



DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET, NW
WASHINGTON, DC 20314-1000

REPLY TO
ATTENTION OF

CECW-CE

DEC 18 2012

MEMORANDUM FOR RECORD

SUBJECT: Dam Safety Modification Report, Isabella Lake, Kern County, California – Final USACE Response to Independent External Peer Review

1. Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Section 2034 of the Water Resource Development Act (WRDA) of 2007, EC 1165-2-209 (superseded by EC 1165-2-214, 15 Dec 2012), and the Office of Management and Budget's Final Information Quality Bulletin for Peer Review (2004).
2. The IEPR was conducted by Battelle Memorial Institute. The IEPR panel consisted of six panel members with technical expertise in assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used in the Isabella Dam Safety review documents.
3. The final written responses to the IEPR are hereby certified. The enclosed document contains the final written responses of the Chief of Engineers to the issues raised and the recommendations contained in the IEPR report. The IEPR report and the USACE responses have been coordinated with the vertical team, endorsed by the Risk Management Center and approved by the South Pacific Division, and will be posted on the internet, as required in EC 1165-2-214.
4. If you have any questions on this matter, please contact me or have a member of your staff contact Mr. Bradd Schwichtenberg, Deputy Chief, South Pacific Division Regional Integration Team, at 202-761-1367.

STEVEN L. STOCKTON, P.E.
Director of Civil Works

Encl

CF:
CECW-P
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CESPD-RBT

Isabella Dam Safety Modification Study
FINAL
U.S. Army Corps of Engineers Response to
Independent External Peer Review
October 2012

Independent External Peer Review (IEPR) was conducted for the subject project in accordance with Section 2034 of the Water Resources Development Act of 2007, EC 1165-2-209, and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (2004).

The goal of the U.S. Army Corps of Engineers (USACE) Civil Works program is to always provide the most scientifically sound, sustainable water resource solutions for the nation. The USACE review processes are essential to ensuring project safety and quality of products USACE provides to the American people. Battelle Memorial Institute (Battelle), a non-profit science and technology organization with experience in establishing and administering peer review panels for USACE, was engaged to conduct the IEPR for the Isabella Dam Safety Modification Report (DSMR) and Environmental Impact Statement (EIS).

The Battelle IEPR panel reviewed the Draft DSMR and the Draft EIS, as well as the supporting documentation. The Final IEPR Battelle Report was issued on 20 September 2012.

Overall, 28 comments were identified and documented. Of the 28 comments, 7 were identified as having high significance, 20 had medium significance, and 1 had low significance. The following discussions present the USACE Final Response to the 28 comments.

‘High’: Describes a fundamental problem with the project that could affect the recommendation, success, or justification of the project.

‘Medium’: Affects the completeness of the report in describing the project, but will not affect the recommendation or justification of the project.

‘Low’: Affects the understanding or accuracy of the project as described in the report, but will not affect the recommendation or justification of the project.

- 1. IEPR Comment – *High Significance*: A site-specific probable maximum precipitation (PMP) analysis integrated into the HEC-HMS model, which could potentially reduce uncertainty in the magnitude of the peak probable maximum flood (PMF) inflow valve, has not been conducted.**

USACE Response: Not Adopted

The recommendation to conduct a site-specific PMP and apply those results to the existing HEC-HMS rainfall-runoff model for the study watershed was not adopted in the Final DSMR. Current USACE guidance does not provide for the use of site-specific PMPs as a basis of design, nor are there approved procedures or tools in conducting a site-specific PMP. It is unclear how a site-specific PMP could improve or change the results of the existing PMP study due to the lack

of PMP studies conducted in California (which uses guidance from the National Weather Service that is the most recent in the nation – HMR No. 58/59, 1999). Due to the many questions that remain on the purpose, methods, and policy behind a site-specific PMP, the design team will coordinate with the South Pacific Division, RMC, and Headquarters USACE to determine whether a site-specific PMP will be beneficial for Pre-Construction, Engineering and Design (PED).

2. IEPR Comment – *High Significance*: The Final Hydrology Report does not discuss the verification process for the HEC-HMS model.

USACE Response: Adopted

Action Taken: The first recommendation to conduct verification runs was adopted. It was also recommended to compare the model results to recorded stream flow data to verify the model as predictor of runoff inflow to Lake Isabella under the Probable Maximum Flood (PMF). To apply the recommendation for verification of the PMF study, three gauges were calibrated in the Kern River basin and the results under two calibration events. The unit hydrograph and routing parameters were ultimately the same for the calibration events, which validated the selection of the storage coefficient and time of concentration values of the unit hydrographs. Additionally, the final parameters of the calibration runs were also used for synthetic precipitation runs, which provided definition to the probabilities of flows in the less frequent range (such as the one percent annual exceedance probability). The model runs produced flows in the one and two percent annual exceedance probability range that was predicted by the inflow frequency curves that were developed based upon observed flows that comprise the more frequent end of the curve (such as the 50 percent annual exceedance probability). The ability to reproduce frequency flows, like the 2% and 1%, offers a better validation than doing verification runs for frequent events, since this model is being used for the PMF simulation. However, to ensure that it is clear that the models that produced the PMF are adequate for the more frequent flows, verification runs were conducted in response to this review and the results are published in the Dr. Checks responses. The second recommendation that refers to additional sensitivity analyses was adopted and documented in the Final Hydrology Report (Section 3.6). The uncertainties associated with the parameters in which the sensitivity of the unit hydrographs, spatial patterns, temperature patterns, and ripeness of snow were tested and discussed resulting in no change to the selected plan.

3. IEPR Comment – *High Significance*: In the future without project condition, it is unlikely that the interim risk reduction measures (IRRM) would be abandoned and that the reservoir would be operated as if there were no risk of dam failure.

This comment includes three recommendations for resolution, one of which has been adopted, and two of which have not been adopted, as discussed below.

USACE Response: Adopted.

Action Taken: the recommendation to clearly define the future without project condition was adopted and section 3.2 of the Isabella Dam Safety Modification Report was revised as recommended to clearly define the future without project condition.

USACE Response: Not Adopted.

The recommendation to forecast a revised future without project condition was not adopted. Engineering Regulation (ER) 1110-2-1156 states that the steps to accomplish the baseline risk estimate are established on a without IRRM condition; therefore, the DSM Report satisfies this requirement. Permanent structural IRRM and permanent changes to the water control manual are to be included in the baseline risk condition; however, this project has one permanent IRRM and no permanent changes to the water control manual. The permanent structural IRRM has been included in the baseline risk (extension of the auxiliary left dam abutment); however, the deviation for the pool restriction was not included since it is a temporary IRRM. Once the modifications are in place and the project satisfies the tolerable risk guidelines, the pool restriction (temporary IRRM) will be released and the authorized pool will be in effect. The study team and RMC believe the first recommendation of forecasting a reasonable and credible future without project condition has already been satisfied and meets USACE regulations and guidance. Removal of the IRRM temporary pool restriction, recommendation 3 was not adopted for the comparison of the plans because it is not appropriate for the dam safety modification study. It is an important part of the study to compare back to the baseline condition as authorized (without the IRRM) since the risk estimates to justify the risk and dam safety action classification are based on this scenario.

4. IEPR Comment – *High Significance*: There is no description of the NED plan, why that plan was rejected, or why the recommended plan is preferable to the NED plan or preferable to dam removal.

USACE Response: Adopted

Action Taken: All three recommendations regarding NED benefits were adopted and additional information was added to the Economics and Life Loss Consequence Appendix in the DSMR. For most civil works projects, planning regulations mandate that net benefits be a primary driver in alternative selection. While Dam Safety projects are not bound by this guidance, the study chose to include net benefits as a means of making this information transparent and maintaining consistency with other USACE planning documents. Therefore, Life Safety Plan 4 was identified as our selected plan and the most cost effective for Life Safety considerations. The recommendation to provide documentation and supporting information describing why dam removal is not preferable was also adopted. Dam Removal was evaluated but was determined not to be preferable because of the consequences downstream (life loss being the primary consequence driver). The tolerable risk guidelines are not met with the dam removal alternative plan. This documentation can be found in Section 3.3.4.2.4. of the DSMR.

5. IEPR Comment – *High Significance*: The uncertainty inherent in seismic deformation modeling and its potential impact on the tentative recommended plan has not been fully considered or documented.

This comment includes five recommendations for resolution, four of which have been adopted, and one of which has not been adopted, as discussed below.

USACE Response: Adopted

Action taken: Recommendations 1, 2, 4, and 5 related to the uncertainties associated with the reassessment of the seismic deformation risk analysis and cost values were adopted. Consideration was given to the selection of blow counts for liquefaction triggering and residual strength of the deeper layers of the fan deposit as the area with the greatest uncertainty. Variation and potential qualitative effects on the selection of median values over 33rd percentile values was evaluated. The evaluation indicated that the blow count selection, for deeper layers, associated with Life Safety Plan 4 in the DSMR is likely on the conservative side, which helps reduce the uncertainty associated with the deformation modeling. As recommended, the cost values were reassessed in the ALARP (as low as reasonable practicable) table (Table 3-48 and 3-49) in the Dam Safety Modification Report (DSMR). The DSMR was also updated to better justify and clearly communicate why Life Safety Plan 4 was selected in Section 3.6.

Action to be taken: Additional FLAC deformation model runs will be conducted in the PED phase of the project.

USACE Response: Not Adopted.

Recommendation 3, related to the annual probability of failure (APF), was not adopted based on the evaluation of risk for potential failure modes (PFM) 35 and 38/44. It was found that the annual probability of failure for each was significantly reduced by the addition of freeboard. For example, PFM 35 has extremely low associated risk under life safety plan 4 since it is only possible if a near probable maximum flood immediately follows and a near maximum credible earthquake. The additional freeboard also greatly reduces the probability of PFM 38/44, as the potential for the reservoir to reach an open crack would require an extreme rain flood event also approaching the PMF following a significant earthquake.

- 6. IEPR Comment – *High Significance*: When considering deformation analyses, the details of the potential seismic cracking mechanisms are not well-defined and the use of filters to mitigate seismic displacements and seepage path formation is not well-documented.**

USACE Response: Adopted

Action taken: Recommendations 1, 2, and 4 related to including further documentation as well as conducting additional deformation analysis were adopted. The details of the potential seismic cracking mechanisms for potential failure mode (PFM) 38/44 and PFM 47 are documented and included in the Baseline Risk Report (Appendix A.1 to the DSMR). For both of these potential failure modes the planned filter zone would be subjected to the same strain and shear potential (from transverse cracking or fault rupture), however its gradation will have fine limits and, therefore will not be conducive to hold an open crack. The filter will be designed to be self healing and the outer drain layer will be utilized to carry seepage away from the filter. The risk associated with a seismically developed seepage path (transverse crack or fault rupture) at the Auxiliary Dam was evaluated as if the flaw developed from the upstream to the filter/drain zone. The same logic was used in the Baseline Risk evaluation with the difference being the fact that there is currently no filter for protection under the baseline condition. The addition of a full height and abutment to abutment filter and drain system is one additional, but significant line of

defense against the potential of a seepage related failure continuum. The crest raises (increases freeboard) also reduces the likelihood of a breach as it decreases the likelihood that the bottom of an open transverse crack, based on case histories, would be at or below the pool elevation, with relative duration, based on case histories.

Action to be taken: The study concluded that the results associated with a 2-Dimensional (2-D) evaluation were sufficient in understanding the elongation and shear strain potential to achieve the study purpose. However, 3-D effects will be qualitatively assessed during the PED phase by evaluating the variation of deformations between adjacent 2-D cross sections.

7. IEPR Comment – *High Significance*: It is difficult to determine whether separable elements are independently justified.

This comment includes two recommendations for resolution, one of which has been adopted, and one of which has not been adopted, as discussed below.

USACE Response: Adopted

Action Taken: The recommendation of providing NED benefits/cost analysis of separable plan elements for each alternative plan carried forward was adopted and can be seen in tables 3-48 and 3-49 of the Isabella Lake Dam Safety Modification Report. However, the alternatives were evaluated based on risk associated with life loss consequences. Each measure was evaluated as separable elements based on the requirements in the Engineering Regulation 1110-2-1156. They were evaluated based on mitigating the risk of each individual potential failure mode, cost effectiveness (as low as reasonably practicable (ALARP) consideration), legal obligations/impacts, meeting tolerable risk guidelines, etc.

USACE Response: Not Adopted.

The second recommendation of displaying costs and benefits of the elements that separate life safety plan 4 and DSAC plan 2 was not-adopted. Since the material from the emergency spillway is being used for the construction of the auxiliary dam buttress and the filter and drainage system on the downstream slope it is difficult to separate these two costs as they "share" material.

8. IEPR Comment – *Medium Significance*: The results of the incremental damage assessment for rejected alternatives under more frequent flooding events (for non-failure scenarios) are not clearly presented in the main review documents.

This comment includes four recommendations for resolution, two of which have been adopted, and two of which have not been adopted, as discussed below.

USACE Response: Adopted

Action Taken: The recommendation to provide a more definitive discussion and a summary of the incremental risk has been added to the Isabella Lake DSMR in section 3.3.2.2 and table 3-11.

It is assumed that there is no incremental damage for events more frequent than the crest of the emergency spillway because the operation of the dam would not change up to that point. Alternative spillways with crests lower than the recommended alternative were analyzed for two smaller flow events (top of dam and a "low emergency flood"). Additional details on these results were added to the summary of each spillway measure where the evaluation was conducted. The threshold for the emergency spillway is 0.001 annual lives lost. Under existing conditions the thresholds for the tolerable risk guidelines are not met. This was addressed at the alternative formulation briefing (AFB) where it was decided that the analysis would not increase flows for the existing condition until the water surface reached the top of existing dam (this is the elevation where overtopping would begin). As discussed above the analysis looked at spillways with lower crest elevations but the loss of life could never meet guidelines since it was already over the limit. It is also evident from the floodplain comparisons that spillways with lower crests have a demonstrable impact on downstream communities. Additional details on these results were added to the summary of each spillway measure where the evaluation was conducted.

USACE Response: Not Adopted.

The recommendation to present the results of the incremental flooding analyses for other storms was not adopted because it is outside the scope of the dam safety study to look at more frequent events for downstream incremental damages that are not a result of a dam failure. The dam safety program is intended to reduce the risk associated with dam failure and its associated consequences. As part of the selected plan additional downstream studies have been recommended to address the non-breach scenarios and require additional authorization that is outside of the Isabella Lake Dam Safety Modification Study.

9. IEPR Comment – *Medium Significance*: It appears the preferred emergency spillway alternative is being disproportionately driven by the more subjective elements of the risk analysis (i.e., Do No Harm and ALARP) criteria.

USACE Response: Adopted

Action Taken: The recommendation of providing a more detailed discussion on how each element is considered and weighted in developing total risk for each of the structural risk management plans was adopted and included throughout the dam safety modification report. It is a requirement that the preferred plan achieves the tolerable risk guidelines. Using HEC-FIA (Hydrologic Engineering Center's Flood Impact Analysis) software, modeling was performed for potential emergency spillway designs that released floodwater prior to the frequency of the event that overtops the dam in its current configuration. This modeling was done in order to quantify the additional fatalities that would be expected with greater outflows from the combined spillway and emergency spillway (again, up to the event frequency that fills the reservoir to the current crest elevation). The modeling results found that any significant increase in outflow for flooding events up to the current crest of dam caused a number of additional fatalities, that when annualized, led to these emergency spillway configurations not meeting the tolerable risk guidelines for annualized life loss. These concepts were rejected due to the incremental increase in life loss risk being intolerable. This concept of incremental risk does not apply to the preferred

emergency spillway design, as the expected fatalities are always less with the outflows from the preferred emergency than with outflows from complete loss of the reservoir with a dam failure

10. IEPR Comment – *Medium Significance*: The execution of the PMF analysis under current baseline conditions (i.e., the calibration and use of the 1965 Clark sub-area Unit Hydrographs) may be outdated.

USACE Response: Not Adopted

The recommendations to conduct supplemental analyses related to unit hydrograph development and to provide additional information and clarification were not adopted. The S-curve was based upon hydrologic studies in 1965, this only served as a starting point in the unit hydrograph development for the current study. As explained in Section 3.3.2 of the Final Hydrology Report and shown in Table 19, the input variables to develop the final unit hydrographs were based upon geo-processing of the best available and current terrain data specific to the Kern River watershed in ArcGIS. These unit hydrographs were calibrated to observed historical storms, verified to the inflow frequency curves, and peaked based upon USACE guidance for the PMF simulation.

11. IEPR Comment – *Medium Significance*: Several components related to the existing spillway require further consideration during the preliminary engineering design (PED) phase of the project.

This comment includes six recommendations for resolution, three of which have been adopted and three of which will be adopted in PED, as discussed below.

USACE Response: Adopted

Action taken: The recommendations to include additional discussion on the basis of design for the Spillways in the DSMR were adopted. The Isabella Lake DSMR was revised in section 3.3.4 to include a measure to increase the spillway right wall to mitigate for overtopping risk under the probable maximum flood event. The project construction cost was revised to include the cost of raising the service (existing) spillway walls as per the cost recommendation.

Action to be taken: The recommendations for additional modeling will be adopted in PED. The existing ogee spillway needs to be evaluated for heads much greater than the design head, and to determine if the structure is adequate to handle the additional head. Spillway walls and the ogee are classified as critical structures, and will be analyzed for both stability and strength under MCE seismic loadings (for the 16-foot dam raise) to design the structural anchor systems per EM 1110-2-2100. These elements currently have the greatest level of cost risk based on the unknowns. The service spillway (existing spillway) will be widened and deepened with potentially raising the right spillway wall to prevent overtopping the right spillway wall during a PMF event. In addition a HEC-RAS model of the Kern River downstream of the emergency spillway will be conducted in PED and a physical model and CFD model will also be developed in PED.

12. IEPR Comment – *Medium Significance*: The review documents do not clearly demonstrate that the Six Step Planning Process from the Principles and Guidelines and ER 1105-2-100 was followed.

USACE Response: Not Adopted

The DSMR follows the dam safety six step planning process as described in the dam safety policy and procedures guidance, Engineering Regulation (ER) 1110-2-1156. ER 1110-2-1156 uses the same six step framework of civil works planning as presented in ER 1105-2-100; however, it specifies required alternatives that should be formulated. The required alternatives are: no action; meeting risk reduction objective for the DSAC class of the dam; achieving only tolerable risk limit for life safety; make IRRM permanent; remove structure; and replace structure. The dam safety projects are based on reducing risk associated with failure and loss of life rather than the national economic benefits. The recommendation was not adopted. The dam safety planning process required in ER 1110-2-1156 has been followed in the DSMR.

13. IEPR Comment – *Medium Significance*: The existing levee systems should be evaluated in terms of their ability to reduce flood damages and loss of life in the event of a dam failure.

USACE Response: Not Adopted

All plausible dam failure scenarios have outflows ranging from several hundred thousand CFS to well over a million CFS, while the levee capacity downstream (at best) is approximately 20,000 CFS. Simply put, the levees would be completely overwhelmed in any plausible dam failure scenario. The Bakersfield levees were included in the hydraulic modeling. During PED the system will be scrutinized in more detail. However, future analyses will focus on operation of the dam, and likely not consider dam failure. During a dam failure, the levees will overtop and almost certainly breach. Attempting to determine how much the levees impact flooding in Bakersfield during a dam failure is irrelevant to selection of a preferred alternative dam remediation; therefore none of the recommendations were adopted. However, the report was updated to include a statement that the consequences could be potentially higher because the plans were evaluated assuming there was no levee failures on the systems.

14. IEPR Comment – *Medium Significance*: The results of the HEC-FDA analyses, which are intended to determine how the alternatives rank in expected flood risk reduced and annual residual flood risk after remediation, have not been provided.

This comment includes three recommendations for resolution, two of which have been adopted, and one of which has not been adopted, as discussed below.

USACE Response: Adopted.

Action Taken: While the recommendations to display NED benefit and discuss flood protection performance were adopted, a HEC-FDA analysis was not conducted for the DSMR. The project justification is one of life safety and not of economics, so FDA cannot provide a

relevant answer. The life safety risk has been adequately characterized by HEC-FIA to rank the alternatives and present in the reports. This approach was coordinated with and supported by the Risk Management Center. HEC-FIA is the consequence analysis tool for Dam Safety projects and HEC-FDA was not supported for this study. As per the recommendations, benefit to cost ratios have been added to the ALARP tables along with a paragraph to explain benefits. Risk management measures have been implemented for each plan and their risk reduction impacts have been included in the report.

USACE Response: Not Adopted.

As discussed above HEC-FIA was used instead of HEC-FDA thereby making it impossible to adopt the recommendation to display HEC-FDA results.

15. IEPR Comment – *Medium Significance*: The Draft Economics Appendix is missing considerable detail on the models used to estimate the future without project condition, future without project risk, and impacts of the various alternatives carried forward.

This comment includes six recommendations for resolution, four of which have been adopted, and two of which have not been adopted, as discussed below.

USACE Response: Adopted.

Action Taken: The four recommendations regarding additional data presentation were adopted. The Economic Appendix and DSMR was revised throughout to include: a concise definition of the study area; the future without project condition; the number, type, and value of the assets at risk in the floodplain; and depth damage functions for the various structure types and justification for their use; and the NED benefits and costs attributable to alternatives carried forward.

USACE Response: Not Adopted.

The recommendations to describe reaches, how they were delineated, the floodplain inventory, and the without project condition by reach were not adopted due to the fact that their incorporation into the analysis would not have changed the selected plan.

16. IEPR Comment – *Medium Significance*: It is unclear to what extent the lack of resilience and robustness will affect the selection of Life Safety Plan 4 as the tentative recommended plan over DSAC Plan 2 and whether sufficient redundancy is provided.

USACE Response: Adopted

Action Taken: Resilience, redundancy, and robustness of Life Safety Plan 4 were reassessed. Based on the EC 209 IEPR Type II SAR definitions Life Safety Plan 4 likely provides “robustness” based on the size of the included Auxiliary Dam buttress, the modifications to the Main Dam, and the Spillway improvement measures to pass the probable maximum flood without failing the dam. However, Life Safety Plan 4 lacks “resilience” and “redundancy” for the items included in the IEPR comments, including the effects of not retrofitting the main dam

outlet works structures. Life Safety Plan 4 is still the preferred plan as it brings the associated risk with the project within tolerable risk guidelines, including ALARP considerations. All three criteria: resilience, redundancy, and robustness would be required as part of the preferred plan if the goal was a DSAC level of remediation.

In response to the tainter gate structure under the Maximum Credible Earthquake, as a redundant structure the stability evaluation shows that the structure is rotationally unstable in the cross-stream direction under the MCE due to the absence of backfill on the left side (looking downstream) of the structure. This instability issue is minor and can be fixed by placing lean concrete on the left side. This fix is included as part of the selected plan and was added to the DSMR. All the recommendations were adopted.

Actions to be taken: The stability of the hydroelectric plant owned by Isabella Partners, which effectively completes the downstream control, is not being addressed. The structural stability of the hydroelectric power plant is not evaluated because it is not part of the Isabella dam safety project. This structure was designed using more stringent seismic criteria in the 1980's and is not expected to have major structural stability issues. The Corps will coordinate with Isabella Partners during the PED phase on a potential seismic evaluation of the powerhouse in order to assess the performance of the structure under MCE seismic loadings. Depending on the findings of the evaluation, the powerhouse may need to be retrofitted to meet the seismic performance criteria as a critical structure.

17. IEPR Comment – *Medium Significance:* The effect of reservoir sediment, regardless of its volume, on downstream channel regimen and ecology has not been evaluated.

USACE Response: Adopted

Action Taken: The following text was added to the DSMR in the "No Action" Plan: "The impact of sediment from a dam failure which is more likely under the no action alternative would completely change the River's flow regime. Riparian habitat and alluvial deposits in the canyon reach would likely be stripped to bedrock during the peak flow and partially re-settle during the recession flow. This material would create a new layer of the alluvial fan at the mouth of the Kern Canyon at Bakersfield raising the river bed and altering its course while fines would deposit in the terminal lakebeds. Sediment stored behind the dam would be mobilized at the end of the flood hydrograph when it becomes exposed to fast moving water and would be deposited along the course of the river as velocities slowed. The dam itself would also contribute a significant amount of material depending on the type of dam break. A dam break flood would likely be the largest event on that river system in its history (unless there is evidence of a glacial outburst) meaning all river sediment could be mobilized. The analysis indicates that under the "Dam Removal" plan the river would return to its natural, pre-dam regime. The "No Action" and "Dam Removal" Plans were screened and not carried forward; therefore, the ecosystem and recreation impacts from sedimentation and its potential effects were not analyzed.

18. IEPR Comment – *Medium Significance:* The structural performance of the modified Main Dam control tower under seismic loading in the absence of seismic retrofitting is not addressed.

USACE Response: Adopted

Action to be taken: The recommendation to for further structural evaluation with regard to seismic loading will be performed in PED. Structural deficiencies were identified on the basis of FLAC analysis of the Main Dam Control Tower for the existing condition. It is expected that the demands on the tower will increase for the 16-ft dam raise under seismic loadings. The structural performance of the tower will be evaluated as a critical structure for the dam raise condition during the PED phase. The tower will be modeled as an assemblage of three-dimensional shell elements and/or solid elements to capture any torsional behavior and in-plane distortions. The future design in PED will address the structural deficiencies and the increased demands due to the dam crest raise.

19. IEPR Comment – *Medium Significance*: Information on discontinuity orientations, types, and aperture and how these discontinuity aspects might influence erodibility of the existing spillway channel has not been provided.

USACE Response: Adopted

Action taken: Recommendation of providing more detailed information about discontinuity characteristics was adopted by adding the results and findings from the 2012 Geologic Mapping efforts and the 2012 Boring Televiewer Survey to Appendix H of the DSMR.

Action to be taken: The recommendation of providing an evaluation of how discontinuity types, orientations and aperture might influence erodibility will be adopted in the PED phase. Furthermore, it is noted that the risk associated with spillway erosion (existing spillway) is relatively low compared to the other risk driving failure modes at the Project. Spillway erosion leading to loss of the right side spillway embankment wall could lead to failure of the main dam. This failure mode is relatively simple to address and is included in the selected plan. The spillway will be lined where needed to further guard against excessive erosion.

20. IEPR Comment – *Medium Significance*: Information about the design and construction of the seepage collection and disposal system for the proposed filter and drainage buttress is missing from the reports.

USACE Response: Adopted

Action Taken: The recommendations for additional design information and a figure were added to Section 3.3.2.6 of the DSMR for the proposed Auxiliary Dam and Main Dam seepage collection systems. In addition (as noted by the IEPR panel) collector pipes will not be installed in the filter and drain system on the dam as they will be prone to damage and separation from deformations (either settlement induced or seismic induced) that could allow for large openings in the pipes resulting in unfiltered exits.

21. IEPR Comment – *Medium Significance*: The DEIS analysis did not provide enough detail in the cumulative effects analysis on climate change and how cloud seeding activities coincide with climate change.

USACE Response: Not Adopted

The EIS does include a qualitative discussion of climate change in relation to cumulative effects but cloud seeding and its cumulative effect on climate change was not included in the analysis, as it is considered to be localized and temporary in nature. As a result, the recommendations to revise Chapter 4 of the EIS to include climate change discussions in a qualitative manner consistent with USFS guidelines and to discuss cloud seeding activities were not adopted.

22. IEPR Comment – *Medium Significance*: The analysis of potential impacts of the project alternatives on various environmental constraints is not complete in the DEIS, as more current data are available for several environmental constraints.

USACE Response: Adopted

Action to be taken: The recommendations to provide additional analysis in the EIS on Air Quality, Noise and Modeling associated with highway relocation work will be performed in PED. This is due to the fact that the highway relocation design has not been developed to the point where environmental impacts associated with this work are ripe for decision. A supplemental NEPA document will be prepared during PED, and these elements will be addressed in that document

23. IEPR Comment – *Medium Significance*: The mitigation measures for water quality, noise and vibration, and biological resources, while appropriate, lack the specificity needed to adequately determine whether they would offset project impacts and/or need clarification, consistent with other state and Federal agency requirements.

USACE Response: Adopted

Action to be taken: None of the recommendations were adopted into the EIS; however, they will be adopted in the subsequent NEPA documents during the PED phase of the project.

24. IEPR Comment – *Medium Significance*: Physical and computational fluid dynamic (CFD) modeling should be performed during the preliminary engineering design phase of the project to properly set the final design configuration of the primary and emergency spillway channels.

USACE Response: Adopted

Action to be taken: The recommendation to conduct physical and CFD modeling studies for the spillway and Borel Tunnel will be completed during the PED phase of the project.

25. IEPR Comment – *Medium Significance*: Using historical records as a means to estimate flood damages reduced is not an appropriate measure of expected future flood risk reduction loss.

This comment includes three recommendations for resolution, two of which have been adopted, and one of which has not been adopted, as discussed below.

USACE Response: Adopted

Action Taken: The recommendation to display historical flood damages reduced as a reference, rather than a benefit category was adopted. The calculations for each of the alternatives considered were displayed in Appendix B of the DSMR.

USACE Response: Not Adopted.

It is acknowledged that the derivation of damage-frequency curves for each of the alternatives would result in more accurate estimates of future annual flood damages prevented. However, it was felt that selection of the most cost efficient plan would not be sensitive to incremental improvements in the damage-frequency curves and that the 57-year sample of historical records to estimate these benefits was sufficient. Therefore, the recommendation to show expected annual flood risk reduction benefits as computed by finding the area under the damage frequency curve was not adopted.

26. IEPR Comment – *Medium Significance*: A detailed geological characterization of the rock mass within the shear zone, through which Borel Canal Measures 1 and 2 will be located, is not provided in the reports.

USACE Response: Adopted

Action Taken: More detailed geological information was provided as part of the 2012 Geological Surface Mapping Technical Memorandum, 2012 Borehole Acoustic and optical televiewer study and the 2012 Phase III Investigation geological appendix. Adjusting the tunnel measure 2 based on the results of tunnel measure 1, has reduced the amount of poor to very poor rock along the alignment. The recommendation to provide a more detailed geological characterization of the rock mass within the shear zone through which the tunnel will pass was adopted by including the 2012 Geologic Mapping Technical Memorandum and the 2012 Boring Televiewer Survey in Appendix H of the DSMR.

Action to be taken: A detailed description of the anticipated behavior of shear-zone mass during tunneling will be included in the Design Documentation Report (DDR) in the PED phase of the project. The descriptions of how the length determinations for various support systems will also be included in the PED DDR.

27. IEPR Comment – *Medium Significance*: Some of the risks associated the Borel Conduit closure, including the potential for incompatible deformations and/or strains caused by filling the Conduit and the details associated with closing it, have not been addressed.

USACE Response: Adopted

Action Taken: Both recommendations were adopted. The downstream end of the conduit will be removed as part of the foundation over-excavation to remove potentially liquefiable soils. The filter and drainage layer will be placed on the downstream end of the conduit to collect any seepage that may occur along the outside perimeter of the conduit. Figure 3-28 in the DSMR was added to include the details for abandoning the existing Borel Conduit tunnel. Life Safety 4 and the DSAC Plans include the risk reduction associated with potential incompatible deformations due to settlement and seismic response in the risk analysis.

Action to be taken: During the Pre-Construction, Engineering, and Design phase of the project, grouting from within the conduit to fill any voids that may exist along the perimeter will occur. The filling of the conduit will occur in stages. Each stage will likely be 20 feet in length. A bulkhead will be installed to create an enclosed 20-foot long chamber that will be filled with a cement material (likely controlled low strength material). After that chamber has been filled, the bulkhead will be removed and reinstalled 20 feet further down for placement of the next 20-foot segment. There will be an increase in dead load from the concrete filled conduit, but this increase will be relatively insignificant compared to the additional weight of earthfill from construction of the downstream buttress and 16-foot high dam raise. The placement of the filter and drain system against the downstream end of the conduit in conjunction with grouting the outside perimeter of the conduit will provide adequate risk reduction.

28. IEPR Comment – *Low Significance*: The reports use economic values that have not been updated to the current fiscal year, as required by USACE guidance.

USACE Response: Adopted

Action Taken: Both recommendations regarding economic values were adopted and the data in the Economic Appendix was updated to FY12 prices. The figures in the main report were also updated.

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