A-TR-2017-COE-002

Independent External Peer Review of the Rahway River Basin, New Jersey Flood Risk Management Feasibility Report

Final Report

22 March 2017

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Prepared for: Department of the Army
US Army Corps of Engineers
Flood Risk Management Planning Center of Expertise
Baltimore District

LMI Contract/Delivery Order No: W912HQ-15-D-0002/0013
APMI Subcontract/Release No: 1525/15

LMI APM Institute

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Executive Summary

Project Background

The Rahway River Basin is located in northeastern New Jersey. It lies within the metropolitan area of Greater New York City and occupies Essex, Union, and Middlesex counties. The basin is 53,300 acres in area and is roughly crescent-shaped. The Rahway River system, which consists of the Rahway River and four branches, flows through the municipalities of Springfield, Union, Cranford, and Clark before traveling through the City of Rahway. After receiving the waters of Robinson's Branch and the South Branch in the City of Rahway, the river enters the city limits of Linden and Carteret. The Rahway River then flows into the Arthur Kill, which connects Newark Bay with the Raritan and Lower Bays of the New York and New Jersey Harbor (see Figure 1).

Fluvial flooding within the Rahway River Basin, which is caused principally by rainfall during storm events, is of concern. The problem is exacerbated by impervious surface coverage associated with development in the area, resulting in a large increase of stormwater runoff into the Rahway River and its tributaries. The increased runoff coupled with inadequate channel capacities and bridge openings account for most of the flooding problems. Flooding causes negative impacts to life safety and critical infrastructure.

The US Army Corps of Engineers (USACE) has prepared a Flood Risk Management Feasibility Report, consisting of a Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR/EIS) and supporting documentation for the Rahway River Basin in order to develop flood mitigation alternatives within the Rahway River watershed. This DIFR/EIS and supporting documentation are also referred to as the Rahway River Study or the Study. USACE and the local sponsor, the New Jersey Department of Environmental Protection, have proposed a Tentatively Selected Plan (TSP) that includes dam modification, operational changes of the Orange Reservoir, channel improvements of the Rahway River, and nonstructural measures for 21 structures along Robinson's Branch.

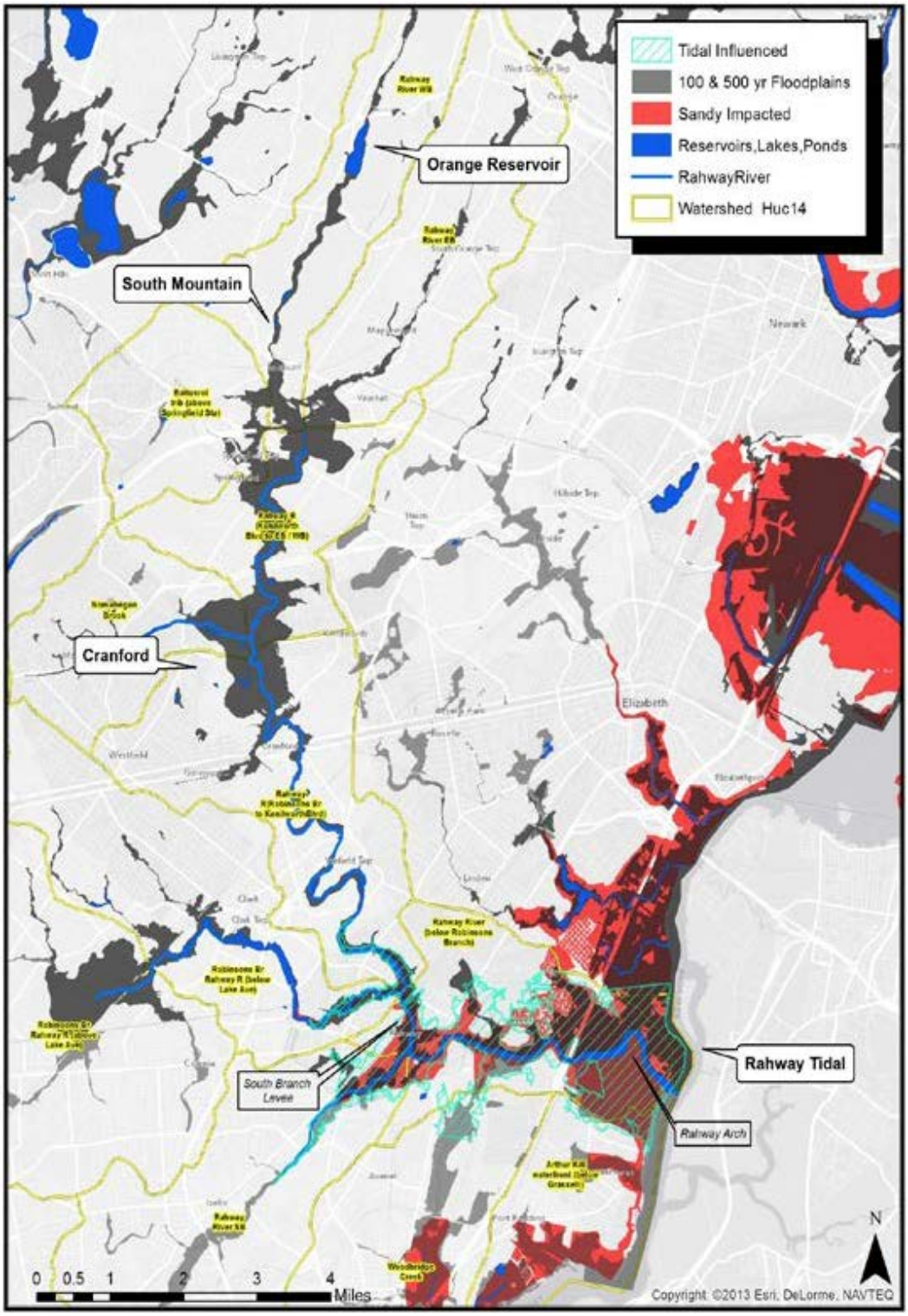

Figure 1: Rahway River Basin and Project Area

Independent External Peer Review Process

The LMI Team, consisting of Logistics Management Institute and Analysis Planning and Management Institute, has conducted an Independent External Peer Review (IEPR) of the Rahway River Study. The IEPR was conducted in accordance with the procedures described in the Department of the Army, USACE Engineer Circular No. 1165-2-214, *Civil Works Review*, dated 15 December 2012. The IEPR was conducted to analyze the adequacy and acceptability of methods, modeling, data, and analyses used. The IEPR focused on an engineering, environmental, and economic technical review and did not involve policy review.

The IEPR was conducted by a panel of subject matter experts with the following expertise and experience:

- Biological Resources and Environmental Law Compliance
- Civil/Geotechnical Engineer
- Civil Works Planner/Economist
- Hydrology and Hydraulic Engineer.

The IEPR Panel (the Panel) was charged with providing a broad technical evaluation of the material contained in the Rahway River Study. This report provides the final comments of the IEPR Panel.

Summary of the Results of the IEPR

Biological Resources and Environmental Law Compliance

Overall, the DIFR/EIS makes a reasonable effort to address the intent of the decision document and the purpose and need for the project. The document also sufficiently describes the range of alternatives considered within the analysis. However, there are specific areas of concern related to environmental and socioeconomic impacts that are not adequately discussed. Specifically, it is not clear from the DIFR/EIS whether there might be disproportional impacts to Environmental Justice (EJ) populations and/or children as a result of the implementation of the project, as the report indicates that there are substantial numbers of minority and low-income populations within areas that may be affected by the TSP, but concludes that there would not be disproportionate impacts to EJ populations; data to support this finding is sparse within the document.

Additionally, it is not clear whether the DIFR/EIS sufficiently considers sources of sediment contamination, Best Management Practices to control disturbance and displacement of sediments, and any sediment analysis for contaminants in areas that would be disturbed by cofferdam installation and channel modification. Further, the DIFR/EIS indicates that thermal impacts associated with the project as a result of the reservoir drawdown would not be expected downstream of the dam, but this conclusion is not well supported in the document. Finally, it is not clear from the DIFR/EIS whether USACE has a comprehensive plan for preventing the proliferation of invasive species as a result of project activities. The document would benefit from more substantive discussion and analysis in these subject areas moving forward.

Civil/Geotechnical Engineering

The Panel concurs with the USACE efforts to use risk-based assumptions in the cost estimate to mitigate for the lack of engineering and environmental detail. USACE has assumed large contingencies in most cost items due to the various unknowns and the Panel agrees with this approach. Overall, the report has a low level of detail, which was driven by the USACE SMART (Specific, Measurable, Achievable, Realistic and Timely) planning process. While the Panel commends USACE for this time-saving approach, the overall level of detail is deficient even considering typical SMART standards. The Panel has significant concerns with the DIFR/EIS that still need to be addressed. There are several important civil, geotechnical, and cost engineering issues that require resolution.

In general, there are very limited engineering calculations, discussion, or assumptions presented in the main report or appendices. In the case of geotechnical engineering, the information is almost entirely lacking. Since the TSP includes modification or even full replacement (e.g., as assumed in the cost estimate) of the embankment dam for the Orange Reservoir, the lack of geotechnical information is disturbing. Similarly, civil and cost engineering efforts appear very preliminary with no design basis provided in the main report and appendices. Another key shortcoming is the insufficient analysis of possible effects on recreation within the Orange Reservoir. Local agencies have invested considerable funds upgrading the reservoir recreational facilities over the last 10 years, yet there is little discussion in the DIFR/EIS regarding the possible impacts from the TSP on the reservoir. Recreation mitigation needs to be considered and discussed by USACE.

Civil Works Planning/Economics

From a plan formulation and economic analyses perspective, the DIFR/EIS does a good job of identifying and explaining the assumptions, data, methods, and models that underlie the project analyses. The conclusions based upon the planning analysis are appropriate and logically follow from the stated problems, opportunities, objectives, constraints, screening, and alternatives evaluation. However, there are a few areas where the data presented appear to be inconsistent; the most important inconsistency is a comparison of the costs of the Without-Project Damages Modeled using the Hydraulic Engineering Center's Flood Damage Reduction Analysis versus Recorded National Flood Risk Insurance Program Damages that shows significantly different results without explaining the differences. There are also several inconsistencies in the reported values and missing information, which should be addressed to improve the quality of the analysis.

Hydrology and Hydraulic Engineering

A review of the documentation suggests that substantial effort was made to develop a realistic plan for flood control improvements along select reaches of the Rahway River in New Jersey. However, the possibly incorrect use of Manning's values in the numerical modeling calls into question the modeling results and has implications for the model output in the larger study. Sediment transport within the system needs to be considered and discussed. In addition, questions are raised about flooding control during construction phases of the project and for the overall level of flood protection provided by the project. Numerical modeling, sediment transport, and hydrologic considerations should be revisited before moving forward with the project.

Summary of Final Panel Comments

Presented below is a summary of the Final Panel Comments. Section 5 contains definitions of comment significance as well as the complete comments with explanations and recommendations.

Significance of Comment	Number of comments
High	2
Medium High	9
Medium	2
Medium Low	1
Low	1

No.	Final Panel Comment
Significance: High	
1	Using the Manning's values for blocking discharges in the Hydraulic Engineering Center's River Analysis System (HEC-RAS) modeling requires additional justification.
2	The values of damages modeled are dramatically higher than Recorded National Flood Insurance Program (NFIP) Damages. This indicates that either the values of damages modeled are substantially overstated compared with those for the Recorded NFIP Damages or the Recorded NFIP Damages are substantially understated.
Significance: Medium High	
3	The proposed Tentatively Selected Plan (TSP) is not based upon any meaningful geotechnical design data.
4	HEC-RAS model calibration is based on peak observed events while current flood control efforts may provide as little as 5-year protection.
5	There is no analysis of flood control during construction, when there will be reduced storage capacity.
6	The DIFR/EIS should include more specific information regarding sources for sediment contamination, Best Management Practices (BMPs) to control disturbance and displacement of sediments, and any sediment analysis for contaminants in areas that would be disturbed by cofferdam installation and channel modification.
7	The report does not discuss the effect of the TSP on sediment transport within the system.
8	The proposed new operational plan for Orange Reservoir required for the TSP is not clearly defined.

9	The recreational impact to Orange Reservoir has not been fully documented in the report.
10	The analysis does not adequately describe the comprehensive plan to prevent the proliferation of invasive species as a result of project activities referenced in Table 31 of the DIFR/EIS, including BMPs, monitoring, and adaptive management and related controls.
11	The DIFR/EIS does not adequately describe the impacts to Environmental Justice (EJ) populations and/or children as a result of the implementation of the project to ensure they are not disproportionally affected.
Significance: Medium	
12	No supporting engineering design information is included in the TSP *Cost Engineering* Appendix D.
13	The analysis does not adequately support the conclusion that reservoir drawdown is unlikely to have downstream thermal impacts.
Significance: Medium Low	
14	The Lands and Damages values for Cranford and Robinson noted in the DIFR/EIS are different from the corresponding values in the *Economics* Appendix.
Significance: Low	
15	To ensure complete and consistent economic analysis and reported results, the documentation should include additional specific information, clarification, or correction.

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1 Introduction

1.1 Introduction and Report Overview

This Independent External Peer Review (IEPR) Final Report provides the results of an IEPR of the Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR/EIS) for the Rahway River Basin, also referred to as the Rahway River Study or the Study. The New York District of the US Army Corps of Engineers (USACE) has been conducting the Study.

Section 1 of the IEPR Final Report provides a description of the objectives of this IEPR, general background information on the IEPR, and a brief introduction to the Logistics Management Institute (LMI) and Analysis Planning and Management Institute (APMI) Team that managed the IEPR process. Section 2 provides an overview description of the USACE project reviewed in this IEPR. Section 3 summarizes the process followed to perform the IEPR. Section 4 describes the IEPR Panel composition and the IEPR Panel Members' expertise. Section 5 presents the IEPR Panel comments, including their basis and recommendations. Appendix A reproduces the Charge to Reviewers provided to the IEPR Panel to use as guidance for the IEPR. Appendix B provides short resumes for the IEPR Panel Members.

1.2 Independent External Peer Review Overview

The USACE lifecycle review strategy for civil works projects provides for a review of project documents from initial planning through the project phases of design; construction; and operation, maintenance, repair, replacement, and rehabilitation. The strategy provides procedures for ensuring the quality and credibility of USACE decision, implementation, and operations and maintenance documents and work products.

Peer reviews, such as this IEPR, are one of the important procedures used to ensure that the quality of USACE published information meets the standards of the scientific and technical community. Peer review typically evaluates the clarity of hypotheses, validity of the research design, quality of data collection procedures, robustness of the methods employed, appropriateness of the methods for the hypotheses being tested, extent to which the conclusions follow from the analysis, and strengths and limitations of the overall product.

The objective of this IEPR was to assess the adequacy and acceptability of economic, engineering, and environmental methods, models, and analyses used to conduct the Rahway River Study. The IEPR was conducted in accordance with the procedures described in the Department of the Army, USACE Engineer Circular (EC) No. 1165-2-214, *Civil Works Review*, dated 15 December 2012.

1.3 IEPR Management Team

This IEPR was conducted by a group of independent experts under the auspices of APMI as a subcontractor to LMI, collectively referred to as the LMI Team. Both organizations are not-for-profit science and technology entities that provide impartial, independent assistance, free of conflict of interest (COI) with federal government organizations. Neither organization has performed or advocated for nor against any federal water resources projects or has real or perceived COI for conducting IEPRs. LMI, APMI, and the Panel Members for this IEPR have not been involved in any capacity with the efforts documented in the Rahway River Study.

2 Project Description

The Rahway River Basin is located in northeastern New Jersey. It lies within the metropolitan area of Greater New York City and occupies approximately 15 percent of Essex County, 35 percent of Union County, and 10 percent of Middlesex County. The roughly crescent shaped basin is 83.3 square miles (53,300 acres) in area.

The Rahway River system consists of the Rahway River and four branches. The West Branch flows south from West Orange through South Mountain Reservation and downtown Millburn. The East Branch also originates in West Orange and Montclair and travels through South Orange and Maplewood. These two branches converge near Route 78 in Springfield to form the mainstem of the Rahway River. The Rahway River flows through the municipalities of Springfield, Union, Cranford, and Clark before traveling through the City of Rahway. The Rahway River receives the waters of Robinson's Branch and the South Branch in the City of Rahway before it enters the city limits of Linden and Carteret. The Rahway River then flows into the Arthur Kill, which connects Newark Bay with the Raritan and Lower bays of the New York and New Jersey Harbor.

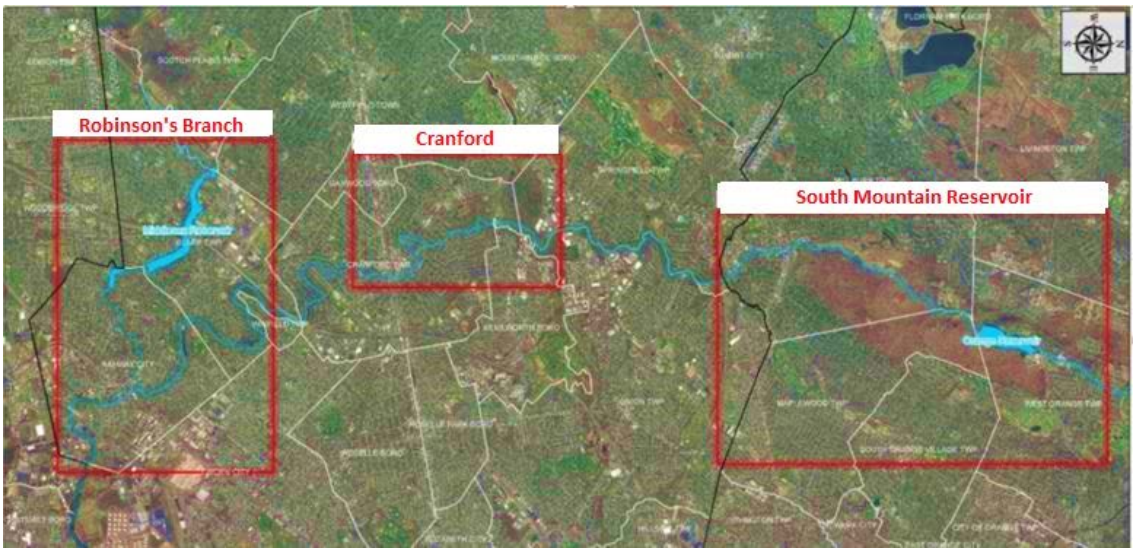

Figure 2: Rahway River Project Area

Flooding has been a major problem in this area. The USACE has prepared a DIFR/EIS in order to address fluvial flooding within the Rahway River Basin, which is caused principally by rainfall during storm events. The flooding is exacerbated by impervious surface coverage from development in the area, resulting in a large increase of stormwater runoff into the Rahway River and its tributaries. The increased runoff coupled with inadequate channel capacities and bridge openings account for most of the flooding problems. Flooding causes negative impacts to life safety and critical infrastructure. Flooded local routes have the potential to block or delay emergency response teams in the area as well as impacting critical infrastructure and facilities.

In 2006, an initial screening of flood damages within the Rahway River Basin led to the identification of the Township of Cranford and the Robinson's Branch in the City of Rahway as two areas within the basin that experienced regular significant flood damages during storm events. As a result of this initial

screening and coordination with the non-federal sponsor and local stakeholders, the main focus of the current study has been on fluvial flooding within Cranford and the Robinson's Branch areas. Additionally, following Tropical Storm Irene in 2011, USACE added the investigation of potential flood storage opportunities upstream of the Township of Cranford that would benefit not only the township but other municipalities as well.

The DIFR/EIS considered a range of nonstructural and structural measures to reduce the risk of storm damage in the study area. Based on an evaluation of the costs and benefits of the alternatives, including potential environmental impacts, a plan was identified as the Tentatively Selected Plan (TSP). The TSP includes project elements in the following three general areas: (1) modifying the Orange Reservoir Dam outlet, allowing water levels in reservoir to be drawn down prior to a storm event; (2) modifying the channel in the Township of Cranford, allowing flood waters to pass through the damage area by adding two 36-inch diameter outlet pipes at the Orange Reservoir dam; and (3) deploying non-structural measures (e.g., dry and wet flood-proofing, ring walls, elevation and buyouts) for 21 structures within in the Robinson's Branch area.

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3 Independent External Peer Review Process

This section summarizes the process for conducting this IEPR. The LMI Team performed the IEPR in accordance with the procedures described in EC 1165-2-214.

3.1 Project Management

The LMI Team developed and executed a Work Plan to define and manage the process for conducting the IEPR. The Work Plan described the process for screening and selecting independent reviewers, communicating and meeting with the USACE project team, maintaining the project schedule and quality control, compiling and disseminating the independent reviewers' comments, and project management and administration.

The organizational structure for managing the IEPR is shown in Figure 3. The purpose of this organizational structure was to assure the independence of the review. As shown, the LMI Team mediated any interactions between the Panel and USACE. There was no direct interaction of Panel Members with USACE.

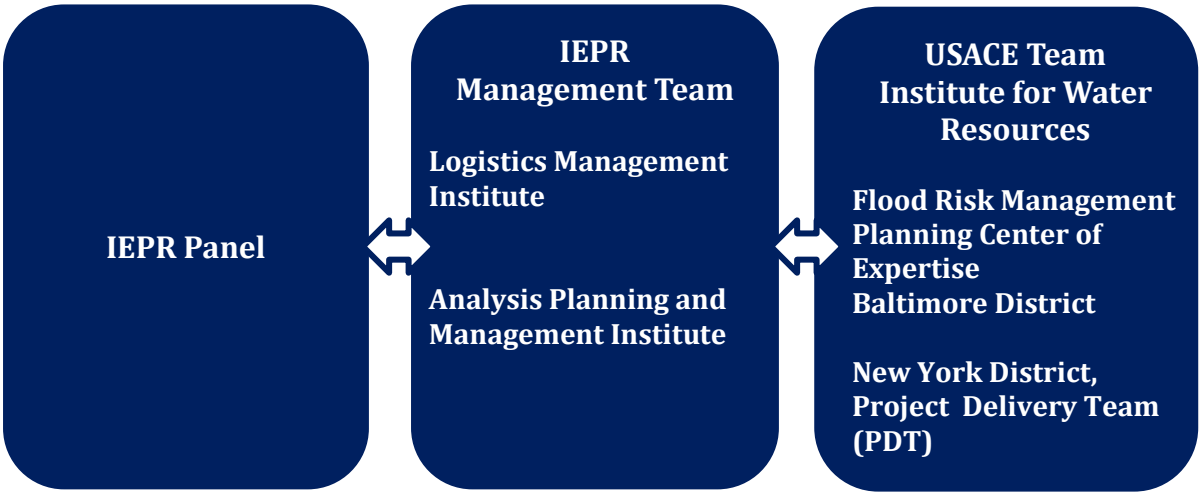

Figure 3: Organization for Managing the IEPR

3.2 Selecting the Independent External Peer Review Panel

We identified experts who met and exceeded the technical expertise and requirements of this IEPR. We identified any potential COI issues that potential Panel Members could have with the project following the standards of the National Academy of Sciences (NAS) and Office of Management and Budget M-05-03, *Final Information Quality Bulletin for Peer Review*. The following criteria were considered in the screening of the candidates:

- **Expertise:** Ensuring the selected reviewer has the knowledge, experience, and skills necessary to perform the review.
- **Independence:** The reviewer was not involved with projects for the (specific project) or in producing the documents to be reviewed.

- **Conflict of interest:** Identifying any financial or other interest that conflicts with the service of an individual on the Panel because it could impair the individual's objectivity or could create an unfair competitive advantage for a person or organization.
- **Availability:** Assessing the candidates' availability to meet the project schedule.

The LMI Team conducted an initial screening of candidates to exclude those with inadequate expertise or potential COI issues. We then selected several candidates for further in-depth screening and evaluation to ensure they met or exceeded the requirements of this task. The list was then narrowed down to identify the most qualified candidates who would be available to serve on the IEPR Panel while ensuring a balanced panel representing perspectives from academia, industry, and government to the extent possible. A list of selected panelists along with their summary qualifications relevant to this IEPR and detailed résumés was provided to USACE. USACE used this information to determine if any proposed Panel Members had a potential COI based on USACE's general knowledge of the candidate's past employment or current involvement with the project. USACE acknowledged the relevancy of Panel Members' experience relative to the requirements of the IEPR and that there were no real or perceived COI issues. Information about the Panel Members is provided in Appendix B.

3.3 Preparing and Charging the Panel

USACE provided to the LMI Team the documents to be reviewed by the IEPR Panel. Table 1 includes the list of the documents used in this review. We provided these documents to the Panel Members along with the final Charge to Reviewers. These charge questions established the general boundaries for the IEPR. The charge questions are in Appendix A.

Table 1: IEPR Documentation

Documents for Review
Draft Integrated Feasibility Report/Environmental Impact Statement
Appendix A1 Habitat Survey Locations
Appendix A2 Vegetation List
Appendix A3 Rahway Fluvial 404(b)1 Evaluation
Appendix A4 USFWS Correspondence
Appendix A5 Cultural Resources
Appendix A6 General Conformity
Appendix B Economics
Appendix CI Hydrology
Appendix CII Hydraulic
Appendix D Cost Engineering Appendix
Appendix E Real Estate Plan
Documents for Reference Only
Public Comments
Appendix F Project Area Photographs

The Panel was provided templates and instructions for preparing their comments to ensure proper coverage of all important issues and consistency in preparing the IEPR comments. The Panel was instructed that the LMI Team would be the conduit for information exchange between the Panel and USACE throughout the project in order to ensure a truly independent review.

3.4 Performing the Independent External Peer Review

This review involved conducting an independent technical peer review of the Rahway River Study to analyze the adequacy and acceptability of engineering methods, models, data, and analyses presented in the documents. The review focused on conducting a technical review and did not involve policy issues. The Panel used the charge questions as guidance for identifying relevant information and developing their comments and recommendations.

A kickoff meeting was held at the start of the IEPR with the Panel, USACE, and the LMI Team. At this meeting, introductions were made among the Panel Members, USACE, and the LMI Team. The main purpose of this meeting was for the USACE to present an overview briefing of the USACE project that was the subject of this IEPR. The Panel asked questions of USACE and discussed any initial issues of interest.

A teleconference was held with the Panel, USACE, and the LMI Team at the approximate midpoint of the IEPR, but before the Panel Members had formulated their comments. The purpose of the meeting was for the Panel to ask USACE questions about the project and the documents under review, discuss project technical issues, and identify any additional USACE documentation and information that could help the Panel in its review. The Panel used the information from the meeting to help prepare and finalize its comments submitted in the Panel Final Report.

Throughout the review process, we communicated to the Panel all relevant project information, instructions, and required actions and deadlines. We acted as the conduit for information exchange between the Panel and USACE throughout the project in order to maintain the integrity and independence of the IEPR process.

3.5 Finalizing the Panel Comments

After completing the review, Panel Members submitted a draft of their comments to the LMI Team. We collated the Panel comments and ensured they were complete and responsive to the charge. We identified overall themes that were presented by multiple peer reviewers or repeated by one reviewer, comments that indicated conflicting peer review opinions, and other noteworthy comments. We ensured that the Panel comments focused on performing a technical review of the documents and did not comment on policy-related issues.

The LMI Team coordinated with the Panel to reach consensus on the comments, identify any overlapping comments, and resolve any contradictions. Further refinement and consolidation of the comments occurred via e-mail exchange and telephone discussions.

Each IEPR Final Panel Comment (FPC) consisted of four parts:

- **Comment:** A clear statement of the concern.
- **Basis for Comment:** A narrative describing the basis for the concern.
- **Significance:** A significance rating (see Section 5) of the concern (the importance of the concern with regard to project implementability) as well as a statement supporting this significance rating. Comments are rated as High, Medium High, Medium, Medium Low, or Low to indicate the general significance the comment has to project implementability.
- **Recommendation[s] for Resolution:** Recommended actions necessary to resolve the concern to include a description of any additional research that would appreciably influence the conclusions.

3.6 USACE Responses to Panel Comments

After submitting this IEPR Final Report to USACE, we will enter the FPCs into the Design Review and Checking System (DrChecks) for USACE internal tracking of the FPCs and recommendations as well as the formal responses by the USACE and IEPR Panel's responses (called the BackCheck) to complete the IEPR process. DrChecks is an Internet-based review and checking application that USACE uses.[1]

USACE will review and respond to the FPCs. USACE will either "Concur" or "Non-Concur" with each Panel comment and will "Adopt" or "Not Adopt" each recommendation provided with that comment. The USACE will prepare a draft written Evaluator Response (ER) to each comment.

The IEPR Panel will then review the USACE draft ERs. The LMI Team will hold a meeting with the Panel Members and the USACE evaluators so that the Panel and USACE can discuss the draft ERs and ensure there is a clear understanding of the intent of original Panel comments. After this meeting, USACE will finalize their ERs and enter them into DrChecks. USACE's responses usually indicate whether documentation will or will not be expanded, revised, or changed in response to the FPCs.

3.7 Panel BackCheck Responses

After the USACE final ERs are submitted and entered into DrChecks, the LMI Team will meet with the Panel, as needed, to discuss the responses and the approach for preparing the Panel's BackCheck. As part of the BackCheck process, the Panel will select either "Concur" or "Non-Concur" with each USACE final ER and provide comments (as needed) to indicate whether each response adequately addresses the Panel's identified concerns. The Panel's BackCheck responses to each USACE ER will be entered into DrChecks.

[1] Hosted on the USACE's PROJect extraNET (ProjNet), a web service that allows secure exchange of information.

4 Panel Organization

The LMI Team assembled a panel of experts that met the qualifications set forth by the USACE in the Performance Work Statement (PWS) for the task. We supported and assisted the Panel in carrying out its review and served as the intermediary for communications between the Panel and USACE during the IEPR process.

4.1 IEPR Management

Figure 4 shows the organization of this IEPR. The purpose of this organization is to ensure the independence of the review.

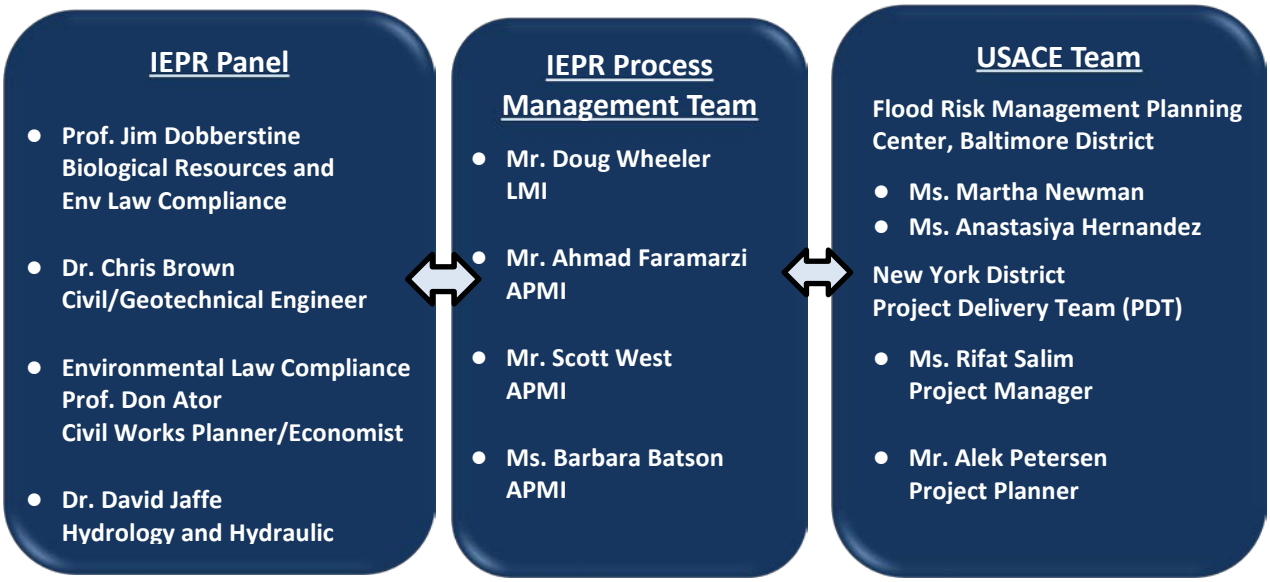

Figure 4: IEPR Organization

4.2 IEPR Panel Members

The IEPR Panel Members satisfied the qualification requirements for each of the areas of expertise called for in the USACE PWS:

- Biological Resources and Environmental Law Compliance
- Civil/Geotechnical Engineer
- Civil Works Planner/Economist
- Hydrology and Hydraulic Engineer.

Prof Jim Dobberstine
Role: Biological Resources and Environmental Law Compliance

Prof. Dobberstine currently serves as chair of the Math, Engineering, and Sciences Division at Lee College. He is responsible for all operational aspects of the Mathematics, Engineering, and Science Division. He holds a BA in Life Sciences from Concordia University, an MS in Environmental Management from the University of Houston-Clear Lake, and an MS in Environmental Science from the University of Houston, Clear Lake. Prof. Dobberstine teaches Environmental Science and Biology and is engaged in ecosystem studies in the Galveston Bay, Texas, estuary with his students, the results of which have been featured through organizations including Restore America's Estuaries, among others.

Prof. Dobberstine holds certificates in USACE wetland delineation (Texas A&M University) and water quality improvement using constructed wetlands (Clemson University). He is frequently called on to serve as an advisor on projects and panels. He currently serves on the Advisory Council to the Arthur Temple College of Forestry and Agriculture at Stephen F. Austin State University and formerly served as a curriculum review advisor to the Environmental Management Program at the University of Houston-Clear Lake. He serves on the Memorial Park Demonstration Project Vegetation Advisory Workgroup, a project led by the Harris County Flood Control District to stabilize the shoreline of Houston's Buffalo Bayou while enhancing riparian habitat. He serves on the Monitoring and Research Subcommittee of the Galveston Bay Council (Galveston Bay Estuary Program), on the Boards of Directors of the Texas Association of Environmental Professionals (President 2010–present) and the South Central Regional Chapter of Society for Environmental Toxicology and Chemistry (as President 2013–2015), and as a former Trustee and current Advisory Board Member of the Galveston Bay Foundation.

Dr. Chris Brown
Role: Civil/Geotechnical Engineer

Dr. Brown is an Associate Professor at the University of North Florida (UNF) teaching civil engineering, fluid mechanics, hydraulics, senior design, and engineering geology. He earned his PhD in Civil Engineering in 2005 from the University of Florida, his Master's degree from Villanova University in 1997, and his BS degree in Civil Engineering from Temple University in 1991. He has over 25 years of experience working on public works projects for the City of Philadelphia, Waste Management, USACE, and for Golder Associates Inc. as a private consultant for various complex civil engineering projects. While working for USACE, he worked within the Planning, Engineering, and Construction Divisions. He was consistently recognized for his excellent technical skills, including with the award of "engineer of the year" twice over 16 years with USACE.

Dr. Brown is familiar with, and has participated in, the design of floodwalls and gated structures, as well as non-structural flood mitigation solutions (e.g., buy-out or minor flood proofing). Specific project examples of direct design experience include Molly Ann's Brook project (included t-walls, l-walls, underpinning of buildings, levee, bridge modification), Portugués Dam (included access road, foundation prep, arch dam, drainage gallery, rock bolts), and City of Savannah storm sewer upgrade (included new conduit, cut/fill construction, utility relocation and hardening, vibration monitoring). Dr. Brown was also a key designer for the F. E. Walter Dam access road replacement (on design team and field inspection) as well as the design of new bridges across Everglades National Park along the Tamiami Trail in Florida. Dr. Brown has also been involved in other large civil works projects including the C&D Canal Deepening Project in Maryland and Delaware and the Delaware Main Channel Deepening Project in Pennsylvania and New Jersey.

Prof Don Ator
Role: Civil Works Planner/Economist

Prof. Ator was chosen primarily for his civil works economics experience and expertise. He earned an MS in Economics and Agriculture Economics from Louisiana State University in 1978 and an MBA in Finance and Accounting from Louisiana State University in 1984. He has over 35 years of experience working for 26 USACE districts. During this time he worked first as a full-time employee with USACE, and then in the private sector with a not-for-profit research institute, and with three architect-engineer firms. He has conducted more than 500 economics flood risk management studies evaluating and conducting complex multi-objective public works projects with high public and interagency interest nationwide. He has worked extensively with USACE conducting economics studies in accordance with Engineering Regulation (ER) 1105-2-100 and other pertinent guidance, laws, and regulations applicable to the USACE Six-Step Planning Process and EC 1165-2-209 review requirements.

Prof. Ator is nationally recognized for experience with USACE flood risk management analysis, economic benefit calculations, and expertise in economic analysis for flood risk management, specifically, with appropriate methodologies for estimating damages, and use of Hydrologic Engineering Center's Flood Damage Reduction Analysis (HEC-FDA). He is intimately familiar with Palisade @RISK Software and has demonstrated experience in determining the cost effectiveness of alternatives evaluations. Prof. Ator is actively involved in professional engineering and scientific societies, including the American Society of Civil Engineers (ASCE) and the Society of American Military Engineers.

Dr. David Jaffe
Role: Hydrology and Hydraulic Engineer

Dr. Jaffe earned his PhD in Civil and Environmental Engineering. He is a registered Civil Engineer and a member of the American Society of Civil Engineers. He is also a diplomat for the American Academy of Water Resource Engineers. Dr. Jaffe was chosen as a Panel Member primarily for his extensive experience in using numerical models for coastal and riverine analysis, both commercial and proprietary. Dr. Jaffe's modeling experience includes significant use of modeling packages from federal agencies, Hydraulic Engineering Center (HEC) in particular. This work has included analysis, design, and related regulatory elements. Dr. Jaffe has focused his technical expertise on the translation of engineering science into actionable environmental benefit, including protection, restoration, and remediation. His areas of technical focus reside in hydrology, hydraulics, and sediment transport. Dr. Jaffe utilizes a broad scope of numerical and analytical methods, including a wide range of numerical models, and is an expert in applying existing, off-the-shelf tools to provide in-depth and forward-looking analysis and insight to complex hydraulic problems.

Dr. Jaffe has maintained his academic and research ties and currently serves as a lecturer in civil and environmental engineering analysis and design. Additionally, his current area of research focuses on using sediment transport, through modeling and measurement, as a proxy for several facets of environmental analysis and design. Dr. Jaffe's background in physical marine science, riverine hydraulics, and numerical modeling provides a broad foundation for developing solutions in a diverse pallet of aquatic habitats, including those at the intersections of littoral and riverine systems. Dr. Jaffe also manages projects and programs that deal with environmental policy and systematic risk. These projects and programs include large or regional government projects and small, locally driven initiatives covering a broad spectrum of

agencies and interests. Dr. Jaffe has served as a project manager for federal and state projects, in particular those of Federal Emergency Management Agency (FEMA), National Marine Fisheries Service, USACE, US Environmental Protection Agency (EPA), and US Bureau of Reclamation.

4.3 IEPR Process Management Team

The IEPR process management team consisted of the following members.

Doug Wheeler, PMP, CCP, RMP, Program Manager (LMI)

Mr. Wheeler is an industrial and mechanical engineer with more than 20 years of experience in strategic process engineering and financial analysis including work for USACE, Department of Energy (DOE), and General Services Administration (GSA). For USACE, he led a consultant and client team in a business process reengineering effort for the Navigation Locks and Dams High-Performing Organization. He also led project teams in a variety of tasks to provide reengineering services to the USACE information technology function. He led the review of the USACE McClellan-Kerr Arkansas River Navigation System maintenance activity and supported the USACE Inland Marine Transportation System. Because of this work, Mr. Wheeler understands USACE's water navigation business area and supporting projects. He has also focused on real property and lease-related projects for GSA as well as economic assessments of infrastructure projects for DOE. Mr. Wheeler will apply LMI's COI process by reviewing each task order (TO) PWS with LMI's management team. LMI's process ensures that each LMI business unit manager is aware of TO scope and can raise organizational COI issues before LMI responds. He currently is focused on LMI's project cost engineering practice, privatization, and competitive sourcing services. Mr. Wheeler holds an MBA and a BS in Mechanical Engineering from Columbia University and an MSE in Industrial Engineering from Arizona State University.

Ahmad Faramarzi, PE, PMP, Project Manager (APMI)

Mr. Faramarzi supervised project personnel and communicated policies, procedures, and goals to the IEPR Team. In coordination with Mr. Wheeler, Mr. Faramarzi maintained regular contact with USACE and was responsible for the overall project plan, project performance, and client satisfaction on this as well as future tasks for USACE. He will also have multiple technical and administrative staff as direct reports. Mr. Faramarzi is a registered Professional Engineer (PE) and a Certified Project Management Professional with 35 years of experience providing managerial and technical expertise to government clients, including USACE, Office of the Secretary of Defense, the US Army, the US Air Force, and Defense Nuclear Facilities Safety Board. He has organized and managed several important and highly visible expert panels in response to recommendations by the NAS. Mr. Faramarzi has a Post-Masters applied scientist/engineer degree from the George Washington University in Aerospace and Mechanical Engineering (fluid mechanics and biomimetics), an MS in Thermofluid Engineering, and a BS in Nuclear Engineering. He has extensive experience with nodal and multi-dimensional fluid flow models, and is on the Board of Directors of the Washington, DC, Section of the American Society of Mechanical Engineers and an active member of the Fluid Dynamics branch.

Scott West, Task Leader (APMI)

Mr. West was a criminal investigator for EPA, Criminal Investigation Division (CID), for almost 20 years. He served as the Special Agent-in-Charge for three different EPA regions where he was the senior environmental crimes expert. He supervised a staff of criminal investigators, scientists, attorneys, and support personnel. EPA CID Special Agents investigate criminal violations of all federal environmental laws and are quite familiar with the full federal environmental regulatory framework. For the past 9 years, Mr. West has been actively engaged in marine conservation issues worldwide. He experienced the March 2011 9.0 earthquake and resulting tsunami in Otsuchi, Iwate Prefecture, Japan. He now is the Executive Director for a non-profit organization dedicated to saving the critically endangered Southern Resident Killer Whales (Puget Sound). Mr. West earned a BSW, Cum Laude, from Virginia Commonwealth University in 1983, and an MDiv. from the General Theological Seminary in 1987.

Barbara Batson, Project Coordinator (APMI)

Ms. Batson has over 20 years of experience with project management and facilitation with both government and corporate clients where she was responsible for ensuring project quality was maintained and schedules were completed on time. She has worked on projects for the Department of Defense, Department of Education, US Treasury, Social Security Administration, and DOE. Her project responsibilities included managing global projects with aggressive schedules and facilitating team members on multiple continents. Her experience with project management will ensure the project stays on schedule and all milestones are met.

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5 Independent External Peer Review Comments

The IEPR Panel has completed a detailed independent technical review of the Rahway River Study prepared by the USACE New York District. The review assessed the adequacy and acceptability of economic, engineering, and environmental methods, models, and analyses used for the Rahway River Study as well as an assessment of the environmental studies documenting potential project impacts.

Section 5.1 provides a summary of the IEPR Panel comments. Section 5.2 presents the complete set of IEPR Panel comments.

5.1 Summary of Independent External Peer Review Comments

Biological Resources and Environmental Law Compliance

Overall, the DIFR/EIS makes a reasonable effort to address the intent of the decision document and the purpose and need for the project. The document also sufficiently describes the range of alternatives considered within the analysis. However, there are specific areas of concern related to environmental and socioeconomic impacts that are not adequately discussed. Specifically, it is not clear from the DIFR/EIS whether there might be disproportional impacts to Environmental Justice (EJ) populations and/or children as a result of the implementation of the project, as the report indicates that there are substantial numbers of minority and low-income populations within areas that may be affected by the TSP, but concludes that there would not be disproportionate impacts to EJ populations; data to support this finding is sparse within the document.

Additionally, it is not clear whether the DIFR/EIS sufficiently considers sources of sediment contamination, Best Management Practices (BMPs) to control disturbance and displacement of sediments, and any sediment analysis for contaminants in areas that would be disturbed by cofferdam installation and channel modification. Further, the DIFR/EIS indicates that thermal impacts associated with the project as a result of the reservoir drawdown would not be expected downstream of the dam, but this conclusion is not well supported in the document. Finally, it is not clear from the DIFR/EIS whether the USACE has a comprehensive plan for preventing the proliferation of invasive species as a result of project activities. The document would benefit from more substantive discussion and analysis in these subject areas moving forward.

Civil/Geotechnical Engineering

The Panel concurs with the USACE efforts to use risk-based assumptions in the cost estimate to mitigate for the lack of engineering and environmental detail. The USACE has assumed large contingencies in most cost items due to the various unknowns and the Panel agrees with this approach. Overall, the report has a low level of detail, which was driven by the USACE SMART (Specific, Measurable, Achievable, Realistic and Timely) planning process. While the Panel commends USACE for this time-saving approach, the overall level of detail is deficient even considering typical SMART standards. The Panel has significant concerns with the DIFR/EIS that still need to be addressed. There are several important civil, geotechnical, and cost engineering issues that require resolution.

In general, there are very limited engineering calculations, discussion, or assumptions presented in the main report or appendices. In the case of geotechnical engineering, the information is almost entirely lacking. Since the TSP includes modification or even full replacement (e.g., as assumed in the cost estimate) of the embankment dam for the Orange Reservoir, the lack of geotechnical information is disturbing. Similarly, civil and cost engineering efforts appear very preliminary with no design basis provided in the main report and appendices. Another key shortcoming is the insufficient analysis of possible effects on recreation within the Orange Reservoir. Local agencies have invested considerable funds upgrading the reservoir recreational facilities over the last 10 years, yet there is little discussion in the DIFR/EIS regarding the possible impacts from the TSP on the reservoir. Recreation mitigation needs to be considered and discussed by USACE.

Civil Works Planning/Economics

From a plan formulation and economic analyses perspective, the DIFR/EIS does a good job of identifying and explaining the assumptions, data, methods, and models that underlie the project analyses. The conclusions based upon the planning analysis are appropriate and logically follow from the stated problems, opportunities, objectives, constraints, screening, and alternatives evaluation. However, there are a few areas where the data presented appear to be inconsistent; the most important inconsistency is a comparison of the costs of the Without-Project Damages Modeled using the HEC-FDA versus Recorded National Flood Risk Insurance Program (NFIP) Damages that shows significantly different results without explaining the differences. There are also several inconsistencies in the reported values and missing information, which should be addressed to improve the quality of the analysis.

Hydrology and Hydraulic Engineering

A review of the documentation suggests that substantial effort was made to develop a realistic plan for flood control improvements along select reaches of the Rahway River in New Jersey. However, the possibly incorrect use of Manning's values in the numerical modeling calls into question the modeling results and has implications for the model output in the larger study. Sediment transport within the system needs to be considered and discussed. In addition, questions are raised about flooding control during construction phases of the project and for the overall level of flood protection provided by the project. Numerical modeling, sediment transport, and hydrologic considerations should be revisited before moving forward with the project.

5.2 Independent External Peer Review Panel Comments

This section contains the complete set of comments of the IEPR Panel. Each comment consists of four parts:

- Comment
- Basis for comment
- Significance of the concern
- Recommendation for resolution of the comment.

Comments were rated to indicate the general significance that the comment has to the project implementability using the following definitions:

- **High:** Comment describes a fundamental problem with the project that could affect the recommendation or justification of the project.
- **Medium High:** Comment affects the completeness or overall understanding of the recommendation or justification of the project. Resolution of the issue determines if it is a fundamental problem with the project or not.
- **Medium:** Comment affects the completeness or overall understanding of the recommendation or justification of the project.
- **Medium Low:** Comment affects the technical quality and understanding of the project based on the presentation of information related to the recommendation or justification of the project. However, the Panel does not have sufficient information to determine the effect on project implementability.
- **Low:** Comment affects the technical quality and understanding of the project based on the presentation of information related to the recommendation or justification of the project, but there is limited concern regarding project implementability.

5.2.1 Significance: High

Comment #1
Using the Manning's values for blocking discharges in the Hydraulic Engineering Center's River Analysis System (HEC-RAS) modeling requires additional justification.
Basis for Comment
Manning's values for overland flows, flows through dense vegetation in channels, and other situations are typically selected by using Cowan's method or another similar method (Chow, V. T; US Department of Transportation). Values of Manning's coefficient may exceed 0.200 in some very densely vegetated locations. When HEC-RAS is used for modeling channels, there are several optional cross-section properties, including ineffective flow areas and blocked obstructions. These are described in the HEC-RAS Reference Manual. Ineffective flow areas are used to identify portions of a section where water will pond, but velocity of that water is approximately zero. Obstructions are used by the modeler, in contrast, to permanently block out areas of a section. The modeling should be changed from using Manning's values for blocking flow to implementing either blocked obstructions or ineffective flow areas unless it can be shown in USACE guidance that using Manning's value is an approved approach. This is significant since inaccurate use of Manning's values and other functions in HEC-RAS may render the calibration questionable, thus raising doubts about the modeling results and the implications of the model output in the larger study. **Cited References:** O*pen Channel Hydraulics*, Chow, V. T. , McGraw Hill, 1954 *Guide for Selecting Manning's Roughness Coefficients for Natural Channels and Flood Plains*, FHWA-TS-84-204 Final Report, 1984
Significance: High
Incorrect use of modeling parameters may lead to poor design choices and project implementation.

Recommendation for Resolution
Recommendation #1: Utilize Corps guidance or references for using Manning's values to block flows, or revise the HEC-RAS model to appropriately model the ineffective or blocked areas within the model.

Comment #2
The values of damages modeled are dramatically higher than Recorded National Flood Insurance Program (NFIP) Damages. This indicates that either the values of damages modeled are substantially overstated compared with those for the Recorded NFIP Damages or the Recorded NFIP Damages are substantially understated.
Basis for Comment
Appendix B tables 15 and 16 in Section 4.2.6 depicts the Without-Project Damages Summary on Comparison of Modeled using Hydraulic Engineering Center's Flood Damage Reduction Analysis (HEC-FDA) while Pages 21-22 include the Recorded NFIP Damages. Table 15 shows an Average Building Damages Paid of $17,493 and an Average HEC-FDA Structure Damage of $44,500 for Cranford and $25,000 and $36,600 for Kenilworth, respectively. Table 16 shows Average Building Damage Paid of $42,192 and Average HEC-FDA Structure Damage of $43,978 for Cranford and $17,248 and $29,111 for Kenilworth, respectively. In addition, the next to last paragraph on page 22 indicates that "…the total building damage from Irene would be in the region of $19 million, compared with $32 million computed by the HEC-FDA model for an event of similar frequency." The report states that "Differences between flood damages modeled in HEC-FDA and NFIP losses are not uncommon…" The report indicates that the differences may be due to several factors, which are noted, but the identified factors do not provide much confidence in the accuracy of the Without-Project Damages reported values.
Significance: High
The Without-Project Damages are the foundation for calculating the project Average Annual Benefits used to determine the benefit-to-cost ratio that indicates whether construction of the project is economically justified.
Recommendation for Resolution
Recommendation #1: Include a clear explanation of the reason for the discrepancies in the damages modeled using HEC-FDA and the Recorded NFIP Damages in the *Economics* Appendix. In addition, evaluate how these discrepancies affected the analysis and justify how the Tentatively Selected Plan (TSP) is adequately supported despite these discrepancies.

5.2.2 Significance: Medium High

Comment #3
The proposed TSP is not based upon any meaningful geotechnical design data.
Basis for Comment
The TSP includes both a dam modification/replacement and channel excavation. In typical USACE feasibility-level reports, some amount of meaningful geotechnical information is included to provide a basis for the proposed alternative design. The only soil information provided in the Draft Integrated Feasibility Report and Environmental Impact Statement (DIFR/EIS) is from US Department of Agriculture soil type maps developed by the Soil Conservation Service/National Resources Conservation Service (NRCS) and a limited summary of a consultant report. The NRCS maps generally cover the first foot of cover soil and may not be that useful within the Rahway River itself. No apparent effort was made to incorporate existing geological information published by the New Jersey Geological Survey (e.g., OFM 34 or Lucey [1976]) or the United States Geological Survey. Lucey reports that the surficial soils consist of glacial deposits including gravel, sand, clay, and boulders. Obviously, large cobbles or boulders would be very important to identify in the area of channel excavation. In addition, as the dam itself is about 100 years old, it is likely that it has not been constructed to current dam safety standards. The Panel recognizes that the cost estimate assumes that dam reconstruction will have to occur due to this fact, but even the cost estimates do not appear to be based upon any local information. Without any geotechnical information on the dam itself, the likelihood of major, unforeseen construction issues increases substantially. Based upon the surficial geology of the area, the foundation conditions of the dam could be quite variable making any type of new dam design complicated and expensive. **Cited References:** Open File Map (OFM) 34, *Bedrock Geology of the Roselle Quadrangle, Union and Essex Counties, New Jersey, 2000*. Monteverde, Donald H., New Jersey Geological Survey, Map Scale 1 to 24,000, 1 sheet. Lucey, C., (1976). *Geology of Essex and Union Counties In Brief, New Jersey Department of Environmental Protection, Bureau of Geology and Topography, New Jersey Geological Survey, 13 p. plus maps*. Doi: http://dx.doi.org/doi:10.7282/T3DV1J2B
Significance: Medium High
Resolution of the issue determines if it is a fundamental problem with the project or not.
Recommendations for Resolution
Recommendation #1: Research the construction and development history of the dam embankment itself as this may provide further insight regarding potential demolition issues. **Recommendation #2:** Review and compile existing geological information on the area covering Orange Reservoir and the proposed channel modifications (see references provided to start). **Recommendation #3:** Consider installation of a few borings in the dam embankment itself to gather necessary geotechnical data. **Recommendation #4:** Consider installation of a few deep borings near the dam embankment to gather necessary geotechnical data on the thickness of surficial soils and the depth to the bedrock foundation in the area.

Recommendation #5: Based upon the additional geotechnical data, revise the dam modification design and cost estimates as required to reflect actual field conditions.

Recommendation #6: Based upon the synthesis of the explorations and existing literature, develop a proposed dam cross section for the new replacement embankment.

Comment #4

HEC-RAS model calibration is based on peak observed events while current flood control efforts may provide as little as 5-year protection.

Basis for Comment

Section 3.2 of Appendix C.II, *Hydraulics*, describes the calibration of the HEC-RAS numerical model based on two events of record. Proposed project improvements to the Rahway River Basin in some instances are limited to substantially less than 25-year protection. The calibration of the model that suits events of record may be substantially different than a calibration appropriate to events of more frequent occurrence.

Significance: Medium High

Successful implementation of the project may be limited if the design of the project elements does not consider directly the level of protection afforded by the project's construction.

Recommendation for Resolution

Recommendation #1: Evaluate and describe model calibration for more frequent events (for example 25-year annual return probability) in comparison to model calibration for events of record. Where the calibration events are substantially less frequent than the level of protection, additional HEC-RAS model calibration should be considered for more frequent events in order to fully understand the impact of flooding on the proposed project conditions.

Comment #5

There is no analysis of flood control during construction, when there will be reduced storage capacity.

Basis for Comment

During construction of dam modifications, there will be reduced storage capacity in the system for flood control. However, there is no discussion of flood fighting during the construction period. This absence is significant since the period of construction will occur with increased vulnerability to flooding as a result of construction-limited flood control capacity. Moreover, the environmental impacts to water quality, sediment transport, scour, habitat and other concerns will likewise be exposed to higher risk. While the potential for increased flood risk is for a limited duration, the risk should be addressed and mitigated in all possible instances.

Cited References:

Passive and Active Control of Diversions to an Off-Line Reservoir for Flood Stage Reduction, Sanders, B.F., J.C. Pau, and D.A. Jaffe, Advances in Water Resources, 2006, 29(6):861–871.

Significance: Medium High

There is concern that if flood fighting and mitigation strategies cannot be developed for the period of construction the project can be implemented, but with significant risk while being built.

Recommendation for Resolution

Recommendation #1: Evaluate and document flood control operations during construction.

Comment #6

The DIFR/EIS should include more specific information regarding sources for sediment contamination, Best Management Practices (BMPs) to control disturbance and displacement of sediments, and any sediment analysis for contaminants in areas that would be disturbed by cofferdam installation and channel modification.

Basis for Comment

Section 6.3 notes the channel modification in the Township of Cranford are located in a segment of the river that is listed on the state 303(d) list for arsenic and phosphorus, and that construction activities may resuspend these sediments. Additionally, in response to a request from the Panel during the mid-point meeting on 14 February 2017, the USACE has provided a map of Hazardous, Toxic, and Radioactive Waste (HTRW) sites near the channel, within the upper and lower limits of the channel modification; the map notes 20 sites within one half mile or less.

Adjacent urban land use is well documented within the literature as negatively influencing conditions in adjacent streams and other water bodies for water and sediment parameters, including bacteria, organic and inorganic contaminants, and altered biologic conditions in both tidal and non-tidal streams, including many in New Jersey (Pratt and Chang, 2012; Vile, 2011; Tran, et al., 2010; Schoonover and Lockaby, 2006; Lerberg, et. al., 2000; Kennan, 1999; Reiser and O'Brien, 1997; Lenat and Crawford, 1994). Contaminant transport from within the watershed can occur through a number of processes, including overland flow, groundwater migration, etc. (Walker and Hopkin, 2006). A number of studies suggest the importance of the riparian buffer zone to minimizing instream contaminant loading (Pratt and Chang, 2012; Tran, et al., 2010). Historically, the Rahway River has been studied and found to have elevated levels of a variety of contaminants in the sediments, including organics (i.e., chlordane, dieldrin, PCBs, DDT, DDE, DDD), and heavy metals (i.e., copper, chromium, lead, zinc) (Stackleberg, 1997; O'Brien, 1997). Not surprisingly, many of these have also been detected in water and fish tissue samples, along with other contaminants including atrazine, metachlor, carbaryl, arsenic, mercury, etc. (Reiser and O'Brien, 1997; *2014 NJ Integrated Water Quality Assessment Report*, 2015). Unfortunately, sediments can be both a sink and a source for contaminants within an aquatic system (Walker and Hopkin, 2006). Additionally, contaminants do not necessarily accumulate uniformly across the sediment surface, but rather will sequester to sediments where the physical and chemical characteristics are most favorable, often forming hotspots, and can vary by depth (Walker and Hopkin, 2006). This understanding suggests substantive, comprehensive precautions and management to minimize disturbance are warranted, and that maintenance of a riparian buffer zone is important to minimizing instream contaminant loading in watersheds that are highly urbanized.

The DIFR/EIS notes BMPs that would be implemented to minimize the effects of resuspension and downstream transport, including planting grass on exposed areas in the reservoir. Additionally, the use of cofferdams to allow construction activities along the dam to occur in dry conditions in order to minimize sedimentation was noted. However, the placement of the cofferdams is likely to displace sediments during installation, and it is presumable that any channel modifications could disturb sediments as well. Further, it is plausible, if not likely, that sediments could be displaced prior to the establishment of grass and similar BMPs as a result of runoff during storm events, recreational activities, etc.

It is not clear at this stage whether any substantive geotechnical work has been completed to identify the composition of sediments that would be disturbed (i.e., cobble, sands, silts, clay), which may prove informative toward identifying the capacity of the sediments to sequester contaminants and the potential for resuspension. The DIFR/EIS notes in a few places that gravel/cobble substrate is present, but appears to lack any specific analyses. Nor is it clear whether any sediment analyses have or would be conducted in the areas that will be disturbed and/or exposed, beyond a reference to ER 1165-2-132, noting that efforts will be made to avoid HTRW-contaminated areas where practicable. Thus, it is not clear that the impacts as a result of the proposed work have been fully identified or quantified. Erosion and resuspension in areas where contaminants have accumulated and concentrated over time would serve to increase project-related risk to the community, possibly including Environmental Justice (EJ) populations, recreational users, and downstream communities during project implementation and into the future.

Additionally, Section 6.3.2 of the DIFR/EIS makes the observation that. "*…the channel modifications are located within a segment of the Rahway River listed in the 303(d) list for arsenic and phosphorus… the length of this 303(d) listed segment extends downstream to the Robinson's Branch, therefore, any sediment transported downstream is already within an impacted river segment*". This seems to suggest that additional contaminant loading downstream of the project site is an acceptable outcome. Furthermore, Section 3.3.2 indicates, "*All of the segments of the Rahway River assessed were rated sub-optimal. Factors contributing to the sub-optimal rating for the portion of the Rahway River assessed below Orange Reservoir include a lack of variety of flow/depth regimes, moderate amount of sediment deposition, and lack of riffles*"; additional deposition of sediment (contaminated or otherwise) would only seem to exacerbate this condition.

During the midpoint meeting with the Panel on 14 February 2017, the USACE noted that BMPs would be employed during installation of the cofferdams (e.g., sediment curtains) and that sediments would be analyzed for contaminants during the Planning, Engineering, and Design phase of the project to verify the presence and concentrations of any contaminants. The Panel suggests that moving forward, the DIFR/EIS would benefit significantly from greater specificity of information as it relates to these BMPs and sediment analysis specific to the installation of the cofferdams. Further, the Panel recommends that additional evaluation be included within the DIFR/EIS regarding sediment contaminants within the area of dam and channel modifications, including a more robust discussion regarding adjacent land use, sediment composition, and potential contaminant contributions from nearby HTRW sites as part of the loading from this urbanized area. Consultation of the historical aerial photography combined with the Sanborn Map Company fire insurance maps for the surrounding area may provide additional information in regard to HTRW site identification. Some consideration should also be given to areas that would be exposed during the reservoir drawdown, specifically evaluating areas that might suffer scour and erosion as a result of point and/or non-point runoff.

Cited References:

2014 New Jersey Integrated Water Quality Assessment Report. NJ Department of Environmental Protection. December 2015.

B. Pratt and H. Chang. *Effects of land cover, topography, and built structure on seasonal water quality at multiple spatial scales*. Journal of Hazardous Materials. Vol. 209-210. Pp. 48-58. 2012.

J. Vile. *Fish IBI Report; 2010 Sampling, Round 3, Year 1 of 5*. Volume 1 of 2. New Jersey Department of Environmental Protection. September 2011.

C.P. Tran, et al. *Land-use proximity as a basis for assessing stream water quality in New York State (USA).* Ecologic Indicators. Vol. 10. Pp. 727-733. 2010.

Walker and Hopkin. Principles of Ecotoxicology. CRC Press. 2006.

J. E. Schoonover and B.G. Lockaby. *Land cover impacts on stream nutrients and fecal coliform in the lower Piedmont of West Georgia*. Journal of Hydrology. Vol. 331. Pp. 371-382. 2006.

Lerberg, S., et al. *Response of Tidal Creek Macrobenthic Communities to the Effects of Watershed Development*. Estuaries. Vol. 23, No.6. Pp. 838-853. 2000.

R. G. Reiser and A. K. O'Brien. *Pesticides in streams in New Jersey and Long Island, New York, and relation to land use*. USGS Water-Resources Investigations Report 98-4261. 1999.

J.G. Kennan. *Relation of macroinvertebrate community impairment to catchment characteristics in New Jersey streams.* Journal of the American Water Resources Association. Vol. 35, No. 4. 1999.

P.E. Stackelberg. *Presence and Distribution of Chlorinated Organic Compounds in Streambed Sediments, New Jersey*. Journal of the American Water Resources Association. Vol. 33, No. 2. 1997.

A. K. O'Brien. *Presence and distribution of trace elements in New Jersey streambed sediments*. Journal of the American Water Resources Association. Vol. 33, No. 2. 1997.

D.R. Lenat and J.K Crawford. *Effects of land use on water quality and aquatic biota of three North Carolina Piedmont streams*. Hydrobiologia. Vol. 294, Issue 3. Pp. 185-199. 1994.

Significance: Medium High

Failure to demonstrate comprehensive consideration of sources for sediment contamination, BMPs to control disturbance and displacement of sediments, and any sediment analysis for contaminants in areas that would be disturbed by cofferdam installation and channel modification affects the completeness or overall understanding of the recommendation or justification of the project. Resolution of the issue determines if it is fundamental problem with the project or not.

Recommendations for Resolution

Recommendation #1: Include a more robust evaluation of adjacent land use, sediment composition, potential contaminant contributions from nearby HTRW sites, and legacy pollutants noted on the 303(d) list in the discussion regarding sediment resuspension and redistribution in relation to the Orange Reservoir drawdown, channel modifications, and dam outlet replacement, including evaluation of areas that would be exposed during the reservoir drawdown, specifically evaluating areas that might suffer scour and erosion as a result of point and/or non-point runoff.

Recommendation #2: Include a more robust evaluation of BMPs and information noting sediment analysis as it relates to installation of the cofferdams and sediment management during drawdown of the Orange reservoir in the DIFR/EIS as noted in the basis for comment section above.

Comment #7
The report does not discuss the effect of the TSP on sediment transport within the system.
Basis for Comment
The proposed TSP conditions include changes to the stream platform, profile, and section, all of which have the potential to alter sediment transport behavior in a channel. The proposed improvements include these kinds of changes, but no discussion is present in the DIFR/EIS regarding how the proposed improvements may change sediment transport in the improved areas. Impacts to sediment transport are significant in flood control and restoration efforts since there are equal and measureable impacts to water quality from increased turbidity, habitat stability, and integrity from increased aggradation and degradation, and other related effects. Similarly, changes in sediment transport in improved systems have the potential to expose bridge abutments, utility crossings and other infrastructure, as well as causing other impacts to infrastructure, such as reduced capacity at ridges and other crossings resulting from aggradation. Finally, changes in sediment transport can expose toe protection with increased scour or reduce flood conveyance with increased deposition.
Significance: Medium High
If sediment transport is not adequately addressed, the resulting stream aggradation and/or degradation may result in additional flooding from insufficient hydraulic capacity or structure failure, respectively.
Recommendation for Resolution
Recommendation #1: Include an analysis and discussion to address how changes to sediment transport resulting from the proposed project may impact habitat, infrastructure and flood control in the proposed conditions.

Comment #8
The proposed new operational plan for Orange Reservoir required for the TSP is not clearly defined.
Basis for Comment
The TSP includes the proposed modification of the Orange Reservoir dam as well as operational changes to the existing project. USACE intends to draw down the reservoir for two days before significant storms. The proposed drawdown will lower the pool elevation 15 feet and provide approximately 660 acre-feet of temporary storage, which will be used to capture floodwaters from upstream. After the storm event recedes, USACE then proposes to refill the reservoir to its existing normal pool. The refilling process could take anywhere from 30 hours to two weeks, depending upon the post-storm hydrologic conditions according to USACE estimates. Currently, area residents use the reservoir for recreational activities and the proposed operational changes to the system call into question whether recreational use will be feasible for many periods during the year. Also, during the drawdown phase, the Panel estimates that the mean flow out the proposed new outlet structures would be about 136 cubic feet per second (cfs) over two days. Although this appears like a small and manageable flow for the Rahway River, no evaluation or calculations are provided demonstrating that there is no induced flooding potential for these cases. Induced flooding potential may be very sensitive to the starting (existing) condition flows in the Rahway River just prior to drawdown activities beginning. In addition, some discussion regarding potential induced erosion or resuspension of sediments downstream of the reservoir during the drawdown phase is sorely needed. Lastly, the Panel cannot discern how the

drawdown activities will be triggered. There is no discussion of this important operational consideration or any long-term simulations to test how a proposed trigger would work. The document assumes that all estimated flood mitigation benefits will be gained by the TSP, but this has not been necessarily demonstrated in the DIFR/EIS report.

Significance: Medium High

Resolution of the issue determines if it is a fundamental problem with the project or not.

Recommendations for Resolution

Recommendation #1: Provide additional evaluation and pertinent calculations to demonstrate that the TSP will not result in any induced flooding, erosion, or sediment resuspension downstream of the reservoir during drawdown operations.

Recommendation #2: Provide additional evaluation, model runs, and calculations regarding the planned operational "trigger" for the drawdown operations. Explain if flow or stage at a particular US Geological Survey (USGS) gauge will be utilized or some other measuring point.

Comment #9

The recreational impact to Orange Reservoir has not been fully documented in the report.

Basis for Comment

The City of Orange Township, New Jersey owns the Orange Reservoir. According to their website, "Under the direction of Mayor Warren and the City Council, the Orange Reservoir was leased to Essex County for $1.6 million. Under the lease, the county is responsible for renovation and maintenance; renovation plans include a dock, paddle boats, an outdoor patio and fireplace, and lighted walkways around the water." (http://www.ci.orange.nj.us/fast_facts_about_Orange.html) Loss of recreational use may trigger a loss of revenue for Essex County such that some sort of mitigation could be required. Further, it appears that Essex County has spent another $2.3 million on recreational upgrades in the reservoir area.

(http://www.nj.com/essex/index.ssf/2013/07/essex_county_unveils_revamped_orange_reservoir with_paddle_boats_recreation_area.html)

Significance: Medium High

Resolution of the issue determines if it is a fundamental problem with the project or not.

Recommendations for Resolution

Recommendation #1: Provide additional evaluation regarding the potential recreational impacts to the owner and area users as a result of the proposed TSP.

Recommendation #2: Provide documentation so that both the City of Orange Township and Essex County understand the potential recreational impacts and support the proposed physical changes to the dam and operational changes to the reservoir.

Recommendation #3: Determine if mitigation is required to compensate Essex County for recreational impacts from the proposed TSP.

Comment #10
The analysis does not adequately describe the comprehensive plan to prevent the proliferation of invasive species a result of project activities referenced in Table 31 of the DIFR/EIS, including BMPs, monitoring, and adaptive management and related controls.
Basis for Comment
Section 3.4 notes a number of invasive plant and animal species that are common to the project area. However, except for a short discussion that any carp and/or goldfish (identified as invasive species) collected within the reservoir will be humanely euthanized and a very brief notation in Table 31 indicating that the USACE would make use of BMPs, monitoring, and adaptive management to prevent proliferation of invasive species, a substantive discussion of this topic is lacking. Areas disturbed by construction-related activities can provide prime opportunities for invasive species to establish and proliferate. The DIFR/EIS appears to provide an acceptable overview of the invasive species known to occur within the vicinity of the project site. However, it does not prominently address invasive species proliferation issues that might arise as a direct result of disturbance associated with the project alternatives, nor does it prominently specify controls on proliferation during construction or post-construction monitoring plans. These might include direct disturbance by construction related activities, and/or additional environmental stress related to changes in hydrology as a result of reservoir and dam operations during (and/or following) construction. Further, impacts to and/or displacement of native species can alter ecologic niche fulfillment within biologic communities, opening pathways for introduction and proliferation of invasive species. The DIFR/EIS would benefit from a more thorough evaluation of invasive species proliferation pathways and concerns as they relate to potential consequences of the preferred alternative. The document would also benefit from some notation that the monitoring and management plan would specify appropriate, biologically relevant monitoring periods and intervals for the noted species, target coverage/abundance for invasive species sufficient to prevent substantive alteration of the biologic community, and protocols for maintenance to prevent post-construction proliferation (again, over a biologically relevant time frame). The Panel also suggests that invasive species management plans for the project clearly include criteria and education for contractors working on the project to avoid and control proliferation on invasive species, or introduction of such species from offsite. Executive Order 13112 and subsequent USACE Invasive Species Policy sets comprehensive goals for invasive species management, such as cooperation with local, state, and federal agencies and Non-Governmental Organizations (NGOs) to identify and interdict pathways for introduction of invasive species, develop monitoring plans, etc., but those do not appear to be reflected by the information provided in the DIFR/EIS. It is advisable to clearly address this issue prior to construction, rather than potentially introducing the need for more cost-intensive, difficult-to-implement controls after the fact. **Cited References:** *US Army Corps of Engineers Invasive Species* Policy Memorandum (with enclosures), USACE, 2009-06-02
Significance: Medium High
Failure to fully consider invasive species impacts and management affects the completeness or overall understanding of the recommendation or justification of the project. Resolution of the issue determines if it is fundamental problem with the project or not.

Recommendation for Resolution
Recommendation #1: Revise the Supplemental Draft Environmental Impact Statement to include a comprehensive plan for invasive species control and management specific to the project, including identification of proliferation pathways, controls (including BMPs), and biologically relevant monitoring and adaptive management periods, and reflect cooperative efforts with local agencies and stakeholders.

Comment #11
The DIFR/EIS does not adequately describe the impacts to EJ populations and/or children as a result of the implementation of the project to ensure they are not disproportionally affected.
Basis for Comment
Section 3.7.2 states, "*According to EO 12898, minority populations exist where the percentage of minorities exceeds 50% or where the minority population percentage in the effected area is meaningfully greater than in the general population. EO 12898 does not provide criteria to determine if an affected area consists of a low-income population*." Further, Section 3.7.2 also notes that, "*Those municipalities where the combined minority populations and/or the low income populations are higher than the County are subject to Environmental Justice considerations*." The DIFR/EIS indicates that there are substantial numbers of minority and low-income populations within areas that may be affected by the TSP. These include the cities of Orange and Rahway, and the Township of West Orange. However, Section 6.8 concluded that there would not be disproportionate impacts to EJ populations, yet data to support this finding are sparse within the document. Significant impacts that persist or repeat over years can result in permanent effects to EJ communities. EJ populations, specifically low-income populations, are often disproportionately impacted as a result of not having the resources to compensate for the impacts while they are occurring, or recover after they have ceased, in comparison to non-EJ populations exposed to the same impact. These issues can include lack of heath care to respond to air quality and other environmental impacts, lack of transportation options to compensate for traffic disruptions, and means to accommodate cost increases to avoid heavily trafficked/closed roadways, noise and air impacts, income to offset lost work days, access to public facilities, restrictions to access for subsistence fishing, etc. Further, the DIFR/EIS does not indicate the level of unemployment or underemployment in the areas/tracts identified as low-income or minority; this status could exacerbate vulnerability to any adverse impacts associated with the project. The DIFR/EIS indicates that some of these communities are located within ¼ mile of the project site. The USEPA suggests in their guidance (1998) that consideration of affected communities should be made carefully, stating, "*The sensitivity to environmental justice concerns should sharpen the focus of the analysis. While the analytical tools to be used are similar, the analysis should focus both on the overall affected area and population and on smaller areas and/or communities within the affected area" and, "Identifying the "affected community" is particularly important...*" Further, the guidance suggests, "*…exhausting all applicable analyses will provide the greatest likelihood of accurately depicting the possibility of disproportionately high and adverse effects on low-income and/or minority communities. Analysts should be as resourceful as possible in addition to seeking information from traditional sources.*" The guidance goes on to exemplify cumulative impacts with EJ implications that should be considered. Additional USEPA guidance (May 2015) notes there are a number of factors that contribute to potential EJ concerns, including proximity and exposure to emission sources,

unique exposure pathways, physical infrastructure, multiple stressors and cumulative impacts, and capacity to participate in decision-making.

It is not clear from the DIFR/EIS whether EJ populations have had an opportunity to meaningfully participate in the development and review of the project alternatives, nor whether there has in fact been meaningful participation by these groups. As noted in EPA guidance (2015), the capacity of EJ populations to meaningfully participate in decision-making of this type is often restricted based on a number of extrinsic and intrinsic factors. It is also not clear from the DIFR/EIS whether impacts to children have been adequately considered. Presumably, the identified EJ communities would include children subject to the same impacts and vulnerabilities as the rest of these populations. However, the DIFR/EIS does not appear to address the requirement to comply with EO 13045 – *Protection of Children from Environmental Health Risks and Safety Risks*.

Failure to fully consider and address EJ concerns can result in avoidable impacts to sensitive populations, and potentially result in both litigation and costly impacts to the project schedule. In the counties exceeding the stated thresholds, it seems advisable to take additional steps to avoid those impacts or provide mitigation. Further, the Panel is concerned that the census-level screen may be too coarse for this project, and additional efforts at a finer resolution may yield more informative data on this subject. In the tracts where the EJ population numbers fail to meet the noted threshold, it would be advisable (responsible) to look at the distribution of EJ populations within the tracts wherever possible to identify whether project activities might disproportionately impact specific micro-populations, impacts that could be avoided or should be mitigated. Data on this issue may be available through local colleges and universities, city planning or development boards, or, in some cases, available via online resources and/or searchable databases such as www.City-Data.com.

In regard to EJ concerns, the DIFR/EIS states that, "*no significant adverse impacts to environmental justice communities is expected*." The DIFR/EIS does not sufficiently support these findings clearly within the appropriate sections of the document. The DIFR/EIS would benefit from a more robust discussion to clarify why these populations would not be disproportionally adversely affected by the project, to demonstrate that they have had the opportunity to meaningfully participate in the decision-making process, and to better discuss and clearly support the findings in regard to potential impacts to these populations.

Cited References:

Final Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses. April 1998.

Guidance on Considering Environmental Justice During the Development of Regulatory Actions. USEPA. May 2015.

Significance: Medium High

Failure to provide a complete analysis of potential project related impacts to EJ populations affects the completeness or overall understanding of the recommendation or justification of the project. Resolution of the issue determines if it is fundamental problem with the project or not.

Recommendations for Resolution

Recommendation #1: Revise the DIFR/EIS to better address potential effects on EJ populations.

Recommendation #2: Justify findings that there will not be disproportionate adverse impacts to these populations.

5.2.3 Significance: Medium

Comment #12
No supporting engineering design information is included in the TSP *Cost Engineering* Appendix D.
Basis for Comment
Appendix D, *Cost Engineering*, provides cost estimates for the various alternatives evaluated. The basis of the cost estimate is rather limited where it is indicated that estimated quantities were *"… provided by the Hydraulics & Hydrology, Civil, and Structural Engineers*." There is no information about the quantities themselves, nor is there any discussion regarding the construction activities themselves. For this project, cofferdams will likely have to be used for dam modification/replacement and possibly for channel excavation. No discussion, drawings, or calculations for these considerations is provided. The engineering assumptions made to support the cost estimate are also important to document. Further, the estimated real estate costs are indicated to be a "placeholder," suggesting that the costs are not known with a high degree of confidence. The Panel does recognize that USACE has completed a significant Abbreviated Cost Schedule Risk Analysis for the project resulting in large contingency factors applied to various cost items. While this is a good strategy, basic engineering backup is needed in the appendix itself (or another appendix) to make it more complete.
Significance: Medium
Comment affects the completeness or overall understanding of the recommendation or justification of the project.
Recommendations for Resolution
Recommendation #1: Provide engineering backup data in Appendix D or another engineering appendix to support the cost estimate. The data should include important information, such as cut and fill cross sections, one-foot survey plan sheets, and details regarding excavations/cofferdams. **Recommendation #2:** Update the real estate costs with better, revised estimates, or include an analysis regarding the basis of the real estate "placeholder" estimate and why it is appropriate to use a "placeholder" estimate in the analysis.

Comment #13
The analysis does not adequately support the conclusion that reservoir drawdown is unlikely to have downstream thermal impacts.
Basis for Comment
Section 6.3.2 (163) notes, "Any thermal increases experienced by the Rahway River within the reservoir during construction will likely effect the portion of the Rahway River immediately below the reservoir. However, thermal impacts further downstream of the reservoir are expected to be offset by the dense forest canopy through which the river flows for much its extent in the South Mountain Reservation. As a result, the impacts are expected to be negligible." However, there does not appear to be any data or modeling to support this statement. It is not currently clear how the forest canopy would be able to better attenuate thermal increases (over current conditions) in response to future thermal increases that are likely as a result of the drawdown. In other words, it is intuitive to expect that the thermal reductions

applied by the forest canopy are "fixed"; thus any increase in temperature input would likely result in a commensurate increase in temperature output. It is not clear if the USACE expects an increase in canopy cover or other elements that would offset the proposed temperature impacts. Additionally, it is not clear what degree of thermal impacts would be considered negligible, nor why.
Significance: Medium
Indeterminate accuracy and subsequent justification of conclusions regarding thermal impacts associated with the project downstream of the dam as a result of the reservoir drawdown affects the completeness and overall understanding of the recommendation or justification of the project.
Recommendation for Resolution
Recommendation #1: Provide clear justification in the DIFR/EIS for the conclusion that thermal impacts would not be likely.

5.2.4 Significance: Medium Low

Comment #14
The Lands and Damages values for Cranford and Robinson noted in the DIFR/EIS are different from the corresponding values in the *Economics* Appendix.
Basis for Comment
"Lands and Damages" in the Feasibility Report TSP Refined Cost Estimate, Section 5.2 on page 126 for Cranford, are $2,947,000, and for Robinson are $526,000. In *the Real Estate Plan* Appendix, Section 11, the "Total Estimated Real Estate Project Cost" is $2,719,918 for Cranford and $485,479 for Robinson.
Significance: Medium Low
The differences are less than ten percent and both sets of numbers are probably correct, but no explanation is provided for the differences.
Recommendation for Resolution
Recommendation #1: Include an explanation in the DIFR/EIS for the differences in the Lands and Damages values reported in the Feasibility Report and the *Real Estate Plan* Appendix.

5.2.5 Significance: Low

Comment #15
To ensure complete and consistent economic analysis and reported results, the documentation should include additional specific information, clarification, or correction.
Basis for Comment
There are four specific issues noted here in regard to information provided in Appendices B and D. It is stated in Section 4.2.4 of Appendix B that "While depreciated structure replacement values were derived using the methodology outlined in Section 4.2.2, the value of contents for each structure was effectively assumed to be equal to 100% of the structure value, in accordance with the appropriate guidance." It is prudent to identify the "appropriate guidance" for reviewers to confirm the appropriateness of guidance used.

In addition to damage to structures and associated contents a third ("other") component for damage to features external to the main structure was included for non-residential structures (Section 4.2.4 of Appendix B). The value of these features was assumed to be 100 percent of structure value, but the damage at each depth of inundation is small compared with the corresponding structure and contents damage. Tables 13 and 14 in Section 4.2.6 of Appendix B show the numbers of damaged structures by damage category for Cranford Upstream and Robinson's Branch by Annual Chance Exceedance Event. Usually the Annual Exceedance Event would be the 500-year instead of the >100-year flood event floodplain noted in the tables. This should be corrected. The Cost Shared percentage value shown in the *Real Estate Plan* Appendix D is indicated to be 50 percent non-federal and 50 percent federal, but the corresponding values the Table are 76 percent non-federal to 24 percent federal. Clarification should be provided or corrections made, as appropriate.
Significance: Low
Considering the verbal clarification provided by USACE during the midpoint meeting, these comments have little impact on project implementability.
Recommendation for Resolution
Recommendation #1: Provide references and clarifications to address discrepancies and inconsistencies noted above.

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Appendix A Charging the Independent External Peer Review Panel

The text below reproduces the Charge to Reviewers as prepared by the USACE. The charge questions were provided to the review Panel at the beginning of the review process. The Panel Members used these charge questions to guide their review.

Rahway River Basin, New Jersey
Flood Risk Management Feasibility Report
New York District

INDEPENDENT EXTERNAL PEER REVIEW
REVIEW CHARGE

The following Review Charge to Reviewers outlines the objectives of the Independent External Peer Review (IEPR) for the subject study and identifies specific items for consideration for the IEPR Review Panel.

The objective of the IEPR is to obtain an independent evaluation of whether the interpretations of analysis and conclusions based on analysis are reasonable for the subject study. The IEPR Review Panel is requested to offer a broad evaluation of the overall study decision document in addition to addressing the specific technical and scientific questions included in the Review Charge. The Review Panel has the flexibility to bring important issues to the attention of decision makers, including positive feedback or issues outside those specific areas outlined in the Review Charge. The Review Panel can use all available information to determine what scientific and technical issues related to the decision document may be important to raise to decision makers. This includes comments received from agencies and the public as part of the public review process.

The Panel review is to focus on scientific and technical matters, leaving policy determinations for USACE and the Army. The Panel should not make recommendations on whether a particular alternative should be implemented or present findings that become "directives" in that they call for modifications or additional studies or suggest new conclusions and recommendations. In such circumstances the Review Panel would have assumed the role of advisors as well as reviewers, thus introducing bias and potential conflict in their ability to provide objective review.

Panel review comments are to be structured to fully communicate the Panel's intent by including the comment, why it is important, any potential consequences of failure to address, and suggestions on how to address the comment. The IEPR PWS provides additional details on how comments should be structured.

The Review Panel is asked to consider the following items as part of its review of the decision document and supporting materials.

Broad Evaluation Review Charge Questions

1. Is the need for and intent of the decision document clear?

2. Does the decision document adequately address the stated need and intent relative to scientific and technical issues?

Given the need for and intent of the decision document, assess the adequacy and acceptability of the following:

3. Project evaluation data used in the study analyses;
4. Economic, environmental, and engineering assumptions that underlie the study analyses;
5. Economic, environmental, and engineering methodologies, analyses, and projections;
6. Models used in the evaluation of existing and future without-project conditions and of economic or environmental impacts of alternatives;
7. Methods for integrating risk and uncertainty;
8. Formulation of alternative plans and the range of alternative plans considered;
9. Quality and quantity of the surveys, investigations, and engineering sufficient for conceptual design of alternative plans, and;
10. Overall assessment of significant environmental impacts and any biological analyses.

Further,

11. Evaluate whether the interpretations of analysis and the conclusions based on analysis are reasonable, and;
12. Assess the considered and tentatively selected alternatives from the perspective of systems, including systemic aspects being considered from a temporal perspective, including the potential effects of climate change.

For the Tentatively Selected Plan, assess whether:

13. The models used to assess life safety hazards are appropriate;
14. The assumptions made for the life safety hazards are appropriate;
15. The quality and quantity of the surveys, investigations, and engineering are sufficient for a concept design considering the life safety hazards and to support the models and assumptions made for determining the hazards;
16. The analysis adequately addresses the uncertainty and residual risk given the consequences associated with the potential for loss of life for this type of project; and
17. From a public safety perspective, the proposed alternative is reasonably appropriate or are there other alternatives that should be considered.

Appendix B Qualifications of the Independent External Peer Review Panel Members

The qualifications or the IEPR Panel Members are provided in this appendix. Appendix B.1 shows how the IEPR Panel Members meet the qualifications for this task. Appendix B.2 provides the overall qualifications and experience of each IEPR Panel Member.

B.1 IEPR Panel Member Technical Requirements

Table 2 shows how the IEPR Panel Members meet the qualifications for the IEPR as specified in the USACE PWS for this IEPR.

Table 2: Summary of Panel Member Qualifications by Discipline for this IEPR

Discipline	Requirements	Prof. Don Ator	Dr. Chris Brown	Prof. Jim Dobberstine	Dr. David Jaffe
General Qualifications	Highest Degree	**MBA**	**PhD**	**MS**	**PhD**
	Years of Experience	**35**	**27**	**22**	**15**
	USACE Experience (Direct (D), Indirect (I), and none (N))	**D**	**D**	**I**	**I**
Civil Works Planner/Economist	Must be from academia, a public agency, a non-governmental entity, or an Architect-Engineer or Consulting Firm.	✓			
	A minimum of 15 years' demonstrated experience in economics	✓			
	A minimum MS degree or higher in economics.	✓			
	Have at least 10 years' experience directly related to water resource economic evaluation.	✓			
	Comprehensive understanding of regional economic development as well as traditional Corps national economic development benefits.	✓			
	Must be familiar with USACE plan formulation processes, procedures, and standards as it relates to flood risk management civil works projects.	✓			
	Must have a minimum of five years of directly dealing with the USACE six-step planning process and policies, which are governed by ER 1105-2-100, Planning Guidance Notebook.	✓			
	Familiarity with the USACE computer program, Hydrologic Engineering Center's Flood Damage Reduction Analysis (HEC-FDA) is preferred but not required.	✓			
Civil/Geotechnical Engineer	A registered professional engineer from academia, a public agency whose mission includes flood risk management, or an Architect-Engineer or consulting firm, having a minimum of 15 years experience in engineering.		✓		

Discipline	Requirements	Prof. Don Ator	Dr. Chris Brown	Prof. Jim Dobberstine	Dr. David Jaffe
	Experience in large public works projects and have understanding of the design of culverts and channel improvements in an urban setting.		✓		
	A minimum of 10 years of experience in engineering with an emphasis on fluvial flood risk management projects.		✓		
	Demonstrated experience with geotechnical evaluation and geo-civil design for all phases of flood risk management projects.		✓		
	Experience in levees, culverts, channel stability, design, and construction, bridge design and construction, as well as design and construction for detention\retention basins, utility relocations, positive closure requirements, interior drainage requirements, and application of non-structural flood risk management measures.		✓		
	Familiar with and have demonstrated knowledge related to Corps of Engineers geotechnical practices associated with flood management channels, construction, and soil engineering.		✓		
	Experience in geotechnical risk and fragility analysis.		✓		
Biological Resources and Environmental Law Compliance	Must be a scientist from academia, a public agency, a non-governmental entity, or an Architect – Engineer or Consulting Firm.			✓	
	Must have at least 15 years experience directly related to water resources environmental evaluation or review with a minimum MS degree or higher in related field.			✓	
	Must demonstrate at least 10 years of experience in evaluating and conducting National Environmental Policy Act (NEPA) impact assessments, including cumulative effects analyses for complex, multi-objective public works projects with competing trade-offs.			✓	
	Must be familiar with evaluation of complex relationships and dynamics for aquatic and riparian ecosystems and must demonstrate ability to assess the consequences of altering environmental conditions.			✓	
	Familiar and have experience with United States Fish and Wildlife Service Habitat Evaluation Procedure (HEP) (USWFS, 1980), Endangered Species Act (ESA), Clean Water Act and essential fish habitat (EFH).			✓	
Hydrology and Hydraulic Engineer	A registered professional engineer with a minimum of 15 years experience in hydrologic and hydraulic engineering.		✓		✓
	Experienced with all aspects of hydrology and hydraulic engineering including: northwest hydrology, urban hydrology and hydraulics, open channel systems, effects of management practices and low impact development on hydrology, design of earthen dams and		✓		✓

Discipline	Requirements	Prof. Don Ator	Dr. Chris Brown	Prof. Jim Dobberstine	Dr. David Jaffe
	detention ponds, use of non-structural systems as they apply to flood proofing, warning systems, and evacuation.				
	Familiar with Hydraulic Engineering Center (HEC) modeling computer software including HEC River Analysis System (RAS) and HEC Hydrologic Modeling System (HMS).		✓		✓
	Since project designs are initiated in the decision document phase, Safety Assurance Review (SAR) is incorporated into Type I IEPR. The initial evaluation of SAR as part of Type I IEPR includes, at a minimum, addressing the following questions (EC 1165-2-214, Appendix D, Para. 2.c(3)): 1. In accordance with ER 1110-2-1150, is the quality and quantity of the surveys, investigations, and engineering sufficient for a concept design? 2. Are the models used to assess hazards appropriate? 3. Are the assumptions made for the hazards appropriate? 4. Does the analysis adequately address the uncertainty and residual risk given the consequences associated with the potential for loss of life for this type of project?	✓	✓	✓	✓

⊖: Direct experience (D): A past USACE employee
Indirect experience (I): Work experience with USACE water resources projects
None (N): No working experience with USACE water resources projects

B.2 IEPR Panel Member Qualifications and Experience

The qualifications of the IEPR Panel Members (in alphabetical order) are provided below in summary form to show their expertise for this project.

B.2.1 Prof. Don Ator

Role: Civil Works Planner/Economist

Prof. Ator is a Research Associate, Professor, and Undergraduate Advisor in the Department of Agriculture Economics and Agribusiness at Louisiana State University. Prof. Ator's responsibilities include research, grant writing and proposal development, extension and outreach, and undergraduate advising and teaching Agricultural Commodity Marketing and Risk Management. His current research is in financial resiliency planning for local governments in Louisiana, Texas, Alabama, Mississippi, Florida, Georgia, Kentucky, and Nebraska.

Prof. Ator has over 35 years of demonstrated experience in public works planning, working with project teams to identify and evaluate measures and alternatives using appropriate planning methodologies to reduce life safety risk. He earned his MS in Economics and Agricultural Economics and has an MBA in

Finance and Accounting from Louisiana State University. He has worked with 22 different USACE districts nationwide, as well as with the Bureau of Land Management, Bureau of Reclamation, and the Department of Commerce. He was the associate director and senior economist for the Gulf South Research Institute and project/program manager and senior economist at three private engineering firms. He has conducted more than 500 civil works projects nationwide that required the development of relevant and credible socioeconomic information and analysis, and performed the quality assurance review for all economic aspects of these projects. He is experienced in determining the scope and appropriate methodologies for impact assessment and analyses for a variety of projects and programs with high public and interagency interests. His scope includes: Economic Evaluation of Benefits from Beneficial Use Disposal Alternatives of Dredged Material for Consistency with State of Texas Coastal Management Plan, Texas (USACE, Galveston District); Missouri River Authorized Purposes Study Project Management Plan (USACE, Omaha and Kansas City Districts); and the Municipal and Industrial Water Use Forecast, Southwest Florida Feasibility Study, Florida (USACE, Jacksonville District).

Prof. Ator's experience has made him intimately familiar with the USACE plan formulation process, procedures, and standards as they relate to flood risk management. He has demonstrated proficiency in the USACE six-step planning process as evidenced by development of a template for preparing Project Management Plans for feasibility studies for USACE Regional Planning and Environment Division South, Mississippi Valley Division, in 2011 and field testing the template in 2012. Most recently, he worked with the USACE New Orleans District PDT to develop the Project Management Plan for the West Shore Lake Pontchartrain Flood and Storm Damage Risk Reduction Project. In 2010, Prof. Ator served as a team leader while embedded in the Plan Formulation Branch USACE New Orleans District directing plan formulation activities of three plan formulators and providing project oversight and review to ensure compliance with USACE guidelines.

Prof. Ator is familiar with the USACE structural flood-risk management analysis and economic benefit calculations and standard USACE computer programs, including HEC-FDA. He has conducted structure inventory surveys for flood damage reduction studies, developed content-to-structure value relationships for urban flood control economic analyses, and has prepared Section 905(b) flood damage reduction and ecosystem restoration reconnaissance reports. A majority of the projects he has conducted have required use of the HEC-FDA computer program. He attended a USACE-sponsored workshop on the model certified version of HEC-FDA in March of 2010 hosted by the Mississippi Valley Division. His related project experience includes the Structure and Content Depth Damage Relationship Surveys, Ouachita Parish, Louisiana (USACE, Vicksburg District); the Development of Content to Structure Value Relationships for Urban Flood Control Economic Analysis, Cypress Creek, Texas (USACE, Galveston District.); and the Orleans Parish, Louisiana, Urban Flood Control Feasibility Study, Structure Inventory (USACE, New Orleans District).

Prof. Ator's experience with National Economic Development analysis procedures, particularly as they relate to flood risk management, includes serving as a team leader in 2010 while embedded in the Plan Formulation Branch (USACE, New Orleans District). His responsibilities included directing plan formulation activities, and providing project oversight and review to ensure compliance with USACE guidelines. In this capacity, he worked closely with PDTs to identify and evaluate measures and alternatives using appropriate planning methodologies on 13 projects to reduce life safety risk, all of which included a combination of flood risk management, life-loss probability analysis, population at risk, residual risk, and vulnerability analysis. For example, Prof. Ator's work on the Greens Bayou Residual Flood Plain Properties Buyout Analysis, Texas (USACE, Galveston District) included flood risk management, population at risk, residual risk,

and vulnerability analysis. In addition, the Donaldsonville to the Gulf – Flood Damage Risk Reduction Feasibility Study, Louisiana (USACE, New Orleans District) included flood risk management, life loss probability analysis, population at risk, residual risk, and vulnerability analysis.

In Prof. Ator's more than 35 years of experience, he has worked on social effects evaluation of large civil works projects for hundreds of NEPA compliance documents, including experience with community cohesion/identity, cultural and historical value, low-income population, economic vitality of the community, and vulnerability of the population. For example, he contributed to a social impact assessment for the Little Colorado River in Holbrook, Arizona (USACE, Los Angeles District) and an environmental impact statement for US Navy Home Porting Projects (USACE, Galveston District), both of which dealt with community cohesion and identity. His work on the Historic American Building Survey Documentation for the Perry Creek Flood Control Project in Sioux City, Iowa (USACE, Omaha District) and on screening the cultural and historic features at the Di-Lane Plantation, Georgia (USACE, Savannah District) illustrates his experience with evaluating cultural and historical value. He gained experience working with low-income populations through assessing the socioeconomic impacts from flooding and flood control measures in the Yazoo Delta, Mississippi (USACE, Vicksburg District) and through the development of an initial job training program for the Community Impact Mitigation Plan for the Inner Harbor Navigation Canal Lock in New Orleans, Louisiana (USACE, New Orleans District). Prof. Ator has experience with the economic vitality of the community through working on the Memphis Riverfront Development Project (USACE, Memphis District) and on an analysis of economic development benefits from the construction of a floodwall and levee system along the Greenbrier River and Knapp Creek in Marlinton, West Virginia (USACE, Huntington District). Finally, he is familiar with the vulnerability of the population through his work on a social impact assessment for the Kissimmee River Upper Basin Restoration Project (USACE, Jacksonville District) and from the Environmental Impact Statement for the proposed widening of the Pascagoula Lower Sound/Bayou Casotte Channel (USACE, Mobile District).

B.2.2 Dr. Chris Brown

Role: Civil/Geotechnical Engineer

Dr. Brown is an Associate Professor at UNF teaching civil engineering, fluid mechanics, hydraulics, senior design, and engineering geology. He earned his PhD in Civil Engineering in 2005 from the University of Florida, his Master's degree from Villanova University in 1997, and his BS degree in Civil Engineering from Temple University in 1991. He has over 25 years of experience working on public works projects for the City of Philadelphia, Waste Management, USACE, and for Golder Associates Inc. as a private consultant for various complex civil engineering projects. While employed at the USACE, he worked within the Planning, Engineering, and Construction Divisions. He was consistently recognized for his excellent technical skills, including with the award of "engineer of the year" twice over 16 years with USACE. He has also recently been recognized for excellence in teaching and mentoring with the award of several teaching accolades at UNF and the national Bliss Medal from the Society of American Military Engineers.

Dr. Brown is a registered Professional Engineer in both Pennsylvania and Florida. During his career, Dr. Brown has worked on flood-risk management structures including dams, levees, retaining walls, gates, closure structures, etc., looking at both geotechnical and general civil engineering aspects. Specific project examples include the Prompton Dam spillway modification project, Molly Ann's Brook flood mitigation project, Portugués Dam design, Everglades Agricultural Area Reservoir project, C-111 levees, and many others. Dr. Brown has extensive experience on public works projects for the City of Philadelphia, City of Savannah, City of Jacksonville, EPA, USACE, State of Florida, and Commonwealth of Puerto Rico. Dr. Brown

has also designed projects that met requirements outlined in Engineering Manual 1110-2-1913. As an expert peer reviewer, Dr. Brown has been involved with review projects in eight USACE districts over a period of 8 years.

Dr. Brown has worked on the geotechnical side of water resources and the hydrologic modeling side of design and modeling projects. Dr. Brown has completed both stability studies using SLOPE/W and UTEXAS and seepage studies using SEEP/W, SEEP2D, and MODFLOW. Dr. Brown has used reliability and stochastic analysis studies on all types of water resources projects dating back to version 1.0 of "@Risk" software. Dr. Brown served on the first Corps of Engineers *ad hoc* committee on levee assessment, which included the initial development of the current USACE fragility curve/risk management design approach.

Dr. Brown has extensive knowledge of USACE cost estimating systems with direct experience using MCACES and working knowledge of MII. Dr. Brown has also developed his own risk-based cost estimates using both @Risk and Crystal Ball. He is experienced in developing estimated construction costs and is knowledgeable regarding construction methods related to large civil works projects including levee design, floodwall design, box culverts, bridge pier modifications, utility relocations, and drainage structure design. Dr. Brown has acted as cost-estimating IEPR reviewer on some of the largest civil works projects in USACE, including the most expensive lock and dam replacement in USACE history.

Dr. Brown is familiar with and has participated in the design of floodwalls and gated structures, as well as non-structural flood mitigation solutions (e.g., buy-out or minor flood proofing). Specific project examples of direct design experience include Molly Ann's Brook project (included t-walls, l-walls, underpinning of buildings, levee, bridge modification), Portugués Dam (included access road, foundation prep, arch dam, drainage gallery, rock bolts), and City of Savannah storm sewer upgrade (included new conduit, cut/fill construction, utility relocation and hardening, vibration monitoring). Dr. Brown was also a key designer for the F. E. Walter Dam access road replacement (on design team and field inspection) as well as the design of new bridges across Everglades National Park along the Tamiami Trail in Florida. Dr. Brown has also been involved in other large civil works projects including Chesapeake and Delaware Canal Deepening Project in Maryland and Delaware and the Delaware Main Channel Deepening Project in Pennsylvania and New Jersey.

B.2.3 Prof. Jim Dobberstine

Role: Biological Resources and Environmental Law Compliance

Prof. Dobberstine currently serves as chair of the Math, Engineering, and Sciences Division at Lee College. He is responsible for all operational aspects of the Mathematics, Engineering, and Science Division. He holds a BA in Life Sciences from Concordia University, an MS in Environmental Management from the University of Houston-Clear Lake, and an MS in Environmental Science from the University of Houston, Clear Lake. Prof. Dobberstine teaches Environmental Science and Biology and is engaged in ecosystem studies in the Galveston Bay, Texas, estuary with his students, the results of which have been featured through organizations including Restore America's Estuaries, among others.

Prof. Dobberstine holds certificates in USACE wetland delineation (Texas A&M University) and water quality improvement using constructed wetlands (Clemson University). He has also completed numerous professional development courses, including Geographic Information System (GIS) Techniques in Environmental Assessment (University of North Texas), Probabilistic Ecological Risk Assessment (Texas Tech University), Application of Adaptive Management to Address Climate Change Related Challenges (National

Oceanic and Atmospheric Administration Coastal Service Center and the PBS&J Ecosystem Restoration Division), Benthic Mapping Techniques (EPA, US Department of Agriculture Natural Resource Conservation Service, and the University of Rhode Island), Sampling Benthic Sediments: Methods, Analyses, and Judgments (University of North Texas Institute of Applied Sciences), and Conserving Land with Conservation Easements (National Land Trust Alliance Land Conservation Leadership Program).

As an environmental scientist focusing on wetlands and other sensitive habitats, Prof. Dobberstine is experienced with the complex regulatory framework affecting projects that potentially impact natural habitats. He has experience working with ecologic models as they relate to adaptive management and resource use planning. He is currently engaged in grant-funded ecosystem studies examining the effect of restoration technique on aquatic ecosystem function. The results will be used to help develop adaptive management techniques for ongoing ecosystem restoration. He has experience assessing aquatic habitats using the Sediment Tri-ad/Multiple Lines of Evidence method (toxicology, chemistry, biologic community) and has a background with a wide range of aquatic and riparian habitats and biologic communities. He also has extensive experience with habitat conservation and restoration, including project development, implementation, monitoring, and adaptive management.

Prof. Dobberstine is frequently called on to serve as an advisor on projects and panels. He currently serves on the Advisory Council to the Arthur Temple College of Forestry and Agriculture at Stephen F. Austin State University and formerly served as a curriculum review advisor to the Environmental Management Program at the University of Houston-Clear Lake. He serves on the Memorial Park Demonstration Project Vegetation Advisory Workgroup, a project led by the Harris County Flood Control District to stabilize the shoreline of Houston's Buffalo Bayou while enhancing riparian habitat. He serves on the Monitoring and Research Subcommittee of the Galveston Bay Council (Galveston Bay Estuary Program), on the Boards of Directors of the Texas Association of Environmental Professionals (President 2010–present) and the South Central Regional Chapter of Society for Environmental Toxicology and Chemistry (as President 2013–2015), and as a former Trustee and current Advisory Board Member of the Galveston Bay Foundation.

Prof. Dobberstine has served on several IEPR panels for USACE projects in the areas of biologic resources and environmental law compliance. His IEPR experience includes infrastructure projects (dam safety and flood risk reduction), ecologic modeling, and water management.

B.2.4 Dr. David Jaffe

Role: Hydrology and Hydraulic Engineer

Dr. Jaffe has worked for more than 15 years at the intersection of water resource development, water infrastructure design, and water policy in coastal and riverine environments. This work has included analysis, design, and related regulatory elements. Dr. Jaffe has focused his technical expertise on the translation of engineering science into actionable environmental benefit including protection, restoration, and remediation. His areas of technical focus reside in hydrology, hydraulics, and sediment transport. Dr. Jaffe utilizes a broad scope of numerical and analytical methods, including a wide range of numerical models, and is an expert in applying existing, off-the-shelf tools to provide in-depth and forward-looking analysis and insight to complex hydraulic problems.

Dr. Jaffe has maintained his academic and research ties and currently serves as a lecturer in civil engineering design. He earned his PhD in Civil and Environmental Engineering. He is a registered Civil Engineer and a member of the ASCE. Dr. Jaffe is also a diplomat for the American Academy of Water Resource Engineers.

Dr. Jaffe's current area of research focuses on using sediment transport, through modeling and measurement, as a proxy for several facets of environmental analysis and design. His background in physical marine science, riverine hydraulics, and numerical modeling provides a broad foundation for developing solutions in a diverse pallet of aquatic habitats, including those at the intersections of littoral and riverine systems. Dr. Jaffe also manages projects and programs that deal with environmental policy and systematic risk. These project and programs include large or regional government projects and small, locally driven initiatives covering a broad spectrum of agencies and interests. Dr. Jaffe has served as a project manager for federal and state projects, in particular those of FEMA, National Marine Fisheries Service, USACE, EPA, and US Bureau of Reclamation.

Dr. Jaffe has extensive experience in using numerical models for coastal and riverine analysis, both commercial and proprietary. Dr. Jaffe modeling experience includes significant use of modeling packages from federal agencies, HEC in particular.

In a recent project, Dr. Jaffe participated to include the analysis to evaluate the impacts from changes to local scour resulting from proposed bridge improvements. A HEC-RAS model was employed for analysis of stream hydraulics. Sediment and hydrologic data was taken from previous efforts, and additional analysis was required to determine down-stream boundary conditions for tidally controlled water surface elevation. The study followed HEC-18 criteria in that general, long-term and local bed adjustment was considered. Bridge hydraulics and related scour were modeled in HEC-RAS. The study found the pier and abutment scour dominated bed impacts. Long-term bed adjustment was found not to be significant factor in impacts since the stream is in an aggrading condition, with regular dredging to control stream bed shape and elevation. Dr. Jaffe led the bridge hydraulics and bridge scour effort as part of the bridge replacement effort.

Douglas County, Nevada retained an outside consultant to perform a restudy of the Airport Wash, Johnson Lane Wash, Buckbrush Wash, and Sunrise Pass Wash watersheds and Phase II of the Buckeye/ Martin Slough watershed located in western Douglas County, Nevada. Dr. Jaffe led the technical review of the numerical modeling and alluvial fan analysis of the project. The purpose of the restudy was to submit a FEMA Physical Map Revision and substantially revise portions of the effective 2010 Flood Insurance Study (FIS) and corresponding Digital Flood Insurance Rate Maps. The restudy sought establish updated FIS peak flow rates and hydrographs at specific locations and provide corresponding floodplain mapping revisions to portions of the 2010 Effective Flood Insurance Rate Maps for Douglas County. The modeling review consisted of multiple FLO-2D models and the methods used by the outside consultants for hydraulically connecting the different models through differing boundary conditions. Other areas of specialty review included the use or absence of culverts, model stability (Courant–Friedrichs–Lewy condition), and boundary condition applications. The supporting Levels of Other Map Revision documentation was also reviewed.

Dr. Jaffe developed protocols for and led the pilot study that examined the hydraulic climate change impacts to infrastructure along the south bank of Guadalupe River in San Jose based on a 50-year (2012–2062) time horizon. The study compared the existing and future conditions levee deficiency and resulting existing and future conditions flood plain using one- and two-dimensional hydraulic modeling, as well as

GIS-based tool sets. Sea level rise was a primary consideration. The impacts to existing bridge soffits in the existing and future conditions were also examined. A preliminary economic impacts analysis was conducted using parcel assessment maps and GIS tools based on 2012 dollars. The conclusion of the study outlined future analytic pathways for analysis of climate change impacts to infrastructure and habitat in riverine systems, including sediment transport and bulking, and watershed burn and sediment yield.

He also participated on a project evaluating the HEC-6T numerical modeling, based on recently update FEMA HEC-RAS numerical models, was employed to determine the magnitude and extent of impacts that large bed load particles would have on improvements to the Freeman Diversion in Santa Clara River. Specifically, improvements to the diversion were intended to improve sensitive and endangered fish species migration within the river. Several design, operation, and long-term maintenance elements of these improvements depend on the size range and relative frequency of the largest particles transported as bed load during 100-year and other large flow events. The study, led by Dr. Jaffe, estimated the largest size of particulate impacting the structure during the FEMA 100-year discharge and the relative frequency of these large particles in the bed load.

He led the modeling and design support team to develop improvements to the existing Army Corp of Engineers' levee with the City of San Jacinto. He led sediment data collection efforts and hydrology determination, including design storm and long-term hydrographs, numerical modeling, gas pipeline protection measures, levee top- and toe-elevation determination, bridge design criteria, and downstream habitat impacts analysis. The project included historical and gravel mining operations analysis. Dr. Jaffe coordinated with local Indian tribe to address local tribal concerns. The primary design concern was to restore river habitat and functions while minimizing impacts to downstream special habitat areas.

Dr. Jaffe lead two-dimensional numerical modeling of the Oxnard Floodplain, including drainage channels, that was conducted to determine the extent of flooding below Highway 101 and upstream of the Pacific Ocean for the 100-year floodplain. The study examined the three sub-watersheds developed by the Ventura County Watershed Protection District including Hueneme Drain, "J" Street Drain, and Rice/ Industrial Drain, separately. The goals of the study were 1) to estimate the locations and extents of flooding on the Oxnard floodplain, including acreage of inundation and 2) to determine the discharges at the floodplain outflow. A FLO-2D numerical model was developed for each of the three sub-watersheds, the boundaries of which closely follow those used in Ventura County's VCRat model. The model grid was assembled using FLO-2D's Grid Developer System (GDS) software and established by importing DTM data provided by Ventura County into the GDS. Model parameters were then imported into the GDS. Following collection and importation, data was area averaged on a grid cell by grid cell basis. Hydrology for all simulations was the county's design 100-year, 24-hour rainfall, Zone B, and was provided by the county's hydrology branch. Modeling suggested that existing topographic conditions determined where flooding occurred adjacent to existing channels. Improvements were recommended based on the location of the topographic controls.

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Acronyms

@RISK	Program to perform risk analysis for Flood Insurance Studies
ASCE	American Society of Civil Engineers
APMI	Analysis Planning and Management Institute
BMP	Best Management Practice
CID	Criminal Investigation Division
COI	Conflict of Interest
DDD	Dichlorodiphenyldichloroethane
DDT	Dichlorodiphenyltrichloroethane
DDE	Dichlorodiphenyldichloroethylene
DIFR/EIS	Draft Integrated Feasibility Report/Environmental Impact Statement
DOE	US Department of Energy
DrChecks	Design Review and Checking System
EC	Engineer Circular
EJ	Environmental Justice
EPA	US Environmental Protection Agency
ER	Engineering Regulation
ER	Evaluator Response
FEMA	Federal Emergency Management Agency
FIS	Flood Insurance Study
GDS	Grid Developer System
GIS	Geographic Information System
GSA	General Services Administration
HEC	Hydraulic Engineering Center
HEC-FDA	Hydraulic Engineering Center's Flood Damage Reduction Analysis
HEC-RAS	Hydraulic Engineering Center's River Analysis System
HTRW	Hazardous, Toxic, and Radioactive Waste
IEPR	Independent External Peer Review
LMI	Logistics Management Institute
MODFLOW	US Geological Survey's modular, finite-difference flow model for groundwater flow equation used to simulate the flow of groundwater through aquifers
NAS	National Academy of Sciences
NEPA	National Environmental Policy Act
NFIP	National Flood Insurance Program
NRCS	Soil Conservation Service/National Resources Conservation Service
OFM	Open File Map
PDT	Project Delivery Team

PE	Professional Engineer
PWS	Performance Work Statement
RAS	River Analysis System
SAR	Safety Assurance Review
SEEP/W	Groundwater flow analysis model by GEO-Slope
SEEP2D	2D Seepage Analysis Program by the USACE
SMART	Specific, Measurable, Achievable, Realistic and Timely
TO	Task Order
TSP	Tentatively Selected Plan
USACE	US Army Corps of Engineers
USFWS	US Fish and Wildlife Service
USGS	United States Geological Survey