



**DeWight Dopslauf, C.P.M., CPPO**  
**Harris County Purchasing Agent**

January 18, 2023

Commissioners Court  
Harris County, Texas

**RE: Job No. 190366**

Members of Commissioners Court:

Please approve the attached Order(s) authorizing the County Judge to execute the attached Third Amendment to the Agreement(s) for the following:

**Description:** Professional Engineering and Related Consulting Services for a Study of the Feasibility of Constructing Storm Water Conveyance Tunnels (Phase 2) for the Harris County Flood Control District

**Vendor(s):** Black & Veatch Corporation

**Amount:** \$5,786,640 previously approved funds  
2,819,924 additional funds  
\$8,606,564

**Reviewed By:** • Harris County Purchasing • Flood Control District

The Amendment increases the funds to continue providing the services. Purchase order(s) will be issued upon Commissioners Court approval.

Sincerely,

DeWight Dopslauf  
Purchasing Agent

JOA  
Attachment(s)  
cc: Vendor(s)

**FOR INCLUSION ON COMMISSIONERS COURT AGENDA JANUARY 31, 2023**



**AMENDMENT TO THE PROFESSIONAL SERVICES AGREEMENT BETWEEN  
HARRIS COUNTY FLOOD CONTROL DISTRICT AND BLACK & VEATCH  
CORPORATION**

THE STATE OF TEXAS     §  
                                     §  
COUNTY OF HARRIS     §

This Third Amendment to the above referenced Agreement is made and entered into by and between Harris County Flood Control District (the "District"), a body corporate and politic under the laws of the state of Texas, and Black & Veatch Corporation ("Contractor"). The District and Contractor are referred to herein collectively as "Parties" and individually as "Party."

***Recitals***

On April 28, 2020, the District entered into a Professional Services Agreement ("Master Agreement") with Black & Veatch Corporation for Professional Engineering and Related Consulting Services to Conduct a Study of the Feasibility of Constructing Storm Water Conveyance Tunnels (Phase 2).

On July 20, 2021, the Parties amended the Master Agreement to provide for a Study of the Feasibility of Constructing the Buffalo Bayou & Tributaries Resiliency Study (BBTRS) Tunnel ("First Amendment").

On December 14, 2021, the Parties amended the Master Agreement to for a Downstream Conveyance Study as part of the Buffalo Bayou & Tributaries Resiliency Study ("Second Amendment").

The Parties desire to amend the Master Agreement a third time to provide a study of the feasibility of constructing storm water conveyance tunnels (Phase 2) for the District as detailed in the Scope of Services and the Explanation of Bill Rates attached hereto and incorporated herein by reference ("Third Amendment")

***Terms***

I.

This Third Amendment shall be governed by the Master Agreement, First Amendment, and Second Amendment incorporated herein by reference as though fully set forth word for word.

II.

Having previously certified funds in the amount Five Million Seven Hundred Eighty-Six Thousand Six Hundred Forty and 42/100 Dollars (\$5,786,640.42), the Parties hereby amend the Master Agreement to provide Two Million Eight Hundred Nineteen Thousand Nine Hundred Twenty-

Three and 77/100 Dollars (\$2,819,923.77) in additional funds bringing the total amount of funds certified as available under the Master Agreement to Eight Million Six Hundred Six Thousand Five Hundred Sixty-Four and 19/100 Dollars (\$8,606,564.19). Contractor understands and agrees, said understanding and agreement also being of the absolute essence of this Third Amendment, that the total maximum compensation that Contractor may become entitled to for the Services performed under this Third Amendment, shall not under any conditions, circumstances, or interpretations thereof exceed the sum of Two Million Eight Hundred Nineteen Thousand Nine Hundred Twenty-Three and 77/100 Dollars (\$2,819,923.77). Contractor understands and agrees, said understanding also being of the absolute essence of this Third Amendment, that the maximum amount Contractor may become entitled to under the Master Agreement shall not exceed the sum of Eight Million Six Hundred Six Thousand Five Hundred Sixty-Four and 19/100 Dollars (\$8,606,564.19). Notwithstanding anything to the contrary, or that may be construed to the contrary, the District's liability under the terms and provisions of this Third Amendment is limited to said sum; and when all the funds so certified are expended, Contractor's sole and exclusive remedy shall be to terminate this Third Amendment.

### III.

All other terms and provisions of the Master Agreement, First Amendment, and Second Amendment shall remain in full force and effect as originally written.

### IV.

It is expressly understood and agreed that the Master Agreement, First Amendment, and Second Amendment are incorporated herein by reference. In the event of any conflict between the terms and provisions of this Third Amendment, or any portion thereof, and the terms and provisions of any other part or portion of the Master Agreement, First Amendment, and Second Amendment, this Third Amendment shall control.

### V.

Execution, Multiple Counterparts: This Third Amendment may be executed in several counterparts. Each counterpart is deemed an original. All counterparts together constitute one and the same instrument. Each Party warrants that the undersigned is a duly authorized representative with the power to execute this Third Amendment.

[Execution Page Follows]

BLACK & VEATCH CORPORATION

By Christopher Mueller  
Name: Christopher Mueller  
Title: Vice President  
Date: 12/28/2022

HARRIS COUNTY

By: \_\_\_\_\_  
Lina Hidalgo  
Harris County Judge

APPROVED AS TO FORM:

Christian D. Menefee  
Harris County Attorney

By: An Le for \_\_\_\_\_  
Philip Berzins  
Assistant County Attorney  
C.A. File 22GEN4375





October 17, 2022

Ms. Tommi Jo G. Scott  
Project Manager  
Harris County Flood Control District  
9900 Northwest Freeway  
Houston, Texas 77092

Re: Explanation of Bill Rates  
HCFCD Project No. Z100-00-00-P028  
HCFCD Agreement No. 2021-18  
Downstream Conveyance Feasibility Study  
Buffalo Bayou & Tributaries Resiliency Study

Dear Tommi Jo,

Black & Veatch was awarded the “Professional Engineering and Related Consulting Services for a Study of Constructing Storm Water Conveyance Tunnels (Phase 2)” Contract on May 14, 2020. This Contract was governed by bill rates by labor classification found in Exhibit C to the Agreement. The Scope of Services associated with the original Agreement could generally be described as tunnel concept level engineering and hydrologic and hydraulic analyses.

After the original Agreement, HCFCD requested that Black & Veatch participate in the Buffalo Bayou & Tributaries Resiliency Study (BBTRS) with the USACE Galveston District. The work associated with BBTRS significantly expanded the Scope of the original Agreement and necessitated additional resources and skills sets from those required for the Phase 2 Study. Specifically, more senior level staff were required in the areas of engineering for channels and detention structure, dam safety, hydraulics, environmental analyses, risk analyses, and economics. To account for the additional skills sets and more experienced resources to conduct the work on BBTRS, Black & Veatch made a verbal request for an increase in bill rates related to the work. This bill rate increase corresponded to a 6% increase on rates included in the original Agreement and was approved by Harris County Commissioner’s Court with Amendment 2 on December 14, 2021.

As you are aware, Black & Veatch has a pending Amendment 3 for continuation of service on BBTRS with additional scope related to Comprehensive Benefits that was not included in prior Amendments 1 and 2 for work on BBTRS. For this new Amendment 3, which is due before Harris County Commissioners Court in November of this year, we are proposing bill rates consistent with those that were approved last year for Amendment 2, plus the addition of some labor classifications required to complete the work. These labor classification additions in the attached proposed bill rate schedule.

I trust this letter is adequate to meet your needs in obtaining required approvals for Amendment 3 with specific reference to the bill rate schedule. If you require additional information, please do not hesitate to reach out to me with questions.

Very truly yours,

A handwritten signature in blue ink that reads "Christopher G. Mueller". The signature is written in a cursive, flowing style.

Christopher G. Mueller  
Project Director/Vice President  
Black & Veatch Corporation

Attachments:

- Attachment 1, Exhibit C – Bill Rate Schedule from Original Agreement, May 14, 2020
- Attachment 2, Exhibit C – Bill Rate Schedule from Amendment 2, December 14, 2021
- Attachment 3, Bill Rate Schedule for Amendment 3

**ATTACHMENT 1**

**EXHIBIT "C"**  
**TO**  
**PROFESSIONAL SERVICES AGREEMENT**

**SCHEDULE OF COMPENSATION (CONTRACTOR'S PROPOSAL)**

**Final Compensation Schedule & Reimbursable Expenses**

**1.0 Hourly Compensation Rates**

<u>Position</u>	<u>Hourly Rate Without Profit</u>
Project Manager .....	\$280.93
Deputy Project Manager .....	\$235.25
Project Control/Scheduler .....	\$160.80
Project Accountant .....	\$ 54.88
Project Assistant .....	\$ 81.77
Design Lead .....	\$233.68
Geotechnical/Tunnel Engineer (I) .....	\$164.49
Tunnel Engineer (II) .....	\$201.76
Civil Engineer .....	\$115.36
CAD Designer .....	\$ 82.41
Hydraulics/Structures Engineer .....	\$169.95
Hydraulics Engineer (I) .....	\$104.30
Hydraulics Engineer (II) .....	\$158.46
Cost Estimator .....	\$231.36
Tunnel/Geotechnical QA/QC (II) .....	\$257.78
Tunnel/Geotechnical QA/QC (I) .....	\$244.50
Hydraulics QA/QC .....	\$118.40
Planning Lead .....	\$178.20
Planning Engineer (II) .....	\$149.61
Planning Engineer (I) .....	\$117.96
Planning QA/QC .....	\$211.84
Environmental Lead .....	\$230.30
Environmental Scientist (I) .....	\$140.39
Environmental Scientist (II) .....	\$157.92

The profit rates will be added at 15% for the overall project.

At the option of the Director, the Director may also issue work authorization(s) for performance of specified professional services to be compensated on a lump sum basis upon acceptance by Contractor. If a work authorization specifies payment on a lump sum basis for certain services, the hourly rates set out above shall not apply. In addition, where work performed pursuant to a work authorization is to be compensated on a lump sum basis, the budget for same shall not be increased pursuant to this Agreement, except to the extent that additional services are assigned to be performed by the Contractor by further written authorization from the Director.

**ATTACHMENT 2**

**AMENDMENT 2 EXHIBIT "C"**

**TO**

**PROFESSIONAL SERVICES AGREEMENT**

**SCHEDULE OF COMPENSATION (CONTRACTOR'S PROPOSAL)**

**Final Compensation Schedule & Reimbursable Expenses**

**1.0 Hourly Compensation Rates**

<u>Position</u>	<u>Hourly Rate Without Profit</u>
Project Manager .....	\$297.79
Deputy Project Manager .....	\$249.37
Project Control/Scheduler .....	\$170.45
Project Accountant .....	\$58.17
Project Assistant.....	\$ 86.68
Design Lead .....	\$247.70
Geotechnical/Tunnel Engineer (I) .....	\$174.36
Tunnel Engineer (II) .....	\$213.87
Civil Engineer .....	\$122.28
CAD Designer .....	\$ 87.35
Hydraulics/Structures Engineer.....	\$180.15
Hydraulics Engineer (I).....	\$110.56
Hydraulics Engineer (II).....	\$167.97
Cost Estimator.....	\$245.24
Tunnel/Geotechnical QA/QC (II) .....	\$273.25
Tunnel/Geotechnical QA/QC (I) .....	\$259.17
Hydraulics QA/QC .....	\$125.50
Planning Lead .....	\$188.89
Planning Engineer (II) .....	\$158.59
Planning Engineer (I) .....	\$125.04
Planning QA/QC.....	\$224.55
Environmental Lead.....	\$244.12
Environmental Scientist (I).....	\$148.81
Environmental Scientist (II).....	\$157.92

The profit rates will be added at 15% for the overall project.

At the option of the Director, the Director may also issue work authorization(s) for performance of specified professional services to be compensated on a lump sum basis upon acceptance by Contractor. If a work authorization specifies payment on a lump sum basis for certain services, the hourly rates set out above shall not apply. In addition, where work performed pursuant to a work authorization is to be compensated on a lump sum basis, the budget for same shall not be increased pursuant to this Agreement, except to the extent that additional services are assigned to be performed by the Contractor by further written authorization from the Director.



ATTACHMENT 3

Harris County Flood Control District Standard Job Classifications						
Consultant Classification	Conversion to HCFCF Classifications	HCFCF Description	Billing Hourly Rate (w/ 15% Profit)	Amendment 2 Bill Rate (Decemeber 2021)	Amendment 2 % Increase from Original Contract	Original Contract (May 2020)
<b>Accounting/Finance</b>						
Project Biller	Accounting Specialist II	Responsible for maintaining a complete and systematic set of records of business transactions. Balances books and prepares reports to show receipts, expenditures, accounts receivable and payable, and various other items pertinent to the operation of a business. Typically has an associates or bachelors degree with 2-5 years of experience.	\$ 66.90	\$ 66.90	6%	\$ 63.11
Project Accountant	Finance Manager	Responsible for the organization's financial information and administration. Supervises accounting, budgeting, and payroll functions. May be a strategic/tactical manager. May be or may report to CFO. Typically has a bachelors degree or higher with 7+ years of experience.	\$ 161.58	N/A	N/A	N/A
<b>CADD/Designers</b>						
CADD Designer I	CADD Tech I	Under general supervision, prepares layouts, drawings, and designs according to engineering specs using CADD or other design software. May have technical training with 0-5 years of experience.	\$ 100.45	\$ 100.45	6%	\$ 94.77
CADD Designer II	CADD Tech II	Under general supervision, prepares layouts, drawings, and designs according to engineering specs using CADD or other design software. May have technical training with 6-12 years of experience.	\$ 156.20	N/A	N/A	N/A
CADD Designer III	CADD Tech III	Under general supervision, prepares layouts, drawings, and designs according to engineering specs using CADD or other design software. May have technical training with 12+ years of experience.	\$ 165.89	N/A	N/A	N/A
<b>Construction Inspectors/Managers</b>						
<b>Communications</b>						
<b>Engineers</b>						
Civil Engineer	Engineer-in-Training (EIT) I	Entry-level/new graduate who uses prescribed methods, standard techniques, and practices to perform beginning level engineering assignments under the guidance of experienced engineers. Typically has a bachelors degree, E.I.T. certification, and 0-2 years of experience.	\$ 115.17	N/A	N/A	N/A
Civil Engineer	Engineer-in-Training (EIT) II	Performs continuing development-level engineering work, requires application of standard techniques and procedures. Receives supervision from experienced engineers on non-routine, complex projects and assignments. Could be new graduate with master's degree in lieu of experience. Typically has a bachelors or master's degree, E.I.T. certification, and 3-5 years of experience.	\$ 140.62	\$ 140.62	6%	\$ 132.66
Civil Engineer	Engineer-in-Training (EIT) III	In addition to above, may coordinate work of technicians. Typically has a bachelors or masters degree, E.I.T. certification, and 6+ years of experience.	\$ 156.65	N/A	N/A	N/A
Civil Engineer	Engineer I	Professional engineer (PE) working under general supervision, establishes basic design criteria and performs a variety of skilled professional engineering work in the office or field. Requires application of standard engineering techniques and procedures and professional judgement to make modifications or execute complex features or solutions. Typically has a bachelors or masters degree and 3-8 years of experience. Requires a PE certification.	\$ 176.84	N/A	N/A	N/A
Civil Engineer	Engineer II	PE with responsibility for technical performance on small to medium projects or designated tasks on large projects. Work requires application of standard engineering techniques and procedures and professional judgment to make modifications or execute complex features or solutions. May have some supervisory duties or work more independently. Typically has a bachelors or masters degree and 9-13 years of experience. Requires a PE certification.	\$ 183.24	N/A	N/A	N/A
Civil Engineer	Engineer III	PE with major responsibility for technical performance on medium to large projects or multiple projects. Possesses diversified knowledge of engineering principles and practices. Applies advanced techniques, modifications, and theories, and serves as technical liaison on matters pertaining to field of practice. Supervises other PEs and may have project management duties. Typically has a bachelor's or master's degree and 14-18 years of experience. Requires a PE certification.	\$ 251.41	N/A	N/A	N/A
Civil Engineer	Senior Engineer	PE with major responsibility for technical performance on medium to large projects or multiple projects. Possesses diversified knowledge of engineering principles and practices. Applies advanced techniques, modifications, and theories, and serves as technical liaison on matters pertaining to field of practice. Supervises other PEs and may have project management duties. Typically has a bachelor's or master's degree and 19+ years of experience. Requires a PE certification.	\$ 268.27	N/A	N/A	N/A
Civil Engineer	Technical Advisor/Senior Specialist	PE with independent responsibility for organizing, directing and coordinating professional engineering activities of considerable scope and complexity. Considered a Subject Matter Expert in their respective field. Oversees and directs complex assignments, including supervision of other engineers, and has ability to provide technical expertise. Typically has a bachelors or masters degree and 19+ years of experience. Requires a PE certification.	\$ 289.74	N/A	N/A	N/A
Design Lead	Engineering Manager	PE with full responsibility for large, complex projects or a number of large projects. Generally, reports directly to the firm's principal/president and has administrative qualifications needed to develop a project or projects with clients. Has project management duties; may be at the vice president (VP) level in the company. Typically has a bachelor's or master's degree and 19+ years of experience. Requires a PE certification.	\$ 284.95	\$ 284.95	6%	\$ 268.73

ATTACHMENT 3

H&H Engineer	H&H Engineer III	PE with independent responsibility for organizing, directing and coordinating professional hydrologic and hydraulic engineering activities of considerable scope and complexity. Oversees and directs complex assignments, including supervision of other H&H engineers, and has ability to provide technical expertise. Typically has a bachelors or masters degree and 12+ years of experience. Requires a PE certification.	\$ 223.74	N/A	N/A	N/A
Project Director	Principal	Responsible for a segment, discipline, business unit, geographic region, or project type. In larger firms, there are typically multiple engineering VPs. Typically reports to chief executive officer (CEO) in smaller/medium sized firms, or an executive VP in larger firms. In very small firms, this position could be the top-level principal/CEO/president who does actual engineering work and charges directly to projects. Typically has a bachelor's or master's degree, PE certification, and 12+ years of management-level experience.	\$ 369.85	N/A	N/A	N/A
<b>Geographic Information Systems</b>						
<b>Information Technology</b>						
<b>Office/Admin Support</b>						
Project Assistant	Executive Assistant	Supports executive by handling a wide variety of situations involving the administrative functions of the office that cannot be brought to the attention of the executive. Advises individuals inside and outside the organization on the executive views on major policies or current issues facing the organization. Contacts or replies to contacts from high- ranking individuals who may be from large national or international firms and may involve unique situations. Typically has an associate degree with 5+ years of experience.	\$ 99.68	\$ 99.68	6%	\$ 94.04
<b>Project Controls</b>						
Project Controls	Project Controls Specialist/Manager	Responsible for working with project teams to analyze project data, create project reports and metrics, and identify risks for project delivery as pertaining to cost and schedule. Assisting other project support departments for data integration and visualization of data for consumption by Stakeholders, Executive staff, Divisional/Departmental staff, and Project Managers. Additionally providing desk side mentoring on project controls guidance and training of District policies as needed. May have supervisory responsibilities of Project Controls staff. Typically has a bachelors degree with 10+ years of experience.	\$ 196.02	\$ 196.02	6%	\$ 184.92
<b>Project &amp; Contract Coordinators</b>						
<b>Project Managers</b>						
Deputy Project Manager	Project Manager II	Same as above. Has sole responsibility for small- to mid-level projects, and/or multiple projects. Has bachelor's degree and typically has 6–10 years of project management-level experience and may have a P.E. or other professional license.	\$ 286.78	\$ 286.78	6%	\$ 270.54
Project Manager	Senior Project Manager	Same as above. Has sole responsibility for multiple large, complex projects. May be executive-level employee. Has bachelor's or master's degree and typically has 16+ years of project management-level experience and may have a P.E. or other professional license.	\$ 342.46	\$ 342.46	6%	\$ 323.07
<b>Right-of-Way/Utility Specialists</b>						
<b>Scientists</b>						
Enivornmental Lead	Environmental Scientist Manager	Oversees the work of scientists. Assigns and directs projects. Serves as expert advisor to clients and interfaces with regulatory agencies. May have a master's degree or higher and 10+ years of management-level experience.	\$ 280.74	\$ 280.74	6%	\$ 264.85
<b>Surveyors</b>						

**AMENDMENT NO. 3 TO AGREEMENT  
SCOPE OF SERVICES**

**July 22, 2022**

**HCP Job No. 19/0366 HCFCD**

**Project No. Z100-00-00-P028**

**Downstream Conveyance Feasibility Study:  
Buffalo Bayou & Tributaries Resiliency Study**

**OVERVIEW**

This document comprises an Exhibit D (AMENDMENT NO. 3) to the AGREEMENT between Black & Veatch Corporation (ENGINEER) and Harris County, for the Harris County Flood Control District (HCFCD) PROJECT numbered Z100-00-00-P019 and titled Study of the Feasibility of Constructing Storm Water Conveyance Tunnels (Phase 2). This AMENDMENT involves a Downstream Conveyance Study as part of the Buffalo Bayou & Tributaries Resiliency Study (BBTRS). Exhibit D contains the detailed scope of services to be performed by the ENGINEER independent of AMENDMENTS NO. 1 and NO. 2 to the Phase 2 Storm Water Tunnel Study. This AMENDMENT NO. 3 involves services directed at a Study of the Feasibility of Construction of the BBTRS Tunnel. This scope of services includes a project description, list of major project assumptions, and scope of services for the study work tasks.

In March of 2022, the decision was made to allow HCFCD to take the lead on a more in-depth evaluation of the tunnel alternative as part of the Buffalo Bayou and Tributaries Resiliency Study (BBTRS). The purpose of this “HCFCD Evaluation”, lasting approximately 12 months, is to:

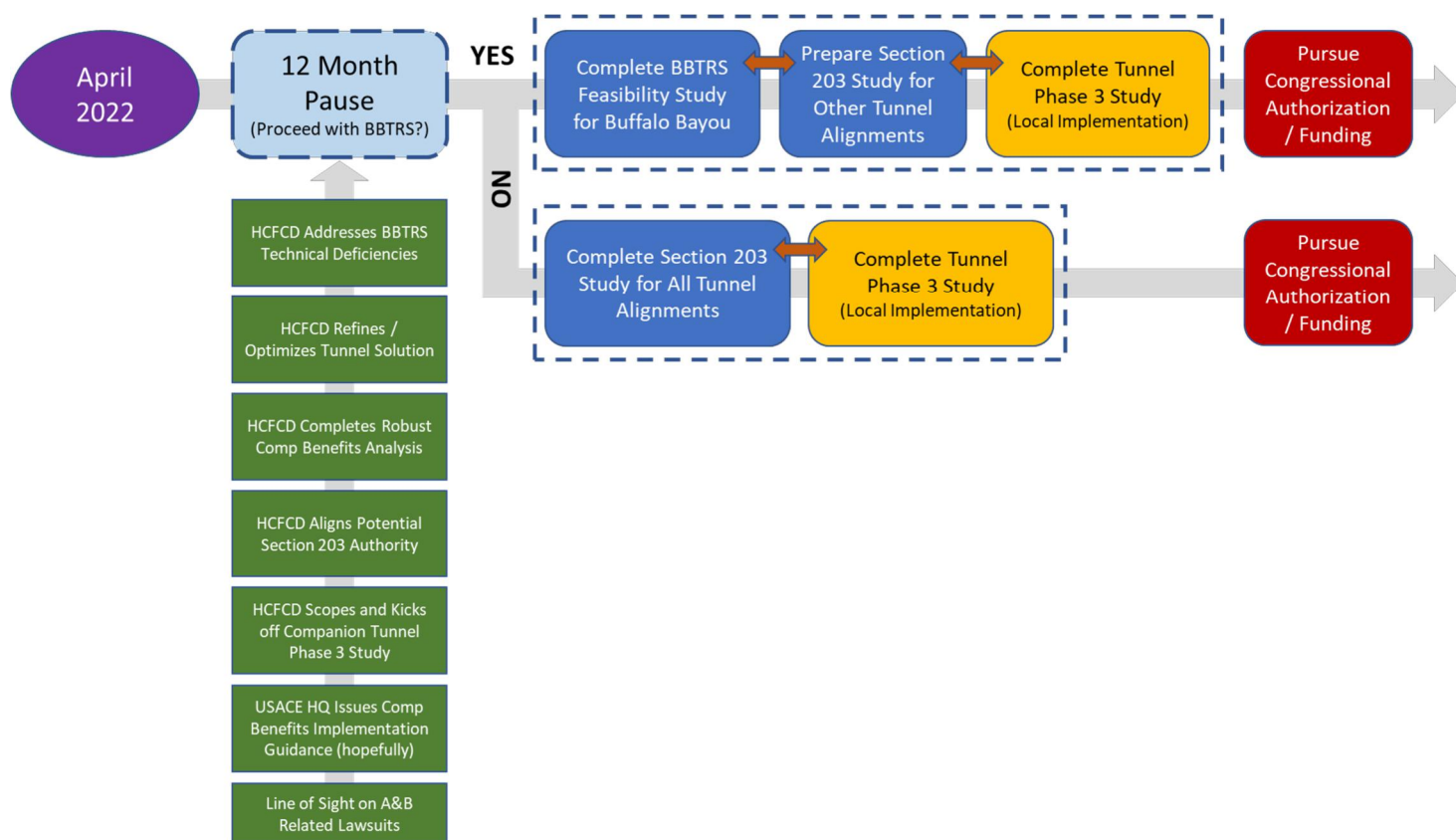
- 1) Allow HCFCD to advance the study and design effort further and prepare a more robust and comprehensive justification for Federal interest in the project, specifically as it relates to the deep stormwater tunnel alternative.
- 2) Allow HCFCD to assess holistically which Federal study authority provides the best opportunity to secure Federal interest and funding, including the possibility of expanding efforts under a different study authority (e.g. Section 203) to formulate a county-wide network of deep stormwater tunnels for Federal consideration.
- 3) Pursue consensus on appropriate policy guidance for considering comprehensive benefits in the development of Federal flood risk management projects, specifically how to equitably consider and balance economic, environmental, and social factors in decision making. This includes determination of how comprehensive benefits should be considered and valued if the traditional benefit-cost-ratio (BCR) remains below 1.0.

By temporarily removing budget, schedule, and policy constraints imposed by the Federal study

process, HCFCD aims to better position the BBTRS effort to achieve a successful outcome in the long-term.

The “path forward” flow chart provided on the following page illustrates the high-level objectives for the HCFCD Evaluation, and the proposed configuration of study efforts envisioned to achieve HCFCD’s goals for BBTRS and companion efforts related to pursuing Federal interest in new flood risk management projects in Harris County. The benefits of this approach include:

- The 12-month HCFCD Evaluation would allow HCFCD sufficient time to refine the Tunnel alternative (and address other deficiencies) and to expand the comprehensive benefits and environmental justice analyses. This would support a stronger argument being made for the NED Exception request, and therefore would provide for the greater likelihood that a NED Exception request would be approved, should it be submitted. The 12-month HCFCD Evaluation may also provide the time necessary for the ASA’s office to issue implementation guidance for comprehensive benefits, reducing risks related to how ASA(CW) may evaluate a NED exception request. Most importantly, this HCFCD Evaluation makes it possible to make these impactful decisions based on strong data.
- The 12-month HCFCD Evaluation would allow HCFCD time to properly assess the feasibility and benefits/risks of converting the effort into a Section 203 study. This leaves multiple pathways forward open, in the near term, and maximizes flexibility to make decisions in the best interest of advancing a solution.
- If the decision is made to continue with the BBTRS effort, a NED Exception request would be submitted, and the PDT would pick up with the standard scope of work for advancing the feasibility study. Likely, a second 3x3x3 Exemption would be necessary to facilitate completing the remaining planning and environmental compliance steps.
- If the decision is made to convert the effort into a Section 203 Study, the BBTRS study could be closed out in an orderly manner, and work completed to date could be re-purposed for the Section 203 effort. This also gives HCFCD 12 months to align the necessary authorization and/or agreements to facilitate the seamless transition to a Section 203 Study, without significant delay.



## PROJECT DESCRIPTION

To meet the public's demand for enhanced flood relief in Harris County, HCFCFCD is implementing studies to identify and evaluate new technologies that can readily be integrated into their existing flood control system as a measure to better protect against the risk of property damage, community disruption, and loss of life. One new technology that has been identified in concept involves implementation of large diameter, deep, gravity conveyance tunnels to collect stormwater from strategic locations (existing damage centers) in Harris County to reduce the risk of flooding and to convey the stormwater to a large receiving water body (e.g., Houston Ship Channel Turning Basin) for ultimate discharge to the Gulf of Mexico.

HCFCFCD requested that the ENGINEER develop a scope of services to complete a more comprehensive study of conveyance downstream of the reservoirs. This scope of services is included herein as AMENDMENT NO. 3.



Services to be provided include project management and meetings, hydrologic and hydraulic modeling, development of a HEC-FDA model, tunnel engineering, environmental evaluations, alternatives evaluation, agency technical review support, project reporting and strategic communication support.

## **MAJOR PROJECT ASSUMPTIONS**

1. The HCFCF Phase 1 Tunnel Study (Harris County Regional Study) established Tunnel Design Criteria for use in future phases. These criteria as defined below were employed during the HCFCF Phase 2 Tunnel Study and are intended to be incorporated into this BBTRS work discussed herein.
  - a. For the planning level H&H analysis completed as part of the HCFCF Phase 2 Tunnel Study, the analysis and evaluation of tunnel alternatives were performed with the objective to eliminate or reduce, to the extent possible, out of bank flooding on major bayous for storm frequencies up to and including the 100-year or 1 percent AEP storm event (NOAA Atlas 14 rainfall). For H&H analysis related to the BBTRS work, it is anticipated that alternatives will be evaluated for eight (8) frequency storm events (2-year through the 500-year Atlas 14 events) as well as up to two (2) historical storm events including Hurricane Harvey.
  - b. The tunnel shall receive flows from Addicks/Barker Reservoirs during extreme events via reservoir intakes.
  - c. Passive, gravity flow conveyance is preferred over pumped conveyance.
  - d. Passive intake structures are preferred over actively managed real time control systems. However, consideration will be given to actively managed real time control of intake systems employing SCADA technology in this study
  - e. Operations and maintenance of the system shall be minimized.
  - f. Public safety during construction and operation is paramount.
  - g. Known obstructions and hazards (faults, water wells, oil wells, etc.) should be avoided when routing tunnels.
  - h. Benefit determination shall not be solely limited to economic flood damage reduction but shall also include number of affected persons/households, critical infrastructure, road miles impacted, and mobility and other non-cost factors.
  - i. Use of public right-of-way shall be maximized for tunnel routing.
  - j. Mitigation for downstream flood damage and environmental impacts shall be considered as part of the project. No adverse impact to downstream areas will be a criterion considered.
  - k. Transferring flow between bayous, streams, and watersheds is not preferred. However, conveyance of stormwater through multiple watersheds via tunnel is considered acceptable.
2. The purpose of this study is to determine the effectiveness of implementing a tunnel solution for flood mitigation within the Buffalo Bayou watershed. Tunnel concepts will also be directed at relieving the Addicks/Barker Reservoirs during extreme storm events. The geotechnical analysis, hydraulic analysis, cost and construction methodology data

employed during the HCFCF Phase 2 Tunnel Study and USACE preliminary BBTRS shall be used as the basis for the analysis discussed herein.

3. All work shall be conducted by the ENGINEER in general accordance with the Programs, Policies, Standards, Protocols, and Procedures listed below:
  - Scheduling Guidance
    - USACE Execution Annual Program Guidance (Engineer Circular No. 11-2-221), December 31, 2019
    - HCFCF Schedule Guide 2019, July 3, 2019
    - HCFCF Scheduling Guide for Project Managers - Draft
    - HCFCF Scheduler Procedures - Draft
    - Initial Project Schedule Scope Definition Template
    - HCFCF Template Schedule, January 27, 2019
    - Schedule Template by Stage, October 21, 2019
  - Hydrologic and Hydraulics (H&H) Guidance
    - USACE Hydrologic Modeling Guidelines for Regulatory Permit Actions January 22, 2018
    - HCFCF Policy Criteria & Procedure Manual
    - Interim Guidelines and Criteria for Atlas 14 Implementation
  - Relevant Environmental Guidance Documents
4. HCFCF will make available relevant background information for the PROJECT, including previous studies directed at tunnel systems, existing and proposed traditional flood control systems, and overall flood mitigation planning; available hydrology and hydraulics modeling results, flood damage center evaluations, relevant as-built drawings of existing flood control systems, available flood and topographic mapping, bid tabulations, and any other relevant GIS information.
5. USACE will make available relevant background information for the PROJECT, including all relevant information related to the BBTRS.
6. Reviews of key work products defined herein will be subject to two levels of review. The first level of review will consist of contemporaneous District Quality Control (DQC) performed by USACE Galveston and independent technical review by HCFCF. The second level of review will consist of Agency Technical Review (ATR) performed by USACE's ATR Team. For DQC reviews, a total review period of five-weeks has been assumed that corresponds to two weeks of review by USACE and HCFCF staff; two weeks by the Black & Veatch Team to review, develop comment responses, and incorporate comments responses into the review documents; and a final week for USACE and HCFCF to back-check comment responses. Similarly, for ATR, a five-week review period has been assumed that corresponds to two weeks of review by USACE staff; two weeks by the Black & Veatch Team to review, develop comment responses, and incorporate comments responses into the review documents; and an additional week for USACE to back-check comment responses. It is assumed that Dr. Checks will be utilized for reviews and comment responses.

7. The ENGINEER will work directly with HCFCD throughout the project and confirm that all major decisions are made collaboratively with HCFCD.
8. Scope of Work has been structured to fit the USACE review process for Agency Technical Review (ATR).
9. Work task timing, durations and deliverables are to be in accordance with the project schedule as presented in Attachment A. Actual project timing will be finalized upon receiving a notice-to-proceed.
10. Consideration for a USACE Dam Safety Oversight Group (DSOG) review has not been included within this scope of work.
11. This work includes development of project cost estimates in accordance with AACEi Class 4 using labor-based cost estimating methodologies.
12. An Abbreviated Risk Analysis (ARA) will be completed to assist in determining an appropriate construction cost contingency.
13. The scope of services and estimated fee do not incorporate any HUD Section 3 requirements.
14. The proposed scope of work to be conducted by HCFCD during the HCFCD evaluation is detailed in the following sections. Importantly, USACE support during the HCFCD evaluation will be paid for by HCFCD through an MOA and similar inter-governmental agreement. It is assumed that the HCFCD evaluation will officially commence when this agreement is signed.

## SCOPE OF SERVICES

### TASK 100 – PROJECT MANAGEMENT, MEETINGS, AND COORDINATION

**Objectives:** ENGINEER will provide overall project management, administration, and meetings throughout the duration of the PROJECT to monitor progress, schedule and facilitate coordination of all work elements and sub-consultants, and conduct meetings with HCFCF and USACE. Assist HCFCF in collaboration efforts with USACE leadership to refine and re- state the objectives for this project and come to a consensus on what the Federal Government and the non-Federal sponsor aim to achieve through this project. In addition, this includes determining the appropriate study area boundaries, and clarifying the appropriate integration of dam safety considerations in this FRM planning effort.

#### **Deliverables**

- Project Schedule and Monthly Progress Updates
- Monthly Invoices
- Meeting Agendas
- Meeting Minutes
- Progress update PPT Presentations, for use in Quarterly IPRs

#### **Scope:**

**Project Management and Administration.** Conduct project management to monitor progress and schedule on the PROJECT at all times and facilitate coordination of all study and design elements and professional services. Prepare monthly progress reports; e-mail progress updates; conduct scope, schedule, and budget tracking; provide staffing management; and maintain communication with HCFCF. Prepare monthly invoices with percent completes by task; conduct project organization and filing of documents on ENGINEER’S ProjectWise site and filing system; and perform project coordination. Conduct meetings for the duration of the project to provide updates on project progress, budget and schedule status, project deliverables, current project issues, trend management, and public involvement activities. Anticipated future activities and HCFCF/USACE needs will be discussed. ENGINEER activities include arranging the meetings, preparing agendas, conducting the meetings, and taking and distributing meeting notes.

**Project Schedule.** Prepare and submit for review and approval a project schedule utilizing Primavera P6 scheduling software to accommodate AMENDMENT NO. 3 tasks. The schedule shall include meetings and workshops. The schedule shall be updated on a monthly basis and submitted to HCFCF and USACE for review and approval on the first Friday of each month.

An engineering budget project control system will be established to monitor costs and budget on a monthly basis based on project production.

**HCFCF Meetings.** Conduct weekly progress meetings with HCFCF for the duration of the project to provide updates on project progress, budget and schedule status, project deliverables, current project issues, trend management, and public involvement activities.

Anticipated future activities and HCFCF needs will be discussed. ENGINEER activities include arranging the meetings, preparing agendas, conducting the meetings, and taking and distributing meeting notes. A total of 54 weekly coordination meetings with HCFCF staff have been assumed for budgeting. Each meeting has been assumed to be an hour in length. Regular attendance at the meetings will include the Project Manager, Deputy Project Manager, and 3 key discipline leads in the areas of tunnel engineering, hydrologic and hydraulic analyses, and comprehensive benefits analyses. Beyond regular weekly progress meetings, an additional four (4) meetings, with HCFCF have been budgeted to address special coordination and technical topics.

**Quality Assurance/Quality Control.** All work products will receive Quality Control (QC) reviews. Work products may involve technical writing, calculations, drawings, design concepts, cost estimating, schedules and evaluations in various formats. Reviews will be completed by internal project team members and independent reviewers.

**USACE Support.** Conduct bi-weekly progress meetings with USACE for the duration of the project to provide updates on project progress, budget and schedule status, project deliverables, current project issues, trend management, and public involvement activities. Conduct quarterly IPR meetings. Engineer activities will include arranging the meetings, preparing agendas, conducting the meetings and taking meeting notes. A total of 26 bi-weekly coordination meetings have been assumed for budgeting with each meeting corresponding to a half-hour in length. Regular attendance at the meetings will include the Project Manager, Deputy Project Manager, and three key discipline leads in the areas of tunnel, hydrologic and hydraulic analyses, and comprehensive benefits analyses. Four quarterly IPR meetings have been budgeted each at two hours in length. Attendance as assumed for the bi-weekly coordination meetings has been assumed for the IPR meetings.

In addition to the bi-weekly coordination meetings and IPRs, technical meetings on development of the work will be conducted with the USACE as follows:

**H&H:** one (1) kickoff workshop (not to exceed 2 hours in length) and eight (8) progress meetings (each not to exceed 1.5 hours in length). The purpose of these meetings is for HCFCF and the Black & Veatch Team to solicit policy and technical guidance regarding H&H modeling methodology and assumptions.

**Economics:** one (1) kickoff workshop (not to exceed 2 hours in length) and twelve (12) progress meetings (each not to exceed 1.5 hours in length). The purpose of these meetings is for HCFCF and the Black & Veatch Team to solicit policy and technical guidance regarding economic modeling and comprehensive benefits methodology and assumptions.



**Planning:** one (1) kickoff workshop (not to exceed two hours in length) and six (6) progress meetings (each not to exceed 1.5 hours in length). The purpose of these meetings is for HCFCFCD and the Black & Veatch Team to solicit policy and technical guidance regarding plan formulation and policy compliance.

**Engineering/Cost Engineering:** one (1) kickoff workshop (not to exceed two hours in length) and four (4) progress meetings (each not to exceed 1.5 hours in length). The purpose of these meetings is for HCFCFCD and the Black & Veatch Team to solicit policy and technical guidance regarding engineering, cost estimating and risk analysis.

Technical meetings on development of the work will be conducted with the USACE as follows:

## **TASK 200 – ENGINEERING APPENDIX**

**Objectives:** Complete refinements and optimization of the Buffalo Bayou Tunnel Concept to maximize hydraulic performance and associated flood reduction benefits. Tasks include tunnel engineering, hydraulics analyses and engineering, dam operation and safety assessments, cost and schedule estimates and associated risk analyses.

### **Deliverables**

- Updated Conceptual Tunnel Plan and Profile Graphics for Baseline Tunnel Alignment
- Updated Geotechnical Plan and Profile/Geologic Hazard Exhibits
- Updated Tunnel Plan and Profile/Hydraulic Structure Drawings for Baseline Tunnel Alignment
- Updated Real Estate Plan Drawings
- Updated Cost Estimates (Construction, Soft Costs, Real Estate and O&M)
- Updated Construction and Program Schedules
- Abbreviated Risk Analysis
- Engineering Narrative for Tunnels and Related Hydraulic Structures
- Cost and Schedule Risk Analyses Narrative
- Engineering Appendix
- Response to DQC/ATR Comments

### **Scope:**

**Site Reconnaissance.** Conduct additional field surface site reconnaissance trips to review the tunnel alignment, inlet/outlet locations, and shaft locations and determine if there are additional considerations or factors not apparent from available records. In addition, observe potential flood damage center locations in coordination with potential tunnel and inlet locations.

**Alignment and Grade Refinements.** Complete refinements and optimization for the existing Buffalo Bayou Baseline Tunnel alignment/grade. This will include considerations for

refinements to hydraulic structure locations and associated sites for construction and long-term operations and maintenance activities.

Update Tunnel Plan and Profile Graphics. Update conceptual level tunnel plan and profile figures and typical tunnel cross sections for the Buffalo Bayou Tunnel alternatives.

Update Conceptual Level Geotechnical Related Graphics. Update conceptual level geotechnical plan and profiles and geologic hazard maps to address tunnel alignment and grade refinements.

Evaluate Refinements to Intake and Outfall Structures. Optimize the hydraulic performance and maximize flood reduction benefits for the Buffalo Bayou Tunnel. Consider changes in intake location and intake configuration to maximize flood risk reduction benefits. Tunnel diameter, length and capacity curves will be updated to consider specific conditions of the tunnel including the effect of the selected diversion structures, drop structures and tunnel outfall. Complete hydraulic analyses to optimize performance of the overall tunnel system. This may involve employment of Computational Fluid Dynamic (CFD) Modeling to facilitate system refinements and overall system optimization. Consider requirements and operation of gates to manage diversion flows at intakes for a range in storm events, including extreme events.

Update conceptual level hydraulic structure plan and section drawings to address revisions to location and flow rates.

Complete Downstream Impact Analysis (Ship Channel Outfall). Determine the impact that discharging diverted water would have on the receiving water body. The evaluation will include (1) determining if discharges would result in increases in the flood elevations due to diversion, (2) potential impact to water quality, and (3) sediment transport and deposition, and hydraulic conditions in the vicinity of the outfall (e.g. high velocities, increased turbulence). Mitigation strategies for these impacts to the receiving water body will be evaluated.

Update Tunnel Plan and Profile Drawings and Shaft/Hydraulic Structure Drawings. Update and refine the conceptual tunnel plan and profile drawings and construction shaft/hydraulic structure drawings (plan and elevation views). In addition, typical tunnel sections will be developed.

Update Real Estate Drawings Illustrating Required Property Easements and Acquisitions. Update tunnel system real estate drawings to accommodate all tunnel system refinements.

Update Existing Class 4 Cost Estimate. Update all cost estimates included in the February 2022 Engineering Evaluation Appendix. Costs include real estate (temporary/permanent easements, acquisitions, etc.), soft costs (owner, program management, design, construction administration), third party stakeholder costs (utility relocations, permits, etc.), construction costs and long-term operations and maintenance costs. The Opinion of Probable Construction Cost (OPCC) will be a Class 4 Estimate in accordance with the Association for the Advancement of Cost Engineering International (AACEi) guidelines. The OPCC will assume that

there are a minimum of three (3) construction contracts. All estimates will be completed within Excel spreadsheets.

*Prepare Total Project and Construction Schedule Estimates.* Update the construction schedule for the Buffalo Bayou Tunnel concept. Schedule will assume that there are a minimum of three (3) construction contracts for the overall project. In addition, update the project master schedule that includes Study Phase, Design Phase, Bidding Phase, Construction Phase and Commissioning/Startup. All schedules will be completed using Primavera P6 software.

*Complete an Abbreviated Risk Analysis (ARA).* The conceptual project risk register submitted in February 2022 will serve as the basis for completing an Abbreviated Risk Analysis (ARA). All ARA work will be completed using the USACE standard Excel spreadsheet. The purpose of the ARA is to assist in evaluating a reasonable construction cost contingency.

*Update Project Construction Cost/Schedule Estimate to Incorporate the ARA results.* Update the construction cost and schedule estimates using the results contained in the ARA spreadsheet. Compare and contrast the ARA spreadsheet results with construction cost contingencies recommended by AACEi. The project construction cost/schedule estimate will be submitted to the USACE Cost Engineering Directory of Expertise (Cost DX) to complete the cost certification process prior to Agency Technical Review (ATR). Revisions will be made throughout the duration of the project.

*LifeSim Modeling.* Update previously prepared USACE LifeSim modeling to reflect conditions currently assumed in the WOP and With Project H&H models. This includes close coordination with USACE on assumptions. This will be performed for all final alternatives. It is assumed this modeling will undergo ATR.

Deliverables for each targeted DQC/ATR associated with the Engineering Appendix are as follows:

**Tunnel Engineering Concepts and Quantities, IPR Quarter # 2** - The deliverables for this ATR will include tunnel concept plan/profile graphics, geotechnical related graphics, pump station concept drawings and tunnel plan and profile drawings. In addition, real estate drawings will be provided that include summaries of property/easement acquisitions by property type, acreage and estimated cost. The entire deliverable package will be presented in a technical narrative for clarity to facilitate USACE and HCFCD review efforts.

**Tunnel Cost Estimating, IPR Quarter # 3** - Deliverables for this ATR will include the Class 4 Cost Estimate, project schedule and Abbreviated Risk Analysis. The cost estimate will be provided in Excel and hard copy format. Project schedules will be in Primavera P6 format. All cost and schedule deliverables will be presented in a narrative that includes summary tables and graphics.

## **TASK 300 – HYDROLOGY & HYDRAULICS APPENDIX**

**Objectives:** Investigate existing flood risk in the Buffalo Bayou, Addicks Reservoir, and Barker Reservoir watersheds (including tributaries of Buffalo Bayou) for design storm events as well as historical events. Development of a Future Without Project (FWOP) scenario will use recently completed MAAPnext models to establish a new baseline to evaluate the flood risk reduction effectiveness of tunnel alternatives. The FWOP scenario will consider different future development conditions and the impacts of climate change (sea level rise and rainfall intensity). Investigate a tunnel concept aimed at mitigating flooding in the Buffalo Bayou (and its tributaries), Addicks Reservoir, and Barker Reservoir watersheds. The primary alternative consists of a refined tunnel alignment based on the Buffalo Bayou Tunnel considered as part of the BBTRS. The H&H analysis involves the hydraulic evaluation and optimization of this refined tunnel concept. Evaluation of both fluvial and pluvial flooding results will be considered to assess the impact of a tunnel on urban flooding. Investigate using a newer version of HEC-RAS to take advantage of new software features and reduced run times. Adjustments will be made as needed to improve model stability and reduce run time. Compare results, including overflows, from the updated baseline models to results from the individual MAAPnext models to ensure consistency between models. Perform internal QA/QC and examine connectivity and model stability. The goal is to create a refined baseline condition to subsequently evaluate the impact of the tunnel by comparing peak flow rate and water surface elevations changes. This task includes preparation of key documentation related to the H&H analysis. This task includes the coordination efforts associated with various “Agency Technical Reviews”, or ATRs, to be performed by the USACE to review work products developed by the HCFCF team. It is expected that District Quality Control (DQC) and HCFCF review of ATR packages would be reviewed contemporaneously, with ATR packages finalized on the basis of response to any comments. Presentations of ATR material would be made at the quarterly ITR meetings, and subsequent ATR performed during the subsequent quarter.

### **Deliverables**

- Report narrative and supporting documentation (exhibits and appendices)
- Digital model geometry and results files including inundation extents and depth grids
- Tabular information and exhibits that summarize the baseline FWOP scenario
- Report narrative and supporting documentation (exhibits and appendices)
- Digital model geometry and results files including inundation extents and depth grids
- Tabular information and exhibits that summarize the flood risk reduction effectiveness of the tunnel alternatives
- Tabular information and exhibits that summarize estimated tunnel benefits and impacts
- DQC/ATR Comment Responses
- H&H Appendix

### **Scope:**

**Data Collection and Review.** Collect and compile current MAAPnext H&H models and available data needed for model development such as terrain data, Atlas 14 rainfall data, and other background GIS data. Adjust and mosaic terrain files from the MAAPnext hydraulic models.

*Develop Baseline Hydraulic Models.* Utilize the MAAPnext models for relevant watersheds to create updated baseline modeling for the study area. Subject watersheds include Addicks Reservoir, Barker Reservoir, Buffalo Bayou, White Oak Bayou, Brays Bayou, and San Jacinto River. Updates to the hydraulic model geometry could include adding new cross-sections, adjusting Manning's n values, incorporating newer terrain information, and connecting 2D flow areas. Integrate the MAAPnext hydrologic and hydraulic models with the current USACE HEC-ResSim model for the Addicks and Barker Reservoirs. Review model results to assess if the modified HEC-ResSim model accurately represents reservoir operations and appropriately links the HEC-ResSim model with the newer MAAPnext models.

*Evaluate, Review, and Troubleshoot Baseline Hydraulic Models.* Run the comprehensive model for eight (8) Atlas 14, 24-hour storm events (50%, 20%, 10%, 4%, 2%, 1%, 0.5%, 0.2% AEP). In addition, run the comprehensive model for the 1% AEP storm event based on a 48-hour duration to understand impact to the baseline condition of a longer duration storm event. Perform any adjustments to hydraulic models needed to allow for successful and stable simulation of all Atlas 14 rainfall events. Develop inundation mapping and depth grids for the modeled rainfall events. A progress meeting will be facilitated with B&V and HCFCD to present model results.

*Perform Model Validation.* Perform a model validation by running two historical events (Tax Day 2016 and Hurricane Harvey 2017) using the combined hydraulic model. Compare results from the combined model with those from the individual MAAPnext model calibration efforts. Perform internal QA/QC on comprehensive model development efforts. A progress meeting will be facilitated with B&V and HCFCD to present model results.

*Develop FWOP Models.* Develop an approach to create a future scenario model. Evaluate different potential factors to consider, such as assumptions for future development, changes to hydrologic parameters, climate change (sea level rise and rainfall intensity), and dam operations (related to operational risk). Modify the MAAPnext hydrologic models to account for future conditions considerations to create FWOP models from the baseline hydraulic models.

*Evaluate, Review, and Troubleshoot FWOP Hydraulic Models.* Using the model geometry from Task 205A, simulate eight (8) Atlas 14 storm events (50%, 20%, 10%, 4%, 2%, 1%, 0.5%, 0.2% AEP). These simulations may be a combination of storm durations, such as using a 24-hour duration for more frequent events (i.e. 20% and 10% AEP events) and adding a 48-hour duration for less frequent events (i.e. 1% and 0.2% AEP events). Perform any adjustments needed to allow successful and stable simulation of all Atlas 14 rainfall events. Provide WSEL profiles and WSEL/depth grids for up to eight (8) Atlas 14 rainfall events to be used as inputs for a newly developed HEC-FDA model. A progress meeting will be facilitated with B&V and HCFCD to present the FWOP modeling approach, FWOP model results, and comparisons with existing baseline model results.

*Develop Proposed Tunnel Modeling.* Incorporate the refined baseline tunnel alternative into the FWOP hydraulic model to determine proposed water surface elevations and inundation extents.



Based on provided hydraulic performance data on the tunnel intake structures, add diversions in the hydraulic model that reflect the diversion of water from the bayou or reservoirs into the tunnel system. Run the proposed tunnel model for the same frequency events and historical storms as specified in Tasks 203A and 204A. Perform internal QA/QC on tunnel modeling.

*Evaluate, Review, and Troubleshoot Tunnel Hydraulic Models.* Using the model geometry from Task 201B, simulate eight (8) Atlas 14 storm events (50%, 20%, 10%, 4%, 2%, 1%, 0.5%, 0.2% AEP). These simulations may be a combination of storm durations, such as using a 24-hour duration for more frequent events (i.e. 20% and 10% AEP events) and adding a 48-hour duration for less frequent events (i.e. 1% and 0.2% AEP events). Perform any adjustments needed to allow successful and stable simulation of all Atlas 14 rainfall events. Provide WSEL profiles and WSEL/depth grids for up to eight (8) Atlas 14 rainfall events to be used as inputs for a newly developed HEC-FDA model. A progress meeting will be facilitated with B&V and HCFCD to present the modeling approach, model results, and comparisons with FWOP model results.

*Tunnel Benefits/Impacts Estimation.* Calculate benefits of the modeled tunnel alternatives. Perform a high-level planning evaluation of potential impacts and benefits related to water surface elevation change. Possible benefit metrics could include instances of flooding, number of flooded structures, areas of inundated area, and miles of inundated roadway. Results from the benefits estimation will help inform the selection of a recommended tunnel alternative. Coordination and status updates will be conducted with B&V and HCFCD to present results and selection of preferred alternative for further refinement.

*Optimize Preferred Alternatives.* Optimize one (1) tunnel alternative. Optimization will focus on gate location, size, and operation in addition to tunnel size and interconnection with adjacent or complimentary systems. Evaluate mitigation needs for the recommended alternative, including peak flow rate or water surface elevation increases. Water surface elevation reduction, damage reduction, impact to vulnerable populations, and costs will be considerations during alternative optimization.

*Prepare Submittal Package.* Develop inundation mapping and depth grids for the modeled storm events for the Without Project (existing), Future Without Project (baseline), and Future With Project (tunnels) scenarios. Compare the updated model results to the baseline model inundation to assess flood risk reduction effectiveness and identify potential adverse impacts. Perform internal QA/QC of the H&H models and examine model validity. Prepare HEC-RAS WSEL profile and depth grid results to be used in the HEC-FDA modeling and comprehensive benefits analysis. Prepare a H&H Analysis Technical Memorandum that documents the assumptions, methodology, and findings from the H&H analysis. Prepare tabular summaries and exhibits that illustrate model results such as change in inundation area, WSEL reductions, and benefits/impacts. Address internal and external review comments on the H&H modeling and draft Technical Memorandum. Prepare a final H&H deliverable package for submittal to HCFCD and USACE that includes the digital model files, GIS data, supporting calculation spreadsheets, and technical documentation.

Agency Technical Review. Participate in the ATR process, which includes preparation and submittal of necessary deliverables for agency review, attendance at ATR meetings to present on the H&H analysis, and USACE coordination as required to facilitate the review and address comments.

H&H Appendix. Prepare a technical memorandum that documents the assumptions, methodologies, and conclusions of the H&H analysis that includes narrative and supporting documentation such as exhibits and appendices. The final technical memorandum will be submitted to HCFCF and USACE for review and approval.

Deliverables for each targeted DQC/ATR associated with the H&H Appendix are as follows:

**Hydrologic & Hydraulic Modeling, IPR Quarter # 2** - The two primary deliverables from Halff related to the H&H analysis include the following: 1) digital H&H model and results files and 2) a technical documentation of the H&H analysis. For the Without Project (existing), Future Without Project (baseline), and Future With Project (tunnels) scenarios, Halff will provide the final digital model files that include the model geometry and results such as inundation extents and depth grids. In addition, tabular summaries and exhibits that illustrate the model results (changes to peak flow rate and water surface elevation) and estimated benefits/impacts of the proposed tunnel will be provided. Technical documentation will be prepared that summarizes the assumptions, methodologies, and results of the H&H analysis. A final H&H deliverable package will be prepared and submitted to the HCFCF and USACE that includes the digital model files, GIS data, supporting calculation spreadsheets, and technical documentation.

## **TASK 400 – ECONOMICS APPENDIX**

**Objectives:** This task includes creation of a HEC-FDA models based on the best available structure inventory for the subject watersheds. HEC-FDA version 1.2 (or later) will be utilized. Later versions of HEC-FDA may be considered if it leads to improved model efficiencies (i.e. model setup, computation, and runtime). Computational resources will predominately rely on the use of local desktop computers, but alternatives may be explored that consider scalable computational efficiencies. Subject watersheds are as follows:

- Addicks Reservoir (Unit ID: U100-00-00)
- Barker Reservoir (Unit ID: T100-00-00)
- Buffalo Bayou (Unit ID: W100-00-00)
- White Oak Bayou (Unit ID: E100-00-00)
- Brays Bayou (Unit ID: D100-00-00) – Limited to DS of SH 288
- San Jacinto Watershed (Unit ID: G100-00-00) – Limited to the HSC

This analysis includes multiple annualized analyses (e.g. one for a 24-hour design storm, another for a 48-hour design storm), considering Low, Medium, and High projections for climate change. This will also include single event damage estimates for notable historic events (e.g. Harvey). Economics will be run for both the WOP/FWOP and With Project scenarios. Economics will include

structure, contents, vehicle, road, utility, and disaster recovery costs.

### **Deliverables**

- HEC-FDA Model Technical Narrative
- Submit HEC-FDA Models for ATR
- Prepare HEC-FDA Models
- Economics Appendix
- Response to DQC/ATR Comments

### **Scope:**

**Development of Standardized Methodology.** Exploration of best practices for integrated 2D depth-grid output into HEC-FDA analysis. This practice will be coordinated with USACE. Development of a standardized methodology for calculating and incorporating vehicle damage, road damage, utility damage, and disaster recovery costs. (Floodplain boundary delineations are necessary for road damage estimation).

**HEC-FDA Data Pre-Processing and Model Configuration.** Preparation of a GIS structure inventory database for target watersheds. It is assumed updated structure inventory data will be shared from HCFCF. If not, added effort will include use of HCFCF Cyclopedia data and HCAD data. Development of automated tools to import HEC-RAS 2D modeling results into a format suitable for input into HEC-FDA. These tools are intended to facilitate rapid bulk conversions of H&H model outputs, facilitating the efficient running of various project scenarios (variations of WOP and With Project). Development of appropriate HEC-FDA parameters, including depth damage curves, uncertainty parameters, etc. Development of automated post-processing tools to export HEC-FDA results into a useable format, geared towards efficiently informing decision making.

**HEC-FDA Analysis (for each watershed).** Prepare and run WOP/FWOP HEC-FDA models, near term and most likely future (with Uncertainty) and generate model outputs. Prepare and run “With Project” HEC-FDA models, near term and most likely future (with Uncertainty) and generate model outputs. Provide structure flooding outputs to help the team to locate benefits and analyze how the project is impacting various communities differently (and in which storm events). Prepare brief technical narratives summarizing model assumptions and results. Submit HEC-FDA models for Agency Technical Review, and response to comments from USACE reviewers. Submit HEC-FDA models for Agency Technical Review, and respond to comments from USACE reviewers.

**RECONS Modeling.** Update previously prepared RECONS modeling to quantify the impact of construction expenditure on employment, income, and economic output.

**REMI Modeling.** Prepare a novel analysis using REMI models to assess the benefit of reduced frequency, duration, and scale of flooding on regional economic output, including regional,

state-wide, and national transfers.

**Rehabilitation Modeling.** Study-Wide System Dynamics Model Setup: Define the critical internally restored infrastructure systems (CIIS) to include in the System Dynamics model for each watershed and establish the pertinent data relationships for use of flood depth outputs from H&H models. Which shall include the following:

- Develop narratives of the typical flood impacts to each CIIS within each study watershed.
- Use narratives to define data relationships to flood depth for each CIIS
- Set up the System Dynamics Model input arrays for each watershed and CIIS
- Document results of System Dynamics Model setup and final watershed specific CIIS data relationships.

Watershed Specific Habitation Infrastructures Data Review, Modeling, and Analysis: Perform System Dynamics modeling for the 100-year and 500-year FWOP H&H flood depth outputs, review H&H flood depth outputs for different alternatives across the 100-year and 500-year event to determine if habitation improvements exist, and perform System Dynamics modeling for the appropriate FWP H&H flood depth outputs per target watershed. Aggregate outputs to develop a study- wide set of habitation results per technical alternative for each reviewed event. Which shall include the following:

- Use data relationships developed in System Dynamics Model to convert flood depth outputs from FWOP H&H models into System Dynamics Model input data and run System Dynamics Model to develop habitation recovery BOTG for each event.
- Analyze H&H flood depth output changes between FWOP and FWP by watershed to determine what events/ concepts demonstrate potential habitation benefits.
- Use data relationships developed in System Dynamics Model to convert flood depth outputs from FWP H&H models into System Dynamics Model input data and run System Dynamics Model to develop habitation recovery BOTG for each event and project concept.

**Assumptions:**

- 4 watersheds are incorporated in this task: Addicks, Barker, Buffalo, and White Oak.
- Model setup work will commence upon authorization from Harris County due to the need for this work to be complete at the time the H&H models are available.
- It is assumed the H&H outputs will be available across all watersheds prior to commencing this the pertinent elements of this task (i.e., FWOP modeling and FWP modeling).
- FWOP System Dynamics modeling in this task is based on H&H modeling for the 100-year and 500-year recurrence interval events.
- FWP System Dynamics modeling in this task is based on H&H modeling for the 100-year and 500-year recurrence interval events.
- Data on water treatment and distribution, wastewater collection, wastewater

treatment, and electrical power distribution will be based on data relationships derived in System Dynamics modeling. If information is not available in the system dynamics model, impacted infrastructures will not be incorporated into the watershed specific habitation infrastructure model.

- HEC-FDA subtasks have a level-of-effort commensurate with watersheds size and associated stream miles.
- Pre- and post-processing analysis may be done external to HEC-FDA to facilitate analysis.
- Risk and uncertainty analyses may be conducted external to HEC-FDA
- Use of best available data in “as is” conditions
  - Structure Inventory (e.g. structure records, structure locations, finished floor elevations, appraisal values)
  - Depth-Damage curves

Deliverables for each targeted DQC/ATR associated with the Economics Appendix are as follows:

**HEC-FDA Modeling, IPR Quarter # 3** - Deliverables for this ATR will include a white paper summarizing the technical approach, methodologies, and inputs utilized for the HEC-FDA analysis, in addition to the structure inventory, the HEC-FDA models themselves, and summary outputs from the modeling effort.

**Other Comprehensive Benefits (Recons, REMI, Life-Sim), IPR Quarter # 3** - Deliverables for this ATR will include a white paper for each benefit category / model proposed, summarizing the technical approach, methodologies, and inputs utilized for the analysis, in addition to the appropriate model files and other associated input files, and summary outputs from the modeling effort. This are being separated out, as it is anticipated the models may be directed to different review teams, based on the subject matter.

## **TASK 500 – ENVIRONMENTAL APPENDIX**

**Objectives:** This task includes advancing environmental evaluations for the Tunnel Alternatives, helping to refine tunnel concepts to avoid or minimize adverse impacts, and providing anticipated inputs to the comprehensive benefits analysis and a future EIS.

### **Deliverables**

- Updated Environmental Permitting and Impact Summaries
- Environmental Justice Technical Narrative
- Environmental Constraints Analysis
- Environmental Clearance and Permitting Plan



- Response to DQC/ATR Comments

**Scope:**

Environmental Justice Review. In compliance with the March 15, 2022 Implementation Guidance from ASA(CW) titled “Implementation of Environmental Justice and the Justice40 Initiative), in addition to Executive Order 12898 and the National Environmental Protection Act (NEPA), the Hollaway team will conduct an environmental justice review of the proposed project. The purpose of this review would be to evaluate the proposed project for disproportionately high and adverse human health or environmental impacts on low-income populations, minority populations, or Indian tribes. Engineer will use publicly available resources including the Environmental Protection Agency’s (EPA) Environmental Justice Screening and Mapping Tool, the CEQ’s Climate and Economic Justice Screening Tool, United States Census Bureau data, and American Community Survey (ACS) data in this evaluation. In addition, Hollaway will utilize this data to prepare recommendations that promote the development of tailored beneficial solutions to environmental justice communities. A summary of the results and recommendations for any further required environmental justice related tasks will be incorporated into a memorandum and submitted to HCFCD for review and consideration.

Environmental Constraints Analysis. Engineer will build upon the previously prepared BBTRS desktop environmental constraints analysis and incorporate additional intake and outfall locations as determined by HCFCD. Data collected during field visits will also be incorporated into this mapping. The report will include maps showing the locations of features of interest, a photolog of existing conditions collected, and recommendations for further studies.

Environmental Windshield Surveys. Qualified biologists will conduct windshield surveys to rapidly assess and loosely verify existing environmental conditions within the proposed intake and outfall locations that are not anticipated to move or change within the Project Area. The purpose of the field visits shall be to supplement, and to the extent feasible, confirm the findings of the desktop review, and to determine the potential need for more detailed studies. Items of interest to be visually assessed include the potential for waters of the United States (WOTUS), threatened and endangered (T&E) species, and potential contamination from petroleum products and/or hazardous materials. Based on the desktop analysis, as supplemented by the windshield surveys, preliminary mitigation needs for any identified impacts will be quantified, and recommendations provided for the most cost-effective means of providing the required mitigation (e.g. credits vs restoration).

Cultural Resources Report Update. Engineer will update the previously submitted Cultural Resources Review narrative, as needed, based on proposed project design changes and alternatives provided. No field work is anticipated or assumed.

Water Quality Engineer will coordinate with HCFCD and the USACE to determine the scope of work which would be necessary in the future to conduct a comprehensive evaluation of water

quality and sediment transport impacts of the proposed action. This would likely include three-dimensional modeling at the outfall location, and would likely consider impacts to sediment transport, erosion, salinity, and fish and wildlife habitat. It is not anticipated that this work would be conducted during this phase of the project. However, it is anticipated to be important to future phases of work.

*Anticipated Environmental Permits, Approvals, and Clearances.* Based on the results of the field visits and constraints analysis, the Hollaway team will update the previously prepared Environmental Clearance and Permitting Plan, as needed, describing the anticipated environmental permits, approvals, and clearances required. If necessary, and with Client approval, Engineer will contact regulatory agencies to confirm the permitting requirements for the proposed project.

#### **Assumptions:**

- Field investigations will be limited to “windshield” surveys, involving visits to and visual observation of proposed project sites. Right of Entry is assumed not to be necessary. Engineer will not access private properties or coordinate with private land owners.
- This scope does not include environmental permitting, formal agency consultations, or preparation of NEPA documentation.

## **TASK 600 – COMPREHENSIVE BENEFITS APPENDIX**

**Objectives:** This task includes performing an expanded comprehensive benefits analysis for the refined/optimized tunnel alternatives. This included NED economic analyses (net excess benefits/BCR), RED economic analyses, EQ analyses, and OSE analyses.

#### **Deliverables**

- Comprehensive Benefits Framework submittal for ATR
- Other Benefits Modeling submittal for ATR
- Comprehensive Benefits Analysis submittal for ATR
- NED Exception Justification Technical Memorandum
- NED Exception Powerpoint Presentation
- Technical paper section documenting CIIS narratives for each assigned watershed
- Technical paper section documenting CIIS data relationships for each watershed
- Interim modeling results (BOTG) for watersheds to support planning team efforts
- Draft Residential Resiliency Benefits Model Report
- Final Residential Resiliency Benefits Model Report
- Comprehensive Benefits Appendix
- Response to DQC/ATR Comments
- “Post HCFCD Evaluation” Scope of Work and Schedule

## **Scope:**

**Framework Development.** Continued development and refinement of a comprehensive benefits decision-making framework. This includes coordination with SWG, SWD, and HQ level staff to solicit policy guidance, and to align efforts with in-development “Implementation Guidance for Comprehensive Benefits” being prepared concurrently by the ASA(CW)’s office. Continue to flush out a resiliency framework which helps the project team to understand how the project may contribute to a more resilient infrastructure network and a more resilient community. This effort focuses on the redundancy, robustness, and adaptability of each alternative. Importantly, this focuses on the ability to the system to perform well under different circumstances, not just the design event.

**NED Account.** Incorporate all findings and outputs from HEC-FDA Modeling. Calculate average annual costs and benefits and determine net excess benefits. Generate benefit-to-cost ratios for each tunnel alternative. The team will continue to evaluate other methods to assess and quantify changes in national economic output.

**RED Account.** Update previously prepared RECONS modeling to quantify the impact of construction expenditure on employment, income, and economic output. This will be performed for all final tunnel alternatives. It is assumed this modeling will undergo ATR and that USACE will provide access to the RECONS model. Prepare a novel analysis using REMI models to assess the benefit of reduced frequency, duration, and scale of flooding on regional economic output, including regional, state-wide, and national transfers. If possible, outputs from the Re-Habitation modeling performed for the OSE account will also be incorporated into this analysis. This will be performed for the WOP condition and all final tunnel alternatives. It is assumed this modeling will undergo ATR, and perhaps full model certification/approval. The team will continue to evaluate other methods to assess and quantify changes to regional economic output.

**EQ Account.** Assess the environmental impact of the project across a broad array of factors, including habitat change / creation, T&E species risk / impacts, cultural resources, air quality, water quality, noise, HTRW impacts, etc. This task pulls heavily on the work conducted for Task 5, Environmental.

**OSE Account.** Conduct comprehensive demographic analysis of the study area, with an emphasis on social vulnerability, environmental justice, limited English proficiency, and other indicators to identify vulnerable populations. Perform risk analyses, integrating flooding data with demographic data to isolate how flooding currently impacts vulnerable populations and to assess how the proposed improvements would benefit these communities, by detailing the degree of residual risk which may persist with each alternative. Assess the social impact of the project across a broad array of factors, including community identify, community cohesion, connectivity, quality of life, critical facilities, displacements, recreational/environmental amenities, etc. Compile comprehensive environmental justice evaluation to assess specific benefits provided to EJ community. Coordinate with FNI/A&M to incorporate the results of re-

habitation modeling being performed separately into the OSE account and the REMI analysis. This includes introduction of this novel approach to USACE decision makers but does not assume that an ATR will be performed yet.

**Recommendations.** Prepare a consolidated justification for the project employing the comprehensive benefits framework, employing an appropriate multi-criteria decision framework. This is anticipated to take the form of a white paper, or a brief report. This consolidated analysis will undergo ATR and will ultimately form the basis for an NED Exception. Coordinate this justification closely with USACE to ensure it is policy compliant.

Deliverables for each targeted DQC/ATR associated with the Comprehensive Benefits Appendix are as follows:

**Comprehensive Benefits Framework, IPR Quarter # 2** - The deliverables for this ATR will include a white paper summarizing the proposed metrics to be considered, the proposed methodologies to be employed, and the multi-criteria decision analysis approach anticipated to be used to synthesize and balance different metrics, across accounts. This white paper will focus on how the proposed approach complies with the requirements stipulated in the Jan 21 Comprehensive Benefits directive from ASA(CW).

**Comprehensive Benefits Analyses, IPR Quarter # 4** - Deliverables for this ATR will include a complete Comprehensive Benefits Analysis report, presenting the full technical approach, methodologies employed, and inputs utilized for each benefit category within the Comprehensive Benefits Analysis as well as a full description of the process and procedure utilized to weigh and consider different metrics in a multi-criteria decision analysis framework. The white paper will clearly present the outputs from all analyses and will summarize all conclusions and recommendations. Model files and ATR summary reports will also be included. It is anticipated that this report will form the basis for a Comprehensive Benefits Appendix, to be included in the Feasibility Report, once the analysis has been conducted for the full array of final alternatives to be considered.

## **TASK 700 – COMMUNICATIONS**

**Objectives:** This task includes provision of strategic communications services to support the “HCFCF Evaluation” of BBTRS. These services will be provided on an as-needed basis as requested by HCFCF.

### **Scope:**

**General Communication Support.** Preparation of a communication plan/strategy document, key messaging, press releases, website content updates, informational graphics, media kits, PowerPoint presentations, and other outreach materials. This is anticipated to focus on efforts at the beginning of the HCFCF evaluation (as we try and explain this new course of action to officials, stakeholders, and the public) and at the end of the HCFCF evaluation (as we explain

the decisions which will be made and the path forward). This includes close coordination with both HCFCFCD communications staff as well as the USACE Public Affairs Office.

*Crisis Communications.* Provision of crisis communications services, in addition to more general media relations / public relations services. This is assumed to be on-call support to address issues as they arise.

*Outreach and Engagement.* Provision of outreach and engagement services for elected officials, key stakeholders, and the general public. This is expected to include support for up to 10 briefings of select key stakeholder groups (e.g. Houston Stronger, Energy Corridor District, etc.), up to 10 elected official briefings, and two virtual public meetings.

*Environmental Justice Focused Engagement.* Focused outreach to federally designated disadvantaged communities within the Buffalo Bayou watershed, in line with the direction provided in the “Implementation of Environmental Justice and the Justice40 Initiative” memorandum from ASA(CW). This is expected to include focused outreach to community groups in three areas; Spring Branch, Downtown/EaDo/Third Ward, and the neighborhood north of downtown (between I-45, I-610, and US-59). This outreach is anticipated to support the environmental justice evaluations being conducted concurrently as part of the environmental scope of work.

ORDER OF COMMISSIONERS COURT  
Authorizing Amendment

The Commissioners Court of Harris County, Texas, convened at a meeting of the Court at the Harris County Administration Building in the City of Houston, Texas, on \_\_\_\_\_, with all members present except \_\_\_\_\_.

A quorum was present. Among other business, the following was transacted:

**ORDER AUTHORIZING EXECUTION OF AN AMENDMENT TO THE AGREEMENT  
FOR PROFESSIONAL ENGINEERING SERVICES  
BETWEEN THE HARRIS COUNTY FLOOD CONTROL DISTRICT  
AND BLACK & VEATCH CORPORATION**

Commissioner \_\_\_\_\_ introduced an order and made a motion that the same be adopted. Commissioner \_\_\_\_\_ seconded the motion for adoption of the order. The motion, carrying with it the adoption of the order, prevailed by the following vote:

Vote of the Court	<u>Yes</u>	<u>No</u>	<u>Abstain</u>
Judge Hidalgo	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comm. Ellis	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comm. Garcia	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comm. Ramsey, P.E.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Comm. Briones	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

The County Judge thereupon announced that the motion had duly and lawfully carried and that the order had been duly and lawfully adopted. The order thus adopted follows:

**IT IS ORDERED** that the Third Amendment is granted and the County Judge of Harris County or her designee is authorized to execute the Third Amendment to the Agreement for Professional Services with Black & Veatch Corporation for Professional Engineering and Related Consulting Services to provide a study of the feasibility of constructing storm water conveyance tunnels (Phase 2). The Third Amendment is attached hereto and made a part hereof for all purposes.

All Harris County Flood Control District officials and employees are authorized to do any and all things necessary or convenient to accomplish the purposes of this order.