PROJECT REVIEW PLAN

Review Plan for
Implementation Documents and Other Work Products
Southwestern Division (SWD)

ADDICKS & BARKER DAMS
Dam Safety Modification Report
Buffalo Bayou & Tributaries
Houston, Texas

Project P2 Number 145913

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US Army Corps
of Engineers ®

REVIEW PLAN

Buffalo Bayou Tributaries, Houston, Texas
Addicks and Barker Dam Safety Modification Study

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1. PURPOSE AND REQUIREMENTS

Purpose. This Review Plan defines the scope and level of peer review for the Buffalo Bayou Tributaries, Houston, Texas, Addicks and Barker Dams, Dam Safety Modification Study and Design.

A. References

(1) Engineering Circular (EC) 1165-2-209, Civil Works Review Policy, 31 Jan 2010
(2) EC 1105-2-412, Assuring Quality of Planning Models, 31 Mar 2010
(3) Engineering Regulation (ER) 1110-1-12, Quality Management, 30 Sep 2006
(4) ER 1105-2-100, Planning Guidance Notebook, Appendix H, Policy Compliance Review and Approval of Decision Documents, Amendment #1, 20 Nov 2007
(5) ER 1110-2-1156, Safety of Dams – Policy and Procedures – Policy and Procedure, 28 October 2011
(6) PMP for study dated March 11, 2011
(7) MSC and/or District Quality Management Plan(s)

B. Requirements. This review plan was developed in accordance with EC 1165-2-209, which establishes an accountable, comprehensive, life-cycle review strategy for Civil Works products by providing a seamless process for review of all Civil Works projects from initial planning through design, construction, and operation, maintenance, repair, replacement and rehabilitation (OMRR&R). The EC outlines four general levels of review: District Quality Control/Quality Assurance (DQC), Agency Technical Review (ATR), Independent External Peer Review (IEPR), and Policy and Legal Compliance Review. In addition to these levels of review, decision documents are subject to cost engineering review and certification (per EC 1165-2-209) and planning model certification/approval (per EC 1105-2-412).

2. REVIEW MANAGEMENT ORGANIZATION (RMO) COORDINATION

The RMO is responsible for managing the overall peer review effort described in this Review Plan. The RMO for decision documents is typically either a Planning Center of Expertise (PCX) or the Risk Management Center (RMC), depending on the primary purpose of the decision document. The RMO for the peer review effort described in this Review Plan is the Risk Management Center.

The RMO will coordinate with the Cost Engineering Directory of Expertise (DX) to ensure the appropriate expertise is included on the review teams to assess the adequacy of cost estimates, construction schedules and contingencies.

The RMC will be the review managing organization (RMO) on technical issues dealing with the review of scope and the ATR team composition. The ATR team will be comprised of individuals from outside

the home district that have not been involved in the development of the decision document and will be chosen based on expertise, experience, and/or skills.

3. STUDY INFORMATION

A. **Decision Document.** The decision documents for the Addicks and Barker DSMS will consist of a Dam Safety Modification Report, an Environmental Assessment (EA), and any other supporting document needed for approval. The DSMR will identify the significant failure modes that could lead to a dam failure and will identify risk management measures and plans to remediate for the significant failure modes. Action is needed because of the hydrologic and seepage deficiencies identified negatively affecting the integrity of the outlet works at Addicks and Barker Dams. The deficiencies identified increase the life safety risk to the downstream communities that are not tolerable according to Corps guidance. These concerns contributed to its classification by the USACE Screening for Portfolio Risk Assessment (SPRA) as a Dam Safety Action Class I – Urgent and compelling project. Rehabilitation is needed to correct these instability issues and to minimize the potential for catastrophic failure of the dams. The decision document will present planning, engineering, real estate and implementation details of the recommended plan to allow design and construction to proceed subsequent to the approval of the recommended plan. This project will not require Congressional authorization.

A cost and schedule risk analysis was completed by the USACE Civil Works Cost Engineering and Agency Technical Review (ATR) Mandatory Center of Expertise (MCX) Walla Walla District as documented in the Addicks- Barker Dam Safety Modification Project Cost and Schedule Risk Analysis Report dated July 24, 2012.

B. **Study/Project Description.**

Addicks and Barker Dams are located in southeast Texas in the San Jacinto River basin approximately 17 miles west of downtown Houston (Figure 1). The dams are strategically located above the confluence of Buffalo Bayou and South Mayde Creek. Beyond this confluence, Buffalo Bayou continues east through downtown Houston, where it joins with White Oak Bayou, and eventually becomes the Houston Ship Channel, which flows into San Jacinto Bay. The majority of both Addicks and Barker Dams fall within Harris County; however, a small portion of Barker Reservoir crosses into Fort Bend County. Addicks Dam is situated on the north side of Interstate Highway 10 (I-10) with State Highway 6 (SH 6) bisecting the dam north to south. Barker Dam is situated on the south side of I-10, west of SH 6.

Addicks Dam Components: Addicks Dam is a homogeneous earthen embankment founded primarily on a clay / sandy clay foundation. The dam consists of 4,794,000 cubic yards of random fill as compacted embankment having an overall length of about 11.6 miles. The

embankment has a maximum elevation of about 53.5 feet. A drainage ditch to replace the dammed off Turkey Creek was excavated parallel and flows adjacent to the downstream toe. The crest elevation of the dam is 121.1 feet NAVD 1988 (2009). The drainage area for Addicks Reservoir is 136 square miles.
The invert elevation of the intake structure is 67.5 NAVD 1988 (2009). The inlet works at the Addicks Dam consists of a riprap approach into five gated 8‘ x 6‘rectangular concrete conduits to intake gates that regulate flows from the reservoir through the dam into Buffalo Bayou.

Barker Dam Components: The Barker Dam is a homogeneous earthen embankment founded primarily on a clay/sandy clay foundation. The dam consists of 3,574,000 cubic yards of random fill as compacted embankment having an overall length of about 13.6 miles. The embankment has a maximum height of about 42.9 feet. The crest elevation of the dam is 112.9 feet NAVD 1988 (2009).

The invert elevation of the intake structure is 70.2 NAVD 1988 (2009). The inlet works at the Barker Dam consists of a riprap approach into five gated 9‘ x 7‘ rectangular concrete conduits to intake gates that regulate flows from the reservoir through the dam into Buffalo Bayou.

Addicks and Barker Dams, floodwater detention structures, are significant features of the Buffalo Bayou Project. The Buffalo Bayou, Texas, Project, as authorized by the Rivers and Harbors Act, approved 20 June 1938, and modified by the Flood Control Acts of 11 August 1939 and 3 September 1954, provides for improvement of Buffalo Bayou and its principal tributaries, White Oak Bayou, and Brays Bayou. The project was authorized for the purpose of protecting urban development in the downstream flood plain of Buffalo Bayou through the city of Houston.

Remediation is necessary to address the dam safety deficiencies at Addicks and Barker Dams. These reservoirs, located adjacent to each other on the upper watershed of Buffalo Bayou, serve as detention basins designed to collect excessive amounts of rainfall and release that rainfall down Buffalo Bayou at a controlled rate that prevents flooding in downtown Houston and the urban areas west of downtown. With the increased development of lands downstream of the reservoirs forcing the tighter regulation of the water releases and the increased development of the watershed upstream of the reservoirs causing increased runoff into the projects, the value of the dams and reservoirs for flood damage reduction is ever increasing. Four of the top ten pools at both Addicks and Barker dams have occurred in the past 10 years.

Normal regulating procedures specify that combined releases from the two reservoirs, in addition to the uncontrolled runoff downstream, should not exceed 2,000 cfs as measured at

the Buffalo Bayou, Piney Point Road gauging station. Figure 1 is a map locating the dams in relation to the Buffalo Bayou watershed.

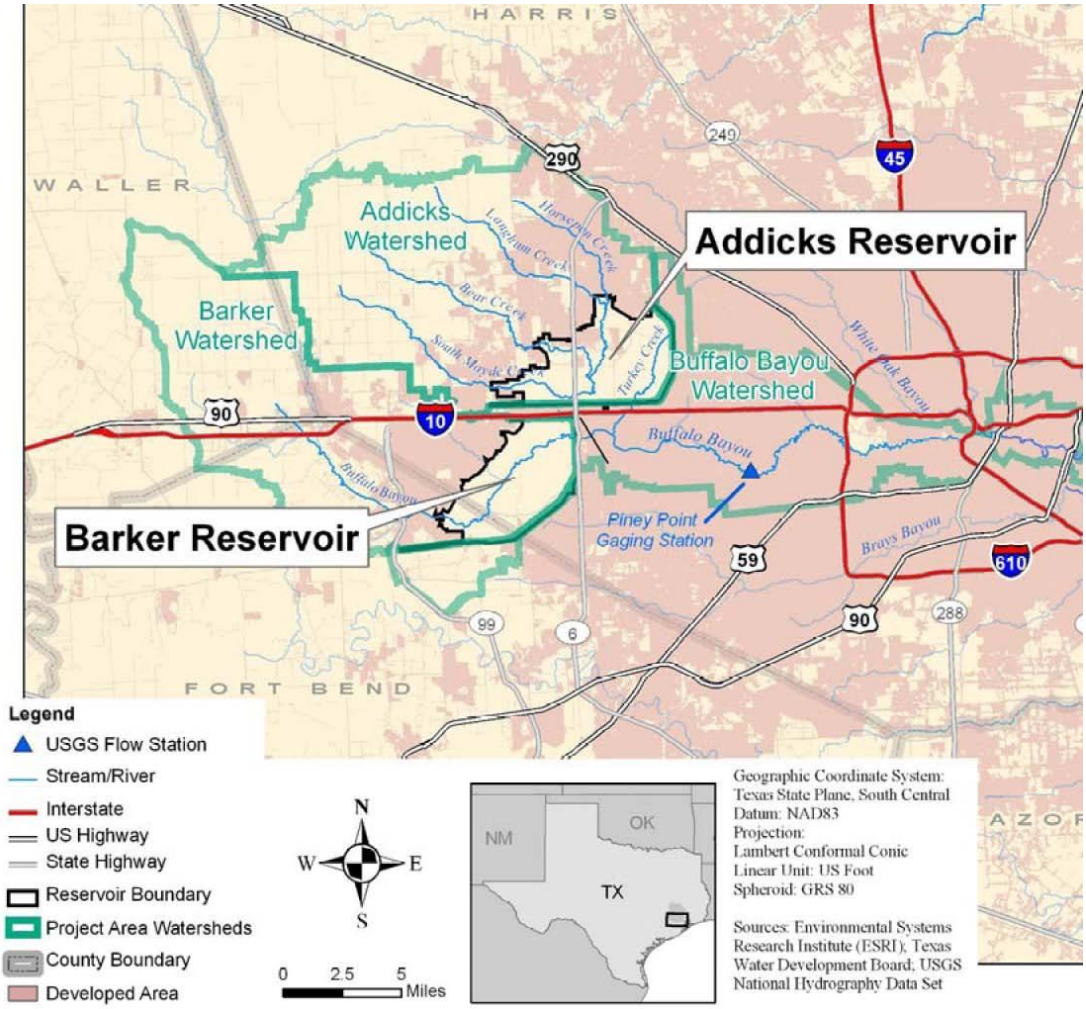

Figure 1. Addicks and Barker Reservoirs, Project Location Map

The encroachment of urban development on Addicks and Baker Reservoirs are evident in Figures 2 and 3. Figure 4 is a typical cross section drawing of the dam at the outfall structure. Figure 5 is an aerial view of Barker outfall structure. Note Hwy. 6 just below the outfall structure of the dam. During extreme weather events such as a hurricane, this road is a crucial evacuation route for cities south of the reservoir.

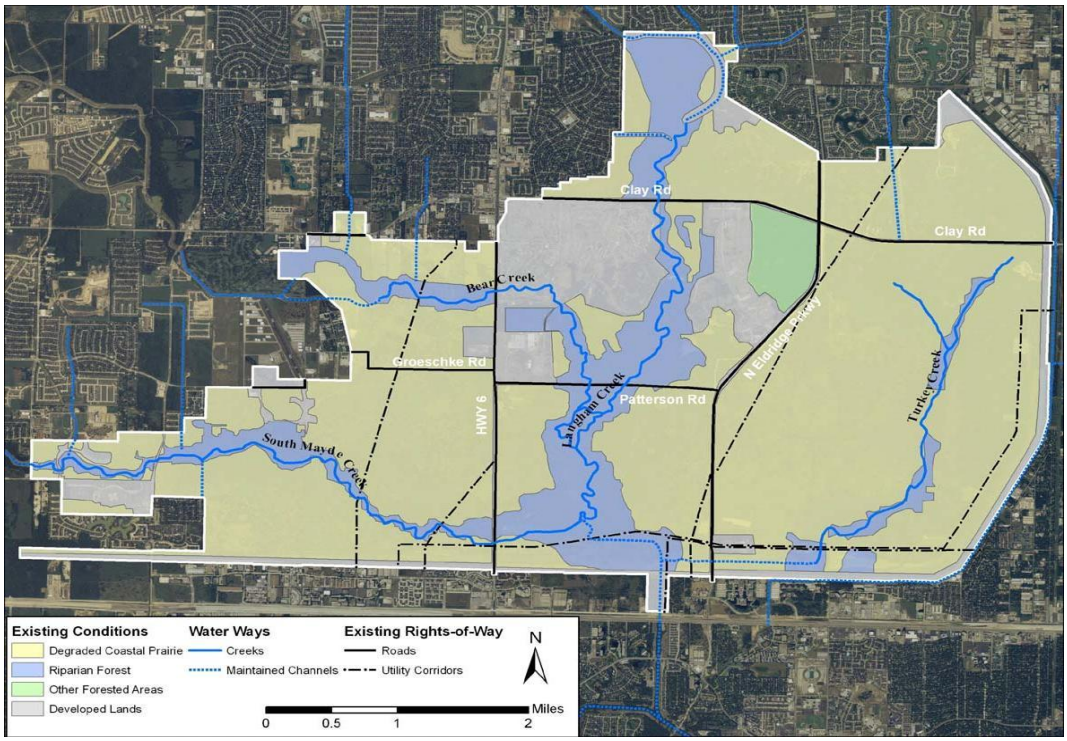

Figure 2: Site Plan of Addicks Reservoir

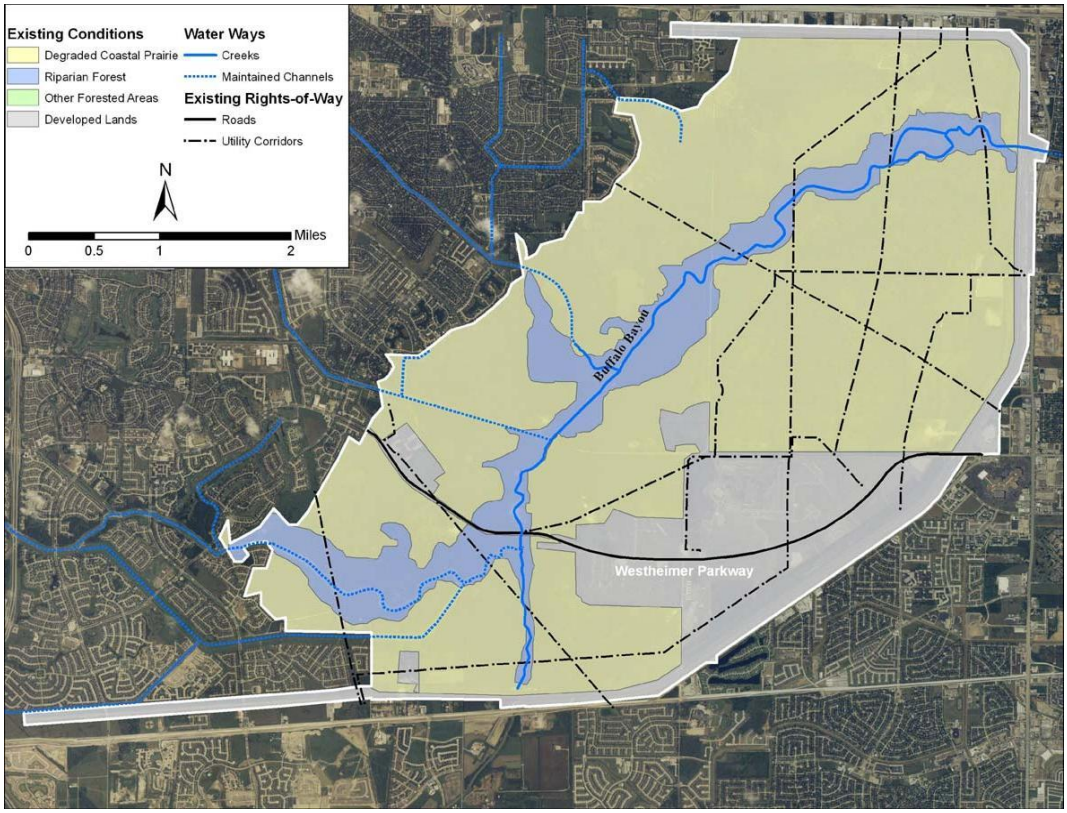

Figure 3: Site Plan of Barker Reservoir

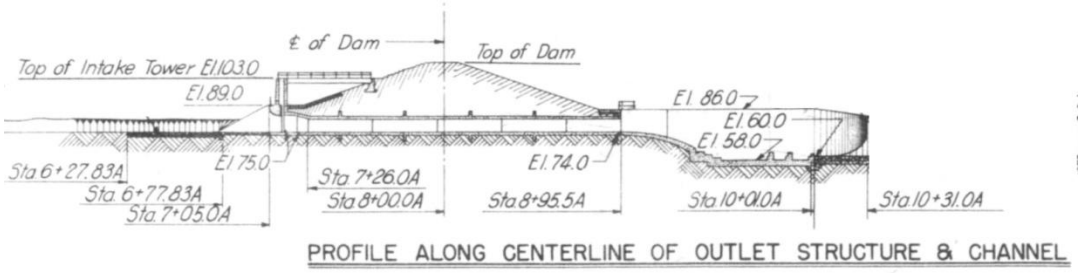

Figure 4: Typical Profile View of Dam at Outlet Structure

Figure 5 – Aerial View of the Outlet Works

C. Dam Safety Issues.

In December 2010 Addicks and Barker Dams were classified as a DSAC I by HQUSACE. Studies conducted since 2004 have determined that the existing dams Addicks Reservoir and Barker Reservoir are a high risk of failure due to seepage and piping issues. The overriding critical issue of this project is the population of the city of Houston is downstream of the two dams.

Significant Failure Modes - Addicks

PFM 1 – Seepage flow along or beneath the outlet works structure due to voids or low stress areas leads to headcut erosion beneath the outlet works structure.

PFM 4a – Erosion of embankment toe due to flow around the north end of the dam and over the spillway results in scour of ditch at embankment toe leading to slope failure of the embankment.

PFM 5 – Loss of spillway slabs and breach of spillway at high pools.

PFM 6 – Foundation seepage and piping through soil beneath conduit or within the window beside the conduit where there is no cutoff wall as the cutoff wall rises and goes over the conduit leading to backward piping and erosion.

PFM 21 – Hydraulic pressure in the conduit exceeds pressure outside the conduit which leads to seepage through conduits joints and erosion along conduits.

PFM 22 – Instability of the outlet works parabolic chute slab and stilling basin training walls due to uplift caused by excessive seepage and/or high tailwater.

Significant Failure Modes - Barker

PFM 1 – Differential settlement beneath conduits leads to seepage and headcut erosion beneath the conduits.

PFM 7 – Seepage and piping in foundation at old Buffalo Bayou channel beneath the existing cutoff wall and exiting at the end of the stilling basin.

PFM 8 – Seepage and piping in foundation at end of cutoff trench at Noble Road.

PFM 21 – Hydraulic pressure in the conduit exceeds pressure outside the conduit which leads to seepage through conduit joints and erosion along conduits.

PFM 22 – Instability of the outlet works parabolic chute slab and stilling basin training walls due to uplift caused by excessive seepage and/or high tailwater.

Factors Affecting the Scope and Level of Review.

The following factors will affect the project study and level of review:

(1) The study will be challenging dealing with many aspects of the project. The list below is a list of challenges that may be an issue during the study or construction:
   - (a) Structural Stability and Capacity of the area soils
   - (b) Probabilistic versus deterministic design
   - (c) Hydrology (Probable Maximum Flood)
   - (d) Developing appropriate conduit and outfall structure designs
   - (e) Non-failure Risk

(2) There will be minor environmental impacts from construction of the project. There will be limited effects to health and safety (noise and air quality), riparian, and listed species. The project is also likely to have minimal economic impacts. Existing recreational opportunities will be minimally impacted by construction noise and air quality. Residents do not live in close proximity to either of the dams outlet works, therefore health and safety issues due to impacts on noise and air quality, will not have to be relocated. The project is unlikely to have further social impacts unless Native American remains are discovered. These impacts of the project will be discussed in detail in the project EA.

(3) The study has local, state and Federal interest. The reservoirs are owned and managed by the Galveston District of the Corps of Engineers.
(4) The project presents a threat to human life/safety because of its high risk of failure under an extreme event and the large population of risk downstream.
(5) The project has potential for public controversy due to reservoir management for flood control and recreation.
(6) The Addicks and Barker DSMS has the potential for setting precedence in disciplines such as hydrology and geo-technology.
(7) There are risks associated with the evaluation of the seepage and piping problems. The methods used to investigate and analyze these two areas of disciplines for Addicks and Barker DSMS could be controversial and have impacts to the project design, cost estimates, and schedule.
(8) Buffalo Bayou and Tributaries is not located in a seismically active region. Due to the flood risk mitigation purpose of the dam, the sequencing of construction operations and the adequate preparation of the subsurface to prevent dam failure during construction must be thoroughly reviewed.

D. In-Kind Contributions.

Products and analyses provided by non-Federal sponsors as in-kind services are subject to DQC, ATR, and IEPR. No in-kind products or analyses will be provided by the non-Federal sponsor because the project is fully funded by the Federal Government.

4. DISTRICT QUALITY CONTROL (DQC)

All decision documents (including supporting data, analyses, environmental compliance documents, etc.) shall undergo DQC. DQC is an internal review process of basic science and engineering work products focused on fulfilling the project quality requirements defined in the Project Management Plan (PMP).

A. Documentation of DQC.

The DQC will be managed by the Galveston District in accordance with ER 1110-1-12 and the Southwest Division and the Galveston District Quality Management Plans. The DQC will be documented using Dr. Checks. A list of the DQC team roster is provided in Attachment 1. The DQC team members represent the following disciplines: Geotechnical Engineering, Hydraulic and Hydrology Engineering, Structural and Civil Engineering, Cost Estimating, Planning and Economics, Real Estate, Environmental Planning/NEPA.

B. Products to Undergo DQC.

- Dam Safety Modification Report
- Dam Safety Modification Report Appendices
- Draft Environmental Assessment

5. AGENCY TECHNICAL REVIEW (ATR)

ATR is mandatory for all decision documents (including supporting data, analyses, environmental compliance documents, etc.). The objective of ATR is to ensure consistency with established criteria, guidance, procedures, and policy. The ATR will assess whether the analyses presented are technically correct and comply with published USACE guidance, and that the document explains the analyses and results in a reasonably clear manner for the public and decision makers. ATR is managed within USACE by the designated RMO and is conducted by a qualified team from outside the home district that is not involved in the day-to-day production of the project/product. ATR teams will be comprised of senior USACE personnel and may be supplemented by outside experts as appropriate. The ATR team lead will be from outside the home MSC.

The ATR will be a three phased approach due to schedule constraints and the high priority associated with a DSAC I project. The goal is to an approved DSM report by December 2012. The three phases are described below and have been accepted by the Risk Management Center, West Office.

A. Documentation of ATR.

The ATR will be managed by the RMC and the ATR lead. DrChecks review software will be used to document all ATR comments, responses and associated resolutions accomplished throughout the review process. Comments should be limited to those that are required to ensure adequacy of the product. The four key parts of a quality review comment will normally include:

(1) The review concern – identify the product's information deficiency or incorrect application of policy, guidance, or procedure;
(2) The basis for the concern – cite the appropriate law, policy, guidance, or procedure that has not been properly followed;
(3) The significance of the concern – indicate the importance of the concern with regard to its potential impact on the plan selection, recommended plan components, efficiency (cost), effectiveness (function/outputs), implementation responsibilities, safety, Federal interest, or public acceptability; and
(4) The probable specific action needed to resolve the concern – identify the action (s) that the reporting officers must take to resolve the concern.

In some situations, especially addressing incomplete or unclear information, comments may seek clarification in order to then assess whether further specific concerns may exist. The ATR documentation in DrChecks will include the text of each ATR concern, the PDT response, a brief

summary of the pertinent points in any vertical team coordination (the vertical team includes the district, RMO, MSC, and HQACE), and the agreed upon resolution.

If an ATR concern cannot be satisfactorily resolved between the ATR team and the PDT, it will be elevated to the vertical team for further resolution in accordance with the policy issue resolution process described in either ER 1110-1-12 or ER 1105-2-100, Appendix H, as appropriate. Unresolved concerns can be closed in DrChecks with a notation that the concern has been elevated to the vertical team for resolution.

At the conclusion of the ATR effort, the ATR team will prepare a Review Report summarizing the review. Review Reports will be considered an integral part of the ATR documentation and shall:

(1) Identify the document(s) reviewed and the purpose of the review;
(2) Disclose the names of the reviews, their organizational affiliations, and include a short paragraph on both the credentials and relevant experiences of each reviewer;
(3) Include the charge to the reviewers;
(4) Describe the nature of their review and their findings and conclusions;
(5) Identify and summarize each unresolved issue (if any); and
(6) Include a verbatim copy of each reviewer's comments (either with or without specific attributions), or represent the views of the group as a whole, including any disparate and dissenting views.

ATR will be certified when all ATR comments are either resolved or referred to the vertical team for resolution and the ATR documentation is complete. The ATR Lead will prepare a Statement of Technical Review certifying that the issues raised by the ATR team have been resolved (or elevated to the vertical team). A Statement of Technical Review should be completed, based on work reviewed to date, for the risk management alternative formulation briefing, draft report, and final report.

B. Products to Undergo ATR.

- Dam Safety Modification Report
- Dam Safety Modification Report Appendices
- Draft Environmental Assessment

C. Required ATR Team Expertise.

Table 1: ATR Team Members

ATR Team Members/Disciplines	Expertise Required
ATR Lead	The ATR lead should be a senior professional with 15-20 years experience in preparing Civil Works decision documents, conducting ATRs and have a current professional registration licensure. The lead should also 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 (such as engineering or planning, etc).
Geotechnical Engineering	The Panel Member should be a registered professional geotechnical engineer with 15-20 years experience with embankment dam design and evaluation is mandatory, as well as seepage and piping and seepage failure mode analysis, risk analysis of embankment dams and preferably possess a MS degree in geotechnical engineering or soils engineering. Must be familiar with the USACE risk informed approach to dam risk decision making. Should have several years of direct dam safety experience through participation in dam safety expert panels, risk evaluation/mitigation studies or similar experience with hydraulic retaining structures. Should have design or construction management experience with underground concrete structures with hydraulic retaining structure rehabilitation projects as either designer or construction project engineer, including necessary worksite earthwork preparation and workflow management.
Structural Engineering	The Structural engineer should be a registered professional structural engineer with 10-15 years experience evaluating dam structural elements such as spillway and regulating gates. The member will preferably possess a MS degree in structural engineering. The member should have design experience or education evaluating reinforced concrete structures with emphasis on buried concrete structures.
Civil Engineering/Construction	The Civil Engineer team member should be a registered professional civil engineer and have 10-15 years experience assessing hydraulic retention structures. The Panel member will hold at minimum, a B.S. degree in Civil Engineering and should have direct design or construction management experience with dam rehabilitation projects especially with regard to spillways, stilling basins and drainage pipes.
Hydrology & Hydraulic Engineering	The Hydrology & Hydraulic Engineering Panel Member should be a registered professional engineer and have 10-15 years experience with engineering analysis related to flood risk management, assessing hydraulic retention structures and dam safety projects. The Panel member will hold at minimum, a B.S. degree in Civil Engineering, or Hydrology and Hydraulics

	Engineering. The Panel Member should be familiar with standard Corps hydrologic and hydraulic computer models (HEC-RAS, HEC-HMS, & HEC-ResSim). The Panel Member should have experience with characterizing surface water flow s in a watershed using inundation mapping software, water-flow scenarios development techniques, and unsteady flow dam failure analysis modeling. The Panel Member must demonstrate knowledge and experience with the routing of inflow hydrographs through multipurpose flood control reservoirs. The panel member should have direct design or construction management experience with dam rehabilitation projects especially related to spillways, stilling basins, and drainage gates.
Cost Engineering	The Engineering cost estimator should be a registered professional engineer and have 10-15 years experience in an appropriate field. The position should be accustom to estimating complex, phased costing of multi-year civil construction projects and using the MII cost estimating software used by USACE. The member should have direct experience estimating hydraulic retention structures.
Real Estate	The Real Estate reviewer should have 10-15 years experience in reviewing dam/reservoir projects. The Panel member should hold at minimum, a B.S. degree.
NEPA Compliance/Cultural Resources/ Environmental Resources	The NEPA Compliance/Cultural Resources/ Environmental Resources Lead should have 10-15 years experience evaluating and conducting NEPA impact assessments, including cumulative effects analyses, for complex multi-objective public works projects with competing trade-offs. The Panel member will hold at minimum, a B.S. degree. This panel member should have experience working with project teams, to identify and evaluate measures and alternatives using appropriate planning methodologies to reduce life safety risk. Must have extensive experience reviewing the analysis in which the measures and alternatives were evaluated and that they are sufficiently comprehensive and complete to result in approval of a recommended alternative. The Panel member will hold at minimum, a B.S. degree.
Economics	The Economist should have 10-15 years experience or equivalent education characterizing the economies of industrial (high tech, food, aerospace) and transportation based economies. The Panel member will hold at minimum, a B.S. degree. Should have experience working with risk models and disaster scenarios with regard to economic impact.

The ATR team roster is listed in attachment 1.

6. INDEPENDENT EXTERNAL PEER REVIEW (IEPR)

IEPR is the most independent level of review, and is applied in cases that meet certain criteria where the risk and magnitude of the proposed project are such that a critical examination by a qualified team outside of USACE is warranted. The Risk Management Center (RMC) will oversee the IEPR effort. Any work product, report evaluation, or assessment that undergoes DQC and ATR also may be required to undergo IEPR under certain circumstances. A risk-informed decision, as described in EC 1165-2-209, is made as to whether IEPR is appropriate for that product. IEPR panels will consist of independent, recognized experts from outside of the USACE in the appropriate disciplines, representing a balance of areas of expertise suitable for the review being conducted. Panel members will be selected using the National Academies of Science (NAS) policy for selecting reviewers. IEPR teams are not expected to be knowledgeable of Army and administration policies, nor are they expected to address such issues. IEPR is divided into two types, Type I is generally for decision documents and Type II is generally for implementation documents:

- Type I IEPR. Type I IEPR reviews are managed outside the USACE and are conducted on project studies. Type I IEPR panels assess the adequacy and acceptability of the economic and environmental assumptions and projections, project evaluation data, economic analysis, environmental analyses, engineering analyses, formulation of alternative plans, methods for integrating risk and uncertainty, models used in the evaluation of environmental impacts of proposed projects, and biological opinions of the project study. Type I IEPR will cover the entire decision document or action and will address all underlying engineering, economics, and environmental work, not just one aspect of the study.

- Type II IEPR. Type II IEPR, or Safety Assurance Review (SAR), are managed outside the USACE and are conducted on design and construction activities for hurricane, storm, and flood risk management projects or other projects where existing and potential hazards pose a significant threat to human life. Type II IEPR panels will conduct reviews of the design and construction activities prior to initiation of physical construction and, until construction activities are completed, periodically thereafter on a regular schedule. The reviews shall consider the adequacy, appropriateness, and acceptability of the design and construction activities in assuring public health safety and welfare. A Type II IEPR will be performed in the future during the PED phase.

  Decision on IEPR. Based on factors from the EC 1165-2-209 (shown in Table 2 below), Type I IEPR is required.

Table 2: Factors determining need for Type I IEPR

EC 1165-2-209 Criteria	Addicks and Barker Dams DSM Report
Is there significant threat to human life?	The project has the potential to pose a significant threat to human life.
Is the total project cost more than $45 million?	The estimated project cost is predicted to cost more than $45 million.
Has the Governor of Texas requested a Type I IEPR?	The Governor has not requested a Type I IEPR.
Has the head of a Federal or state agency charged with reviewing the project study requested a Type I IEPR?	Yes, per the USACE ER 1165 -2-209 a Type I IEPR has been requested.

Will there be significant public controversy as to size, nature, or effects of the project?	Yes, the project has potential for public controversy.
Will there be significant public controversy as to the economic or environmental cost or benefit of the project?	Yes, the project has the potential for public controversy regarding the economic and environmental cost/benefit of the project.
Will the study be based on information from novel methods, present complex challenges or interpretation, contain precedent-setting methods or models, or present conclusions that are likely to change prevailing practices?	The study will not be based on information from novel methods; however the study may present complex challenges or interpretation, and also may contain precedent-setting methods or models.

A. Products to Undergo Type I

The products to undergo Type I IEPR will include:

- Dam Safety Modification Report
- Appendix 1 - Risk Assessment and Risk Management Alternative Formulation
- Appendix 2 - Addicks Dam Life Loss and Economic Evaluation and Economic Consequences
- Appendix 3 – Barker Dam Life Loss and Economic Evaluation and Economic Consequences
- Appendix 5 - Environmental Assessment
- Appendix 11 – Engineering

Type I IEPR panel members will be provided with ATR documentation and significant public comments made during public meetings and on the products under review. Arising issues between PDT and reviewers should be resolved with face-to-face resolution.

B. Required Type I IEPR Panel Expertise.

Type I IEPR panel members will be comprised of individuals that have not been involved in the development of the decision document, meet National Academy of Science guidelines for independence, and will be chosen by the OEO.

The OEO will determine the final participants on the Type I IEPR panel. Once the OEO designates the IEPR panel members, the review plan will be updated to reflect this selection. The following types of expertise should be represented on the Type I IEPR team:

(1) Geotechnical Engineering Panel Member

Shall be a registered professional geotechnical engineer from an Architect-Engineer or consulting firm, a public agency, or academia with 20 years of demonstrated experience in the specific field of dams engineering in evaluating, designing, and constructing large embankment dams (>150 feet high) for water storage; and with a minimum MS degree or higher in engineering. Active participation in related profession societies is encouraged. The Geotechnical panel member should be a recognized expert in cutoff wall design and construction and soil improvement including experience with various methods of cutoff wall construction. Geotechnical panel member shall have at least 15 years or more experience in the general field of geotechnical engineering; experience in subsurface investigations; field & laboratory testing and the determination of in-situ material properties; soil compaction and

earthwork construction; soil mechanics; seepage and piping; bearing capacity and settlement; dewatering; design and construction of foundations on alluvial soils; foundation inspection and assessment; foundation grouting and other foundation treatment methods including construction of foundation seepage barriers; the design, installation and assessment of instrumentation; and preparing plans and specifications for USACE projects, and knowledge of USACE design and construction procedures and policies. The Geotechnical panel member shall have knowledge and experience in the forensic investigation of seepage, settlement, stability, and deformation problems associated with embankments constructed on alluvial soils. The Geotechnical panel member shall have familiarity with preparing plans and specifications for USACE projects, knowledge of USACE design and construction procedures and policies, and USACE dam safety assurance policy and guidance. The Geotechnical panel member shall have experience in evaluating risk reduction measures for dam safety assurance projects.

(2) Engineering Geologist Panel Member

Shall be a registered professional geologist from an Architect-Engineer or consulting firm, a public agency, or academia with 20 years or more of demonstrated experience in the general field of engineering geology; and should have extensive experience in similar types of work as described in the project description. Active participation in related professional engineering and scientific societies is encouraged. The Engineering Geology panel member should be proficient in assessing seepage and piping through and beneath dams constructed on or within various geologic environments, including but not limited to alluvial soils, colluvium, and other geological formations. The Engineering Geology panel member should be familiar and knowledgeable with identification of geological hazards; exploration techniques including soil and rock logging, geologic mapping, geophysical investigations, and air photo interpretation; field & laboratory testing and the determination of in-situ material properties; geomorphology; foundation inspection and assessment; foundation grouting and other foundation treatment methods including construction of foundation seepage barriers; and the design, installation and assessment of instrumentation. The Engineering Geology panel member shall have familiarity with preparation of factual data and interpretative geology reports, including the preparation of Geotechnical Baseline Reports for USACE projects. The Geotechnical panel member shall have familiarity with preparing plans and specifications for USACE projects, knowledge of USACE design and construction procedures and policies, and USACE dam safety assurance policy and guidance.

(3) Civil / Structural Engineer Panel Member

Shall be a registered professional civil engineer from an Architect-Engineer or consulting firm, a public agency, or academia with 15 or more years of demonstrated experience, with a minimum MS degree or higher in engineering. Active participation in related profession societies is encouraged. The Civil / Structural Engineering panel member shall have extensive experience and should be a recognized expert in the design and construction of hydraulic structures for large and complex civil works projects including outlet works and spillways, and the stability analysis and structural design of mass concrete scour protection and stilling features including the design of baffles, end sills, and training walls. The Civil / Structural Engineering panel member shall have familiarity with preparing plans and specifications for USACE projects, knowledge of USACE design and construction procedures and policies, and USACE dam safety assurance policy and guidance. The Civil / Structural Engineering shall have experience in evaluating risk reduction measures for dam safety assurance projects. The Civil

/ Structural Engineering panel member shall have demonstrated knowledge in a variety of construction related activities involving site layout, surveying, 3-dimensional modeling, construction techniques, grading, hydraulic structures, erosion control, interior drainage, earthwork, concrete placement, design of access roads, retaining walls design, and relocation of underground utilities. Practical knowledge of construction methods and techniques as it relates to structural portions of projects is required.

(4) Hydraulic / Hydrology Engineering Panel Member

Shall be a registered professional engineer from an Architect-Engineer or consulting firm, a public agency, or academia with 10 or more years of demonstrated experience in hydraulic engineering with an emphasis on large public works projects, with extensive background in hydraulic theory and practice, and river geomorphology, with a minimum MS degree or higher in engineering. Active participation in related professional engineering and scientific societies is encouraged. The H&H panel member shall have experience associated with flood risk management projects, and the analysis and design of hydraulic structures related to flood control projects including the design of hydraulic structures such as outlet works, spillways, and stilling basins, flood control channels and levees, diversion channel design, and large river control structures. The H&H panel member must have performed work in hydrologic analysis, floodplain analysis, hydraulic design of channels and levees using various channel and bank protection works, and river sedimentation. The H&H panel member must demonstrate knowledge and experience with physical modeling and the application of data from physical model testing to the design of stilling basins and scour protection, and in the ability to coordinate, interpret, and explain testing results with other engineering disciplines, particularly structural engineers, geotechnical engineers, and geologists. In regard to hydrologic analysis, the H&H panel member must demonstrate knowledge and experience with the routing of inflow hydrographs through multipurpose flood control reservoirs utilizing multiple discharge devices, including gated sluiceways and gated spillways. The H&H panel member shall be familiar with Corps application of risk and uncertainty analyses in flood damage reduction studies and also have a familiarity with standard Corps hydrologic and hydraulic computer models (including but not limited to HEC-1, HEC-HMS, HEC-2, HEC-RAS, FLO-2D, and HEC-DSS) used in drawdown studies, dam break inundation studies, hydrologic modeling and analysis for dam safety investigations. The H&H panel member shall have familiarity with preparing plans and specifications for USACE projects, knowledge of USACE design and construction procedures and policies, and USACE dam safety assurance policy and guidance. The H&H panel member shall have experience in evaluating risk reduction measures for dam safety assurance projects.

(5) Economics/Planning Panel Member

Should be from an Architect-Engineer or consulting firm, a public agency, a non-governmental entity, or academia with 10 or more years of experience directly related to water resource economic evaluation or review, should possess a Bachelors degree or higher in economics. Direct experience working for or with USACE is highly preferred but not required, and active participation in related profession societies is encouraged. The Economics/Planning panel member should be very familiar with the USACE plan formulation process, procedures, standards, guidance and economic evaluation techniques. The Economics/Planning panel member should be familiar with the USACE flood risk and hurricane/coastal storm damage risk reduction analysis and economic benefit calculations, including use of standard USACE computer programs including HEC-FDA. The candidate

should also have experience with the National Economic Development analysis procedures, particularly as they relate to hurricane and coastal storm damage risk reduction. The candidate should have demonstrated experience in public works planning experience, working with project teams to identify and evaluate measures and alternatives using appropriate planning methodologies to reduce life safety risk. Must have extensive experience reviewing the analysis with which the measures and alternatives were evaluated and that they are sufficiently comprehensive and complete to result in approval of a recommended alternative. The panel member shall have a minimum of five years experience directly dealing with the USACE six-step planning process, which is governed by ER 1105-2-100, Planning Guidance Notebook. In addition, the Panel Member must have experience identifying and evaluating impacts to environmental resources from structural flood risk management and hurricane and coastal storm damage risk reduction projects.

(6) Environmental Planner / NEPA Impact Assessment Panel Member
Should be a environmental planner / wetland ecologist / fisheries biologist / scientist from an Architect-Engineer or consulting firm, a public agency, or academia with 10 or more years of experience directly related to water resource environmental evaluation or review, implementation of the NEPA compliance process and Endangered Species Act requirements, with a minimum MS degree or higher in a related field. The Environmental Planner panel member should have extensive demonstrated experience in the environmental assessment process with knowledge of the NEPA process, cultural surveys, biological assessments, and endangered species, working with coastal and estuarine ecosystems, and evaluating and conducting NEPA impact assessments, including cumulative effects analyses, for complex multi-objective public works projects with competing trade-offs. The Environmental Planner panel member should be familiar with USACE calculation and application of environmental impacts and benefits, determining the scope and appropriate methodologies for impact assessment and analyses for a variety of projects, potential project impacts to nearby sensitive habitats, programs with high public and interagency interests. Experience in the Gulf of Mexico coastal region is preferred but not required.

In addition, at least one of the expert reviewers shall have recent and relevant experience on multi-million dollar projects verifying the constructability of the proposed designs and then verifying that these projects were being constructed per the Plans and Specifications.

The OEO will determine the final participants on the IEPR panel. The name, organization, contact information, credentials, and years of experience of each member will be identified at the time the review is conducted and will be included in Attachment 1 of this Review Plan. Future revisions to these panel members will be made for Type II IEPR Panel established to peer review the final design and construction documents.

C. Documentation of Type I.
The IEPR panel will be selected and managed by an Outside Eligible Organization (OEO) per EC 1165-2-209, Appendix D. DrChecks software will be used to document Type I IEPR comments and aid in the preparation of the Review Report. Comments should address the adequacy and acceptability of the economic, engineering and environmental methods, models, and analyses used. Type I IEPR comments should generally include the same four key parts as described for ATR comments. The OEO will be responsible for compiling and entering comments into

DrChecks. The Type I IEPR panel will prepare a Review Report that will accompany the publication of the final report for the project and shall:

(1) Disclose the names of the reviewers, their organizational affiliations, and include a short paragraph on both the credentials and relevant experiences of each reviewer.
(2) Include the charge to the reviewers prepared by the RMC.
(3) Describe the nature of their review and their findings and conclusions.
(4) Include a verbatim copy of each reviewer's comments (either with or without specific attributions), or represent the views of the group as a whole, including any disparate and dissenting views.

The final Review Report will be submitted by the OEO no later than 60 days following the close of the public comment period for the draft decision document. USACE shall consider all recommendations contained in the Review Report and prepare a written response for all recommendations adopted or not adopted. The final decision document will summarize the Review Report and USACE response. The Review Report and USACE response will be made available to the public, including through electronic means on the internet.

7. POLICY AND LEGAL COMPLIANCE REVIEW

All decision documents 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. 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.

8. MSC APPROVAL

The MSC is Southwestern Division and is responsible for approving the review plan. Approval is provided by the MSC Commander. The commander's approval should reflect vertical team input (involving district, MSC, RMC, PCX, and HQUSACE members) as to the appropriate scope and level of review for the decision document. Like the PMP, the review plan is a living document and may change as the study progresses. Changes to the review plan should be approved by following the process used for initially approving the plan. In all cases the MSCs will review the decision on the level of review and any changes made in updates to the project.

The RP is a "living document" and shall be updated as needed during the study process. The RMC shall be provided an electronic copy of any revised RP. The PDT shall follow their DST's guidance for processing the revised RPs for their respective MSCs.

9. COST ENGINEERING DIRECTORY OF EXPERTISE (DX) REVIEW AND CERTIFICATION

All decision documents shall be coordinated with the Cost Engineering DX, located in the Walla Walla District. The DX will assist in determining the expertise needed on the ATR team and Type I IEPR

team (if required) and in the development of the review charge(s). The DX will also provide the Cost Engineering DX certification. The RMO is responsible for coordination with the Cost Engineering DX.

10. MODEL CERTIFICATION AND APPROVAL

EC 1105-2-412 mandates the use of certified or approved models for all planning activities to ensure the models are technically and theoretically sound, compliant with USACE policy, computationally accurate, and based on reasonable assumptions. Planning models, for the purposes of the EC, are defined as any models and analytical tools that planners use to define water resources management problems and opportunities, to formulate potential alternatives to address the problems and take advantage of the opportunities, to evaluate potential effects of alternatives and to support decision making. The use of a certified/approved planning model does not constitute technical review of the planning product. 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, and IEPR (if required).

EC 1105-2-412 does not cover engineering models used in planning. 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. As part of the USACE Scientific and Engineering Technology (SET) Initiative, many engineering models have been identified as preferred or acceptable for use on Corps studies and these models should be used whenever appropriate. 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, and IEPR (if required).

Table 3: Models Used for Dam Safety

Model Name	Model Description	Model Type
HEC-FIA	Economic model used to calculate estimated economic damages and loss of life corresponding to floodplain mapping.	Planning
DAMRAE (DAM safety Risk Analysis Engine)	This is a generalized event tree analysis tool that includes a graphical interface for developing and populating an event tree, and a tool for calculating and post-processing and event tree risk model for dam safety risk assessment.	Engineering
HEC-HMS	By applying this model the PDT is able to: a. Define the watersheds' physical features b. Describe the metrological conditions c. Estimate parameters d. Analyze simulations e. Obtain GIS connectivity	Engineering
HEC-ResSims	This model predicts the behavior of reservoirs and to help reservoir operations plan releases in real-time during day-to-day and emergency operations. The following describes	Engineering

	the major features of the HEC-ResSim a. Graphic User Interface b. Map-Based Schematic c. Rule-Based Operations	
HEC-RAS	Unsteady 1-dimensional flow model used to simulate the channel hydraulics of the Buffalo Bayou channel.	Engineering
FLO-2D	Unsteady 2-dimensional flow model used to simulate wide alluvial fan floodplain inundation, and produce corresponding floodplain mapping.	Engineering
Groundwater Modeling System (GMS)	This model is used to conduct seepage analysis.	Engineering
UTEXAS4	This model is used to conduct slope stability analysis.	Engineering
SEEP2D	This is a finite element model used for seepage analyses for earth embankments and foundations.	Engineering
MCASES or MII	These are cost estimating models. This is a cost estimating model that was developed by Building Systems Design Inc. Crystal Ball risk analysis software will also be used.	Cost Estimating

11. REVIEW SCHEDULES AND COSTS

A. DQC Review Schedule and Cost

The Galveston District will provide labor funding by cross charge labor codes. The Project Manager will work with the DQC team leader to ensure that adequate funding is available and is commensurate with the level of review needed. Any funding shortages will be negotiated on a case by case basis and in advance of a negative charge occurring.

The DQC team leader shall provide organization codes for each team member and a responsible financial point of contact (CEFMS responsible employee) for creation of labor codes. Reviewers shall monitor individual labor code balances and alert the DQC team leader to any possible funding shortages. DQC review is estimated to be $25,000 for the study.

Table 4. DQC Schedule

Task	Completion Date
DQC Team Identified	May 2012 (Actual)
DQC Review of Draft DSM Report, Appendices & EA	4 Jun 2012 (Actual)
Resolution of DQC Comments	11 Jun 2012 (Actual)

B. ATR Review Schedule and Cost

The Galveston District will provide labor funding by cross charge labor codes. Funding for travel will be provided through government order, if needed. The Project Manager will work with the ATR team leader to ensure that adequate funding is available and is commensurate with the level of review needed. Any funding shortages will be negotiated on a case by case basis and in advance of a negative charge occurring.

The ATR team leader shall provide organization codes for each team member and a responsible financial point of contact (CEFMS responsible employee) for creation of labor codes. Reviewers shall monitor individual labor code balances and alert the ATR team leader to any possible funding shortages. ATR review is estimated to be $100,000 for the study.

Table 5. ATR Schedule

Task	Completion Date
ATR Team Identified	29 May 2012 (Actual)
ATR Kick-off Meeting	12 Jun 2012 (Actual)
ATR Review of DSM Report, Appendices & EA	10 Jul 2012 (Actual)
Resolution of ATR Comments in Dr. Checks	14 Dec 2012
ATR Certification	20 Dec 2012

C. Type I IEPR Review Schedule and Cost

The full Type I IEPR panel will receive the DSM report, environmental assessment, and all technical appendices following the review by the RMC's Senior Oversight Group (SOG) in January 2013. The DSM report and technical appendices will be updated with review comments from the SOG review prior to the IEPR review. The final report to be submitted by the Type I IEPR panel must be submitted to the PDT within 30 days of the conclusion of the review. The PM will coordinate with RMC and MSC DSO before any document is released for public review.

The cost of the Type I IEPR is estimated to be $260,000 for this study.

Table 6. Type I IEPR Schedule

Task	Completion Date
IEPR Work Plan & Charge to External Peer Review Panel	22 Jan 2013
Selection of External Peer Review Panel	11 Jan 2013
Site Visit & Kick-off Meeting with External Peer Review Panel	24 Jan 2013
Conduct External Peer Review	21 Feb 2013

Task	Completion Date
Final IEPR Report	22 Feb 2013
Resolution of IEPR Comments in Dr. Checks	8 Mar 2013

12. PUBLIC PARTICIPATION

The study PDT is determining the extent to which the project may impact the environment. The draft policy which is being used to organize and provide this Dam Modification Study does not provide guidance on public participation. However, the extent to which the project affects the environment may necessitate a public comment period. Public information meetings were held at locations upstream and downstream of the Dams at the beginning of the study in November and December 2010. The purpose of these meetings was to provide the public and stakeholders with the latest information on the Addicks and Barker Dams and the Addicks and Barker Dam Safety Modification Study.

The public will be kept informed throughout the life of the project. Public review of the DSM report and Environmental Assessment will occur in October 2012. Upon completion of the review period, comments will be consolidated in a matrix and addressed. A comment resolution meeting will take place, if needed, to decide upon the best resolutions of comments. A summary of the comments and resolutions will be included in the decision document.

13. REVIEW PLAN APPROVAL AND UPDATES

The Galveston District Commander is responsible for approving this Review Plan. The Commander's approval reflects vertical team input (involving district, MSC, RMO, and HQUSACE members) as to the appropriate scope and level of review for the decision document. Like the PMP, the Review Plan is a living document and may change as the study progresses. The home district is responsible for keeping the Review Plan up to date. Minor changes to the review plan since the last MSC Commander approval are documented in Attachment 3. Significant changes to the Review Plan (such as changes to the scope and/or level of review) should be re-approved by the MSC Commander following the process used for initially approving the plan. The latest version of the Review Plan, along with the Commanders' approval memorandum, should be posted on the Home District's webpage. The latest Review Plan should also be provided to the RMO and home MSC.

14. REVIEW PLAN POINTS OF CONTACT

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

- Enrique Villagomez, Project Manager, Buffalo Bayou and Tributaries Dam, enrique.villagomez@usace.army.mil , (409) 766-3173.

ATTACHMENT 1: Team members

SWG Project Delivery Team and Vertical Team Members:

Project Title	Name	Organization
Dam Safety Officer		CESWG-EC-ES
Project Manager		CESWG-PM-J
Lead Geotechnical		CESWG-EC-ES
Lead Structural		CESWG-EC-ES
Lead H&H		CESWG-EC-HB
Lead Planner		CESWG-PE-PL
Environmental		CESWG-PE-PR
Economics		CESWG-PE-PL
General Engineering		CESWG-EG-EC
Cost Engineer		CESWG-EG-EC
Real Estate		CESWG-RE-A
Vertical Team Member		CESWD-RBT-W
Vertical Team Member		CEIWR-RMC
Vertical Team Member		CEIWR-RMC
Vertical Team Member		CECO-C-RAO (HQUSACE)
Geotechnical Consultant		URS
Public Involvement Consultant		Crouch Environmental

Risk Cadre Team Members

The current risk assessment teams conducting the base line risk assessment at the dams include:

Overall Team Leader:

Team Leaders: **Addicks Team** **Barker Team**

Team Members:
Geotech
Geologist
H&H
Structural
Mech/Elect

DQC Review Team Members:

DQC Lead/Overall QA	SWT
H&H Engineering	SWT
Geotechnical Engineering	SWT
Structural & Civil Engineering	SWL
Cost Engineering	SWT
Economics & Planning	SWT
Real Estate Lands	SWG
Environmental/NEPA Resources	SWG

ATR Team Members:

	USACE, Risk Management Center (Lead)
	USACE Louisville District (Geotechnical)
	USACE Louisville District (Structural)
	USACE Louisville District (Civil)
	Hydrology and Hydraulics Engineering
	USACE St. Paul District (Cost Engineering)
	USACE Louisville District (Real Estate)
	USACE Little Rock District (NEPA Compliance)
	USACE St. Paul District (Economics)
	USACE Rehired Annuitant (Construction)
	USACE, Risk Management Center (Geotechnical)
*ATR on the cost engineering analysis will be performed by the St. Paul District and overseen by the Cost Engineering DX, Walla Walla District.	

Type I IEPR Proposed Review Team Member Disciplines:

Geotechnical Engineering Panel Member	
Engineering Geologist Panel Member	
Civil / Structural Engineer Panel Member	
Hydraulic / Hydrology Engineering Panel Member	
Economics/Planning Panel Member	
Environmental Planner/NEPA Impact Assessment Panel Member	

ATTACHMENT 2: SAMPLE STATEMENT OF TECHNICAL REVIEW FOR DECSION DOCUMENTS

COMPLETION OF AGENCY TECHNICAL REVIEW

The Agency Technical Review (ATR) has been completed for the DSMR for Addicks and Barker Dams. The ATR was conducted as defined in the project's Review Plan to comply with the requirements of EC 1165-2-209. During the ATR, compliance with established policy principles and procedures, utilizing justified and valid assumptions, was verified. This included review of: assumptions, methods, procedures, and material used in analyses, alternatives evaluated, the appropriateness of data used and level obtained, and reasonableness of the results, including whether the product meets the customer's needs consistent with law and existing US Army Corps of Engineers policy. The ATR also assessed the District Quality Control (DQC) documentation and made the determination that the DQC activities employed appear to be appropriate and effective. All comments resulting from the ATR have been resolved and the comments have been closed in DrChecks[sm].

SIGNATURE _____ _____

Date

ATR Team Leader
CEIWR-RMC

SIGNATURE _____ _____

Date

Project Manager
CESWG-PM-J

SIGNATURE _____ _____

Date

Review Management Office Representative
CEIWR-RMC

CERTIFICATION OF AGENCY TECHNICAL REVIEW

Significant concerns and the explanation of the resolution are as follows: *Describe the major technical concerns and their resolution.*

As noted above, all concerns resulting from the ATR of the project have been fully resolved.

SIGNATURE _____ _____

Date

Chief, Engineering Division
CESWG-EC

SIGNATURE _____ _____

Date

Chief, Planning Division
CESWG-PE-PL

ATTACHMENT 3: REVIEW PLAN REVISIONS

Revision Date	Description of Change	Page / Paragraph Number

ATTACHMENT 4: ACRONYMS AND ABBREVIATIONS

Term	Definition	Term	Definition
AFB	Alternative Formulation Briefing	NED	National Economic Development
ASA(CW)	Assistant Secretary of the Army for Civil Works	NER	National Ecosystem Restoration
ATR	Agency Technical Review	NEPA	National Environmental Policy Act
CSDR	Coastal Storm Damage Reduction	O&M	Operation and maintenance
DPR	Detailed Project Report	OMB	Office and Management and Budget
DQC	District Quality Control/Quality Assurance	OMRR&R	Operation, Maintenance, Repair, Replacement and Rehabilitation
DX	Directory of Expertise	OEO	Outside Eligible Organization
EA	Environmental Assessment	OSE	Other Social Effects
EC	Engineer Circular	PCX	Planning Center of Expertise
EIS	Environmental Impact Statement	PDT	Project Delivery Team
EO	Executive Order	PAC	Post Authorization Change
ER	Ecosystem Restoration	PMP	Project Management Plan
FDR	Flood Damage Reduction	PL	Public Law
FEMA	Federal Emergency Management Agency	QMP	Quality Management Plan
FRM	Flood Risk Management	QA	Quality Assurance
FSM	Feasibility Scoping Meeting	QC	Quality Control
GRR	General Reevaluation Report	RED	Regional Economic Development
HQUSACE	Headquarters, U.S. Army Corps of Engineers	RMC	Risk Management Center
IEPR	Independent External Peer Review	RMO	Review Management Organization
LRR	Limited Reevaluation Report	RTS	Regional Technical Specialist
MSC	Major Subordinate Command	SAR	Safety Assurance Review
		SOG	Senior Oversight Group
		USACE	U.S. Army Corps of Engineers
		WRDA	Water Resources Development Act