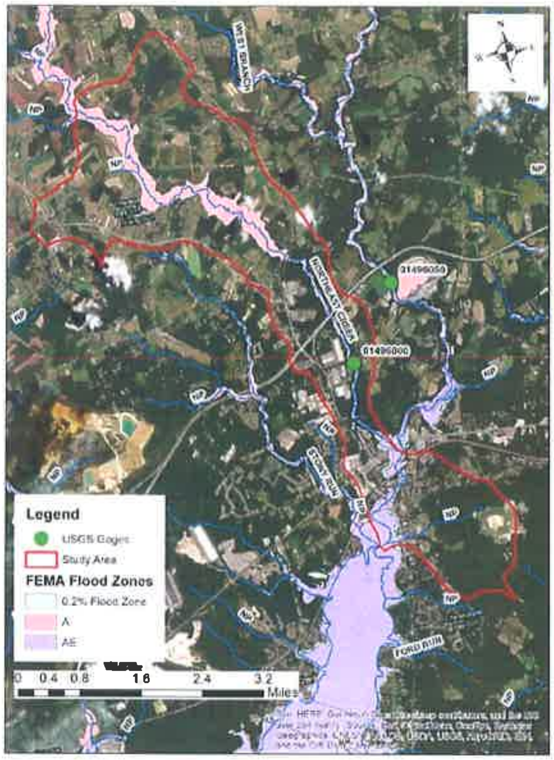
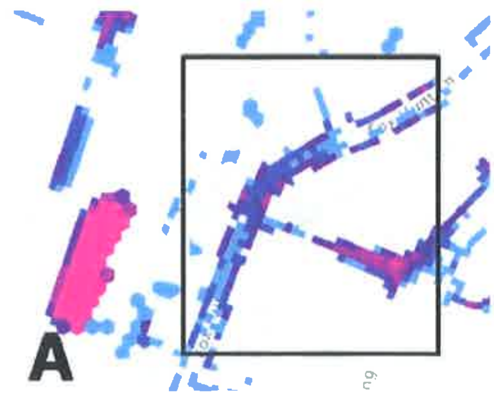
Dewberry





Quality Assurance Project Plan for the Lower North East Creek Watershed Management Plan

Effective Date: February 2021

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Quality Assurance Project Plan:
LOWER NORTH EAST CREEK WATERSHED MANAGEMENT PLAN

Project ID:

Effective Date: February 2021

EPA Document Control
Number (DCN):

200 Chesapeake Blvd., Suite 2300
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A PROGRAM MANAGEMENT

A1. Approval Sheet

Concurrence

Preparer/Author

Name: Mark Voli Title: Project Manager Organization: Dewberry Engineers Inc.	Signature: Date: 03/16/2021
Name: Jessica Seipp Title: Department Manager Organization: Dewberry Engineers Inc.	Signature: Date: 03/16/2021

Management/Supervisor

Name: Bryan Lightner Title: Zoning Administrator Organization: Cecil County LUDS	Signature: Date: 3/23/21
Name: Title: Organization:	Signature: Date:

Quality Assurance Officer

Name: Jessica Seipp Title: Department Manager Organization: Dewberry Engineers Inc.	Signature: Date: 03/16/2021

EPA Region 3

Name: Title: R3 Designated Project Manager Organization:	Signature: Holly Waldman Date: 03/31/2021

Approval

EPA Region 3

Name: Durga Ghosh Title: R3 Delegated Approving Official Organization: CBP / USGS	Signature: Durga Ghosh Date: 03/31/2021

Note: This approval action represents EPA's determination that the document(s) under review comply with applicable requirements of the EPA Region 3 Quality Management Plan [https://www.epa.gov/sites/production/files/2020-06/documents/r3qmp-final-r3-signatures-2020.pdf] and other applicable requirements in EPA quality regulations and policies [https://www.epa.gov/quality]. This approval action does **not** represent EPA's verification of the accuracy or completeness of document(s) under review, and is **not** intended to constitute EPA direction of work by contractors, grantees or subgrantees, or other non-EPA parties.

Revision History

This table shows changes to this controlled document over time. The most recent version is presented in the top row of the table. Previous versions of the document are maintained by Quality Manager.

Document Control Number	History/Changes	Effective Date
#1	Creation of document	02/11/2021
#2	Address Round 1 comments from EPA	03/15/2021

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DISTRIBUTION LIST

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Siva Sangameswaran – Dewberry Engineers Inc.

Jessica Seipp – Dewberry Engineers Inc.

Mathini Sreetharan – Dewberry Engineers Inc.

1. PROJECT MANAGEMENT

1.1. Project Organization

Table 1: Project Organization

Title & Responsibility	Name	Agency Affiliation	Number & Email
MDDNR Grant Manager – Oversees grant award	Megan Granato, Senior Program Director	Maryland Department of Natural Resources (MDDNR)	410.260.8799 megan.granato@maryland.gov
County Project Manager – oversees direction of project/County grant management	Bryan Lightner, Zoning Administrator	Cecil County	410.996.5220 blightner@ccgov.org
County Stakeholder – provides input on County priorities related to stormwater and NPDES permit	Marshall McSorley, Planner	Cecil County	410.996.5265 mmcsorley@ccgov.org
Project Manager – Directs day-to-day work of the project	Siva Sangameswaran, Project Manager	Dewberry	703.849.0379 ssangameswaran@Dewberry.com
Programmatic Advisor and Quality Assurance Manager – Oversees data quality assurance and maintains QAPP	Jessica Seipp, Department Manager	Dewberry	410.645.1838 jseipp@Dewberry.com

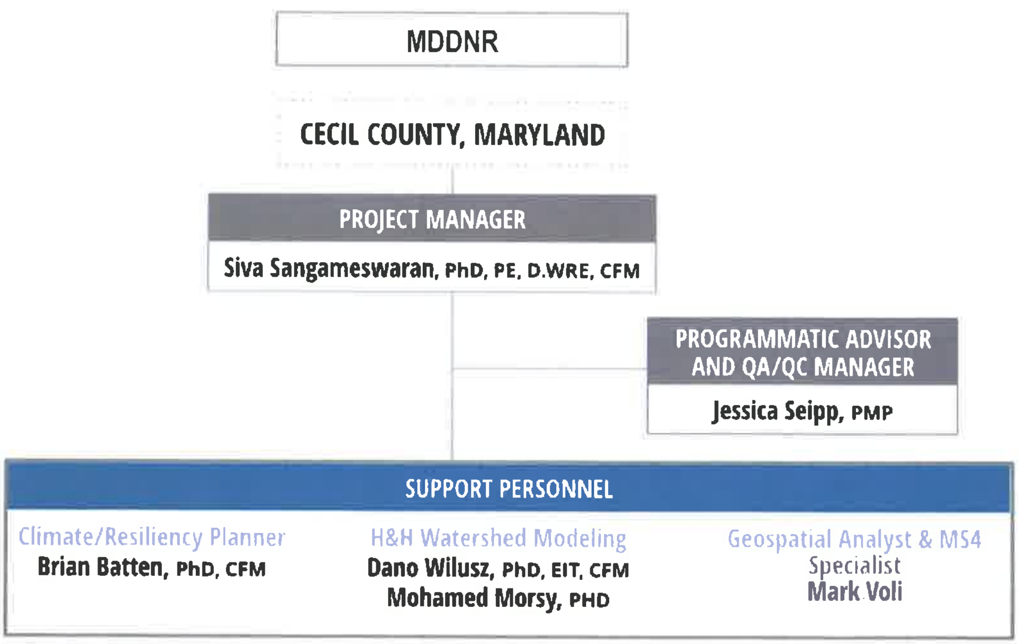

Figure 1: Project Organization Chart

1.2. Problem Definition and Project Background

The Lower North East Creek Watershed (Figure 2) is a 12-square mile sub-watershed of the North East River watershed located in Cecil County, MD. The watershed is vulnerable to riverine, coastal, and pluvial (urban stormwater) flooding. Cecil County has contracted with Dewberry Engineers to develop a Watershed Master Plan (WMP) which summarizes the results of hydrologic and hydraulic (H&H) analysis of current and future conditions to better understand flood hazards; forecasts flood vulnerabilities for a range of extreme precipitation events, sea level rise, and storm surge scenarios; identifies mitigation opportunities; preserves/enhances local water quality and natural systems; and creates a plan for future mitigation strategies.

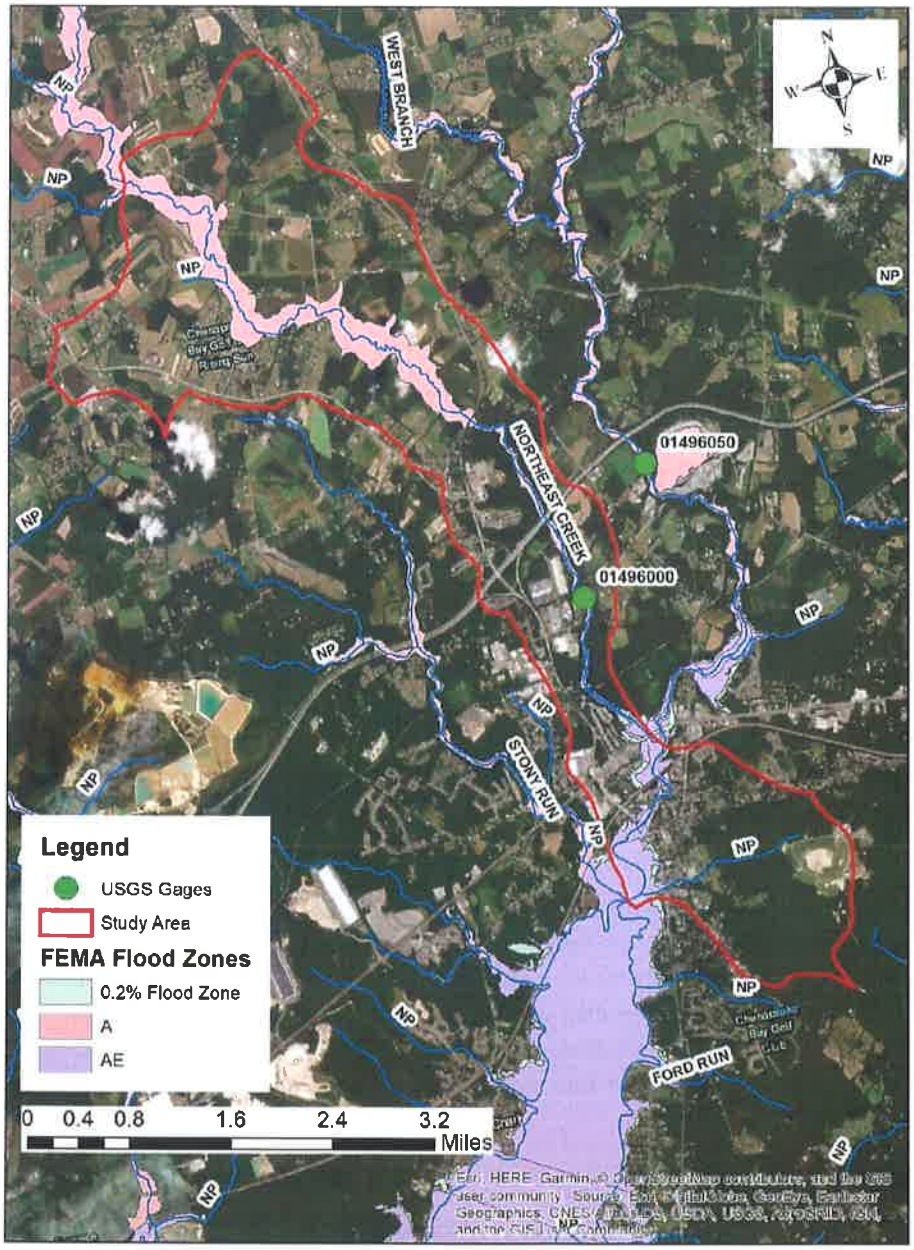

Figure 2: Lower North East Creek WMP Study Area

1.3. Project Description and Schedule

Dewberry's approach for completing this project will utilize a USACE HEC RAS 5.0.7 model to analyze the inundation impacts of riverine, coastal and rainfall-based watershed runoff using a 2D rain-on-grid methodology. This model will serve as the basis for future land use and best management practice (BMP) evaluations. Figure 3 shows the process flow that will be used to collect information, develop an existing conditions model, develop a future conditions model, and compile the WMP.

Figure 3: Process Flow of Project Execution

There are six tasks that will be completed as part of this project. A summary of each task is provided below:

Task 1 - Inventory & Compile Existing GIS Data

Dewberry will collect/obtain published, publicly available datasets necessary for developing the watershed models. A GIS master geodatabase will be developed for these various datasets that will be the basis for creating H&H model inputs. Various vector GIS shapefiles and raster files such as imagery, topography and others will be assembled and stored in the master geodatabase.

Task 2 - Community Workshop #1

A community workshop will be held to engage watershed and County stakeholders and solicit input on issues, concerns, and problem areas. Dewberry will provide a high-level overview of the approach and answer questions posed by attendees during the workshop. Prior to the workshop, Dewberry will work with the County to develop a survey to assist in collecting data associated with landowner flooding observations. The survey will be a critical tool to ensure public involvement in the process and will provide valuable data for model validation and/or calibration. The survey will be distributed online and through targeted mailing. The County will identify property owners to receive the targeted mailing and will print and mail the surveys. Respondents will be asked to mail surveys back to Dewberry. Dewberry will scan returned hard copy surveys and track responses in GIS. Online responses to the survey will be reviewed and incorporated into GIS as well. Dewberry anticipates including questions such as (1) date of noted flooding events, (2) extent of flooding (numeric or qualitative), (3) photographs of flooding with date, and (4) descriptions/comments/observations respondents would like to submit for potential in the study/analysis. Dewberry will provide the County with questions to be included in the survey and guidance on which online survey tool to use for posting the online survey.

Task 3 - Perform Hydrologic and Hydraulic Analysis

Dewberry will adopt a statistical approach to flood risk evaluation using H&H models for the study area with appropriate coastal boundary conditions. A hydrologic analysis will be performed using a USACE HEC HMS model developed for the HUC12 area. A 2D watershed hydraulic model will be developed using USACE HEC RAS 5.0.7 to simulate pluvial and fluvial risks. Dewberry will work with Cecil County to identify a maximum of two historical events to calibrate/validate the model.

Dewberry's typical watershed analysis for flood risk evaluation includes the steps outlined below. It is an iterative, non-linear process. Information generated at each step will inform whether re-work is required or whether we can proceed to the next step.

Steps for typical watershed analysis for flood risk evaluation:

1. Define the model extents.
2. Process watershed parametric datasets (topobathy, land use, soils, precipitation, boundary conditions, etc.) to the model boundary adequate to cover upstream contributions and downstream influences, if any.
3. Perform watershed hydrologic analysis using gage data and/or rainfall runoff model.
4. Generate 2D hydraulic model (HEC RAS 5.0.7) using the process datasets. Define 2D mesh resolution based on project needs - finer wherever necessary.
5. Determine the scenarios necessary to develop flood risk using a statistical approach.
6. Finalize model run time-step based on courant number for run duration optimization without losing accuracy of results.
7. Generate geospatial datasets based on model run output to compile, visualize, and analyze comprehensive flood risk within the study area.

Above is the generalized work flow that will be used for the project with situation/parameter/assumptions-based modifications as necessary. For example, if the urbanized area within the study extents requires a SWMM model-type analysis, Dewberry will use such methods upon coordination with the County. In general, modeling practices will be compliant with CMMI (Capability Maturity Model Integration) Level 5.

Task 4 - Identify & Evaluate BMPs

Dewberry will identify and propose high-level mitigation strategies for the worst-case scenarios and determine how infrastructure and operational costs to the County change over time based on climate scenarios. Utilizing the model developed in Task 3, Dewberry will calibrate the model, work with Cecil County to incorporate BMPs (i.e. flood risk reduction interventions) in the watershed model and assess their efficacy in drainage service and flood mitigation. Dewberry will provide conceptual schematics of BMPs, a suite of high-level strategies, and proposed locations for implementation which will assist the County in making informed planning decisions for next steps. We will assess the impact of interventions on H&H across the watershed at a high-level by rerunning scenarios identified as most problematic with different sets of stormwater interventions based on coordination and guidance from Cecil County.

Task 5 - Community Workshop #2

The purpose of the second Community Workshop will be to share the results of the study. We will explain the modeling effort and present the priority mitigation strategies. Watershed and County stakeholders will have the opportunity to provide feedback on the results and proposed strategies, and Dewberry will answer questions posed by attendees.

Task 6 - Development of Watershed Master Plan

Dewberry will summarize the results of the study in a narrative format and provide associated deliverables as appendices. The County will compile supplied deliverables into the final Watershed Master Plan.

The project schedule is provided in Table 2.

Table 2: Project Schedule

Task/Activity	Deliverable	Schedule
Task 1 – Inventory & Compile Existing GIS Data	GIS geodatabase of compiled data	11/01/2020 – 03/31/2021
Task 2 – Community Workshop #1	Stakeholder questionnaire, responses tracked in GIS, compilation of comments/input from workshop	12/01/2020 – 07/31/2021
Task 3 – Perform H&H Analysis	Geospatial flood hazard products	04/01/2021 – 07/31/2021
Task 4 – Identify & Evaluate BMPs	High-level mitigation strategies and concepts	08/01/2021 – 12/31/2021
Task 5 – Community Workshop #2	Compilation of comments/input from workshop	12/01/2020 – 07/31/2021
Task 6 – Development of WMP	Compiled report/narrative of project	01/01/2022 – 06/30/2022

1.4. Quality Objectives and Criteria

Dewberry's overarching quality objectives include provisions for evaluating quality issues if and when they occur by carefully examing root causes and solutions intended to minimize or eliminate future occurrences; provisions for developing new best practices arising from lessons learned; and clearly communicating our continuous improvement philosophy throughout the organization.

Quality control is integrated into every Dewberry project throughout the study, design, and production phases rather than being applied as a separate oversight activity. Our program contains standardized procedures for Quality Control (QC), Quality Assurance (QA), and independent quality audits. Dewberry's QC Program is based on ISO 9001:2015 quality management standards, guided by our Plan-Do-Check-Act (PDCA) cycle of quality management.

This four-step process is as follows:

1. Plan - Define the requirements and processes needed to produce high-quality deliverables.
2. Do – Perform the work per the defined requirements and codified processes.
3. Check – Validate that steps 1 and 2 yielded desired results.
4. Act – Act on the results of step 3.

The process for developing the Lower North East Creek WMP was designed to meet the goals and objectives summarized in Sections 1.2, and to complete the tasks discussed in Section 1.3. The quality of the modeling results will largely depend on the calibration/validation efforts which will be verified as described in Section 2.5.

1.5. Special Training and Certification Requirements

The staff committed to this project include Professional Engineers, Project Management Professionals, and Certified Floodplain Managers. Staff have extensive experience and training in H&H modeling, water quality modeling, geospatial analysis, stormwater BMP planning and design, and other specialties related to Water Resource assessments.

1.6. Documents and Records

The use of accurate, pertinent and latest input datasets is key to the development of H&H models that can simulate conditions. All datasets used for the study are assumed quality-reviewed and suitable for use in the analysis. Metadata documentation of public datasets can be referenced for additional details on precision and tier level. For County provided data, data holdings quality and precision are the responsibility of the Cecil County GIS Program overseen by the County's GIS Coordinator. We have coordinated with Cecil County to ensure the feasibility and usability of the data. A complete list of data and sources to be utilized as part of this study is provided in Appendix A.

Datasets, records, and documents anticipated to be produced during this study include the following:

Task 1:

- Compiled GIS-based master geodatabase of existing data to serve as inputs for the H&H model
  - Dewberry has included a 500 foot buffer area around the perimeter of the Lower North East Creek Watershed boundary for clipping the data sets to the study extents. This is necessary to avoid issues like data pruning and loss at the boundary, edge effects, etc. Once the clipping is complete, Dewberry will perform an investigation at various locations, especially boundaries, to make sure all the data is correct and consistent with the respective sources. This process will ensure that there are no outliers. If any deviations are found, the buffer extents will be modified iteratively to eliminate outliers.

Task 2:

- List of suggested questions for landowner questionnaire
- Recommendations for online survey platform
- Scanned copies of hard-copy surveys
- Compiled survey results in GIS

Task 3:

- Calibrated/validated H&H model for existing and proposed conditions
- High-level future land use analysis
- Geospatial flood hazard products in formats compliant with Cecil County GIS requirements:
  - Flooding extents (shapefiles)
  - Flood hazard data – depth and water surface elevation data (rasters)

Task 4:

- Suite of high-level mitigation strategies for worst case flooding event scenarios
- Conceptual schematics for proposed BMPs
- Proposed locations for implementation

Task 6:

- Watershed Master Plan Report

The current approved QAPP will be distributed to the project staff (as listed in on the distribution list) in either hard copy or electronic format. Changes to the QAPP will be discussed within the project management team then issued as an advisory email when a revision to the QAPP is warranted. Revisions of specific items in the QAPP usually will not warrant republication of the entire QAPP; the QAPP will be revised as necessary. If the QAPP is revised in its entirety, then copies of the new QAPP will be distributed to those on the distribution list. Electronic and/or hard copies will be maintained in the Project Manager's office.

2. DATA GENERATION AND ACQUISITION

2.1. Experimental Design/Methodology

The following scenarios will be modeled and analyzed as part of this study:

- 2-year rainfall– multiple durations (between 6 and 24 hours) with available sea level rise and storm surge boundary conditions
- 10-year rainfall– multiple durations (between 6 and 24 hours) with available sea level rise and storm surge boundary conditions
- 25-year rainfall– multiple durations (between 6 and 24 hours) with available sea level rise and storm surge boundary conditions
- 100-year rainfall– multiple durations (between 6 and 24 hours) with available sea level rise and storm surge boundary conditions
- Existing and future land use scenarios for the above events / selected ones (by Cecil County)
- Performance evaluation of selected stormwater BMPs during events deemed necessary by Cecil County
- Multiple precipitation depth and time frame inputs (e.g.: 1", 5" and 10" over 1-hour and 24-hour duration)

For existing "conditions", Dewberry will set up a 2D HEC RAS model that includes the Lower North East Creek watershed area and incorporates tidal, storm surge and SLR boundary conditions (using available sources of data such as ESLC, UMD, etc.). To get a comprehensive flood hazard picture under the existing conditions, we anticipate approximately 100 simulations to cover a range of scenarios (2-, 10-, 25- and 100-year recurrence interval events with 6- to 24-hour durations, 1", 5" and 10" over 1-hour and 24-hour durations). Stabilizing the 2D model and ensuring accuracy and reproducibility of results will be an essential part of this effort. The calibration/validation of the model will require roughly 20 (+/-) of the 100 anticipated simulations. The necessary statistical analysis (including development of code and graphics) will be performed to understand, interpret and visualize the results.

Proposed "conditions" modeling will involve incorporating retrofits to known BMPs or addition of proposed BMPs. This will require 2D mesh and geometry changes to incorporate the BMPs and possibly hydrologic input modifications. Depending on the number and locations of the BMPs, and the "scenarios" that need to be run, it is anticipated that this will take 80 simulations (+/-). It is an iterative process during which the model will be "tweaked" to maximize the flood mitigation impacts.

2.2. Sampling Methods

There will be no field measurements performed or samples collected during this study; therefore, this section is not applicable.

2.3. Sample Handling and Custody

There will be no field measurements performed or samples collected during this study; therefore, this section is not applicable.

2.4. Analytical Methods

There will be no environmental samples collected during this study; therefore, the only analytical methods applicable to the project are the modeling methods discussed in Section 2.1.

2.5. Quality Control

Dewberry's Quality Management System (QMS), is scalable and flexible. The Project's Programmatic Advisor and QA/QC Manager has carefully evaluated each QMS requirement and selectively applied and scaled the quality management control to address the needs of the Project's stakeholders and the services and products provided. Table 3 outlines Dewberry's ten (10) QMS Standards and how they will be implemented as part of the Lower North East Creek WMP. In addition, all data-related tasks being carried out as a part of this project follow guidelines described in the CBP Quality Manual (https://www.chesapeakebay.net/documents/CBPO_Quality_Manual_Final_08April2020.pdf) and are covered by the EPA Region 3 approved DNR Quality Management Plan (valid through September 07, 2021).

Table 3: QMS Standards

QMS Standard	How Applied
QMS Standard 1: A team skills and training assessment must be performed	Performed during task scoping. Support for project solicited from Dewberry's Owings Mills and Fairfax offices.
QMS Standard 2: An appropriately scaled Knowledge Management System (KMS) must be provided that enables easy access to controlling guidance and standards	Each office is responsible for their own KMS which is located on company server and accessible to all staff on the project.
QMS Standard 3: Producers must use production checklists and must provide completed production checklists to the independent QC reviewers.	See checklist example (Figure 4) and Appendix B.
QMS Standard 4: Produces must self-certify their work before independent QC and before delivery to the client.	Staff on project required to complete production checklist and submit with deliverable for QC review.
QMS Standard 5: QC Reviewers must not have been involved in production of the item being reviewed and must be trained in QC review best practices.	See Table 1, Section 3.1, and Section 4.1
QMS Standard 6: QC Checklists must be prescriptive and must provide provisions for documentation of QC citation resolution.	See checklist example (Figure 4) and Appendix B.
QMS Standard 7: All QC citations must be fully resolved, and an escalation protocol must be in place for contested citations.	See Section 3.1 and Section 4.1
QMS Standard 8: Quality records must be retained in the project file.	Quality records will be stored in the project file
QMS Standard 9: Root Cause Analysis must be conducted for significant issues.	Will be performed as necessary
QMS Standard 10: Lessons learned, and new best practices must be documented and shared, and must be monitored for effectiveness.	Will be compiled and shared with the project team, Cecil County, DNR, and Dewberry's Project Management Community of Practice as appropriate

Jessica Seipp will serve as the QA/QC Manager. She is responsible for developing and maintaining the QAPP, ensuring the plan is adopted and utilized by all team members during the project execution, and overseeing proper implementation of quality reviews. She will provide advice and assistance to the Project Manager in developing and maintaining effective work controls and will initiate follow-up corrective actions for quality-related issues, as described in Section 3.1 and 4.1. As an example, we will develop a QA checklist for the H&H model (Appendix B). An experienced and independent QC modeler will be assigned to utilize the checklist to ensure the model meets the quality requirements. Internal QA/QC of the various interim and final deliverables will be performed by Dewberry subject matter experts.

2.6. Instrument/Equipment Testing, Inspection, and Maintenance

There will be no field measurements performed or samples collected during this study; therefore, this section is not applicable.

2.7. Instrument/Equipment Calibration and Frequency

There will be no field measurements performed or samples collected during this study; therefore, this section is not applicable.

2.8. Inspection/Acceptance of Supplies and Consumables

There will be no field measurements performed or samples collected during this study; therefore, this section is not applicable.

2.9. Non-direct Measurements

Data will be reviewed and extracted from GIS files, historical records, and climate change/sea level rise reports to build input datasets for this study. A complete list of the data and data sources are provided in Section 1.6 – Table 3.

2.10. Data Management

Data associated with this study will be compiled and managed using one of two primary storage methods, depending on the site of the model outputs. The primary option includes Dewberry's proprietary services including daily, automatic backups with the secondary option including public close providers (e.g. AWSS3), if necessary.

The data submitted will be accompanied by metadata that fully conforms to the Federal Geographic Data Committee's requirements for metadata (https://www.fgdc.gov/metadata). Data will be submitted in the following formats:

- Model input data – File geodatabase
- Landowner survey results – GIS shapefile
- Modeled flood extents – GIS shapefiles
- Modeled flood hazard data – GIS Raster files and shapefiles

It is anticipated that all data analysis will be conducted using latest version of publicly available USACE HEC HMS model (4.7.1 as of the date of this QAPP) and/or USACE HEC RAS (5.0.7 as of the date of this QAPP), and ArcGIS 10.6.1.

3. ASSESSMENTS AND OVERSIGHT

3.1. Assessments and Response Actions

All deliverables submitted during this project will be produced and reviewed against prescriptive checklists (Figure 4 and Appendix B) as outlined in Section 4.1. Producers will self-certify the quality of their work before submitting for QC review. Mathini Sreetharan or her designee will be responsible for independent QC review. She will coordinate her review and comments with the Project Manager and QA/QC Manager. All QC comments will be fully resolved before finalization of deliverables. She will escalate disputed comments to the QA/QC Manager who will further escalate comments to an appropriate level of authority for a resolution, as necessary. A root cause analysis will be conducted for any significant issues discovered during the QC review. All quality records will be retained in the project file. Dewberry will maintain regular coordination with the Cecil County Project Manager throughout the project lifecycle so deliverable content and format are not saved for County QC review. Any significant QC problems which arise during project execution, will also be include in a detailed report submitted to Cecil County and DNR.

3.2. Reports to Management

Dewberry will submit monthly invoices and progress reports to Cecil County which will detail the work performed during each billing cycle. Cecil County will use the monthly submittals from Dewberry to submit progress reports to the MDDNR Grant Manager through the Chesapeake and Coastal Service (CCS) federal funding grants management portal. Each report will document progress toward the achievement of the project's goals, objectives, and milestones during each quarter and semi-annual timeframe. A succinct description of activities will be reported for each objective. The reports will also describe difficulties encountered for each activity, any changes in expected deliverable dates, budget changes, or changes in staffing. Each report will also include an upload of all written deliverables developed during the reporting period.

Cecil County will submit the final report/work product(s) to the Grant Manager through the CSS federal funding grants management portal. The final report will cover activities conducted over the entire project period. In addition to the final report/work product(s), Dewberry will prepare and submit a one-page abstract suitable for distribution in newsletters, online, etc.

4. DATA VALIDATION AND USABILITY

4.1. Data Review, Verification, and Validation

Section 2.5 describes the methods Dewberry will use to conduct data review, verification, and validation using checklists as shown in Figure 4 and included in Appendix B. Sections 2.10 and 3.1 discuss the methods Dewberry will use to accept, reject and qualify all data produced during this project.

Report Production Checklist and Self-Certification of Readiness for Independent Review			
Job Name		Producer	Date
ID	Task	Comments	Producers Initials / Date
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			
Additional Comments:			

Self-Certification		
I certify that I have used all available knowledge resources and have to the best of my ability ensured that the FIS report reads well; is accurate; is in agreement with the FIRM database; meets all contractual and client requirements; and is ready for independent QC review.		
	Project Manager or Task Manager	Date

Figure 4: Example Production Checklist

4.2. Verification and Validation Methods

Dewberry will use landowner questionnaire responses, County GIS datasets, and other data sources to effectively calibrate and/or validate model results with known historical events. Statistical analyses (R2, Index of agreement, RMSE, etc.) will be performed to investigate and present the results of the calibration effort. These methods are established scientific protocols for comparing model predictions with field observations and hence will provide a reliable basis for ensuring model accuracy.

4.3. Reconciliation with User Requirements

The purpose of this study is to quantify flood risk within the study area due to coastal, riverine and rainfall (pluvial) sources. Dewberry will regularly and continuously coordinate with Cecil County to ensure that the requirements of the County and obgligations to Community, Maryland DNR and USEPA stakeholders are met. When discrepancies arise, Dewberry will communicate with the County and facilitate necessary coordination with other partners listed above to reconcile them within the scope of work of the current project.

APPENDIX A: LIST OF DATA AND SOURCES

APPENDIX B: QC CHECKLIST

Lower Northeast Creek Watershed Master Plan

Task 1: Inventory & Compile Existing GIS Data

Date: 21 January, 2021

S No	Data Set	Date	Source
1	FEMA 100 Year Floodplain	10/27/2017	Cecil County Website
2	Address Points	12/30/2020	Cecil County Website
3	Bathymetry	8/12/2012	Cecil County Website
4	Billboards	9/30/2016	Cecil County Website
5	Bridges	9/30/2019	Cecil County Website
6	Buildings	12/31/2020	Cecil County Website
7	Cemeteries	1/2/2020	Cecil County Website
8	Census Tracts	2/24/2011	Cecil County Website
9	Climate Ready Action Boundary Flood Depth Grid	1/13/2021	Maryland Coast Smart
10	Communications Towers	2/28/2020	Cecil County Website
11	County Boundary	12/31/2020	Cecil County Website
12	Critical Area	12/6/2018	Cecil County Website
13	Election Districts	2/28/2014	Cecil County Website
14	Enterprise Zones	1/6/2021	Cecil County Website
15	Fire Hydrants	9/29/2020	Cecil County Website
16	Forest Conservation	11/25/2020	Cecil County Website
17	Historic Properties	7/27/2018	Cecil County Website
18	Hydrography (lines)	7/5/2017	Cecil County Website
19	Hydrography (polygons)	11/2/2012	Cecil County Website
20	Land Use, Physical	10/24/2011	Cecil County Website
21	Landscape Agreements	12/31/2020	Cecil County Website
22	Major Subdivisions (1925-present)	12/31/2020	Cecil County Website
23	Minor Subdivisions	12/31/2020	Cecil County Website
24	Monumentation	9/27/2017	Cecil County Website
25	National Elevation Dataset Digital Elevation Model	2005	USDA Data Gateway
26	National Land Cover Data	2016	MRLC
27	Outbuildings	12/31/2020	Cecil County Website
28	Places of Worship	5/30/2018	Cecil County Website
29	Priority Funding Areas	8/6/2019	Cecil County Website
30	Proposed Major Subdivisions	12/31/2020	Cecil County Website
31	Protected Lands	12/31/2020	Cecil County Website
32	Railroads	3/30/2012	Cecil County Website
33	Rezonings	12/31/2020	Cecil County Website

Lower Northeast Creek Watershed Master Plan

Task 1: Inventory & Compile Existing GIS Data

Date: 21 January, 2021

S No	Data Set	Date	Source
34	Road Centerlines	12/31/2020	Cecil County Website
35	Road Classifications	1/2/2009	Cecil County Website
36	Sanitary Sewer (County Owned)	10/28/2020	Cecil County Website
37	Sanitary Sewer (Town & Private)	10/28/2020	Cecil County Website
38	Schools	2/27/2019	Cecil County Website
39	Site Plans	10/28/2020	Cecil County Website
40	Soils (KML)	11/5/2010	Cecil County Website
41	Soils (SHP)	11/5/2010	Cecil County Website
42	Special Exceptions	12/31/2020	Cecil County Website
43	Storm Drain System (incomplete)	1/29/2020	Cecil County Website
44	Sub-Watersheds	3/18/2009	Cecil County Website
45	Town Boundaries	1/6/2021	Cecil County Website
46	Traffic Control Devices	12/31/2020	Cecil County Website
47	Trails	3/19/2015	Cecil County Website
48	Transportation Analysis Zones	6/6/2018	Cecil County Website
49	Transportation, Detailed	1/23/2009	Cecil County Website
50	Treeline	2/28/2020	Cecil County Website
51	Water Systems	9/29/2020	Cecil County Website
52	Zip Codes	7/27/2018	Cecil County Website
53	Buildings at Risk (SLR)	1/28/2021	provided by Cecil County
54	Completed Restoration Projects & Proposed BMPs	1/26/2021	provided by Cecil County
55	Critical Infrastructure	1/28/2021	provided by Cecil County
56	Drainage Lines (from DEM)	1/27/2021	provided by Cecil County
57	Ecosystem Services	1/27/2021	provided by Cecil County
58	Green Infrastructure	1/27/2021	provided by Cecil County
59	Impervious Area Surface & Classification	1/26/2021	provided by Cecil County
60	Impervious Surface 2014	1/27/2021	provided by Cecil County
61	Lidar Tiles (Block 4 and 5)	1/27/2021	provided by Cecil County
62	MS4 Area and Outfalls	1/27/2021	provided by Cecil County
63	NE River Watershed Assessment	1/26/2021	provided by Cecil County
64	Planimetrics - 2019	1/27/2021	provided by Cecil County
65	SHA Storm Drain Infrastructure	1/27/2021	provided by Cecil County
66	Steep Slopes (from LIDAR)	1/27/2021	provided by Cecil County

Lower Northeast Creek Watershed Master Plan

Task 1: Inventory & Compile Existing GIS Data

Date: 21 January, 2021

S No	Data Set	Date	Source
67	Storm Surge	1/27/2021	provided by Cecil County
68	Stormwater BMP Database	1/26/2021	provided by Cecil County
69	Surface Water Designated Uses	1/27/2021	provided by Cecil County
70	Wetlands	1/27/2021	provided by Cecil County
71	Coastal Defense Preservation Ranking Polygons	2/14/2021	provided by Cecil County
72	Natural Resource Protection Ranking Polygons	2/14/2021	provided by Cecil County
73	Stormwater BMP Ranking Polygons	2/14/2021	provided by Cecil County

PROJECT LOCATION/SYSTEM NAME:

Probabilistic Modeling QC Review Checklist	Reviewer Name	Originator(s)/Team Members	Date Ready for Review	Review Completed Date	Verification Date
Terrain					
Fluvial Hydrology					
Pluvial Hydrology					
Fluvial Hydraulics					
Pluvial Hydraulics					
Risk Assessment					
Narrative & Overall Deliverable					

I.D.	QC Check and Description	Citation	Internal Base Flood QC Checkpoints				
		Reference	P/F/NA	Reviewer Comment	Originator Response		Back Check Complete? Y/N/NA
Terrain							
A1	Does the digital terrain model input for the 2D model cover the entire 2D study area?	SID #50					
A2	Does the model use terrain data at least as current as the current effective study and meet FEMA topo standards?	Two-Dimensional Analysis 2016, Section 3.1 Elevation Guidance: 3.3.5 SID #43					
A3	Is the input topography reasonably dense? (Cell size should be 10-foot or less.)	SD LSAE Guidance					
A4	Have topographic abnormalities been corrected? (No. drops or rises due to underlying data errors.)	SD LSAE Guidance					
A5	Are the vertical and horizontal distances in the same unit (ft/m)?						
A6	Are notable features (e.g., levee crests) built into the terrain?						
A7	Is channel bathymetery correctly added and seem reasonable at transitions.						
A8	Does the breached terrain correctly reflect reasonable openings at breach locations? Does it line up with the levee toe?						
A9	Are all terrains projected in the correct coordinate system established for the project area?						
Fluvial Hydrology - Gage Analysis							
B1	Were the correct gage locations used?						
B2	Were the correct gage records used? Check gage locations and whether records for annual peaks were used.						
B3	Outliers were removed appropriately and with good reason?						
B4	Did the analysis follow Bulletin 17B guidelines for flood flow frequency determination? Use of other analysis techniques must be approved by the FEMA Project Officer and written justification must be provided.						
B5	Was sufficient number of years of data used in the frequency analysis (after extended)? Must use at least 20 years of data for frequency analysis. Sometimes additional data are available upon request.						
B6	Were appropriate skew value(s) used? PEAKFQ program has built-in Bulletin 17B skew map for generalized skew. The Bulletin 17B skew map is superseded by updated skew studies in many states. Check latest USGS regression equations report or USGS State office. Station skew may be appropriate for lengthy records.						
B7	Was flow record analyzed as mixed population, if neccesary? Use mixed population approach if the annual peaks are clearly from 2 indepenedent sources.	USACE Engineering Manual, No. 1110-2-1415, Chapter 10, page 10-1.					

I.D.	QC Check and Description	Citation	Internal Base Flood QC Checkpoints			
		Reference	P/F/NA	Reviewer Comment	Originator Response	Back Check Complete? Y/N/NA
B8	Was flow regulated? For regulated watersheds, flow frequency curves are often developed for unregulated conditions and then converted into regulated conditions.					
B9	Were correct procedures used to reflect regulated conditions?	USACE Engineering Manual, No. 1110-2-1415, Chapter 3, page 3-22.				
B10	Was data extended for a gage with short record? Short record of a station can be adjusted on the basis of a regression analysis with a nearby long-term record.					
B11	Were appropriate procedures used to extend the gage records (e.g., using stage data)?	Bulletin 17B, Appendix 7, page 7-1, , Review Bulletin 17B procedures				
B12	Was gage analysis data correctly transferred to ungaged site? Use procedures described in USGS regional flood frequency reports to transfer data from the gage to ungaged sites located within 50–200 percent of drainage area of the gaging station.					
B13	Where multiple gages are present, do they make sense relative to each other? For example, are combined flows from upstream tribs greater than the downstream main stem? Also, are individual flows from upstream tribs lower than the downstream mainstem (except where regulated)?					
B14	The drainage area is measured at stream gage location and the measured area compares well with the published drainage areas for the location (i.e. FIS and USGS)					
Fluvial Hydrology - Regression Analysis						
C1	Is regional regression analysis applicable? It can be applicable if the site is ungaged; the watershed, climate, and urbanization characteristics of the project site are within the range of those at the gaging stations used to develop the regional regression equations; and the flow is not regulated.					
C2	Was the appropriate regional analysis method used? Use the most recently published USGS report for estimating flood magnitude and frequency for the State.					
C3	Was the hydrologic region identified correctly?					
C4	Were values for variables correct? Verify values for basin and climate characteristics used in the regression equations (area & slope).					
C5	Was flood discharge adjusted to reflect urban conditions? Were appropriate urban regression equations used? Use USGS urban regression equations for the State or metropolitan area where the project is located; use the nationwide urban equation if the statewide urban regression is not available.					
C6	Were regression estimates weighted with gaging station estimates? Guidelines for weighting regression estimates and gaging station estimates can be found from USGS report for estimating magnitude and frequency of peak flows for the subject State.					
C7	Were regression estimates comparable with estimates from nearby gaging station? Compare regression estimates with estimates in nearby watersheds having similar characteristics.					
C8	Were new regression estimates compared to effective discharges?					
Fluvial Hydrology - Developing hydrographs						
D1	Were actual flood events used to create mutliple unit hydrographs? Do they span the whole flood event?					

I.D.	QC Check and Description	Citation	Internal Base Flood QC Checkpoints				
		Reference	P/F/NA	Reviewer Comment	Originator Response		Back Check Complete? Y/N/NA
D2	For ungaged streams, was an appropriate approach used to develop hydrograph? Were nearby gaged basins used to create a hydrograph using regression estimated peaks?	USGS NSS, using Chapter 6 of Book 4, Hydrologic Analysis and Interpretation Section A, Statistical Analysis, page 13					
D3	Were hydrographs shortened or optimized where possible to avoid unnecessarily long run durations?						
D4	Do the unit hydrographs and associated intervals in the script & models reflect the flood events well? Does "1" show up for at least one interval?						
Fluvial Hydrology - Monte Carlo							
E1	Were the appropriate confidence limits calculated and correctly input to Monte Carlo spreadsheet?						
E2	Were user-specified intervals (HEC-SSP) used to estimate the upper end (e.g., 3000 yr) rather than extrapolating?						
E3	Are the random numbers capped between 0.05 & 0.95 for the 5 & 95% confidence limit, rather than random numbers between 0 & 1. Do they generate a good random distribution when looking at them graphically?						
E4	Were the random numbers changed between different project locations, but held constant between streams in a single location?						
Pluvial Hydrology - Applied to RAS							
F1	The correct rainfall depth was used as input to the model. Nationwide rainfall data are available from NOAA Atlas 14 (http://hdsc.nws.noaa.gov/hdsc/pfds/), NWS TP-40, and NOAA Atlas-2. Use of regional data must be approved by FEMA.	SID 61, 90, 93					
F2	The rainfall duration is appropriate. The duration must exceed the time of concentration. Critical storm duration is acceptable. Longer duration is required for a flooding source in a closed basin.	SID 61, 90, 93					
F3	Appropriate temporal distribution of rainfall is used in the model. The temporal distribution must be developed or recommended by Federal or State agencies.	SID 61, 90, 93					
F4	An appropriate method is used for runoff transformation.	SID 61, 90					
F5	The loss rate estimate is correct. Loss rate methodology, reasoning, and sources of data must be provided.	SID 61, 90, 93					
F6	Curve numbers are reasonable and correctly derived and applied.	SID 61, 90, 93					
F7	An Areal Reduction factor is applied appropriately, or documented why one was not used.	SID 61, 90, 93					
Pluvial Hydrology - Outside of RAS for Input Flows (may not be applicable)							
G1	Drainage area basins were delineated within the limits that the unit hydrograph is able to reflect hydrologic response.	SID 61, 90, 93					
G2	Time of concentration and/or the lag time computations are correct. Impact of urbanization and channel modification must be reflected. The method developed by Federal agencies is preferred. Empirical formulas developed by or approved by State agencies can only be used within those States.	SID 61, 90, 93					
G3	Storm runoff diversions are accounted for.	SID 61, 90, 93					
G4	Channel routing is reasonable.	SID 61, 90, 93					
G5	Was the appropriate flow routing method used? Routing method must be able to analyze hydrograph attenuation and translation.	SID 61, 90, 93					
G6	Uncontrolled storage modeled correctly. If the storage discharge relationship was simulated by the rainfall-runoff model, verify the storage elevation area relationship.	SID 61, 90, 93					

I.D.	QC Check and Description	Citation	Internal Base Flood QC Checkpoints				
		Reference	P/F/NA	Reviewer Comment	Originator Response		Back Check Complete? Y/N/NA
G7	Controlled storage defined and modeled appropriately. Normally, storage capacity below the normal pool level for non-flood control reservoirs is not considered and joint use storage is not acceptable.	SID 61, 90, 93					
Pluvial Hydrology - Monte Carlo Specific							
H1	Spot check output Hyetographs DSS file to determine the confirmations below. Do this for each duration.						
H2	Verify that duration of output DSS hyetograph matches the intended duration of the input. (6,12,24, or 96 hours)						
H3	Verify that Quartile and Decile of output DSS hyetograph matches the intended quartile and decile from the input excel files. (6,12,24, or 96 hours)						
H4	Verify that the cumulative precipitation of output DSS hyetograph matches the precipitation value from the input excel files. (6,12,24, or 96 hours)						
H5	Verify that the output excess precipitation hyetograph matches expected shape based on precipitation, CN, quartile, duration, and decile from the input excel files.						
H6	Spot check to verify the HMS script input matches the excel input files for each area and duration.						
H7	Verify that the shapefiles used to create the CN values match the values used to calculate the CN values for the HMS input in excel.						
Hydraulics - Domain & BCs							
I1	Is the model domain delineated properly to capture all contributing flows through rain-on-grid or external hydrograph?	Engineering Judgement					
I2	Are the boundary conditions established, documented, and reasonable?	SD LSAE Guidance					
I3	If using a clipped model domain, do enhancement results tie-in with BLE model results at a point downstream?						
I4	If applicable, is the transfer line between this model and a downstream model well away from any boundary condition effects?	SD LSAE Guidance					
I5	Are the initial conditions and final conditions reasonable?	SD LSAE Guidance					
Hydraulics -Tolerances & Settings							
J1	Does the software meet FEMA's requirements for Nationally and Locally accepted models	https://www.fema.gov/hydraulic-numerical-models-meeting-minimum-requirement-national-flood-insurance-program					
J2	Is the 2D mesh reasonably sized to limit cell count and obtain reasonable velocities?	SD LSAE Guidance Guidance for Flood Risk Analysis and Mapping Hydraulics: Two-Dimensional Analysis 3.1					
J3	Is the mass balance/volume conservation reasonable? A percent error less than or equal to 1% would be ideal however, values of 2-3% can be acceptable (i.e. rain on grid). Percent error values greater than 3% indicate that there are major problems with the model	TUFLOW User's Manual, Table 14-1					

I.D.	QC Check and Description	Citation Reference	Internal Base Flood QC Checkpoints P/F/NA	Reviewer Comment	Originator Response	Back Check Complete? Y/N/NA
J4	Is the timestep appropriate for the mesh size and calculated velocities (are the associated Courant numbers reasonable)?	SD LSAE Guidance Best Practice for Flood Risk Analysis and Mapping 2D Modeling: Zone AE Upgrades and Floodways v2.0 Section 2.7.1.2				
J5	Are both the "hydrograph output interval" and "mapping output interval" set at a reasonable interval to capture peak flows within the model?	Engineering Judgement				
J6	Is the correct equation set being used (Full Momentum vs. Diffusion Wave)?					
J7	Use of any Restart Files? If so, does the subsequent hydrograph begin at nearly similar conditions?					
Hydraulics - Results						
K1	Are all water-surface elvation convergence warning messages acceptable per computation tolerances?					
K2	Was the model simulation long enough to fully pass all peak flows through the downstream extents of the model	SD LSAE Guidance				
K3	Have instances of model instabilities at the beginning of the simulation due to initial wetting of a dry grid been addressed? Should an initial condition (wet start) be used?	Engineering Judgement				
K4	Check to make sure the computed maximum depth, WSEL, and velocity values are not from numerical surge (i.e.beginning of model).	Engineering Judgement				
Hydraulics - 2D Mesh Refinement						
L1	Have sufficient breaklines been delineated and added to the 2D mesh within the enhancement area to define topographic restraints such as roads, railroads, dams, levees, and natural high ground areas?	Best Practices 2D Modeling: Zone AE Upgrades and Floodways v2.0 Section 2.2.1				
L2	Has an appropriate cell spacing on either side of the breaklines been chosen to mimic topgraphic restraint?	Best Practices 2D Modeling: Zone AE Upgrades and Floodways v2.0 Section 2.2.1				
L3	Is the 2D cell size within the enhanced area of adquate size to describe the water surface slope and potential changes in water surface slope (i.e. is enough detail being captured by a reduced cell size)?	Best Practices 2D Modeling: Zone AE Upgrades and Floodways v2.0 Section 2.2.1				
L4	Are offset break lines or "V" break lines utilized in accordance with the project guidance to allow flow to pass high ground/embankments where information on detailed hydraulic structures doesn't exist outside of the detailed enhancement reach?	SD LSAE Guidance				
Hydraulics - Pump Stations within 2D Domain						
M1	Have all pump stations been included in the model at the correct locations?					
M2	Is the method used to model the pump stations appropriate? (e.g. pumps, rating curve, etc.)					
M3	Is the method for developing the rating curves documented and appropriate?					
Hydraulics - Model Calibration & Verification						
N1	Is the method for developing the model calibration documented and appropriate along with model calibration spreadsheet?					

I.D.	QC Check and Description	Citation	Internal Base Flood QC Checkpoints				
		Reference	P/F/NA	Reviewer Comment	Originator Response		Back Check Complete? Y/N/NA
N2	Are comparison points/lines (i.e., internal 2-D connections or RAS Mapper profile lines) captured and compared against applicable benchmarks? (gage, high water mark, effective BFE, etc.)	SD LSAE Guidance					
N3	Where applicable, have USGS gage rating curve(s) been used to verify model results?	Best Practices 2D Modeling: Zone AE Upgrades and Floodways v2.0 Section 2.7					
N4	Was the pluvial model verified against data (if available), such as a flow frequency curve or against known storms in the study area?	SID 59, 61, 90, 93					
N5	Do pluvial flow discharges seemreasonable when compared with gaged discharges or USGS regional regression estimates? The estimates are considered reasonable if they are generally within one standard error of the regression equation or 68 percent of confidence intervals of gaging station estimates. If the model estimates are not comparable with regional regression and/or gage estimates, the rainfall runoff model must be reviewed in greater detail to determine whether the estimates are reasonable.	SID 59, 61, 90					
Hydraulics - Structures within 2D Domain (gravity drains & culverts)							
O1	Are significant hydraulic structures and embankments accounted for? (i.e., placing breaklines, 2D-structures, terrain processing, etc.)	FOA 2.2.2.9					
O2	Does the model account for any significant flow-regulating dams?						
O3	Does the vertical datum of the structures/surveys match the vertical datum of the terrain?	Engineering Judgement					
O4	Do stuctures added as internal connections inside the 2D domain reflect the field survey data, as-built drawings, or desktop analysis?						
O5	Have internal connections been enforced as breaklines into the 2D mesh						
O6	Have reasonable values been entered into the internal connection's Htab Parameters to define the limits of the connection & structure	HEC-RAS 5.0 User's Manual [6-149 & 8-22]					
O7	Do the 2D cells just upstream and downstream of the structure have adequate volume at any given time step and have been properly aligned to the sructure?	Best Practices 2D Modeling: Zone AE Upgrades and Floodways v2.0 Section 2.51					
O8	Internal Connection: Has an appropriate overflow computation method been selected (2D equation or weir equation) If the weir equation has been selected is the weir coefficient of discharge reasonable	HEC-RAS 5.0 2D Modelin User's Manual [3-67]					
O9	Does the top of road elevation and rail data match the field survey						
O10	Culverts: Do the culvert invert elevations match the field survey						
O11	Culverts: Does the culvert length match the field survey						
O12	Culverts: Do the culvert dimensions and shape match the field survey						
O13	Culverts: Have the appropriate FHWA Chart & Scale #'s been selected per the field survey phtotographs	HEC-RAS 5.0 Reference Manual, [6-30]					
O14	Culverts: Has an appropriate entrance loss coefficient been selected per the field survey	HEC-RAS 5.0 Reference Manual, Chpt. [6-28, Tables 6-3, 6-4, & 6-5]					

I.D.	QC Check and Description	Citation: Reference	P/F/NA	Reviewer Comment	Originator Response	Back Check Complete? Y/N/NA
O15	Culverts: If the surveyed culvert invert elevation is below the DEM elevation, has appropriate depth to block the culvert portion below ground been described?	Best Practices 2D Modeling: Zone AE Upgrades and Floodways v2.0 Section 2.5.1				
O16	Are the entrance and exit locations of flow for all 2D internal structures reasonable and properly span terrain features?	Engineering Judgement				
Hydraulics - Energy Loss Coefficients (Manning's N)						
P1	Has a roughness coefficient been assigned to each cell and a layer properly associated in RAS Mapper?	Hydraulics: 2D Analysis Guidance Section 3.4				
P2	Does the land cover layer brought into RAS Mapper have the proper look up code for the script to change manning's values?					
P3	Are roughness coefficients properly documented?	Hydraulics: 2D Analysis Guidance Section 3.4				
P4	Have roughness coefficients been validated through calibration (where calibration data are available)?	Hydraulics: 2D Analysis Guidance Section 3.4				
P5	Is the source of the roughness coefficients or criteria for selecting default roughness coefficients reasonable and documented in the report?	Guidance for Flood Risk Analysis and Mapping Hydraulics: Two-Dimensional Analysis 3.4				
P6	Do the roughness coefficients correctly represent existing or proposed conditions? Both in mesh/ground and structures.	Guidance for Flood Risk Analysis and Mapping Hydraulics: Two-Dimensional Analysis 3.4				
P7	Are buildings, towns/cities, or other major infrastructure accounted for (e.g. raising elevations in terrain, high roughness coefficients, etc.)?	Guidance for Flood Risk Analysis and Mapping Hydraulics: Two-Dimensional Analysis 3.3				
Breach Modeling						
Q1	Are selected breach locations reasonable and based on system evidence or conditions? Were all areas in the periodic inspection or LSOG PPT captured? Other conditions ot consider include seepage, underlying geology, overtopping, transition from embankment to floodwall, eroded, trees, sharp bends, and high velocity.					
Q2	Are breach widths appropriate, representing either historic breaches or anticipated widths from USACE documentation? Do widths make sense relative to flows and depths?					
Q3	Has the terrain been modified at the correct locations for the correct widths?					
Q4	Has the terrain been modified correctly along the toes of the levee, transitioning to natural ground?					
Q1	Do break lines align properly with breach edges (end of breach within levee)?					
Q2	Do break lines align properly with levee toes? At least one break line should align with the higher of the two toes (riverside or landside).					
Q3	Is every breached portion of the terrain fully closed off with a structure? Does the structure/embankment elevation match the unbreached terrain/levee profile?					
Q4	Is the breach method selected as simplified physical model? Does it have the correct widths and center stations?					
Q1	Is the correct structure selected to breach for the associated geometry?					
Q2	Does the breach method include an overtopping failure mode with the mass wasting feature activated?					

I.D.	QC Check and Description	Citation	Internal Base Flood QC Checkpoints				
		Reference	P/F/NA	Reviewer Comment	Originator Response		Back Check Complete? Y/N/NA
Q3	Does the structure breach settings have the same elevation for the minimum possible bottom elv, final bottom elev, and starting WSEL for trigger failure and do all of these match the riverside toe elev at the breach center.						
Q4	Does the trigger failure include WSEL + duration? The immediate initiation WSEL should be no less than 1 ft greater than the threshold WSEL.						
Q1	Are the downcutting rates and widening rates reasonable for the levee material type? Do they cover a wide enough range of velocity for the simulation?						
Q2	Does the breach model with weirs closed/not breached match the fluvial intact model? No leaky cells?						
Simulations & Script Setup							
R1	Do hydrographs ramp up slowly enough to avoid a WSEL surge at the beginning of the simulation?						
R2	Do all hydrographs extend far enough to cover the entire simulation time?						
R3	Are the hydrographs paired correctly in that their peaks align when mutliple streams are present?						
R4	Are all of the simulation end times optimized with respect to when the max WSEL will occur (e.g., compared to overtopping for intact or the levee toes for breaching).						
R5	Is the WSEL result checked as save to raster & "floodplain mapping" box checked in the plan?						
R6	Is there a single plan (.p01) and flow file (.u01)?						
R7	Is the spatial project set and correct terrain (breach vs intact) assigned?						
R8	Are the geometry associations done correctly, especially with mannings?						
R9	Do boundary conditions match the names used in the script?						
R10	Are the scripts labeled for each scenario (e.g., LI, BA, BB, etc.)						
R11	Are unnecessary simulations removed from breach scenarios? There are often peak flows that are too low to enter the levee breaches.						
Risk Assessment							
S1	Was the correct/anticipated number of WSEL rasters exported?						
S2	Spot check "compute messages" and "error logs"						
S3	Spot check that run times correctly captured peaks for various pluvial storm durations and quart les and fluvial hydrographs and discharges.						
S4	Do the fragility curves extend from the toe to crest? Does the toe elevation match with the breach simplified physical model trigger WSEL?						
S5	Do the weighting factors add up to 50% per independent stream?						
S6	Do the weighting factors account for the correct number of breaches within a single system for failure probability (Ptopi)?						
S7	Do the AALs make sense with modeling? Look at high and low areas.						
S8	Is stormwater reduction begin properly accounted for in pluvial analysis?						
S9	Were heatmaps generated correctly?						
Narrative & Deliverable							
T1	Does the narrative include key figures and tables?						

Dewberry

I.D.	QC Check and Description	Citation	Internal Base Flood QC Checkpoints			
		Reference	P/F/NA	Reviewer Comment	Originator Response	Back Check Complete? Y/N/NA
T2	Does the narrative documents important assumptions and their influence on modeling/results?					
T3	Does the narrative document data sources and references used?					
T4	Are the project directories clean and organized. Have old files been archived or deleted?					