Appendix J
DAM SAFETY SURVEILLANCE AND MONITORING PLAN OUTLINE

DAM SAFETY SURVEILLANCE AND MONITORING PLAN OUTLINE

PURPOSE:
The Dam Safety Surveillance and Monitoring Plan Outline (DSSMP) provides the details of how an owner will monitor and evaluate the performance of a dam or project structure. The DSSMP is Section 7 of the Supporting Technical Information Document (STID) which for the most part contains information that is relatively unchanging throughout the life of the project. This information includes details such as types of instruments, definition of action levels and threshold values, reading procedures, surveillance plans and procedures for visual inspection and documentation of data processing and evaluation methods.

A dam safety surveillance and monitoring plan should be developed for every project regardless of its size or hazard potential rating. The DSSMP should be appropriate to the complexity of the project. The DSSMP could be as simple as a single page document outlining the basic observations necessary to evaluate the condition of the dam.

The DSSMP includes the requirement to periodically submit a Dam Safety Surveillance and Monitoring Report (DSSMR). The DSSMR is a separate periodic report that presents an evaluation and interpretation of the dam safety surveillance and monitoring data, and provides findings on the overall performance of the dam. The DSSMR outline is described in Appendix K.

The DSSMP and DSSMR should be submitted in hard copy. On a case by case basis upon request of the Regional Office, the hard copy of the DSSMP and DSSMR will be required to be supplemented with an electronic format although voluntary electronic submissions are encouraged.

The DSSMP and DSSMR should include a detailed table of contents; all pages including the content of any appendices should be numbered in order for the reviewer(s) to confirm that all materials are included in the documents.

I. Dam Safety Surveillance Program

Include enough information in this section to describe the Licensee's visual inspection program. The visual inspection plan should include as a minimum:

- The major components of the Project included in regular surveillance such as dam, penstock, spillway, etc.
- Identify what typical observations are made; for example: alignment/misalignment of dam structures or appurtenants in place on the

structures (fences, guardrails, pavements, signposts, and power lines), leakage/seepage, depressions/ruts, cracks, consistency of crest elevation or slope, spalling/pitting, rust, tight/open joints, buckling, bending, corrosion, clean, recently painted, bulging, etc. Consider documenting both positive as well as negative dam safety observations.

- Identify areas requiring regular or special monitoring or repeatable photographs for historical documentation such as, crack monitoring, rock erosion, or seepage. These areas may be identified from a PFMA or standards based engineering analyses i.e., slope stability, or be site specific features such as deicing mechanisms, etc). Note the actual photos should be reproduced in the DSSMR and a map of the photo locations should be provided in the DSSMP.
- Provide the frequency of the inspections.
- Describe procedures to report unusual observations.
- Describe inspection procedures used during and immediately following significant floods, earthquakes, or other unusual events.
- The training performed to ensure the inspectors complete reliable inspections and understand the relationship between the inspections and the safety of the dam or structure.
- Procedures to integrate inspection findings into maintenance schedules or initiate responses or actions if a moderate or serious condition is found.
- Archival, peer review, and dissemination of information procedures should be documented.

Appendix C of this outline presents an optional form that could be used to aid in the visual assessment of the project structures. An example of any customized blank inspection forms developed for the project shall be included in Appendix C of the DSSMP. Actual inspection forms completed since the last periodic submission can be presented in Appendix A of the DSSMR. Inspection forms that contain relevant important information can be preserved in the DSSMP however, a complete chronology of the actual inspection forms should not be preserved in the DSSMP.

II. Instrumentation Monitoring Program

This section shall include information about the Licensee's current instrumentation program.

Where appropriate, summary tables should be used to provide the desired information. Also, appendices shall include information such as schematics/drawings, blank data

collection sheets, and other instrumentation details, if available. Although the licensee may elect to preserve copies of the 'raw' field or processed data forms in the DSSMP or DSSMR, consideration should be given to reduce the bulk by including only those documents containing significant information. The document should explain how electronic data is collected or reported i.e. headwater/tailwater readings, temperature, precipitation, piezometers, etc. The drawings should clearly show the location of the instruments in both plan and section views. The section drawings should show the top, bottom and critical elevations of the instrument including the sensing zone(s).

Examples of instrumentation types include, but are not limited to: piezometers, observation wells, weirs/seepage collection points, load cells, stress/strain gages, settlement/alignment/deformation monuments or instruments, crack gauges, river flow and/or rain gaging stations, headwater and tailwater gages (including electronic, staff and alarm systems), seismic instrumentation, temperature, etc.

II.1. Instrumentation

The following information, as appropriate, should be included in this section. This list is not all-inclusive.

- Tables documenting pertinent details of each instrument should be developed. These tables will be used to help confirm that all instrumentation data has been plotted and evaluated. Include abandoned instruments and note date and reason for abandonment. All pertinent reference information that is known about the instrument such as instrument ID, Boring Number, location, date of installation, elevations (top of casings, tip, ground, etc,) type, brand, model, calibration, date of manufacture, sensing elevation, and location (for piezometers), etc., should be included in the table. Readout instruments should be similarly documented especially with calibrations and calibration dates.
- Note: a specific instrument (instrument ID) may have been referenced in the past using a different designation system than that currently in use; a correlation of the old versus new designation should be provided.
- The purpose/intent of the instrument should be documented (e.g., relation to potential failure mode (this should be very brief as more elaborate discussion of PFMs should be covered in section III), monitor pore pressures in the foundation, evaluate phreatic surface through the embankment, measure specific areas of seepage or total seepage, etc.). A brief historical discussion regarding instrumentation (reason installed or abandoned, method of

installation/abandonment, problems, changes in performance, changes in reading schedule, etc.). The actual intent of the instrument versus the terminology used to reference the instrument should be verified and documented (e.g. the difference between "observation well", "monitoring well", and "piezometer").

- Method of data collection (*e.g.*, manual, semi-automated or fully automated). Can automated systems be confirmed by manual readings? How often are automated systems confirmed?
- Where remedial construction has been performed, the inclusion of any new instrumentation or the effect of construction on any existing instrumentation should be discussed. For example: grouting or maintenance drain cleaning may alter weir readings; post tension stabilization may alter the pattern and magnitude of deformations.
- For abandoned instruments, the method of abandonment should be described.
- If drilling logs and/or detailed drawings for instruments are available they should be included in Appendix B. If drilling logs are already placed in another location in the STID, it would be acceptable to simply refer to their location. However, a list of each instrument should be created with a reference to its associated drilling log.
- Photographs of different instrument types used at a project are encouraged.
- Provide a table showing the history of maintenance performed (i.e. falling head tests, control surveys, cleaning/purging of drains/piezometers, etc.) or clearly indicate such historic testing as notes on the time-series plots provided in the DSSMR. An optional Section II.2 can be created to cover this item

II.1.1. Action Levels

Action Levels should be developed to aid in immediate field-verification of instrumentation readings and/or to assist in determining if readings are approaching a level which would cause concern regarding the instability of a structure. It is highly recommended that Action Levels be established for instruments that are used to evaluate and monitor the development of a specific Potential Failure Mode.

The Design Basis Value for the DSSMP/DSSMR is the value used in the design analysis of the project. For instance, if the stability analysis of a concrete gravity dam assumed a particular uplift distribution, the Design Basis for a foundation interface piezometer would be the value corresponding to the design uplift

pressure at that piezometer. For an embankment dam the Design Basis for a piezometer in the dam might be the pressure corresponding to the phreatic level at that piezometer.

The Threshold Value is a reading that indicates a significant departure from the normal range of readings and prompts an action.

Exceeding the Threshold Value usually does not by itself directly imply a perceived instability of the structure. For example, a high reading of one piezometer in an earth dam may exceed the phreatic surface used in the stability analysis at that location, but other piezometers along the same cross section could indicate the overall phreatic surface is lower than assumed in the design stability calculations. The same logic holds for piezometers used to evaluate the uplift pressure beneath a concrete gravity dam. For these cases a single instrument indicating values above design level does not automatically indicate a process headed towards instability.

In some instances, a Threshold Value may be a lower limit; i.e. a decreasing trend of piezometric level may indicate the opening of a flow path to the downstream side of the dam. Or it may be desirable to maintain a certain piezometric level in order to retain submergence and prevent deterioration of wooden piles. For this reason, the setting of Threshold Values should include a careful consideration of Potential Failure Modes and more than one Threshold Value may be appropriate if development of different PFMs would result in different responses. In either case, deviation of the readings relative to the Threshold level starts the process of a more detailed examination defined by the Action Levels.

Once an instrument reading exceeds the Threshold Value an action is necessary. The range of response will vary greatly according to the severity of the situation. It may be necessary to designate multiple Action Levels that are progressively serious. These should account for:

- a minor departure from the historical record (possibly in order to simply receive an alert from the person reading the instrument thus verifying that measurements are being made);
- a major departure from the historical record (possibly indicating a developing failure mode);
- a departure from historical reaction to other instruments or;
- levels indicating the approach of instability or other forms of failure such as piping.

Depending on the performance and response of the instruments to changing conditions, Action Levels related to magnitude and rate of change limits as well as to address daily, seasonal, or other cyclic relationships may need to be established.

Actions to be taken may include; double checking the reading(s), checking the instrumentation, increased surveillance, review of stability analysis assumptions and/or additional analyses, field investigations, or emergency action.

For those projects where Action Levels are incorporated, the following must be documented: how these were developed; how they are used; actions to be taken for each level; and why they were developed. Where appropriate, a table or drawings should be developed to summarize the Action Levels for each instrument.

II.1.2. Reading Frequency and Procedures

This section should include information on the frequency and procedures used to acquire, confirm the validity, resolve irregular or atypical readings and evaluate data. Considerations for this section should address:

- When are instruments read and how?
- How fast is the parameter that is being monitored changing and what is the basis for the reading frequency?
- Describe any situations such as seasonal limitations that may restrict the ability to acquire data. What procedures are followed to assure dam safety if the dam or instrumentation is inaccessible for a portion of the year?
- How is the raw data confirmed to be valid, etc.? Describe what testing and quality control procedures are in place to ensure the reliability of the data collected.
- Training for personnel in both proper reading of the instrumentation and in how the instrumentation relates to safety of the dam or structure particularly as it pertains to PFM's.

During and immediately following significant flood or earthquake events, instruments should be read, recorded and evaluated along with documentation of the event.

Appendix C presents an optional table **(SCHEDULE FOR DAM SAFETY DAM SAFETY SURVEILLANCE AND MONITORING)** that could be used to list the dam safety surveillance and monitoring methods, frequency or schedule of readings, and other pertinent observation and instrumentation reading information. This table could prove very useful in: a) updating/revising instrument reading

frequency or schedules, and b) providing field personnel a one-page reference sheet for instrumentation reading frequencies. In using this table, this section of the report could be structured to refer the reader to the table in Appendix C for specific information regarding the frequency of readings and other monitoring information that may be more subject to change. Therefore, if, or when, these types of monitoring changes occur, then only the table would have to be revised and the updated copy replaced in the Appendix of the DSSMP. Alternately, these types of revisions would be made in the text of the DSSMP and the appropriate page(s) updated and revised.

II.2. Equipment Maintenance Program

A maintenance plan for the instrumentation should be developed and followed. The maintenance program should include an annual visual inspection, cleaning, and calibration check for all instrumentation. Maintenance of abandoned instruments should be considered in the case readings need to be reinstated. The program should also include procedures for checking instrument performance if erratic readings are observed. If automatic data acquisition equipment is used then the maintenance program will need to include visual observations for moisture intrusion and overheated components, replacing desiccant, testing transient protection devices, testing batteries, and testing that the notification capabilities are working properly in order to determine if an action level has been encountered.

III. Potential Failure Modes

A discussion should be provided that addresses the dam safety surveillance and monitoring related to site-specific potential failure modes that are identified in the PFMA report. The DSSMP should address all Category I and appropriate Category II and Category III failure modes and be designed to minimize the risk associated with these potential failure modes by providing early warning if the failure modes become active or worsen.

APPENDICES FOR THE DSSMP

DSSMP Appendix A:

Drawings

Hard copies of drawings, etc. should be provided in a size that allows all details to be easily read without the use of optical magnifiers. If reduced size copies result in unreadable drawings, the drawings, etc. should be provided as full size copies and folded in pocket dividers. Preferably any drawings submitted in an electronic format should be such that details can be enlarged without loss of resolution (AutoCAD or others). Judgment should be applied in assembling drawings, etc, clutter should be avoided; additional figures may be required.

Plan Drawings

Plan drawing(s) of the project structures should clearly show project components and instrument locations (actively being monitored and those having been abandoned/terminated/idled). The drawing(s) should have a graphical bar type scale to facilitate interpretation of enlarged or reduced copies and the title block should include what horizontal or vertical control is being used (i.e. state plane coordinates, plant datum or NGVD datum). Locations of notable seepage or other structure irregularities that are visually monitored should also be shown. If scalable drawings are not yet available, schematic drawings should be provided in the initial DSSMP and efforts to complete scalable drawings for the next DSSMP update should be initiated. Text on the drawings should be readable in the format presented.

Cross-Section Drawings

Representative cross-sections of project structures should be made to show the dam structure/foundation configuration/zonation, instrument locations, and pertinent instrument details. A graphical scale or a vertical axis with elevations and a horizontal axis with distance should be included on the sections. Each drawing should include a title block. Where practical, the phreatic surface used in the stability analyses for embankment dams or the uplift diagram for concrete structures, the slip circles for minimum FERC required factors of safety, Threshold Values and Action Levels should be shown on each cross section. Locations of notable seepage or other structure irregularities that are visually monitored should also be shown if possible.

Aerial Photographs

When available, include aerial photos to help orient the reviewer to the project structures and their relative locations with respect to each other.

DSSMP Appendix B: Instrumentation Details

Provide any instrumentation details in this appendix that may help the reviewer understand the instrumentation and its intended use. For example: soil boring logs and installation details for a piezometer.

DSSMP Appendix C: Inspection Forms

This appendix shall include the blank inspection forms used to document any formal inspections of project dams or facilities conducted by the Licensee or blank instrumentation collection forms. Inspection forms that contain relevant important information can be preserved in this appendix however, a complete chronology of the actual inspection forms should not be preserved in the DSSMP.

Example of Optional Inspection Form For Embankment Dams

Ongoing Visual Inspection Checklist
Sams Dam

Schedule: Perform **monthly** under normal operating conditions,. Perform **immediately** if the reservoir rises above 9332.0 feet (historical maximum) or after an earthquake that is felt at or near the site. If unusual conditions are seen during or after the high reservoir event or earthquake, perform **daily** until conditions stabilize.

Inspector: _____ Date: _____
Reservoir Elev.: _____feet Time: _____
Weather: _____ Temperature: _____ ^{o}F

A "Yes" response should only be given to question(s) below where observed conditions are different from previously observed conditions. Any observed conditions that have previously been reported and are currently unchanged should receive a "No" response. For any question below answered "Yes", please provide additional information describing the situation as completely as possible under item 7, "Additional Information." Also, take photographs of the situation, and include with this report. A "Yes" response indicates unexpected behavior that needs to be investigated.

1. Crest of Dam:

a.	Any cracks, either transverse or longitudinal?	No	Yes
b.	Any scarps, sinkholes or areas of unusual settlement?	No	Yes

2. Downstream Slope of the Dam:

a.	Any new seepage areas or wet areas?	No	Yes
b.	Any changes in conditions at existing seepage areas or wet areas?	No	Yes
c.	Any materials being transported by seepage flows at existing or new Seepage areas (such as discolored seepage water or sediment deposits)?	No	Yes
d.	Any scarps, sinkholes, sloughs, slides or areas of unusual settlement?	No	Yes

3. Upstream Slope of the Dam:

a.	Any significant erosion due to wave action?	No	Yes
b.	Any scarps, sinkholes, sloughs, slides or areas of unusual settlement?	No	Yes
c.	Any whirlpools in the reservoir?	No	Yes

4. Downstream Toe Area, Abutments and other Areas Downstream :

Note: Extend the inspection to all areas within 50 feet of the toe of the dam and all the way up both abutment groins and to within 50 feet either side of the groins. Inspection for seepage and sediment in the river channel should be performed during low flows and be extended along the river channel for at least 300 feet.

a.	Any new seepage areas or wet areas?	No	Yes
b.	Any changes in conditions at existing seepage areas or wet areas?	No	Yes
c.	Any cracks, sinkholes, sloughs or areas of unusual settlement?	No	Yes
d.	Any new seepage areas along the banks of the river channel?	No	Yes
e.	Any new sediment deposits along the banks of the river channel?	No	Yes

5. Outlet Works:

a.	Any new or enlarged cracks or spalls in the concrete?	No	Yes
b.	Any unusual deformations or displacements?	No	Yes
c.	Any unusual flow patterns or conditions during releases?	No	Yes
d.	Any new seepage into the outlet works conduit?	No	Yes
e.	Any sediment accumulation upstream from the weir plate at SM-1? (Feel the material and determine if it contains sediment. If yes, dry, weigh and determine the volume and report in item 7 below and have a sample of it analyzed for soil content at a laboratory. Once the analysis results are received transmit them to the contact listed below).	No	Yes

6. Spillway:

a.	Any new or enlarged cracks or spalls in the concrete?	No	Yes
b.	Any unusual deformations or displacements?	No	Yes
c.	Any unusual flow patterns or conditions during releases?	No	Yes

7. Additional Information:

NOTE: All descriptions should include specific location information and all other seemingly relevant information. Seepage area descriptions should include: estimated seepage amount and water clarity description (clear/cloudy/muddy, etc.). Crack descriptions should include orientation and dimensions. Descriptions of changes at cracks should include the estimated amount of movement, and movement direction. Deteriorated or spalled concrete descriptions should include degree of deterioration and approximate dimensions of the affected area.

Example Schedule For Dam Safety Surveillance And Monitoring

SCHEDULE FOR DAM SAFETY SURVEILLANCE AND MONITORING

PROJECT No. P-XXXX DATE
PROJECT VERSION
DAM CONTACT
State

MONITORING METHOD	FREQUENCY/ SCHEDULE	COMMENTS
	Daily	During the winter, the scope of inspections can be scaled back to what reasonably can be performed, given the site conditions. 1/ 2/ 3/ 4/
Seepage Monitoring Installations	Weekly	During the winter, obtain readings when this can reasonably be done, based on site conditions. 2/ 3/ 4/ 5/
Mapping of Seepage Areas on a Plan View Drawing	Annually	On approximately July 1.
Piezometers (Porous-Tube and Vibrating-Wire)	Monthly	During the winter, obtain readings when this can reasonably be done, based on site conditions. 2/ 3/ 4/
Internal Vertical Movement (IVM) Devices	On Standby	Obtain readings only if a specific request is received.
Embankment Measurement Points	In 2007	Thereafter, on standby - survey only if a specific request is received. 6/

REFERENCE DRAWINGS: 426-D-2073 Plan View of Instrumentation

NOTES AND REMARKS:

1/ Visual Observations should be performed using the “Dam Safety Observation Checklist". A copy of each completed "Dam Safety Observation Checklist" should be placed in the instrumentation notebook. A copy of pertinent checklists should be included in the DSSMR.

2/ To the extent possible, obtain readings and perform inspections at times when no precipitation or significant snowmelt has occurred in the preceding 72 hours. If this is not possible, precipitation and/or snowmelt within the last 72 hours should be reported (amount and time).

3/ In the event that the reservoir elevation rises above 1235.5 feet, visual inspections and seepage and piezometer readings are to be performed every other day. Should the reservoir elevation rise above 1239.0 feet, visual inspections and seepage and piezometers readings are to be performed daily.

4/ Obtain instrument readings and perform an ongoing visual inspection as soon as possible following significant seismic shaking at the damsite (peak horizontal acceleration in excess of 0.05g) and following a significant flood event (reservoir elevation above 1239.0 feet).

5/ Whenever flow rates are being read, check for indications of sediments being carried by the flows (discolored water, sediment deposits in front of weirs, etc.) and report immediately if noted.

6/ Obtain current top of casing elevation for IVM installations whenever surveys are performed.

Appendix K
Dam Safety Surveillance and Monitoring Report OUTLINE (DSSMR)

DAM SAFETY SURVEILLANCE AND MONITORING REPORT OUTLINE (DSSMR)

The results of the dam safety surveillance and instrumentation monitoring plan should be evaluated on a real-time basis and not simply accumulated throughout the year only to be evaluated prior to making the annual (periodic) DSSMR submittal.

1. Findings

This section should contain a summary of significant findings, conclusions, actions, changes or recommendations for the subject year or review period. If considered appropriate, bulleted categories may be used to establish priorities for dam safety or maintenance issues such as “serious issues”, “moderate issues” and “minor issues”.

- State if the dam is performing adequately based on the visual inspections and instrumentation evaluations included in the DSSMR or specify any dam safety concerns.
- A statement should be added for each adverse finding to clarify if it is confirmed or not by instruments and/or visual inspection.
- State if the instrumentation and dam safety surveillance monitoring program is appropriate for the critical PFM’s. If not, make recommendations for improvements.
- Maintenance or actions proposed or completed addressing DSSMR concerns.
- Actions requiring future remediation.
- Changes in inspections, in reading procedures and frequencies, or overall instrumentation program. The DSSMP should be updated accordingly.
- Recommendations for additional instruments or to abandon instruments.
- Recommendations to address additional potential failure modes that may be identified as a result of this entire process.
- Have the readings, evaluations etc been timely completed?

2. Field Observations

This section will include a summary of dam safety surveillance and monitoring items detected during inspections performed by plant personnel, staff inspectors or engineers, FERC engineers, state dam safety officials or special inspections such as a diver’s inspection, a penstock/tunnel inspection, etc.. Include a summary of significant or notable observations or items requiring maintenance or repair. This may be in tabular form for

minor or routine maintenance items. Structural irregularities such as cracks, depressions, and seepage should be shown on plan and section views if possible. Actual field-completed inspection forms or interim reports can be included in Appendix A, however to reduce the bulk of the DSSMR, consideration should be given to include only those documents containing significant observations or minimally a single form documenting typical observations.

3. Instrumentation Evaluation

This section should include an evaluation of active instrumentation supported by sound engineering judgment. Timely compilation and evaluation of the data should be performed to determine if the data supports the satisfactory performance of a structure or that the instrumentation is giving reliable data. Timely evaluation ensures that any adverse trends are recognized and that an appropriate response can be initiated. Unusual observations of data are sometimes due to human error in measurement or compilation that if left unchecked could later raise serious concerns about what actually happened. Periodic evaluation of just how much data is actually needed is also required to monitor the performance of the project structures.

The evaluation should include a statement that the data shown by each instrument or each group of instruments is consistent with reasonable design assumptions or, if not, list the instruments that are inconsistent, why actual performance is not consistent with design assumptions, and the action(s) required to investigate or an explanation to accept the inconsistency. The evaluation of the data should be supported by the documentation included within the DSSMP. If the evaluation concludes the dam is performing satisfactorily or un-satisfactorily, the evaluation should state why and what information led to this conclusion. This may be a reference to a design document, construction documentation, etc.

Water temperature, dam temperature, precipitation, or any other phenomenon that influences the instrument readings should be included in the evaluation of the data. The evaluation can include statistics, if appropriate, from the period covered by this report and compared to relevant historical performance as well as reference to Threshold Values. Also, appendices shall include information such as schematics/drawings, and plots.

The following questions are examples of the items which should be considered in compiling the evaluation:

- How do the readings relate to the design of the project feature?
- How do the readings relate to the Threshold Values and Action Levels?
- How do the readings relate to the design or installation of the instrument?

- Have any calibrations changed? What is the impact on previous readings?
- Are electronic sensors, semi-automated or fully automated systems being confirmed by manual readings?
- Does the instrument still fulfill its intended purpose?
- Does the data support the stability of the structures?
- Is the data supported by the visual observations of the behavior of the structures?
- Is there any trend to the data?
- Are all similar instruments in similar zones responding similarly?
- Can the movement/trend of the readings of an instrument be correlated to any movement/trend of the readings of another type of instrument? (Examples: Is a rise in the water level in a piezometer reflected by an increase in flow at a weir? Are piezometers responding to changes in headwater/tailwater levels?)
- Has enough data been plotted to assess long term trends?
- The use of the terms 'normal', within historical range' and 'no adverse trends' should include an interpretation. Why is it normal? What is the historical range? What is the current reading? Etc.
- Are there any USGS or other off-site instruments that could be used to evaluate the dam performance?

4. DSSMP/DSSMR Changes

This section should document any changes such as updates to the instrumentation, program, and personnel. These changes should be reflected in the DSSMP as appropriate. If there are no changes, so state. List any improvements suggested by the Licensee, FERC, other agencies, or Consultants for the DSSMP or DSSMR.

5. Certification

The DSSMR shall include a signature page indicating who prepared the report (and reviewed the report, if more than one). A professional engineer's stamp is recommended but not required. The qualifications of the reviewer should be included. The certification should identify the date or revision of the DSSMP/DSSMR guidelines that was used to assemble the reports.

APPENDICES FOR THE DSSMR

The figures and other content of the appendices included in the DSSMR should be adequate to support the Evaluations, Findings and Conclusions. Replication of figures and drawings developed for the DSSMP and STID should be limited to those that are needed to illustrate specific points or features of interest with annotations to show specific areas of concern or current levels, etc. to the reader of the DSSMR

The author of the DSSMR, for clarity, may elect to present select figures within the text of the report; however most figures and drawings should be presented in appendices. Regardless of location, all figures and drawings should be individually listed in the table of contents.

Hard copies of drawings, data, plots, etc. should be provided in a size that allows all details to be easily read without the use of optical magnifiers. If reduced size copies result in unreadable drawings, the drawings, etc. should be provided as full size copies and folded in pocket dividers. Judgment should be applied in assembling drawings, etc, clutter should be avoided; additional figures may be required. The submission of supplemental electronic copies are encouraged.

DSSMR Appendix A: Significant Inspection Forms or Reports

A selection of the latest inspection forms/reports can be included to document visual inspections and instrument readings. These forms shall include enough detail by structure to document site specific conditions as found during the inspection. To reduce the bulk of the DSSMR, consideration should be given to include only those documents containing significant observations or minimally a single form documenting typical observations. Documentation of inspection and readings made as a result of the occurrence of a significant flood or earthquake events should always be included.

DSSMR Appendix B: Supporting Drawings

Plan Drawings
Cross-Section Drawings
Aerial Photos

DSSMR Appendix C: Instrumentation Plots

This section includes data plots of all pertinent instrumentation. There are four types of plots that can be considered; Time versus Reading Plots, Cross Section Plots, Correlation Plots, or Special Plots. These plots are described below.

Time versus Reading Plots:

- The amount of data shown on each plot and the scales used for the time versus reading plots should be sufficient to show any historical trend. Historical plots of all data should be developed to illustrate long-term trends such as slowly rising pore pressures, or slowly increasing movement of a structure. However, as years of data accumulate, additional plots of the historical data may have value, i.e., from 5 to 15 years of data.
- Data from similar instruments should be logically grouped on the same page. For example, you might want to compare the performance of all core piezometers relative to each other. Other examples include showing all the instruments installed across a cross-section through the dam or along the crest of the structure. It is common to plot data from one instrument in several groupings to evaluate the response to different reference points.
- When the data is being plotted relative to time, an actual time scale should be used. The data should not be plotted on an incident basis where each tick mark along the axis represents one reading. Normally, time is plotted along the abscissa (x-axis).
- All time scales should avail the interpretation of seasonal trends. Showing month and day designations on a long duration time scale is not always practical. This should be an option for short duration scales. Annual designations with semi-annual or quarterly divisions can be used to reveal seasonal trends. Note that some spreadsheet programs can only select 30 days to approximate the months of the year.
- Consistent time scales or horizontal scales should be used so that direct comparison of plots from different instruments can be evaluated.
- Consider forcing vertical scales on all plots of the same type of instrument to have the same scale or total range so plots can be directly overlaid. Engineering judgment should be used in selecting the scale as some instruments may react with large swings whereas others may show only minor variations. The variation of the instruments that only have small reactions may be lost if plotted at the same scale as those with large variations. A secondary axis at another scale may be of use.
- Time-history plots of data should be prepared to provide a graphical representation of the performance. Do not put too much information on a single figure as the data will be more difficult to interpret.
- Tic marks along the axis should be placed at logical intervals so that intermediate divisions can be easily interpreted.

- Use symbols and/or different line types for each instrument in addition to colors. Note that some colors do not reproduce on copying machines nor are easily visible on computer monitors.
- The influence of precipitation on various instruments should be considered although it may be extremely difficult to determine. It may be necessary to plot precipitation daily or some variation on summing or averaging the data over several days or weeks. Often, no correlation can be made.
- Deformation or movement data should be resolved relative to the axis of the dam or structure, not just to the standard east, west, north, and south coordinates.
- For all instruments such as piezometers and weirs or other recordings that may be influenced by reservoir or tailwater levels, plot these levels to show the influence.

Cross Section Plots:

- Create cross-sections plots for critical stability sections or where particular concerns are noted. The sensing zones of the piezometric data must be carefully evaluated to ensure that different phreatic surfaces that may exists in the embankment and foundation are not being incorrectly mixed together and plotted.
- The instruments do not have to be physically in the same plane in order to develop a cross-section plot. Some instruments (piezometers) may be offset from the section and the distance offset should be indicated by distance and direction (left or right) from the section; e.g. 20R could mean 20 feet right. An explanation of the notation should be included below the cross-section.
- Consideration should be given to developing separate cross sections that show data collected on the same day versus all-time historical high/low points.
- Cross section plots should show; a vertical axis with elevations and a horizontal axis with distance; location of the instruments, tip elevations, current instrument reading levels, geologic zonation, assumed phreatic surface or pore pressure distribution (uplift) used in stability analyses. Optionally, Threshold Values, Action Levels, screen zones, unscreened length, etc. can be shown however clutter should be avoided. Some of these could be designated along the vertical axis rather than at the instrument locations. Most of the actual details of this information should already be provided in a table and on cross-sections drawings in the DSSMP.
- Cross section plots are not a substitute for Time Series plots.

Correlation Plots:

Correlation plots may clearly indicate a developing failure mode that can not be easily identified on a time-history plot.

- Use correlation plots where it can enhance the reviewers understanding of repeatable changes in instrumentation due to external factors or site conditions. Examples can include seasonal changes in reservoir levels that are reflected in instruments or seepage; changes in tailwater levels that influence instruments or seepage; precipitation effects upon seepage; etc. These plots may be useful for instant identification of adverse developments following special events as earthquakes.
- Use correlation plots for monitoring of filling or refilling of reservoirs dewatered for repairs.
- Identification of the real stimulus that causes instrument reading variations (example: Is the reservoir causing a foundation piezometer level variation, or is the piezometer level variation caused by pressure in the aquifer fed from a different source?; is the crack movement caused by the reservoir or by temperature?)
- Investigation to determine the level of responsiveness of the instrument (level of piezometer clogging, etc.)
- For impoundments that do not show significant seasonal changes in elevation, correlation plots are not likely to be useful.

Special Plots:

- Use special plots where they can show relationships that help in the evaluation of the data collected. Examples can include: x-y ‘wander’ plots of movement data about survey monuments to show accuracy/repeatability (however, do not include a mass of these plots when there is no significance to the data); cross-sections or plan drawings annotated with sequential lines indicating progressive change such as presentations of the profile of the settlement of the crest or bulging of the slope of an embankment dam (profile plots of settlement data should include IDF/PMF levels to easily show a low spot in the reservoir rim). Inclinometer data is often presented in a sequential format.

DSSMR Other Appendices: As desired