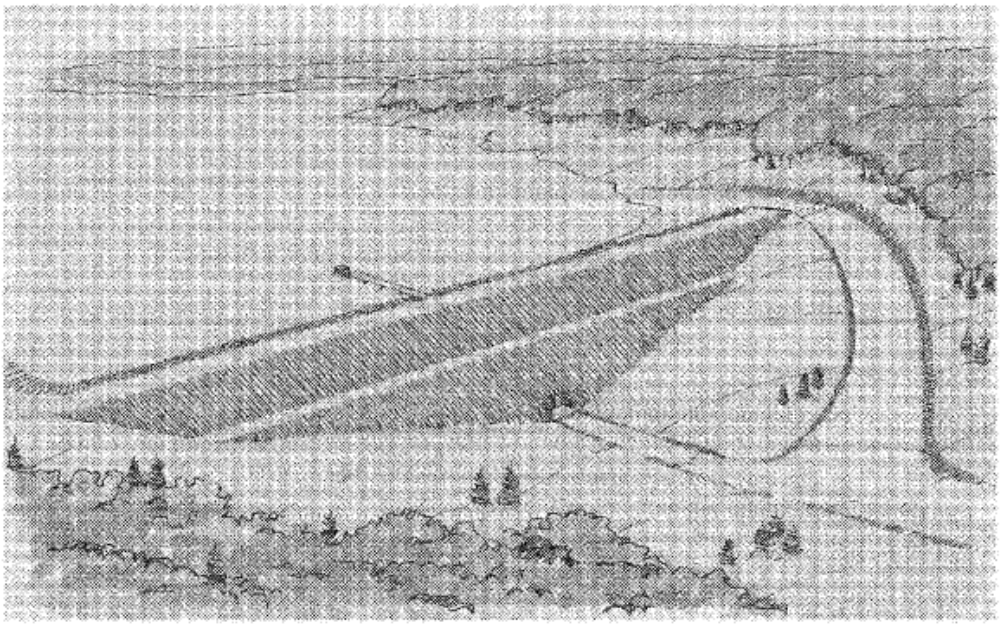
The overall format for this suggested table of contents is substantially influenced and patterned after several dam safety engineering reports compiled by the engineering firms of Goldsmith and Associates of Bellevue in collaboration with Northwest Hydraulic Consultants of Tukwila.

The content for the dam failure and hydrology sections is substantially influenced by the content and format developed by Mel Schaefer, Bruce Barker, and Doug Johnson for these sections in Dam Safety's Periodic Inspection Reports. Mel and Bruce currently work for the engineering firm of MGS Engineering Consultants of Olympia.

Caveats

This suggested table of contents is intended only as a vehicle for communication between design engineers and Dam Safety, to supplement the guidance given in our Dam Safety Guidelines with regard to the content and level of detail needed in the dam safety engineering report to document the professional judgment behind the engineering designs for dams and spillways. Designers and project engineers will need to revise both the content and the format of their engineering reports as appropriate for their specific projects.

Any questions or comments may be directed to Marty Walther, H/H specialist, Dept of Ecology, Dam Safety Office, phone 360-407-6420, E-mail: martin.walther@ecy.wa.gov.



Dam Safety Guidelines

Part II:

Project Planning and Approval
of Dam Construction or Modification

WASHINGTON STATE
DEPARTMENT OF
ECOLOGY

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3.3 ENGINEERING DESIGN REPORTS

Engineering design reports summarizing the various engineering investigations and pertinent project information are an important element of the project design documents. All pertinent design reports shall be submitted to the DSO to provide basic information about the project.

The content of design reports will normally include a general section describing the proposed project and sections relating to specific areas of engineering design. The general section should include:

- A description of the basic purposes of the project;
- A description of the normal operational requirement; and
- A discussion of any unique or important design considerations associated with the site and project configuration.

Those sections involving the various areas of engineering design should address the pertinent items listed below and be supported by appropriate engineering analyses.

3.3.1 Dam Size and Reservoir Operation Classification

The size classification and reservoir operation classification of the proposed project should be listed as defined by Tables 2 and 3. These classifications are used throughout *Part IV of the Dam Safety Guidelines* for determining the degree of conservatism of design, and the sophistication of the methodologies to be used in analyses.

TABLE 2. DAM SIZE CLASSIFICATION

SIZE CLASSIFICATION	DAM HEIGHT
Small Dam	Less than 15 feet
Intermediate Dam	15 feet or greater but less than 50 feet
Large Dam	50 feet or greater

TABLE 3. RESERVOIR OPERATION CLASSIFICATION

RESERVOIR OPERATION CLASSIFICATION	DETERMINING FACTOR
Permanent Pool or Seasonal Pool Operation	Steady state seepage or saturated flow conditions occur in impounding barrier and foundation at or near normal pool conditions.
Intermittent Operation	Duration of normal high pool condition is insufficient for steady state seepage or saturated flow conditions to develop in impounding barrier and foundation.

3.3.2 Geologic/Geotechnical Analyses and Reports

A Geologic/Geotechnical report should provide, as a minimum, the following basic information:

- A presentation of the findings from subsurface explorations based on test pits and/or boring logs, field tests, laboratory testing, and classification of samples.
- A characterization of the site geology and identification of potential problems posed by site conditions. Generalized subsurface formations or stratigraphy, profiles, and sections should be developed.
- An identification and characterization of the seismotectonic provinces that could generate earthquakes large enough to significantly affect the project site.
- A description of the local groundwater regime.

3.3.3 Hydrologic/Hydraulic Analyses and Reports

A hydrologic/hydraulic report should address the pertinent items listed below and provide the following information:

- A topographic map delineating the watershed boundary and stream network. For extensively urbanized watersheds, an outline of storm sewer networks and pertinent hydraulic features should be included. Where it is necessary to divide a watershed into subbasins for analysis, a map is needed delineating the subbasins, along with a schematic description of the stream network used in the analysis.

- A description and a map delineating the various land uses, soil types, ground covers, and associated runoff characteristics of the subbasins or watershed.

- A listing of all sources of inflow to the reservoir.

- A description of initial watershed conditions and associated assumptions prior to the occurrence of the Inflow Design Flood (IDF). Initial conditions of interest may include streamflow and/or other inflow to the reservoir, reservoir levels, gate settings or outlet works discharge, antecedent soil moisture and associated runoff characteristics, antecedent snowpack conditions, and climatic information such as temperature and wind speeds needed for snowmelt computations and any other pertinent information.

- The unit hydrograph(s) or other similar flood response parameters for the subbasins or watershed, together with calculations or data supporting the selection of the parameters.

- The magnitude and temporal distribution of the design storm selected for use in computing the IDF described in either graphical or tabular form. Specific guidelines for selecting the design storm are provided in *Part IV* and *Technical Notes 2 and 3* of the *Dam Safety Guidelines*. (Ref: *Guidelines Part IV*, Section 2.4, Inflow Design Flood)

- A listing of input and output of any computer models used in the analysis.

3.3.4 Dam Failure Analysis

An assessment of the consequences of a dam failure on downstream areas is required and should include the following:

- An estimation of the magnitude of the dam break flood hydrographs resulting from a hypothetical dam failure occurring with the reservoir at normal storage elevation and maximum storage elevation.

- A general description of the areas downstream of the dam that could be affected by floodwater from a dam failure.

- If there is the potential for loss of life, an inundation map delineating the maximum areal extent of flooding that could be produced by a dam failure. Inundation mapping should extend to a point downstream where the dam break flood would no longer pose

a risk to life. This is often interpreted to be coincident with the point where inundation from the dam failure is within the 100 year floodplain for the affected watercourse.

- The downstream hazard classification as defined by Table 4, which reflects the above conditions and those conditions that might be reasonably anticipated from future downstream development. The most serious potential consequences of failure for those conditions listed in columns 4A, 4B, and 4C shall be used to establish the appropriate downstream hazard classification.

Specific guidelines for dam break analyses are found in the *Dam Safety Guidelines - Technical Note 1, Dam Break Inundation Analysis and Downstream Hazard Classification*.

TABLE 4. DOWNSTREAM HAZARD CLASSIFICATION

Downstream Hazard Potential	Downstream Hazard Classification	Column 4A Population at Risk	Column 4B Economic Loss Generic Descriptions	Column 4C Environmental Damages
Low	3	0	Minimal. No inhabited structures. Limited agriculture development.	No deleterious materials in water
Significant	2	1 to 6	Appreciable. 1 or 2 inhabited structures. Notable agriculture or work sites. Secondary highway and/or rail lines.	Limited water quality degradation from reservoir contents and only short-term consequences.
High	1C	7 to 30	Major. 3 to 10 inhabited structures. Low density suburban area with some industry and work sites. Primary highways and rail lines.	Severe water quality degradation potential from reservoir contents and long-term effects on aquatic and human life.
High	1B	31-300	Extreme. 11 to 100 inhabited structures. Medium density suburban or urban area with associated industry, property and transportation features.	
High	1A	More than 300	Extreme. More than 100 inhabited structures. Highly developed, densely populated suburban or urban area with associated industry, property, transportation and community life line features.	

3.3.5 Engineering Calculations

Engineering calculations and data supporting the detailed design of project components should be included with the submittal of the design reports. The design, analyses, and construction details should satisfactorily address the conditions at the proposed site. The supporting information should generally include:

- The design step level(s) used in the design of the critical project elements based on guidance contained in *Part IV of the Dam Safety Guidelines* and information in *Technical Note 2*.

- Stability analyses corroborating the design of the proposed embankment/barrier section under static and seismic loadings and rapid drawdown conditions.

- An assessment of the impoundment permeability and any associated local groundwater problems which may develop from the impoundment of water.

- Calculations for the design of any hydraulic structures, particularly outlet works, which are subject to high lateral earth pressures, relatively large seismic loads or excessive uplift pressures.

- Computations for sizing the principal and emergency spillways, and routing computations defining the reservoir inflow and outflow design flood hydrographs. If a computer model of the watershed is developed, a listing of pertinent input and output data should be included.

- A graph or chart describing the relationship between reservoir pool elevation and reservoir surface area (in acres).

- A graph or chart describing the relationship between reservoir pool elevation and reservoir storage volume (in acre-feet).

It should be emphasized, particularly for small projects, that many of the foregoing items, and those items described in the geologic, hydrologic and dam failure analyses sections can be adequately addressed through a simple reconnaissance of the site and surrounding topography. In addition, much of the needed guidance and information is contained in standard engineering texts, references and publications, some of which is summarized in *Part IV of the Dam Safety Guidelines*.

More detailed information on items commonly covered in design reports is provided in the U.S. Bureau of Reclamation's publication *Design of Small Dams*.