Final Independent External Peer Review Report Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR)

Prepared by
Battelle Memorial Institute

Prepared for
Department of the Army
U.S. Army Corps of Engineers
Risk Management Center
Huntington District

Contract No. W912HQ-15-D-0001
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October 16, 2017

BATTELLE
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Columbus, Ohio 43201

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Executive Summary

PROJECT BACKGROUND AND PURPOSE

Moose Creek Dam, the main component of the Chena River Lakes Flood Control Project, is located 17 miles east of Fairbanks, Alaska, near the town of North Pole. Moose Creek Dam is an earthfill structure approximately 7.5 miles long that functions as a dry dam and provides flood control for the downstream communities of North Pole, Fairbanks, and Fort Wainwright, Alaska. Construction was initiated in 1973 and completed in 1979, although the dam did not retain floodwaters until 1981. The pool of record, equivalent to a 40-year design storm, occurred in 1992.

In 2009, Moose Creek Dam was evaluated by a Screening Portfolio Risk Assessment Cadre and ultimately given a Dam Safety Action Classification (DSAC) of I (Urgent and Compelling). The DSAC I rating was primarily due to seepage and piping in the foundation. The other identified failure modes were control works stability under seismic loading and foundation liquefaction under seismic loading. In addition, the structure has only been loaded to a 40-year event. The Interim Risk Reduction Measures Plan (IRRMP) was approved in November 2009.

A Baseline Risk Assessment was prepared and submitted to the Dam Senior Oversight Group (DSOG) in January 2014. The Baseline Risk Assessment Risk Cadre identified three significant potential failure modes that were believed to be the primary risk drivers: (1) backward erosion and piping with vertical exit (heave) adjacent to permafrost zones below the downstream stability blanket; (2) backward erosion and piping with horizontal exit in the South Seepage Collection channel or old Chena Channel; and (3) scour along the base of the silty core from high flows through layers of open-work gravel with horizontal exit in the South Seepage Collection Channel or old Chena Channel.

The potential failure modes were best correlated by performance and site conditions to locations near the central embankment area near the low-point drainage structure. The risk assessment concluded that the boils observed during the high-water events were limited to movement of the natural silt blanket and that the exit gradients were insufficient to begin backward erosion and piping of the sand and gravel foundation matrix.

The DSOG recharacterized the Moose Creek Dam as a DSAC III in May 2014 and directed the completion of a Dam Safety Modification Study (DSMS). Based on the information presented in the Risk Assessment Report and briefing, the DSOG was concerned that the Risk Cadre did not adequately address potential failure modes that may exist due to the discrete boring locations along a highly variable, 45,000-foot-long alluvial foundation. The DSOG believes the silt and finer sand layers may potentially be more extensive than the foundation data portrayed. Therefore, the risk assessment may have significantly underestimated the probability that failure could progress through the foundation from backward erosion and piping failure modes.

The U.S. Army Corps of Engineers-Headquarters (USACEHQ) Dam Safety Officer approved the change to DSAC III, with instructions to the Alaska District to perform a DSMS and to make other related changes. The Cadre was directed to re-evaluate risks posed by failure modes in the foundation as part of the DSMS, based on concerns that the project risk was underestimated by the Baseline Risk Assessment due to the unusual length of the dam and difficulty in characterizing foundation uncertainties and unknowns.

Independent External Peer Review Process

Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analysis. USACE is conducting an Independent External Peer Review (IEPR) of the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR) (hereinafter: Moose Creek Dam). As a 501(c)(3) non-profit science and technology organization, Battelle is independent, free from conflicts of interest (COIs), and meets the requirements for an Outside Eligible Organization (OEO) per guidance described in USACE (2012). Battelle has experience in establishing and administering peer review panels for USACE and was engaged to coordinate this IEPR. The IEPR was external to the agency and conducted following USACE and Office of Management and Budget (OMB) guidance described in USACE (2012) and OMB (2004). This final report presents the Final Panel Comments of the IEPR Panel (the Panel). Details regarding the IEPR (including the process for selecting panel members, the panel members' biographical information and expertise, and the charge submitted to the Panel to guide its review) are presented in appendices.

Based on the technical content of the decision documents and the overall scope of the project, Battelle identified potential candidates for the Panel in the following key technical areas: Civil Works planning/economics, environmental biology, hydraulic and hydrology (H&H) engineering, geotechnical engineering, and civil engineering. Battelle screened the candidates to identify those most closely meeting the selection criteria and evaluated them for COIs and availability. USACE was given the list of all the final candidates to independently confirm that they had no COIs, and Battelle made the final selection of the four-person Panel from this list.

The Panel received electronic versions of the decision documents (1,602 pages in total), along with a charge that solicited comments on specific sections of the documents to be reviewed. Following guidance provided in USACE (2012) and OMB (2004), USACE prepared the charge questions, which were included in the draft and final Work Plans.

The USACE Project Delivery Team (PDT) briefed the Panel and Battelle during an on-site meeting at the start of the review to provide the Panel an opportunity to ask questions of USACE and clarify uncertainties. The meeting was held at the USACE Moose Creek Dam Project Office near North Pole, Alaska on August 15, 2017; three panel members attended this meeting. As part of this meeting, USACE provided an overview presentation and led Battelle and the Panel on a site investigation of the Moose Creek dam. Other than the site visit and Battelle-facilitated teleconferences, there was no direct communication between the Panel and USACE during the peer review process. The Panel produced individual comments in response to the charge questions.

IEPR panel members reviewed the decision documents individually. The panel members then met via teleconference with Battelle to review key technical comments and reach agreement on the Final Panel Comments to be provided to USACE. Each Final Panel Comment was documented using a four-part format consisting of (1) a comment statement; (2) the basis for the comment; (3) the significance of the

comment (high, medium/high, medium, medium/low, or low); and (4) recommendations on how to resolve the comment. Overall,12 Final Panel Comments were identified and documented. Of these, one was identified as having high significance, two were identified as having medium/high significance, three had a medium significance, and six had medium/low significance.

Results of the Independent External Peer Review

The panel members agreed on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (USACE, 2012; p. D-4) in the Moose Creek Dam review documents. Table ES-1 lists the Final Panel Comment statements by level of significance. The full text of the Final Panel Comments is presented in Section 4.2 of this report. The following summarizes the Panel's findings.

Based on the Panel's review, the report is well-written, thorough, and provides well-organized supporting documentation on engineering, environmental, economic, and plan formulation issues. The alternative formulation process was very detailed, with an extensive array of options considered. The report provided a balanced assessment of the economic, engineering, and environmental issues of the overall project; however, the Panel identified elements of the project where additional analyses are warranted and places where clarification of project findings and objectives need to be documented or revised.

Engineering: The documents provided for review were well-written and easy to follow. The Panel's primary concern is that the geotechnical data presented are not sufficient to conclude with certainty that the mix-in-place cut-off wall has sufficient depth to prevent Backward Erosion Piping (BEP). The Panel fully understands there will always be some uncertainty with respect to the soil types that may initiate BEP, and uncertainty regarding the extent of those soils in the dam's foundation. However, the geotechnical data presented are not sufficiently detailed or complete enough to confirm that a new cut-off wall extending a minimum of 10 feet beneath the dam will provide a suitable interruption of BEP where more permeable soils exist immediately below the cut-off wall. The Panel suggests additional geotechnical investigations, with particular attention to variations in grain size distributions and how this may affect gradients that may initiate BEP.

Additionally, the Panel noted that the information on permafrost conditions downstream of the dam is not complete enough to assess whether thermal erosion may occur. Without fully understanding the thermal regime, it is difficult to determine whether this type of risk exists. The study does not describe this type of risk and provides no geotechnical data that would confirm the amount of ice content that may exist in the soil column in these areas. Quantification of this risk is needed to fully evaluate the recommended plan decision. The Panel also agrees that the risk and uncertainty surrounding both seismically induced or thaw-consolidation settlement of the cut-off wall have not been fully considered. With respect to thaw consolidation of permafrost beneath the dam, the risk is likely to be somewhat lower than a seismic event if ice contents are low. However, information provided in the study gives only an indication that permafrost is present and does not describe the ice content in the soil column or make any estimate of the thaw consolidation that may occur should permafrost in these zones thaw in future years. Since there is no description of either the means of detecting the potential for flaws or the means of adequately repairing cracks, the risk of BEP failure during future flooding may not be fully considered.

Finally, the Panel noted that the recommended plan proposes initiation of construction in the critical reaches. The Panel is concerned that construction of a test section in a critical reach may result in gaps in the wall resulting in increased hydraulic gradients and concentrated flow. These issues should be

resolved by constructing a test section first in a non-critical area. A test section may reduce the risk of potential problems prior to construction in the most critical areas. Additionally, changing the construction order may result in less uncertainty and increased robustness.

Civil Works Planning/Economics: The decision documents are thorough and well-organized. However, the Panel believes that there is little documentation of the operations and maintenance (O&M) costs in the future without-project condition. The lack of O&M cost data results in incomplete project information, which could possibly affect the justification of the recommended plan costs. The Panel suggests that O&M costs for future without-project and future with-project conditions be provided to support the DSMR statements that these costs are identical. Additionally, the Panel agrees that the rationale for selecting F9 over F11 as the recommended plan needs to be supported in more detail. Both F9 and F11 meet Tolerable Risk Guidelines. Although F11 is lower in costs, it does not meet the ALARP (as low as reasonably possible) guidelines. Alternately, F9 offers the lowest cost to save a statistical life and reduces the average life loss, and also meets the ALARP guidelines. Apart from the ALARP consideration, it could be argued that the large cost increase of F9 over F11 is not necessarily justified by the small cost to save a statistical life (CSSL) difference. The requirement that the recommended plan must be the ALARP plan is not specified in the main report or Appendix A. Incomplete information in the decision documents on USACE requirements for ALARP creates uncertainty affecting the justification of the selection of Alternative F9 over F11.

Environmental: This is clearly a complex project with substantial challenges. The Panel commends the Project Delivery Team for the impressive effort that went into the alternative formulation process as described in the project documents. However, the Panel noted that the cumulative impacts of improving the dam have not been fully considered in either the preferred or no-action alternatives. Also, expected changes/losses in flood plain values have not been addressed in the Environmental Assessment (EA). The indirect impacts on floodplains and floodplain functions for the preferred and no-action alternatives have not been analyzed, which adversely affects project completeness.

The Panel also found that the EA does not fully evaluate the impacts of each alternative presented in the document, which may affect the selection of the recommended plan. Alternatives that are presented in the EA ought to be carried forward through the entire document for full and detailed analysis of impacts. Incomplete analysis of impacts in the EA could negatively affect the justification for the recommended plan. The Panel suggests that additional detail be added to the EA to provide more analysis and explanation.

Table ES-1. Overview of 12 Final Panel Comments Identified by the Moose Creek Dam IEPR Panel

No.	Final Panel Comment
Significance – High	
1	The geotechnical data presented are not sufficient to conclude with certainty that the mix-in-place cut-off wall has sufficient depth to prevent Backward Erosion Piping.
Significance – Medium/High	
2	Geotechnical information on permafrost conditions downstream of the dam is not complete enough to assess whether thermal erosion may occur.
3	Risk and uncertainty may not have been fully characterized or estimated for seismically induced or thaw-consolidation settlement of the cut-off wall.
Significance – Medium	
4	The recommended plan proposes initiation of construction in the critical reaches and without a test section, thereby increasing risks to project implementation.
5	The discussion of the recommended plan does not address how current and planned relief wells will affect the performance of the centerline cutoff wall.
6	The cumulative impacts of improving the dam have not been given full consideration in either the preferred or no-action alternatives.
Significance – Medium/Low	
7	The Environmental Assessment does not fully evaluate the impacts of each alternative presented in the document, which may affect the selection of the recommended plan.
8	Full compliance with several Federal environmental laws has not been demonstrated, which may affect ability to implement the recommended plan.
9	The O&M scope and costs for the recommended plan appear insufficient to meet the objectives and function of the project design.
10	The rationale for selecting F9 over F11 as the recommended plan needs to be more detailed.
11	The Probable Maximum Flood estimate of total runoff volume appears to be quite large relative to the size of the watershed; more data are needed to support watershed soil infiltration and water retention assumptions.
12	Verification that permafrost is not present should be performed in the vicinity of the Low Drain Sheet Pile Installation to confirm that piles can be successfully installed.

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Table ES-1. Overview of 12 Final Panel Comments Identified by the Moose Creek Dam IEPR Panel ix

LIST OF ACRONYMS

ALARP	As Low As Reasonably Possible
ATR	Agency Technical Review
BEP	Backward Erosion Piping
CE/ICA	Cost Effectiveness/Incremental Cost Analysis
COI	Conflict of Interest
CSSL	Cost to Save a Statistical Life
CWA	Clean Water Act
DSAC	Dam Safety Action Classification
DSMR	Dam Safety Modification Report
DSMS	Dam Safety Modification Study
DSOG	Dam Senior Oversight Group
DrChecks	Design Review and Checking System
EC	Engineer Circular
EA	Environmental Assessment
EO	Executive Order
ER	Engineer Regulation
ERDC	Engineer Research and Development Center
FONSI	Finding of No Significant Impact
HEC-HMS	Hydrologic Engineering Center-Hydrologic Modeling System
H&H	Hydrology and Hydraulics
HQ	Headquarters
HTRW	Hazardous, Toxic, and Radioactive Waste
IEPR	Independent External Peer Review
IRRMP	Interim Risk Reduction Measures Plan
IWR	Institute for Water Resources
NED	National Economic Development
NEHRP	National Earthquake Hazard Reduction Program
NEPA	National Environmental Policy Act
OEO	Outside Eligible Organization
O&M	Operations and Maintenance
OMB	Office of Management and Budget

PDT	Project Delivery Team
PGA	Peak Ground Acceleration
PMF	Probable Maximum Flood
PMP	Probable Maximum Precipitation
RMP	Risk Management Plan
SPS	Standard Project Storm
TSP	Tentatively Selected Plan
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Services
USGS	United States Geologic Survey

1. INTRODUCTION

Moose Creek Dam, the main component of the Chena River Lakes Flood Control Project, is located 17 miles east of Fairbanks, Alaska, near the town of North Pole. Moose Creek Dam is an earthfill structure approximately 7.5 miles long that functions as a dry dam and provides flood control for the downstream communities of North Pole, Fairbanks, and Fort Wainwright, Alaska. Construction was initiated in 1973 and completed in 1979, although the dam did not retain floodwaters until 1981. The pool of record, equivalent to a 40-year design storm, occurred in 1992.

In 2009, Moose Creek Dam was evaluated by a Screening Portfolio Risk Assessment Cadre and ultimately given a Dam Safety Action Classification (DSAC) of I (Urgent and Compelling). The DSAC I rating was primarily due to seepage and piping in the foundation. The other identified failure modes were control works stability under seismic loading and foundation liquefaction under seismic loading. In addition, the structure has only been loaded to a 40-year event. The Interim Risk Reduction Measures Plan (IRRMP) was approved in November 2009.

A Baseline Risk Assessment was prepared and submitted to the Dam Senior Oversight Group (DSOG) in January 2014. The Baseline Risk Assessment Risk Cadre identified three significant potential failure modes that were believed to be the primary risk drivers: (1) backward erosion and piping with vertical exit (heave) adjacent to permafrost zones below the downstream stability blanket; (2) backward erosion and piping with horizontal exit in the South Seepage Collection channel or old Chena Channel; and (3) scour along the base of the silty core from high flows through layers of open-work gravel with horizontal exit in the South Seepage Collection Channel or old Chena Channel.

The potential failure modes were best correlated by performance and site conditions to locations near the central embankment area near the low-point drainage structure. The risk assessment concluded that the boils observed during the high-water events were limited to movement of the natural silt blanket and that the exit gradients were insufficient to begin backward erosion and piping of the sand and gravel foundation matrix.

The DSOG recharacterized the Moose Creek Dam as a DSAC III in May 2014 and directed the completion of a Dam Safety Modification Study (DSMS). Based on the information presented in the Risk Assessment Report and briefing, the DSOG was concerned that the Risk Cadre did not adequately address potential failure modes that may exist due to the discrete boring locations along a highly variable, 45,000-foot-long alluvial foundation. The DSOG believes the silt and finer sand layers may potentially be more extensive than the foundation data portrayed. Therefore, the risk assessment may have significantly underestimated the probability that failure could progress through the foundation from backward erosion and piping failure modes.

The U.S. Army Corps of Engineers-Headquarters (USACEHQ) Dam Safety Officer approved the change to DSAC III, with instructions to the Alaska District to perform a DSMS and to make other related changes. The Cadre was directed to re-evaluate risks posed by failure modes in the foundation as part of the DSMS, based on concerns that the project risk was underestimated by the Baseline Risk Assessment due to the unusual length of the dam and difficulty in characterizing foundation uncertainties and unknowns.

Independent, objective peer review is regarded as a critical element in ensuring the reliability of scientific analysis. The objective of the work described here was to conduct an Independent External Peer Review (IEPR) of Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR) (hereinafter: Moose Creek Dam IEPR) in accordance with procedures described in the USACE, Engineer Circular (EC) *Civil Works Review* (EC 1165-2-214) (USACE, 2012) and the Office of Management and Budget (OMB), *Final Information Quality Bulletin for Peer Review* (OMB, 2004). Supplemental guidance on evaluation for conflicts of interest (COIs) was obtained from the *Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports* (The National Academies, 2003).

This final report presents the Final Panel Comments of the IEPR Panel (the Panel) on the existing engineering, economic, environmental, and plan formulation analyses contained in the Moose Creek Dam IEPR documents (Section 4). Appendix A describes in detail how the IEPR was planned and conducted, including the schedule followed in executing the IEPR. Appendix B provides biographical information on the IEPR panel members and describes the method Battelle followed to select them. Appendix C presents the final charge to the IEPR panel members for their use during the review; the final charge was submitted to USACE in the final Work Plan according to the schedule listed in Table A-1. Appendix D presents the organizational conflict of interest form that Battelle completed and submitted to the Institute for Water Resources (IWR) prior to the award of the Moose Creek Dam IEPR.

2. PURPOSE OF THE IEPR

To ensure that USACE documents are supported by the best scientific and technical information, USACE has implemented a peer review process that uses IEPR to complement the Agency Technical Review (ATR), as described in USACE (2012).

In general, the purpose of peer review is to strengthen the quality and credibility of the USACE decision documents in support of its Civil Works program. IEPR provides an independent assessment of the engineering, economic, environmental, and plan formulation analyses of the project study. For the purpose of this IEPR, USACE has been directed by Congress to develop the Moose Creek Dam, Alaska, DSMR. In particular, the IEPR addresses the technical soundness of the project study's assumptions, methods, analyses, and calculations and identifies the need for additional data or analyses to make a good decision regarding implementation of alternatives and recommendations.

In this case, the IEPR of the Moose Creek Dam was conducted and managed using contract support from Battelle, which is an Outside Eligible Organization (OEO) (as defined by EC 1165-2-214). Battelle, a 501(c)(3) organization under the U.S. Internal Revenue Code, has experience conducting IEPRs for USACE.

3. METHODS FOR CONDUCTING THE IEPR

The methods used to conduct the IEPR are briefly described in this section; a detailed description can be found in Appendix A. The IEPR was completed in accordance with established due dates for milestones and deliverables as part of the final Work Plan, and are based on the award/effective date and the receipt of review documents.

Battelle identified, screened, and selected four panel members to participate in the IEPR based on their expertise in the following disciplines: Civil Works planning/economics, environmental biology, hydraulic

and hydrology (H&H) engineering, geotechnical engineering, and civil engineering. The Panel reviewed the Moose Creek Dam IEPR documents and produced 12 Final Panel Comments in response to 21 charge questions provided by USACE for the review. This charge included one overview question and one public comment question added by Battelle. Battelle instructed the Panel to develop the Final Panel Comments using a standardized four-part structure:

1. Comment Statement (succinct summary statement of concern)
2. Basis for Comment (details regarding the concern)
3. Significance (high, medium/high, medium, medium/low, or low; in accordance with specific criteria for determining level of significance)
4. Recommendation(s) for Resolution (at least one implementable action that could be taken to address the Final Panel Comment).

Battelle reviewed all Final Panel Comments for accuracy, adherence to USACE guidance (EC 1165-2-214, Appendix D), and completeness prior to determining that they were final and suitable for inclusion in the Final IEPR Report. There was no direct communication between the Panel and USACE during the preparation of the Final Panel Comments. The Panel's findings are summarized in Section 4.1; the Final Panel Comments are presented in full in Section 4.2.

4. RESULTS OF THE IEPR

This section presents the results of the IEPR. A summary of the Panel's findings and the full text of the Final Panel Comments are provided.

4.1 Summary of Final Panel Comments

The panel members agreed on their "assessment of the adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (USACE, 2012; p. D-4) in the Moose Creek Dam review documents. Table ES-1 lists the Final Panel Comment statements by level of significance. The full text of the Final Panel Comments is presented in Section 4.2 of this report. The following summarizes the Panel's findings.

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Engineering: The documents provided for review were well written and easy to follow. The Panel's primary concern is that the geotechnical data presented are not sufficient to conclude with certainty that the mix-in-place cut-off wall has sufficient depth to prevent Backward Erosion Piping (BEP). The Panel fully understands there will always be some uncertainty with respect to the soil types that may initiate BEP, and uncertainty regarding the extent of those soils in the dam's foundation. However, the geotechnical data presented are not sufficiently detailed or complete enough to confirm that a new cut-off wall extending a minimum of 10 feet beneath the dam will provide a suitable interruption of BEP where more permeable soils exist immediately below the cut-off wall. The Panel suggests additional

geotechnical investigations with particular attention to variations in grain size distributions and how this may affect gradients that may initiate BEP.

Additionally, the Panel noted that the information on permafrost conditions downstream of the dam is not complete enough to assess whether or not thermal erosion may occur. Without fully understanding the thermal regime it is difficult to determine whether this type of risk exists. The study does not describe this type of risk and provides no geotechnical data that would confirm the amount of ice content that may exist in the soil column in these areas. Quantification of this risk is needed to fully evaluate the recommended plan decision. The Panel also agrees that the risk and uncertainty surrounding both seismically induced or thaw-consolidation settlement of the cut-off wall have not been fully considered. With respect to thaw consolidation of permafrost beneath the dam, the risk is likely to be somewhat lower than a seismic event if ice contents are low. However, information provided in the study provides only an indication that permafrost is present and does not describe the ice content in the soil column or make any estimate of the thaw consolidation that may occur should permafrost in these zones thaw in future years. Since there is no description of either the means of detecting the potential for flaws or the means of adequately repairing cracks, the risk of BEP failure during future flooding may not be fully considered.

Finally, the Panel noted that the recommended plan proposes initiation of construction in the critical reaches. The Panel is concerned that construction of a test section in a critical reach may result in gaps in the wall resulting in increased hydraulic gradients and concentrated flow. These issues should be resolved by constructing a test section first in a non-critical area. A test section may reduce the risk of potential problems prior to construction in the most critical areas. Additionally, changing the construction order may result in less uncertainty and increased robustness.

Civil Works Planning/Economics: The decision documents are thorough and well-organized. However, the Panel believes that there is little documentation of the operations and maintenance (O&M) costs in the future without-project condition. The lack of O&M cost data results in incomplete project information, which could possibly affect the justification of the recommended plan costs. The Panel suggests that O&M costs for future without-project and future with-project conditions be provided to support the DSMR statements that these costs are identical. Additionally, the Panel agrees that the rationale for selecting F9 over F11 as the recommended plan needs to be supported in more detail. Both F9 and F11 meet Tolerable Risk Guidelines. Although F11 is lower in costs, it does not meet the ALARP (as low as reasonably possible) guidelines. Alternately, F9 offers the lowest cost to save a statistical life and reduces the average life loss, and also meets the ALARP guidelines. Apart from the ALARP consideration, it could be argued that the large cost increase of F9 over F11 is not necessarily justified by the small cost to save a statistical life (CSSL) difference. The requirement that the recommended plan must be the ALARP plan is not specified in the main report or Appendix A. Incomplete information in the decision documents on USACE requirements for ALARP creates uncertainty affecting the justification of the selection of Alternative F9 over F11.

Environmental: This is clearly a complex project with substantial challenges. The Panel commends the Project Delivery Team for the impressive effort that went into the alternative formulation process as described in the project documents. However, the Panel noted that the cumulative impacts of improving the dam have not been fully considered in either the preferred or no-action alternatives. Also, expected changes/losses in flood plain values have not been addressed in the Environmental Assessment (EA). The indirect impacts on floodplains and floodplain functions for the preferred and no-action alternatives have not been analyzed, which adversely affects project completeness.

The Panel also found that the EA does not fully evaluate the impacts of each alternative presented in the document, which may affect the selection of the recommended plan. Alternatives that are presented in the EA ought to be carried forward through the entire document for full and detailed analysis of impacts. Incomplete analysis of impacts in the EA could negatively affect the justification for the recommended plan. The Panel suggests that additional detail be added to the EA to provide more analysis and explanation.

4.2 Final Panel Comments

This section presents the full text of the Final Panel Comments prepared by the IEPR panel members.

Final Panel Comment 1

The geotechnical data presented are not sufficient to conclude with certainty that the mix-in-place cut-off wall has sufficient depth to prevent Backward Erosion Piping.

Basis for Comment

The Dam Safety Modification Report (DSMR), Appendix A, Decision Support Documents for Moose Creek Dam (p. 6), describes the cut-off wall as varying in depth from 51 to 66.5 feet. The document states that the cut-off wall will extend a minimum of 10 feet below the original excavation for the dam from stations 240+00 to 493+00. The primary purpose of the cut-off wall is to interrupt the downstream flaw and protect the dam from Backward Erosion Piping (BEP) by severing the depths where fine silty sand and sands could form a pipe.

Appendix A (p. 240) presents historic geologic and geotechnical data on soil and permafrost conditions anticipated beneath and downstream of the dam. The historic data date back to the early 1970s and include both boreholes and excavations conducted during the design and construction of the dam. In typical sections, poorly graded and well-graded gravels exist beneath the fine silty sand and sand that could form a pipe.

The Panel also reviewed the Baseline Risk Assessment Report, which provides analysis of borings and 2,400+ gradations performed. The document states that geologic uncertainty will not allow a full understanding of geotechnical and geologic conditions no matter how much data are collected for design (p. 65). The Panel agrees with this statement since the material underlying the dam consists of alluvium with high variability.

One of the key risk drivers for BEP are fine silts and sands that could form a path for BEP beneath the dam. However, another potential risk is the zone immediately beneath the potential piping path where a more highly permeable soil exists. The higher permeability layer may facilitate movement of fines without clogging, and therefore may increase the risk of BEP when the cut-off wall is not constructed to sufficient depth.

The Panel fully understands there will always be some uncertainty with respect to the soil types that may initiate BEP, and uncertainty regarding the extent of those soils in the dam's foundation. However, the geotechnical data presented are not sufficiently detailed or complete enough to confirm that a new cut-off wall extending a minimum of 10 feet beneath the dam will provide a suitable interruption of BEP where more permeable soils exist immediately below the cut-off wall.

Significance – High

Construction of a cut-off wall extending 10 feet beneath the dam in areas where more permeable soils exist beneath the pipable fine sands and silty sands may still result in risk of BEP.

Recommendation for Resolution

1. Implement additional geotechnical investigations with particular attention to variations in grain size distributions and how this may affect gradients that may initiate BEP.
2. Evaluate whether the depth of installation of the cut-off wall is appropriate for the geotechnical conditions encountered.

Final Panel Comment 2

Geotechnical information on permafrost conditions downstream of the dam is not complete enough to assess whether thermal erosion may occur.

Basis for Comment

The DSMR, Appendix A, Decision Support Documents for Moose Creek Dam (pp. 225-251), provides a generalized description of soil conditions and the location of permafrost beneath the dam embankment. The Moose Creek Dam Baseline Risk Assessment Report from 2014 also provides information on the location of permafrost beneath the dam and associated risks.

One of the risks identified is that permafrost may tend to block flow beneath the dam and increase hydraulic gradients in some locations. The Panel agrees with the assessment and risk identified. However, no information is provided on the amount of visible ice content present in the soil column either beneath the dam or downstream of the dam.

During the site visit, the Panel observed that Black Spruce exist downstream from the dam in several areas. Black Spruce typically occur in permafrost terrain. The Panel also reviewed the generalized boring information presented for each reach of the dam and found no information on visible ice content in the permafrost.

Thermal erosion is a potential risk where soil columns exist with considerable visible ice or massive ice (greater than 50 percent ice in the soil column). Water flow beneath the dam during a large flood event has the potential to thermally erode ice. Significant thaw consolidation is possible, which may lead to increased uplift pressures downstream of the dam. Thermal erosion can develop over short time periods, as was observed on an Arco project on the North Slope where 80 feet of thermal erosion occurred in less than one week.

Without fully understanding the thermal regime, it is difficult to determine whether this type of risk exists. The study does not describe this type of risk and provides no geotechnical data that would confirm the amount of ice content that may exist in the soil column in these areas. Quantification of this risk is needed to fully evaluate the recommended plan decision.

Significance – Medium/High

Thermal erosion downstream of the existing dam embankment could present a significant risk to the project if considerable visible ice or massive ice is present.

Recommendation for Resolution

1. Conduct geotechnical investigations consisting of boreholes and/or sonic boreholes to more fully describe soil and ice conditions adjacent to and downstream of the dam near areas where Black Spruce exist or permafrost is known to occur. Confirm boundaries of permafrost with geophysical techniques as necessary.
2. Determine whether thermal erosion of ice-rich permafrost is a credible risk to uplift pressures in permafrost areas downstream of the dam.

Final Panel Comment 3

Risk and uncertainty may not have been fully characterized or estimated for seismically induced or thaw-consolidation settlement of the cut-off wall.

Basis for Comment

DSMR, Appendix A presents the following information on seismicity for the geologic setting:

- The peak ground acceleration (PGA) range anticipated for the earthen dam is 0.37 to 0.47g (p. L-6).
- "Liquefaction has the potential in the area of the dam but was found to not be a credible failure mode since the probability of having both a large earthquake and an event at the same time is rare. It is expected that if any liquefaction does occur the Alaska District will be able to repair the damage relatively quickly without risk to the dam." (p. 25)
- According to the annual O&M costs presented in the recommended plan, $0 has been included for future needs for the soil-cement cut-off wall system proposed (p. 19).

Geology can significantly influence the amplitude, frequency, and duration of seismic motions at the ground surface. Near-surface soil and rock conditions, such as depth to bedrock, thickness of soil layers, site topography, variations in stiffness, and material damping, may significantly impact PGA. Permafrost also affects material damping and shear strain amplitude. The combination of sporadic permafrost and steeply sloping bedrock may result in seismic wave reflection that could significantly increase PGA in some reaches of the dam.

It is the Panel's opinion that PGA may vary significantly from design values provided from sources such as the U.S. Geologic Survey (USGS) or National Earthquake Hazard Reduction Program (NEHRP) or publications typically used in determining PGA. The Moose Creek Dam is situated on an alluvial floor that on one abutment has bedrock at the surface and in other locations is over 600 feet in depth. Portions of the underlying river alluvium beneath the dam contain permafrost and also have nearby permafrost extending from near the surface to significant depths. This results in a site where PGA may vary significantly from location to location along the dam, and where PGA could increase significantly from reflection. It is unclear if these factors were considered in developing the design values of 0.37 to 0.47g.

The DSMR (p. L-6) indicates that damage from a seismic event would not increase risk significantly since the embankment could be repaired fairly quickly and only fine cracks are anticipated in the cut-off wall. However, potential seismic cracking of the mix-in-place, soil-cement cut-off wall cannot be observed and therefore the damage may go undetected and unrepaired. Should significant cracks form in the cut-off wall in zones identified where BEP could occur, the increased risk of a BEP would not be known until another flood occurs. This risk is not described in the study.

With respect to thaw consolidation of permafrost beneath the dam, the risk is likely to be somewhat lower than a seismic event if ice contents are low. However, information provided in the study provides only an indication that permafrost is present and does not describe the ice content in the soil column or make any estimate of the thaw consolidation that may occur should permafrost in these zones thaw in future years.

No calculations are provided for estimating the following:

- The amount of thaw consolidation that may occur in areas of the cut-off wall where permafrost is present beneath the dam.
- The amount of liquefaction-induced settlement that may occur should a major earthquake occur.
- The ductility of the soil-cement mix or how to make this system more ductile should a major seismic event occur.
- Maintenance costs for the soil-cement wall. The DSMR (p. 84) states that cracking may occur, but describes cracking as minor in nature. It is difficult to understand whether minor cracking would occur when no calculations with respect to the amount of liquefaction-induced settlement are included in the documentation.

Since there is no description of either the means of detecting the potential for flaws or the means of adequately repairing cracks, the risk of BEP failure during future flooding may not be fully considered.

Significance – Medium/High

The risk of significant cracking of the cut-off wall system in zones used to minimize potential for BEP may not be detected following a seismic event, thereby potentially increasing the risk of BEP for future events.

Recommendation for Resolution

1. Evaluate whether variations in bedrock and the presence of permafrost could result in potential seismic reflection and implications to the design PGA values of 0.37 to 0.47g.
2. Calculate the anticipated liquefaction-induced total and differential settlement along the dam and how this may affect risk to the Recommended Plan.
3. Evaluate and describe the potential for thaw consolidation of permafrost along the dam, including the potential total and differential settlement.
4. Evaluate the potential damage that may occur to a cut-off wall from a major seismic event or longer-term thaw consolidation of permafrost. Describe how repairs to the cutoff wall would be implemented and what the associated costs would be. Include these considerations in the TSP selection process. Evaluate whether the addition of plasticizers to the soil cement mix could create a more ductile soil-cement cut-off wall, and thereby reduce systemic risk.
5. Evaluate whether a soil-cement cut-off wall mix design using plasticizers may reduce risk of cracks due to settlement from liquefaction or thaw-consolidation settlement.

Final Panel Comment 4

The recommended plan proposes initiation of construction in the critical reaches and without a test section, thereby increasing risks to project implementation.

Basis for Comment

The recommended plan consists of a soil-cement cut-off wall that will be constructed in Reaches 4, 5, and 6 first, followed by construction in Reaches 8 and 9 (Appendix A, Draft Project Management Plan, p. 11). Potential failures of the recommended plan in Reaches 4, 5, and 6 pose a greater risk than a failure at Reaches 8 and 9. The Panel recommends that the PDT consider revising the construction sequence so that adaptive construction management procedures can be implemented in the less critical reaches first.

Initial construction of the cut-off wall could have issues such as gaps in the wall resulting in increased hydraulic gradients and concentrated flow. These issues should be resolved by constructing a test section as construction proceeds in non-critical areas. A test section could confirm mix design, construction procedures, and provide improved assurance of continuity for the cut-off wall system. The test section should be constructed at a location other than the critical areas identified.

Significance – Medium

A test section may reduce the risk of potential problems prior to construction in the most critical areas. Reversal of the construction order may result in less uncertainty and increased robustness.

Recommendation for Resolution

1. Construct a test section for the mix-in-place cut-off wall at a location other than the most critical area to confirm that construction procedures and mix design are effective.
2. Review the rationale for constructing Reaches 4, 5, and 6 before Reaches 8 and 9 and consider reversing the construction order.

Final Panel Comment 5

The discussion of the recommended plan does not address how current and planned relief wells will affect the performance of the centerline cutoff wall.

Basis for Comment

DSMR, Appendix D, Section 3, Moose Creek Dam Preliminary Groundwater Hydraulic Modeling (December 2016) discusses input assumptions for groundwater modeling, and states (pp. 2-3):

> "It is reasonable to assume that the conductivity of the foundation granular materials actually varies by orders of magnitude vertically and horizontally over short distances due to grain size heterogeneity. However, it is generalized as a deep layer of sand and gravel for simplicity. Similarly, due to uncertainties in the extent, depth, and location of permafrost, localized permafrost zones were not integrated into the model. For the most conservative model, the constructed upstream silt blanket and relief wells were not modeled in this effort to account for the possibility a failed relief well and lack of silt on the upstream side of the embankment."

These simplifying assumptions in the groundwater modeling do not represent the foundation soil conditions that the recommended plan is intended to overcome and may influence the comparison of action alternatives in the final array.

Groundwater modeling should clearly demonstrate that the recommended plan achieves the desired risk reduction even when permafrost lenses and soil layers vulnerable to erosion are present. These models should be evaluated with and without relief wells so that the benefits and locations for new relief wells can be fully understood. Failure modes described in the Baseline Risk Assessment Report (January 2014, Section 8) include various combinations of erodible soil layers in the dam foundation, relief wells, and permafrost lenses. However, it is not clear that these failure modes and mitigating factors were included in the groundwater modeling discussed in the December 2016 study.

Remedial measures taken at Moose Creek Dam since 1979 have included the installation of 158 relief wells in seepage-critical locations. A planning budget of $1M for additional relief wells and surveying in 2018 appears in DSMR, Appendix A. The plan for additional relief wells was verbally confirmed during the Panel's site visit. If relief wells are an integral part of the recommended plan, then the groundwater modeling should reflect that plan element. Modeling could then be used to optimize the location of new wells to be constructed in 2018.

Significance – Medium

The efficacy of the final action alternatives cannot be accurately compared if the known soil conditions, existing relief wells, and expected soil anomalies are not evaluated.

Recommendation for Resolution

1. Include the results of groundwater modeling of the recommended plan with expected soil conditions and relief wells in the DSMR.
2. Clarify text in the DSMR to show how the groundwater modeling described in the 2014 report was used in the development of the final action alternatives array.

3. Expand text in the DSMR to demonstrate how the recommended plan resolves the risks associated with permafrost lenses, discontinuous lenses of fine erodible sands, and void spaces created by the melting of permafrost. Show the impact on the model of a functioning relief well vs. a non-functioning relief well.

Final Panel Comment 6

The cumulative impacts of improving the dam have not been given full consideration in either the preferred or no-action alternatives.

Basis for Comment

The objectives of Executive Order (EO) 11988 are to avoid "to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of the base flood plain and the avoidance of direct and indirect support of development in the base flood plain wherever there is a practicable alternative" (USACE, 1984). The conclusions in the project Environmental Assessment (EA) related to the EO are not supported by the information presented and do not address the main objectives of the Order.

Expected changes/losses in flood plain values and how the project meets (or fails to meet) the objectives of the EO have not been addressed in the EA. For example, the discussion of floodplain impacts (EA, pp. 45-46) does not mention that the preferred alternative will indirectly encourage additional development in the base flood plain downstream of the dam. Yet this expected development is tied to concerns about public safety elsewhere in the EA (p. 57).

The Panel believes that non-structural alternatives (e.g., Evacuation Plan, Risk Communication, Early Warning System, and Automated Monitoring), which are directly tied to public safety, should be considered in greater detail. The fact that some of these measures would be under the control of non-Federal agencies is not an absolute reason to disqualify the measures from further consideration. Non-structural measures may be politically difficult to implement, but offer perhaps the least cost to save a statistical life (CSSL). The DSMR cites the difficulty of implementing traditional floodplain management techniques on lands without zoning ordinances (DSMR p. 45). It is still possible for non-Federal project partners to implement passive and active flood warning systems that can reduce the risk of loss of life, especially if USACE is a funding partner for these efforts. All efforts by USACE to create partnerships within the community to achieve flood risk reduction will benefit the project, and will demonstrate a good-faith effort to comply with EO 11988, and may lead to broader community support for the project.

Significance – Medium

The indirect impacts on floodplains and floodplain functions for the preferred and no-action alternatives have not been analyzed, which adversely affects project completeness.

Recommendation for Resolution

1. Evaluate whether or not the alternatives encourage the occupancy and modification of the base flood plain and/or supports development in the base flood plain; revisit the value of non-structural measures in bringing the project into better compliance with EO 11988.
2. Revise the Draft EA to describe specific ways the preferred and no-action alternatives do or do not comply with EO 11988.

Literature Cited:

USACE (1984). Implementation of Executive Order 11988 on Flood Plain Management. Engineer Regulation (ER) 1165-2-26. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. March 30.

Final Panel Comment 7

The Environmental Assessment does not fully evaluate the impacts of each alternative presented in the document, which may affect the selection of the recommended plan.

Basis for Comment

Alternatives that are presented in Section 2 of the Environmental Assessment (EA) ought to be carried forward through the entire document for full and detailed analysis of impacts, unless they are specifically identified as alternatives not to be carried forward for further consideration. The two non-preferred structural alternatives (Filter Berm with Decommissioned Relief Wells and Filter Berm with Buried Relief Wells), as well as the four non-structural alternatives (Evacuation Plan, Risk Communication, Early Warning System, and Automated Monitoring) were identified as viable alternatives in the EA, Section 2. However, they were not evaluated in a manner consistent with, and as detailed as, the evaluation of the preferred alternative (Mix In Place Cutoff Wall) and the no-action alternatives.

The Panel also finds that the rationale to evaluate two separate no-action alternatives is not clear, and is not consistent with National Environmental Policy Act (NEPA) Procedures (USACE, 1988). Analysis of only one action alternative (Mix In Place Cutoff Wall) is justified given the extensive alternative evaluation process, but the basis for selecting just one should be discussed in the EA.

Beneficial impacts are not distinguished from adverse impacts in the EA's analysis of environmental consequences. There are obvious benefits associated with this project and the EA should summarize them. In addition, the scale of analysis completed for the different alternatives is not always consistent. For example, evaluation of impacts on land use for the preferred alternative is confined to consideration of the dam and its immediate vicinity, whereas evaluation of land use impacts for the No-Action Alternative with Dam Failure considers potential property damage in the floodplain. Similar discrepancies in the scale of analysis among alternatives are found in the evaluation of consequences to soils, socioeconomics, hazardous, toxic, and radioactive waste (HTRW), and others.

Significance – Medium/Low

The incomplete description of alternative selection and types of impacts in the Environmental Assessment could negatively affect the justification for the recommended plan.

Recommendation for Resolution

1. Revise Section 2 of the EA to cite the Dam Safety Modification Report (December 2016), which provides detail on the range of alternatives that were evaluated in the project.
2. Revise Section 2 of the EA to explain in greater detail why only one action alternative is analyzed and why two no-action alternatives are presented.
3. Revise Section 4 and Figure 12 of the EA to distinguish beneficial impacts from adverse impacts.

Literature Cited

USACE (1988). Procedures for Implementing National Environmental Policy Act. Engineer Regulation (ER) 200-2-2. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. March 4.

Final Panel Comment 8

Full compliance with several Federal environmental laws has not been demonstrated, which may affect ability to implement the recommended plan.

Basis for Comment

The proposed dam modification must comply with existing Federal laws. Project compliance with environmental regulations is typically undertaken during the project planning phase and is then described in the NEPA compliance document. Coordination and consultation with Federal agencies is usually necessary to fulfill the requirements to identify potential impacts of a project and identify appropriate ways to mitigate the impacts. The Panel found some of the documentation to demonstrate how the project complies with Federal laws to be incomplete:

- **Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act.** Bald eagles are present at the site (they were observed during the Panel's site visit), and that is not clearly stated in the EA. Fox sparrows breed at the project site (EA, p. 36). Suitable breeding habitat for other species of migratory birds is also reported to be present at the project site (EA, p. 36-37). The potential for indirect take of migratory birds and eagles during non-breeding activities and seasons has not been fully addressed.
- **Clean Water Act (CWA), Section 404.** The project description indicates that mechanized clearing in forested wetlands will occur in the spoils disposal areas. The EA states that a wetland delineation will be completed in the future for this project (p. 54). The CWA Section 404 compliance group at USACE is required to complete a Pre-Construction Notification review under NEPA to verify that wetland impacts have been minimized. Ideally, this review is completed as part of the EA process; it is not obvious that this review has been completed.
- USACE procedures for Implementing **National Environmental Policy Act** (ER 200-2-2; USACE, 1988) advise that the Draft Finding of No Significant Impact (FONSI) should be prepared with a Draft EA and both the FONSI and EA should be circulated for a 30-day public review and comment period. The Draft FONSI was not available for Panel review. The Panel understands that Section 6.1 in the Draft EA is a place-holder to describe the public involvement process for this project. However, that text provides no assurance that public and agency comment will be undertaken independent of a Dam Safety Oversight Group (DSOG) meeting. It is not obvious to the Panel how a DSOG meeting will fulfill the requirement to engage the public in a meaningful way.

Significance – Medium/Low

Compliance documentation is incomplete, which could negatively affect implementation of the recommended plan.

Recommendation for Resolution

1. Coordinate with the U.S. Fish and Wildlife Service (USFWS) to determine whether or not a “take permit” for disturbance to Bald eagles and other migratory birds will be required, document that coordination in the Draft EA, and summarize it in the Draft FONSI.
2. Coordinate with the USACE Regulatory Program to determine which wetland impacts should be addressed; document the findings in the project’s administrative record, summarize them in the Draft EA, and use them to inform the FONSI.
3. Prepare a Draft FONSI and attached it to the Draft EA before releasing these documents for public and agency review. Revise the Final EA to include details on the methods used to notify the public about the project, engage with the public, and respond to comments. The Final EA should Include a summary of all public and agency comments and how they were addressed.

Literature Cited

USACE (1988). Procedures for Implementing National Environmental Policy Act. Engineer Regulation (ER) 200-2-2. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. March 4.

Final Panel Comment 9

The O&M scope and costs for the recommended plan appear insufficient to meet the objectives and function of the project design.

Basis for Comment

There is little documentation of the operations and maintenance (O&M) costs in the future without-project condition. The DSMR, Section 5.2.2 (p. 110) states that O&M costs for the future without- and future with-project conditions will be identical, and that the recommended plan would reduce the probability of failure and thus reduce O&M cost. This assumes that the reduced cost to repair would offset any additional O&M cost for the recommended plan. This assumption is not substantiated. To support the claim that O&M would be unchanged in the recommended plan would require reporting future without-project O&M costs, as well as estimating avoided repair costs from failure under the future without-project condition.

In addition, the recommended plan, alternative F9, consists of centerline cutoff walls at reaches 4, 5, 6, 8, and 9. The DSMR does not specify what monitoring, maintenance, and repair costs would be associated with this considerable length of cutoff wall. It also does not specify costs associated with remediation of possible cracking of the cutoff walls due to thaw consolidation or seismic damage to the cutoff walls in the event of one or more earthquakes.

In addition, there is no discussion of relief flow wells that are being added between existing relief flow wells and the costs associated with operating and maintaining these structures. It is not clear whether these costs are different in the future with- and future without-project scenarios.

Significance – Medium/Low

The lack of O&M cost data results in incomplete project information, which could possibly affect the justification of the recommended plan.

Recommendation for Resolution

1. Provide O&M costs for both the future without-project and the F9 and F11 alternatives to support the DSMR statements that these costs are identical.

Final Panel Comment 10

The rationale for selecting F9 over F11 as the recommended plan needs to be more detailed.

Basis for Comment

The rationale for selecting alternative F9 over alternative F11 is not clear:

- Both F9 and F11 meet Tolerable Risk Guidelines.
- F9 offers the lowest CSSL, making F9 more efficient than F11. However, the difference in CSSL is small in both relative terms (4%) and absolute terms.
- Alternative F9 reduces the average life loss by 0.0006 compared with F11.
- This difference does not necessarily justify the selection of F11 whose first cost is $24 million (26%) lower than that of F9.
- Both F9 and F11 meet the resiliency, redundancy, and robustness criteria.
- However only Plan F9 meets the ALARP (as low as reasonably possible) guidelines (USACE, 2014).

Plan 11 meets all criteria except ALARP. It is not clear that USACE policy requires that, regardless of economic considerations, only plans which satisfy the ALARP criteria (in this case only Plan 9) are acceptable.

Section 3.3.11 of the Safety of Dams regulation (USACE, 2014) specifies that, to achieve a DSAC 5 classification, ALARP considerations must be included when determining incremental risk. It is not clear whether this policy requires implementation of only the plan that satisfies the ALARP consideration. Similarly, Section 5.3.5.4.3 of the USACE regulation specifies that the tolerability of incremental risks must be “informed by” ALARP considerations. Again, it is not clear that selection of the plan that satisfies the ALARP considerations is mandatory.

Apart from the ALARP consideration, it could be argued that the large cost increase of F9 over F11 is not necessarily justified by the small CSSL difference. The requirement that the recommended plan must be the ALARP plan is not specified in the main report or Appendix A.

Significance – Medium/Low

Incomplete information on USACE requirements for ALARP creates uncertainty, which affects the justification of the selection of Alternative F9 over F11.

Recommendation for Resolution

1. Include an explanation of the USACE’s requirement to select only plans that satisfy the ALARP consideration in the discussion of tolerable risk in the Main Report and Appendix A.
2. If selection of the plan that satisfies ALARP considerations is not mandatory, provide justification for selection of F9 as opposed to F11.

Literature Cited

USACE (2014). Engineering and Design: Safety of Dams – Policy and Procedures. Engineer Regulation (ER) 1110-2-1156. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C., March 31.

Final Panel Comment 11

The Probable Maximum Flood estimate of total runoff volume appears to be quite large relative to the size of the watershed; more data are needed to support watershed soil infiltration and water retention assumptions.

Basis for Comment

Actual soil infiltration characteristics are not well-documented, perhaps because there is little real data to use. The Chena River Watershed Hydrology Model (April 2012) concludes that "… analysis of the soil types and percolation rates in both permafrost and unfrozen areas may reduce some uncertainty in the soil moisture accounting model." There is also discussion about a decrease in the extent of permafrost in the watershed as a result of long-term warming trends and/or forest fires. Changes in permafrost would lead to increases in soil infiltration and increases in surficial vegetation. It does not appear that these changes in the watershed are factored into the runoff calculations.

Descriptions of the Probable Maximum Precipitation (PMP) and the Probable Maximum Flood (PMF) are not consistent among some of the reports reviewed by the Panel:

- Table 1 in the Project Data of the Hydrology and Hydraulic Appendix (June 2013) lists the watershed area as 1,447 square miles, the PMP rainfall as 11.0 inches, and the PMF peak discharge as 173,168 cubic feet per second (cfs), and does not list a total runoff volume.
- The Executive Summary of the Moose Creek DSMR (December 2016) lists the watershed area as 1,496 square miles, the PMP rainfall as 12.8 inches, and the PMF peak discharge as 186,000 cfs, and does not list a total runoff volume.
- Section 5 of the Chena River Watershed Hydrology Model (April 2012) lists the watershed area as 2,115 square miles (including the Little Chena River watershed) and the PMF peak discharge into MCD as 171,481 cfs, and does not list a total runoff volume.
- Appendix B, Hydrology and Hydraulics (June 2013, p. 41) describes total runoff volume: "The PMF of the Chena River … has a total inflow volume of approximately 830,000 acre-feet ……". This volume works out to 10.75 inches of runoff from the entire 1447 square mile watershed, and suggests that 98% of the PMP (11.0 inches of rainfall) reaches Moose Creek Dam in a period of 5 days. This watershed response is comparable to watersheds with 100% impervious cover, a high degree of hydraulic connectivity, and no depressional areas that could retain water.
- The Chena River Watershed Hydrology Model (April 2012, p. 51) assumes that a Standard Project Storm (SPS, or ½ PMP) occurs immediately before the PMF event occurs, "to saturate the ground within the model, representing the worst hydrologic conditions expected." Other input assumptions described for the Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS) model include: "Initial soil moisture conditions were set at 80% saturated to represent typical summer conditions based on earlier model runs. The sub basin times of concentration were adjusted by 25%, as is recommended (USACE 1991), to account for unit hydrographs being typically developed from smaller events." Collectively, these conservative modeling assumptions appear to result in a 98% efficient delivery of water from the watershed. In a risk-based assessment, it is often most instructive to model the expected conditions first, and then consider

the probability that more conservative hydrologic conditions might occur in the context of the entire risk and probability matrix.

Significance – Medium/Low

If the total PMF runoff volume has been overestimated, the maximum flood pool elevation at Moose Creek Dam will also have been overestimated. A lower maximum pool elevation may not eliminate the risk of a dam breach event, but the magnitude of risk may be lower than the Moose Creek DSMR currently shows in the f-N chart.

Recommendation for Resolution

1. Verify that the 830,000 acre-feet total runoff volume number is correct. Provide information in the Moose Creek DSMR on the specific assumptions used in the calculation of PMF total runoff volume.
2. Include data from field measurements of soil infiltration characteristics in the Moose Creek Dam watershed to support the runoff model input assumptions. Verify that the extent of permafrost and large vegetation in the watershed has been accurately incorporated into the HMS model.
3. Clarify in the Moose Creek DSMR the basis for modifying the calculated PMF peak discharge from both the 2012 study and the 2013 study.

Final Panel Comment 12

Verification that permafrost is not present should be performed in the vicinity of the Low Drain Sheet Pile Installation to confirm that piles can be successfully installed.

Basis for Comment

During its review of the recommended plan, the Panel could not clearly determine whether permafrost was absent in the vicinity of the Low Drain Sheet Piles. The presence of permafrost typically demands alternative construction procedures where steam thawing may be required immediately prior to pile installations.

Encountering permafrost during construction may lead to difficulty in pile driving or potentially splitting the sheet pile ball-and-knuckle joints during the pile driving process. This could also lead to the contractor being required to mobilize steam thawing equipment to drive sheet.

Significance – Medium/Low

Construction delays and changes to the project implementation could result if permafrost is encountered.

Recommendation for Resolution

1. Verify pile driving conditions and whether permafrost is present through use of boreholes and temperature monitoring prior to construction.

5. REFERENCES

OMB (2004). Final Information Quality Bulletin for Peer Review. Executive Office of the President, Office of Management and Budget, Washington, D.C. Memorandum M-05-03. December 16.

The National Academies (2003). Policy on Committee Composition and Balance and Conflicts of Interest for Committees Used in the Development of Reports. The National Academies (National Academy of Science, National Academy of Engineering, Institute of Medicine, National Research Council). May 12.

USACE (2014). Engineering and Design: Safety of Dams – Policy and Procedures. Engineer Regulation (ER) 1110-2-1156. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. March 31

USACE (2012). Water Resources Policies and Authorities – Civil Works Review. Engineer Circular (EC) 1165-2-214. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. December 15.

USACE (1988). Procedures for Implementing National Environmental Policy Act. Engineer Regulation (ER) 200-2-2. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. March 4.

USACE (1984). Implementation of Executive Order 11988 on Flood Plain Management. Engineer Regulation (ER) 1165-2-26. Department of the Army, U.S. Army Corps of Engineers, Washington, D.C. March 30.

APPENDIX A

IEPR Process for the Moose Creek Dam Project

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A.1 Planning and Conduct of the Independent External Peer Review (IEPR)

Table A-1 presents the major milestones and deliverables of the Moose Creek Dam IEPR. Due dates for milestones and deliverables are based on the award/effective date listed in Table A-1. The review documents were provided by the U.S. Army Corps of Engineers (USACE) on July 17, 2017. Note that the actions listed under Task 6 as well as the public comment review occur after the submission of this report. Battelle anticipates submitting the pdf printout of the USACE's Design Review and Checking System (DrChecks) project file (the final deliverable) on December 18, 2017. A Final IEPR Report addendum will be submitted after the review of the public comments on approximately May 31, 2018. The actual date for contract end will depend on the date that all activities for this IEPR are conducted and subsequently completed.

Table A-1. Major Milestones and Deliverables of the Moose Creek Dam IEPR

Task		Due Date
1	Award/Effective Date	7/10/2017
	Review documents available	7/17/2017
	Public comments received from USACE (estimated)	4/30/2018
	Battelle submits draft Work Plan[a]	7/18/2017
	USACE provides comments on draft Work Plan	7/19/2017
	Battelle submits final Work Plan[a]	7/24/2017
2	Battelle submits list of selected panel members[a]	7/27/2017
	USACE confirms the panel members have no COI	8/1/2017
3	Battelle convenes kick-off meeting with USACE	7/13/2017
	Battelle convenes kick-off meeting with panel members	8/8/2017
	Battelle convenes site visit/kick-off meeting with USACE and panel members	8/15/2017
4	Panel members complete their individual reviews	9/8/2017
	Panel members provide draft Final Panel Comments to Battelle	9/25/2017
	Panel finalizes Final Panel Comments	10/10/2017
5	Battelle submits Final IEPR Report to USACE[a]	10/16/2017
	Battelle submits Addendum to the Final IEPR Report[a]	5/31/2018
6[b]	Battelle convenes Comment Response Teleconference with panel members and USACE	11/30/2017
	Battelle submits pdf printout of DrChecks project file[a]	12/18/2017
	Battelle participates in the Dam Senior Oversight Group (DSOG) Meeting[c]	TBD/ January 2018
	Contract End/Delivery Date	8/31/2018

[a] *Deliverable.*
[b] *Task 6 occurs after the submission of this report.*
[c] *If Option 1 is awarded, the DSOG meeting will be arranged and hosted by USACE.*

At the beginning of the Period of Performance for the Moose Creek Dam IEPR, Battelle held a kick-off meeting with USACE to review the preliminary/suggested schedule, discuss the IEPR process, and address any questions regarding the scope (e.g., terminology to use, access to DrChecks, etc.). Any revisions to the schedule were submitted as part of the final Work Plan. The final charge consisted of 21 charge questions provided by USACE, one overview question and one public comment question added by Battelle (all questions were included in the draft and final Work Plans), and general guidance for the Panel on the conduct of the peer review (provided in Appendix C of this final report).

Prior to beginning their review and after their subcontracts were finalized, all the members of the Panel attended a kick-off meeting via teleconference planned and facilitated by Battelle in order to review the IEPR process, the schedule, communication procedures, and other pertinent information for the Panel. Battelle planned and facilitated a site meeting/kick-off meeting during which USACE presented project details to the Panel at the Moose Creek Dam USACE project office. Before the meetings, the IEPR Panel received an electronic version of the final charge, as well as the review documents and reference/supplemental materials listed in Table A-2.

Table A-2. Documents to Be Reviewed and Provided as Reference/Supplemental Information

Review Documents	No. of Review Pages
DSMR Main Report	161
Appendix A: Decision Support Documents for Moose Creek Dam	350
Appendix B: Risk Management Plans Risk Assessment	413
Appendix C: Screened Measures, Alternatives and F Plans	103
Appendix D: Drawings and Design Information for F Plans	103
Appendix E: Environmental Assessment	63
Appendix F: Cost Estimates	62
Appendix G: Reviews	297
Public Review Comments[a]	50
Total # of Pages to be Reviewed	**1,602**
Supplemental Document	
Baseline Risk Assessment (includes Site Characterization Report Appendix)[b]	485
Reference Documents	
Abbreviated Risk Register[b]	10

[a] *USACE will submit public comments to Battelle upon their availability according to the schedule in Table A-1. Battelle in turn will submit the comments to the IEPR Panel for review. A separate Addendum to the Final Report will be submitted if additional Final Panel Comments are necessary.*

[b] *Supporting documentation only. These documents are not for Panel review and should be used as information sources only. They are not included in the total page count.*

In addition to the materials provided in Table A-2, the panel members were provided the following USACE guidance documents.

- USACE guidance, *Civil Works Review* (EC 1165-2-214), December 15, 2012
- Office of Management and Budget, *Final Information Quality Bulletin for Peer Review,* December 16, 2004.
- ER 1110-2-1156, Engineering and Design - Safety of Dams - Policy and Procedures, 31 March 2014
- USACE Climate Change Adaptation Plan (June 2014)
- ETL 1100-2-1 – Procedures to Evaluate SLR Change Impacts Responses Adaptation
- ER 1100-2-8162 – Incorporating SLR Change in CW Programs.

The Panel did not have any clarifying questions for USACE during the course of their review. Therefore, Battelle determined and the RMC confirmed that a mid-review teleconference with USACE was not necessary.

In addition, throughout the review period, USACE provided documents at the request of panel members. These documents were provided to Battelle and then sent to the Panel as additional information only and were not part of the official review. A list of these additional documents requested by the Panel is provided below.

- A site map showing the project site with respect to populated areas and confluence of the Tanana and Chena rivers
- Moose Creek Dam, Dam Risk Analysis, Dam Safety Program, Hydrology and Hydraulics Appendix

The final kick-off meeting and site visit, which included USACE, Battelle, and the Panel, was held on August 17, 2017 after the IEPR panel members were selected. Prior to this final kick-off meeting, panel members received the review materials to allow them time to begin their review of the documents. The purpose of this final kick-off meeting was to familiarize the panel members with the project and allow them to ask questions directly of USACE. Three of the four IEPR panel members attended. The economics panel member was unable to attend the site visit.

A.2 Review of Individual Comments

The Panel was instructed to address the charge questions/discussion points within a charge question response form provided by Battelle. At the end of the review period, the Panel produced individual comments in response to the charge questions/discussion points. Battelle reviewed the comments to identify overall recurring themes, areas of potential conflict, and other overall impressions. At the end of the review, Battelle summarized the individual comments in a preliminary list of overall comments and discussion points. Each panel member's individual comments were shared with the full Panel.

A.3 IEPR Panel Teleconference

Battelle facilitated a teleconference with the Panel so that the panel members could exchange technical information. The main goal of the teleconference was to identify which issues should be carried forward as Final Panel Comments in the Final IEPR Report and decide which panel member should serve as the lead author for the development of each Final Panel Comment. This information exchange ensured that the Final IEPR Report would accurately represent the Panel's assessment of the project, including any conflicting opinions. The Panel engaged in a thorough discussion of the overall positive and negative comments, added any missing issues of significant importance to the findings, and merged any related individual comments. At the conclusion of the teleconference, Battelle reviewed each Final Panel Comment with the Panel, including the associated level of significance, and confirmed the lead author for each comment.

A.4 Preparation of Final Panel Comments

Following the teleconference, Battelle distributed a summary memorandum for the Panel documenting each Final Panel Comment (organized by level of significance). The memorandum provided the following detailed guidance on the approach and format to be used to develop the Final Panel Comments for the Moose Creek Dam IEPR:

- Lead Responsibility: For each Final Panel Comment, one Panel member was identified as the lead author responsible for coordinating the development of the Final Panel Comment and submitting it to Battelle. Battelle modified lead assignments at the direction of the Panel. To assist each lead in the development of the Final Panel Comments, Battelle distributed a summary email detailing each draft final comment statement, an example Final Panel Comment following the four-part structure described below, and templates for the preparation of each Final Panel Comment.

- Directive to the Lead: Each lead was encouraged to communicate directly with the other panel member as needed and to contribute to a particular Final Panel Comment. If a significant comment was identified that was not covered by one of the original Final Panel Comments, the appropriate lead was instructed to draft a new Final Panel Comment.

- Format for Final Panel Comments: Each Final Panel Comment was presented as part of a four-part structure:

  1. Comment Statement (succinct summary statement of concern)
  2. Basis for Comment (details regarding the concern)
  3. Significance (high, medium/high, medium, medium/low, and low; see description below)
  4. Recommendation(s) for Resolution (see description below).

- Criteria for Significance: The following were used as criteria for assigning a significance level to each Final Panel Comment:

  1. **High:** There is a fundamental issue within study documents or data that will influence the technical or scientific basis for selection of, justification of, or ability to implement the recommended plan.

2. **Medium/High:** There is a fundamental issue within study documents or data that has a strong probability of influencing the technical or scientific basis for selection of, justification of, or ability to implement the recommended plan.
3. **Medium:** There is a fundamental issue within study documents or data that has a low probability of influencing the technical or scientific basis for selection of, justification of, or ability to implement the recommended plan.
4. **Medium/Low:** There is missing, incomplete, or inconsistent technical or scientific information that affects the clarity, understanding, or completeness of the study documents, and there is uncertainty whether the missing information will affect the selection of, justification of, or ability to implement the recommended plan.
5. **Low:** There is a minor technical or scientific discrepancy or inconsistency that affects the clarity, understanding, or completeness of the study documents but does not influence the selection of, justification of, or ability to implement the recommended plan.

- Guidelines for Developing Recommendations: The recommendation section was to include specific actions that USACE should consider to resolve the Final Panel Comment (e.g., suggestions on how and where to incorporate data into the analysis, how and where to address insufficiencies, areas where additional documentation is needed).

Battelle reviewed and edited the Final Panel Comments for clarity, consistency with the comment statement, and adherence to guidance on the Panel's overall charge, which included ensuring that there were no comments regarding either the appropriateness of the selected alternative or USACE policy. At the end of this process,12 Final Panel Comments were prepared and assembled. There was no direct communication between the Panel and USACE during the preparation of the Final Panel Comments. The full text of the Final Panel Comments is presented in Section 4.2 of the main report.

A.5 Conduct of the Public Comment Review

Battelle will complete the public comment review following the schedule in Table A-1. The public comment review for the IEPR panel members will take place after the Final IEPR Report (this document) has been submitted to USACE. Battelle will send the public comments to the panel members in addition to the following charge question:

1. Do the public comments raise any additional discipline-specific technical concerns with regard to the overall report?

A.6 Final IEPR Report

After concluding the review and preparation of the Final Panel Comments, Battelle prepared a final IEPR report (this document) on the overall IEPR process and the IEPR panel members' findings (this document). Each panel member and Battelle technical and editorial reviewers reviewed the IEPR report prior to submission to USACE for acceptance.

A.7 Comment Response Process

As part of Task 6, Battelle will enter the12 Final Panel Comments developed by the Panel into USACE's Design Review and Checking System (DrChecks), a Web-based software system for documenting and

sharing comments on reports and design documents, so that USACE can review and respond to them. USACE will provide responses (Evaluator Responses) to the Final Panel Comments, and the Panel will respond (BackCheck Responses) to the Evaluator Responses. All USACE and Panel responses will be documented by Battelle. Battelle will provide USACE and the Panel a pdf printout of all DrChecks entries, through comment closeout, as a final deliverable and record of the IEPR results.

APPENDIX B

Identification and Selection of IEPR Panel Members for the Moose Creek Dam Project

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B.1 Panel Identification

The candidates for the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR) (hereinafter: Moose Creek Dam IEPR) Panel were evaluated based on their technical expertise in the following key areas: Civil Works planning/economics, environmental biology, hydraulic and hydrology (H&H) engineering, geotechnical engineering, and civil engineering. These areas correspond to the technical content of the review documents and overall scope of the Moose Creek Dam project.

To identify candidate panel members, Battelle reviewed the credentials of the experts in Battelle's Peer Reviewer Database, sought recommendations from colleagues, contacted former panel members, and conducted targeted Internet searches. Battelle evaluated these candidate panel members in terms of their technical expertise and potential conflicts of interest (COIs). Of these candidates, Battelle chose the most qualified individuals, confirmed their interest and availability, and ultimately selected four experts for the final Panel. The remaining candidates were not proposed for a variety of reasons, including lack of availability, disclosed COIs, or lack of the precise technical expertise required.

Candidates were screened for the following potential exclusion criteria or conflicts of interest (COIs). These COI questions were intended to serve as a means of disclosure in order to better characterize a candidate's employment history and background. Battelle evaluated whether scientists in universities and consulting firms that are receiving USACE-funding have sufficient independence from USACE to be appropriate peer reviewers. Guidance in OMB (2004, p. 18) states,

> "…when a scientist is awarded a government research grant through an investigator-initiated, peer-reviewed competition, there generally should be no question as to that scientist's ability to offer independent scientific advice to the agency on other projects. This contrasts, for example, to a situation in which a scientist has a consulting or contractual arrangement with the agency or office sponsoring a peer review. Likewise, when the agency and a researcher work together (e.g., through a cooperative agreement) to design or implement a study, there is less independence from the agency. Furthermore, if a scientist has repeatedly served as a reviewer for the same agency, some may question whether that scientist is sufficiently independent from the agency to be employed as a peer reviewer on agency-sponsored projects."

Panel COI Screening Statements for the Moose Creek Dam IEPR	
1. Previous and/or current involvement by you or your firm in the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR) and related projects.	
2. Previous and/or current involvement by you or your firm in dam safety modification projects in Alaska, specifically in the Fairbanks.	
3. Previous and/or current involvement by you or your firm in the conceptual or actual design, construction, or operation and maintenance (O&M) of any projects in the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR) related projects.	
4. Current employment by the U.S. Army Corps of Engineers (USACE).	

Panel COI Screening Statements for the Moose Creek Dam IEPR	
5. Previous and/or current involvement with paid or unpaid expert testimony related to the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR).	
6. Previous and/or current employment or affiliation with the non-Federal sponsor (Fairbanks North Star Borough) or cooperating Federal, state, county, regional, and local agencies, environmental organizations, and interested groups *(for pay or pro bono).*	
7. Past, current, or future interests or involvements (financial or otherwise) by you, your spouse, or your children related to Alaska, specifically in the Fairbanks.	
8. Current personal involvement with other USACE projects, including whether involvement was to author any manuals or guidance documents for USACE. If yes, provide titles of documents or description of project, dates, and location (USACE district, division, Headquarters, Engineer Research and Development Center [ERDC], etc.), and position/role. Please highlight and discuss in greater detail any projects that are specifically with the Alaska District.	
9. Previous or current involvement with the development or testing of specific models that will be used for, or in support of, the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR) project.	
10. Current firm involvement with other USACE projects, specifically those projects/contracts that are with the Alaska District. If yes, provide title/description, dates, and location (USACE district, division, Headquarters, ERDC, etc.), and position/role. Please also clearly delineate the percentage of work you personally are currently conducting for the Alaska District. Please explain.	
11. Any previous employment by USACE as a direct employee, notably if employment was with the Alaska District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.	
12. Any previous employment by USACE as a contractor (either as an individual or through your firm) within the last 10 years, notably if those projects/contracts are with the Alaska District. If yes, provide title/description, dates employed, and place of employment (district, division, Headquarters, ERDC, etc.), and position/role.	
13. Previous experience conducting technical peer reviews. If yes, please highlight and discuss any technical reviews concerning dam safety modifications, and include the client/agency and duration of review (approximate dates).	

Panel COI Screening Statements for the Moose Creek Dam IEPR	
14. Pending, current, or future financial interests in the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR) related contracts/awards from USACE.	
15. Significant portion of your personal or office's revenues within the last three years came from USACE contracts.	
16. Significant portion of your personal or office's revenues within the last three years came from non-Federal sponsor (Fairbanks North Star Borough), cooperating agencies contracts.	
17. Any publicly documented statement (including, for example, advocating for or discouraging against) related to the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR).	
18. Participation in relevant prior and/or current Federal studies relevant to this project and/or the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR).	
19. Previous and/or current participation in prior non-Federal studies relevant to this project and/or the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR).	
20. Has your research or analysis been evaluated as part of the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR)?	
21. Is there any past, present, or future activity, relationship, or interest (financial or otherwise) that could make it appear that you would be unable to provide unbiased services on this project? If so, please describe.	

Providing a positive response to a COI screening question did not automatically preclude a candidate from serving on the Panel. For example, participation in previous USACE technical peer review committees and other technical review panel experience was included as a COI screening question. A positive response to this question could be considered a benefit. The term "firm" in a screening question referred to any joint venture in which a firm was involved. It applied to whether that firm serves as a prime or as a subcontractor to a prime. Candidates were asked to clarify the relationship in the screening questions.

B.2 Panel Selection

In selecting the final members of the Panel, Battelle chose experts who best fit the expertise areas and had no COIs. Table B-1 provides information on each panel member's affiliation, location, education, and overall years of experience. One panel member held a dual role serving as both the geotechnical engineer and the civil engineer expert. One of the four final reviewers is an independent consultant, while the other three were affiliated with a consulting company. Battelle established subcontracts with the panel members when they indicated their willingness to participate and confirmed the absence of COIs through

a signed COI form. USACE was given the list of candidate panel members, but Battelle selected the final Panel.

Table B-1. Moose Creek Dam IEPR Panel: Summary of Panel Members

Name	Affiliation	Location	Education	P.E.	Exp. (yrs)
Civil Works Planning/Economist					
Marvin Feldman	Resources Decisions	Captain Cook, HI	Ph.D., Natural Resource Economics	NA	37
Environmental Biologist					
Judith Dudley	Independent consultant	Bellingham, WA	Ph.D., Biology (ecosystems ecology)	N/A	32
Hydrology and Hydraulics Engineering					
Christopher Philips	Riverbend Engineering	Albuquerque, NM	M.S., Civil Engineering	Yes	30
Geotechnical/Civil Engineering (Dual Role)					
Michael Hartley	PND Engineers, Inc.	Seattle, WA	M.S., Civil/Geotechnical Engineering	Yes	39

Table B-2 presents an overview of the credentials of the four members of the Panel and their qualifications in relation to the technical evaluation criteria. More detailed biographical information regarding each panel member and his or her area of technical expertise is given in Section B.3.

Table B-2. Moose Creek Dam IEPR Panel: Technical Criteria and Areas of Expertise

Technical Criterion	Feldman	Dudley	Philips	Hartley
Civil Works Planner/Economist				
Minimum 10 years of demonstrated experience in public works planning	X			
Very familiar with USACE plan formulation process, procedures, and standards	X			
Familiar with evaluation of alternative plans for Dam Safety Modification Studies	X			
Familiar with USACE standards and procedures	X			

Technical Criterion	Feldman	Dudley	Philips	Hartley
Experience related to evaluating traditional Civil Works plan benefits associated with Dam Safety Modification Studies, to include experience in USACE methodologies for determining the cost effectiveness of alternatives evaluations	X			
Environmental Biologist				
At least 10 years of experience directly related to environmental evaluation or review		X		
Minimum M.S. degree or higher in a related field		X		
Extensive knowledge of the following: estuarine ecology, salmonid biology (spawning, rearing, freshwater migration), wetlands, riparian habitats, riverine systems, and process-based restoration		X		
Demonstrated experience working with National Environmental Policy Act (NEPA) impact assessments, including cumulative effects analyses, for complex ecosystem projects with competing trade-offs is highly desirable		X		
Hydrology and Hydraulic Engineering				
Registered Professional Engineer			X	
Minimum 15 years of experience in hydrologic and hydraulic engineering			X	
Experienced with all aspects of hydrology and hydraulic engineering including: northwest hydrology, urban hydrology and hydraulics, open channel systems, effects of management practices and low impact development on hydrology, design of earthen dams and detention ponds, use of non-structural systems as they apply to flood proofing, warning systems, and evacuation			X	
Familiar with Hydraulic Engineering Center (HEC) modeling computer software, or equivalent commercial software, including HEC River Analysis System (RAS) and HEC Hydrologic Modeling System (HMS)			X	
Specialized experience in river engineering, sediment transport, and familiarity with rivers with water control structures and dredging project			X	
Geotechnical Engineering				
Senior-level geotechnical engineer with extensive experience, a minimum of 15 years, in the field of geotechnical engineering related to the analysis, design, and construction of embankment dams and levees, including rehabilitations of these structures				X
Knowledge and experience in the evaluation of backward erosion piping (BEP) potential failure modes in the foundations of embankment dams and/or levees, and in the development, design, and construction of remediation alternatives for correcting BEP issues				X

Technical Criterion	Feldman	Dudley	Philips	Hartley
Experience in failure mode analysis, risk assessment of embankment dams and/or levees, evaluation of risk reduction measures for dam safety assurance projects, and familiarity with the USACE dam safety guidance				X
Working knowledge of all applicable USACE design criteria				X
Licensed Professional Engineer				X
Civil Engineering				
Registered Professional Engineer				X
Minimum of 10 years of experience in civil engineering with a minimum M.S. degree in engineering				X
Demonstrated experience in developing construction costs, construction methods, sequencing and schedules (e.g., relevant experience includes design and construction of dams, levees, channel construction, and road removal/relocation)				X

B.3 Panel Member Qualifications

Detailed biographical information on each panel members' credentials and qualifications and areas of technical expertise are summarized in the following paragraphs.

Name	*Role*	*Affiliation*
Marvin Feldman, Ph.D.	**Civil Works Planning/ Economist**	**Resource Decisions**

Dr. Feldman, an independent consultant and principal economist at Resource Decisions, has more than 37 years of experience in water resource and environmental economics. He earned his M.S. in water resource management in 1969 and a Ph.D. in natural resource economics in 1979 from the University of Wisconsin.

Dr. Feldman is experienced in the evaluation and conduct of complex, multi-objective public works projects with high public and interagency interests, including flood risk analysis and dam safety studies. As a senior economist at Dames & Moore, under contract to the U.S. Department of Energy, he worked on developing a multi-attributable site selection model for evaluating risks of alternative sites for the Preliminary Nevada High-level Nuclear Waste Siting Analysis. For the Smith Lake Improvement and Stakeholder Association (SLISA), Alabama, he provided economic evaluation of alternative costs and benefits of municipal and industrial, navigation, recreation, and hydroelectric water uses and non-power evaluations for recreation, property values flood control, navigation, and erosion control to support SLISA's negotiations with the Federal Energy Regulatory Commission and Alabama Power. For the Alaska Department of Natural Resources, he applied risk/cost/benefit analysis to environmental protection methods for petroleum exploration in the Beaufort Sea. He recently performed an analysis of the Civil Works costs and benefits of a dam on Reynolds Creek for the Alaska Power and Telephone Company.

He is familiar with the evaluation of alternative plans for Dam Safety Modification Studies. His participation in the selection of alternatives for the USACE/Bureau of Reclamation Central Arizona Water Control Study (discussed below) was ultimately determined by the USACE Safety of Dams evaluation. He has experience related to evaluating traditional Civil Works plan benefits associated with Dam Safety Modification Studies, which includes using USACE methodologies to determine the cost effectiveness of alternatives evaluations. Dr. Feldman is familiar with the USACE plan formulation process, procedures, and standards as they relate to flood risk management and has experience dealing directly with the USACE Six-Step Planning Process, governed by ER 1105-2-100, Planning Guidance Notebook. Most notably, he applied the Six-Step Process to his work on the USACE/Bureau of Reclamation Central Arizona Water Control Study.

In addition, Dr. Feldman's has experience related to the economic evaluation of traditional National Economic Development (NED) plans, including as part of the University of Wisconsin test team that helped develop the original U.S. Water Resources Council (USWRC) Principles and Guidelines. In conjunction with the USACE/Bureau of Reclamation Central Arizona Water Control Study, he designed a multi-attribute utility analysis framework for selecting preferred alternatives. This framework included flood risk management and National Ecosystem Restoration (NER) attributes and structured the tradeoffs among hundreds of alternative plans with regard to these and other attributes. The framework used portfolio analysis to optimize benefits, subject to the specification of minimum and maximum acceptable

attribute values. Identification of attributes and the importance of weighting these attributes was a key aspect of the public involvement program. By focusing the public involvement on NER and flood control, as well as other key attributes, the plan selection process was more cooperative and less competitive. While working at USACE Sacramento District, he developed and applied a methodology for the cost effectiveness/incremental cost analysis (CE/ICA) of alternative mitigation measures to enhance the habitat of the endangered winter-run salmon on the Sacramento River.

Dr. Feldman has a strong working knowledge of USACE economic benefit calculations. Throughout his career, he has conducted studies requiring economic benefit analysis for flood risk management. For example, he evaluated the state-of-the-art municipal and industrial water conservation benefit evaluation techniques for the California Urban Water Conservation Council (CUWCC), and identified promising methods for application by CUWCC member water agencies in evaluating their conservation options. His advanced expertise and extensive experience in flood damage analysis and risk and decision analysis is reflected in his work on such studies as the Smith Lake-Black Warrior River (Alabama) benefit-cost analysis of lake levels, studies of cost-benefit tradeoffs for the North Fork of the Feather River (Pacific Gas and Electric, California), and an economic analysis of agricultural diversion alternatives for the Glenn-Colusa Irrigation District (California).

Dr. Feldman is also familiar with methodologies for estimating damages, including the Hydrologic Engineering Center's Flood Damage Reduction Analysis (HEC-FDA) software. His familiarity with HEC-FDA includes his knowledge of inputs, assumptions, calculations, and results attributed to the program. Other studies requiring the assessment of risk and damage included the aforementioned Preliminary Nevada High-level Nuclear Waste Siting and the SLISA studies. Dr. Feldman has participated on a previous USACE IEPR (model certification review) panel as an economics expert for the Institute of Water Resources (IWR) Planning Suite Model II Review.

Name	*Role*	*Affiliation*
Judith Dudley, Ph.D.	**Environmental Biologist**	**Independent consultant**

Dr. Dudley is an independent consultant specializing in environmental impact analysis, ecological risk assessment, aquatic ecology, and water quality assessments. She has more than 24 years of experience directly related to environmental evaluation or review. She earned her M.S. in biological sciences (aquatic ecology) from the University of Pittsburgh in 1983, and a Ph.D. in ecosystem ecology from Boston University in 1991. She is a Certified Lake Manager per standards set by the North American Lake Management Society, and has more than 32 years of experience in field surveys, soil/sediment/water analyses, bioassays, biological community surveys, bioaccumulation modeling, nutrient modeling and best management practice (BMP) evaluation, artificial stream studies, data analysis, and coordinating data collection by volunteers.

Dr. Dudley has extensive knowledge of estuarine ecology, salmonid biology (spawning, rearing, freshwater migration), wetlands, riparian habitats, riverine systems, and process-based restoration. This can be demonstrated by her work on NCASI's Long Term Receiving Water studies, which included multiple rivers with important salmonid populations, as well as her successful record of completing Endangered Species Act Section 7 consultations at numerous habitat restoration project sites in western

Washington, all of which considered impacts on salmon, and which included estuarine, riverine and stream habitats.

In addition, Dr. Dudley has extensive experience working in the North. For example, she managed the ecological risk assessment at an abandoned cinnabar mine site in central Alaska on land owned by the BLM. ADEC protocols were used in the assessment, including preparation of an Ecoscoping Form, preparation of a Conceptual Site Model, selection of receptors for the appropriate ecoregion as defined in ADEC guidance, applying ADEC's screening levels, etc. She worked on environmental baseline studies for three separate mine permitting projects in British Columbia and was responsible for data management and reporting on potential impacts on aquatic communities. She is a CABIN Project Manager per Environment Canada's certification process. And she has recently completed two successful permitting efforts for mineral exploration programs in the Northwest Territories, both of which required her to complete impact analysis and impact mitigation documentation.

Dr. Dudley has contributed to permitting efforts with myriad state and Federal agencies on issues ranging from NEPA compliance, to Clean Water Act permits and compliance studies, to Endangered Species Act consultations. She is experienced in conducting NEPA impact assessments, including cumulative effects analysis and she has provided senior technical support and management on NEPA projects for many Federal agencies, including USACE. Notable studies include an environmental assessment (EA) for a City of Temple Terrace, Florida redevelopment site; multiple EAs and categorical exclusions for the Federal Aviation Administration in Virginia; multiple EAs for the Veterans Administration at sites in California, Florida, Washington, Oregon, and EAs at various USACE sites in Washington state. Dr. Dudley has coauthored several publications and given numerous presentations at conferences and international meetings.

She also has demonstrated experience working on NEPA impact assessments, including cumulative effects analyses, for complex ecosystem projects with competing trade-offs. An example of this is a Master Plan and associated NEPA EA that she completed for a U.S. Air Force research facility. The project included watershed and stormwater modeling for future expansion and protection of Tom's Creek with the Federally endangered Okaloosa Darter, wetland delineations, rare species assessments, erosion evaluation, and environmental considerations for the expanded operational procedures anticipated with expansion of the research complex. Long-term sustainability planning included an evaluation of existing and future stormwater drainage needs, stormwater quantity and quality modeling, anticipated waste streams and pollution prevention analyses, water reuse and conservation assessment, and energy conservation planning for existing and future building HVAC systems and central utilities upgrades. Dr. Dudley prepared the NEPA-compliant EA and provided task management and senior technical review of the Master Plan and associated technical appendices. She has served on an Independent External Peer Review Panel for USACE as a subcontractor to Battelle to review the Kansas Citys, Missouri and Kansas, Section 216 Flood Risk Management Project Phase 2 Feasibility Report. Her particular responsibility was to evaluate the Environmental Impact Assessment process.

Name	*Role*	*Affiliation*
Christopher Philips, P.E., CFM	**Hydrology and Hydraulics Engineering**	**Riverbend Engineering**

Mr. Philips is the owner and senior engineer at Riverbend Engineering in Albuquerque, New Mexico. He earned his M.S. in civil engineering, with a specialty in water resources, in 1996 from the University of New Mexico. He is a registered professional engineer in New Mexico, Colorado, and Texas; a certified floodplain manager in New Mexico; and Natural Resources Conservation Service (NRCS) Technical Services Provider in New Mexico and Colorado. He has 30 years of experience in hydrologic and hydraulic (H&H) engineering, with an emphasis on large public works projects associated with ecosystem restoration and natural channel design. He has designed more than 60 river restoration, fish habitat, and fish passage/barrier projects, most of which were based on natural channel design methods. His design work has included all types of flood conveyance systems: closed conduit and open channel, with and without detention facilities, energy dissipaters, weirs, and side-channel spillways. He also designed more than 50 irrigation diversion structures on rivers.

He is also experienced with all aspects of hydrology and hydraulic engineering, including urban hydrology and hydraulics, open channel flood control channels, effects of management practices and low impact development on hydrology, design of earthen dams and detention ponds, use of non-structural systems as they apply to flood proofing and warning systems. Mr. Philips' H&H project experience covers a wide range of geographic areas, including mountain terrain in Colorado, river systems in Washington state, flood control works in Texas, and extensive experience in New Mexico with desert landscape flash flood modeling.

Mr. Philips is very familiar with the USACE's suite of hydrologic and hydraulic computer models, including HEC-RAS 5.0, HEC-HMS, and with traditional versions of HEC-1, HEC-2, and HEC-6. Mr. Philips' specific hydraulic modeling experience includes hydraulic design of two Flood Control channels in Alamogordo, New Mexico for the USACE Albuquerque District; the Rio Fernando in Taos, New Mexico; the San Juan River in Pagosa Springs and Farmington, New Mexico; the Animas River in Aztec, New Mexico; the Rio Grande in Alamosa, Colorado; the Uncompahgre River in Ridgway, Colorado; the Pecos River near Pecos, New Mexico; the Santa Fe River in Santa Fe, New Mexico; and numerous ephemeral arroyo systems in the greater Albuquerque metropolitan area. Additionally, he has experience with physical modeling of complex hydraulic structures in large river systems. Mr. Philips has conducted sedimentation studies at the reach level and at the watershed level, including long-term sediment accumulation studies in four reservoirs within the Zuni river watershed.

Mr. Philips' firm, Riverbend Engineering, has its own in-house laboratory for physical hydraulic modeling of river systems (fixed boundary). They have combined physical model studies with numeric modeling on five different river systems in New Mexico and Colorado. Mr. Philips actively participates in professional societies, including the American Society of Civil Engineers, the American Water Resources Association, the New Mexico Floodplain Managers Association, and the New Mexico Dam Owners Coalition.

Name	*Role*	*Affiliation*
Michael Hartley, P.E.	**Geotechnical/Civil Engineering (Dual Role)**	**PND Engineers, Inc.**

Mr. Hartley is a past senior vice president of PND Engineers, Inc. and currently provides consulting services as a senior geotechnical engineer through PND. He earned his M.S. in civil/geotechnical engineering in 1979 from Oregon State University and is a registered professional engineer in the states of Alaska, Washington, and Oregon. He has 39 years of experience providing civil, coastal, and geotechnical engineering services for projects throughout the United States and overseas. His geotechnical engineering experience includes the studies and design for marine infrastructure, levees, dams, buildings, roads, trails, bridges, breakwaters, and dredging projects. He is also recognized in the Federal court system as an expert in civil, coastal, and geotechnical engineering. Mr. Hartley is knowledgeable and experienced in the analysis, design, and construction of embankment dams and levees, including rehabilitations of these structures. Since 1979 he has been active in the evaluation of seepage and piping potential failure modes in the foundations of embankment dams and levees. He has knowledge and experience in the evaluation of backward erosion piping (BEP) potential failure modes in the foundations of embankment dams and/or levees, and in the development, design, and construction of remediation alternatives for correcting BEP issues. Studies have involved intermediate and high head earthfill dams, levees, and impoundments for roads. He has performed many dam safety inspections for cities, counties and boroughs meeting the requirements of Federal Energy Regulatory Commission (FERC) and the State of Alaska Dam Safety Division of Department of Natural Resources requirements in Alaska and Department of Ecology requirements in Washington state. He has also performed dam design or rehabilitation assessment for concrete gravity, concrete arch, and earthfill dams and levees. This has included many challenging projects such as the design of a 1,000-foot-long, 30-foot head earthfill dam constructed at temperatures down to -30 degrees Fahrenheit.

He is the Senior Geotechnical Engineer responsible for quality assurance oversight and training of personnel in flow net, seepage, and piping analysis at PND and provides training to other geotechnical engineers at PND in dam safety evaluation. He recently assisted in QA analysis for piping and seepage analysis of three football-size cofferdams constructed in New Orleans for the Permanent Canal Closures and Pumps project. He has also recently conducted Backward Erosion Piping (BEP) peer reviews for Zoar Levee and for Dover Dam both conducted for Huntington District.

Mr. Hartley is experienced in the development, design, and construction of remediation alternatives for correcting seepage and piping issues and has evaluated various dam and levee structures for remediation using hydromax panels, clay cores, sheetpile, and other techniques to mitigate piping and seepage issues. He has served on numerous panels as a geotechnical engineer expert involving large high-head dams, performing peer review of proposed seepage corrections. Relevant design modifications include Campbell Lake Dam safety studies and design of rehabilitation measures using sheetpile. He is experienced in both failure mode analysis and risk assessment of embankment dams and using risk-based procedures, most recently having reviewed the risk assessment for levees in Mt. Vernon and Burlington. He evaluated the procedures used by two separate geotechnical firms for levee stability assessments as part of the USACE Skagit River, Washington IEPR.

Mr. Hartley has experience in the evaluation of risk reduction measures for dam safety assurance projects, reflected in his efforts in support of USACE IEPR dam safety assurance projects for the Dover, Bluestone, and Bolivar Dams, as well as other construction-phase review services. He has testified in

Federal court on risk-based assessment analysis and is very familiar with probabilistic methods of geotechnical assessment of levees, recently performing an IEPR review for the Skagit river levee system in Washington state. Other relevant projects include Sherwood Estates Dam, Squaw Harbor Dam, Lyon Lake Dam, Upper Petersburg Creek Dam, Cabin Creek Dam, Campbell Lake Dam, Valdez Creek Dam, and levee assessment for Skagit County. He is very familiar with USACE dam safety guidance and has used USACE publications in the design, risk-based assessment, and review of flood control dam and levee reviews. For example, he has worked on previous USACE peer reviews and the current cofferdam design for the permanent canal closures project for USACE New Orleans District. He is also familiar with all applicable USACE design criteria and USACE engineering manuals, and has used these in the design of projects and in the peer review of designs by others. Examples include the West Bank Levee designs peer review for WBV 12, 14f.2, and 18 levees, and the geotechnical design analysis for the PCCP cofferdams in New Orleans.

Mr. Hartley has demonstrated experience in developing construction costs, construction methods, sequencing, and schedules (e.g., relevant experience includes design and construction of dams, levees, channel construction, and road removal/relocation). For example, Mr. Hartley provided road design for the DeLong Mountain Regional Transportation System with over 50 miles of road in ice-rich to massive permafrost. He worked closely with Mr. Henry Springer and Mr. Jim Lane from Alaska DOT/PF in development of construction costs, construction methods, construction sequencing, and scheduling for this $50 million project. This work also included recommended quarry road removals and quarry closure plans. Mr. Hartley also provided assessment of the tailings dam seepage of contaminated materials into nearby creeks and assessment of heat syphons to control seepage underneath the earthfill dam. Mr. Hartley has also worked on road design, road decommissioning, and fish passage structure design at hundreds of sites in Washington, Oregon, California and Alaska as part of many indefinite delivery contracts. He has also worked on many road design projects for Alaska DOT/PF, including over 50 miles of design for the Dalton Highway and location studies of over 800 miles of route for the Pebble Copper project in Alaska.

APPENDIX C

Final Charge for the Moose Creek Dam IEPR

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Charge Questions and Guidance to the Panel Members for the Independent External Peer Review (IEPR) of the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR)

This is the final Charge to the Panel for this IEPR. This final Charge was submitted to USACE as part of the final Work Plan, originally submitted on July 24, 2017.

BACKGROUND

Moose Creek Dam, the main component of the Chena River Lakes Flood Control Project, is located 17 miles east of Fairbanks, Alaska, near the town of North Pole. Moose Creek Dam is an earthfill structure approximately 7.5 miles long that functions as a dry dam and provides flood control for the downstream communities of North Pole, Fairbanks, and Fort Wainwright, Alaska. Construction was initiated in 1973 and completed in 1979, although the dam did not retain floodwaters until 1981. The pool of record, equivalent to a 40-year design storm, occurred in 1992.

In 2009, Moose Creek Dam was evaluated by a Screening Portfolio Risk Assessment Cadre and ultimately given a Dam Safety Action Classification (DSAC) of I (Urgent and Compelling). The DSAC I rating was primarily due to seepage and piping in the foundation. The other identified failure modes were control works stability under seismic loading and foundation liquefaction under seismic loading. In addition, the structure has only been loaded to a 40-year event. The Interim Risk Reduction Measures Plan (IRRMP) was approved in November 2009.

A Baseline Risk Assessment was prepared and submitted to the Dam Senior Oversight Group (DSOG) in January 2014. The Baseline Risk Assessment Risk Cadre identified three significant potential failure modes that were believed to be the primary risk drivers.

1. Backward erosion and piping with vertical exit (heave) adjacent to permafrost zones below the downstream stability blanket.
2. Backward erosion and piping with horizontal exit in the South Seepage Collection channel or old Chena Channel.
3. Scour along the base of the silty core from high flows through layers of open-work gravel with horizontal exit in the South Seepage Collection Channel or old Chena Channel.

The potential failure modes were best correlated by performance and site conditions to locations near the central embankment area near the low-point drainage structure. The risk assessment concluded that the boils observed during the high-water events were limited to movement of the natural silt blanket and that the exit gradients were insufficient to begin backward erosion and piping of the sand and gravel foundation matrix.

The DSOG recharacterized the Moose Creek Dam as a DSAC III in May 2014 and directed the completion of a Dam Safety Modification Study (DSMS). Based on the information presented in the Risk Assessment Report and briefing, the DSOG was concerned that the Risk Cadre did not adequately address potential failure modes that may exist due to the discrete boring locations along a highly variable, 45,000-foot-long alluvial foundation. The DSOG believes the silt and finer sand layers may potentially be more extensive than the foundation data portrayed. Therefore, the risk assessment may have significantly underestimated the probability that failure could progress through the foundation from backward erosion and piping failure modes.

The DSOG concluded that the total incremental risk posed by the dam under all loading cases was most likely higher than presented in the risk assessment report due to the difficulties in characterizing data uncertainties and unknowns and grouping them into representative sections that can be quantitatively analyzed. However, the

DSOG also acknowledged that additional data collection, analysis, or elicitation was unlikely to reduce the high degree of uncertainty. Therefore, the DSOG accepted the risk assessment in its current form with an understanding that the risks presented to DSOG likely underestimated the risk for internal erosion in the foundation due to a potential flaw near the embankment-foundation contact.

The U.S. Army Corps of Engineers-Headquarters (USACEHQ) Dam Safety Officer subsequently approved the change to DSAC III, with instructions to the Alaska District to perform a DSMS and to make other related changes. The Cadre was directed to re-evaluate risks posed by failure modes in the foundation as part of the DSMS based on concerns that the project risk was underestimated by the Baseline Risk Assessment due to the unusual length of the dam and difficulty in characterizing foundation uncertainties and unknowns.

The Moose Creek, Alaska, DSMR has been developed to reflect USACE's modernized planning initiative, in which project studies use a risk-informed assessment, generally with only enough detail developed for each alternative to allow relative comparison, to determine the appropriate information to identify a Tentatively Selected Plan (TSP).

For Dam Safety Modification Studies, independent external peer review (IEPR) occurs after DSOG approves the TSP and releases the National Environmental Policy Act (NEPA) document for public review. To help explain the results of the risk-informed assessment and alternative evaluation, a risk register and other risk management documentation will generally accompany the DSMR main report and appendices. A primary objective of IEPR is to evaluate whether adequate information was available and appropriate technical analyses were completed to support selection of a TSP within the context of the risk-informed decision-making process.

OBJECTIVES

The objective of this work is to conduct an IEPR of the Moose Creek Dam, Alaska, Dam Safety Modification Report (DSMR) (hereinafter: Moose Creek Dam IEPR) in accordance with the Department of the Army, U.S. Army Corps of Engineers (USACE), Water Resources Policies and Authorities' *Civil Works Review* (Engineer Circular [EC] 1165-2-214, dated December 15, 2012), and the Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (December 16, 2004). Peer review is one of the important procedures used to ensure that the quality of published information meets the standards of the scientific and technical community. Peer review typically evaluates the clarity of the hypotheses, validity of the research design, quality of data collection procedures, robustness of the methods employed, appropriateness of the methods for the hypotheses being tested, extent to which the conclusions follow from the analysis, and strengths and limitations of the overall product.

The purpose of the IEPR is to assess the "adequacy and acceptability of the economic, engineering, and environmental methods, models, and analyses used" (EC 1165-2-214; p. D-4) for the decision documents. The IEPR will be limited to technical review and will not involve policy review. The IEPR will be conducted by subject matter experts (i.e., IEPR panel members) who meet the technical criteria and areas of expertise required for and relevant to the project.

The Panel will be "charged" with responding to specific technical questions as well as providing a broad technical evaluation of the overall project. Per EC 1165-2-214, Appendix D, review panels should identify,

explain, and comment upon assumptions that underlie all the analyses, as well as evaluate the soundness of models, surveys, investigations, and methods. Review panels should be able to evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable. Reviews should focus on assumptions, data, methods, and models. The panel members may offer their opinions as to whether there are sufficient analyses upon which to base a recommendation.

DOCUMENTS PROVIDED

The following is a list of documents, supporting information, and reference materials that will be provided for the review.

Documents for Review

The following is a list of documents, supporting information, and reference materials that will be provided for the review.

Review Documents	Subject Matter Experts				
	No. of Review Pages	Civil Works Planning/ Economics	Environmental Biologist	Hydrology and Hydraulics Engineering	Geotechnical/ Civil Engineering (Dual Role)
DSMR Main Report	161	161	161	161	161
Appendix A: Decision Support Documents for Moose Creek Dam	350	350		350	350
Appendix B: Risk Management Plans Risk Assessment	413	413	413	413	413
Appendix C: Screened Measures, Alternatives and F Plans	103	103			
Appendix D: Drawings and Design Information for F Plans	103			103	103
Appendix E: Environmental Assessment	63		63		
Appendix F: Cost Estimates	62	62			62
Appendix G: Reviews	297	297	297	297	297
Public Review Comments*	50	50	50	50	50
Total # of Pages to be Reviewed	**1,602**	**1,436**	**984**	**1,374**	**1,436**
Supplemental Document					
Baseline Risk Assessment (includes Site Characterization Report Appendix)**	485	485	485	485	485
Reference Documents					
Abbreviated Risk Register**	10	10	10	10	10
Total # of Reference Documents	**10**	**10**	**10**	**10**	**10**

* Page count for public comments is approximate. USACE will submit public comments to Battelle, which will in turn submit them to the IEPR Panel.

** Supporting documentation only. These documents are not for Panel review and should be used as information sources only. They are not included in the total page count.

Documents for Reference

- USACE guidance *Civil Works Review,* (EC 1165-2-214, December 15, 2012)
- Office of Management and Budget's *Final Information Quality Bulletin for Peer Review* (December 16, 2004)
- ER 1110-2-1156, Engineering and Design - Safety of Dams - Policy and Procedures, 31 March 2014
- USACE Climate Change Adaptation Plan (June 2014)
- ETL 1100-2-1 – Procedures to Evaluate SLR Change Impacts Responses Adaptation
- ER 1100-2-8162 – Incorporating SLR Change in CW Programs

SCHEDULE

This schedule is based on the receipt of the final review documents. Note that dates presented in the schedule below also could change due to panel member and USACE availability.

Task	Action	Due Date
2	Battelle requests input from USACE on the conflict of interest (COI) questionnaire	7/13/2017
	USACE provides comments on COI questionnaire	7/18/2017
	Battelle submits list of selected panel members*	7/27/2017
	USACE confirms the panel members have no COI	8/1/2017
	Battelle completes subcontracts for panel members	8/8/2017
	Subcontractors complete mandatory Operations Security (OPSEC) training	9/7/2017
3	Battelle convenes kick-off meeting with USACE	7/13/2017
	Battelle sends review documents to panel members	8/8/2017
	Battelle convenes kick-off meeting with panel members	8/8/2017
	Battelle convenes kick-off meeting and site visit with USACE and panel members	8/21/2017
	Battelle convenes mid-review teleconference for panel members to ask clarifying questions of USACE	8/30/2017
	Battelle participates in the Senior Oversight Group (SOG) Meeting	TBD
4	Panel members complete their review of the documents	9/14/2017
	Battelle provides talking points to panel members for Panel Review Teleconference	9/18/2017
	Battelle convenes Panel Review Teleconference	9/19/2017
	Battelle provides Final Panel Comment templates and instructions to panel members	9/20/2017
	Panel members provide draft Final Panel Comments to Battelle	9/28/2017
	Battelle provides feedback to panel members on draft Final Panel Comments; panel members revise Final Panel Comments	9/29/2017 - 10/09/2017
	Panel finalizes Final Panel Comments	10/10/2017
4	Battelle receives public comments from USACE	4/30/2018

Task	Action	Due Date
	Battelle sends public comments to Panel	5/1/2018
	Panel members complete their review of the public comments	5/8/2018
	Battelle and Panel review Panel's responses to public comments	5/9/2018
	Panel drafts Final Panel Comment on public comments, if necessary	5/11/2018
	Panel finalizes Final Panel Comment regarding public comments, if necessary	5/15/2018
5	Battelle provides Final IEPR Report to panel members for review	10/12/2017
	Panel members provide comments on Final IEPR Report	10/13/2017
	Battelle submits Final IEPR Report to USACE*	**10/17/2017**
	USACE Risk Management Center (RMC) provides decision on Final IEPR Report acceptance	10/24/2017
5	Battelle provides Addendum to Final IEPR Report to panel members for review	5/17/2018
	Panel members provide comments on Addendum to Final IEPR Report	5/21/2018
	Battelle submits Addendum to Final IEPR Report to USACE*	5/23/2018
	USACE Risk Management Center (RMC) provides decision on Addendum to Final IEPR Report acceptance	**5/31/2018**
6	Battelle inputs Final Panel Comments to Design Review and Checking System (DrChecks) and provides Final Panel Comment response template to USACE	10/26/2017
	Battelle convenes teleconference with USACE to review Comment Response process	10/26/2017
	Battelle convenes teleconference with Panel to review Comment Response process	10/26/2017
	USACE Project Delivery Team (PDT) provides draft Evaluator Responses to USACE RMC for review	11/13/2017
	USACE RMC reviews draft Evaluator Responses and works with USACE PDT regarding clarifications to responses, if needed	11/20/2017
	USACE RMC provides draft PDT Evaluator Responses to Battelle	11/20/2017
	Battelle provides draft PDT Evaluator Responses to panel members	11/22/2017
	Panel members provide draft BackCheck Responses to Battelle	11/29/2017
	Battelle convenes teleconference with panel members to discuss draft BackCheck Responses	11/30/2017
	Battelle convenes Comment Response Teleconference with panel members and USACE	12/1/2017
	USACE inputs final PDT Evaluator Responses to DrChecks	12/8/2017
	Battelle provides final PDT Evaluator Responses to panel members	12/11/2017
	Panel members provide final BackCheck Responses to Battelle	12/14/2017
	Battelle inputs the panel members' final BackCheck Responses to DrChecks	12/15/2017
	Battelle submits pdf printout of DrChecks project file*	12/18/2017
	Contract End/Delivery Date	8/31/2018

* Indicates deliverables.

CHARGE FOR PEER REVIEW

Members of this IEPR Panel are asked to determine whether the technical approach and scientific rationale presented in the decision documents are credible and whether the conclusions are valid. The Panel is asked to determine whether the technical work is adequate, competently performed, and properly documented; satisfies established quality requirements; and yields scientifically credible conclusions. The Panel is being asked to provide feedback on the economic, engineering, environmental resources, and plan formulation. The panel members are not being asked whether they would have conducted the work in a similar manner.

Specific questions for the Panel (by report section or appendix) are included in the general charge guidance, which is provided below.

General Charge Guidance

Please answer the scientific and technical questions listed below and conduct a broad overview of the decision documents. Please focus your review on the review materials assigned to your discipline/area of expertise and technical knowledge. Even though there are some sections with no questions associated with them, that does not mean that you cannot comment on them. Please feel free to make any relevant and appropriate comment on any of the sections and appendices you were asked to review. In addition, please note that the Panel will be asked to provide an overall statement related to 2 and 3 below per USACE guidance (EC 1165-2-214; Appendix D).

1. Your response to the charge questions should not be limited to a “yes” or “no.” Please provide complete answers to fully explain your response.
2. Assess the adequacy and acceptability of the economic and environmental assumptions and projections, project evaluation data, and any biological opinions of the project study.
3. Assess the adequacy and acceptability of the economic analyses, environmental analyses, engineering analyses, formulation of alternative plans, methods for integrating risk and uncertainty, and models used in evaluating economic or environmental impacts of the proposed project.
4. If appropriate, offer opinions as to whether there are sufficient analyses upon which to base a recommendation.
5. Identify, explain, and comment upon assumptions that underlie all the analyses, as well as evaluate the soundness of models, surveys, investigations, and methods.
6. Evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable.
7. Please focus the review on assumptions, data, methods, and models.

Please **do not** make recommendations on whether a particular alternative should be implemented, or whether you would have conducted the work in a similar manner. Also, please **do not** comment on or make recommendations on policy issues and decision making. Comments should be provided based on your professional judgment, **not** the legality of the document.

1. If desired, panel members can contact one another. However, panel members **should not** contact anyone who is or was involved in the project, prepared the subject documents, or was part of the USACE Agency Technical Review (ATR).

2. Please contact the Battelle Project Manager (Project Manager; tenzarj@battelle.org) or Program Manager (Rachel Sell; sellr@battelle.org) for requests or additional information.

3. In case of media contact, notify the Battelle Program Manager, Rachel Sell (sellr@battelle.org) immediately.

4. Your name will appear as one of the panel members in the peer review. Your comments will be included in the Final IEPR Report, but will remain anonymous.

Please submit your comments in electronic form to the Project Manager, tenzarj@battelle.org, no later than 10 pm ET by the date listed in the schedule above.

Charge Questions and Relevant Sections as Supplied by USACE

GENERAL (4)

1. Were risk and uncertainty sufficiently estimated and characterized for the existing, future without- and future with-project conditions?
2. Were risk and uncertainty sufficiently considered during the study?
3. In your opinion, is there sufficient data upon which to base the selection of a risk management plan (RMP)?
4. In your opinion, is the proposed RMP appropriate given the risks and uncertainty estimated for Moose Creek Dam?

EXISTING AND FUTURE WITHOUT-PROJECT RESOURCES (3)

5. Are the methods used to estimate the risk adequate and appropriate given the circumstances?
6. Have all the significant potential failure modes been identified and appropriately considered?
7. Are future Operation, Maintenance, Repair, Replacement, and Rehabilitation efforts adequately described and are the estimated costs of those efforts reasonable for future without-action risk condition?

PLAN FORMULATION / EVALUATION (5)

8. Was a reasonably complete array of possible measures considered in the development of alternatives/RMPs, including non-structural measures such as removing the project?
9. In your professional opinion, are the metrics used in the alternatives/RMP evaluation and screening that lead to a final array of alternatives/RMPs acceptable?
10. Please comment on the evaluation and comparison of the proposed alternatives/RMPs. Were the evaluation criteria applied correctly and was the final array of alternatives/RMPs compared appropriately?
11. Have the potential benefits and impacts of each alternative/RMP been clearly and adequately presented?
12. Were the engineering, economic, and environmental analyses used for this study consistent with generally accepted methodologies? Why or why not?

RECOMMENDED PLAN (2)

13. Does the proposed RMP address the study objectives and avoid violating the study constraints?

14. Please comment on the completeness of the proposed RMP. Will any additional efforts, measures, or projects be needed to realize the expected benefits?

DAM SAFETY (2)

15. Has the condition of the project, including the design and construction of the project and appurtenant features, project maintenance, previous remediation, and the dam's performance over time, been clearly described?

16. Is there sufficient information presented to identify, explain, and comment on assumptions which underlie engineering analyses? Why or why not?

SAFETY ASSURANCE REVIEW (SAR) (4)

17. In accordance with ER 1110-2-1150, are the quality and quantity of the surveys, investigations, and engineering sufficient for a concept design?

18. Are the models used to assess hazards appropriate?

19. Are the assumptions made for the hazards appropriate?

20. Does the analysis adequately address the uncertainty and residual risk given the consequences associated with the potential for loss of life for this type of project?

FINAL OVERVIEW QUESTION (1)

21. What is the most important concern you have with the document or its appendices that was not covered in your answers to the questions above?

Battelle Summary Charge Questions to the Panel Members[1]

Summary Questions

22. Please provide positive feedback on the project and/or review documents.

Public Comment Questions

23. Do the public comments raise any additional discipline-specific technical concerns with regard to the overall report?

[1] Questions 22 through 23 are Battelle supplied questions and should not be construed or considered part of the list of USACE-supplied questions. These questions were delineated in a separate appendix in the final Work Plan submitted to USACE.

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APPENDIX D

Conflict of Interest Form

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Conflicts of Interest Questionnaire

Independent External Peer Review

MOOSE CREEK DAM, ALASKA, DAM SAFETY MODIFICATION REPORT (DSMR)

The purpose of this document is to help the U.S. Army Corps of Engineers identify potential organizational conflicts of interest on a task order basis as early in the acquisition process as possible. Complete the questionnaire with background information and fully disclose relevant potential conflicts of interest. Substantial details are not necessary; USACE will examine additional information if appropriate. Affirmative answers will not disqualify your firm from this or future procurements.

NAME OF FIRM: **Battelle Memorial Institute**
REPRESENTATIVE'S NAME: **Courtney M. Brooks**
TELEPHONE: **614-424-5623**
ADDRESS: **505 King Avenue, Columbus, OH 43201**
EMAIL ADDRESS: brooksc1@battelle.org

I. INDEPENDENCE FROM WORK PRODUCT. Has your firm been involved in any aspect of the preparation of the subject study report and associated analyses (field studies, report writing, supporting research etc.) **No** Yes (if yes, briefly describe):

II. INTEREST IN STUDY AREA OR OUTCOME. Does your firm have any interests or holdings in the study area, or any stake in the outcome or recommendations of the study, or any affiliation with the local sponsor? **No** Yes (if yes, briefly describe):

III. REVIEWERS. Do you anticipate that all expert reviewers on this task order will be selected from outside your firm? No **Yes** (if no, briefly describe the difficulty in identifying outside reviewers):

IV. AFFILIATION WITH PARTIES THAT MAY BE INVOLVED WITH PROJECT IMPLEMENTATION. Do you anticipate that your firm will have any association with parties that may be involved with or benefit from future activities associated with this study, such as project construction? **No** Yes (if yes, briefly describe):

V. ADDITIONAL INFORMATION. Report relevant aspects of your firm's background or present circumstances not addressed above that might reasonably be construed by others as affecting your firm's judgment. Please include any information that may reasonably: impair your firm's objectivity; skew the competition in favor of your firm; or allow your firm unequal access to nonpublic information.
No additional information to report.

Courtney M. Brooks

Courtney M. Brooks June 9, 2017

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BATTELLE

It can be done