US Army Corps of Engineers®

Prepared by:
SAW District
SAD Division

W. Kerr Scott Dam (NC00300)

Review Plan – IES

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Reason: RMO Endorsement of Review Plan
Date: 2020.06.29 11:00:50 -04'00'

David E. Carlson, P.E
Chief, Eastern Division

MSC Approval Date: ***Pending***

Last Revision Date: **24** ***June 2020***

Section 1
Purpose and Requirements

1.1 Purpose

This Review Plan (RP) for W. Kerr Scott Dam Issue Evaluation Study (IES) (P2# 111658) (NID# NC00300) will ensure a quality-engineering product is developed by the Corps of Engineers. Per the definition provided in EC 1165-2-217, *Review Policy for Civil Works*, an implementation document is "generally prepared subsequent to the decision document, which supports project implementation or project modification consistent with the decision document and its authorization." The IES, as described in ER 1110-2-1156, is intended to identify the conditions of an existing dam and determine the nature of safety issues or concerns. The IES Report will comply with ER 1165-2-217 and undergo District Quality Control (DQC), Agency Technical Review (ATR) and Dam Senior Oversight Group (DSOG) Review. Due to the implementation nature of the IES, an Independent External Peer Review (IEPR) is not required. The RP will layout a value-added process and describe the scopes of the reviews for the IES.

1.2 References

- EC 1165-2-217, Review Policy for Civil Works, 20 February 2018
- ECB 2019-15, Interim Approach for Risk-Informed Designs for Dam and Levee Projects, 08 October 2019
- ER 1110-1-12, Quality Management, 31 March 2011
- ER 1110-1-8159, DRCHECKS, 1 January 2015
- ER 1110-2-1156, Safety of Dams – Policy and Procedure, 31 March 2014
- W. Kerr Scott IES Work Plan, April 2020 (pending approval)
- SAD Regional Quality Management Plan, 27 April 2006
- W. Kerr Scott Periodic Inspection No. 12, Periodic Assessment No. 1 (Revised), March 2015
- W. Kerr Scott Periodic Inspection No. 13, July 2019

1.3 Requirements

This RP was developed in accordance with EC 1165-2-217, which establishes an accountable, comprehensive, life-cycle review strategy for Civil Works products. This RP will be provided to Project Delivery Team (PDT), District Quality Control (DQC), Hydrologic Hazards and Loading Curve Reviewer, Agency Technical Review (ATR) Team, and Quality Control and Consistency Review (QCC) Teams.

1.4 Review Management Organization

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

Section 2
Project Background and Information

2.1 Project Background

W. Kerr Scott Dam is a high hazard dam on the Yadkin River in Wilkes County, North Carolina, approximately 3.7 miles west of Wilkesboro, 66 miles northwest of Charlotte, and 146 miles west of Raleigh, North Carolina (Figure 1). The main components of the project are shown in Figure 2 and include: an earth embankment; an uncontrolled chute spillway; and a concrete outlet works. The earthen dam is 1,740 feet long with a maximum height of about 148 feet above the streambed and a crest width of 32 feet. The spillway is an uncontrolled chute spillway located in the left (facing downstream) abutment. It is 400 feet wide with a concrete sill at the crest elevation of 1075 feet (NGVD29). The outlet works consists of an intake tower and a conduit. The intake tower has a coarse trash rack, two 6 feet x 12.67 feet gate bays, which transition to a single, circular conduit, two stem-operated fixed-wheel service gates with hydraulic hoists, and one fixed-wheel emergency gate with an electric hoist. The reinforced concrete conduit is 12.25 feet in diameter, and it extends through the dam with a total length of 749 feet. The concrete outlet works consist of a stilling basin with training walls and 11 baffle blocks, which dissipate the energy of water exiting the conduit. The reservoir at top of conservation pool contains about 36,639 acre-feet of water.

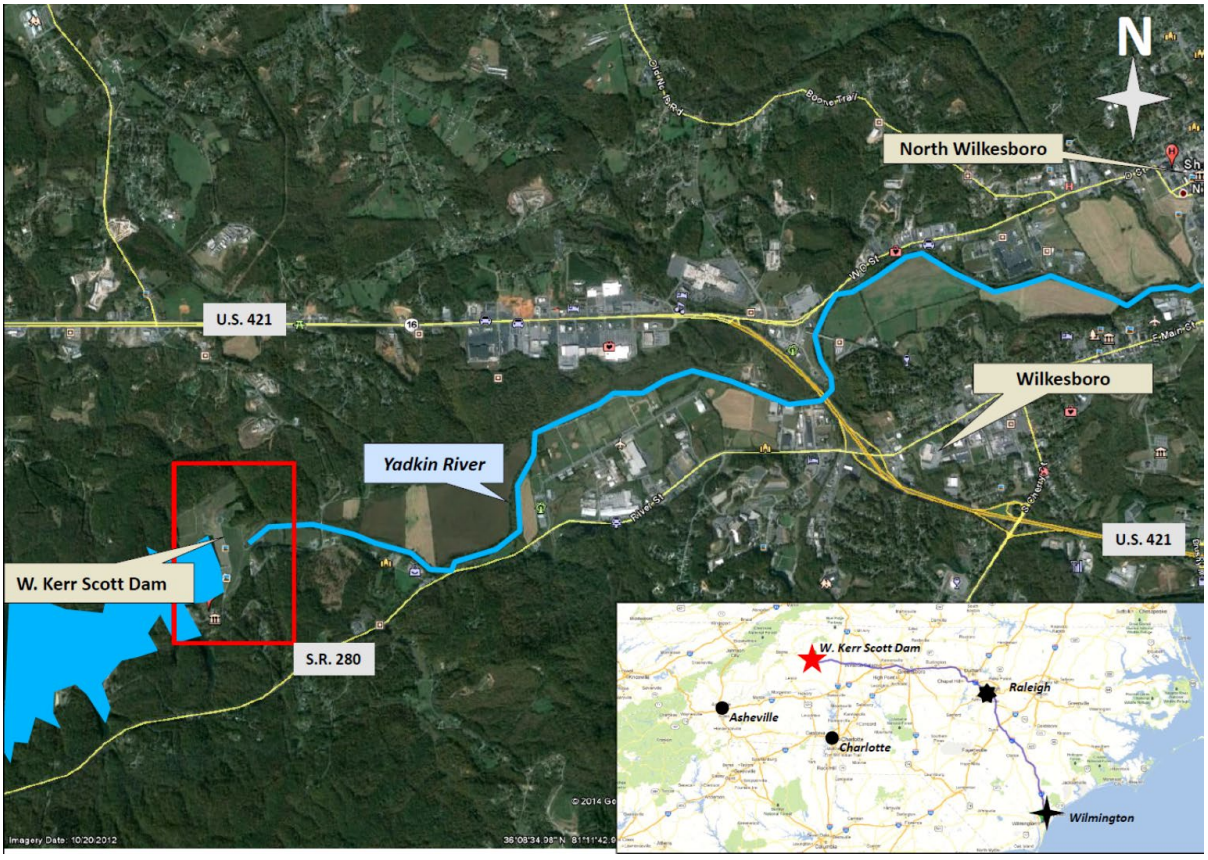

Figure 1. Location map of W. Kerr Scott Dam

Figure 2. Aerial view of W. Kerr Scott Dam

W. Kerr Scott Dam's primary purposes include flood risk management, water supply, recreation, and low flow releases. There are no non-Federal sponsor Operation and Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) responsibilities. The construction contract was awarded in September 1960; reservoir filling started on 22 August 1962. Normal pool elevation of 1030 feet was reached in February 1963.

The dam was designed as an earth and rock fill embankment with a maximum height of 148 feet above the riverbed. Soil and rock materials that were used to construct the embankment were obtained from the excavation of the emergency spillway, according to the 1958 GDM. In the event additional material was needed, a supplementary borrow site located on top of the hill immediately north of the spillway area was proposed; however, it is unlikely that this was used. The alternate borrow site mentioned in the 1958 GDM was compared to Google Earth imagery, and no sign of site disturbance was observed. The embankment has a 4-part zoned design (Figure 3). Selected impervious fill forms the core of the dam, denoted as Zone 1. The Zone 1 material is flanked on either side by compacted random fill (Figure 4). The Zone 3 random fill was graded to 1V:2.5H to accept a layer of dumped rock on its upstream side. The downstream side of the embankment was built to a finished grade of 1V:3H, with room for a dumped rock toe.

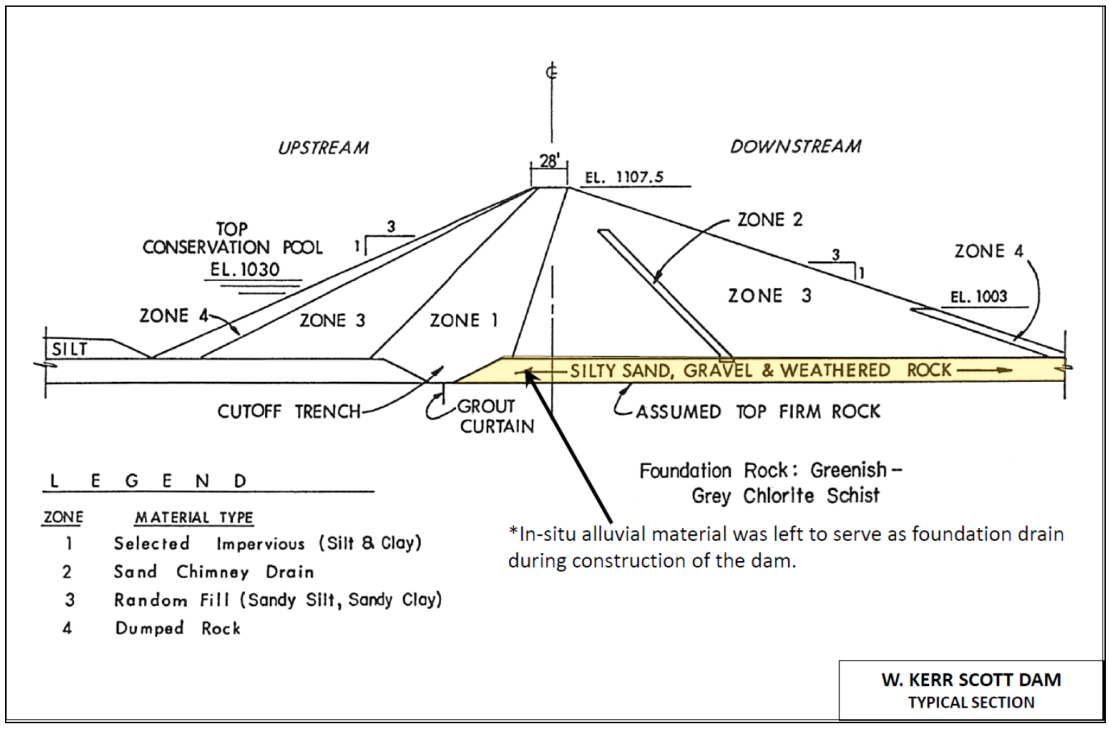

Figure 3. Typical section showing embankment components of W. Kerr Scott Dam

These materials are placed atop a foundation drainage blanket comprised of the partially stripped, in-situ river alluvium (Figure 4). A sand chimney drain (Zone 2) was installed within Zone 3 of the downstream embankment in order to control anticipated embankment seepage (Figure 4). Zone 4 material consists of gravel to boulder sized dumped rock to serve as erosion control and slope protection along the upstream face and toe of the dam. Plans and Specifications indicate that the vertical thickness of the dumped rock varies from 7-feet near the crest to over 30-feet near the toe. The dumped rock was graded to a 1V:3H slope and compacted by multiple passes with a bulldozer.

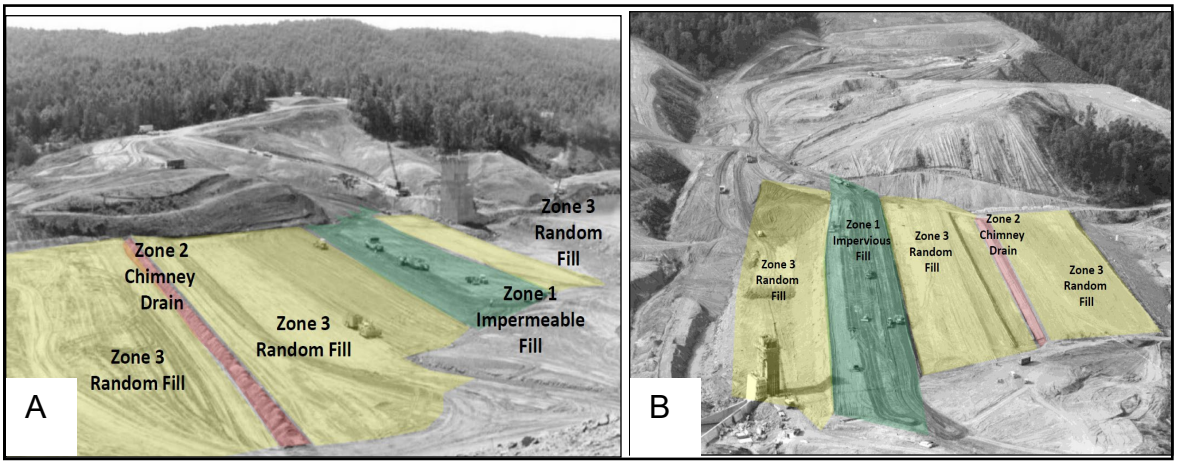

Figure 4. Construction photos showing zoning in the dam

The bulk of the dam is constructed of Zone 1 (selected impervious) and Zone 3 (random) fill material. Addition of Zone 2 (sand chimney drain) and Zone 4 likely occurred in stages as each section of the embankment progressed (Figure 4). Material for selected impervious fill was specified to consist of clays, silty clays or clayey silts. Material for random fill was specified to consist of material which, from the standpoint of

compacted stability, would be suitable for use in embankments. Soft weathered bedrock or saprolite, which breaks up under rolling to form essentially a soil that compacts without excessive voids, was suggested for use. Within both impervious and random fill sections, the fill material was specified to be graded so that finer-grained material would be placed towards the interior, while coarser material would be placed towards the exterior.

The outlet works consists of an intake tower, a 12.25-foot diameter by 749-foot-long conduit (with four seepage collars), service gates, emergency gates, stilling basin, and a service bridge. The outlet works also provides for the release of a minimum low flow. The intake tower, training wall, conduit, and stilling basin are all founded on a prepared bedrock surface.

The intake tower is a wet well, reinforced concrete, gated structure. The structure is 149 feet high, and at its base, 34 feet wide by 42.25 feet long. The invert elevation of the intake tower is 965.0 feet. The tower is divided into two chambers below elevation 1080 feet, each of which contains a service gate and a framed slot into which the emergency gate can be lowered. The service gate hoisting equipment is housed between elevations 1080 feet and 1102.5 feet. The operating room floor and the tower roof deck are provided with covered watertight openings for the removal of the service gates and equipment. The emergency gate hoist is mounted on a monorail overhanging the upstream side of the intake tower roof deck. Only one emergency gate hoist was specified for the project. Operation of either emergency gate would require the operator to actuate the first gate into position, have an assistant on the platform unshackle the gate chain from the hoist, then move the hoist to the second gate for actuation. Presently, the second emergency gate is stored within the project's storage yard facility.

The emergency uncontrolled chute spillway is utilized in the event the reservoir level rises above the top of the flood control pool elevation, 1075.0 feet. It is located on the left side of the dam (Figure 2) and is 400 feet long. The spillway and adjacent training walls are founded in firm bedrock. The orientation of the spillway directs floodwaters into a small tributary of Fish Dam Creek, which empties into the Yadkin River downstream of the dam. The spillway can pass 176,500 cfs of floodwater at the maximum design pool elevation of 1102.5 feet NGVD29.

On 5-14 May 2014, the Wilmington District completed a Periodic Assessment (PA) for W. Kerr Scott Dam. The PA confirmed the initial 2008 Screening Portfolio Risk Analysis (SPRA) for the Dam Safety Action Classification (DSAC) 3. The primary reason for this rating is due to the potentially high consequences downstream due to breach at unusual and extreme events for multiple failure modes. Incremental risk is driven primarily by: 1) the potential for internal erosion of the embankment core material through the foundation, and 2) slope instability of the toe due to tailwater recharge of the foundation drainage blanket and inclined chimney drain. The primary consequence center is Wilkesboro, North Carolina, located approximately 6-7 river miles below the dam. Levees in the metropolitan area would be overtopped. Consequences are driven by the large Population at Risk (PAR) (approximately 2600 during daytime, 932 at night) that are within the flood plain in the vicinity of Wilkesboro, NC. Even small percentages of the population who do not evacuate for whatever reason could result in large life loss numbers. The majority of the estimated life loss occurs in businesses which are located in the flood plain. The estimated depth of flooding for TAS breach within Wilkesboro typically ranges from 30 to 45 feet in affected areas.

2.2 Project Sponsor

Products and analyses provided by non-Federal sponsors as in-kind services are subject to DQC, ATR, and policy and legal compliance reviews. There will not be in-kind contributions for this effort. There are no non-Federal sponsor(s) for the project.

Section 3
District Quality Control

3.1 Requirements

All work products (including supporting data, analyses, reports, etc.) shall undergo DQC in accordance EC 1165-2-217. The District shall perform these minimum required reviews in accordance with ER 1110-1-8159. DQC comments and resolution will be documented utilizing DrChecks[SM], and DQC Certification will be verified by the ATR Team. As a part of DQC, the RMC Senior Advisor and Technical Advisor will review the IES report prior to submission for ATR to ensure completeness.

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

3.2 Documentation

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

3.3 DQC Schedule and Estimated Cost

The following reviews are scheduled in Table 1. The cost for DQC is approximately $50,000.

Project Phase/Submittal	Review Start Date	Review End Date
DQC Review of Hydrologic Hazards and Loading Curves	01JUN20	13AUG20
DQC Review of IES Report	09NOV20	08DEC20

Table 1 DQC Schedule

Section 4
Agency Technical Review

4.1 Requirements

All Civil Works products (including supporting data, analyses, environmental compliance documents, water control manuals, etc.) shall undergo ATR in accordance with EC 1165-2-217. ATR reviews will occur seamlessly, including early involvement of the ATR team for key decisions, and at the scheduled milestones as shown in Table 2 ATR and QCC Schedule. ATR Reviews will be scaled to the appropriate level of technical effort required to evaluate the project findings and recommendations based on the complexity of the project and the level of risk assessment that was conducted. A site visit will not be scheduled for the ATR Team since one is not required for IES's.

4.1.1 ATR Requirements for Hydrologic Hazards and Loading Curves

The Hydrologic Hazards Assessment and Loading Curve will undergo an Agency Technical Review by an RMC Hydrology and Hydraulic (H&H) Advisor or designated Alternate prior to the Risk Assessment Elicitation, or as directed by the RMC. The reviewer will provide advance review of this work product to avoid unnecessary delays to the completion of the risk analysis and IES report. Ideally, this reviewer will serve as the H&H ATR team member for the IES Report. The reviewer is shown in Attachment 1.

4.1.2 ATR Requirements for IES Phase I & II Reports

No reviews were conducted on the Semi-Quantitative Risk Assessment (SQRA). It was decided at the SQRA out-briefing to the RMC that work would proceed for the IES without DQC or other reviews of the SQRA. The SQRA information will all be presented in the IES report that is specified for review in this Review Plan. ATR for Issue Evaluation Studies conducted using quantitative risk methodology will consist of a review of the technical products by an independent ATR team of USACE dam safety professionals who have past experience with dam safety projects and work products. The ATR Team Lead and ATR team shall be selected by the IES Program Manager.

Due to the diverse backgrounds and levels of experience of the cadres and PDTs preparing these reports and the expertise of the ATR team required to ensure the quality and credibility of the government's scientific information, an independent panel of senior-level, highly experienced experts from USACE, other agencies, and private industry, shall supplement the ATR by performing a quality and consistency review (QCC) of the risk assessment findings for quantitative risk assessments. While the ATR Team is given wide latitude to confirm that the technical data, analysis, and methodology meets current agency and state of the practice standards, the scope of the QCC review is more focused and defined by providing written responses to very specific questions that convey the panels professional and technical opinions on the major findings and understandings, the estimated levels of risk and risk reduction, and the appropriateness of the recommendations. The QCC Review findings provide a technical basis to resolve differences of opinion between the PDT and ATR teams, and helps USACE ensure recommended actions are appropriate and applied consistently across the USACE national portfolio of dams. The ultimate decisions concerning the risks and appropriate actions remain with the USACE vertical team.

4.2 Documentation of ATR

4.2.1 Documentation of Hydrologic Hazards Review

Hydrologic Hazards review comments are documented in the form of a Word document or DrChecks^{SM}, as specified below. After resolution of the comments, the reviewer will sign the ATR completion form, and this will be included in the W. Kerr Scott Dam IES review documentation. This signature will ensure all comments have been addressed during ATR and signify concurrence.

4.2.2 Documentation of IES Phase I and II ATR

Documentation of ATR for the IES Phase I and Phase II studies will be performed using the requirements of EC 1165-2-217. This should include the four-part comment structure and the use of DrChecks^{SM} for comment collaboration, response, and back checking.

The scope of the QCC Panel, is to review the draft documents, submit written draft comments that address a series of charge questions, attend a panel discussion with the PDT and ATR Lead to collaborate their major

findings and understandings of the project, and submit updated responses to the charge questions following the panel discussion as a deliverable. Documentation of the review findings shall be in written format and in accordance with the A-E contract or Agency Scope of Work. The Panel's responses to the charge questions will be included in the final ATR documentation of the IES Report.

4.3 Products to Undergo ATR

Below is a list of products the ATR team will review.

- IES Report (includes SQRA documentation that did not previously undergo ATR)
- Modeling, Mapping, and Consequences Production Center (MCC) Updated Consequences and Flood Maps using LifeSim Model

4.4 Required Team Expertise and Requirements

4.4.1 IES Phase I & II ATR Team

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

ATR Lead - The ATR team leader will be a senior USACE dam safety professional and will have experience leading and conducting ATR for similar projects and work products. The ATR lead will direct the scope and focus of the review efforts by each discipline. The ATR team leader will be from outside the home MSC and will have 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 - The geotechnical engineer will have experience in the design, construction, and evaluation of embankment dams, potential failure mode analysis, and dam safety risk analysis. The geotechnical engineer will have experience in subsurface investigations, rock and soil mechanics, internal erosion evaluation, slope stability evaluation, and earthwork construction.

Engineering Geologist - The engineering geologist will have experience in assessing the geologic setting, bedrock geology, unconsolidated deposits, and hydrogeology and correlating the performance of foundations with the significant engineering properties. The engineering geologist will have specialized experience with embankment dam founded on alluvium.

Hydrology and Hydraulics (H&H) Engineer – The H&H engineer will have experience in the analysis and design of hydraulic structures for dams and will be knowledgeable and experienced with the routing of inflow hydrographs through multipurpose flood control reservoirs utilizing multiple discharge devices, evaluation of extreme flood events (e.g., PMF), development of the flood hazard/loading (i.e., stage-frequency and duration relationships), USACE hydrologic and hydraulic modeling, and breach and non-breach inundation for dam safety risk analysis. (This may be two separate reviewers and will be split if needed)

Structural Engineer – The structural engineer will have experience evaluating the design, construction, and evaluation of hydraulic structures for dams (including gates/closure structures and penetrations), potential failure mode analysis, and dam safety risk analysis.

Consequences (Economist) – The economist (or consequence specialist) will have experience evaluating flood risk management projects in accordance with ER 1105-2-100 and USACE models and techniques to estimate population at risk, life loss, and economic damages for dam safety risk analysis.

4.4.2 IES Phase I and II QCC Panel

The panel will consist of Senior Technical Experts from A-E firms and/or Technical Specialists from USACE. It is anticipated that three to four panel members from any of these groups will be selected by the RMC to review each project report. The panel members selected for each specific project will be referred to as the QCC Panel for that project. The ATR Lead will be invited to attend the QCC review.

4.5 Statement of Technical Review Report

4.5.1 IES Phase I & II Review Report

At the conclusion of each ATR effort, the ATR team will prepare a Statement of Technical Review Report with a completion and certification memo. The report will be prepared in accordance with EC 1165-2-217. At the conclusion of the QCC, the review facilitator will prepare a memo for the RMC Director's Signature that summarizes what issues must be addressed prior to presentation to DSOG. ATR and QCC will take place concurrently. Both will be completed prior to the presentation to DSOG.

4.6 ATR and QCC Schedule and Estimated Cost

The preliminary ATR and QCC schedule is listed in Table 2. The cost for the ATR is approximately $30,000, The cost for the QCC is approximately $80,000.

Project Phase/Submittal	Review Start Date	Review End Date
ATR of Hydrologic Hazards and Loading Curves	14AUG20	27AUG20
ATR of IES Report	09DEC20	05FEB21
QCC of IES Report	09DEC20	05FEB21

Table 2 ATR and QCC Schedule

Section 5
DSOG Review

5.1 Requirements

All IES work products will undergo a review by the Dam Safety Senior Oversight Group (DSOG). The DSOG is provided an advanced copy of the final report approximately four weeks prior to the DSOG Panel Discussion, or as directed by the Program Manager. The PDT will prepare DSOG Briefing Slides summarizing the project Risk, the report findings, and recommendations. These slides will be reviewed by the Program Manger prior to presentation to DSOG for clarity and conciseness.

5.2 Documentation

At the conclusion of the DSOG briefing, a memo will be prepared by the DSOG Chairperson that summarizes the risk characterization of the dam, confirms or adjusts the recommended DSAC, proposes Dam Safety and Operations and Maintenance (O&M) actions to reduce risk, and is signed by the Headquarters Dam Safety Officer.

Section 6
Policy and Legal Compliance Review

All IES products will be reviewed throughout the study process for their compliance with law and policy. Guidance for policy and legal compliance reviews is addressed in Appendix H, ER 1105-2-100, and Chapter 8 of ER 1110-2-1156. These reviews culminate in determinations that the recommendations in the reports and the supporting analyses and coordination comply with law and policy, and warrant approval or further recommendation to higher authority by the home MSC Commander. DQC and ATR augment and complement the policy review processes by addressing compliance with pertinent published Army policies, particularly policies on analytical methods and the presentation of findings in decision documents. Initial and final policy compliance reviews will be conducted concurrently by the MSC and HQUSACE.

Section 7
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.saw.usace.army.mil/Library/Review-Plans/). 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 8
Review Plan Approval and Updates

The MSC Commander, or delegated official, is responsible for approving this RP. 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 RP is a living document, all changes made to the approved RP will be documented in Attachment 3, Table 9 RP Revisions. Re-approval of RPs by the MSC, with re-endorsement by the RMO, will be required when there are significant changes, such as when the project advances from an SQRA to additional IES Phases. Some projects with small changes will not require re-approval and re-endorsement. The latest version of the RP, along with the Commander's approval memorandum, will be posted on the District's webpage and linked to the HQUSACE webpage. The approved RP should be provided to the RMO.

Section 9
Engineering Model Certification and Approval

The use of certified or 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 and ATR. Where such validations have not been completed, appropriate independent checks of critical calculations will be performed and documented as part of DQC. The following engineering models, software, and tools are anticipated to be used:

Model Name	Version	Validation Date
Life Simulation Model	2.0	Certified
HEC-RAS	5.0	Certified
WinDAM	C 1.01.0007	Certified August 2017

Table 3 Models and Status

Section 10
Points of Contact

Title	Organization	Email/Phone
CESAW DSPM	CESAW-ECP-EG	910-251-4918
Cadre Lead	CEMVN-EDC	504-862-2127
Senior Reviewer	CEIWR-RMC	304-399-5217

Table 4 RP POCs