# Humboldt Bay Municipal Water District Matthews Dam Advance Assistance – Scope of Work

## PROPOSED ADVANCE ASSISTANCE ACTIVITIES

The mitigation goals and objectives of this project are to assess the seismic response of the existing dam and spillway structures and then perform designs for corresponding retrofit(s) so indicated by the assessment such that the spillway and dam will be designed to withstand the projected Cascadia Subduction Zone seismic event. Prevention of such a disaster would protect the estimated 10,152 people and 3,057 buildings including 48 critical facilities that would be exposed to the inundation flooding resulting from the failure of the dam and prevent the estimated loss of $513,920,907 in damages. The failure of the dam would also likely result in the loss of human life, which is why the dam is classified as a High Hazard Potential dam. Furthermore, the loss of the dam would result in damage to the District's source water collector wells, thereby interrupting drinking water and wastewater service to 88,000 people.

It should be noted that past consultant work for Matthews Dam is referenced herein, and a consultant prepared this grant application. Past consultant use for work on the dam that is noted in this Advance Assistance (AA) subapplication has not been grant-funded, therefore federal procurement requirements were not required. No statements of work or other items listed in 2 CFR Part 200.319 were developed as related to the proposed AA project as a part of past consultant work on the dam. The District is aware of and will comply with federal procurement regulations for the project as proposed in this subapplication. As HBMWD does not have in-house engineers on staff, the alternate contact (GHD) is the contract District Engineer for HBMWD and supports the District with general day-to-day engineering services, including preparation of this grant application. GHD and HBMWD are aware that GHD will be precluded from competing for future work associated with this project as described in this subapplication.

Work for this Advance Assistance project will be performed as outlined in the following tasks. Deliverables are described for each respective task.

### Task 1 – Advance Assistance Subapplication (pre-award costs)

This is the work associated with the preparation of this Hazard Mitigation Grant Program Advance Assistance subapplication.

The deliverable for this task is the Advance Assistance subapplication and has been completed.

### Task 2 – Geotechnical Assessment, Core through Spillway Floor

As is common with many spillways of this age, there is not a detailed geological map of the spillway chute. Accordingly, there is an inherent uncertainty characterizing the engineering geological properties of the bedrock below the chute. From the construction photographs, the bedrock generally appears to be of better quality near the ogee weir (upstream end of the spillway) than at the flip bucket (downstream end of the spillway). The construction photographs and the boring data from PH-4 suggest the left lower one-third of the spillway could be grounded on more erodible bedrock.

GHD
718 Third Street Eureka California 95501 USA
T 707 443 8326 F 707 444 8330 W www.ghd.com

This Geotechnical Assessment task will seek to gather data and assess the seismic stability of the spillway. To further assess the integrity of the bedrock below the spillway slab, it is anticipated that borings/cores will be installed through several points of the spillway slab. The general vicinity of where these cores will be installed is shown on Figure 2, see the “Spillway” outline as shown in the legend. This area encompasses a concrete spillway that of course is previously disturbed area. It is anticipated that cores will be no larger than six inches in diameter, and they could be much smaller. No large-scale disturbance will be required for this coring work. Prior to the coring, the proposed coring and repair plan must be developed and submitted to HBMWD, Federal Energy Regulatory Commission (FERC), and the California Department of Water Resources Division of Safety of Dams (DSOD) for approval. These cores will be used to assess how well the concrete of the slab is bonded to the underlying bedrock and assess the condition of the bedrock underlying the spillway under the flip bucket as well as along the left lower one-third of the spillway chute. The results of this investigation will be assessed and analyzed, and they will be summarized in the Geotechnical Report (Task 4).

There will not be a specific deliverable for this task, but the information gathered as a part of this task will be summarized in the Geotechnical Report, which will be the Task 4 deliverable.

**Task 3 – Geotechnical Assessment, Additional Borings**

In order to address the questions brought forth during the PFMA concerning the possibility of a global stability failure of the area encompassing the dam and spillway that could result from seismic activity, additional borings will be installed and regional geology assessed to evaluate this likelihood. Prior to the coring, the proposed coring and repair plan must be developed and submitted to HBMWD, FERC and DSOD for approval. As a part if this assessment, it is anticipated that additional geotechnical borings will be installed near the downstream shell of the dam. See the “Geotech Borings” outline as shown in the legend in Figure 2 for a general vicinity of proposed geotechnical borings and access. This area is all previously disturbed and is accessible without performing any improvements. It is anticipated that borings will be no larger than six inches in diameter, and they could be smaller. It is not anticipated that any earth movement or large-scale disturbance will be required. A calibrated Becker hammer drill or cone penetration testing
(CPT) rig may be required to get adequate in place densities in the river alluvium under the dam shells that may not have been removed during construction to see if it is potentially liquefiable. Results will be used in the seismic stability analysis (Task 6), and the results of the analysis and associated recommendations will be used to develop 65% seismic stability retrofit design (Task 7).

There will not be a specific deliverable for this task, but the information gathered as a part of this task will be summarized in the Geotechnical Report, which will be the Task 4 deliverable.

**Task 4 – Geotechnical Report**

All of the information gathered and analyses performed as described in Tasks 2 and 3 will be presented and summarized in the deliverable for Tasks 2 – 4, which is the Geotechnical Assessment Report. The results of the Geotechnical Assessment Report will be used to perform the Seismic Stability Analysis (Task 6).

Previous reports/analyses did not analyse the resilience of Matthews Dam and spillway to the Cascadia Subduction Zone 9.2M seismic event. The Federal Energy Regulatory Commission (FERC) is concerned that the controlling Cascadia Subduction Zone 9.2M seismic event has not be analysed lo perform risk assessment. Previous spillway slab investigations and condition assessments were limited to conditions of the spillway and were not related to a seismic analysis. The focused spillway report provided an analysis (desktop, non-technical) of potential failure modes of the spillway, which included potential spillway failure due to a 9.2M seismic event. This report only identified this as a potential failure mode and did not include an analysis of the resilience of the spillway to such a seismic event. Previous geological assessments have been associated with slope stability above the right and left abutments of the dam and did not gather data or perform analyses related to the dam itself nor the Cascadia seismic event. The geotechnical assessments proposed as tasks #2-4 for this Advance Assistance project will specifically analyse the composition of the dam itself and materials underlying the dam and spillway. Results of this comprehensive geotechnical assessment will include information on how cohesive the materials are that compose the dam and implications for slope stability, whether the dam and spillway are founded on bedrock material (and if so, how well the concrete of the spillway is bonded to the underlying bedrock and an assessment of the condition of the bedrock/materials), whether the materials underlying the dam are prone to liquefaction, and other information relevant to performing a seismic stability analysis for a 9.2M event.

**Task 5 – LiDAR Survey**

It is anticipated that a LiDAR survey will be required for use in the Seismic Stability Analysis (Task 6). Control points will be established and an aerial survey will be performed for the area around the dam. LiDAR data will be collected as part of this survey and approximately 1-foot topographic contours will be generated for the area around the dam. A topographic survey will be used to supplement and rectify the data that is gathered during the LiDAR survey.

Additionally, the LiDAR survey will provide necessary slope information that will be used for an analysis of slope stability in response to the 9.2M seismic event. Detailed surface elevation information of the dam slopes is not currently available and has not been provided by previous studies. These studies/analyses would provide information that is required to perform a seismic stability analysis, design alterative analysis, and ultimately perform appropriate seismic retrofit designs to be constructed.

The deliverables for this task will be figures that detail the results of the survey in both AutoCAD and PDF format.

**Task 6 – Seismic Stability Analysis and Alternatives Analysis**

A 2016 study by GEI found that the controlling ground motion for the dam is a 9.2M event on the Cascadia Subduction Zone, resulting in an 84th percentile peak ground acceleration (PGA) of 0.70g. Although previous seismic stability analyses have been performed for the dam, the dam has not been analyzed for this seismic event. This event would be used to analyze the spillway and dam under this seismic loading

magnitude. The seismic stability of the dam in response to a 9. 2M seismic event must be analyzed prior to determining appropriate, cost-effective design alternatives.

The geotechnical information gathered in Tasks 2 through 4 and the LiDAR data gathered in Task 5 will be used to analyze the stability of the dam and spillway structure under seismic loading. The seismic stability evaluation will consist of slope stability analyses of the upstream and downstream slopes for static and dynamic (i.e., seismic loading) conditions. Slope stability analyses will be performed for long-term steady-state, rapid drawdown, pseudostatic, and post-earthquake conditions. Stability analyses will likely be performed using the GeoStudio computer program SLOPE/W. Phreatic surfaces for analysis will be selected considering available piezometer data at the dam.

Post-earthquake stability analysis will consider the potential for soil strength loss due to the design input seismic loading. Rapid, cyclic (or earthquake) loading can lead to strength loss in saturated sands, gravels, and non-plastic silts (i.e., liquefaction) and in plastic silts and clays (i.e., cyclic softening). The loss of strength may subsequently lead to intolerable deformations or instabilities of slopes. The potential for liquefaction and cyclic softening will be evaluated with available information on the embankment material characteristics using state of the practice approaches. Evaluation of post-earthquake strengths and post-earthquake slope stability analysis for the upstream and downstream slopes will be performed.

Seismically-induced slope deformations will be estimated for the design input seismic loading, provided post-earthquake slope stability analyses meet criteria. Seismically-induced slope deformations will be estimated with simplified empirical approaches, which based on a preliminary review of available information, is expected to be adequate to satisfy FERC and DSOD requirements for a modern analysis. The severity of the estimated crest and slope deformations on the dam's stability will be evaluated considering the available freeboard of the dam and the character and configuration of the embankment materials. If excessive deformations are computed, alternatives will be analyzed and recommendations will be provided for potential remedial actions. For cost estimating purposes, we have assumed seismically-induced slope deformations will be estimated for the upstream and downstream slopes. A Seismic Stability and Alternatives Analysis Report will be prepared to document the above detailed analysis. The final draft will be submitted for review and acceptance by HBMWD, FERC, and DSOD.

All of the above seismic stability analysis work constitutes Task 6. Based on the results of the Seismic Stability Analysis and its recommendations, 65% design plans will be developed for any recommended retrofits (Task 7), and the plans will be submitted to HBMWD, FERC, and DSOD for review and approval. Upon agency approval, the retrofit measures will be implemented under a future grant.

The deliverable for this task is the Seismic Stability and Alternatives Analysis Report.

**Task 7 – 65% Seismic Stability Retrofit Design**

The District is proposing to take the design for this project to the 65% level, rather than 30%, for multiple reasons. The intent is to take the design to 65% to confirm feasibility and constructability of the proposed project to help determine an appropriate scope for Environmental, Historic, and Preservation (EHP) review. Additionally, this project is subject to review and approval by HBMWD, FERC, and DSOD. The 65% level is

when these agencies typically comment heavily on design of dam retrofit projects. There is potential for comments from these agencies to affect the design, and advancing the design to the 65% level will likely better define the area that will be impacted by the project and confirm that it will be approved by FERC and DSOD as designed. Bringing the design to the 65% level will make the design feasible both from a constructability standpoint and a permitting standpoint. This will make this project more shovel ready for the next phase, which will be a project subapplication for final design and construction.

All of the information gathered and analyses performed as described in Tasks 2 through 6 will be used for developing 65% design plans for the potential proposed seismic retrofit that results from Task 6, which will be the deliverable for this task.

It is suspected that relatively large deformations to the dam would result from a 9.2M seismic event on the Cascadia Subduction Zone. The level of deformation that could reasonably be expected from an event like this is uncertain due to the lack of available data, which means that the magnitude of potential retrofit solutions that are required are also uncertain. Potential deformation ranges vary widely depending on the material properties assumed in the analysis. Additional studies/analyses would provide information about material properties that is needed to reduce the band of uncertainty that goes into this analysis and development of alternative design solutions. The alternative design solutions may include but are not limited to: retrofit designs such as increasing the height of the dam (thereby increasing freeboard); buttressing the upstream slope of the dam, buttressing the downstream slope of the dam, and/or buttressing the left spillway wall; and/or foundation improvements such as deep soil mixing. The potential need for raising the dam crest elevation, whether buttresses are required, how large of buttresses are required, the strength of material for the buttresses, the extent to which buttresses need to be keyed into the foundation, whether foundation improvements such as deep soil mixing are required, and other solution uncertainties would be answered by performing the analyses as proposed for this Advance Assistance project.

**Task 8 – Environmental Special Studies**

This Advance Assistance project will include the performance of the special studies to satisfy the National Environmental Protection Act (NEPA) and California Environmental Quality Act (CEQA). It is anticipated that biological, wetlands, and cultural resource surveys will be conducted for the site. The special studies will be performed for the Area of Potential Effects (APE) that is developed as a part of the project design. It is assumed that FEMA will complete an Environmental Assessment (EA) and complete the required NEPA procedural tasks.

Reports will be developed for each study and will constitute the deliverables for this task.

**Task 9 – Permitting**

This Advance Assistance project will include the preparation of permits, review and processing of permits, and permit completion. The following permits are anticipated for the Advance Assistance project:

- North Coast Regional Water Quality Control Board 401 Water Quality Certification
- U.S. Army Corps of Engineers CWA Section 404 permit
- California Department of Fish and Wildlife 1600 Lake and Streambed Alteration Agreement
- California Department of Fish and Wildlife Incidental Take Permit (ITP)

- County Conditional Use Permit
- Biological Assessment and Biological Opinion (BABO)

The deliverable for this task will consist of final permits for all permits listed above.

**Task 10 – CEQA Environmental Impact Report**

This Advance Assistance project will include the completion of a CEQA Environmental Impact Report (EIR). This task will include the following:

- Coordination with all relevant agencies and stake holders
- Prepare a Notice of Preparation (NOP)
- Preliminary Draft EIR (DEIR)
- Draft EIR Review Meeting
- Prepare public DEIR
- Prepare a Notice of Completion (NOC) and Notice of Availability (NOA)
- Prepare draft final EIR, response to comments, and a review meeting with relevant agencies
- Prepare a draft Mitigation Monitoring and Reporting Program (MMRP) based on the impact analysis and comments on the DEIR
- Final EIR and Final MMRP
- Prepare Notice of Determination (NOD)

The deliverable for this task will be the completion of a CEQA EIR.

**Task 11 – Project Subapplication and Final BCA**

After all of the other tasks under the Advance Assistance grant are complete, the District will complete a BCA and a project subapplication under a future disaster declaration for final design and construction of the seismic stability retrofit. This task includes effort for development of the project BCA and completion and submission of the project subapplication itself.

The final BCA and subapplication will be the deliverables for this task and will be completed by the District.