TETRA TECH

PROPOSAL:

LAKE ARROWHEAD INUNDATION MAPPING

SCOPE OF SERVICES

This document outlines the services that Tetra Tech will provide to San Bernardino County for engineering services for the Lake Arrowhead Inundation Mapping project. Tetra Tech originally prepared an inundation mapping study for Lake Arrowhead, dated August 17, 2011. The extents of the original study inundation mapping terminated at the Mojave Forks Dam (also known as Mojave River Dam). The California Division of Safety of Dams (DSOD) recently requested that mapping be continued downstream of the Mojave Forks Dam (in the Mojave River). This Scope reflects the modeling and report effort required to extend the update the previously prepared mapping between Lake Arrowhead and Mojave Forks Dam and prepare new inundation mapping downstream of Mojave Forks Dam.

Task 1: Project Management, Coordination, Meetings, and Miscellaneous Follow-Up

This task includes time for ongoing project management, meetings, and coordination with the County and DSOD. Time spent completing minor miscellaneous tasks requested by the Client not accounted for in tasks described below will also be billed as part of this task. This estimate includes approximately 26 hours of staff time for these services throughout the project; invoicing will be provided for actual time required. If we find that additional time is needed as we approach the limit of our budget, we will notify you and request approval of a change order.

Task 2: Modeling and Report

Tetra Tech will prepare dam breach inundation maps for areas downstream of Lake Arrowhead to supplement the original study prepared by Tetra Tech in 2011. The DSOD has requested that inundation maps in the 2011 study be extended downstream from the Mojave Forks Dam to a point where the flood wave no longer poses a threat to life or critical facilities. Our preliminary evaluation suggests this modeling termination point is located approximately 40 miles east of Barstow, CA, or approximately 100 miles downstream of Mojave Forks Dam. Flows will pass through the cities of Hesperia, Victorville, and Barstow. We have assumed through preliminary evaluation of the nearby Cedar Springs Dam study (HDR, 2019) that flow downstream from Mojave Forks Dam is contained within the banks of the Mojave River.

This study focuses on analyzing the approximate inundation zone for downstream reaches as a result of a dam break at Lake Arrowhead. Existing conditions will be based on publicly available data which will limit the resolution of the results. Further, river systems are dynamic, and plan, profile, and cross-section characteristics can change as a result of unexpected conditions, such as a dam break. The inundation maps cannot account for these types of changes and represent only the estimated inundation zone under existing topographic conditions. Therefore, future uses based on these maps should reasonably account for these types of uncertainties.

The DSOD previously commissioned an inundation mapping study (HDR, 2019) for the Cedar Springs Dam that is located nearby in a different drainage, and upstream of Mojave Forks Dam. Tetra Tech reviewed materials previously prepared for the Cedar Springs Dam (Silverwood Lake) to evaluate whether the data could be repurposed for the Lake Arrowhead Inundation Mapping. Our evaluation showed that some of the data can be used for the Lake Arrowhead Inundation Mapping project, but additional publicly available data will be needed to conduct the study.

The original study was prepared by Tetra Tech in 2011. In the time that has passed since our original submittal, significant changes in the "state of the practice" have occurred. The original mapping was prepared using techniques, software, and regulatory expectations that have changed. We will conduct a pre-study conference call with the DSOD to discuss which elements of the 2011 study may be used now. For budgeting purposes, we

assume that the dam breach study and inundation mapping of Lake Arrowhead would be partially redone. We assume that information regarding the volume, material composition of the dam, and maximum normal water surface elevations would not change for this study. The hydraulic model downstream of the dam would be revised to incorporate the digital elevation model data that is required for a two-dimensional simulation.

Tetra Tech will prepare a two-dimensional hydraulic model of the flow areas downstream of Lake Arrowhead using publicly available digital elevation model data and supplemented with data from the Cedar Springs Dam study. Tetra Tech will not collect any new topographic data for this study. We plan to rely on publicly available data and do not assume any liability for use of this data. This hydraulic model will form the analytical basis of the dam breach study and inundation mapping. A sensitivity analysis of dam breach parameters such as breach size, time of formation, and Manning's *n* value will be conducted to reasonably estimate the inundation zone within the potential range of uncertainty of input data. The hydraulic model will incorporate the Mojave Forks Dam outlet works to estimate the amount of attenuation in peak flow that would occur due to the flood storage capacity of the dam.

Tetra Tech will prepare a report detailing the study effort. This report will include inundation maps from Lake Arrowhead to the model termination point east of Barstow. Tetra Tech will submit the report to San Bernardino County and the DSOD for review and comment. Tetra Tech will respond to one round of comments and revise the report accordingly, assuming no additional analyses are requested.

This task includes up to 270 hours of staff time. If additional budget is needed, we will request approval of a change order.

Task 3: Future Additional Services

This task is included as a future discretionary task for effort not originally contemplated or anticipated as a part of this work. An example of unanticipated effort would include travel to an in-person meeting either with the County or the DSOD. Another example is a request from DSOD for additional analysis beyond their standard regulatory requirements.

This task will not be used unless explicitly authorized by San Bernardino County. We have included \$9,000 in our budget for this task. This amount is equal to 20% of the total costs of Tasks 1 and 2 and would cover an additional 50 hours of Jeff Butson's time.

Other Direct Costs

Tetra Tech has included a budget of \$250 for other direct costs such as postage or delivery services. However, if other direct costs are incurred for this project (such as travel expenses for a trip to San Bernardino County or Sacramento), Tetra Tech will invoice San Bernardino County on a cost-plus-15-percent fee basis for all expenses incurred.

CLARIFICATION OF SERVICES

This proposal is on a Time and Expenses, Not-to-Exceed Fee basis, and allows for versatility in the project approach. It is understood and agreed between the parties that the estimated total fee is for the services set forth herein. However, it is important to note that services may require adjustments during project development that affect the cost estimate. The fee reflects the estimated cost of work to complete each task one time.

DELIVERABLES

Tetra Tech will provide San Bernardino County with an electronic copy of all documents, models, and maps that we prepare and submit. Hard copies can be provided if requested; additional budget may be needed to cover the associated costs.



Upon Authorization to Proceed, Tetra Tech will define the schedule through discussions with San Bernardino County and, if needed, the DSOD. The total estimated project duration is five months. The initial discussions on approach and data may require up to one month. Once we determine the approach, we anticipate completing the hydraulic modeling in approximately two months. Report preparation and submittal will require one additional month. We expect to submit the draft report to San Bernardino County and DSOD four months after Authorization to Proceed. An additional month may be required for Tetra Tech to respond to comments and revise the report.

ESTIMATED FEE

This table outlines the cost estimate to complete each task within the Scope of Services above.

Task	Cost Estimate
Task 1: Project Management, Coordination, Meetings, & Miscellaneous Follow-up	\$ 5,200
Task 2: Modeling and Mapping	\$ 39,800
Task 3: Future Additional Services (20% of Total of Task 1 and Task 2)	\$ 9,000
Other Direct Costs	\$ 250
Time and Expenses, Not-to-Exceed Fee	\$ 54,250

TERMS

The Estimated Fee information contained within this Scope of Services is valid for 90 days from the date of this document. Services outlined herein will be performed on a Time-and-Expenses basis with a Not-To-Exceed amount. The cost estimates outlined are for budgetary purposes only; actual costs may vary. We will not exceed the total contract amount without prior authorization. If additional services are requested or required, Tetra Tech will submit a Scope of Services Change Request (i.e., change order) for your authorization.

This project will be conducted under the terms of the San Bernardino County Purchase Order.

AUTHORIZATION TO PROCEED

To authorize Tetra Tech to proceed, please sign and date below, and issue executed .

TETRA TECH, INC. (Project Contact)

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Jeffrey Butson, PE, CFM, Senior Engineer

TETRA TECH, INC. (Authorization)

Pamela Hora, AICP,

CLIENT AUTHORIZATION

Signature

Date

September 30, 2020

September 30, 2020

Print Name and Title

This Scope of Services is intended solely for use by San Bernardino County and is proprietary to Tetra Tech.

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