This is Task Order No. 9, Amendment 6, consisting of 16 pages.

Task Order No. 9, Amendment ~~6~~7

In accordance with Paragraph 1.01 of the Agreement between Fargo-Moorhead Flood Diversion Authority ("Owner") and Houston-Moore Group, LLC (HMG) ("Engineer") for Professional Services – Task Order Edition, dated March 8, 2012 ("Agreement"), Owner and Engineer agree as follows:

The parties agree that in the event of a conflict between Task Order No. 9 and this Amendment, the terms and conditions in this Amendment shall prevail, provided however, nothing herein shall preclude ENGINEER from invoicing for work authorized under prior versions of this Task Order and performed prior to effective date of this Amendment, even to the extent such prior work was revised by this Amendment. All other terms and conditions shall remain the same and are hereby ratified and affirmed by the parties.

1. Specific Project Data
   - A. Title: HYDROLOGY AND HYDRAULIC MODELING
   - B. Description: Provide hydrology and hydrologic modeling services in order to advance design components of the Diversion Channel. Specific modeling subtasks include: modeling of Diversion inlets to determine design flows, modeling to evaluate hydraulic impacts of various Diversion Channel sizes, extending model geometry of the Rush and Lower Rush Rivers, providing technical assistance and support for the physical modeling of the Maple and Sheyenne River aqueduct structures, and on-call services as requested.
2. Services of Engineer
   - A. HMS DIVERSION INLET MODELING:

     The objective of this subtask is to develop an HMS model for each Diversion inlet subbasin using synthetic rainfall events, and to obtain parameters for an estimate of discharge-frequency using a methodology coordinated with the U.S. Army Corps of Engineers..

     - I. Discharge frequency curve at Amenia.
     - II. Adopted discharge frequencies at the inlet location after the initial HMS simulations.

     Scope:

     - I. Model Diversion inlet inflows for 1.3-, 1.5-, and 2-yr rain events. Inlets to be modeled are:
       1. Diversion Inlet
       2. Local Drain 1
       3. Drain 50
       4. Drain 21C
       5. Local Drain 2
       6. Local Drain 3
       7. Local Drain 4
       8. Drain 14 (new location)
       9. Original Drain 14
       10. Local Drain 5
       11. Maple River
       12. Lower Rush River
       13. Local Drain 6
       14. Rush River

15. Drain 30
16. Drain 29
17. Drain 13

II. Calibrate model to match each subbasin's adopted discharge-frequency to obtain HMS hydrographs for each inlet to the Diversion.

III. Obtain the following parameters: Clark's Tc, R, R/(Tc+R), CN, slopes, and drainage area. Parameters to be used to estimate Diversion inlet discharge-frequency using the NRCS method for small subbasins, as per the ND Hydrology Guide.

Deliverables:

I. HMS hydrographs at each inlet to the Diversion in a separate DSSVue file.

II. List of parameters used or determined such as: precipitation, Clark's Tc, R, R/(Tc+R), CN, slopes, and drainage area.

III. Schematic showing drainage area for each inlet, with the Diversion alignment.

IV. Brief report describing method, assumptions, parameters used, maps, and results.

B. UPDATES TO THE RUSH/LOWER RUSH:

The objective of this subtask is to produce working HEC-RAS models using updated HEC-HMS hydrology for local peak flows in the Rush and Lower Rush areas for use in project design.

Scope:

I. Red River Peak Flood - Modified Rush River hydrographs from the existing conditions model will be input into the Phase 6 LPP model, which initially will be conducted for the 100-year flood event.

II. Rush River and Red River Peak Flood - The updated hydrographs from the HEC-HMS models developed for existing conditions will be run for the Red River Peak 10 and 100-year flood events in the Phase 6 LPP model.

III. RAS Mapper will be used to map the floodplain outside of the diversion channel for the peak tributary event on the Rush and Lower Rush Rivers.

Deliverables: Updated existing conditions and with-project HEC-RAS unsteady models.

C. EVALUATION OF CHANNEL SIZE:

The objective of this subtask is to evaluate various Diversion Channel width sizes to determine hydraulic impacts based on channel size.

Scope:

I. Evaluate alternatives using the criteria below to assess the size of the Diversion Channel and conduct a Screening Analysis using the HEC-RAS steady state software with the objective of determining the most favorable alternatives:

1. Bottom width of the main Diversion Channel.
2. Channel bottom elevation of the Diversion Channel.
3. Considerations of the water surface profile in the Diversion Channel with respect to existing ground elevations.
4. Modification of the Hydraulic Structure at the Maple River.
5. Other criteria can be applied at a later time if it is determined that optimizing the Diversion Channel is justified with this initial evaluation.

6. The 100 and 500-year events for the Red River peak flood event will be analyzed.
7. Peak discharge values from the current Phase 6 unsteady model will be used, which is also being applied to the bridge analysis (MFR-001) currently being updated by the USACE.

II. Conduct an Impact Analysis using the HEC-RAS unsteady state software for the most favorable alternatives identified in Task 1.

1. The 100 and 500-year events for the Red River peak flood event will be analyzed using the latest Phase 6 unsteady flow model.
2. River impacts will focus only on the Red River upstream, downstream, and throughout Fargo-Moorhead. Impacts will be compared to those determined in Phase 4 and Phase 5, which may require that the gate operations may be modified to obtain similar impacts.
3. Additional impacts can be further evaluated at a later time if it is determined that optimizing the Diversion Channel is justified with this initial evaluation.

III. Develop a preliminary cost estimate for the most favorable alternative identified for optimizing the Diversion Channel.

2. Quantify the cost savings based on unit-cost savings using the Feasibility Study unit prices, focusing primarily on costs associated with earth work and at the Maple River Hydraulic Structure.
3. Additional cost detail can be further evaluated at a later time if it is determined that optimizing the Diversion Channel is justified with this initial evaluation.

IV. Prepare a Technical Memorandum (TM) summarizing whether the size of the Diversion Channel warrants additional and more detailed study.

Deliverables:

I. Draft report.

II. Final report.

D. EXTEND RAS GEOMETRY OF THE RUSH/LOWER RUSH

The objective of this subtask is to account for break-out flows between the Rush and Lower Rush Rivers by extending the RAS model geometry of the Rush and Lower Rush Rivers upstream to the beach ridge of Glacial Lake Agassiz.

Scope:

I. Extend existing conditions Rush River HEC-RAS model approximately 10 miles upstream from Amenia and add model detail between the Rush and Lower Rush Rivers to incorporate breakout discharges.

Deliverables:

I. Updated existing conditions and with-project HEC-RAS unsteady models.

E. PHYSICAL MODELING ASSISTANCE:

Provide ongoing assistance to the Diversion Authority during the transition for Feasibility Study to Preliminary Engineering and Design (PED) in support of the Maple and Sheyenne River aqueduct structures.

Scope:

I. Participate in USACE design team meetings, Local Sponsor/Local Consultants Technical Team (LSLCTT) meetings, and workshops as requested.

II. Provide technical assistance for physical modeling of hydraulic structures.

III. Provide hydrology information, as requested, to USACE.

IV. Provide additional assistance as requested.

Deliverables: Meeting minutes.

F. ON-CALL SERVICES**:**

Respond to requests for services from PMC for tasks not identified to date. Requests will be provided by PMC in writing. Work will not be performed by Engineer without authorization by PMC or Owner.

Deliverables: On-call service deliverables as requested.

I. EXTREME RAINFALL EVENTS – Complete the work originally authorized in AWD-00016 and deliver the final report. The scope of work specified in AWD-00016 was:

1. Develop a Technical Memorandum (TM) that determines whether or not a meander belt width of 200 feet is sufficient to allow establish a low-flow channel that is in dynamic equilibrium, and if so, provide sufficient information and criteria for others to design the four (4) low-flow channel reaches:

   a. Diversion Outlet to Lower Rush

   b. Lower Rush to Drain 14

   c. Drain 14 to Drain 21C

   d. Drain 21C to Diversion Inlet

   The focus of this meander belt width analysis is on the reach Diversion Outlet to Lower Rush. Meander belt width for other reaches will be confirmed in subsequent analyses.

   The Final Feasibility Report includes a grade control feature across the entire width of the main section of the diversion channel every 5,000 feet along the length of the diversion. The use of grade control to set some constraints on the low-flow channel migration rates within the meander belt width should be considered as part of this study. The distance between grade control features can be modified if warranted. Discuss, and if appropriate, recommend other methods to limit meander belt width.

   The following data will be provided by the Diversion Authority at the commencement of the work effort:

   a. Soil test data to include Atterberg limits and gradations, boring log plates, boring location diagrams, and boring profile plates

   b. Sediment grain size distribution and sediment transport (both as bedload and in suspension) data that has been collected recently by the US Geological Survey and West Consultants, including low and high flow events, for streams near the proposed diversion, including the Rush, Lower Rush, Maple and Sheyenne rivers

c. Current, and if available, also historical cross sections for streams near the proposed diversion, including the Rush, Lower Rush, Maple and Sheyenne rivers

d. Required diversion profile information along the centerline of the diversion

e. Typical cross-sections for the low-flow channel and main section of the diversion channel for the four reaches referred to above (i.e., 1) Mouth to Lower Rush, 2) Lower Rush to Drain 14, 3) Drain 14 to Drain 21C, and 4) Drain 21C to Diversion Inlet)

f. Current, and if available, also historical general slope and sinuosity information for streams near the proposed diversion, including the Rush, Lower Rush, Maple and Sheyenne rivers

g. Current, and if available, also historical digitized information (GIS format) on planform alignments for streams near the proposed diversion, including the Rush, Lower Rush, Maple and Sheyenne rivers

h. Stage (water depth)-discharge, flow velocity-discharge, discharge-duration and discharge-frequency information for the four reaches referred to above (i.e., 1) Mouth to Lower Rush, 2) Lower Rush to Drain 14, 3) Drain 14 to Drain 21C, and 4) Drain 21C to Diversion Inlet)

i. Typical flood hydrographs for the four reaches referred to above (i.e., 1) Mouth to Lower Rush, 2) Lower Rush to Drain 14, 3) Drain 14 to Drain 21C, and 4) Drain 21C to Diversion Inlet)

j. Compilation of frequency and duration of operation, typical cross sections, slopes, erosion protection measures, and sedimentation records for the two existing diversions on the Sheyenne River (Horace to West Fargo, and West Fargo)

Deliverables:

1. Prepare a first Draft Technical Memorandum to include:
   - Outline approach for meander belt width analysis
   - Brief literature review on constructed meandering channels
   - Preliminary summary of data available
   - Initial thoughts on feasibility of meander belt width concept
2. Prepare a second Draft Technical Memorandum to include:
   - Description of approach for meander belt width analysis
   - Processing of data for input in meander belt width analysis
   - Meander belt width analysis
   - Stabilization alternatives, including grade-control measures, non-structural measures (e.g., vegetation), widening of main diversion channel in certain reaches, among other considerations, to ensure low-flow channel migration occurs within prescribed meander belt width
   - Determination of need for rock toe protection along the entire length of the inner diversion toe to prevent erosion
   - Suggestions for future field investigations
   - Recommended design criteria for Final Design
3. Consult with Professor Gary Parker (University of Illinois at Urbana-Champaign) during development of the meander belt width analysis and recommendations.

4. Develop a brief, graphics-rich, PowerPoint presentation of the background and results. This presentation must be suitable for a non-technical audience.

5. Determine timing of tributary contributions to the low flow channel by reviewing and comparing the Phase 1 HEC-HMS model results for the Rush and Lower Rush Rivers, and Drains 14 and 21C for the 2-year and 5-year 24-hour rainfall events. Compare model results to low flow channel hydrology developed by USACE.

6. Prepare a Technical Memorandum presenting summarizing results.

II. EXTREME EVENT EVALUATIONS

1. Evaluate the following for extreme (103,000 cfs and Probable Maximum Flood (PMF)) events

   a. Adequacy of aqueduct openings

   b. Lowering the left EMB to reduce the amount of flow in the Diversion Channel

   c. Head differential across raised road in the staging area

   d. For VE-13 Option D, sloping the Diversion Channel from the Wild Rice River toward the Diversion Inlet

III. TRIBUTARY PEAK MODEL RUNS TO SUPPORT THE MAPLE RIVER AQUEDUCT PHYSICAL MODEL

Background: To provide 10-, 50-, 100-, and 500-year tributary peak hydrographs in the current version of the unsteady RAS model to obtain the best available tributary peak flow information for the Maple River physical modeling effort. These updated tributary peak model runs will aid in the effort of determining the flow combinations to be modeled during maple River physical modeling effort.

Scope: Perform model runs for the 10-, 50-, 100-, and 500-year tributary peak hydrographs to support the USACE's physical and numeric modeling of the Maple River Aqueduct Structure. Provide modeling results to USACE.

IV. ADDITIONAL ASSISTANCE FOR THE MAPLE RIVER AQUEDUCT PHYSICAL MODEL

Scope: Additional assistance includes participating in bi-weekly conference calls, providing additional technical information and support from Feasibility Study team to USACE's physical modeling team, and attending a four-day value-based design charrette.

V. UNSTEADY HEC-RAS MODELING OF EXISTING PMF INFLOWS

Background: The existing Probably Maximum Flood (PMF) was developed almost 30 years ago (1984) and is based on simple hydrologic routing that likely does not account for the full effects of flooplain storage and cross-basin flow that occurs upstream of Fargo-Moorhead. USACE has updated the unsteady HEC-RAS model upstream of the unsteady HEC-RAS model currently being used for the FMMFRM project so that it has the extents and connections necessary to model the PMF event. The portion of the FMMFRM unsteady HEC-RAS model from Abercrombie, ND (the upstream extents of the unsteady HEC-RAS model being used for the FMMFRM study) through Fargo-Moorhead has been added to the upstream model to create the unsteady HEC-RAS model required for this PMF analysis. To avoid confusion, the unsteady HEC-RAS model being used for the PMF analysis will be referred to as the "Upstream" model, while the unsteady HEC-RAS model generally being used for most of the FMMFRM study will be referred to as the "FMMFRM" model.

To get an idea of how much the PMF might change, the Corps and the Project Sponsor previously decided that it would be useful to investigate routing the existing PMF inflows using the Upstream model. The Corps has set up the Upstream model with the proper inflows.

Scope:
a) Perform a technical review of the model

b) Address the instability issues related to running the model with very large inflows

c) Produce final model runs using the 1984 hydrology that provide the PMF at the Fargo gage.

Deliverables:
a) Draft unsteady HEC-RAS models.
b) Draft technical memorandum (hard copy and electronic).
c) Final unsteady HEC-RAS input and output files for the PMF event.
d) Final technical memorandum.

Phase 2 - Numerical Modeling Scope:

a) Set Up Unsteady HEC-RAS Model for New PMF Inflows
USACE has developed a number of new inflow locations for the unsteady HEC-RAS model that are associated with HMS output hydrographs. These inflow locations have been provided separately in an HEC-RAS unsteady flow data file. Develop a draft unsteady HEC-RAS model with updated inflow locations. If requested, modify names of certain reaches and storage areas to be consistent with the final unsteady HEC-RAS model used for the PMF flow routing.

Deliverables:
i. Draft unsteady HEC-RAS model with updated inflow locations.

b) Unsteady HEC-RAS Modeling of New PMF Inflows
Using the updated unsteady HEC-RAS model with the updated inflow locations, model two sets of hydrographs representing two different runoff scenarios. USACE will provide the two sets of inflow hydrographs. Evaluate the inflow locations and the magnitude and shape of the hydrographs for reasonableness and model stability. Modify as required, in consultation with USACE, to allow the model to run successfully.

Once any model instabilities have been addressed and the model runs are complete, evaluate, in consultation with USACE, the hydrographs at the Fargo gage location to determine whether additional sets of hydrographs representing other runoff scenarios are required to determine the PMF at the Fargo gage location (to be performed under subtask c).

Deliverables:
i. Preliminary unsteady HEC-RAS models.
ii. Draft Technical Memorandum. Prepare a Technical Memorandum that summarizes the work effort and the resulting hydrograph at the Fargo gage location.

c) Additional Unsteady HEC-RAS Modeling of New PMF Inflows (if authorized).
If additional sets of hydrographs need to be developed to determine the PMF at the Fargo gage location, as determined in subtask b, USACE will provide one to four additional sets of hydrographs to be modeled with HEC-RAS. Prepare update of draft Technical Memorandum prepared in subtask b.

Deliverables:

i. Preliminary unsteady HEC-RAS.
ii. Second draft Technical Memorandum.

d) Final Technical Memorandum.
Upon review of the model results and draft Technical Memorandum by USACE, finalize the HEC-RAS models and prepare a Final Technical Memorandum, addressing comments provided by USACE.

Deliverables:

i. Final unsteady HEC-RAS input and output files for the PMF event.
ii. Final Technical Memorandum.

VI. UPDATE HEC-RAS MODEL

a) Update the HEC-RAS model geometry for the revised western alignment from the Maple River to the Sheyenne River and the proposed upstream staging area ring levees.
b) Provide on-going hydrology and hydraulic modeling services as requested in order to keep HEC-RAS model consistent with project features.

VII. CONNECTING CHANNEL AND 20-YEAR EXISTING CONDITIONS

Scope:

a) **Connecting Channel Geometry:** Update the HEC-RAS model geometry to incorporate the geometry of the connecting channel between the Wild Rice and Red Rivers. Complete the 10-yr, 20-yr, and 50-yr model runs to determine the proper model modifications and to determine the impacts of the updated geometry. If the modifications affect the 50-yr model results, complete the 100-yr, 500-yr, SPF, and PMF model runs to determine the impact of the updated geometry. If the modifications do not affect the 50-yr model results, the updated 100-yr, 500-yr, SPF, and PMF model runs will be made under a future authorization. Develop flooded outline polygons and depth grids for the 10-yr, 20-yr, 50-yr, 100-yr, 500-yr, SPF, and PMF events.
b) **20-year Existing Conditions Modeling:** Develop 20-year Existing Conditions models and provide floodplain mapping for the Staging Area.

Deliverables:

a) Preliminary unsteady HEC-RAS models.
b) Final unsteady HEC-RAS input and output files.
c) 20-year existing conditions model results.

VIII. MAPLE RIVER AQUEDUCT FLOW ANALYSIS

a) Conduct modeling of Maple River flows across the proposed Maple River Aqueduct and into the Risk Reduction Area.
   i. Use the latest HEC-RAS model for the FMMFRM Project and the best available topographic data.

ii. The study area is the area within the Risk Reduction Area that is affected by the flow coming across the Maple River Aqueduct.
iii. Account for coincident flows on the Sheyenne River and other local drains and ditches.
iv. Select Maple River design flows such that insurable structures in the Risk Reduction Area, and within the expected future 1% Maple River floodplain, are minimally affected by the Maple River design flows and the coincident flows on the Sheyenne River and the other local drains and ditches in the Risk Reduction Area.

b) Establish Maple River design flows across the Maple River Aqueduct for the 1% and 0.2% flood events.
c) Recommend a maximum Maple River flow across the Maple River Aqueduct for the Standard Project Flood (SPF) event.

Deliverables:
a) Preliminary unsteady HEC-RAS models.
b) Final unsteady HEC-RAS input and output files.
c) 20-year existing conditions model results.
d) Final Technical Memorandum.

IX. UPDATE HEC-RAS MODELS – MAPLE RIVER AQUEDUCT AND REACH 6 BRIDGE
a) Modify the unsteady-flow HEC-RAS model to reflect the lateral structure and spillway changes recommended by the Maple River aqueduct study team.
b) Update the flow profile information (1% and 0.2% chance events, and 103,000 cfs event) needed for the bridge design effort, using the current Phase 7 unsteady-flow HEC-RAS model as the source of the geometry for the steady-flow HEC-RAS model. Continue to use the bridge design criteria provided in MFR-005 (General Bridge Re-Assessment for the Diversion from Inlet to Outlet) to determine the low-chord elevation and hydraulic opening of bridges in the Diversion Channel.

Deliverables:
a) Draft Technical Memorandum.
b) Final Technical Memorandum.

X. WATER MONITORING GAGE SURVEYING
a) Prepare and provide maps and coordinates of installation locations for 10 HOBO gages to USGS installation teams.
b) After HOBO gages are installed, survey the elevations of the installed gages and provide survey data to USGS.

Deliverables:
a) Maps and coordinates of installation locations for 10 HOBO gages.
b) Surveyed elevations of 10 HOBO gages.

G. BASIN-WIDE RETENTION SUPPORT

I. Objective: Assist Owner in supporting retention projects by others in the region.

II. Background: The Diversion Board has authorized up to $25 million for Basin-wide Retention Projects that are compatible with, and provide benefits for, the Diversion Project. An initial study is underway by the Red River Basin Commission (RRBC).

This subtask is not creditable by USACE.

III. Scope:

a. Assist Owner with developing a method of evaluating existing, planned, or potential regional retention projects' potential benefits to the Diversion Project. Scope to include up to two (2) site evaluations.

b. Provide technical assistance to the RRBC in its study "Halstad Upstream Retention (HUR) Modeling – Phase 1".

IV. Deliverables

a. As requested.

H. PHASING PLAN INTERIM MODELING

I. Objective: Incorporate the Phase 1 and Phase 2 project features into the hydraulic model, evaluate project benefits, and determine interim measures needed for a phased project.

II. Background: The original project execution plan assumed unconstrained funding, an approximate 8 year project schedule, and project design and construction starting on the downstream (north) end of the project and progressing sequentially upstream. Currently, it is anticipated that Federal funding will be constrained and, therefore, a phased plan was developed to allow the project to proceed with limited Federal funding and provide benefits as early as practical. This results in a three phased project. Phase 1 includes the Diversion Channel from the Outlet to downstream of the Maple River and associated bridges, in-town levees, and the Oxbow-Hickson-Bakke area levee. Phase 2 includes the Red River and Wild Rice River control structures, the Staging Area embankment, overflow embankment, tie-back levee, the Diversion Inlet structure, staging area land, associated bridges and transportation improvements, and associated mitigation projects. Phase 3 includes the Diversion Channel from the Maple River to the Diversion Inlet structure, associated bridges, the Maple River Aqueduct, the Sheyenne River Aqueduct, and associated mitigation projects.

There may be a lag of several years between completion of Phases 1 and 2, and the completion of Phase 3, and, therefore, modeling and evaluation is needed to 1) determine project benefits and 2) the need for and extent of temporary measures between phases of the project.

III. Scope: Perform 100-year and 500-year modeling evaluations of Phase 1 and Phase 2 project components, quantify interim benefits, and determine what interim measures are needed until completion of Phase 3.

IV. Deliverables:

a. Draft Technical Memorandum.

b. Final Technical Memorandum.

I. PHASE 7.1 MODEL UPDATE

I. Task 1 - Update the Red River peak flow model geometry. Complete modeling for the Red River peak flood events, including the 10-, 2-, 1-, 0.2-percent chance events and the 103kcfs and PMF flood events for both existing conditions and with-project conditions. Geometry updates include:

a. Update storage connections for the existing and with-project model in the area west of the diversion between the Maple River and the Sheyenne River. to better reflect floodplain impacts and diversion side inlet sizing.

b. Revise the Wild Rice River Control Structure and embankment alignment (combine bridges).

c. Analyze the removal of the connecting channel between the Wild Rice River and Red River. Replace with storage areas.

d. Analyze Hwy 81/Hwy 75/Red River Control Structure Bridge/Culvert Sensitivity at the tie back levee.

e. Change the channel size from the Wild Rice River to the Diversion Inlet based on cross section volume of the southern embankment.

f. Account for staging area levees including the proposed Oxbow/Hickson/Bakke and Comstock levees.

g. Verify the eastern staging area tieback is modeled as being used in storage. Add detail to check if culverts are adequate to convey water west to the Red River Control Structure.

h. Revise Maple River south bank near the Maple River Aqueduct. Set elevation to 901.0.

i. Investigate diversion gate operations for events larger than the 0.2% chance event.

j. Update the Drain 14 inlet at the diversion.

II. Task 2 – Update tributary peak flow models with geometry developed in Task 1. Complete modeling for the 10-, 2-, 1-, 0.2-percent chance flood events for both existing conditions and with-project conditions.

III. Task 3 - Conduct a higher volume sensitivity analysis using the Red River peak flow geometry from Task 1 and the high volume hydrology developed as part of the Phase 5 unsteady modeling effort. Complete evaluations for the 1- and 0.2-percent chance flood events for both existing conditions and with-project conditions. The main objective of this task is to determine how the diversion system would operate with higher volumes and if the higher volumes would affect the staging area elevation. No mapping is required; however, calculate impacts and compare to Phase 7.0. For comparison purposes, match Phase 7.1 downstream impacts, flows through town, and diversion flows to the targeted values from Phase 7.0. The variable parameter will be the staging area elevation. Prepare a technical memorandum to summarize the sensitivity analysis.

IV. Task 4 – QA/QC of Phase 7.1 modeling.

V. Task 5 – Complete additional modeling and mapping tasks as part of the Phase 7.0 modeling effort. These items include details such as:

a. Update geometry to include the City of Fargo Comprehensive Flood Protection Plan.

b. Additional mapping for existing and project conditions.

c. Development of Tributary Peak models.

d. Add detail to Interstate 94 near the Red River and also to Drain 27 area.

e. Update weir coefficients, culverts, initial elevations, and cross section duplication.

f. Diversion centerline alignment rectification due to Microstation and GIS formats.

g. Add Excavated Material Berms into project geometry.

h. Add designed bridges for Reaches 1 through 5 into the geometry.

VI. Deliverables:

a. Updated phase 7.1 model for the Red River peak flood events, including the 10-, 2-, 1-, 0.2-percent chance events and the 103kcfs and PMF flood events for both existing conditions and with-project conditions.

b. Updated phase 7.1 tributary peak flow models with geometry developed in Task 1, for the 10-, 2-, 1-, 0.2-percent chance flood events for both existing conditions and with-project conditions.

c. Higher volume sensitivity analysis:

d. Updated phase 7.0 model.

J. UPDATE PMF WITH REVISED DISTRIBUTION OF SNOWMELT RUNOFF:

I. Background:

a. Initial results from the current PMF study for the USGS Gage at Fargo, ND indicate that the peak flow is about 25% higher than what was determined during the 1985 study. Comparisons with the 1985 study indicate that the Wild Rice, North Dakota basin requires further investigation. Contributing drainage area for the PMF also requires further investigation. Two HMS model runs (two storm centerings) are available from the USACE St. Paul District for each of the eight sub-basins that are included in the PMF study. The HMS models that were used in the initial PMF work were modified from the Phase 1 HMS final product by peaking unit hydrograph parameters for each subbasin, re-incorporating the entire drainage area, and extending several storage outflow relationships that were exceeded with the magnitude of discharges generated from the PMF simulations.

b. It has been proposed that GIS can be used in conjunction with the HMS models to better estimate the amount of runoff occurring during a PMF event. The GIS/HMS effort would determine areas that contribute runoff, areas that do not contribute runoff, and areas that partially contribute runoff for the events investigated.

II. Scope:

a. Discuss the GIS/HMS effort with USACE before proceeding with this work.

b. Update the USACA-provided HMS model runs in conjunction with the GIS/HMS-based runoff-determination effort. Determine the order of HMS model simulations and account for the breakout flows between the various models. Coordinate between the HMS model simulations and RES-SIM with USACE. Save Reservoir inflows for Traverse and Orwell in DSS and submit to USACE for simulation. Forward the regulated flow DSS records for inclusion into the RAS Model.

c. Upon completion of the update to the Wild Rice River basin HMS model by USACE,, perform final model runs. Perform work that can be accomplished in advance to prepare for the final HMS models runs.

d. Use the HMS results as input for an updated unsteady HEC-RAS model run for each storm centering. Complete the existing scope of work [can we cite a Paragraph here?] for the PMF study using the updated unsteady HEC-RAS model runs.

e. Prepare a report section documenting the GIS/HMS-based runoff-determination effort and comparing the 1985 PMF study to this current study, including input assumptions. Incorporate this draft report section into the overall current PMF study report.

III. Deliverables

a. Updated runoff grids resulting from the GIS/HMS-based runoff-determination effort.
b. Draft report .
c. Updated HMS models (16 models: 2 storms centering for 8 sub-basins.)
d. Updated unsteady HEC-RAS models (2 models, one for each storm centering).

3. Owner's Responsibilities

Owner shall have those responsibilities set forth in Article 2 and in Exhibit B.

4. Times for Rendering Services

Subtask	**Start Time**	**Completion Time**
A. HMS Diversion Inlet Model	April 1, 2012	July 31, 2012
B. Updates to Rush/Lower Rush	March 8, 2012	May 31, 2012
C. Evaluation of channel size	March 8, 2012	May 31, 2012
D. Extend RAS geometry of Rush/Lower Rush	March 8, 2012	May 31, 2012
E. Physical Modeling Assistance	April 26, 2012	September 30, 2012
F. On-Call Services	June 14, 2012	September 30, 2013
F.I Extreme Rainfall Events	September 13, 2012	November 30, 2012
F.II. Extreme Event Evaluations	September 13, 2012	November 30, 2012
F.III. Tributary Peak HEC-RAS Model Runs	September 14, 2012	December 31, 2012
F.IV. Additional Assistance for the Maple River Aqueduct Physical Model	September 14, 2012	September 30, 2013
F.V. Unsteady HEC-RAS Modeling of Existing PMF Inflows	November 8, 2012	January 31, 2013
F.V. Phase 2 Numerical Modeling	February 14, 2013	September 30, 2013
F.VI. Update HEC-RAS Model	December 13, 2012	January 31, 2013
F.VII. Connecting Channel and 20-year Existing Conditions	December 18, 2012	September 30, 2013
F.VIII. Maple River Aqueduct Flow Analysis	March 14, 2013	September 30, 2013
F.IX. Update HEC-RAS Models – Maple River Aqueduct & Reach 6 Bridge	April 18, 2013	September 30, 2013
F.X. Water Monitoring Gage Survey	April 9, 2013	May 31, 2013
G. Basin-Wide Retention Support	December 13, 2012	September 30, 2013
H. Phasing Plan Interim Modeling	April 24, 2013	September 30, 2013
I. Phase 7.1 Model Update	July 11, 2013	December 31, 2013
J. Update PMF Study with Revised Distribution of Snowmelt Runoff	July 11, 2013	December 31, 2013

5. Payments to Engineer

   A. Owner shall pay Engineer for services rendered as follows:

      I. Compensation for services in accordance with the Standard Hourly Rates shown in Appendix 2 of Exhibit C of the Agreement.

      II. The total compensation for services identified under the Task Order is not-to-exceed the amount as defined in the table below.

      III. Estimated budget for Subtask F. On-Call Services, and G. Basin-Wide Retention Support, is based on an allowance.

         1. Engineer will notify Owner when eighty percent (80%) of the budget on Subtask F. On-Call Services, and G. Basin-Wide Retention Support, is expended.

         2. Engineer will prepare and submit an amendment for additional compensation when ninety percent (90%) of budget on Subtask F. On-Call Services, and G. Basin-Wide Retention Support, is expended.

         3. Engineer will not perform work beyond one hundred percent (100%) of the budget for Subtask F. On-Call Services, and G. Basin-Wide Retention Support, without Owner's authorization by an amendment to this Task Order.

Subtask	Current Budget ($)	Change ($)	Revised Budget ($)
A. HMS Diversion Inlet Modeling	22,121	0	22,121
B. Updates to Rush/Lower Rush	16,401	0	16,401
C. Evaluation of Channel Size	27,605	0	27,605
D. Extend RAS Geometry of Rush/Lower Rush	17,714	0	17,714
E. Physical Modeling Assistance	10,500	0	10,500
F. ON-CALL SERVICES (ALLOWANCE)	94,900	0	94,900
F.I. Extreme Rainfall Events	7,500	0	7,500
F.II. Extreme Event Evaluations	26,600	0	26,600
F.III Tributary Peak Model Runs to Support the Maple River Aqueduct Physical Model	20,000	0	20,000
F.IV Additional Assistance for the Maple River Aqueduct Physical Model	49,000	0	49,000
F.V Unsteady HEC-RAS Modeling of Existing PMF Inflows	50,000	0	50,000
F.V Phase 2 Numeric Modeling	60,000	0	60,000
F.VI Update HEC-RAS Model	36,000	0	36,000

Subtask	Current Budget ($)	Change ($)	Revised Budget ($)
F.VII Connecting Channel and 20-year Existing Conditions	9,000	0	9,000
F.VIII Maple River Aqueduct Flow Analysis	15,000	0	15,000
F.IX Update HEC-RAS Models – Maple River Aqueduct & Reach 6 Bridge	15,000	0	15,000
F.X Water Monitoring Gage Survey	5,000	0	5,000
G. Basin-Wide Retention Support	55,000	0	55,000
H. Phasing Plan Interim Modeling	90,000	0	90,000
I. Phase 7.1 Model Update		130,000	130,000
J. Update PMF Study with Revised Distribution of Snowmelt Runoff		80,000	80,000
TOTAL	**627,341**	**210,000**	**837,341**

B. The terms of payment are set forth in Article 4 of the Agreement and in Exhibit C.

6. Consultants: None
7. Other Modifications to Agreement: None
8. Attachments: None
9. Documents Incorporated By Reference: None

10. Terms and Conditions: Execution of this Task Order by Owner and Engineer shall make it subject to the terms and conditions of the Agreement (as modified above), which Agreement is incorporated by this reference. Engineer is authorized to begin performance upon its receipt of a copy of this Task Order signed by Owner.

The Effective Date of this Task Order is June 14, 2012.

ENGINEER:

Houston-Moore Group, LLC

Signature Date

Jeffry J. Volk
Name

President
Title

DESIGNATED REPRESENTATIVE FOR TASK ORDER:

C. Gregg Thielman
Name

Sr. Project Manager
Title

925 10th Avenue East
West Fargo, ND 58078
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cgthielman@houstoneng.com
E-Mail Address

(701) 237-5065
Phone

Fax

OWNER:

Fargo-Moorhead Metro Diversion Authority

Signature Date

Darrell Vanyo
Name

Chairman, Flood Diversion Board of Authority
Title

DESIGNATED REPRESENTATIVE FOR TASK ORDER:

Keith Berndt
Name

Cass County Administrator
Title

211 9th Street South, PO Box 2806
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Fax

PREPARED FOR:	Technical Advisory Team (TAC)
COPIES:	United States Army Corps of Engineers (USACE)
PREPARED BY:	Program Management Consultant (PMC)
DATE:	7/3/2013
SUBJECT:	**Task Order No. 9, Amendment 7: Hydrology and Hydraulic Modeling**
ATTACHMENT(S):	HMG Cost Proposal

Purpose:
The purpose of this document is to present an independent estimate of the engineering fees required to accomplish the above listed Task Order No. 9, Amendment 7 as well as a recommendation to the TAC on the total cost for this action.

Scope:

Subtask 2.I - Phase 7.1 Model Update:

Update the Red River peak flow model geometry. Complete modeling for the Red River peak flood events, including the 10-, 2-, 1-, 0.2-percent chance events and the 103kcfs and PMF flood events for both existing conditions and with-project conditions. Update tributary peak flow models with geometry developed in Task 1. Complete modeling- for the 10-, 2-, 1-, 0.2-percent chance flood events for both existing conditions and with-project conditions. Conduct a higher volume sensitivity analysis using the Red River peak flow geometry from Task 1 and the high volume hydrology developed as part of the Phase 5 unsteady modeling effort. Conduct QA/QC of Phase 7.1 modeling. Complete additional modeling and mapping tasks as part of the Phase 7.0 modeling effort.

Subtask 2.J – Update PMF Study with Revised Distribution of Snowmelt Runoff:

a. Discuss the GIS/HMS effort with USACE before proceeding with this work.

b. Update the USACA-provided HMS model runs in conjunction with the GIS/HMS-based runoff-determination effort. Determine the order of HMS model simulations and account for the breakout flows between the various models. Coordinate between the HMS model simulations and RES-SIM with USACE. Save Reservoir inflows for Traverse and Orwell in DSS and submit to USACE for simulation. Forward the regulated flow DSS records for inclusion into the RAS Model.

c. Upon completion of the update to the Wild Rice River basin HMS model by USACE, perform final model runs. Perform work that can be accomplished in advance to prepare for the final HMS models runs.

d. Use the HMS results as input for an updated unsteady HEC-RAS model run for each storm centering. Complete the existing scope of work for the PMF study using the updated unsteady HEC-RAS model runs.

e. Prepare a report section documenting the GIS/HMS-based runoff-determination effort and comparing the 1985 PMF study to this current study, including input assumptions. Incorporate this draft report section into the overall current PMF study report.

Background
USACE requested the Diversion Authority to provide the above described work as creditable work-in-kind assistance.

PMC Cost Estimate

The PMC used the attached level of effort (LoE) estimate to determine a baseline of cost for this amendment. This LoE estimate is used to compare to the estimate received from the consultant.

Subtask 2.I - Phase 7.1 Model Update:

		Estimated Hours		
Position/Grade	**Rate / Hr.**	**F.XI**	**Total**	**Cost**
Principal Engineer	$ 163	20	20	$ 3,260
Senior Project Manager	$ 158		0	$ -
Senior Project Engineer	$ 147	40	40	$ 5,880
Project Manager	$ 142	40	40	$ 5,680
Professional Engineer	$ 132	240	240	$ 31,680
Project Engineer	$ 116	160	160	$ 18,560
Engineer/GIS Manager	$ 132		0	$ -
H&H Modeler	$ 115	160	160	$ 18,400
Geotechnical Engineer	$ 132		0	$ -
Environmental Scientist	$ 119		0	$ -
Construction Engineer	$ 109		0	$ -
Project Controls Mgr	$ 142		0	$ -
Engineering Technician	$ 93	200	200	$ 18,600
GIS Technician	$ 111	200	200	$ 22,200
Land Surveyor	$ 116		0	$ -
CADD Technician	$ 105		0	$ -
Administrative Assistant	$ 65		0	$ -
Expenses				$ -
TOTALS		1060	1060	$ 124,260

The PMC independently estimated the cost for this task order amendment to be approximately $124,260. The local consultant estimated the work to be $129,784. The PMC recommends a budget of $130,000 for this task.

Subtask 2.J - Update PMF Study with Revised Distribution of Snowmelt Runoff:

		Estimated Hours		
Position/Grade	**Rate / Hr.**	**F.V**	**Total**	**Cost**
Principal Engineer	$ 163	10	10	$ 1,630
Senior Project Manager	$ 158	20	20	$ 3,160
Senior Project Engineer	$ 147		0	$ -
Project Manager	$ 142	40	40	$ 5,680
Professional Engineer	$ 132	40	40	$ 5,280
Project Engineer	$ 116	200	200	$ 23,200

Engineer/GIS Manager	$ 132		0	$ -
H&H Modeler	$ 115	200	200	$ 23,000
Geotechnical Engineer	$ 132		0	$ -
Environmental Scientist	$ 119		0	$ -
Construction Engineer	$ 109		0	$ -
Project Controls Mgr	$ 142		0	$ -
Engineering Technician	$ 93	80	80	$ 7,440
GIS Technician	$ 111	80	80	$ 8,880
Land Surveyor	$ 116		0	$ -
CADD Technician	$ 105	40	40	$ 4,200
Administrative Assistant	$ 65		0	$ -
Expenses				$ -
TOTALS		710	710	$ 82,470

The PMC independently estimated the cost for this task order amendment to be approximately $82,470. The local consultant estimated the work to be $79,992. The PMC recommends a budget of $80,000 for this task.

HMG proposal

HMG's proposals are included as an attachment.

Recommendation and Justification

The PMC independently estimated the cost for this task order amendment and reviewed the HMG proposal and believes a $210,000 budget is reasonable. The PMC recommends the Authority execute Task Order No. 9, Amendment 7 to increase the contract amount by $210,000.

HMG

FM Metro Risk Management Project

Cost Proposal for Phase 7.1 HEC-RAS Models

		Personnel Costs												
		Senior Project Manager		Senior Project Engineer		Project Manager		Project Engineer		Graduate Engineer		GIS Technician III		
Task	Activity Description	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	Cost Per Task
The Phase 7.1 modeling will incorporate desired geometry changes to the HEC-RAS model that have been identified since the Phase 7.0 modeling effort was completed and set the table for modeling the Phase 8 higher volume hydrology once it is available. As part of the Phase 7.1 effort, the following tasks will be completed:														
Task 1	Update the Red River peak flow model geometry. Modeling will be completed for the Red River peak flood events, including the 10-, 2-, 1-, 0.2-percent chance events and the 103kcfs and PMF flood events for both existing conditions and with-project conditions.	4	$ 632	4	$ 588	40	$ 5,680	250	$ 29,000	120	$ 12,000	8	$ 888	$ 48,788
Task 2	Update tributary peak flow models with geometry developed in Task 1. Modeling will be completed for the 10-, 2-, 1-, 0.2-percent chance flood events for both existing conditions and with-project conditions.	4	$ 632	4	$ 588	5	$ 710	40	$ 4,640	40	$ 4,000	8	$ 888	$ 11,458
Task 3	Conduct a higher volume sensitivity analysis using the Red River peak flow geometry from Task 1 and the high volume hydrology developed as part of the Phase 5 unsteady modeling effort. Evaluations will be completed for the 1- and 0.2-percent chance flood events for both existing conditions and with-project conditions. The main objective of this task is to see how the diversion system would operate with higher volumes and if the higher volumes would affect the staging area elevation. No mapping will be completed, however impacts will be calculated and compared to Phase 7.0. For comparison purposes, Phase 7.1 downstream impacts, flows through town, and diversion flows will match the targeted values from Phase 7.0. The variable parameter will be the staging area elevation. A technical memorandum will be created to summarize the sensitivity analysis.	4	$ 632		$ -	20	$ 2,840	60	$ 6,960	60	$ 6,000	8	$ 888	$ 17,320
Task 4	QA/QC of Phase 7.1 modeling.	4	$ 632	4	$ 588	10	$ 1,420	32	$ 3,712	32	$ 3,200	6	$ 666	$ 10,218
Task 5	Additional modeling and mapping tasks completed as part of the Phase 7.0 modeling effort.													$ 42,000
	Total	16	$ 2,528	12	$ 1,764	75	$ 10,650	382	$ 44,312	252	$ 25,200	30	$ 3,330	$ 129,784
	Grand Totals													$ 129,784

Modeling Details

- Update storage connections for the existing and with-project model in the area west of the diversion between the Maple River and the Sheyenne River. T
- Revise the Wild Rice River Control Structure and embankment alignment (combine bridges).
- Analyze the removal of the connecting channel between the Wild Rice River and Red River. Replace with storage areas.
- Hwy 81/Hwy 75/Red River Control Structure Bridge/Culvert Sensitivity at the tie back levee.
- Change the channel size from the Wild Rice River to the Diversion Inlet based on cross section volume of the southern embankment.
- Account for staging area levees including the proposed Oxbow/Hickson/Bakke and Comstock levees.
- Verify the eastern staging area tieback is modeled as being used in storage. Add detail to ensure culverts are adequate to convey water west to the Red
- Revise Maple River south bank near the Maple River Aqueduct. Set elevation to 901.0.
- Make updates to the Drain 14 inlet at the diversion. (upstream of I-94)

FM Metro Risk Management Project

Cost Proposal for Task Order 9 - PMF Study with Revised Snowmelt Runoff

Task	Activity Description	Senior Project Manager		Senior Project Engineer		Project Manager		Project Engineer		GIS Technician III		Cost Per Task
		Personnel Costs										
		Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	Hours	Cost	
Update PMF Study with Revised Snowmelt Runoff - Update HMS Models for 2 storm centerings												
Task 1	Evaluate contributing drainage areas and runoff for the PMF event using GIS and the HEC-HMS Models. The following subwatersheds will be analyzed: Bois de Sioux, ND Wild Rice River, Ottertail River, Sheyenne River, Maple River, Elm River, Buffalo River, and the Red River Local watersheds. This will include the development of updated runoff grids from 16 models (2 storm centerings for 8 sub-basins)	4	$ 632	0	$ -	40	$ 5,680	320	$ 37,120	160	$ 17,760	$ 61,192
Task 2	Update the Unsteady HEC-RAS models using the results from Task 1 (2 models - one for each storm centering)	2	$ 316	0	$ -	16	$ 2,272	60	$ 6,960	8	$ 888	$ 10,436
Task 3	QA/QC of HEC-HMS and HEC-RAS models	2	$ 316		$ -	16	$ 2,272	8	$ 928	4	$ 444	$ 3,960
Task 4	Draft Report sections documenting the GIS/HMS based runof determination effort	2	$ 316	0	$ -	16	$ 2,272	8	$ 928	8	$ 888	$ 4,404
	Total	10	$ 1,580	0	$ -	88	$ 12,496	396	$ 45,936	180	$ 19,980	$ 79,992
	Grand Totals											$ 79,992