EXHIBIT 1

Scope of Work

(Attached behind this cover page)

SCOPE OF WORK

A. Background Information

Each year the District designs numerous projects, including, but not limited to, channels, storm drains, basins, box culverts, etc. and utilizes Master Plans of Drainage (MPDs) as a preliminary planning tool to identify project priorities, approximate flowrates, facility sizing, and cost estimates prior to performing a detailed hydrologic and hydraulic study. Currently, the unincorporated area of Big Bear City does not have an MPD and with recent flooding in this area, this document would help identify and prioritize future flood control facilities.

Consultant shall be responsible for all services and required documents identified in the Scope of Work and Terms and Conditions Section.

B. Project Description

1. Project goals and objectives

Consultant shall prepare a Master Plan of Drainage for the unincorporated area of Big Bear City. The MPD must include, at a minimum, the following sections:

a. Executive Summary Section including, but not limited to, the basis of study, study approach, characteristics of the watershed, development of the master plan alternatives, issues and considerations, and conclusions and recommendations.
b. Introduction Section including, but not limited to, the study area, purpose/general intent, goals and objectives, policies, stakeholders, Flood Control District Act compliance, facility designations (e.g. regional vs. secondary vs. local facility), and the use of study/disclaimer.
c. Environmental Considerations and Regulatory Section including, but not limited to, policies and regulations, wildlife habitat, natural aesthetics, routine access for maintenance and improvements, and historical discussion.
d. Hydrology Section including, but not limited to, an introduction, boundary development, watershed characteristics, hydrologic model parameter development, rational method studies, unit hydrograph studies, and hydrologic factors (land use, hydrologic soil groups, loss rate criteria, precipitation analysis, antecedent moisture condition (AMC), etc.).
e. Existing Infrastructure Section including, but not limited to, existing drainage facilities and basin analyses, historical investigation, and deficiency analyses.
f. Hydraulic Modeling, Design Criteria and Facility Sizing Section including, but not limited to, an introduction, discussion of closed conduits and open channel hydraulics and design criteria, alignments and proposed drainage facilities (brief discussion of each drainage system), basin considerations, debris yield and bulking factors, and design storm frequencies.
g. Debris and Detention Basin Analysis Section including, but not limited to, locations, detention basin options, alternatives, and recommendations.
h. Cost Estimate Section including, but not limited to, an introduction, assumptions, types of costs (construction, acquisitions, environmental mitigation), open channel costs, closed conduit costs, debris basin costs, contingencies, development fees analysis, and discussion of funding opportunities. This section provides general costs assumptions and drainage system specific costs are to be provided in a separate volume with the specific drainage system plans and profiles.
i. Priority Recommendations Section including, but not limited to, general recommendations and specific project recommendations and priorities.
j. Conclusion and Recommendations Section including, but not limited to, an introduction, study conclusions and final recommendations.

The MPD should be divided into a minimum of four (4) volumes including, but not limited to, the following:

- Volume 1 – Final Report (includes at a minimum the sections listed above)
- Volume 2 – Plans, Profiles, and Cost Estimates
- Volume 3 – Hydrology Calculations
- Volume 4 – Hydraulic Calculations and Alternative Analyses

The approved software to be used for the MPD hydrology analyses is Advanced Engineering Software (AES) or Civil Design and for the preliminary hydraulic analysis is WSPG, FlowMaster, HEC-RAS, and PondPack. Current topography data should be utilized for the hydrology and hydraulic analyses and the consultant is responsible for obtaining suitable topography for a Master Plan of Drainage Study.

This Project is partially funded with Flood Mitigation Assistance Grant Program 97.029 funds awarded by the U.S Department of Homeland Security (DHS), Federal Emergency Management Agency (FEMA) and the Consultant shall comply with 2 Code of Federal Regulations (CFR) 200. All subcontractors must be procured per 2 CFR §200.317-.327 and local and State procurement policies, whichever is more stringent.

2. Project Requirements and Deliverables:

a. Work Plan

The Consultant will prepare a Work Plan that includes, but not limited to, a list of deliverables, milestone submittal schedule, summary of organization responsibilities and contacts, scope of work, task budgets, reporting and invoicing procedures, quality assurance plan, and project filing system. The Work Plan shall be submitted to the District prior to the first invoice.

<u>Deliverables:</u>

- Work Plan

b. Meetings/Coordination

The Consultant shall document project meetings and prepare minutes of the meetings for the District's review within three (3) working days after each meeting. Upon receipt of the District's comments, if any, the Consultant shall incorporate comments into the meetings' minutes. Comments, which are not incorporated, shall be discussed with the District as to why such information has not been incorporated. The project at minimum shall include the following meetings:

- Kick-off Meeting - The Consultant shall organize an initial project meeting with the District staff to review and confirm project scope, risks, issues, assumptions and constraints as well as project schedule.
- Monthly Progress Updates - The Consultant shall schedule and conduct monthly progress meetings via video conference call with District staff to review project direction and redirect some elements as necessary to ensure the project's progress within the available budget and/or funding and schedule. The Consultant shall maintain a list of action items with projected completion dates and shall use this as a basis for monthly **updates to the District's staff. The** Consultant shall send current action item list via e-mail to the District staff three (3) working days prior to each progress meeting.
- Additional Meetings - The Consultant shall organize additional meetings, as required, to complete the project. Additional meetings include, but are not

necessarily limited to, meetings to discuss review comments and responses, meetings with stakeholders such as other agencies, and the community.

Deliverables:
- Meeting Minutes
- Written summaries of telephone/email coordination as appropriate
- Monthly Progress Reports

c. Quality Assurance and Quality Control

The Consultant will have a Quality Assurance and Quality Control Plan in effect for the duration of the Scope of Services. The plan will establish a process whereby all deliverables are independently checked, corrected and back checked prior to any formal submission and all job-related correspondence and memoranda are routed and received by affected persons and then appropriately filed. An appointed Quality Assurance Officer will monitor and review project activities and deliverable schedules. All deliverables shall contain signature of the Quality Assurance Officer.

Deliverables:
- Deliverables such as reports, maps, preliminary plans and profiles, cost analysis, etc. shall be subject to signature by Quality Assurance Officer.

d. Project Schedule

The Consultant proposal shall include a Project schedule for a period that does not exceed twenty-four (24) months starting from the award date. The Consultant will prepare and update a monthly Project schedule with tasks and milestones. The Consultant will break down the schedule by logical tasks consistent with the scope of work and with enough detail to track project progress. Both a baseline schedule and tracking updates are required. The schedule must reflect realistic estimates of review periods by the District for tasks, such as reports, plans, and coordination. The schedule shall be provided prior to the first invoice.

Deliverables:
- Project Schedule
- Updated Quarterly Project Schedule

e. Monthly Progress Report and Invoice

The Consultant will establish and apply internal accounting methods and procedures acceptable to the District for documenting and monitoring contract costs. The Consultant will submit monthly invoices broken down in a manner consistent with the Work Plan. The Consultant shall include with the monthly invoice a progress report that reflects the work completed within the invoice period. Payments to the Consultant are to be in arrears. In other words, the Consultant must have actually incurred and paid the costs before invoicing the District.

Invoices shall include the following:
- Prepared on the Consultant’s letterhead;
- Signed by the Consultant’s project manager;
- Have a unique invoice number;
- Progress report that reflects the work completed within invoice period;
- Appropriate backup documentation attached;

- If the contract involves subconsultants, a separate invoice for each subconsultant shall be attached in the same format as the prime Consultant's invoice and should be included in the summary of the prime Consultant's invoice.

Consultant shall regularly review project budgets per task versus percent of work completed per task to determine if there are any issues that need to be resolved, or if effective practices can be implemented to keep costs within budget. Tasks anticipated to exceed the total estimated costs must be identified and presented to the District as early as possible.

If the Consultant fails to comply with the above requirements, the District shall have the right to delay payment.

<u>Deliverables:</u>

- Monthly Progress Report and Invoice

f. Submittal Requirements

The Consultant shall submit draft reports and a final report of the Master Plan of Drainage Study for District review. The Consultant shall submit in PDF format electronic half-size (11"x17") and full-size hydrology maps for review by the District. All deliverables shall be clearly marked as being fully checked, and the preparation of the material followed the quality control plan established for the work. All deliverables shall contain signature by the Quality Assurance Officer. Reports, Cost Analysis Estimates, etc. The Consultant shall, at no additional cost to the District, correct errors, omissions, and unworkable and/or improper design/drafting on the original reports/drawings that are covered subsequent to the completion of the review process. The Consultant shall provide a copy of all transmittals, submittals, and letters sent to agencies regarding the project. Reports, Maps, Estimates shall be in English units and must conform to Federal, and District standards, regulations, policies, procedures, manuals, and practices. The Consultant shall provide clear, concise, and complete reports.

All plans (if applicable) shall be prepared in AutoCAD or Civil 3D. All maps shall be prepared in AutoCAD, Civil 3D, or ArcGIS Pro. The report, maps, H&H analyses, cost analyses, etc. are to be considered to be the property of the District at all times and shall be submitted to the District as hard and electronic files, upon completion or as otherwise directed by the District.

All project submittals shall meet the current guidelines and standards required by the applicable authority, be it District, County, State, FEMA, or CFR.

The Consultant shall be responsible for preparing the final Master Plan of Drainage signed by a Professional Engineer registered in the State of California.

<u>Deliverables:</u>

- Four (4) hard copy sets of the final Master Plan of Drainage
- Four (4) hard copy sets of full-size final Hydrology Maps
- Digital Files of all reports, studies, technical memorandums, maps, topographic data, and H&H analyses files
- 11"x17" PDF maps
- Full-size PDF Hydrology Maps
- Applicable referenced reports (digital copies only)

3. Project Approach

Tasks shall include project management and all tasks necessary to complete the Master Plan of Drainage, including, but not limited to, Literature Review and Field Investigations, obtaining suitable Topography data, Hydrology Analyses, Preliminary Hydraulics, Alternative Analysis including with and without basin alternatives, Cost Estimates, Recommendations and Facility Prioritization, Specific Drainage System Plans, Profiles, and Estimates, and Community Outreach. The consultant shall thoroughly document and discuss the hydrologic and hydraulic modeling including input parameters, standards used, and assumptions in the report. The consultant shall perform the hydrology analyses per the San Bernardino County Hydrology Manual utilizing software listed above.

a. Literature Review and Field Investigation

- Literature review of all relevant plans, drainage studies, hydrology reports, and other applicable data necessary to complete the MPD.
- The Consultant shall conduct field reviews of the project area as required for the MPD study. Field investigation will be used to evaluate current conditions, identify potential obstacles, perform surveying or measurements as needed, and provide photo documentation for reference. The field investigation will also be important to identify and evaluate existing drainage facilities and/or drainage courses.

b. Hydrologic and Hydraulic Analyses

(a) Hydrologic Analyses

(i) Perform hydrology calculations for the entire watershed per the San Bernardino County Hydrology Manual. Provide flowrates for the 5-, 10-, 25-, and 100-year storm events for the ultimate land use condition.

(ii) Current topography data shall be used for the hydrology analyses.

(iii) Determine bulking factor recommendations, and clear water flowrates should be determined.

(iv) Provide all hydrology calculations as a separate volume of the MPD.

(b) Preliminary Hydraulic Analyses

(i) Current topography data shall be used for the hydraulic analyses.

(ii) The hydraulic analyses should be performed on software specified above or using Manning's Equation to determine water surface elevations.

(iii) The hydraulic analyses will be approximate and preliminary. Facility sizing, type, and material should be determined and the water surface elevations calculated to demonstrate adequate freeboard per the Los Angeles County Flood Control District Hydraulic Design Manual (March 1982).

(c) Alternate Analysis

(i) Provide an alternative analysis that includes channel/storm drain only options versus channel/storm drain with basin options with final recommendation on channel/storm drain and/or basin combinations that should be implemented for each specific drainage system.

c. Cost Estimates

(i) Provide background and basic assumptions used for planning equivalent cost estimates including design (can be a percentage of construction costs), construction, right-of-way or easement acquisitions, environmental mitigation, and contingency costs.

(ii) Perform a development fee analysis to determine the cost per acre development to potentially fund future projects. The costs for this analysis should only consider the costs of implementing regional facilities.

(iii) Provide planning equivalent cost estimates for each drainage system divided into logical phases or reaches and include in the Specific Drainage System Plans, Profiles and, Estimates volume of the MPD.

d. Recommendations and Facility Prioritization

(i) Provide general recommendations relating to the goals and principles of the MPD and the District.

(ii) Provide specific recommendations including, but not limited to, facility priorities, basin and channel/storm drain alternatives, funding recommendations (e.g. development fee implementation), and periodical update recommendations.

e. Specific Drainage System Plans, Profiles, and Estimates

(i) Overall system reference map/s (could be divided into multiple maps) should be provided with existing and proposed channel and storm drain alignments. These maps can be 11”x17” maps for the report but full-size maps should also be provided. Unique systems identifiers should be used to distinguish different drainage systems.

(ii) Individual System channel and storm drain routing and alignments should be determined and include a minimum, but not limited to, approximate plans with alignments and flowrates and profiles with invert, top of channel, water surface elevations, slopes, flowrates, sizing, channel/storm drain type, channel/storm drain materials, etc.

(iii) The alignment and profile maps should be provided on 8.5”x11” sheets in a separate volume from the report.

<u>Deliverables:</u>

- At the Draft submittal phases (may consist of more than one (1) draft):
  - Digital Files of all reports, studies, technical memorandums, maps, topographic data, and H&H analyses files
  - 11”x17” PDF maps
  - Full-size PDF Hydrology Maps
  - Applicable referenced reports (digital copies only)
  - Responses to previous comments (not required for first draft)
- At the Final submittal phase:
  - Four (4) hard copy sets of the final Master Plan of Drainage
  - Four (4) hard copy sets of full-size final Hydrology Maps
  - Digital Files of all reports, studies, technical memorandums, maps, and H&H analyses

f. Community Outreach

- Community outreach shall be provided to inform the residents and stakeholders of the newly prepared Master Plan of Drainage and the benefits of this study.
- The consultant, with the assistance and cooperation of District staff, will conduct the outreach.

4. San Bernardino County Hydrology Manual

It should be noted that the District is in the process of updating its Hydrology Manual and the updated manual is anticipated to be released in the first quarter of 2026. Changes to the updated manual that may affect this MPD include a climate change factor applied to the precipitation, new bulking factor guidance, slight changes in the curve numbers, revised AMC maps, and new guidance for utilizing HEC-HMS.

Proposal description

Meets District Needs

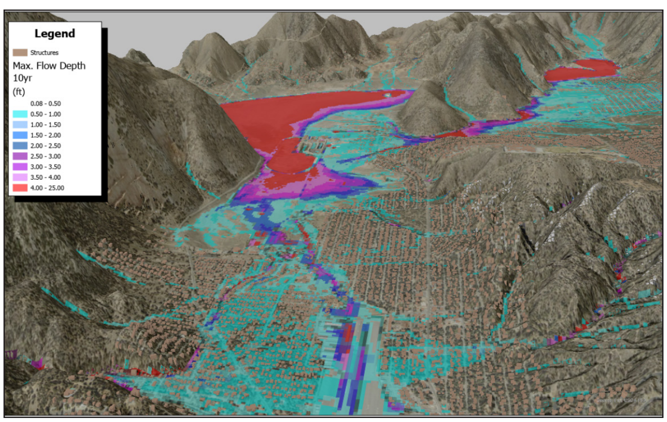
Brief synopsis of District/project needs and plans to meet needs

In general, the Big Bear Master Plan of Drainage (MPD) is a two-phase regional flood control planning study/project. Phase I involves identifying and characterizing the existing drainage, flooding sources, and flooding hazards. The second phase entails the evaluation of flood hazard mitigation alternatives based on Phase I findings. Major MPD objectives include:

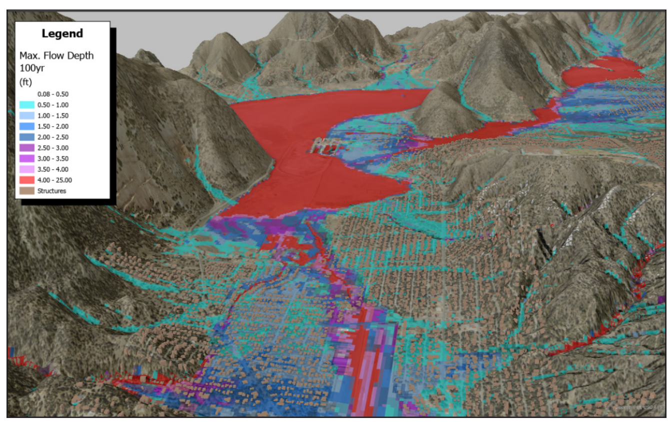
- Compile project-related information, including known flooding and drainage problems and existing infrastructure data, in a comprehensive dataset.
- Develop hydrologic and hydraulic (H&H) models that incorporate significant drainage landscapes, features, and infrastructure.
- Prepare a Flood Hazard Assessment (FHA) based on collected information/data and H&H modeling results. The FHA identifies, quantifies, and qualitatively describes significant drainage and flooding issues by evaluating flood prone area risk in terms of extent and magnitude of flooding and assessing the socioeconomic and financial impacts of flood damages.
- In collaboration with the District, City, and other affected stakeholders, prepare a Flooding and Drainage Issues Mitigation Plan and Strategy that identifies the following: flood mitigation projects that meet qualifying criteria; appropriate partnering relationships; and funding options for recommended projects.

Detailed statement of the proposed services

The Big Bear MPD study area is approximately 39.5 square miles in size. As shown in images directly below, an approximate H&H analyses of the 10-year and 100-year storm events show much of Big Bear may be subject to significant, broad flooding conditions. This type of flooding may result from significant precipitation, an intense rainfall pattern, and/or post-wildfire watershed conditions.



Approximate H&H analysis of the 10-year storm event.



Approximate H&H analysis of the 100-year storm event.

Watershed characteristics that influence flooding and drainage issues include the following:

1. **Mountainous terrain/steep watersheds.** Big Bear sits in the San Bernardino Mountains. Many drainages are steep, with rapid runoff during storms. Thus, rainfall can produce fast responses that can result in flash flooding and mud/debris flows.
2. **Post-wildfire flooding.** With steep slopes and post-wildfire watershed conditions, intense storms can generate fast runoff, bulked flows, and debris flows.

3. **Snowpack.** When a warm rainstorm hits snowpack, rapid melting can overload drainages, exacerbate runoff, possibly inundate low-lying areas.
4. **Culvert/inlet/channel blockage.** Debris (sediment, vegetation, fallen trees) can block inlets, culverts, or drainage channels, leading to local flooding. This is an issue especially during intense storms or with post-wildfire watershed conditions.
5. **Regulated lake/dammed reservoir.** Big Bear Lake has been regulated since the 1800s. The Lake's water surface level influences inflows from both natural and constructed channels/features.
6. **Drainage infrastructure constraints.** Fully coordinated storm drainage systems are limited in location, scale, and effectiveness. Much of the drainage is handled locally (streets, culverts, ditches, etc.). Major flood-carrying drainages have been constructed or improved, but may still be undersized.
7. **Flood risk.** A significant number of properties and roadways are believed to be at moderate or major risks from flooding.

Local drainage within Big Bear MPD study area.

Professional services to be provided under the Big Bear MPD are discussed in detail in the following sections.

Literature review and field investigation

Literature/data collection, compilation, and review

Given the size and complexity of the study area, the data collection effort must be efficient, accurate, comprehensive, and well documented. Based on our experience with similar projects, we recognize that data collection is a cornerstone task for the success of the MPD. Relevant plans, drainage studies, hydrology reports, and other supporting data will be compiled and reviewed to inform the analysis. This effort will encompass information such as existing infrastructure (location, size, and configuration), as-builts, utilities, land-use and zoning plans, soils data, rainfall records, documented maintenance records, GIS datasets, and FEMA flood hazard information. The findings from the literature review and data collection will be documented in a comprehensive **Literature Review and Field Investigation Report.**

Field investigations

High-tech tablet-based data collection will be employed during field investigations to maximize efficiency and accuracy in compiling site information. This approach is well suited for documenting large quantities of features within a short timeframe—for example, the numerous hydraulically significant structures (culverts, pipes, inlets, manholes, and outlets) within the study area that require field verification.

Field investigations will evaluate the condition of existing drainage facilities and natural drainage courses, documenting issues such as blockages, maintenance needs, damages, and evidence of overtopping. Photographs taken during fieldwork will be georeferenced, and a **Field Investigation Photograph Location Shapefile** will be prepared and provided.

Filed investigation efforts will be fully documented in a **Literature Review and Field Investigation Report.**

Infrastructure GIS database

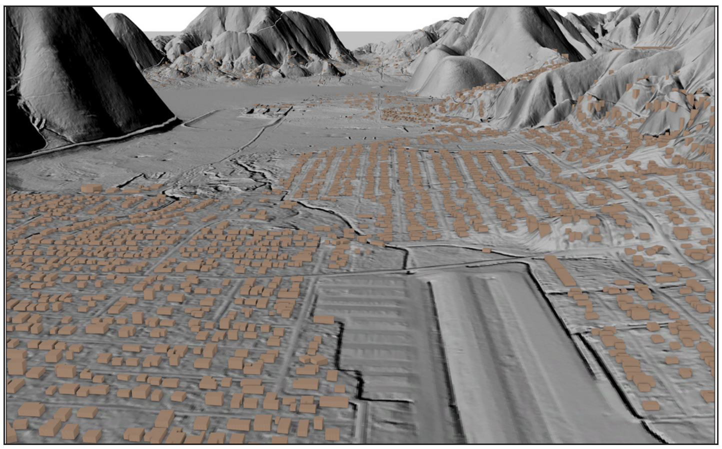
Collected infrastructure data (culverts, channels, basins, storm drain system components, etc.) will be compiled and provided to the District and City in an easy-to-use GIS database. The **Infrastructure GIS Database** will provide valuable information such as location, alignment, size, configuration, maintenance observations, and photographs.

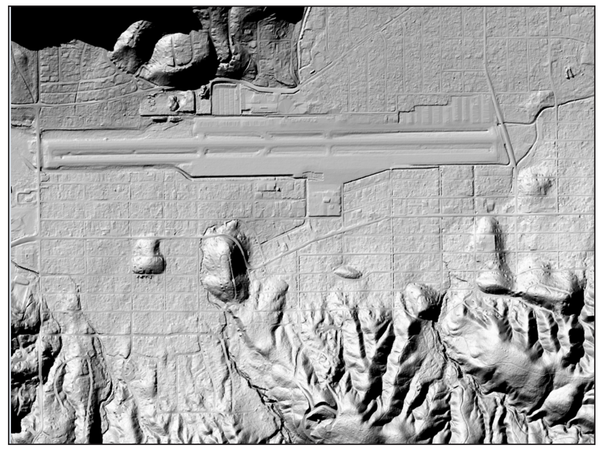
Survey and topographic data collection

Added Value

Review of existing topographic data

It is understood that current topographic data will be used for hydrologic and hydraulic analyses. If existing data proves insufficient, additional topographic data will be collected as needed. At present, the most readily available dataset is the USGS bare-earth digital elevation model (DEM) at 1-meter resolution. The USGS 3DEP LiDAR Base Specification requires 1-meter DEM at a minimum vertical accuracy of 10 centimeters or 4 inches measured as root mean square error (RMSEz), which in general is adequate for planning-level hydrologic modeling and for approximate, preliminary hydraulic modeling. To confirm accuracy and suitability for the MDP, the USGS DEM will be compared against known elevations (e.g., as-built plans, local survey data).





Renderings of available USGS topography and building footprints.

Supplemental topographic data collection

Where USGS topographic data is determined to be unsuitable for planning-level hydrologic modeling or preliminary hydraulic modeling, supplemental topographic data will be obtained through conventional surveying and/or drone-based acquisition. Our team includes local professional land surveyors who can be deployed quickly to help maintain the project schedule. All supplemental data will undergo accuracy review and will be certified by a California-registered land surveyor.

Hydrologic and hydraulic analyses

As highlighted above, Wilson & Company stays at the forefront of industry-standard H&H and sediment transport modeling. We employ cutting-edge GIS techniques and automation for modeling/project efficiency, without sacrificing accuracy. **For the Big Bear MPD, we have the technical expertise to perform the requisite H&H modeling, using any of the District-prescribed methodologies – including Advanced Engineering Software (AES), Civil Design, WSPG, FlowMaster, HEC-RAS (1D/2D), and PondPack.**

Technical Specs

At project initiation, an H&H Modeling Recommendations Memorandum will be provided to justify and document the recommended modeling methodologies, with specific reference to their consistency with the San Bernardino County Hydrology Manual. H&H modeling methodologies will be approved by the District prior to commencement of the modeling efforts.

Our team brings the technical expertise to efficiently perform District-approved, industry-standard H&H analyses that are critical to the success of the Big Bear MPD. This expertise is demonstrated by our extensive experience on numerous recent projects of similar scope (see **Table 1** on page 35).

Table 1. Abbreviated list of similar Drainage Master Plan projects.

Master Plan of Drainage Project	Client	Completion Date
Blood Tanks Wash Drainage Master Plan	Town of Miami, AZ	Ongoing
Queen Creek/East Mesa ADMS/P	FCD of Maricopa County	Ongoing
AC/DC ADMS/P	FCD of Maricopa County	Ongoing
Sunland Avenue ADMS and Floodplain Delin.	FCD of Maricopa County	Ongoing
Nye County FEMA Risk MAP	Nye County, NVD	Ongoing
Ajo Drainage Master Plan	Pima County FCD	Ongoing
Edwards AFB Piute Pond Complex DMP and Floodplain Delin.	Edwards AFB	09/2025
Adobe ADMS/P	FCD of Maricopa County	08/2025
East Shea Corridor ADMS/P	FCD of Maricopa County	06/2024
Camp Verde ADMS	Town of Camp Verde, AZ	06/2024
Prescott ADMS/FEMA Risk MAP	City of Prescott, AZ	06/2023
Desert Mountain ADMS	FCD of Maricopa County	09/2019
Detrital FEMA Risk MAP	Mohave County FCD	12/2018
Upper East Fork Cave Creek ADMS/P	FCD of Maricopa County	12/2017
Sacaton ADMS/P	Gila River Indian Community	02/2017

Our team has deep experience with the U.S. Army Corps of Engineers' Hydrologic Engineering Center (HEC) modeling suite, including HEC-RAS (1D/2D) and HEC-HMS. As an example, for the Edwards AFB Piute Pond Complex Drainage Master Plan and Floodplain Delineation, we performed watershed-scale H&H analyses with HEC-RAS 2D over an approximately 1,600-square-mile basin; the modeling was reviewed and approved by FEMA for use in official flood-hazard delineation.

To maximize overall project efficiency and make sure scope, schedule, and fee are maintained, preliminary H&H modeling will be completed as quickly as possible without sacrificing accuracy. Wilson & Company will use custom GIS automation to efficiently develop preliminary H&H models so that appropriate portions of the budget are spent on model refinements and model validations to yield results that accurately reflect drainage conditions. Wilson & Company stays at the forefront of H&H analyses and sediment transport modeling by leveraging cutting-edge GIS techniques and automation, including ESRI, QGIS, and Python programming. These tools allow us to efficiently develop precise model inputs, streamline the analysis process, and visualize results in user-friendly GIS formats. This approach enhances quality assurance, reduces project timelines, and provides cost savings for clients.

Hydrologic analyses

Technical Specs

General hydrologic modeling approach

Hydrologic analyses will be conducted for the full watershed extents and in compliance with the San Bernardino County Hydrologic Manual. Hydrologic modeling will be completed for the 5-, 10-, 25-, and 100-year storm events based on the ultimate land-use condition. Readily available and/or supplemental topographic data will be employed (**see "Survey and topographic data collection" on page 33**).

Key elements of hydrologic modeling center around capturing how rainfall (or other sources of water) becomes runoff, how that runoff moves through a watershed, and how it interacts with physical and environmental features. At a high level, hydrologic modeling considerations include:

1. **Watershed characteristics**
   - **Topography** – Defines watershed boundaries, slopes, and flow paths.
   - **Drainage network** – Streams, channels, and overland flow patterns.
   - **Land use/land cover** – Influences infiltration, evapotranspiration, and surface roughness.
   - **Soils** – Key to infiltration, percolation, and storage (hydrologic soil groups, hydraulic conductivity, storage capacity).

Technical Specs

2. **Meteorological inputs**
   - **Precipitation** – Rainfall depth, intensity, temporal distribution, spatial variability.
   - **Snowmelt** – Energy balance or temperature-index methods where relevant.
   - **Evapotranspiration (ET)** – Affects water balance and soil moisture.
3. **Hydrologic processes**
   - **Infiltration** – How rainfall penetrates soil (e.g., SCS Curve Number methods).
   - **Surface runoff** – Excess rainfall becoming direct runoff.
   - **Interception and depression storage** – Initial abstractions before runoff begins.
4. **Routing of flow**
   - **Overland flow** – Time of concentration, sheet vs. shallow concentrated flow.
   - **Channel routing** – Hydrologic (e.g., Muskingum) or hydraulic (e.g., kinematic/dynamic wave).
   - **Reservoirs and detention basins** – Storage-discharge relationships.
5. **Boundary conditions and validation**
   - **Initial conditions** – Antecedent soil moisture, lake levels.
   - **Calibration** – Adjusting model parameters against observed data (streamflow, rainfall-runoff events).
   - **Validation** – Testing model performance on independent events.
6. **Model setup and execution**
   - **Model choice** – Lumped vs. distributed.
   - **Parameterization** – Assigning physical or empirical parameters.
   - **Computational mesh/grid** – For distributed models.
   - **Simulation controls** – Time step, simulation period, rainfall distribution.
7. **Outputs and applications**
   - **Hydrographs** – Flow vs. time at points of interest.
   - **Runoff volumes and peak discharges** – Key design parameters.
   - **Water balance summaries** – Partitioning into runoff, ET, infiltration.
   - **Flood frequency analysis** – Linking hydrology to risk assessment.

It is recognized that San Bernardino County's hydrologic modeling guidance is currently being updated. As appropriate, the hydrologic modeling for the Big Bear MPD will adhere to the revised guidance, including requirements for Curve Number (CN) application, rainfall adjustment factors, rainfall intensity determination, and bulking factors. **The Big Bear MPD is a pivotal project for the District because it provides an opportunity for "third-party" application and verification of the new guidance.** As part of the Big Bear MPD, we will provide the District with a detailed review of new hydrologic guidance.

Post-wildfire hydrologic modeling

Added Value

HEC-HMS is a strong and practical tool for post-wildfire hydrology, especially for simulating peak flows, hydrographs, and flood hazards in burned watersheds. Its performance depends heavily on careful parameterization and periodic updates to reflect evolving watershed conditions. For sediment/debris flow hazards, it often needs to be paired with HEC-RAS or debris-flow models for a more complete post-fire flood risk picture.

Strengths of HEC-HMS for post-wildfire hydrology include the following:

- **Flexibility in loss methods** – HEC-HMS supports a range of loss models (e.g., SCS Curve Number, Green-Ampt, Deficit/Constant). These can be adapted to represent wildfire-impacted soils with drastically reduced infiltration.
- **Event-based & continuous modeling** – Useful for both single-storm flood assessment and longer-term recovery simulations.
- **Established workflows** – The U.S. Army Corps of Engineers, USFS, NRCS, and many state agencies provide guidance for adapting HMS to burned watersheds.
- **Integration with GIS/DEM** – Works well with burned-area emergency response (BAER) products, such as soil burn severity maps, which can be tied to curve number adjustments.
- **Routing options** – Muskingum, kinematic wave, and reservoir routing can capture flashy hydrologic response downstream of burned basins.

Limitations of HEC-HMS for post-wildfire hydrology include the following:

- **Spatial resolution** – HEC-HMS is typically lumped or semi-distributed; it doesn't natively simulate detailed erosion, debris flows, or hyperconcentrated flows (though sediment modules exist in newer versions).
- **Calibration challenges** – Post-fire conditions often lack long-term data; models must rely on regional regression, literature, or short post-fire gage records.
- **Rapidly changing conditions** – Soil infiltration and vegetation recovery evolve within months to years post-fire, requiring time-staged parameter adjustments.
- **Extreme runoff scenarios** – HEC-HMS can simulate high-runoff events, but it may under- or over-predict if infiltration reduction and hydrophobicity are not parameterized carefully.

Best practices for using HEC-HMS for post-wildfire hydrologic modeling include:

- **Adjust curve numbers / infiltration rates** based on burn severity (often 5–30% higher CNs than pre-fire, or nearly impervious in severely burned areas).
- **Incorporate rainfall–runoff sensitivity testing** with short-duration, high-intensity storms (e.g., NOAA Atlas 14, convective storm, quartile 1 intensity curves).
- **Use local/regional post-fire guidance** (e.g., USFS BAER team data, NRCS post-fire hydrology adjustments).
- **Update soil and vegetation parameters** periodically as the watershed recovers.
- **Validate against observed events** (even if limited) or leverage nearby burned watershed studies.

Clear water flow rates and bulking factors

Added Value

Clear water flow rates and bulking factors will be determined as part of the hydrologic modeling effort. Understanding both is critical in flood hazard assessment, post-wildfire hydrology, sediment transport, and debris flow analyses. New bulking factor guidance will be appropriately adopted.

Technical Specs

Clear water flow rates represent runoff without sedimentation/debris (hydrologic flow only). They can be estimated through standard hydrologic modeling methodologies – such as use of HEC-HMS. Bulking factors account for sediment and debris volume entrained in runoff, increasing flow depths and discharges. Bulking factors are applied as multipliers to the clear-water hydrograph or volumes. Bulking factor determination methods include:

1. **Empirical/guidance-based approaches**
    - **Post-fire hydrology guidance (FEMA, USFS, NRCS, state manuals)** often recommends bulking factors in the range of 1.1–1.5 for sediment-laden flow and up to 2.0–3.0+ for debris flow conditions, depending on watershed condition.
    - Local agencies provide **standard bulking factors** based on geology, slopes, and burn severity.

2. **Sediment yield methods**
   - Estimate sediment yield using models (e.g., MUSLE, WEPP, AGWA, sediment transport modules in HEC-HMS).
   - Convert yield (volume or mass) to an equivalent flow bulking factor by distributing across hydrograph volume.
3. **Debris flow probability/volume models**
   - **USGS empirical equations** (Cannon et al., Gartner et al.) predict debris-flow volumes from burned basins using predictors like basin area, slope, and rainfall intensity.
   - Resulting debris volume is added to the clear-water hydrograph, producing a bulked hydrograph.
4. **Hydraulic/geomorphic judgment**
   - Compare with field evidence (sediment deposits, past flood events, channel aggradation).
   - Use geomorphic assessment + regional regression equations.

A typical workflow when accounting for clear water flow rates and bulking factors is as follows:

1. **Develop clear-water hydrographs** → hydrologic modeling.
2. **Estimate sediment/debris contribution** → agency factors, sediment yield models, or debris flow equations.
3. **Apply bulking factor** → scale hydrograph discharge or volume (e.g., Qbulked = Qclear × Factor).
4. **Run hydraulic model (e.g., HEC-RAS)** → simulate depths, velocities, and inundation.

Preliminary hydraulic analyses

General hydraulic modeling approach

Technical Specs

Using hydrologic modeling results (**see "Literature review and field investigation" on page 32**), **preliminary hydraulic analyses will be conducted to determine drainage facility conveyance capacity per the Los Angeles County Flood Control District Hydraulic Design Manual.** Readily available and/or supplemental topographic data will be employed (**see "Survey and topographic data collection" on page 33**). Hydraulic modeling may be conducted using HEC-RAS (1-D/2-D). A 2-dimensional hydraulic modeling approach may be employed where drainage conditions are defined by the following: channel overtopping onto broad overbank areas; broad, shallow, unconfined sheetflow; and/or flowpath uncertainty. Key modeling elements that will be evaluated during hydraulic model development include the following:

1. **High-quality base data**
   - **Topography/survey** – LiDAR DEMs, bathymetric survey, channel cross-sections, and bridge/culvert geometry.
   - **Land-use/roughness** – Manning's n values calibrated to channel and floodplain conditions.
   - Hydrologic inputs – Hydrographs from HEC-HMS or other approved methods; boundary conditions at upstream/downstream limits.
   - **Structures** – Accurate representation of bridges, culverts, levees, dams, weirs, and storage areas.
2. **Well-constructed geometry**
   - **Cross-section placement** – Enough density to capture hydraulic controls (constrictions, bends, junctions, tributary confluences).
   - **Proper alignment** – Cross-sections perpendicular to flow paths and extending far enough into floodplains.
   - **Hydraulic connectivity** – Bank stations, ineffective flow areas, and levee markers applied correctly.
   - **Terrain integration** – For 2D models, well-resolved computational mesh that balances detail with stability.

3. **Appropriate hydraulic parameters**
   - **Manning's *n*** – Values based on field conditions, literature, and (ideally) calibration.
   - **Expansion/contraction coefficients** – Applied near bridges, culverts, and transitions.
   - **Boundary conditions** – Stage, normal depth, rating curves, or known hydrographs chosen appropriately.
   - **Flow distribution** – Reasonable split between main channel and overbanks.
4. **Appropriate model setup**
   - **Steady vs. unsteady choice** – Appropriate to study objectives (e.g., design water surfaces vs. dynamic hydrographs).
   - **Computation controls** – Time step and tolerances chosen to balance accuracy and stability.
   - **Storage/2D areas** – Applied for floodplains, reservoirs, or complex hydraulics.
   - **Structures modeled correctly** – Bridge decks, weir flow, pressure flow, culvert barrel roughness.
5. **Calibration and validation**
   - **Observed data comparison** – High-water marks, stream gage records, past flood events.
   - **Adjustments** – Manning's n, ineffective areas, expansion/contraction coefficients tuned within reasonable ranges.
   - **Sensitivity testing** – Confirms model robustness under parameter uncertainty.

H&H modeling validation

Validation is one of the most important steps in H&H modeling, because it verifies that **models reflect real-world conditions** rather than just theoretical assumptions. Validated models provide the following benefits:

Added Value

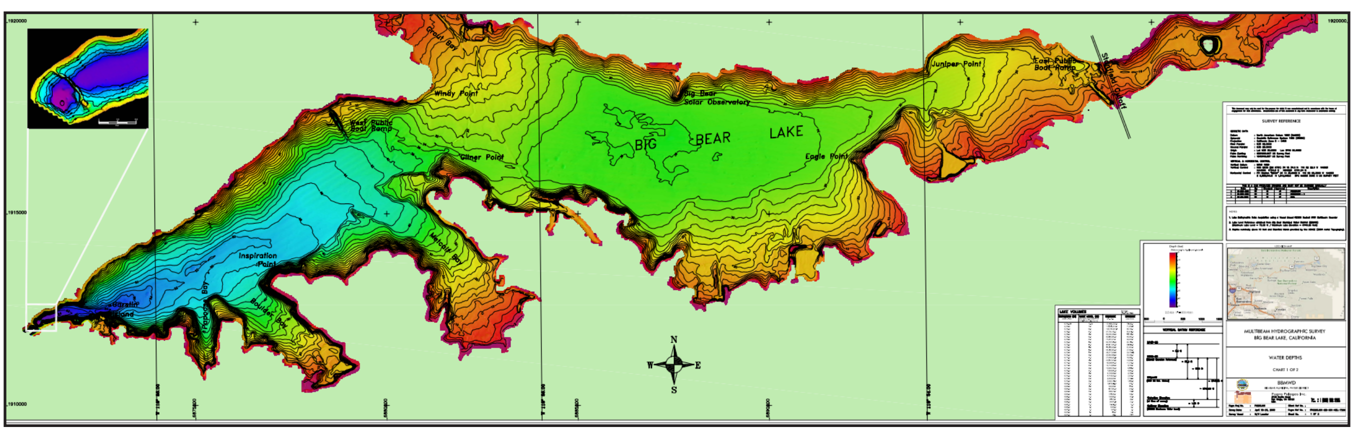
Technical Specs

Quality Control

1. Improves accuracy of predictions.
2. Accounts for local watershed conditions.
3. Supports regulatory and stakeholder acceptance.
4. Reduces uncertainty in design and risk assessment.
5. Enables more reliable scenario testing.

For the Big Bear MPD, H&H modeling validation opportunities include:

1. Big Bear Municipal Water District (BBMWD) monitors the lake water surface elevation. **Given the influence of the lake level on drainage, modeling real storms with the known lake levels as a boundary condition is an H&H calibration approach.**
2. BBMWD has lake bathymetry (see image below), which could be incorporated in the H&H modeling.



Big Bear Lake bathymetry.

3. In 2019 February, a severe storm caused significant flooding across the area (see photographs below). Modeling of this real storm could be used for model validation and to identify areas for drainage improvements. **It should be noted that Wilson & Company routinely models actual historic storm events, both spatially and temporally, for model validation.**

2019 flooding within Big Bear. Images courtesy of KBHR933.com.

Alternatives analysis

Validated base/existing condition H&H modeling will be the basis for modeling of flood mitigation and stormwater management alternatives that improve drainage, decrease flood risk, and reduce flood-prone areas. The alternatives analysis will compare channel/storm drain only versus channel/storm drain with basin options. Comparison results will be utilized to determine recommended alternatives for each Area of Interest (AOI) and each specific drainage system (**see "Flood Hazard Assessment" on page 39 and "Development of flood mitigation alternatives" on page 43**).

Flood Hazard Assessment

Added Value

A Flood Hazard Assessment (FHA) pulls together hydrology, hydraulics, risk analysis, and collected information/data to identify where flooding is likely to occur, how severe it may be, and what risk it poses to people, property, and infrastructure. The FHA identifies, quantifies, and qualitatively describes significant drainage and flooding issues by evaluating flood prone area risk in terms of extent and magnitude of flooding and assessing the socioeconomic and financial impacts of flood damages. As part of the Big Bear MPD, a **Flood Hazard Assessment Report** will be provided to document hazard classifications, identified Areas of Interest (AOIs), and prioritization of AOIs.

Hazard classifications

When assessing flood hazards, the hydrologic and hydraulic modeling results typically focused on independently are discharge, flow depth, and flow velocity. However, for a robust assessment of flood hazards, the relationship between flow depth and flow velocity should be evaluated. **As part of the FHA, combined flood hazard classifications based on the relationship between flow depth and flow velocity will be provided across the full watershed – neighborhoods, streets, channels, parks, critical facilities, etc.**

The FEMA-approved flood hazard classifications presented below were based on research conducted by the University of New South Wales, School of Civil and Environmental Engineering, Water Research Laboratory and published in the WRL Flood Hazard Technical Report. Combined flood hazard classifications (curves) prescribed in the WRL Flood Hazard Technical Report are based on the relationship between flow depth and flow velocity. These flood hazard curves address flood risk to people, vehicles, and buildings. There are six hazard classifications as shown in **Figure 1**, **Table 2**, and **Figure 2**. This information can be used to assess the flood risks to the population as well as the structures within the study area. This information will be provided for each modeled storm event and alternative scenario.

Figure 1. Combined flood hazard classifications chart.

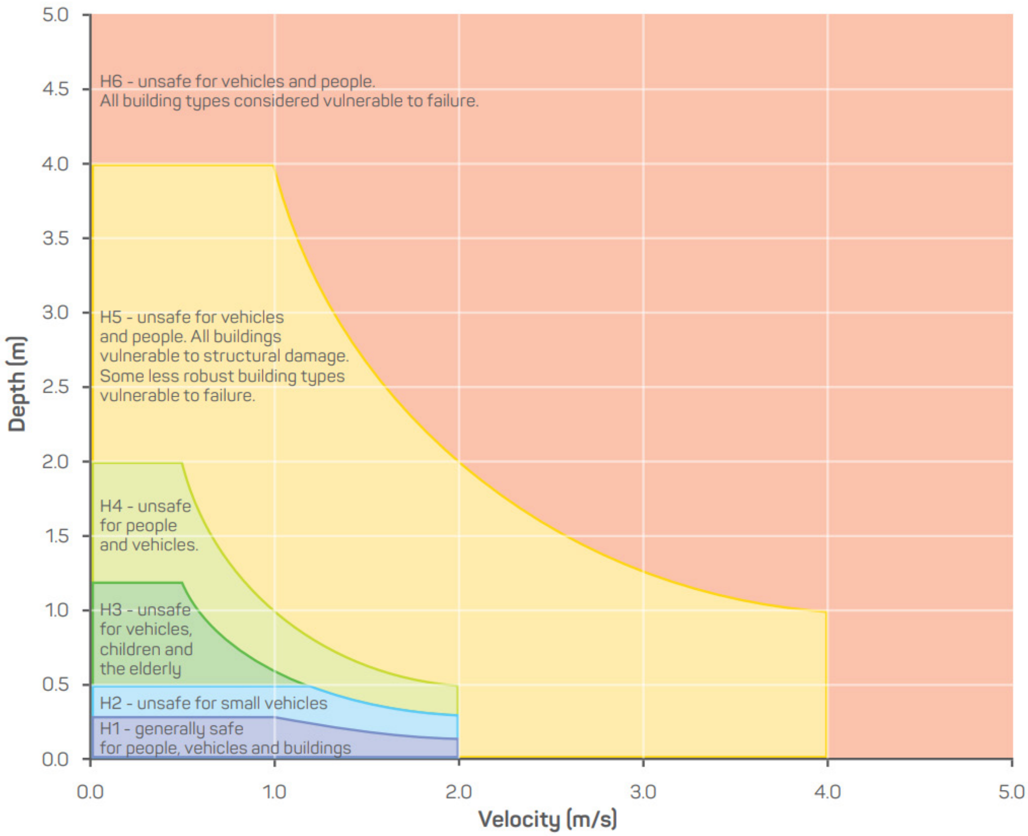
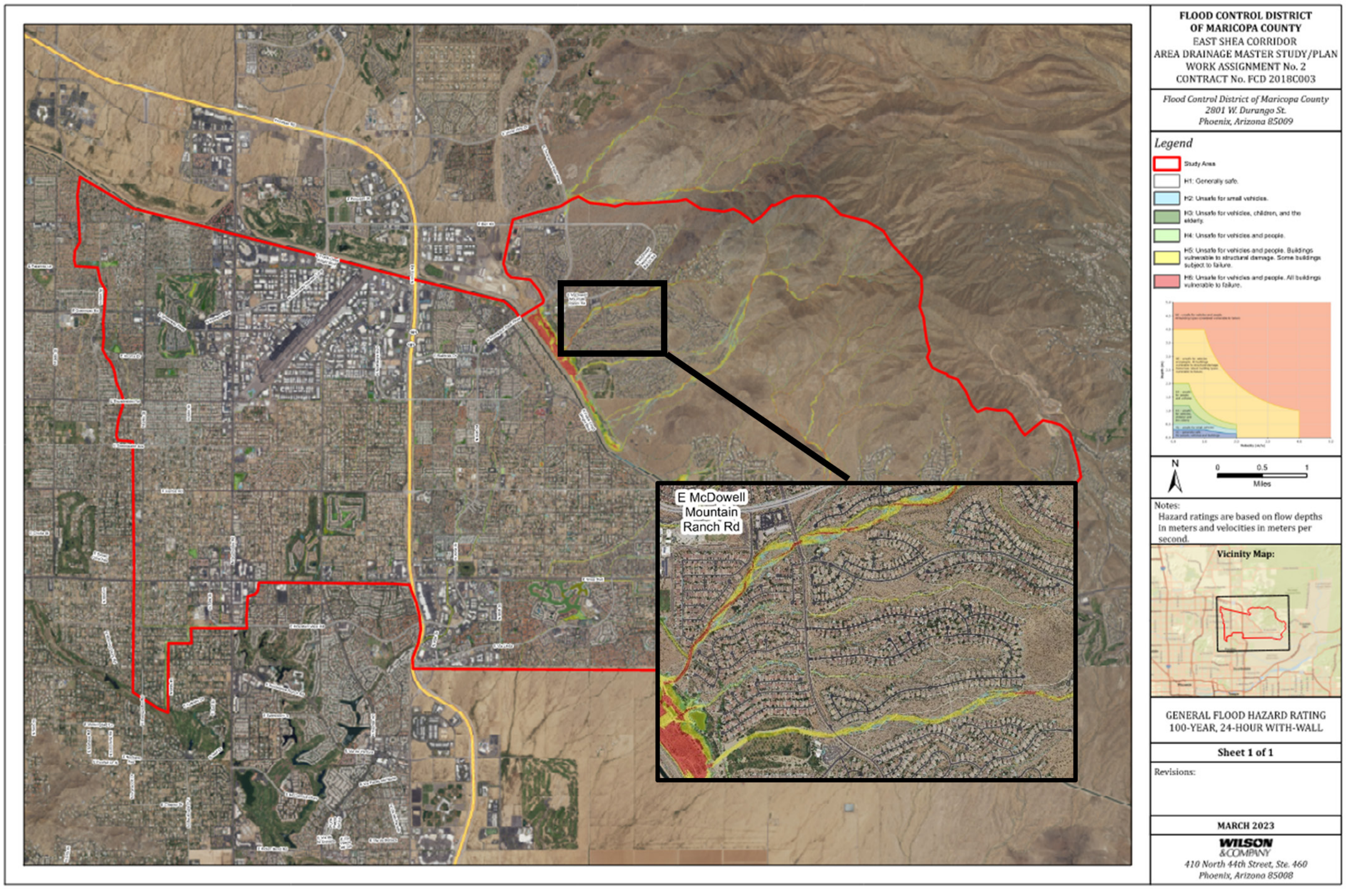


Table 2. Combined flood hazard classification descriptions.

Hazard Vulnerability Classification	Description
H1	Generally safe for vehicles, people and buildings.
H2	Unsafe for small vehicles.
H3	Unsafe for vehicles, children, and the elderly.
H4	Unsafe for vehicles and people.
H5	Unsafe for vehicles and people. All buildings vulnerable to structural damage. Some less robust buildings subject to failure.
H6	Unsafe for vehicles and people. All building types considered vulnerable to failure.

Figure 2. Flood hazard classifications at a study-scale for an Area Drainage Master Study for the Cities of Scottsdale and Phoenix, AZ.



Identification of Flooding Areas of Interest

A Flooding Area of Interest (AOI) is a specific location or sub-area within a larger study region that has been identified as being at risk of flooding, or that requires focused analysis. It is essentially a "hotspot" for more detailed hydrologic and hydraulic evaluation and flood mitigation alternative development. A flooding AOI commonly has one or more of the following key characteristics:

- **Known or reported flood problems** – areas with documented flooding during past storms, citizen complaints, or observed high-water marks.
- **Hydraulic controls** – locations where culverts, bridges, or channels may be undersized, blocked, or restrictive.
- **High-value assets at risk** – neighborhoods, businesses, roads, utilities, or critical facilities located within flood-prone areas.
- **Modeling significance** – areas where localized conditions (steep slopes, confluences, flat floodplains) may drive unique hydraulic responses not captured at the watershed scale.
- **Regulatory/management interest** – zones highlighted by FEMA floodplains, local flood control districts, or municipalities for detailed flood hazard assessment.

Flooding AOIs will be identified as part of the FHA based on several pieces of data and information, including, but not limited to, the following: modeling results; hazard classifications; maintenance reports/records; drainage complaint logs; stakeholder/public input; and District and City staff reporting. Once identified, AOI information offers the following beneficial uses:

- **Prioritization** – Helps focus resources on the areas with the greatest risk or stakeholder concern.
- **Detailed modeling** – Higher-resolution H&H models (e.g., 2D HEC-RAS) are developed at AOIs, even if the rest of the watershed is modeled at planning-level detail.
- **Targeted mitigation planning** – AOIs become the basis for identifying and evaluating flood mitigation alternatives (detention basins, storm drains, channel improvements, GSI, etc.).
- **Stakeholder communication** – AOIs provide a clear way to present results to communities, showing where flood risks are most critical.

Identified Flooding AOIs will be fully documented in the Flood Hazard Assessment Report.

Building structures impacted by flooding

Added Value

Wilson & Company has developed custom scripts to quickly and accurately evaluate various scenarios for building structures impacted by flooding (see **Table 3**). Knowing how many building structures are impacted by flooding helps to prioritize AOIs, evaluate effectiveness of mitigation measures, and justify need of grant money assistance.

Table 3. Impacted buildings table excerpt from an Area Drainage Master Study for Cities of Scottsdale and Phoenix, AZ.

Building Perimeter Impacts	Number of Flood-Impacted Buildings per Modeled Scenario			
	Without-Walls 10-Year, 24-Hour	Without-Walls 100-Year, 24-Hour	With-Walls 10-Year, 24-Hour	With-Walls 100-Year, 24-Hour
3-inches of flow depth for at least 80% of the building footprint	29	41	137	128
6-inches of flow depth for at least 25% of the building footprint	215	241	799	743
12-inches of flow depth for at least 10% of the building footprint	217	245	474	567
3-inch average flow depth along full building footprint	351	378	1,219	1,162
6-inch average flow depth along full building footprint	47	50	173	198
12-inch average flow depth along full building footprint	10	11	35	40

Prioritization of Flooding Areas of Interest

Meets District Needs

As noted above, prioritizing Flooding AOIs confirms resources and efforts are directed toward the areas of greatest risk and stakeholder concern. AOIs will be ranked using collected data, analytical results, and recommendations documented in the Flood Hazard Assessment Report. The prioritization process will be guided by criteria established in collaboration with the District and project stakeholders. Based on these priorities, flood mitigation alternatives will be developed for the highest-ranked AOIs (**"Development of flood mitigation alternatives" on page 43**).

Development of flood mitigation alternatives

Preliminary flood mitigation alternatives development and evaluation

Based on the collected data, modeling results, and flood hazard assessment findings discussed above, **Preliminary Flood Mitigation Alternatives** will be developed for each identified Area of Interest (AOI) (**see "Flood Hazard Assessment" on page 39**). These alternatives will be qualitatively evaluated using District-approved criteria and a **Mitigation Alternatives Evaluation Matrix** (see **Table 4**).

Table 4. Flood Mitigation Evaluation Matrix excerpt from an Area Drainage Master Study for Cities of Scottsdale and Pheonix, AZ.

AOI No. 1 Evaluation							
Scoring Criteria	**Weighting Factor**	**Do Nothing**	**Alternative 1**	**Alternative 2**	**Alternative 3**	**Total Raw Score**	**Total Weighted Score**
Capital Costs (Low, Medium, High)	3	4.0	1.5	3.0	1.5	10.0	30.0
Level of Protection (Low, Medium, High)	3	0.0	5.0	3.0	2.0	10.0	30.0
Stakeholder Support (Unlikely, Likely, Very Likely)	3	1.0	5.0	3.0	1.0	10.0	30.0
O&M Costs (Low, Medium, High)	2	3.0	4.0	1.5	1.5	10.0	20.0
GSI Benefits (Low, Medium, High)	2	0.0	0.0	5.0	5.0	10.0	20.0
Utility Conflicts (None, Minor, Significant)	2	5.0	1.0	2.0	2.0	10.0	20.0
Available Right-of-Way (None, Partial, Full)	3	2.5	2.5	2.5	2.5	10.0	30.0
Project Partnership (Unlikely, Likely, Very Likely)	1	1.0	5.0	2.0	2.0	10.0	10.0
	Composite Score	**39.5**	**57.0**	**53.5**	**40.0**	**80**	**190.0**

A **Preliminary Flood Mitigation Alternatives Evaluation Meeting** will be held to review and assess each alternative against approved criteria. Meeting participants will include District staff, identified project partners, and the Consulting Team. The Mitigation Alternatives Evaluation Matrix will document the qualitative evaluation findings for each AOI.

Development of the Preliminary Flood Mitigation Alternatives will remain conceptual—sufficient to clearly describe the alternative and support its qualitative evaluation.

Based on the Mitigation Alternatives Evaluation Matrix results approved during the Preliminary Flood Mitigation Alternatives Evaluation Meeting, a **Recommended Flood Mitigation Alternative** will be identified for each AOI. This recommendation will represent the most viable and feasible solution for that location.

Recommended flood mitigation alternatives development and refinement

Initial development

Recommended flood mitigation alternatives may include a range of treatments such as inline basins, offline basins, channelization, channel modifications, new/upgraded storm drain systems, and/or a combination of listed alternatives. In addition, decentralized approaches—such as Low Impact Development (LID), Green Stormwater Infrastructure (GSI), and other low-cost, low-tech solutions—will be considered as part of an integrated stormwater management strategy. The goal is to identify the most viable, feasible, cost-effective alternative for each AOI.

Each Recommended Alternative will include the following conceptual-level information:

Meets District Needs

1. Approximate location, size, and alignment of proposed improvements;
2. Anticipated performance of improvements;
3. Opinion of probable construction costs;
4. Identification of potential utility conflicts; and
5. Estimated right-of-way or easement requirements.

Documentation will include plan view drawings of the proposed improvements, with profile views, detail sheets, and specifications provided as appropriate.

Where necessary, conceptual-level hydraulic analyses will be performed for each Recommended Alternative. The analysis approach—including the level of effort, modeling techniques, and associated computations—will be reviewed and approved by the District prior to implementation.

Refinement

A **Recommended Flood Mitigation Alternatives Presentation Meeting** will be held with District staff, identified project partners, and the Consulting Team. The purpose of this meeting is to solicit feedback and gather input on the Recommended Flood Mitigation Alternative for each AOI. The findings and information obtained will guide the refinement of the Recommended Alternatives.

Following the meeting, the **Recommended Flood Mitigation Alternatives** will be refined and re-evaluated as necessary. The refined alternatives will be provided to the District and project partners for review. All review comments will be addressed before the Recommended Flood Mitigation Alternatives are finalized.

Cost estimates for recommended alternatives

Background investigation

A good cost estimate not only predicts project cost but also builds confidence for owners, designers, and contractors. Our reliable, accurate cost estimating will incorporate the following:

- Using **up-to-date unit costs** from trusted sources (RSMeans, state DOT bid tabs, agency databases, past projects).
- Adjusting for **regional factors** (labor rates, materials availability, haul distances, urban vs. rural).
- Incorporating **market conditions** (supply chain volatility, inflation, fuel prices).

A **Basis of Estimate (BOE)** will be provided to document methods used, data sources and unit cost references, assumptions, and contingency rationale.

Development fee analysis

To determine costs of implementing flood mitigation alternatives, a **Development Fee Analysis** will be performed to determine cost per acre, linear foot, square foot, cubic yard, etc. for each alternative component.

Planning equivalent cost estimates

Based on the Development Fee Analysis for each flood mitigation alternative, a **Planning Cost Estimate** for each drainage system will be developed and include logical implementation phases/reaches. The Planning Cost Estimate information will be included with the drainage system plans, profiles, etc.

Recommendations and facility prioritization for recommended alternatives

Meets District Needs

General recommendations

General recommendations aligned with the goals and principles of the MPD and the District will be developed, evaluated, refined, and ultimately approved. While these general recommendations will focus on flood mitigation alternatives and drainage system improvements, they may also address updates to floodplain ordinances, revisions to flood hazard delineations, enhanced public and stakeholder outreach efforts, identification of future projects, project phasing, environmental permitting, and pursuit of grant funding opportunities. Furthermore, **project and drainage system prioritization and phasing will be provided with the general recommendations.**

Specific recommendations

Specific recommendations for drainage systems and flood mitigation alternatives will be provided. Specific recommendations may include construction techniques, material types, facility priorities, construction phasing, channel/storm drain alternatives, and funding recommendations.

Added Value

It should be noted that Wilson & Company has a dedicated Grantsmanship Group working to secure project funding for our clients. Wilson & Company's funding services team collaborates with clients to identify, prioritize, and plan infrastructure and community development project needs. Our experienced funding specialists have experience assisting clients in preparing grant applications for numerous funding agencies including state, federal, and private sources. We have over 20 years of experience providing these services to a variety of clients, including urban and rural communities, councils of governments, tribal entities, school districts, departments of transportation, special districts, and others. We take pride in our ability to work with communities to find sources of funding so they can pursue much-needed infrastructure and community development projects. **Since 2020, Wilson & Company has secured over $280 million in funding for our clients.**

Drainage system plans, profiles, and estimates for recommended alternatives

Overall system reference maps (full study area)

An **Overall Drainage Systems Map** will be provided. The Overall Drainage Systems Map will show existing and proposed channel and storm drain alignments. Unique system identifiers will be developed to distinguish the different drainage systems.

Individual system plans, profiles, and estimates (system specific)

Plans, profiles, and cost estimates will be developed, reviewed and approved for specific drainage systems. Plan views will include alignments and identified project constraints, such as utilities, rights-of-way, easements, property ownership, etc. Profile views will include inverts, top-of-channel, water surface elevations, utility conflicts, etc. Both plan and profile sheets will include facility dimensions, material, flow rates, etc.

It should be mentioned that Wilson & Company excels in the production of plans, specifications, and cost estimates (PS&E). Our extensive design resume demonstrates our expertise in developing high quality PS&E. **Our PS&E documents will be clear, concise, and thorough.**

Specific drainage system recommendations will be provided as 8.5"x11" figures, 11"x17" maps, and full-size drawings (24"x36" or larger).

Environmental review

An environmental review will be conducted. This review will compile and evaluate existing data to identify potential environmental opportunities, constraints, and risks. The environmental review will assess the biological environment (e.g., vegetation, wildlife, wetlands), cultural and socioeconomic environment (historic/cultural resources), and regulatory environment (e.g., EPA, NEPA, CEQA, CWA Section 404/401 requirements). The environmental review will document relevant findings, such as:

- **Potential impacts, risks, and constraints.**
- **Fatal flaws** or red flags (e.g., large wetland fill, listed species habitat).
- **Highlight opportunities** (mitigation banking, habitat restoration, green infrastructure).
- **Data gaps** requiring field verification.

Community outreach and stakeholder coordination

Outreach to community members and stakeholders will begin early and remain consistent throughout the project, with an emphasis on providing materials that are clear, accessible, and easy to understand. Because many community members may be unfamiliar with drainage studies and related concepts, the outreach program will prioritize education, convenient access to project information, and multiple opportunities for input. Drawing on our experience with similar projects, we recognize that while developing technically effective solutions is essential, long-term success requires those solutions to also reflect community character and earn public acceptance.

Arellano Associates brings proven expertise in public engagement and is uniquely qualified to foster meaningful connections with diverse audiences. Their involvement will achieve sustained engagement, open dialogue, and constructive feedback. All outreach activities will be thoroughly documented and summarized in a **Public Involvement Report**, which will also include a comprehensive **Project Stakeholder Database**.

Quality assurance/quality control (QA/QC)

Quality Control

It is understood that all project submittals will meet current guidelines and standards required by the applicable authority, be it District, County, State, FEMA, and/or CFR.

A **good Quality Control (QC) Plan** is structured, repeatable, and transparent — ensuring that project deliverables meet technical standards, client expectations, and regulatory requirements. In engineering and planning projects (like drainage studies, watershed plans, or design packages), the QC workflow should combine **independent review, documentation, and accountability.** The QC Plan will be drafted, reviewed and approved by the District prior to the Kick-Off Meeting.

David Song of Civiltec will serve as the Quality Assurance Officer. He brings 20-plus years of professional engineering experience to the project. David is well qualified to manage QA/QC workflow for each major task and specific drainage system. **He will confirm deliverables meet District standards, document the QA/QC workflow, and sign off on all final deliverables.** The QA/QC workflow will be well documented in the QC Plan, which will include the following:

1. **Plan QC early**
    - Define QC expectations prior to kick-off meeting.
    - Identify reviewers and their roles (technical lead, independent reviewer, discipline-specific experts).
    - Establish QC checkpoints tied to project milestones.

2. **Data and input verification**
   - Confirm all source data (survey, GIS, rainfall records, as-builts) are correct, current, and properly referenced.
   - Check consistency between datasets (e.g., DEM vs. cross-sections, land use vs. soils).
   - Document data sources.
3. **Modeling/analysis QC**
   - **Self-checks** – Modeler/analyst verifies inputs, runs sensitivity checks, reviews warnings/errors.
   - **Peer review** – Independent team member reviews hydrologic/hydraulic models, parameterization, and results.
   - **Calibration/validation check** – Compare modeled outputs against observed or expected data.
   - **Redundancy** – Spot-check calculations manually or with alternative methods.
4. **Draft deliverable review**
   - **Technical review –** Confirm methods, assumptions, and results align with standards (District, County, State, FEMA, USACE, etc.).
   - **Consistency review** – Cross-check figures, tables, maps, and narrative for alignment.
   - **Clarity review** – Confirm results are clearly communicated and defensible for technical and non-technical audiences.
5. **Document QC process**
   - Use **checklists** for model setup, calculations, report sections, and graphics.
   - Record comments and resolutions in a **QC log** or comment-response matrix.
   - Require reviewer sign-off (with date and initials) for accountability.
6. **Final QA/QC sign-off**
   - **Quality assurance (QA)** – Quality Assurance Officer confirms QC was performed properly.
   - Confirm that all comments were addressed before submittal.
   - Archive final deliverables, QC checklists, and comment logs for future reference.
7. **Continuous improvement**
   - Conduct a **post-project debrief** to capture lessons learned.
   - Update QC checklists/templates to reflect new standards or recurring issues.
   - Provide training where systematic errors are observed.

Risk management

Risk Mgmt.

Risk management is about reducing the likelihood or severity of negative outcomes while enabling informed decision-making. Effective risk management improves decision-making and confidence; protects scope, schedule, and budget; reduces surprises (costly rework); enhances project team collaboration; and promotes proactive rather than reactive management. As part of the Big Bear MPD, a Risk Management Register will be developed to document identified risks, the likelihood of risks, the impact of risks, and the risk mitigation actions. An abbreviated list of potential project risks and mitigation strategies is provided below in **Table 5**.

Table 5. Abbreviated list of potential project risks and mitigation strategies.

Potential Project Risk	Risk Mitigation Strategies
Modeling validation	Obtain lake level data early to analyze and cross-reference actual storm events for validation H&H modeling. Coordinate with maintenance crews and residents to collect anecdotal evidence of flooding. Collect field photographs, social media postings, etc. showing flooding conditions.
Data adequacy (e.g., topography, as-builts, utilities, property information)	Early assessment and determination of adequacy of data to be used for H&H modeling, development of flood mitigation alternatives/systems, preparation of PS&Es, etc. Where data is inadequate, develop cost-effective strategy for developing/obtaining supplemental data, such that scope, schedule and cost are not adversely impacted.
Post-fire hydrologic, debris flow modeling	Select modeling methodology capable of simulating steep terrain and high sediment loads. Calibrate against post-fire event data if available. Run sensitivity analyses on key parameters. Use best available topographic data. Incorporate burn severity mapping into hydrologic parameterization. Collect field data to validate assumptions.
Snowmelt hydrologic and hydraulic modeling	Use coupled rainfall-runoff/snowmelt models (such as HEC-HMS). Validate against historic streamflow records and/or anecdotal flooding evidence. Conduct ensemble runs with varying temperature, precipitation type, and snowpack depth. Present outputs as a range of possible outcomes rather than a single prediction. Incorporate climate projections (earlier snowmelt, reduced snowpack) into long-term planning.
Climate change	Utilize District-approved rainfall adjustment factors. Compare median and bounding scenarios (e.g., “middle of the road” vs. “worst case”). Use ensembles to create probability distributions of hydrologic outcomes, not just single values. Conduct sensitivity analyses for temperature (snowpack/rain–snow transition) and precipitation intensity. Present results as scenarios (e.g., wetter future, drier future, more variable future).
Regulatory compliance – County, State, Federal	Clearly identify regulatory agencies and associated roles/responsibilities at onset of project. Coordinate with local, County, State, and Federal jurisdictions early and confirm consistency with general/comprehensive plans. Early environmental/cultural screenings, consultation with agencies, and conservative assumptions about potential resource impacts. Track regulatory updates continuously, involve compliance specialists, and build flexibility into design criteria.
Public and stakeholder acceptance	Early outreach, clear communication of benefits, minimizing local impacts, and offering mitigation. Build trust through transparent decision-making, consistent messaging, and following through on commitments. Use collaborative planning approaches (charrettes, working groups), highlight multi-benefit solutions, and document how input is considered. Explain site selection process, highlight community-specific benefits, and incorporate design features that address concerns.
Cost estimating and inflation	Use cost estimating team with local, similar project experience. Use wide array of material cost datasets, bid tabs, etc. Perform a Development Fee Analysis and develop a District-approved Planning Cost Estimate for each drainage system. Use an inflation factor for future projects.

Potential Project Risk	Risk Mitigation Strategies
Schedule	Proactive planning. Hold regular schedule reviews (weekly/biweekly) with the project team. Use earned value or milestone tracking to compare planned vs. actual. Rebaseline or reforecast when conditions change instead of waiting until delays compound. Communicate schedule risks early and transparently. Set expectations for decision turnaround times and reviews. Document agreements on schedule-critical items in meeting minutes. Escalate resource needs (additional staff, extended hours) when critical path is threatened. Adjust scope sequencing to keep work moving. Revise the project schedule formally so all parties align on the new baseline.
Budget	Define scope clearly in the contract, including assumptions and exclusions. Set expectations at kickoff about what is and isn't covered in the budget. Provide transparent budget status updates in progress reports. Build a Risk Register at project initiation that flags cost drivers and uncertainty areas. Use project management software (or variance reports) to track earned value vs. actual spend. Monitor burn rate weekly or biweekly. Watch "red flag" tasks that consume budget faster than planned.
Subconsultant management	Prequalify subconsultants for technical capabilities, financial stability, and past performance. Match subconsultants' expertise precisely to project needs. Use well-defined subcontracts with clear scope, deliverables, schedule, and rate structure. Document subconsultant roles in the Project Management/QC Plan and organizational chart. Clarify communication channels (direct client contact or through prime only). Establish review/approval protocols for deliverables. Establish open lines of communication. Address issues promptly (scope creep, missed deadlines, QA issues) before they escalate. Recognize good performance to build loyalty and long-term partnerships.
Future funding	Work with Wilson & Company's grantsmanship professionals that focus on identifying project-specific funding sources and assist with grant applications, management, and reporting.

Reports and documentation

Meets District Needs

All deliverables discussed/listed in the RFP will be provided. It is understood that the MPD will be divided into a minimum of four (4) volumes, including, but not limited to the following:

- Volume I – Final Report
- Volume II – Plans, Profiles and Cost Estimates
- Volume III – Hydrology Calculations
- Volume IV – Hydraulic Calculations and Alternatives Analyses

Project management and meetings/coordination

Project management

Hari Raghavan, PhD, PE, CFM will serve as project manager. His successful project management approach is based on a few simple elements: full transparency, effective communication, and emphasis on client needs. Communication goes beyond regularly scheduled meetings; Hari will be readily available, and you can rest assured that the District PM will immediately be made aware of project challenges.

Project management transparency will be achieved using Microsoft Project. MS Project tracks individual tasks and overall project scope, time, and costs – the project elements necessary to calculate earned value (EV). EV is a means to determine if a project is on track by showing how much of the budget and time should have been spent, considering the amount of work done to date.

To manage subconsultants and support smooth work-flow, Hari will develop formal project management documents, including **a Project Management Plan, an Action Item Tracking Log, and a Risk Register.**

Progress reports will accompany monthly invoicing based on work completed.

The Project Work Plan and Schedule are provided in Section 6.

The Consultant will prepare a Work Plan that includes, but not limited to, a list of deliverables, milestone submittal schedule, summary of organization responsibilities and contacts, scope of work, task budgets, reporting and invoicing procedures, quality assurance plan, and project filing system. A Summarized Project Work Plan and General Project Schedule are provided in Section 6.

Meetings/coordination

The project manager shall document all project meetings and submit meeting notes to the District within three (3) working days. District comments will be incorporated; unresolved comments will be discussed with District staff. Required meetings include:

- Kick-off Meeting – Review project scope, risks, issues, assumptions, constraints, and schedule with District staff.
- Monthly Progress Updates – Conduct monthly video meetings to review project direction, budget, and schedule. Provide action item lists with completion dates and email updated lists to District staff three (3) working days before each meeting.
- Additional Meetings – Organize as-needed to address review comments, stakeholder coordination, or community engagement.

Assumptions or constraints

Added Value

- It is assumed that the Consultant will have the opportunity to coordinate with the District regarding the use of HEC-HMS and HEC-RAS for hydrologic and hydraulic analyses. If it can be demonstrated that these models are consistent with the methodologies outlined in the San Bernardino County Hydrology Manual and the Los Angeles County Flood Control District Hydraulic Design Manual, their use may be approved for this project.
- USGS 1-m DEM adequate where survey is not justified; supplemental survey will be limited to targeted gaps. However, as budget allows, Wilson & Company has the capability to conduct c**omprehensive aerial survey and data collection** for the entire study area—or beyond. Such efforts could include **topography, high-resolution imagery, planimetrics** (roads, buildings, parking lots), **drainage infrastructure, and land-use classifications.** The resulting datasets would provide significant value not only to the Flood Control District but also to other County departments, the City of Big Bear, engineers, developers, emergency response planners, and a wide range of stakeholders. To maintain cost-effectiveness, aerial survey and data collection are **not included in the current cost estimate** (Section 8). A fee for these services can be determined during detailed project scoping if this level of effort is desired.
- The Rathbun Creek watershed is currently outside the defined study area; however, it is anticipated that this watershed could be incorporated into the scope of work for a relatively modest additional fee.

Summarized work plan and general project schedule

Summarized work plan

Work Plan

The Management/Work Plan summary below serves as an executable roadmap. A detailed Management/Work Plan and Project Schedule will be developed and submitted for review prior to the Kick-Off Meeting. As reflected in the plan and the accompanying schedule, the project is planned for completion within 19 months.

Project initiation (week 0–2)

- Kickoff: confirm scope, standards (County/City/FEMA/USACE), data needs, AOI definitions, and schedule.
- Set up PM tools (MS Project, Action Log, Risk Register) and shared data environment.
- Approve QA/QC plan and subconsultant roles.

Milestones/deliverables: Kickoff notes (within 3 business days), baseline schedule & budget, QA/QC plan, Risk Register v1.

Literature review and field investigation (months 1 - 16)

- It is assumed that field investigations will be conducted throughout most of the project's duration.
- Compile & review plans/studies/as-builts, utilities, land use, soils, rainfall, FEMA, GIS, complaint logs.
- Tablet-based field verification of hydraulically significant features; condition assessment; photo log (georeferenced).
- Build Infrastructure GIS database (locations, attributes, photos, maintenance notes).

Milestones/deliverables: Literature Review & Field Investigation Report (incl. photo location shapefile); Infrastructure GIS Database (feature classes, schema, metadata).

Survey and topographic data collection (months 2 - 5)

- Validate USGS 1-m DEM vs. known elevations/as-builts; identify gaps.
- Acquire supplemental topo (UAS or conventional survey) where needed; QA and LS certified.

Milestones/deliverables: Topo Data Review Memo; Supplemental Topo Dataset; Survey Control Report.

Hydrologic and hydraulic analyses (months 2 - 9)

Technical Specs

- Draft H&H Modeling Recommendations Memo (methods, parameters, standards alignment).
- Hydrology per SB County Manual for 5-, 10-, 25-, 100-yr (ultimate land use); clear-water and bulked flows.
- Rapid-build preliminary H&H models using GIS automation (Esri/QGIS/Python).
- Post-wildfire hydrology approach where applicable; define bulking factor methodology.
- Preliminary hydraulics (1D/2D RAS) focusing on channel/overbank controls and complex sheetflow zones.
- Hydrology and hydraulics calibration using available events (e.g., 2019 storm), lake levels, bathymetry; sensitivity analyses.
- Detailed HMS/RAS models for AOIs.

Milestones/deliverables: Approved H&H Recommendations Memo; Calibrated Base Condition H&H Models; H&H Calibration Technical Memo (data, fits, adjustments); Preliminary and Detailed H&H models.

Flood hazard assessment (Months 6 - 9)

- Compute depth–velocity hazard classifications (WRL/FEMA framework) across study area.
- Identify Flooding AOIs from models, hazards, complaints, maintenance logs, stakeholder input.
- Quantify impacted structures.
- Develop AOI prioritization criteria with District.

Milestones/deliverables: Flood Hazard Assessment Report (hazard maps, AOIs, prioritization, impacted-structure tables).

Development of flood mitigation alternatives (concept → recommended → refined) (months 8 -11)

- Develop Preliminary Alternatives per AOI (channel/storm drain only vs. with basins; include LID/GSI).
- Qualitative screening with Mitigation Alternatives Evaluation Matrix; hold Evaluation Meeting for selection of Recommended Alternatives.
- Advance Recommended Alternatives (concept-level plans/profiles, performance, ROM costs, utilities/ROW)..

Milestones/deliverables: BOE + Development Fee Analysis; Alternatives Matrix and documentation of process and selections.

Finalization of recommended alternatives (months 12 - 18)

- It is assumed that Recommended Alternatives cost estimating, prioritization, and PS&E will take place in parallel.
- Basis of Estimate (sources, regional factors, contingencies); Development Fee Analysis (unitized costs).
- Planning-level cost estimates by system and phasing/reaches.
- System-level plans/profiles/estimates; overall drainage systems map with unique IDs.
- General & specific recommendations (policy, permitting, funding, phasing, outreach).

Milestones/deliverables: Planning Cost Estimates (by AOI/system, phased); System Plans/Profiles/Estimates + Overall Systems Map; Recommendations & Facility Prioritization Memo; Recommended Alternatives Package (plans/profiles, narratives, performance); Refined Alternatives Submittal responding to comments.

Environmental review (Months 2 – 4, 12)

- Desktop environmental review (biological, cultural/socioeconomic, regulatory; risks/opportunities/gaps).

Milestone/deliverables: Environmental Review Summary (constraints/opportunities, fatal flaws, data gaps).

Community outreach and stakeholder coordination (months 1 – 18)

- Outreach: Arellano-led engagement plan, materials, meetings.

Milestones/deliverables: Public Involvement Report + Stakeholder Database.

QA/QC (months 1 – 18)

- QC gates at each major submittal (data, models, FHA, alternatives, costs, PS&E, systems).
- Monthly progress updates; action log; risk review.

Quality Control

Milestones/deliverables: Deliverables such as reports, maps, preliminary plans and profiles, cost analysis, etc. shall be subject to signature by Quality Assurance Officer.

Reports and documentation

- Vol I Final Report; Vol II Plans/Profiles/Estimates; Vol III Hydrology Calcs; Vol IV Hydraulics & Alternative Analyses.

Milestones/Deliverables: Volumes 1 – 4; GIS deliverables; modeling input, output, supporting data, etc.

Project management and meetings/coordination (months 1 – 19)

- Project management
  - Work plan
  - Scope, schedule, and budget; updated Quarterly Project Schedule.
  - Monthly progress report
  - Monthly invoicing
  - Earned value
  - Project Management Plan, an Action Item Tracking Log, and a Risk Register.
- Meetings and coordination
  - Kickoff (Week 0–2) to review and confirm project scope, risks, issues, assumptions and constraints as well as project schedule.
  - Monthly progress meetings (standing, with minutes and action items circulated ≥3 days prior)
  - Additional meetings, such as: as-necessary coordination; H&H Methods Approval; Alternatives Evaluation Meetings; Recommended Alternatives Review/Refinement; Final Review Meetings for deliverables, etc.

Deliverables: Meeting minutes, written summaries, monthly progress reports

Key deliverables (at a glance)

Meets District Needs

- All project submittals shall meet the current guidelines and standards required by the applicable authority, be it District, County, State, FEMA, or CFR. The Consultant shall be responsible for preparing the final Master Plan of Drainage signed by a Professional Engineer registered in the State of California.
- Draft submittal phase:
  - Digital Files of all reports, studies, technical memorandums, maps, topographic data, PS&Es, and H&H analyses files.
  - 11"x17" PDF maps.
  - Full-size PDF Hydrology Maps.
  - Applicable referenced reports (digital copies only).
  - Responses to previous comments (not required for first draft).
- Final submittal phase:
  - Four (4) hard copy sets of the final Master Plan of Drainage.
  - Four (4) hard copy sets of full-size final Hydrology Maps.
  - Digital Files of all reports, studies, technical memorandums, maps, PS&Es, and H&H analyses.

General project schedule

Wilson & Company is committed to flexibility and is prepared to work with the District to confirm the scope of work aligns with project schedule. We greatly appreciate the opportunity to collaborate with the District in aligning scope, schedule, and budget. A general project schedule is provided below.