US Army Corps of Engineers®

Prepared by:

Pacific Ocean Division
Alaska District

Moose Creek Dam Safety Modification Preconstruction, Engineering and Design NID # AK00085

Review Plan – PED/Construction

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Last Revision Date: *None*

Section 1
Introduction

1.1 Purpose

This Review Plan for Moose Creek Dam (P2# 481758) will help ensure a quality-engineering project is developed by the U.S, Army Corps of Engineers in accordance with Engineer Circular (EC) 1165-2-217, “Review Policy for Civil Works”. As part of the Project Management Plan this Review Plan establishes an accountable, comprehensive, life-cycle review strategy for Civil Works products and lays out a value added process and describes the scope of review for the current phase of work. The EC outlines five general levels of review: District Quality Control (DQC/Quality Assurance (QA), Agency Technical Review (ATR), Biddability, Constructability, Operability, Environmental and Sustainability (BCOES) Review, Independent External Peer Review (IEPR), and Policy and Legal Compliance Review. This Review Plan will be provided to Project Delivery Team (PDT), DQC, ATR, BCOES, and IEPR Teams. The technical review efforts addressed in this Review Plan, DQC and ATR, are to augment and complement the policy review processes. The District Chief of Engineering has assessed that the life safety risk of this project is significant; therefore a Type II IEPR/Safety Assurance Review (SAR) will be required, see Paragraph 7.1. Any levels of review not performed in accordance with EC 1165-2-217 will require documentation in the Review Plan of the risk-informed decision not to undertake that level of review.

This Review Plan supersedes the Moose Creek Dam Safety Modification Study Review Plan dated December 2014. This review addresses Preconstruction Engineering and Design (PED) products, including:

- Contract Drawings
- Contract Specifications
- Construction Schedule
- Cost Estimate
- Design Criteria/Documentation Report
- Engineering Consideration and Information for Field Personnel (ECIFP)
- Quality Assurance Plan (QAP)

Reviewers from the previous study phase will be retained for the PED reviews when possible and appropriate.

1.2 References

- Moose Creek Dam Safety Modification Report, March 2019
- EC 1165-2-217, Review Policy For Civil Works, 20 February 2018.
- Engineering and Construction Bulletin (ECB) 2019-15, Interim Approach for Risk-Informed Designs for Dam and Levee Projects, 08 October 2019.

- Engineer Regulation (ER) 1110-1-12, Quality Management, 21 July 2006, and Change 2, 31 March 2011.

- ER 415-1-11, Biddability, Constructability, Operability, Environmental and Sustainability (BCOES) Reviews, 1 January 2013.

- ER 1110-2-1156, Safety of Dams – Policy and Procedure, 31 March 2014.

- Engineer Manual (EM) 1110-2-1913 Design, Construction, and Evaluation of Levees, 30 April 2000.

- Moose Creek Dam Project Management Plan (PMP) for Preconstruction, Engineer and Design and Construction.

- Pacific Ocean Division, POD Quality Management Plan, October 2013.

- CEPOA-CW-6.1-2-WI-01, District Quality Control of Civil Works Decision Documents, April 2014.

- Alaska District Quality Management Plan, CEPOA-QMP-001, January 2010.

- ER 5-1-11, Management USACE Business Practices, 1 November 2006.

- ER 415-1-13, Design and Construction Evaluation (DCE), 29 February 1996.

- ER 200-2-2, Procedures for Implementing NEPA, 4 March 1988.

- ER 11-1-321, Value Engineering, 01 January 2011.

- ER 1110-1-8159, Engineering and Design, DrChecks, 1 January 2015.

- ER 1110-2-1150, Engineering and Design for Civil Works Projects, 31 August 1999.

- ER 1110-2-1302, Civil Works Cost Engineering, 30 June 2016.

- ER 1110-2-1806, Earthquake Design and Evaluation for Civil Works Projects, 31 July 1995.

- ER 1110-2-1942, Inspection, Monitoring, and Maintenance of Relief Wells, 29 February 1988.

- EM 1110-2-1420, Hydraulic Engineering Requirements for Reservoirs, 31 October 1997.

- EM 1110-2-6054, Inspection, Evaluation, and Repair of Hydraulic Steel Structures, 1 December 2001.

- Engineer Pamphlet (EP) 1165-2-1, Digest of Water Resources Policies and Authorities, 30 July 1999.

- ECB 2016-16 Mega Project Guidance, 26 May 2016.

1.3 Review Management Organization

The USACE Risk Management Center (RMC) is the Review Management Organization (RMO) for this project. This Review Plan will be updated for additional project phases and for the construction phase.

Section 2
Project Description

2.1 Project Description

2.1.1 Proposed Action

The Chena River Lakes Flood Control Project, commonly referred to as "Moose Creek Dam", is located southeast of the City of North Pole, Alaska, approximately 15 miles east-southeast of the City of Fairbanks, Alaska. The dam is located at approximately 40 river miles upstream of the Chena's confluence with the Tanana River. Figure 1 shows the existing project vicinity and location. The Alaska District proposes to construct a barrier wall within the dam embankment to increase the path of seepage. This wall would prevent groundwater from coming to the surface in the immediate area below the dam and creating erosive features that jeopardize the integrity of the dam.

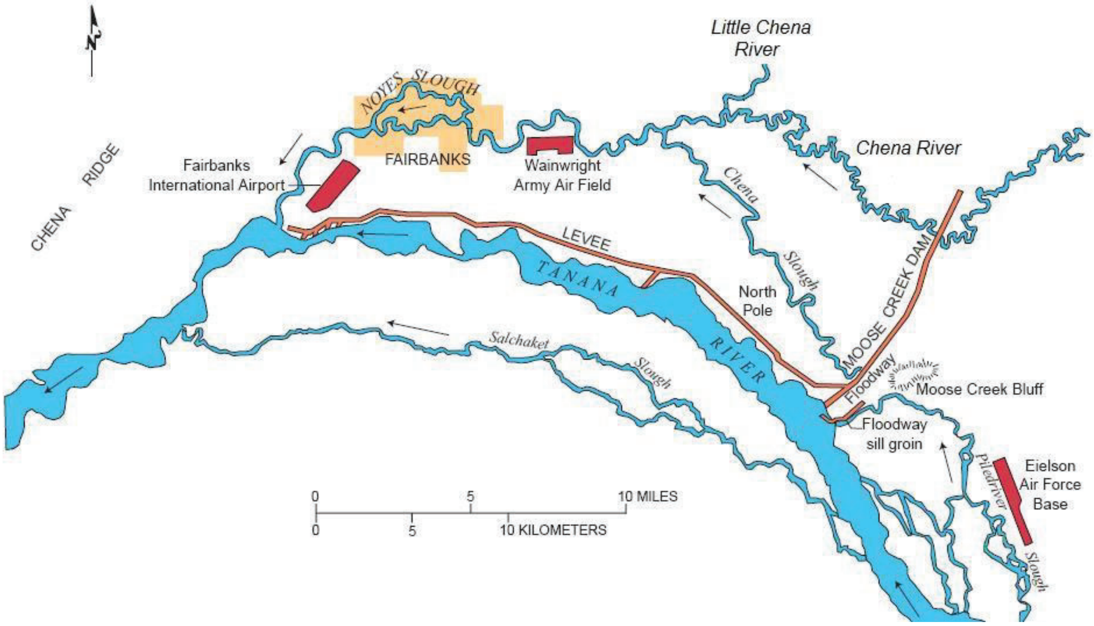

Figure 1. Existing Project Vicinity and Location

2.1.2 Project Purpose

The purpose of the Moose Creek Dam Safety Modification is to reduce the risk of dam failure to human life, property, and the environment associated with geotechnical conditions to below the USACE Tolerable Risk Guidelines (TRG).

2.1.3 Project Need

The Alaska District proposes to modify structures at the existing Chena River Lakes Flood Control Project to reduce dam failure risk associated with geotechnical conditions that pose unacceptable risks to human life, property, and the environment in exceedance of USACE TRG.

The Moose Creek Dam Safety Modification Report (USACE 2019) describes the following three potential failure modes that create the need for the proposed action:

- Backward erosion and piping of a continuous fine sand or silty sand layer with vertical exit at the toe of the downstream stability berm
- Backward erosion and piping of a continuous fine sand or silty sand layer with horizontal exit in the South Seepage Collection Channel
- Contact erosion of a continuous fine sand or silty sand layer through open work gravels with horizontal exit in the South Seepage Collection Channel

The District proposes to begin construction no earlier than 2021. The proposed action is intended to present a permanent remedy to the identified failure modes.

2.1.4 Project Features

The primary purpose of the existing Chena Lakes River Flood Control Project is to provide flood risk reduction and flood damage reduction for the downstream areas; including the City of Fairbanks, North Pole, Fort Wainwright cantonment area, and unincorporated areas in the vicinity. Much of the greater Fairbanks area is in the floodplains of the Chena and Tanana rivers.

Moose Creek Dam is a 7.5-mile long dam located in North Pole, Alaska. The dam consists of an earth-filled embankment and a concrete control works with four gated bays to regulate flow on the Chena River. In non-operational mode, the dam is dry and the Chena flows unregulated through the control structure. During operation, gates are lowered to reduce flow through the control works, pooling water upstream of the dam. When the pool reaches an elevation of 507.1 feet North American Vertical Datum of 1988 (NAVD88), excess waters flow south into the Tanana River. Diverting water reduces flood risks to the cities of Fairbanks and North Pole and adjacent downstream areas.

Figure 2 shows an aerial view of the Chena River Lakes Flood Control Project with project features noted. All elevations stated in this document are referenced to the NAVD88. Major features are labeled. Their roles in flood control are described as follows:

<u>Moose Creek Dam-Main Embankment</u>

The main embankment is a 7.5-mile long zoned earthen fill structure that reaches a maximum height of 50 feet above the Chena River streambed. The northern end of the dam abuts an unnamed ridge a natural rock nose of schistose bedrock that was stripped of overburden and weathered rock during construction. The southern end terminates at the Tanana River. The southernmost 4,500 feet of the dam beyond the Tanana River Levee is referred to as the “Dam Extension” and directs floodwaters from the floodway directly into the Tanana River instead of allowing the flows to travel along the Tanana River Levee.

<u>Moose Creek Dam-Outlet Control Structure</u>

Commonly referred to as the “Control Works”, the outlet control structure has four 25-foot-wide concrete bays divided by piers. Each bay is designed to pass a maximum of 3,000 cubic feet per second with additional flows through associated fishways and the fish ladder. Flow through the structure is regulated by four hydraulically-operated vertical steel sliding gates.

<u>Project Floodway</u>

The Floodway is an excavated and cleared channel approximately 6.5 miles in length with a maximum width of 2,400 feet. The floodway has a maximum outflow of 160,000 cubic feet per second (cfs), limited by a constriction at the Richardson Highway Bridge. There is a control sill at the southern terminus of the floodway that prevents the Tanana River from flowing up into the floodway during Tanana River flood events. The sill height is 507.1 feet NAVD88. When the reservoir elevation exceeds the sill height, flood waters spill into the Tanana River.

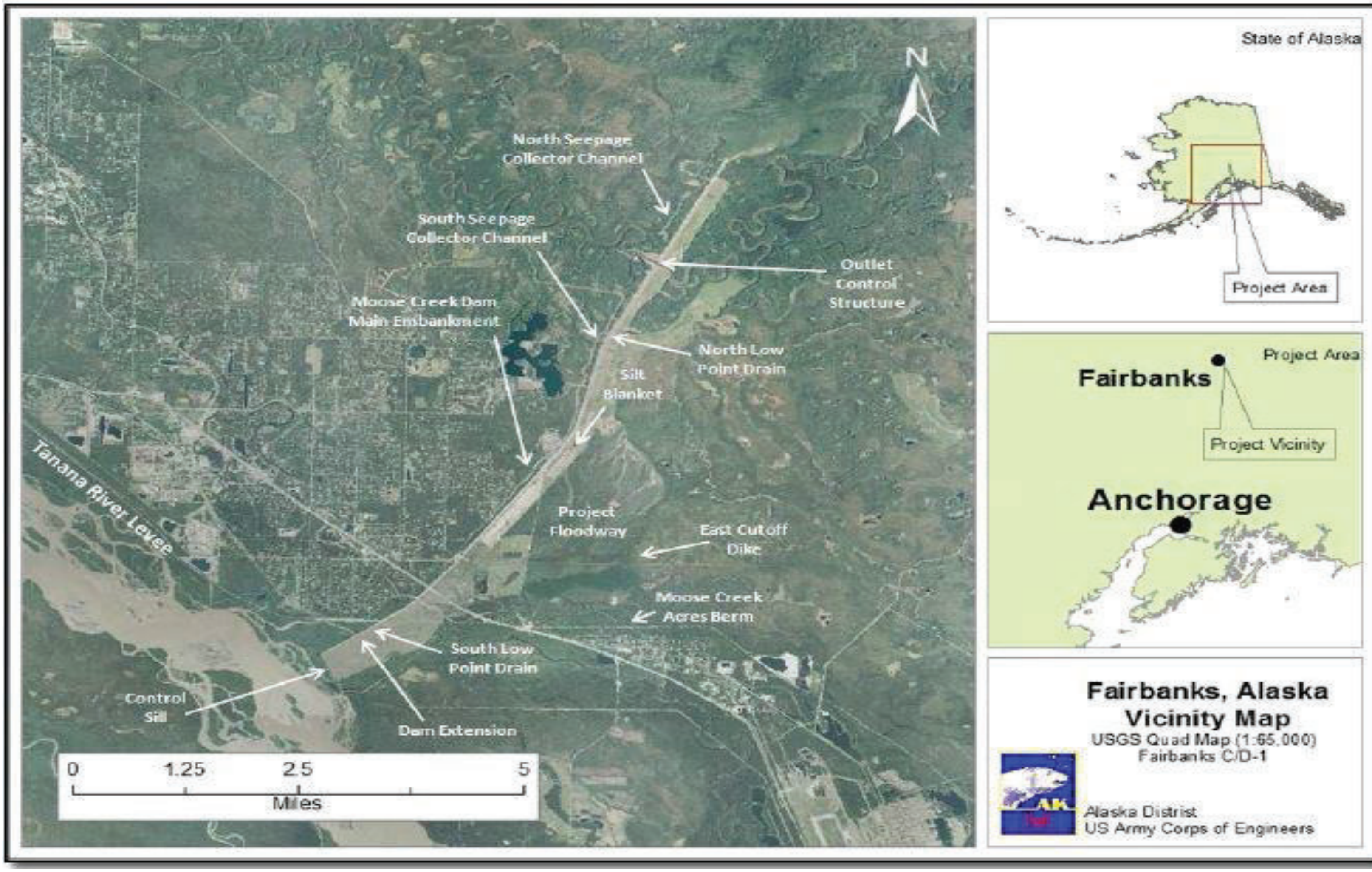

Figure 2. Aerial view of the Chena River Lakes Flood Control Project

East Cutoff Dike

The East Cutoff Dike is a 7,600-foot-long saddle dam that prevents impounded flood waters below an elevation of 524.1 NAVD88 from flowing into the Moose Creek drainage.

Low Point Drains

The embankment has two low point drains which are used to remove trapped, stagnant water from the floodway after floodwaters recede. The north or "main" low point drain is located near the mid-point of the embankment and is a concrete structure with four gates. The south low point drain is a gated corrugated metal pipe culvert that passes through the dam extension and into the Tanana River.

Seepage Collector Channels

Seepage collection channels on the north and south side of the Chena River collect seepage and outflow from relief wells on the downstream side of the dam and convey water back to the Chena River.

Moose Creek Acres Berm

The Moose Creek Acres Berm is a small levee that protects the neighborhood of Moose Creek Acres from inundation during high water events on Moose Creek related to high flows on the Tanana River.

Tanana River Levee

The Tanana River Levee is not part of the Corps' Chena River Lakes Flood Control Project, but is maintained by the Fairbanks North Star Borough as part of the Borough's flood risk management program. The Tanana River Levee runs along the Tanana River from Moose Creek Dam 22 miles downstream to the Tanana's confluence with the Chena River. It protects the greater Fairbanks area from high water on the Tanana River.

Remote meteorological and gaging stations arrayed across the 2,115-square-mile Chena River drainage provide information about rainfall, temperature, snow depth, and stream flows in tributaries to help project operators predict severity and duration of floods.

2.1.5 Current Operations

The control works structure on the Chena River is actively operated during flood events. Normal Chena River flows are less than 2,000 cubic feet per second (cfs), and the project typically is not operated for flood control until necessary to keep discharge in Fairbanks to less than 12,000 cfs. Chena River water is not retained by the project during normal flows; the dam control gates are open and the river flows downstream unimpeded.

During flood events, when river discharge in Fairbanks exceeds or is expected to exceed about 12,000 cfs, dam control gates are partially closed to control discharge of floodwaters. The gates at the outlet control structure are manipulated to ensure discharge from the Chena River, or other sources from below the dam, through downtown Fairbanks does not exceed 12,000 cfs. Minimum discharge of 1,000 cfs is maintained whenever control gates are lowered to ensure that fish and their habitat downstream from the dam have sufficient water.

Total damages prevented since the project became operational in 1981 are estimated to at $397.6 million. Total project costs thru the end of Fiscal Year 2017 are $294 million. Including the 2020 operations, the Chena River Lakes Flood Control Project has regulated flows on the Chena River 30 times since becoming operational in 1981.

The project is also authorized for recreation and environmental stewardship, providing benefits for visitors pursuing water related activities including boating, hiking, hunting, fishing, swimming and picnicking. Using annual project visitation data obtained from the Corps' Operation and Maintenance Business Information Link (OMBIL) the average annual visitation during 2012 was approximately 171,000 visits, totaling 181,000 annual visitor days. Applying the Unit Day Value methodology (EGM15-03), the benefit annually from recreation visitation is estimated to be $1.6 Million. Similar recreation benefits are expected in the future.

The Chena River channel bottom at Moose Creek Dam is about 485 feet NAVD88. At average summer flows the water surface elevation of the river at the dam is 490 to 495 feet NAVD88. At elevations of 500 to 501 feet NAVD88, the Chena River begins to overflow its banks and into the floodway. Floodwaters pool in the floodway until they rise above 507.1 feet NAVD88, after which the water flows over the control sill into the Tanana River. The highest pool recorded in 39 years of Chena River Lakes Flood Control Project operation was in May and June 1992, when Chena River water surface elevations rose to 512.7 feet NAVD88; which was the height of the control sill at that time. The control sill was lowered to 507.1 feet NAVD88 in 2009 during the implementation of the interim risk reduction measures (IRRM) plan. This has been only event high enough to overflow the floodway sill.

2.1.6 Issues and Dam Safety Concerns

Principal issues associated with floodwater retention and operation of the Moose Creek Dam control structure are public safety in the inundation area downstream of the dam, potential for flooding downstream property structures, and effects on migratory fish passage. The safety of people who are protected by the Chena River Lakes Flood Control Project and who could be at risk by failure of any project component are the greatest concern. Their safety is the principal driving force leading to this action and to the decisions that will be made. Issues and concerns can be defined and categorized as follows:

<u>Dam Safety</u>

Moose Creek Dam and the smaller and lower East Cutoff Dike were constructed primarily of silty gravel and gravel. The Moose Creek Dam was constructed on soils that are primarily sands and gravels. The East Cutoff Dike was constructed on frozen silts and organic silts that are likely underlain with sands and gravels.

Water can migrate beneath both the dam and the East Cutoff Dike when floodwater is retained in the floodway. Water moving beneath both structures can weaken them and can lead to failure. Water beneath the dam or dike also raises groundwater down-gradient from them and may cause flooding in those down-gradient areas.

Current risk reduction considerations call for retained floodwaters to be discharged as soon as possible and to be kept at minimum pool elevations behind dams of this type. Other measures are employed in construction and operation to minimize water movement through dams. Upstream silt blankets and relief wells have been installed at the Chena River Lakes Flood Control Project to prevent water movement from causing damage to the structures and their foundations.

Vegetation control is important to prevent water from piping beneath dams, to ensure unimpeded discharge of flood waters into drainage channels, and to assist in performing effective inspection during flood events.

<u>Flooding and Loss of Property</u>

Flood risk management benefits (damages prevented) accruing from when the project began operation in 1981 through fiscal year 2017 are estimated at over $397 million. It is expected the dam will continue to provide a similar amount of annual flood risk management benefits. The flood risk management benefits are realized in the communities of North Pole, Fairbanks to its confluence with the Tanana River.

Additional justification is provided from the existing condition risk assessment (ECRA) when considering the estimated total population at risk (PAR) given a breach at maximum pool levels of approximately 85,000 people and the associated direct economic damages of over $6 Billion resulting from a failure.

2.1.7 Proposed Barrier Wall

The Mix-In-Place Barrier Wall has been selected by the Alaska District as the method of reducing dam failure associated with geotechnical conditions. It would consist of a mix-in-place partial barrier wall in Reaches 4, 5, 6, 8 and 9. This system uses in-situ soils, water, and a cement mix to construct a barrier that would effectively impede the development of pipes and increase the seepage path. As with other barrier wall measures, this measure is expected to experience some amount of cracking over time but should remain effective even with minor cracking. The barrier wall would be located on the crest of the dam slightly upstream of the centerline where it would extend through the semi-pervious core, penetrating the Types II and III fill, extend into virgin material, and avoid penetrating the select gravel drain.

In general, a mix-in-place barrier wall is expected to reduce the likelihood of failure by 1.5 orders of magnitude, be highly acceptable and implementable, and have minimal environmental impacts.

The preferred alternative would not require the clearing of any vegetation for the construction of the wall; however, land clearing may be required for the disposal of spoils material and gravel mining.

The barrier wall would be connected to the low point drain by sheetpile and a small amount of concrete in order to create a continuous barrier and prevent the formation of pipes. The sheetpile would be driven using a vibratory or impact hammer.

Three additional temporary access ramps would be constructed to enable construction access to the crest of the dam. Material for these ramps would be procured locally; quarries excavated downstream of the dam on lands owned by the Alaska District. Barrier wall construction would generate spoils by displacing the in-situ materials.

The project is anticipated to produce about 60,000 cubic yards of Portland cement/bentonite mixed spoils, which would be disposed in the Fairbanks North Star Borough landfill. Gravel mining would require the removal of overburden consisting primarily of organic material, silt, and soil in order to access the gravel. The suitable overburden would be stockpiled for reclamation and unusable material would be placed in the disposal area upstream of the dam. The proposed borrow sites and disposal area are shown in relation to the barrier wall and existing site conditions in Figure 3.

A 188-acre location has been identified for the disposal of overburden cleared from the quarries, upstream of the embankment and about 7,500 feet directly south of the project office. This area covers about 188 acres, including 18.9 acres of wetlands. The total volume of material to be disposed in this area is about 16,425 cubic yards, which would cover an area of about two acres when piled to a height of five feet above base elevation. The South Disposal area is adjacent to existing roads and has been partially cleared in the past. Paper birch is the dominant species in the uplands of the north facing slope and quaking aspen dominates the low-lying uplands at the base of the hill to the cleared power line right-of-way bisecting the site. The areas north of the right-of-way are mixed; anthropogenic disturbance, shrubs such as resin birch and green alder, and spruce-birch forest.

The North Borrow Site is an area covering 109 acres, adjacent to the North Seepage Collector Channel. An area of 0.4 acres would be cleared and excavated to a maximum depth of 35 feet below ground surface. Additional area for staging may be developed as well. This area is bisected by an old trail leading to the pond and contains some old burn areas, as well as a cleared area managed for moose browse and grouse cover. The entire area is uplands; primarily mature stands of white spruce, paper birch, and balsam poplar.

The South Borrow site is located adjacent to the Chena Lakes, about 7,500 feet north of the project office. This area covers about 78 acres, including 11.1 acres of wetlands and abuts existing roads. A three-acre site would be excavated to a maximum depth of 35 feet below ground surface. Additional area may be cleared for staging and material stockpile. The plant communities are variable in this area; mature paper birch and white spruce dominate much of the upland areas, grading into shrubs like green alder and resin birch before transforming into grasses in the palustrine emergent wetlands.

The Floodway Borrow Source is located within the floodway of the dam, adjacent to Reached 4 and 5. The area covers about 5.7 Acres. The boundary in Figure 3 is not to scale, but a representation of the approximate borrow location.

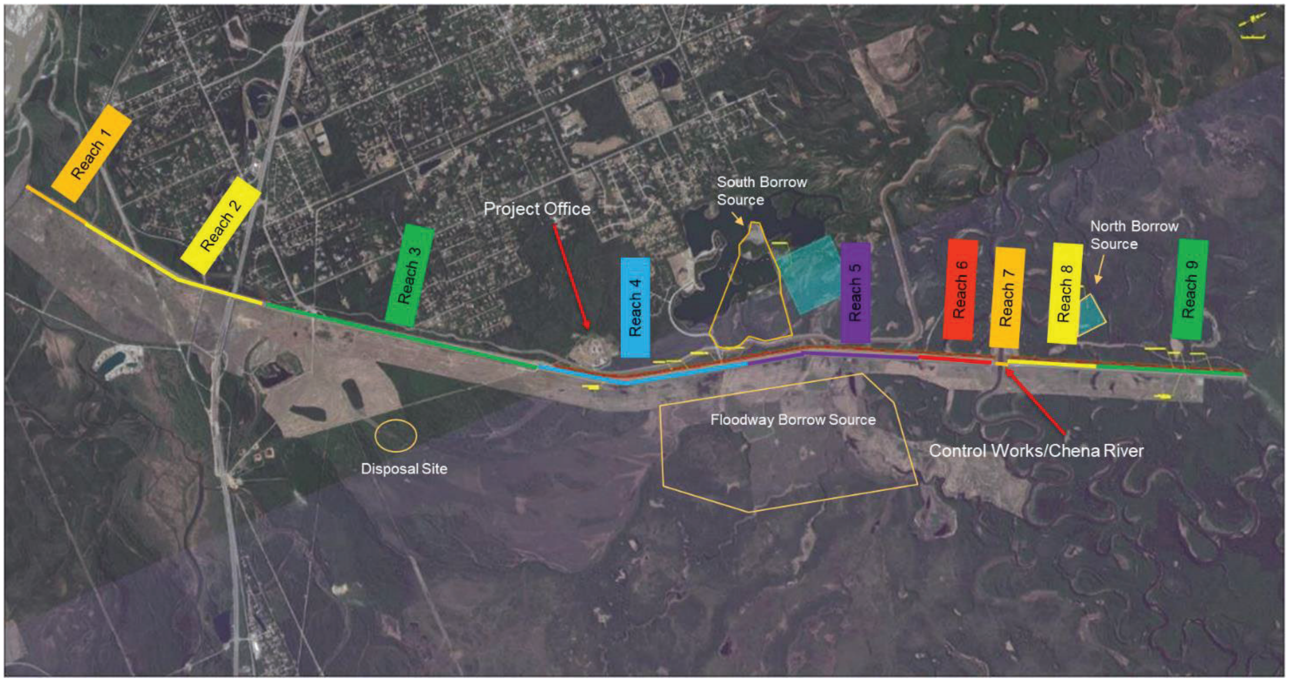

Figure 3. Moose Creek Dam Borrow and Disposal Sites

2.2 Project Sponsor

The project sponsor is the Fairbanks North Star Borough. Products and analyses provided by non-Federal sponsors as in-kind services are subject to DQC, ATR, policy and legal compliance, BCOES, and SAR reviews. Sponsor Peer Review of In-Kind Contributions - There will not be in-kind contributions for this effort.

Section 3
District Quality Control

3.1 Requirements

All implementation documents (including supporting data, analyses, reports, environmental compliance documents, water control manuals, etc.) shall undergo DQC in accordance EC 1165-2-217. The District shall perform these minimum required reviews in accordance with District's Quality Management Plan, https://team.usace.army.mil/sites/POA/POAQMS/default.aspx.

See Attachment 1, Table 6 for the DQC Lead, reviewers, and reviewer's disciplines.

3.2 Documentation

Documentation of DQC activities is required and will be implemented by the process linked/described in paragraph 3.1.

3.3 DQC Schedule and Estimated Cost

Although DQC is always seamless, the following milestone reviews are schedule in Table 1. The cost for the DQC is approximately $175,000.

Table 1 DQC Schedule

Project Phase/Submittal	Review Start Date	Review End Date	Status
DQC 65% P&S Review	01/08/20	02/14/20	Completed
DQC ATR Review	06/20	07/20	Completed
IEPR II P&S Review	08/17/20	09/18/2020	Pending
DQC 95%/ATR Final P&S Review	10/13/20	11/03/20	Pending

Section 4

Agency Technical Review

4.1 Requirements

All implementation documents (including supporting data, analyses, reports, environmental compliance documents, water control manuals, etc.) shall undergo ATR in accordance EC 1165-2-217. ATR reviews will occur seamlessly, including early involvement of the ATR team for validation of key design decisions, and at the scheduled milestones as shown in Section 4.6. A site visit will be scheduled for the ATR Team.

4.2 Documentation of ATR

Documentation of ATR will occur using the requirements of EC 1165-2-217. This includes the four-part comment structure and the use of DrChecks^{SM}.

4.3 Products to Undergo ATR

Products to undergo ATR include:

- Contract Drawings
- Contract Specifications
- Construction Schedule
- Cost Estimate
- Design Criteria/Documentation Report

4.4 Required Team Expertise and Requirements

ATR teams will be established in accordance with EC 1165-2-217. The following disciplines will be required for ATR of this project:

ATR Lead - The ATR team lead is a senior professional outside the home MSC with extensive experience in preparing Civil Works documents and conducting ATRs. The lead has the necessary skills and experience to lead a virtual team through the ATR process. The ATR lead may also serve as a reviewer for a specific discipline. The ATR lead should also have experience with seepage barriers and dam safety projects.

Geotechnical Engineer - shall have experience in the field of geotechnical engineering, analysis, design, and construction of barrier wall dams. The geotechnical engineer shall have experience in subsurface investigations, rock and soil mechanics, internal erosion (seepage and piping), slope stability evaluations, erosion protection design, and earthwork construction. The geotechnical engineer shall have knowledge and experience in the forensic investigation of seepage, settlement, stability, and deformation problems associated with high head dams and appurtenances constructed on rock and soil foundations. The geotechnical engineer shall also have specific experience with seepage barriers.

Engineering Geologist – The geologist shall have experience in mix design seepage barriers built in permafrost laden soils. They shall have experience in assessing internal erosion (seepage and piping) beneath earthen dams with a barrier wall constructed soils that are primarily sands and gravels, frozen silts, and organic silts that are likely underlain with sands and gravels. The engineering geologist shall be familiar with identification of geological hazards, exploration techniques, field and laboratory testing, and instrumentation. The engineering geologist shall be experienced in the design of grout curtains and must be knowledgeable in concrete mix designs and other materials used in foundation seepage barriers.

Civil Engineer – A civil reviewer will be used during design phase to review the seepage barrier wall tie-ins at the existing concrete structures of the low point drain's concrete box culverts and the control works, mass concrete structure. Sheet pile will be used to facilitate these tie-ins. A civil reviewer shall have experience and be proficient in the design and use of sheet pile retaining structures for temporary excavations. The civil engineer shall have familiarity with the design and construction of seepage barrier walls. The Civil and Structural Engineer can be combined into one reviewer if need be.

Structural Engineer – The barrier wall will need to be tied-in to two points along the dam with sheetpile; the low point drain, the control works. A structural engineer will be needed to review these tie-ins and shall have experience and be proficient in performing stability analysis, finite element analysis, seismic time history studies, and external stability analysis including foundations on high head mass concrete dams. The structural engineer shall have specialized experience in the design, construction and analysis of seepage barriers.

Construction Engineer – The success of the projects depends on accurate placement of materials that are unseen well below the surface and experience is needed to assure the proper methods are designed and specified. The reviewer shall have experience with seepage barriers or cutoff walls constructed into dams. Reviewer should be a senior level, professionally registered engineer with extensive experience in the engineering construction field with particular emphasis on dam safety projects. The Construction reviewer should have a minimum of 10 years of experience.

Cost Engineering – The reviewer for cost estimating shall be a registered or certified cost engineer with a BS degree or higher in engineering or construction management, and should have experience estimating complex, phased multi-year civil works construction projects and hydraulic retention structures. The reviewer shall have extensive knowledge of MII software and the Total Project Cost Summary (TPCS) as required during ATR. A certification from the Cost Engineering Center of Expertise (MCX) in Walla Walla District may be required. The cost reviewer shall have experience in estimating project cost related to a seepage barrier constructed into an existing dam.

4.5 Statement of Technical Review Report

At the conclusion of each ATR effort, the ATR team will prepare a review report with a completion and certification memo. The report will be prepared in accordance with EC 1165-2-217.

4.6 ATR Schedule and Estimated Cost

Although ATR is always seamless, the preliminary ATR milestone schedule is listed in Table 2. The cost for the ATR review team will range from $50,000 to $100,000.

Table 2 ATR Schedule

Project Phase/Submittal	Review Start Date	Review End Date	Status
ATR P&S 65% Review	06/20	07/20	Complete
ATR P&S Final Review	08/17/20	09/18/2020	Pending

Section 5
Constructability Evaluation

ER 1110-2-1156 requires a constructability evaluation (CE) to ensure dam safety risks are adequately addressed by the designs and that all construction-related risks are fully identified and mitigated to an acceptable level. The CEs will be conducted on the 65% design submittal for each project component.

The PDT will coordinate with the DSMMCX to identify the CE team. The CE will be performed in accordance with section 22.2.6.1 of ER 1110-2-1156. The PDT may need to brief the CE team on the potential failure modes mitigated by construction and on potential failure modes that may be present during construction activities. A Constructability Evaluation Report will be prepared by the CE team, reviewed, and approved.

Section 6
BCOES Review

6.1 Requirements

All implementation documents (including supporting data, analyses, reports, environmental compliance documents, water control manuals, etc.) shall undergo BCOES review in accordance ER 415-1-11 and ER 1110-1-12. BCOES reviews are done during design for a project using the design-bid-build (D-B-B) method. The BCOES review results are to be incorporated into the procurement documents for all construction projects.

6.2 Documentation of BCOES

The BCOES review will be documented using DrChecks℠. The BCOES reviewers will include local sponsors' facility operators and maintenance staff, as well as construction, operations, and environmental staff to improve the BCOES aspects of designs. The BCOES roster is provided in Attachment 1.

Section 7
Safety Assurance Review

7.1 Decision on SAR

The District Chief of Engineering has made a risk-informed-decision that this project does pose a significant threat to human life (public safety) and therefore a SAR will be performed.

Per EC 1165-2-217, Section 12(h)3(a) a SAR would be required for this project as there is a significant safety risk. This dam safety modification project which would modify the line of flood risk reduction and could introduce new failure modes or lead to progression of existing failure modes that could result in potential for life loss which has resulted in its identification as a high-risk project and was assigned a Dam Safety Action Classification rating of 3 in 2014

Principal issues associated with floodwater retention and operation of the Moose Creek Dam control structure are public safety in the inundation area downstream of the dam, potential for flooding downstream property structures, and effects on migratory fish passage. The safety of people who are protected by the Chena River Lakes Flood Control Project and who could be at risk by failure of any project component are the greatest concern. Their safety is the principal driving force leading to this action and to the decisions that will be made.

Moose Creek Dam and the smaller and lower East Cutoff Dike were constructed primarily of silty gravel and gravel. The Moose Creek Dam was constructed on soils that are primarily sands and gravels. The East Cutoff Dike was constructed on frozen silts and organic silts that are likely underlain with sands and gravels.

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Current risk reduction considerations call for retained floodwaters to be discharged as soon as possible and to be kept at minimum pool elevations behind dams of this type. Other measures are employed in construction and operation to minimize water movement through dams. Upstream silt blankets and relief wells have been installed at the Chena River Lakes Flood Control Project to prevent water movement from causing damage to the structures and their foundations.

Additional justification is provided from the existing condition risk assessment (ECRA) when considering the estimated total population at risk (PAR) given a breach at maximum pool levels of approximately 85,000 people and the associated direct economic damages of over $6 Billion resulting from a failure.

For a SAR the selection of an independent external peer review (IEPR) panel members will be made up of independent recognized experts from outside of the USACE in the appropriate disciplines, representing a balance of expertise suitable for the review being conducted. The selection of IEPR review panel members will be selected using the National Academy of Science (NAS) Policy which sets the standard for “independence” in the review process.

7.2 Products to Undergo SAR

The SAR Panel will be tasked with reviewing the following technical products:

- Contract Drawings
- Contract Specifications
- Design Criteria/Documentation Report

To enhance the SAR process and afford early and regular involvement, SAR panel members will provide real time (over- the-shoulder) consultation on an as needed basis during the design phase. SAR panel members will participate in web/teleconference technical meetings with the project design team members. The District will identify which SAR panel members will be needed for each consultation. The SAR panel members will provide consultation/opinions concerning key design, construction, analyses, and modeling considerations. SAR panel members will provide an opinion memorandum summarizing the advice or opinion rendered during the meeting.

The SME will provide a consultation opinion memorandum summarizing the advice or opinion rendered during web/teleconference technical meetings and site visits.

7.3 Required SAR Panel Expertise

SAR panels will be established in accordance with EC 1165-2-217. The following disciplines will be required for SAR of this project:

Geotechnical Engineer - The Geotechnical Engineering panel member should be a senior-level geotechnical engineer with experience in the field of geotechnical engineering, analysis, design, and construction of embankment dams and levees. The Panel Member should have knowledge and experience in the forensic investigation and evaluation of seepage and piping, settlement, slope stability, and deformations problems associated with embankments constructed on weathered and jointed rock and alluvial soils. The Panel Member should have experience in the design and construction of seepage barriers or cutoff walls. The Panel Member should have experience in failure mode analysis, risk assessment of embankment dams, and evaluating risk reduction measures for dam safety assurance projects.

Civil/Structural Engineer – A civil/structural reviewer will be used during design phase to review the barrier wall tie-ins at the existing concrete structures of the low point drain's concrete box culverts and the control works, mass concrete structure. Sheet pile will be used to facilitate these tie-ins. A civil/structural reviewer shall have experience and be proficient in the design and use of sheet pile retaining structures for temporary excavations. The civil/structural engineer shall have familiarity with the design and construction of soil-bentonite and cement barrier walls; which are similar to cutoff walls except that seepage/permeability are of less concern.

Materials Engineer for Seepage Barriers – Materials Engineering panel member shall be a registered professional civil engineer from an Architect-Engineer or consulting firm, a public agency, or academia with 10 or more years of experience and have extensive knowledge in cutoff walls and construction of cutoff walls, soil and rock earthwork control (field and laboratory testing); mix designs and materials for soil cement, concrete, roller compacted concrete, self-consolidating concrete, mass concrete, pavement design and construction. A Master's Degree in Materials Engineering and experience in preparing plans and specifications and field applications for mix in place soil cement seepage barrier walls and construction is preferred.

7.4 Documentation of SAR

Documentation of SAR will be prepared in accordance with EC 1165-2-217. See RMC SAR Report template.

7.5 Scope, Schedule, and Estimated Cost of SAR's

The SAR's will be performed in accordance with EC 1165-2-217. SAR reviews will occur at the milestones shown in Table 3. The estimated cost for the SAR's of this project are in the range of $245,000. This estimate will be refined when the Scope of Work for the SAR task order is completed. Milestones to consider for a SAR are at the midpoint and final design in the Design Documentation Report; at the completion of the plans, specifications, and cost estimate; at the midpoint of construction for a particular contract, prior to final inspection, or at any critical design or construction decision milestones.

Table 3 Scheduled Milestone Reviews with Required Reviewers and Site Visit Duration

Milestone Reviews	Geotech (Level 2)	Materials (Level 2)	Structural (Level 2)	Site Visit Duration (days with travel)	Start Date*	End Date*	Status
Design Review/ Orientation Briefing	X	X	X	3	08/17/2020	09/18/2020	Pending
Real Time Consultation – Design Phase	X	X	X	0	As Requested		Pending
Construction Kickoff/ Demonstration Wall Review**	X		X	3	TBD	TBD – 30 day review	Pending
Midpoint of Construction**	X		X	3	TBD – approx. 1 year after kickoff meeting	TBD – 30 day review	Pending
Real Time Consultation – Const. Phase**	X		X	0	As Requested		Pending
Construction Completion Review**	X		X	3	TBD – aprox. End of 3rd construction season	TBD – 30 day review	Pending

**Note, all dates relating to construction activities are subjects to change. These dates are dependent upon funds received for construction.*

***Milestones are included in options.*

Section 8

Mega Project Design and Construction Evaluation (DCE)

Mega Project DCEs shall be conducted in accordance with ECB 2016-16 and soon to be published ECB 2020-XX. Mega DCE execution will be organized by the HQUSACE Engineering & Construction Division, Construction Branch along with support from various USACE offices and teams. The Mega DCE team will be multi-disciplined and will evaluate project management, procurement, engineering and construction processes for compliance with USACE policy and its effectiveness in achieving desired project outcomes. The team will meet with the Mega Project's PDT (primarily by web/teleconference), to obtain a 360-degree perspective of the project prior to establishing focus areas of the visit. The Regional Integration Team (RIT) or Programs Integration Division (PID) representative, and the MSC, will participate in Mega DCEs and assist in the arrangements for the visits, gathering and reviewing data, and development of reports, etc. In the event the MSC sponsors and performs their own DCE on a Mega Project or Program, HQUSACE representatives will be invited to participate in the MSC-led evaluation. Upon completion of a Mega DCE, the Mega DCE Team will provide an out brief to the PDT, including representation from USACE at each of the tiered governance levels. The out brief will include a current summary of findings, and a schedule for completing any follow-up work and issuing the final report.

Per ECB 2016-16, A three-tiered governance structure will be established for Mega Projects in order to achieve needed accountability, visibility, understanding, and timely decision-making to assure effective communication and issue resolution at appropriate levels. The Construction Industry Institute (CII) defines project culture as "the degree to which (1) project leadership is defined, effective, and accountable; (2) communication within the team and with stakeholders is open and effective; and (3) the team fosters trust, honesty, and shared values."

- The senior level is the Senior Executive Board (SEB) and will be composed of senior leaders from all stakeholders. The typical members are the MSC's (senior project executives (SPE) staff; project sponsors and DoD commands; and corporate level officers from the Designer of Record (DOR) and Construction Contractor. HQUSACE Senior Leaders, National Program Manager, and Engineering and Construction senior engineers must be included as advisors to the SEB, involved in all critical activities addressed by the SEB, and invited to all SEB meetings. The SEB shall be chaired by the SPE. The Enhanced PMP will describe the extent to which HQ leadership will be involved in the regular review and oversight of a Mega Project. The PMP will outline how parity will be achieved between stakeholder agencies (for example: who will represent USACE in the event that the using agency is represented by a 2 or 3 star representative). The PMP will also describe how the Mega Projects reporting and briefing processes will synch with other project and program level approaches.

- The mid-level Executive Leadership Team (ELT) is composed of the USACE District senior leaders (i.e. Corporate Board); project sponsors and proponents; and the DOR and Construction Contractor's regional representative. This team is responsible and accountable to make decisions and apply resources to solve problems that rise above the typical day-to-day management of the project. The ELT shall be chaired by the District Commander or the Deputy District Engineer for Programs and Project Management (DPM).

- The working-level Project Leadership Teams (PLT) are the working level teams assigned to each major phase of the project. This is the level where the typical day-to-day management of engineering and/or construction efforts are performed and includes the Project Manager and Technical Lead.

This three-tiered governance structure for Mega Projects will be incorporated in PMPs and recognized and supported by the entire vertical team for the Mega Project. The governance structure may be adjusted to accommodate differences in programs, command structures and funding between Civil Works, Military, and International and Interagency Services (IIS) Programs, etc. Additional elements may be added where other stakeholder and USACE elements are involved which may include Centers of Expertise or Standardization (CX or COS), the Institute for Water Resources (IWR), or the Risk Management Center.

Section 9

Public Posting of Review Plan

As required by EC 1165-2-217, the approved RP will be posted on the District public website (http://www.alaska.usace.army.mil/pm/pmPeerReview.html). This is not a formal comment period and there is no set timeframe for the opportunity for public comment. If and when comments are received, the PDT will consider them and decide if revisions to the RP are necessary.

Section 10

Review Plan Approval and Updates

The MSC Commander, or delegated official, is responsible for approving this Review Plan. The Commander's approval reflects vertical team input (involving the District, MSC, and RMC) as to the appropriate scope, level of review, and endorsement by the RMC. The Review Plan is a living document and should be updated in accordance with 1165-2-217. All changes made to the approved Review Plan will be documented in Attachment 3, Table 11 RP Revisions. The latest version of the Review Plan, along with the Commanders' approval memorandum, will be posted on the District's webpage and linked to the HQUSACE webpage. The approved Review Plan should be provided to the RMO.

Section 11
Engineering Models

The use of certified, validated, or agency approved engineering models is required for all activities to ensure the models are technically and theoretically sound, compliant with USACE policy, computationally accurate, and based on reasonable assumptions. The responsible use of well-known and proven USACE developed and commercial engineering software will continue and the professional practice of documenting the application of the software and modeling results will be followed. The selection and application of the model and the input and output data is still the responsibility of the users and is subject to DQC, ATR, BCOES, policy and legal review, and SAR. Where such approvals have not been completed, appropriate independent checks of critical calculations will be performed and documented. The following engineering models, software, and tools are anticipated to be used:

Table 4 Models and Status

Model Name	Version	Description
GIS (ESRI ArcMap)	Allowed	Mapping Software package
GeoStudio 2019	10.0.0.17401 (Allowed)	Software package that includes limit equilibrium stability analysis and finite element seepage analysis modeling
Flac Model		Finite element model software to evaluate seismic deformation of the barrier wall and embankment.
Micro-Computer Aided Cost Estimating System (MCACES)	MII 4.4 (Enterprise)	Multi-user software program used by the U.S. Army Corps of Engineers for the preparation of detailed construction cost estimates for military, civil works, and environmental projects
SimDams		Using for data management

Section 12

Review Plan Points of Contact

Public questions and/or comments on this review plan can be directed to the following points of contact:

Table 5 RP POC's

Name	Organization	Phone
Project Manager, Alaska District	CEPOA-PM-C	907-753-2837
Lead Engineer, Alaska District	CEPOA-EC-G-GM	907-753-2686
USACE Pacific Ocean Division	CEPOD-PDC	808-835-4624
Risk Management Center	CEIWR-RMC	304-399-5217

ATTACHMENT 1

Team Rosters (FOUO)

Table 6 DQC/QA Reviewers

Name	Discipline/Role	DQC/QA Role
Doug Bliss	Civil Engineering - Supervisor	Review Lead
Tom Gill	Civil Engineer	Reviewer
Au Nguyen	Contracting	Reviewer
Adam Cole	Construction	Reviewer
Mark Estes	Construction	Reviewer
Phil Ohnstad	Cost Engineering	Reviewer
Tom Sloan	Geologist	Supervisory Reviewer
Mike Salyer	Environmental Resource Specialist	Supervisory Reviewer
Mike Salyer	Cultural Resource Specialist	Supervisory Reviewer
Karl Harvey	Cost Engineering	Supervisory Reviewer
Julie Anderson	Operations, Chena Dam Manager	Supervisory Reviewer
Monica Velasco	Construction	Supervisory Reviewer
Nathan Epps	HH Engineer	Supervisory Reviewer
Brandee Ketchum	Office of Counsel	DQC Reviewer

Table 7 Advisors

Discipline/Role	Name	Description of Credentials
RMC PED/Construction Advisors	Gregg Batchelder Adams Mike Miller	RMC Senior Advisors for PED & Supervisory DQC Reviewer
Technical Advisor	Greg Hensley	DSMMCX Senior Geotech Engineer
Technical Advisor	Greg Hammer	DSMMCX Senior Geologist
Construction Advisor	Matt Sheskier	RMC Senior Construction Liaison
Cost Advisor	Andy Jordan	DSMMCX Senior Cost Engineer
Technical Advisor – Production Center	Robert Worden	NWD DSPC Senior Geotech Engineer

Table 8 ATR Team

Discipline	Name	Description of Credentials
ATR Review Lead	Mike Robinette	The ATR team lead is a senior professional outside the home MSC with extensive experience in preparing Civil Works documents and conducting ATRs. The lead has the necessary skills and experience to lead a virtual team through the ATR process. The ATR lead may also serve as a reviewer for a specific discipline.
Geotechnical Engineer	Michael Navin	The Geotechnical Engineering reviewer should have experience in the field of geotechnical engineering, analysis, design, and construction of barrier wall dams, subsurface investigations, rock and soil mechanics, internal erosion (seepage and piping), slope stability evaluations, erosion protection design, and earthwork construction. The geotechnical engineer shall have knowledge and experience in the forensic investigation of seepage, settlement, stability, and deformation problems associated with high head dams and appurtenances constructed on rock and soil foundations.
Construction	William DeBruyn	The Construction Reviewer should be a senior level, professionally registered engineer with extensive experience in the engineering construction field with particular emphasis on dam safety projects. The Construction reviewer should have a minimum of 10 years of experience.
Civil Engineer	Stephen Wallington	A civil reviewer will be used during design phase to review the barrier wall tie-ins at the existing concrete structures of the low point drain's concrete box culverts and the control works, mass concrete structure. Sheet pile will be used to facilitate these tie-ins. A civil reviewer shall have experience and be proficient in the design and use of sheet pile retaining structures for temporary excavations. The civil engineer shall have familiarity with the design and construction of soil-bentonite and cement barrier walls; which are similar to cutoff walls except that seepage/permeability are of less concern. The Civil and Structural Engineer can be combined into one reviewer if need be.

Discipline	Name	Description of Credentials
Structural Engineering	Robert Reed	The Structural Engineer shall have experience and be proficient in performing stability analysis, finite element analysis, seismic time history studies, and external stability analysis including foundations on high head mass concrete dams. The structural engineer shall have specialized experience in the design, construction and analysis of concrete dams.
Engineering Geologist	Steve Jirousek	The Engineering Geologist shall have experience in assessing internal erosion (seepage and piping) beneath earthen dams with a barrier wall constructed on soils that are primarily sands and gravels, frozen silts, and organic silts that are likely underlain with sands and gravels. The engineering geologist shall be familiar with identification of geological hazards, exploration techniques, field and laboratory testing, and instrumentation. The engineering geologist shall be experienced in the design of grout curtains and must be knowledgeable in grout theology, concrete mix designs, and other materials used in foundation seepage barriers.
Cost Engineering	Sean Weston	The reviewer for cost estimating shall be a registered or certified cost engineer with a BS degree or higher in engineering or construction management, and should have experience estimating complex, phased multi-year civil works construction projects and hydraulic retention structures. The reviewer shall have extensive knowledge of MII software and the TPCS as required during ATR. A certification from the Cost Engineering Center of Expertise (MCX) may be required. The cost reviewer shall have experience in estimating project cost related to a seepage barrier constructed into an existing dam.

Table 9 BCOES Team

Discipline	Name	Description of Credentials
Biddability	TBD	TBD
Constructability	TBD	TBD
Operability	TBD	TBD
Environmental	TBD	TBD
Sustainability	TBD	TBD

Table 10 SAR Panel

Discipline	Name	Description of Credentials
Geotechnical Engineer	TBD	The Geotechnical Engineering panel member should be a senior-level geotechnical engineer with experience in the field of geotechnical engineering, analysis, design, and construction of embankment dams and levees. The Panel Member should have knowledge and experience in the forensic investigation and evaluation of seepage and piping, settlement, slope stability, and deformations problems associated with embankments constructed on weathered and jointed rock and alluvial soils. The Panel Member should have experience in the design and construction of seepage barriers or cutoff walls. The Panel Member should have experience in failure mode analysis, risk assessment of embankment dams, and evaluating risk reduction measures for dam safety assurance projects.
Materials Engineer	TBD	Materials Engineering panel member shall be a registered professional civil engineer from an Architect-Engineer or consulting firm, a public agency, or academia with 10 or more years of experience and have extensive knowledge in soil and rock earthwork control (field and laboratory testing); mix designs and materials for soil cement, concrete, roller compacted concrete, self-consolidating concrete, mass concrete, pavement design and construction. A Master's Degree in Materials Engineering and experience in preparing plans and specifications and field applications for mix in place soil cement barrier walls is preferred.
Structural Engineering	TBD	A structural reviewer will be used during design phase to review the barrier seepage wall tie-ins. A structural reviewer shall have experience and be proficient in performing stability analysis, finite element analysis, seismic time history studies, and external stability analysis including foundations on high head mass concrete dams. The structural engineer shall have specialized experience in the design, construction and analysis of concrete dams.

ATTACHMENT 2

Project Risk Information (FOUO)

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 the 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 IRRMP was approved in November 2009.

A Baseline Risk Assessment was prepared and submitted to the Senior Oversight Group (SOG) in January 2014. The Baseline Risk Assessment Risk Cadre identified 3 significant potential failure modes that were believed to be the primary risk drivers.

i. Backward erosion & piping with vertical exit (heave) adjacent to permafrost zones below the downstream stability blanket.

ii. Backwards erosion and piping with horizontal exit in the South Seepage Collection channel or old Chena Channel.

iii. 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 the exit gradients were insufficient to begin backwards erosion and piping of the sand and gravel foundation matrix.

The SOG re-characterized the Moose Creek Dam as a DSAC 3 (Moderate Urgency) in May 2014 and directed the completion of a Dam Safety Modification Study. A Risk Assessment was conducted during the study phase of the project and the project design includes measure to reduce the 3 primary risk drivers identified. The Risk Assessment team will be coordinated with during PED ATR review to allow for feedback on the project design. Additionally, the Risk Assessment team will be invited to monthly PDT meetings to inform if any changes to the design will increase or decrease the risks. A Post Implementation Evaluation will be conducted after construction to determine if the intent was met through construction of the barrier wall.

Plan F9

Average Annual Life Loss Tolerable Risk Guideline

Average Annual Life Loss is 1.36E-04.

With a high degree of confidence, this plan meets tolerable risk guideline confidence (99.6% chance that average annual life loss is below 1E-03).

Individual Risk Tolerable Risk Guideline

Individual Incremental Life Loss is 5.81E-07.

Meets the Individual Incremental Life Safety Tolerable Risk Guideline.

Annual Probability of Failure Tolerable Risk Guideline

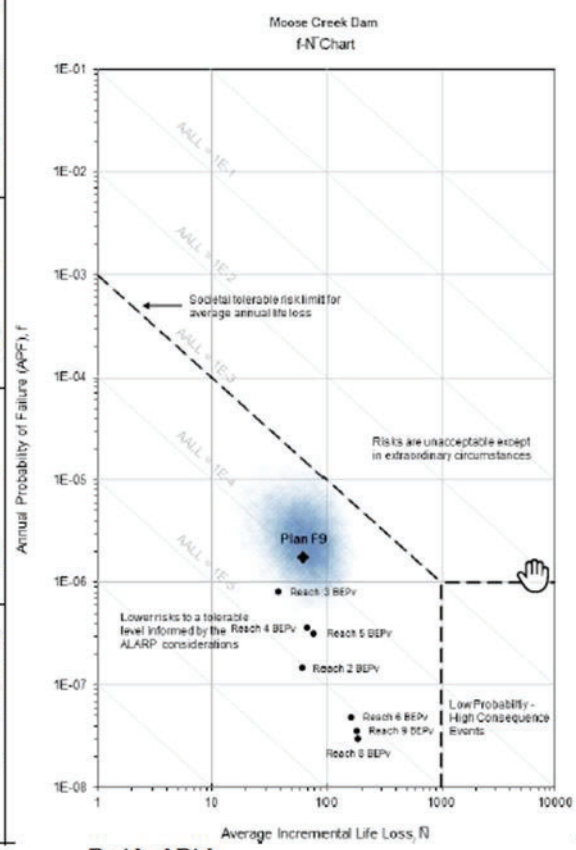
Annual Probability of Failure is 2.90E-06.

Meets the Annual Probability of Failure Tolerable Risk Guideline of 1E-04.

Non-Breach Risk

Does not change as a result of structural measures and remains low since the spillway spills into the Tanana River and does not affect downstream populations. Nonstructural measures improve non-breach risk.

f-N Chart Tolerable Risk Guideline



Residual Risk

Non-actionable Backwards Erosion and Piping with a vertical exit in reaches 2-3.

Figure 4. f-N Chart

ATTACHMENT 3

Review Plan Revisions

Table 11 RP Revisions

Revision Date	Description of Change	Page/Paragraph Number