Proposal to Prepare a Groundwater Sustainability Plan for the Spadra Basin

February 26, 2019

Prepared by:

WEI
Wildermuth Environmental, Inc.

West Yost Associates

Prepared for:
Spadra Basin Groundwater Sustainability Agency

City of Pomona, California, Incorporated Jan. 1888.

Walnut Valley Water District, Quality Since 1952

WILDERMUTH ENVIRONMENTAL, INC.

February 26, 2019

Walnut Valley Water District
Attn: Sheryl L. Shaw, Director of Engineering
271 South Brea Canyon Road
Walnut, CA 92789

Subject: *Proposal to Prepare a Groundwater Sustainability Plan for the Spadra Basin*

Dear Ms. Shaw,

Thank you for the opportunity to submit this proposal to the Walnut Valley Water District representing the Spadra Basin Groundwater Sustainability Agency (GSA) to provide professional services for the preparation of a Groundwater Sustainability Plan (GSP) for the Spadra Basin. Wildermuth Environmental, Inc. (WEI) and our engineering partner West Yost Associates (WY) are excited to work collaboratively with the GSA and other interested stakeholders. We understand your objectives are to develop a GSP that is fully compliant with the requirements of the Sustainable Groundwater Management Act of 2014 (SGMA) and serves as new groundwater management plan that maximizes the beneficial use of the Spadra Basin.

The WEI/WY team of scientists and engineers is uniquely qualified and able to serve the GSA based on our combined experience and successes over the last 25 years in providing hydrogeological, engineering, Watermaster, modeling, water management planning, water-rights, regulatory compliance, well construction, and other similar services to multiple clients throughout California. The WEI/WY team has been successfully providing these services for decades with its clients in adjudicated groundwater basins and in other basins struggling with sustainability issues.

Our team's approach will leverage our experience in the region and will build upon past and current work efforts in neighboring groundwater basins. This approach has several advantages for the Spadra Basin GSA: it will lead to high-quality work products that are consistent with current understanding in the neighboring basins; it enables efficiencies in performing the work; and it will demonstrate that the final GSP has analyzed and considered its impacts on neighboring and downgradient basins, and vice versa, which is an SGMA requirement. A key element to this approach is the use of the exiting groundwater-flow model prepared by WEI to support groundwater-management, planning, and regulatory-compliance efforts in the Chino Basin and Six Basins. We intend to extend the Chino Basin/Six Basins groundwater-flow model, and its underlying hydrogeologic conceptual model, into the Spadra Basin for this effort; thereby, taking full advantage of the existing models and the associated understanding that has been developed and refined extensively over the last 20 years.

Our team understands the importance of a well-developed and thoughtful stakeholder process. We will develop and build upon existing positive working relationships with the GSA staff and interested stakeholders, including members of the Watermasters in bounding adjudicated basins. Our approach to partnering with GSA staff and stakeholder engagement coupled with extensive knowledge of the

hydrogeology and groundwater conditions of the Spadra Basin, puts the WEI/WY team in an excellent position to develop a complete GSP in a timely, high-quality, and cost-effective manner.

Our proposed fee for preparing the GSP is about $703,000. This is a slightly greater amount than was included in the Sustainable Groundwater Planning Grant (plus local cost share) that was awarded to the GSA to support GSP preparation. The main reason for the greater amount was that some of the engineering and cost estimating tasks that are necessary to evaluate the Basin Optimization Scenarios were not included in the Grant application and award. At your request, we included those tasks herein to enable the development of a GSP that is fully compliant with the SGMA and your expectations.

This proposal is organized in the following manner:

Cover Letter
Section 1 – Firm Background and Qualifications
Section 2 – Relevant Experience (and Appendix A)
Section 3 – Key Personnel and Team Organization (and Appendix B)
Section 4 – Project Understanding and Scope of Work
Section 5 – Fee Proposal
Section 6 – Project Schedule

We thank you for the opportunity to serve.

Very truly yours,

Wildermuth Environmental, Inc.

Andy Malone
Vice President, Principal Geologist
Project Manager

Mark Wildermuth, PE
President, Principal Engineer
Principal-in-Charge, Technical Reviewer

1. Firm Background and Qualifications

Wildermuth Environmental Inc.
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Lake Forest, CA 92630
T: 949.420.3030
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Year Founded:
1990 – California S Corporation

Size of Firm:
20 Employees

Certified Small Business Enterprise:
Certification ID: 47755

Project Manager:
Andy Malone, PG
Vice President, Principal Geologist
949.600.7503
amalone@weiwater.com

Principal-in-Charge/Technical Reviewer:
Mark Wildermuth, PE
President, Principal Engineer
949.600.7500
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Wildermuth Environmental Inc. (WEI) is a specialized water resources consulting firm dedicated to creating visionary yet practical solutions to the complex water problems facing California municipalities, governmental agencies, and private companies.

The Why and How of WEI: At WEI, we believe in challenging the status quo in everything we do. We think differently than our peers. We challenge the status quo by clearly identifying the impediments our clients face in achieving their goals and developing creative approaches to eliminating those impediments. We invent new approaches that replace status quo processes through listening, exhaustive research, data assembly, and analytics; by creating powerful and elegant decision-support tools; by assisting our clients in the implementation of solutions; and by building features into those solutions that provide for learning and future adaptation.

Raising the Bar in Water Resources Management: WEI is unmatched in its ability to design and implement holistic, sustainable solutions that fuse the needs of clients, the environment, and surrounding communities. The forward-thinking scientists and environmental engineers at WEI identify problems precisely and solve them through a methodical process that weighs political, legal, regulatory, and technical considerations while building consensus for ideas and solutions. To the greatest extent possible, WEI strives to create "shared-value" solutions. The cornerstone value of our firm's relationships with employees, clients, regulatory agencies, and business partners is our pledge to perform every service, every engagement, and every project with integrity.

Areas of Excellence

- Development and implementation of groundwater management plans.
- Development and application of numerical models to evaluate the hydrologic and water quality response of ground and surface waters to historical operations and future water resources management plans. Specifically, we use surface and ground water models to simulate groundwater flow and quality, surface water discharge and quality, and aquifer mechanics. We use models that are in public domain, and, when necessary, we develop our own models. With our client's approval, all models developed by WEI are put in the public domain for review by our peers and for use.
- Development and implementation of monitoring plans for surface water, groundwater, and land subsidence.
- Development and implementation of data-management systems with a priority on HydroDaVE—our secure, cloud-based, data-management and data-analysis software.

- Development and implementation of recharge master plans and managed aquifer recharge projects.
- Development and implementation of salt and nutrient management plans. This includes the development of so-called "Maximum Benefit" demonstrations to Regional and State Boards to enable the efficient and environmentally sound reuse and recharge of recycled water.
- Regulatory compliance—especially related to water rights, waste discharges to groundwater and surface water, and the reuse of recycled and storm waters.
- Acquisition and application of remote-sensing data to support hydrologic investigations and water resources management.
- Watermaster services.
- Climate change assessment and adaptation.
- Expert witness services.
- Forensic analyses and peer review services.
- General consulting in the areas of water resources, hydrology, and hydrogeology.

Areas of Focused Research

- Development and application of watershed-scale hydrology and salinity models.
- Development of decision support rubrics for complex water resource project evaluation.
- Research and development of projected hydrologic time series for use in models to estimate the impact of climate change on surface and ground water systems, infrastructure, and future water supply reliability, and to develop no-regrets climate change adaptation plans.

West Yost Associates
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Irvine, CA 92618
T: 949.517.9060
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Size of Firm:
170 Employees

Project Manager:
Kristen Whatley, PE
Senior Engineer
949.517.9064
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Principal-in-Charge/Technical Reviewer:
Stephen Dopudja
Vice President
949.517.9062
sdopudja@westyost.com

West Yost Associates (West Yost) is a consulting engineering firm providing a high level of client service in one technical area: water.

West Yost has broad experience in providing planning, design, construction management, and program management services. West Yost's groundwater resources team offers a full-service approach across the entire spectrum of disciplines. This team consists of certified or registered professionals in civil, environmental, and mechanical engineering; geology, engineering geology, and hydrogeology. The West Yost team brings the value of understanding and knowledge gained from groundwater modeling and aquifer evaluations through planning and into the design of facilities that best meet long-term goals of quantity, quality, and conjunctive use supply strategies.

- Facilities design and optimization.
- Groundwater management planning.
- Hydrogeologic conceptual model (HCM) development.
- Regulatory and permitting assistance.
- Well rehab and municipal and aquifer storage and recovery well design.
- Funding assistance.
- Construction phase services.
- Operation and maintenance (O&M) and optimization of existing systems.

2. Relevant Experience and Client References

The table on the following page lists several WEI projects that were recently completed or are on-going for several clients in California. Across the top of the table are the services that are relevant to the preparation of a GSP for the Spadra Basin. The table demonstrates the nexus of WEI's projects to the services requested by the Spadra Basin GSA and illustrates WEI's experience and technical competency to perform the services requested, which include:

- Groundwater management planning
- Basin-scale groundwater studies
- Hydrogeologic studies
- Groundwater modeling
- Design and implementation of monitoring networks
- Sting and construction of monitoring wells
- Stakeholder facilitation in groundwater management
- Preparing technical reports

Appendix A contains descriptions of the projects listed on the table and their relevance to the Spadra Basin GSA and its requested services. Note that some of the project descriptions include internet links to client websites that WEI has developed or helps maintain or to project deliverables, such as final reports. We are proud of the quality of our project deliverables, the technical work performed to prepare our project deliverables, and the associated client satisfaction with our work. We encourage you to explore and learn more about our technical competencies and our desire to perform important and useful work for our clients. The project descriptions also contain contact information for our client references. Each reference will attest to WEI's high-quality and value-added services and to WEI's long-standing relationships as "extended staff" to their respective agencies.

Appendix A also includes relevant project descriptions of our engineering partner, West Yost Associates.

Projects Completed by WEI	Services Necessary to Prepare the Spadra Basin GSP								
	Groundwater Management Planning	Basin-Scale Groundwater Studies	Groundwater Modeling	Design and Implementation of Monitoring Networks	Groundwater Use Impact on Streamflow and Ecosystems	Stakeholder Facilitation in Groundwater Management	Siting and Construction of Monitoring Wells	Hydrogeologic Studies	Preparing Technical Reports
Projects / Clients									
Development and Use of High-Resolution Models to Recalculate the Chino Basin Safe Yield and Follow-on Model Applications Chino Basin Watermaster	✓	✓	✓		✓	✓		✓	✓
Watermaster Engineer Services and Groundwater Management Planning for the Six Basins Six Basins Watermaster	✓	✓	✓	✓		✓	✓	✓	✓
Determination of the Native Safe Yield of the Coldwater Basin Elsinore Valley Municipal Water District and City of Corona	✓	✓				✓		✓	✓
Water Rights Compliance, Groundwater Management, and Monitoring and Reporting Programs San Juan Basin Authority	✓	✓	✓	✓	✓	✓		✓	✓
Application of High-Resolution Models to Develop a Storage Management Strategy for a 500,000 Acre-foot Water Bank Chino Basin Watermaster	✓	✓	✓			✓		✓	✓
Review of Geothermal Project Impacts on Mammoth Community Water Districts Water Supply Mammoth Community Water District		✓		✓				✓	✓
Subsidence Management Plan for the Chino Basin Chino Basin Watermaster	✓	✓	✓	✓		✓	✓	✓	✓
TDS and Nitrate Concentration Projections in the Temescal Basin City of Corona Department of Water and Power	✓	✓	✓						✓
2010 Chino Basin Recharge Master Plan Update, 2013 Amendment, and Subsequent Implementation Chino Basin Watermaster	✓	✓	✓			✓			✓
Monitoring for Impact of Groundwater Management Plans on Critical Riparian Habitat Chino Basin Watermaster and the Inland Empire Utilities Agency	✓	✓	✓	✓	✓	✓	✓	✓	✓
Bi-Annual State of the Basin Reports for the Chino Basin Chino Basin Watermaster		✓	✓	✓				✓	✓
Development of a Salt and Nutrient Management Plan for the Chino Basin Chino Basin Watermaster and Inland Empire Utilities Agency	✓	✓	✓			✓	✓	✓	✓
Water Supply Reliability Assessment and Support for Urban Water Management Plans (UWMPs) Mammoth Community Water District	✓	✓	✓					✓	✓

3. Key Personnel and Team Organization

We have selected a team of highly skilled scientists and engineers to execute the scope of work outlined in *Section 4 – Project Understanding and Scope of Work*. As described in Section 1, our team will be made up of WEI and West Yost Associates (WY). The WEI/WY team. With the experience of the WEI/WY team, the Spadra Basin GSA can be certain that the project will be executed in a technically proficient, high-quality and time-efficient manner.

The WEI/WY team of scientists and engineers is uniquely qualified to provide the services required to develop Groundwater Sustainability Plans pursuant to the Sustainable Groundwater Management Act and other hydrogeological services that may be requested by the Spadra Basin GSA. This statement of qualifications is based on our team's combined experience and successes over the last 20 years in providing hydrogeologic services, SGMA compliance, annual reporting, and regulatory compliance support for multiple clients located in California.

Andy Malone, PG, well serve as the Project Manager and main contact for the Spadra Basin GSA. Mr. Malone is a Vice President and the Principal Geologist at WEI. He is qualified to serve this role based on over 20 years of experience performing similar services for numerous water agencies in California. He has wide-ranging and successful experience in the services requested by the Spadra Basin GSA. Specifically, he served as WEI's project manager at the Chino Basin Watermaster and the Six Basins Watermaster, where he has coordinated and prepared engineer's reports that describe the conditions of water supplies, groundwater levels, groundwater production and replenishment, and accounting of storage. Additionally, his abilities to communicate to clients and decision-makers in an accurate and understandable manner on the meaning of complex technical information is second to none. He will meet or exceed all requirements and expectations of the Spadra Basin GSA.

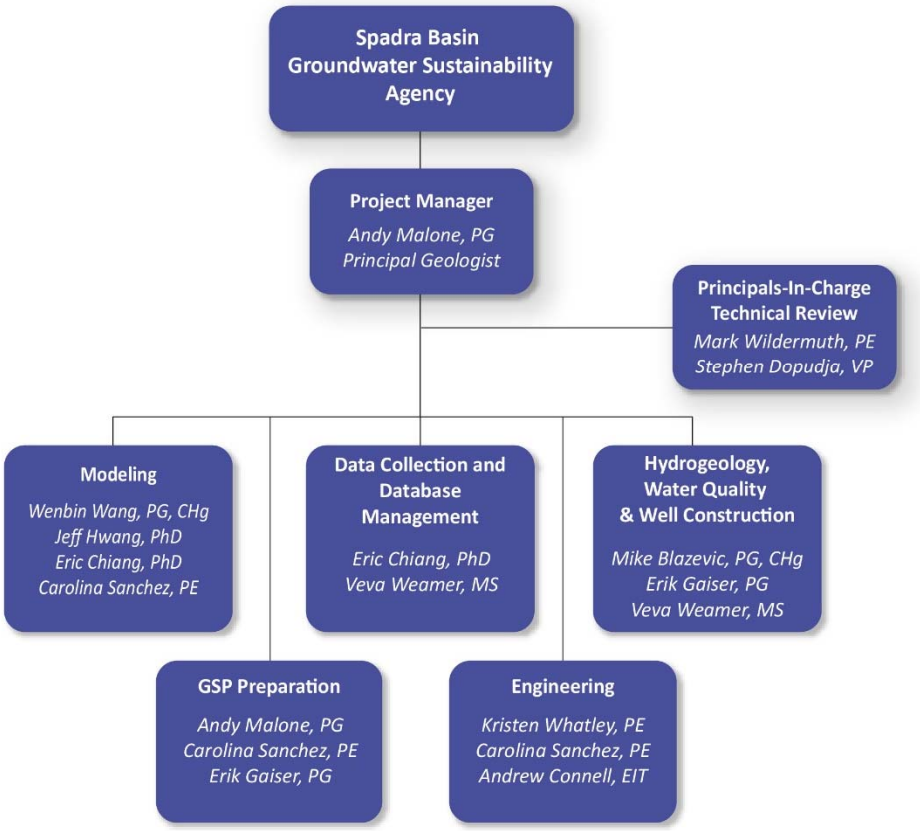
Mr. Malone will have a talented and experienced team to assist him with all tasks required for the preparation of the Spadra Basin GSA. Figure 3-1 is the proposed organizational structure, which identifies the principals-in-charge, principal technical reviewers, project manager, and the key personnel that will manage and perform the main project tasks described in Section 4. Summary bios of our key personnel and a description of their project assignments follow. Detailed resumes have been included in Appendix B to this proposal.

Andy Malone, PG is the Principal Geologist and a Vice President at WEI. Mr. Malone has over 23 years of professional experience in water resources consulting and the geologic sciences. His technical expertise includes basin characterization, hydrogeologic and hydrologic analyses, aquifer mechanics, sedimentary geology, tectonics, Geographic Information Systems (GIS), groundwater management planning, and database design and implementation. Mr. Malone will serve the Spadra Basin GSA as the Project Manager. His long history of successfully managing projects and staff at WEI and his expert communication skills make him the ideal candidate for this position. As the Project Manager, Mr. Malone will be responsible for: working with project task managers to plan and execute tasks pursuant to their scopes, schedules, and budgets; coordinating staff resources; scheduling WEI senior technical review of project deliverables; reporting progress to the Spadra Basin GSA; leading stakeholder outreach efforts; and defining sustainability criteria.

Mark Wildermuth, PE is the Principal Engineer and President at WEI. He has 40 years of experience in water resources engineering and planning, including: surface and groundwater hydrology; hydraulics and water quality; surface and ground water modeling; groundwater management, including recharge master plans; water resources systems planning, operation, and optimization; water rights; evaluation of receiving water impacts; and flood control facility design. He founded WEI in 1990, and since that time, he has built his expertise in the development of water resource management plans for groundwater

basins and watersheds in Southern California. His work has withstood rigorous peer review and has been relied on in basin adjudications, including the Antelope Valley Adjudication and regulatory processes. He has developed and/or managed a team in the development of several sophisticated numerical models for groundwater flow, surface water, and water quality in watersheds and basins across California, including the Chino Basin groundwater and surface water models and the Wasteload Allocation Model (surface water flow and quality) for the Upper Santa Ana River Watershed. Mr. Wildermuth will serve the Spadra Basin GSA as a Principal-in-Charge and in a senior technical review capacity for all services. He will be responsible for reviewing all interim deliverables and final work products, and ensure the project team delivers a final product that meets and exceeds the expectations laid out in the RFP.

Figure 3-1 Organization of the Project Team



Stephen Dopudja, PE is a Principal Engineer and Vice President at West Yost. He has 29 years of experience managing water resources projects. His experience also includes residential land development and roadway infrastructure improvements. His capabilities range from the planning and computer modeling of water and sewer systems, serving as an Owner's Advisor, to the design and construction of water resources facilities, including pump stations, reservoirs, and pipelines. Mr Dopudja also has experience in comprehensive planning, including master plans, flow/demand projections, hydraulic modeling, regulatory requirements, operations and maintenance activities, and recommendations for improvements. He is experienced in using a variety of project delivery methods including Design-Build,

traditional Design-Bid-Build and Public Private Partnerships. Throughout his career, Mr. Dopudja has worked for private engineering firms in the Southern California area, ranging in size from four employees to 46,000. He has also worked on several international projects. He has served as the Principal-in-Charge for a number of large, complex water infrastructure projects. He has also conducted peer reviews of systems design criteria as well as several existing water and wastewater master planning reports. Mr. Dopudja will serve the Spadra Basin GSA as a Principal-in-Charge and in a senior technical review capacity for engineering services.

Wenbin Wang, PhD is a Principal Hydrogeologist at WEI. Dr. Wang has 26 years of professional experience in the field of hydrogeology. His technical expertise includes the development of hydrogeological conceptual models for complex surface and subsurface water systems; site/basin scale characterization; numerical modeling of multiphase flow and contaminant transport in saturated and unsaturated porous and fractured mediums; developing flow and transport codes; estimating hydraulic parameters via direct and indirect methods; applying statistics, geostatistics, and stochastic methods in hydrogeology; sensitivity and error analysis; and designing Windows-based software. He is an expert in various models, including TOUGH2/ITOUGH2, MODFLOW, PEST, MT3D, PATH3D, MODPATH, FLOWPATH, HYDRUS-1D/2D, UNSAT, HEC, GSLIB, ROSETTA, AQTESOLV, PHREEQC, and MINTEQ. He is highly proficient in several major programming languages, including Fortran, Visual Basic, Java, and C#. He has developed multiple groundwater-flow and transport codes and is the author of U-Win software—a user-friendly, unsaturated flow code that is applied in heap leach mining. Dr. Wang will serve on the project team for groundwater-modeling services.

Jeffrey Hwang, PhD is a Principal Engineer and the chief surface-water modeler at WEI. Dr. Hwang has more than 30 years of professional experience in water resources engineering, including hydrology, hydraulic design, surface and groundwater modeling, statistical analysis, GIS applications, water resources planning and management, and software development. He has developed and applied numerous procedures and computer models to solve water resources problems, including the Wasteload Allocation Model (WLAM), Rainfall-Runoff-Router-Rootzone model (R4), HSPF, recharge basin performance evaluation procedures, and the hydraulic design of recharge basins, among others. Dr. Hwang will serve on the project team in overseeing the development and implementation of the surface water models.

Eric Chiang, PhD, is a Principal Engineer at WEI and has more than 30 years of professional experience in hydrogeologic engineering. His areas of expertise include hydrology, groundwater modeling, statistical analysis, numerical computer modeling, database management, and software development. Dr. Chiang is proficient in major programming languages (C/C++/C#, FORTRAN, JavaScript, Visual Basic), relational database design, and the development of client-server applications. At WEI, Dr. Chiang has developed cutting-edge software tools to support the work of WEI staff and clients. One of his most significant contributions is the development and deployment of HydroDaVE^{SM} (Hydrologic Database and Visual Explanations), which enables professionals to remotely visualize and analyze groundwater, surface water, and climatic data, and model results that are either stored on the HydroDaVE^{SM} Management Service Platform maintained by WEI or stored on national databases that are accessible through public web services, such as USGS Water Services or the NWQMC Water Quality Portal. Dr. Chiang will serve on the project team for groundwater-modeling services.

Carolina Sanchez, PE is a Senior Engineer at WEI and has over five years of professional experience in water-resources engineering and planning. Her expertise as a Professional Engineer includes recharge master planning, surface water modeling, implementation of monitoring programs, numerical analysis, Watermaster services, database management, and regulatory compliance reporting. Ms. Sanchez is involved in a variety of regulatory compliance projects that include the collection and organization of

complex datasets; the analysis of groundwater-level and water-quality data; time-certain reporting for CASGEM, SGMA, water rights, and salt and nutrient management plan compliance; conducting hydrologic and hydraulic analyses of groundwater recharge using imported, recycled, and storm waters; and the preliminary design of surface-water management facilities. Ms. Sanchez will serve on the project team for modeling, engineering, and GSP preparation.

Erik Gaiser, PG is a Supervising Geologist at WEI. He has over 20 years of professional experience in the environmental, water-resources consulting, and well construction industries. His technical expertise includes: hydrogeology; conceptual site model development; well siting, design and rehabilitation; depositional facies interpretation; fate and transport analysis; environmental site assessment (Phase I & II, adaptive design, and real-time data collection); and environmental permit compliance. He has a long record of leading and contributing to the success of large-scale, complex projects throughout California and the United States. Mr. Gaiser will serve as the task manager for the conceptual model development, will assist in hydrogeology-related tasks, and will support GSP preparation.

Veva Weamer, MS is a Supervising Scientist at WEI and has 11 years of professional experience in water-resources management. Her technical expertise includes hydrologic and hydrogeologic data analysis, database management, water-quality analysis, implementation of salt and nutrient management plans, hydrogeology, GIS, and groundwater and surface water monitoring program implementation and evaluation. In her 10 years with WEI, Ms. Weamer has been a critical resource in the timely implementation of multiple of the Chino Basin Watermaster's regulatory compliance and reporting programs, including the Maximum-Benefit salt and nutrient management plan, the Prado Basin Habitat Sustainability Program, and the Sustainable Groundwater Management Act (SGMA). She is also responsible for overseeing the collection and processing of data and performing quality assurance/quality control reviews for the Chino Basin Watermaster's database, which includes over one thousand groundwater and surface water monitoring sites with associated production, elevation, water quality, discharge, and other data. Ms. Weamer will serve on the project team for all data-management and water quality-related tasks.

Mike Blazevic, PG/CHG is a Supervising Hydrogeologist at WEI. Mr. Blazevic has over 11 years of professional experience in the geological and hydrogeological sciences. His technical expertise includes borehole drilling, well construction and development, basin characterization, hydrogeologic and hydrologic analyses, sedimentology, stratigraphy, and the application of GIS to solve complex hydrological and hydrogeological problems. He has worked throughout southern and Central California on drilling and testing water supply and monitoring wells; collecting and interpreting basin-wide geologic, hydrogeologic, and hydrogeologic data; supporting surface-water and groundwater modeling projects; performing well-siting studies; and preparing technical reports. Mr. Blazevic will serve as task manager for monitoring well siting and construction.

Kristen Whatley, PE is a Senior Engineer at West Yost with experience working on and managing water resource projects. Her capabilities range from the planning and computer modeling of water systems, designing and bidding of water resources including wells, water treatment, booster pump stations, reservoirs, and pipelines. Project experience includes serving as the project manager on major water resources and wastewater design and permitting projects and residential land development projects; water storage, treatment, and distribution projects; and master planning efforts on several land development projects including coordination with regulatory agencies. Kristin's experience with detailed engineering design will allow her to efficiently develop the basin-wide feasibility-level projects required in this effort with a clear understanding of what is practical, cost-effective, and operable in the long-run.

Ms. Whatley will serve as the Project Engineer for engineering services associated with new projects that will be proposed for the Basin Optimization Scenarios.

Andrew J. (AJ) Connell, EIT is a Civil Engineer-In-Training with experience in water resource evaluation, modeling, and engineering design. Mr. Connell's broad experience that ranges from detailed design to distribution system-level analysis will allow him to get the details of the potential capital projects and management actions correct within the context of this basin-wide evaluation. This ability will be critical to the effective evaluation of potential Basin Optimization Scenarios. Mr. Connell will serve as Staff Engineer for engineering services associated with new projects that will be proposed for the Basin Optimization Scenarios.

4.1 Project Understanding and Technical Approach

The Spadra Basin is a relatively small, non-adjudicated subbasin of the San Gabriel Valley Basin (DWR Basin 4-013). The DWR has re-designated the San Gabriel Valley Basin as a "low-priority" basin because the groundwater rights in most of the basin have been adjudicated; hence, the San Gabriel Valley Basin is not required by the SGMA to develop and implement a GSP The WEI/WY team understands that, even though it is not a strict requirement of the SGMA, the Spadra Basin GSA has elected prepare and adopt a GSP with the objectives of maximizing the beneficial use of the subbasin while ensuring long-term sustainability.

The WEI/WY team's understanding of the Project is derived from a thorough review and understanding of:

- the Request for Proposal (RFP)
- the Sustainable Groundwater Planning (SGWP) grant application that was awarded to the GSA and will support this effort
- GSP Emergency Regulations, DWR GSP annotated outline guideline document, DWR best management practices for sustainable groundwater management, and the SGMA
- Our long and successful experience in the region of developing and implementing groundwater management plans that focus on long-term sustainability

Our team's approach will leverage our experience in the region and will build upon past and current work efforts in neighboring groundwater basins. This approach has several advantages for the Spadra Basin GSA: it will lead to high-quality work products that are consistent with current understanding in the neighboring basins; it enables efficiencies in performing the work; and it will demonstrate that the final GSP has analyzed and considered its impacts on neighboring and downgradient basins, and vice versa, which is a SGMA requirement. A key element to this approach is the use of the exiting groundwater-flow model prepared by WEI to support groundwater-management, planning, and regulatory-compliance efforts in the Chino Basin and Six Basins. We intend to extend the Chino Basin/Six Basins groundwater-flow model, and its underlying hydrogeologic conceptual model, into the Spadra Basin for this effort; thereby, taking full advantage of the existing models and the associated understanding that has been developed and refined extensively over the last 20 years.

In this proposal, we describe a phased approach to preparing the Spadra Basin GSP, which includes the development of five key Technical Memorandums (TMs) as interim milestones within the schedule:

1. *Conceptual Model of the Spadra Basin*
2. *Construction and Calibration of the Spadra Basin Groundwater Model*
3. *Sustainable Management Criteria for the Spadra Basin*
4. *Sustainability of Future Baseline Conditions*
5. *Basin Optimization Scenario to Achieve Sustainability*

These TMs will allow for efficient and focused review by GSA staff and the planned stakeholder advisory committees of the complex information that will form the foundation of the GSP.

Our team understands the importance of a well-developed and thoughtful stakeholder process. We will develop and build upon existing positive working relationships with the GSA staff and interested stakeholders, including members of the Watermasters in bounding adjudicated basins. Our approach to

partnering with GSA staff and stakeholder engagement coupled with extensive knowledge of the hydrogeology and groundwater conditions of the Spadra Basin, puts the WEI/WY team in an excellent position to develop a complete GSP in a timely and cost-effective manner.

The scope of work provided below more fully describes our technical approach to completing the Spadra Basin GSP. The tasks to complete the GSP include all tasks in the scope of work of the RFP and all of the tasks in SGWP grant application except grant administration. Additionally, some tasks have been added based on responses to questions posed on the RFP. And, we have combined and sequenced the tasks differently than outlined in the RFP. This was done to fully comply with the GSP Regulations and requirements of SGMA and to efficiently lead the GSA staff and stakeholders through the required steps to complete the GSP. The scope of work is divided into the following phases:

Phase 0 Project Management and Administration
Phase I Describe the Plan Area and Basin Setting
Phase II Develop Sustainable Management Criteria for the Spadra Basin
Phase III Evaluate the Sustainability of Future Baseline Conditions
Phase IV Evaluate Basin Optimization Scenarios to Achieve Sustainability
Phase V Prepare and Adopt the GSP

Table 5-3 (see Section 5 – *Fee Proposal*) is a detailed work breakdown structure and line-item cost estimate that shows the process and steps involved in each phase of the work. Table 5-3 also contains two columns that map the tasks in this proposal to the tasks as thy are numbered in the RFP and the SGWP Grant application.

4.2 Scope of Work

Phase 0 – Stakeholder Outreach and Project Management and Administration

Task 1. Stakeholder engagement and public outreach.

The objectives of this task are to ensure that interested stakeholders are engaged in the project, to receive important feedback from the stakeholders, and to ensure that consensus assumptions are fully vetted. In this task, WEI will coordinate with GSA staff to attend and lead up to twelve GSP process meetings to review and finalize the task TMs (described below). WEI will assist the GSA staff in maintaining a GSP website for posting of all GSP-related notifications, deliverables, schedules, etc.

Deliverables: *Meeting materials for 12 GSA process meetings*

Meeting minutes for 12 GSA process meetings

Task 2. Project administration and management.

In this task, WEI will: prepare for and attended up to 10 quarterly coordination meetings with GSA staff; coordinate project staffing and sub-contractors over the duration of the process; and provide monthly invoices and progress reports to GSA staff of project progress, schedule, and budget status. These invoices and progress reports will be formatted to support GSA progress reporting to DWR for grant administration.

Deliverables: *Meeting minutes for 10 GSA staff coordination meetings*

30 monthly project management summary reports

Phase I – Develop Hydrogeologic Conceptual Model and Groundwater Model for the Spadra Basin

The objectives of Phase I are to achieve consensus amongst all stakeholders on the current and historical physical conditions and management activities within the Spadra Basin, and to develop the modeling tools to assist in the development and evaluation of the GSP. Phase I will address the requirements of Article 5, Subarticle 1 and 2 of the GSP Emergency Regulations. This phase must be completed prior to establishing Sustainable Management Criteria as required by the GSP Emergency Regulations, such as identifying the relevant Sustainability Indicators and establishing Minimum Thresholds and Measurable Objectives. Existing historical data and information will be used to the maximum extent possible to execute Phase I.

Task 3. Prepare hydrologic database and library of reports

The SGMA requires that each GSA develop and maintain a data management system (DMS) that can store and report information relevant to the development and implementation of the GSP and ongoing monitoring of the basin. The SGMA also requires that ongoing GSP updates/data be submitted to DWR electronically through an online reporting system in a format provided by the state. WEI possesses and maintains a DMS that is robust enough to meet these requirements and is practical for the end-users, called Hydrologic Database and Visual Explanations (HydroDaVE^{SM}). HydroDaVE is an online, password-protected, environmental database with a map-based user-friendly interface which allows end-users to view and download environmental data. HydroDaVE has the following features and advantages for the GSA:

- Web-enabled
- Password-protected for security and to allow for custom user-profiles (level of access)
- Can house all data necessary for the development and implementation of the GSP
- Can readily accommodate the changing needs of the GSA over time
- Allows for collaborative management of watershed-scale environmental data sets
- Supports advanced data analyses, such as contouring of groundwater levels, modeling studies, etc.
- Prepares standardized and custom reports/graphical outputs for SGMA, CASGEM and other programs

All historical and current data that are necessary to prepare the GSP will be collected, checked, and uploaded to HydroDaVE, including: GIS layers; well and borehole information; groundwater elevations; groundwater quality; surface-water discharge and quality; and precipitation, among others. A database expert from WEI will meet with GSA staff and define user profiles and passwords for GSA staff and stakeholders during the development of the GSP. HydroDaVE is fully capable of serving the long-term DMS needs of the GSA during GSP implementation.

All relevant scientific reports that have been published on the Spadra Basin will be collected, reviewed, digitized as PDF files if necessary, and uploaded to HydroDaVE in a project library. These reports will be used in the subsequent task to prepare the conceptual model of the Spadra Basin.

Task 4. Describe Plan Area and Prepare Basin Setting (conceptual model of the Spadra Basin)

A description of the Plan Area will be prepared and used to describe the interaction of the GSP with existing jurisdictions, monitoring and management plans, and land use. The Plan Area description will

address the requirements of Article 5, Subarticle 1, Section 354.8 of the GSP Emergency Regulations and will include:

- Description of jurisdictional areas and other features. A map will be prepared to display the GSP area, adjudications, the water supply agencies within basin, and Federal and State land use boundaries.
- Description of the existing monitoring and groundwater management programs. A map will be prepared to display all current well locations and the current groundwater/surface-water monitoring network.
- Description of historical and current land use, water use, and disposal. Maps will be prepared to display the current and ultimate land use plans across the Spadra Basin and their associated water use and disposal plans.

The Basin Setting is a detailed description of the surface-water and groundwater hydrology of the Spadra Basin over a long-term historical period to current conditions, including the identification of data gaps and levels of uncertainty of the description. The Basin Setting description will address the requirements of Article 5, Subarticle 2 of the GSP Regulations, and becomes the basis for: the monitoring well siting efforts in Task 5; the construction and calibration of the numerical groundwater-flow model in Task 6, and the development of the Sustainable Management Criteria in Phase II. Key work efforts of this task include:

- Description of the hydrogeologic conceptual model. Maps will be prepared to display: the surface water system and source/point of imported water supplies; topography and surficial geology; the bottom of the aquifer; soil types and characteristics; areas of recharge and discharge; and aquifer geometry and initial aquifer properties, among others. Up to four profile-view hydrogeologic cross sections will be prepared to illustrate the aquifer geometry, composition, and hydrostratigraphic layering.
- Description of the current and historical groundwater conditions. Maps, tables, and charts will be prepared to display: groundwater production; groundwater elevations and groundwater flow directions and how they have changed over time; groundwater quality (TDS, nitrate, other constituents of concern); historical land subsidence; and the location of interconnected groundwater/surface water systems and groundwater dependent ecosystems. A time-series chart will be prepared to reveal the relationships between climate, groundwater production, and groundwater levels.
- Description of the current and historical water budget. Initial estimates of the basin's water budget will be made based on the conceptual model and will be updated based on the model calibration results over the historical calibration period (Task 6). The final water budget will be a table that will list, on an annual time-step, the individual recharge and discharge terms for the Spadra Basin, the change in storage, and the resultant basin yield.
- Identification of data gaps in the conceptual model. Task 5 will attempt to fill a data gap in the understanding of the hydrologic relationships between the Chino, Six, and Spadra Basins.

A technical memorandum will be prepared titled *Technical Memorandum 1 – Conceptual Model of the Spadra Basin* (TM1) to describe the Plan Area and Basin Setting. Ultimately, the report will become chapters in the final GSP. The outline of the TM1 is:

1. Introduction

2. Plan Area
3. Basin Setting
4. Data Gaps
5. Appendix A – Comments and Responses-to-Comments for TM1

An administrative draft TM will be prepared by WEI for internal technical review. A draft TM will be subsequently prepared and provided to GSA staff and interested stakeholders in electronic format for review and comment. Two weeks following the distribution of the draft TM, WEI will prepare for and lead a public meeting to present the draft TM to GSA staff and stakeholders. GSA staff and stakeholder feedback will be recorded at the meeting. GSA staff and stakeholders will have two weeks following the public meeting to submit written comments and suggested revisions to the draft TM. In coordination with GSA staff, WEI will update the draft TM to a final TM based on the comments received and will prepare an appendix to the TM that documents all comments and responses-to-comments. The final TM will be distributed to GSA staff and stakeholders as an electronic document and will be published on the GSA website.

Deliverable: *Technical Memorandum 1 – Conceptual Model of the Spadra Basin*

Task 5. Collect additional hydrogeologic information (Construct new monitoring well)

The objective of this task is to fill a data gap identified in the Basin Setting. It is assumed in the RFP and grant application that the data gap will be filled with a new monitoring well located in an area that will provide information on the groundwater interactions between the Spadra and Chino or Six Basins. The data collected from the monitoring well will include: geologic information, aquifer properties, hydraulic head data, and groundwater-quality data. The data and information will be used to improve the description of the Basin Setting and assist in the construction and calibration of the groundwater-flow model. Key work efforts of this task include:

- Conduct a well-siting study to identify the appropriate parcel/site for the monitoring well
- Prepare technical specifications for new monitoring well site
- Obtain permits and perform required CEQA analysis
- Support the bid process for well construction contractor
- Conduct well construction and development
- Purchase, install, and test long-term monitoring devices
- Prepare well-completion report

Subsequent ongoing monitoring at the well site is not included in this proposal.

The grant application states that the estimated cost for this task is $160,000. In this proposal, we assume a cost of about $160,000 for this task to be consistent with the grant application. However, it is important to note that the actual cost for this task is highly dependent on the selected well site, the depth of the monitoring well, and other well-construction details to be included in the technical specifications (*e.g.,* the need for sound walls, the need for multiple well completions, etc.). In this proposal, the assumed budget should be considered provisional and subject to change depending on the outcome of the Basin Setting description (data gaps), the well-siting study, and the final technical specifications.

Deliverable: *Monitoring Well Completion Report*

Task 6. Construct and calibrate a numerical groundwater-flow model

The Chino Basin is just east of and adjacent to the Spadra Basin. In preparation of this proposal, WEI reviewed groundwater elevation and chemistry data from the Spadra and adjacent Chino Basin wells and demonstrated that there is hydraulic connection. This means that future groundwater management activities in the Chino Basin will impact the yield of the Spadra Basin and vice versa. The sustainable yields of both basins are interdependent and depend on the management of each Basin. There may be a similar relationship between the Spadra and Six Basins. The Chino Basin model includes the Chino, Cucamonga and Six Basins and has been extensively calibrated and used for planning purposes. The Chino Basin model is currently being updated. Our proposal herein is to add the Spadra Basin to the Chino Basin model and calibrate the Spadra Basin as part of the Chino Basin model. Task 4 above includes subtasks to develop the hydrogeologic conceptual model for the Spadra Basin. That information will be used in this task to extend the Chino Basin model into the Spadra Basin. This Task 6 includes subtasks to extend the surface water models used in the Chino Basin model to estimate the deep infiltration of precipitation and applied water and other recharge components in the Spadra Basin. The update Chino Basin model includes the capability to estimate land subsidence. To the extent that information is available, land subsidence simulation will be incorporated into the Spadra Basin area.

WEI's R4 model is in the public domains and we will use it to simulate land surface processes that include precipitation, infiltration and runoff, applied water for irrigation, deep infiltration of precipitation and applied water, soil moisture storage, surface water discharge, streambed infiltration and, if applicable, managed artificial recharge. The USGS MODFLOW-NWT model will be used to simulate groundwater flow.

WEI will use a guided optimization approach to calibrate and train the Spadra Basin l along with the other groundwater basins in the Chino Basin model. This approach involves conducting an iterative process that includes sensitivity analysis, parameter optimization and residuals analysis. The groundwater model parameters will be optimally estimated and constrained to a range of plausible values based on rock type and geologic setting. The results of the calibration process will be presented in a table of final hydraulic parameter values, scatter plots with statistics to characterize fit, residuals plots, groundwater elevation hydrographs that show observed and model compute values and a water budget table.

WEI will prepare a technical memorandum to document the construction and calibration of the groundwater model title *Technical Memorandum 2 – Model Construction and Calibration* (TM 2). An administrative draft TM will be prepared by WEI for internal technical review. A draft TM will be subsequently prepared and provided to GSA staff and interested stakeholders in electronic format for review and comment. Two weeks following the distribution of the draft TM, WEI will prepare for and lead a public meeting to present the draft TM to GSA staff and stakeholders. GSA staff and stakeholder feedback will be recorded at the meeting. GSA staff and stakeholders will have two weeks following the public meeting to submit written comments and suggested revisions to the draft TM. In coordination with GSA staff, WEI will update the draft TM to a final TM based on the comments received and will prepare an appendix to the TM that documents all comments and responses-to-comments. The final TM will be distributed to GSA staff and stakeholders as an electronic document and will be published on the GSA website.

Deliverable: *Technical Memorandum 2 – Model Construction and Calibration*

Phase II – Develop Sustainable Management Criteria for the Spadra Basin

The objective of Phase II is to achieve consensus amongst all stakeholders on quantitative Sustainable Management Criteria that define conditions in the GSP that constitute sustainable groundwater

management. These criteria are critical to the success of a GSP as they provide quantitative and measurable goals for the avoidance of undesirable results. Phase II addresses the requirements of Article 5, Subarticle 3 of the GSP Emergency Regulations.

The following questions will be answered during the development of the Sustainable Management Criteria:

- What are the relevant Sustainability Indicators for the Spadra Basin (e.g., chronic lowering of groundwater levels, degradation of water quality, land subsidence)?
- What causes Undesirable Results to occur for the relevant Sustainability Indicators?
- What is the Minimum Threshold for each Sustainability Indicator? In other words, at what measurable point do groundwater conditions trigger an Undesirable Result for each Sustainability Indicator?
- What should be the Measurable Objectives for groundwater conditions for each Sustainability Indicator?
- Are Management Areas appropriate in the Spadra Basin. If so, how should they be delineated?
- What is the appropriate monitoring program to evaluate sustainability and support GSP implementation?

Task 7. Define Sustainable Management Criteria

WEI will utilize the information generated in Phase I to answer the questions above and develop draft Sustainable Management Criteria. The Phase I information to be analyzed and considered will include:

- The Plan Area description including the beneficial uses and users of the Spadra Basin
- The Basin Setting description for historical and current basin conditions
- The water budget and other modeling results

A technical memorandum will be prepared titled *Technical Memorandum 3 – Sustainable Management Criteria* (TM3). WEI will develop a proposal for the Sustainable Management Criteria that will be documented in the draft TM3. The Criteria will be refined and finalized through the public review process of the TM. Ultimately, the TM will become chapters in the final GSP.

The outline of the TM3 is:

1. Sustainability Indicators for the Spadra Basin
2. The Causes of Undesirable Results for each Sustainability Indicator
3. Minimum Thresholds for each Sustainability Indicator
4. Measurable Objectives for each Sustainability Indicator
5. Management Areas
6. Monitoring Network and Monitoring Program
7. Appendix A – Comments and Responses-to-Comments for Phase II TM

An administrative draft TM will be prepared by WEI for internal technical review. A draft TM will be prepared based on the internal technical review. The draft TM will be provided to GSA staff and interested

stakeholders in electronic format for review and comment. Two weeks following the distribution of the draft TM, WEI will prepare for and lead a public meeting to present the draft TM to GSA staff and stakeholders. GSA staff and stakeholder feedback will be recorded at the meeting. GSA staff and stakeholders will have two weeks following the public meeting to submit written comments and suggested revisions to the draft TM. In coordination with GSA staff, WEI will update the draft TM to a final TM based on the comments received and will prepare an appendix to the TM that documents all comments and responses-to-comments. The final TM will be distributed to GSA staff and stakeholders as an electronic document and will be published on the GSA website.

Deliverable: *Technical Memorandum 3 – Sustainable Management Criteria*

Phase III – Evaluate the Sustainability of Future Baseline Conditions

The objective of Phase III is to determine the future of sustainability in the Spadra Basin under the current water supply and groundwater management plans of the stakeholders. The current water demand and supply plans will be collected from the stakeholders and described as a "Baseline Scenario." Groundwater modeling of the Spadra Basin will be the method to quantitatively evaluate and determine sustainability for each Sustainability Indicator over a 60-year planning horizon for the Baseline Scenario. The results of this phase will help define the future projects and/or management actions that are necessary to achieve sustainability. Phase III addresses the requirements of Article 5, Subarticle 2, Section 354.8 of the GSP Emergency Regulations and includes the following tasks:

Task 8. Develop and document the Baseline Scenario

In this task, the future water demands and water-supply plans of the water-supply agencies will be collected and summarized in tables and figures. Assumptions will be made for the operations of private pumpers in the basin based on past and potential future production. The tables and figures will describe the Baseline Scenario which will be a 60-year planning projection of: the future water demands and water supply plans, land use changes, and pumping and managed aquifer recharge in the basin. The most recent planning projections for the Chino Basin and the Six Basins will also be assumed for the Baseline Scenario. The Baseline Scenario will be provided to the water suppliers for review and comment. A meeting will be held with the water suppliers to explain the Baseline Scenario. The Baseline Scenario will be updated based on the comments and suggested revisions of the water suppliers.

Deliverable: Tables and figures that describe the Baseline Scenario

Task 9. Conduct modeling evaluation of the Baseline Scenario

In this task, the surface-water and groundwater models are updated to reflect future project conditions and plans, model input files are prepared, and the Baseline Scenario is simulated to predict the response of the Spadra Basin to the Baseline Scenario. The surface-water model is updated first to account for future land-use and other changes that will impact surface-water flows. A daily projection will be prepared over the planning period of precipitation, applied water and ET for each surface-water model sub-area incorporating DWR guidance for representing climate change. The surface-water model will estimate future deep infiltration of precipitation and applied water, sub-surface boundary inflows, streambed infiltration, and surface-water inflows/outflows. The output from the surface-water modeling will provide input data for the groundwater model. Other input files for the groundwater model will be prepared, including estimated future groundwater pumping and managed artificial recharge of storm, imported, and recycled water.

The results of the groundwater modeling will represent the groundwater basin response to the Baseline Scenario. The model results will be displayed as tables, charts, and maps and will be compared to the Sustainability Criteria developed in Phase II to evaluate sustainability under the Baseline Scenario. Impediments to achieving sustainability will be identified, including: the specific Sustainable Management Criteria that are challenged, the specific areas where the impediments occur, and the timing and magnitude of the impediments. This task includes an analysis of impacts to neighboring groundwater basins.

Task 10. Prepare Technical Memorandum 4 - Sustainability of Baseline Management Plan (TM4)

The objective of this task is to document the results of the evaluation of the Baseline Scenario in TM4. Ultimately, the TM will become chapters in the final GSP. The outline of the TM will be:

1. Description of the Baseline Scenario
2. Projected Basin Response to the Baseline Scenario
3. Impediments to Sustainability
4. Appendix A – Comments and Responses-to-Comments for Phase III TM

An administrative draft TM will be prepared by WEI for internal technical review. A draft TM will be prepared based on the internal technical review. The draft TM will be provided to GSA staff and interested stakeholders in electronic format for review and comment. Two weeks following the distribution of the draft TM, WEI will prepare for and lead a public meeting to present the draft TM to GSA staff and stakeholders. GSA staff and stakeholder feedback will be recorded at the meeting. GSA staff and stakeholders will have two weeks following the public meeting to submit written comments and suggested revisions to the draft TM. In coordination with GSA staff, WEI will update the draft TM to a final TM based on the comments received and will prepare an appendix to the TM that documents all comments and responses-to-comments. The final TM will be distributed to GSA staff and stakeholders as an electronic document and will be published on the GSA website.

Deliverable: *Technical Memorandum 4 – Sustainability of Baseline Management Plan*

Phase IV – Evaluate Basin Optimization Scenarios to Achieve Sustainability

The objective of Phase IV is to develop and evaluate up to eight future projects and/or management actions that will remove the impediments to achieving sustainability (as identified in Phase III). The projects and/or management actions that are deemed feasible will be described up to four "Basin Optimization Scenarios" that will bracket a range of reasonable implementation plans. Groundwater modeling of the Spadra Basin will be the method to quantitatively evaluate and determine sustainability for each Sustainability Indicator over a 60-year planning horizon for each Scenario. A long-term cost analysis of each Scenario will be prepared for comparison to the Baseline Scenario and to each other. While this cost analysis was not included as a required task in the RFP, it is necessary to develop an accurate long-term financing plan for the GSP. A preferred Scenario of projects and/or management actions will be identified in this phase, Measurable Objectives will be established for said Scenario, and the Sustainable Yield will be estimated from the associated model-generated water budget. Phase IV addresses the requirements of Article 5, Subarticle 5 of the GSP Emergency Regulations and includes the following tasks:

Task 11. Describe new projects or management actions as up to four Basin Optimization Scenarios

In this task, the WEI/WY team will work closely with the stakeholders in the Spadra Basin to develop a list of potential future projects and management actions that are anticipated to help achieve sustainability in the Spadra Basin. Data and information will be collected from the stakeholders to help describe the projects and management actions. WEI/WY will prepare tables and text that describe planning criteria to be used in describing and evaluating projects (i.e., design, operational, financial, and cost assumptions) and obtain consensus with the stakeholders on the planning criteria. WEI/WY will prepare feasibility-level designs and operating schemes for each new project and develop cost estimates for construction and operations and maintenance. This information will be used to describe four Basin Optimization Scenarios that are logical combinations of feasible projects and management actions that will help to achieve sustainability and maximize the utilization of the Spadra Basin.

A technical memorandum will be prepared titled *Technical Memorandum 5 (Part 1) – Basin Optimization Scenarios* (TM5-1) to describe the four Basin Optimization Scenarios. An administrative draft TM will be prepared by WEI for internal technical review. A draft TM will be prepared based on the internal technical review. The draft TM will be provided to GSA staff and interested stakeholders in electronic format for review and comment. Two weeks following the distribution of the draft TM, WEI will prepare for and lead a public meeting to present the draft TM to GSA staff and stakeholders. GSA staff and stakeholder feedback will be recorded at the meeting. GSA staff and stakeholders will have two weeks following the public meeting to submit written comments and suggested revisions to the draft TM. In coordination with GSA staff, WEI will update the draft TM to a final TM based on the comments received and will prepare an appendix to the TM that documents all comments and responses-to-comments. The final TM will be distributed to GSA staff and stakeholders as an electronic document and will be published on the GSA website.

Deliverable: *Technical Memorandum 5 (Part 1) – Basin Optimization Scenarios*

Task 12. Conduct modeling evaluation of the Basin Optimization Scenarios

In this task, the surface-water and groundwater models are updated to reflect future project conditions and plans, model input files are prepared, and the Basin Optimization Scenarios are simulated to predict the response of the Spadra Basin to the Scenarios. The surface-water model from the Baseline Scenario is refined based on the changes in the Basin Optimization Scenarios that would affect surface water. The surface-water model will be run for each Scenario to estimate future deep infiltration of precipitation and applied water, sub-surface boundary inflows, streambed infiltration, and surface-water inflows/outflows. The output from the surface-water modeling will provide input data for the groundwater model. Other input files for the groundwater model will be prepared, including estimated future groundwater pumping and managed artificial recharge of storm, imported, and recycled water.

The results of the groundwater modeling will represent the groundwater basin response to the Basin Optimization Scenarios. The model results will be displayed as tables, charts, and maps and will be compared to: (i) the Sustainable Management Criteria developed in Phase II to evaluate sustainability and (ii) the results of the Baseline Scenario to describe any projected improvements in basin conditions (e.g., enhanced basin yield). This task includes an analysis of impacts to neighboring groundwater basins.

Task 13. Prepare long-term cost analyses for Baseline and Basin Optimization Scenarios

In this task, the total annual cost of the aggregate water supply for the water supply agencies ($/acre-ft) will be estimated over the 60-year planning horizon for the Baseline and the Basin Optimization Scenarios. The annual costs of the aggregate water supply over the 60-year period will be displayed as time-series curves on a chart to compare all Scenarios.

Task 14. Identify the preferred Basin Optimization Scenario

In this task, the information derived from the groundwater modeling and cost analyses will be utilized to identify a preferred and recommended Basin Optimization Scenario. Measurable Objectives will then be established for 5-, 10-, and 15-years following GSP implementation based on the selected Scenario. The Sustainable Yield (acre-feet per year) will be estimated from the model-generated water budget of the preferred and recommended Basin Optimization Scenario.

Task 15. Update TM5 to Document Model Results and the Preferred Basin Optimization Scenario

The objective of this task is to document the process and outcome of identifying a preferred and recommended Basin Optimization Scenario in *Technical Memorandum 5 – Sustainability of Basin Optimization Scenarios* (TM5). Ultimately, the TM will become chapters in the final GSP. The outline of the TM5 will be:

1. Description of the Basin Optimization Scenarios
2. Projected Basin Response to the Basin Optimization Scenarios
3. Cost Analysis for the Baseline and Basin Optimization Scenarios
4. Recommended Basin Optimization Scenario
5. Appendix A – Comments and Responses-to-Comments for Phase IV TM

An administrative draft TM will be prepared by WEI for internal technical review. A draft TM will be prepared based on the internal technical review. The draft TM will be provided to GSA staff and interested stakeholders in electronic format for review and comment. Two weeks following the distribution of the draft TM, WEI will prepare for and lead a public meeting to present the draft TM to GSA staff and stakeholders. GSA staff and stakeholder feedback will be recorded at the meeting. GSA staff and stakeholders will have two weeks following the public meeting to submit written comments and suggested revisions to the draft TM. In coordination with GSA staff, WEI will update the draft TM to a final TM based on the comments received and will prepare an appendix to the TM that documents all comments and responses-to-comments. The final TM will be distributed to GSA staff and stakeholders as an electronic document and will be published on the GSA website.

Deliverable: *Technical Memorandum 5 – Sustainability of Basin Optimization Scenarios*

Phase V – Develop Groundwater Sustainability Plan (GSP)

The objective of Phase V is to prepare the final GSP through a transparent and public process.

Task 16. Develop Groundwater Sustainability Plan (GSP)

In this task, the information derived from Phase I through IV will be used to prepare a statement of the Sustainability Goal, describe the long-term monitoring and reporting program for the GSP, describe the GSP database management system, and develop a GSP implementation plan. This information will be combined with the final TMs prepared during the prior phases of work to prepare the final GSP report. The outline of the final GSP report will be:

Executive Summary

Section 1: Introduction, GSA Description, Purpose, Sustainability Goal

Section 2: Plan Area and Basin Setting (already documented in TM-1 and TM-2)

Section 3: Management Goals and Objectives (already documented in TM-3)

Section 4: Projects and Management Actions (already documented in TM-4 and TM-5)

Section 5: GSP Implementation plan

Section 6: References

Appendix A: Summarize notice and communication activities for the GSP

Appendix B: Comments and Responses-to-Comments for Final GSP

An internal draft GSP will be prepared by WEI for internal technical review. An administrative draft GSP will be prepared based on the internal technical review. The administrative draft TM will be provided to GSA staff and interested stakeholders in electronic format for review and comment and will be published on the GSA website. Two weeks following the distribution of the administrative draft GSP, WEI will prepare for and lead a public meeting to present the administrative draft GSP to GSA staff and stakeholders. GSA staff and stakeholder feedback will be recorded at the meeting. GSA staff and stakeholders will have two weeks following the public meeting to submit written comments and suggested revisions to the administrative draft GSP. In coordination with GSA staff, WEI will update the administrative draft GSP to a draft GSP based on the comments received and will prepare an appendix to the draft GSP that documents all comments and responses-to-comments. The draft GSP will be distributed to GSA staff and stakeholders as an electronic document and will be published on the GSA website. Two weeks following the distribution of the draft GSP, WEI will prepare for and lead a public meeting to present the draft GSP to GSA staff and stakeholders. GSA staff and stakeholder feedback will be recorded at the meeting. GSA staff and stakeholders will have two weeks following the public meeting to submit written comments and suggested revisions to the draft GSP. In coordination with GSA staff, WEI will update the draft GSP to a final GSP based on the comments received and will prepare an appendix to the draft GSP that documents all comments and responses-to-comments. The final GSP will be published on the GSA website.

Deliverables: *Administrative Draft GSP*

Draft GSP

Final GSP

Table 5-1 below shows the WEI/WY 2019 schedule of billing rates and reimbursable unit costs. This rate schedule was used to prepare the fee estimate for this project.

Table 5-1
WEI 2019 Time and Material Rate Sheet and Reimbursable Unit Costs

Professional Level	Hourly Rate
WEI Professionals Levels	
Principal III Engineer/Scientist	$285
Principal II Engineer/Scientist	$267
Principal I Engineer/Scientist	$253
Supervising II Engineer/Scientist	$236
Supervising I Engineer/Scientist	$230
Senior II Engineer/Scientist	$206
Senior I Engineer/Scientist	$193
Staff II Engineer/Scientist	$167
Staff I Engineer/Scientist	$155
Technical Editor/Admin Asst.	$132
West Yost Professionals Levels	
Vice President	$298
Senior Engineer	$234
Engineer	$157
Appearance at depositions and expert witness testimony in court will be billed at twice the hourly rate listed above for a minimum of eight hours each day.	

Reimbursibles	Unit Costs
Mileage	
Automobiles	Current IRS Rates
Field Vans	$0.80 per Mile
Tolls	As incurred at prevailing rates
Field Equipment	
2" Purge Pump/Control Box	$270 per day
Generator	$39 per day
Low Flow Sampling Device	$75 per day
Precision Water Level Meter	$19 per day
Water Quality Meter	$27 per day
Turbidity Meter	$22 per day
Other as-needed rental equipment or supplies	Cost of materials

The total estimated cost to implement the project is $703,389. Table 5-2 below summarizes the costs by project phase.

Table 5-2
Summary of Project Cost

Task Number and Name	Cost
Phase 0 – Project Management and Administration	$98,714
Phase I – Describe the Plan Area and Basin Setting	$318,301
Phase II – Develop Sustainable Management Criteria for the Spadra Basin	$33,544
Phase III – Evaluate the Sustainability of Future Baseline Conditions	$68,469
Phase IV – Evaluate Basin Optimization Scenarios to Achieve Sustainability	$137,649
Phase V – Prepare and Adopt the GSP	$46,712
Total Cost	***$703,389***

Table 5-3 on the following pages is a detailed line-item cost estimate, which reflects the task detail provided in the scope of work presented in Section 4. The line-item estimate includes a breakdown of labor hours by employee billing classification. Labor hours and cost, reimbursable expenses, and total costs are show as sub-totals by Task and for the entire project.

Table 5-3
Work Breakdown Structure and Line-Item Cost Estimate
Development of a Groundwater Sustainability Plan for the Spadra Basin

Map to RFP Tasks	Map to Grant Projects (P) and Tasks (T)	Task and Subtask Descriptions	Labor Hours and Cost Estimate														Reimbursable Expenses				Total Project Costs	
			Wildermuth Environmental								West Yost					Labor Cost						
			Principal III (Wildermuth)	Principal II (Malone)	Modelers (Wang/Hwang/Chiang)	Supervising II (Gaiser)	Supervising I (Blazevic, Weamer)	Senior I (Sanchez)	Staff I/II	Editor/Admin	Vice President (Dopudja)	Senior Engineer (Whatley)	Engineer (Connell)	Task Repetition Multiplier	Person Hours	Sub-Task	Task and Phase	Travel	Sub	Total Sub-Task	Total Task and Phase	Sub-Task	Task and Phase
		Phase 0 Stakeholder Outreach and Project Management and Administration																				
5, 10	P1-T6 P2-T4 P3-T4	**Task 1** Stakeholder outreach															**$60,939**				**$780**		**$61,719**
		Prepare meeting materials and attend 12 public stakeholder meetings to review deliverables; document meeting minutes for distribution after each meeting		6.5		4.5	2.0	4.5	3.0					12	246	$55,308		$780		$780		$56,088	
		Assist the GSA with website maintenance and stakeholder notifications (2.5 years)		0.1					1.0					30	33	$5,631				$0		$5,631	
na	na	**Task 2** Project administration and management															**$36,345**				**$650**		**$36,995**
		Prepare for and attended quarterly coordination meetings with GSA staff/admin (10)		3.0		1.5	1.5	1.5						10	75	$17,895		$650		$650		$18,545	
		Coordinate project staffing and sub-contractors (2.5 years)		1.0										30	30	$8,010				$0		$8,010	
		Monthly tracking and reporting to GSA staff of project progress, schedule, and budget status (2.5 years); these reports support GSA progress reporting to DWR for grant admin		0.5		0.5		0.5						30	45	$10,440				$0		$10,440	
		Phase 0 Subtotals	**0**	**156**	**0**	**84**	**39**	**84**	**66**	**0**	**0**	**0**	**0**		**429**		**$97,284**	**$1,430**	**$0**		**$1,430**		**$98,714**
		Phase I Develop Hydrogeologic Conceptual Model and Groundwater Model for the Spadra Basin																					
1	P1-T1 P3-T2	**Task 3** Prepare hydrologic database and library of reports															**$19,662**				**$0**		**$19,662**
		Collect and review historical reports on Spadra Basin		4.0	2.0	4.0	1.0		8.0					1	19	$4,036				$0		$4,036	
		Collect, compile, and review data																					
		GIS layers (topography, soil type, surface geology, land use, hydrography, septic, etc)	1.0			1.0	0.5		16.0					1	18.5	$3,194				$0		$3,194	
		Well and borehole information					0.5		4.0					1	4.5	$759				$0		$759	
		Groundwater-elevations					0.3		4.0					1	4.25	$702				$0		$702	
		Groundwater-quality					0.3		4.0					1	4.25	$702				$0		$702	
		Precipitation, surface-water discharge/quality					0.3		4.0					1	4.25	$702				$0		$702	
		QA/QC and upload data to database (HydroDaVE)				2.0	6.0		20.0					1	28	$5,072				$0		$5,072	
		Prepare project GIS and map templates	2.0			1.0	4.0		16.0					1	23	$4,266				$0		$4,266	
		Create user profiles for GSA-member access to online database (HydroDaVE)					1.0							1	1	$230				$0		$230	
1	P1-T1 P3-T3	**Task 4** Describe Plan Area and Prepare Basin Setting (conceptual model of the Spadra Basin)															**$58,454**				**$0**		**$58,454**
		Prepare map of Plan Area				0.5			3.0					1	3.5	$601				$0		$601	
		Prepare map of existing groundwater/surface-water monitoring network					0.3		3.0					1	3.25	$541				$0		$541	
		Prepare maps of historical, current, and ultimate land use, water use, and wastewater disposal						1.5	8.0					1	9.5	$1,578				$0		$1,578	
		Prepare location map showing prominent hydrologic and geologic features, wells, precipitation stations and surface water gaging stations				0.5			3.0					1	3.5	$601				$0		$601	
		Prepare surface geologic map				0.5			3.0					1	3.5	$601				$0		$601	
		Prepare map of soil types and characteristics						0.5	3.0					1	3.5	$580				$0		$580	
		Estimate the spatial distribution of the bottom of the aquifer based on borehole data and prepare elevation-contour maps to characterize it				4.0			8.0					1	12	$2,232				$0		$2,232	
		Prepare four hydrogeologic cross-sections (one longitudinal and three transverse) based on geologic features, borehole information, groundwater-level data and water-quality data	1.0	2.0		6.0			16.0					1	25	$4,765				$0		$4,765	
		Construct lithologic model of the basin		8.0										1	8	$2,024				$0		$2,024	
		Estimate the spatial distribution of specific yield from lithologic model and prepare maps to characterize it		4.0		1.0			4.0					1	9	$1,892				$0		$1,892	
		Estimate the spatial distribution of vertical and horizontal hydraulic conductivities from lithologic model and prepare maps to characterize them		4.0		1.0			4.0					1	9	$1,892				$0		$1,892	
		Prepare and review tables and charts that show the time-histories of groundwater level, groundwater pumping, groundwater water quality, precipitation, ET and surface water discharge				2.0		2.0	10.0					1	14	$2,468				$0		$2,468	

Table 5-3
Work Breakdown Structure and Line-Item Cost Estimate
Development of a Groundwater Sustainability Plan for the Spadra Basin

Map to RFP Tasks	Map to Grant Projects (P) and Tasks (T)	Task and Subtask Descriptions	Labor Hours and Cost Estimate													Reimbursable Expenses				Total Project Costs	
			Wildermuth Environmental							West Yost			Task Repetition Multiplier	Person Hours	Labor Cost		Travel	Sub	Total		Sub-Task	Task and Phase
			Principal III (Wildermuth)	Principal II (Malone)	Modelers (Wang/Hwang/Chiang)	Supervising II (Gaiser)	Supervising I (Blazevic, Weamer)	Senior I (Sanchez)	Staff I/II	Editor/Admin	Vice President (Dopudja)	Senior Engineer (Whatley)	Engineer (Connell)			Sub-Task	Task and Phase			Sub-Task	Task and Phase		
		Select four representative points in time to prepare groundwater-elevation maps (one map will be initial condition for groundwater model calibration)		1.0		1.0								1	2	$503				$0		$503	
		Prepare four historical groundwater-elevation contour maps		1.0		4.0			20.0					1	25	$4,431				$0		$4,431	
		Estimate the spatial distribution of the depth-to-groundwater for each groundwater-elevation map and prepare maps to characterize them				2.0			8.0					1	10	$1,760				$0		$1,760	
		Estimate the spatial distribution of change in groundwater elevations and prepare 3 maps to characterize them				2.0			8.0					1	10	$1,760				$0		$1,760	
		Review water-quality time histories; select four representative points in time and prepare maps (TDS, nitrate, constituents of concern)					3.0		12.0					1	15	$2,622				$0		$2,622	
		Prepare maps of Geotracker sites and known contaminant plumes					0.5		6.0					1	6.5	$1,081				$0		$1,081	
		Prepare tables of historical groundwater production				0.3			2.5					1	2.75	$462				$0		$462	
		Collect available InSAR data and prepare maps of historical land subsidence		1.0		2.0			8.0					1	11	$2,027				$0		$2,027	
		Collect and compile as-built drawings of major drainage improvements						2.0	4.0					1	6	$1,030				$0		$1,030	
		Identify surface-water features and drainage areas and prepare maps to characterize them						1.5	6.0					1	7.5	$1,256				$0		$1,256	
		Identify historical occurrence of GDEs that could be influenced by groundwater pumping and other water management activities in the watershed				1.0	6.0							1	7	$1,616				$0		$1,616	
		Develop hydrologic properties of watershed tributary to and overlying the basin			8.0			8.0						1	16	$3,568				$0		$3,568	
		Prepare administrative draft Technical Memorandum#1 - Hydrogeologic Conceptual Model (TM1)		4.0		24.0	4.0	8.0	8.0					1	48	$10,484				$0		$10,484	
		Perform internal technical review of administrative draft memorandum	4.0							4.0				1	8	$1,668				$0		$1,668	
		Prepare draft TM1 based on internal technical review				4.0		2.0	4.0					1	10	$1,974				$0		$1,974	
		Distribute administrative draft TM1 to GSA staff and stakeholders for review and comment							0.1					1	0.1	$16				$0		$16	
		Prepare for and attend public GSA/stakeholder meeting to review TM1 and receive feedback												1	0	$0				$0		$0	
		Catalog GSA/stakeholder comments; prepare appendix of GSA/stakeholder comments and responses-to-comments		1.0		2.0		0.5	2.0					1	5.5	$1,158				$0		$1,158	
		Prepare final TM1 with comments/responses as an appendix		0.5		2.0			4.0					1	6.5	$1,250				$0		$1,250	
		Publish final TM1 to GSA website and notify all stakeholders							0.1					1	0.1	$16				$0		$16	
2	**P1-T2**	**Task 5** Collect additional hydrogeologic information (Construct new monitoring well)														**$50,672**				**$109,686**		**$160,358**
		Perform well-siting study to identify appropriate parcel/site for new monitoring well		1.0		2.0	8.0		40.0					1	51	$9,019		$490		$490		$9,509	
		Prepare technical specifications for new monitoring well site		1.0		2.0	8.0							1	11	$2,579				$0		$2,579	
		Permitting and CEQA					8.0							1	8	$1,840			$3,000	$3,000		$4,840	
		Support of bid process for well construction contractor				2.0	8.0							1	10	$2,312				$0		$2,312	
		Well construction and development; water quality sampling and analysis		4.0		6.0	24.0		80.0					1	114	$20,884			$100,000	$100,000		$120,884	
		Well head completion					4.5		8.0					1	12.5	$2,323			$5,000	$5,000		$7,323	
		Purchase, install, and test long-term monitoring devices					0.5		12.0					1	12.5	$2,047		$196	$1,000	$1,196		$3,243	
		Prepare well-completion report		2.0		4.5	16.0		24.0	4.0				1	50.5	$9,668				$0		$9,668	
3	**P1-T3**	**Task 6** Construct and calibrate a numerical groundwater-flow model														**$79,827**				**$0**		**$79,827**	
		Determine the active cells for the Spadra Basin in the Chino Basin model domain		0.5	1.5									1	2	$513				$0		$513	
		Convert hydrogeologic conceptual model from Task 3 into groundwater model files that include basin geometry and associated hydraulic properties			12.0									1	12	$3,036				$0		$3,036	
		Determine cells to be included in the groundwater model where surface water/groundwater interaction occurs that needs to be represented in the model and develop associated model input file	1.0		6.0									1	7	$1,803				$0		$1,803	
		Develop surface water model sub areas and routing scheme (routing sequence, link-node data)			4.0			24.0						1	28	$5,644				$0		$5,644	
		Develop surface water model parameters (land use, hydrologic soil type, CNs, others)			4.0			32.0						1	36	$7,188				$0		$7,188	
		Develop precipitation, applied water and ET estimates for each surface water model sub area			2.0			16.0						1	18	$3,594				$0		$3,594	
		Prepare input files and get surface water model to run			2.0			16.0						1	18	$3,594				$0		$3,594	
		Use the surface water model to estimate deep infiltration of precipitation and applied water, sub surface boundary inflows, streambed infiltration and surface water inflows			4.0			30.0						1	34	$6,802				$0		$6,802	

Table 5-3
Work Breakdown Structure and Line-Item Cost Estimate
Development of a Groundwater Sustainability Plan for the Spadra Basin

Map to RFP Tasks	Map to Grant Projects (P) and Tasks (T)	Task and Subtask Descriptions	Labor Hours and Cost Estimate													Reimbursable Expenses				Total Project Costs	
			Wildermuth Environmental								West Yost			Task Repetition Multiplier	Person Hours	Labor Cost		Travel	Sub	Total		Sub-Task	Task and Phase
			Principal III (Wildermuth)	Principal II (Malone)	Modelers (Wang/Hwang/Chiang)	Supervising II (Gaiser)	Supervising I (Blazevic, Weamer)	Senior I (Sanchez)	Staff I/II	Editor/Admin	Vice President (Dopudja)	Senior Engineer (Whatley)	Engineer (Connell)			Sub-Task	Task and Phase			Sub-Task	Task and Phase		
		Estimate managed artificial recharge of storm, imported and recycled water						6.0						1	6	$1,158				$0		$1,158	
		Develop recharge file(s) for the groundwater model			6.0									1	6	$1,518				$0		$1,518	
		Assemble groundwater pumping data and assign it model layer cells in the layers that wells are screened (well by well basis)			6.0									1	6	$1,518				$0		$1,518	
		Determine cells where losses to ET can occur			2.0									1	2	$506				$0		$506	
		Develop groundwater model input files for groundwater pumping and ET			8.0									1	8	$2,024				$0		$2,024	
		Develop parameter zones for calibration			4.0									1	4	$1,012				$0		$1,012	
		Develop groundwater-level calibration targets			8.0									1	8	$2,024				$0		$2,024	
		Compile all groundwater model input files and get the groundwater model to run			12.0									1	12	$3,036				$0		$3,036	
		Prepare initial water budget table and perform final check of all recharge and discharge stresses that are independent of the model computations; finalize model input file preparation	2.0		8.0			2.0						1	12	$2,980				$0		$2,980	
		Use PEST to conduct initial sensitivity analysis			8.0									1	8	$2,024				$0		$2,024	
		Use PEST to conduct an iterative groundwater model calibration			24.0									1	24	$6,072				$0		$6,072	
		Prepare tables, charts and maps to document the calibration (table of final calibrated hydraulic parameters compared to expected range, residual tables and charts, time histories and scatter plots at individual wells, residual maps, water budget table, others)	3.0		6.0			12.0	20.0					1	41	$7,909				$0		$7,909	
		Prepare administrative draft TM #2 - Model Construction and Calibration (TM 2)		3.0	4.0			24.0	8.0					1	39	$7,733				$0		$7,733	
		Perform internal technical review of administrative draft TM2	4.0							4.0				1	8	$1,668				$0		$1,668	
		Prepare draft TM2 based on internal technical review		1.0	2.0			4.0	4.0					1	11	$2,189				$0		$2,189	
		Distribute draft model report to GSA staff and stakeholders for review and comment								0.1				1	0.1	$13				$0		$13	
		Prepare for and attend a public GSA/stakeholder meeting to review TM2 and receive feedback												1	0	$0				$0		$0	
		Catalog GSA/stakeholder comments; prepare appendix of GSA/stakeholder comments and responses-to-comments	1.0		1.0			1.0	2.0					1	5	$1,053				$0		$1,053	
		Prepare final TM2 with comments/responses as an appendix	2.0		2.0			6.0	6.0					1	16	$3,200				$0		$3,200	
		Publish final TM2 to GSA website and notify all stakeholders							0.1					1	0.1	$16				$0		$16	
		Phase I Subtotals	**17**	**29**	**165**	**84**	**105**	**199**	**438**	**12**	**0**	**0**	**0**		**1,048**	**$208,615**		**$686**	**$109,000**		**$109,686**		**$318,301**
GSP	**P3-T3**	**Phase II** **Develop Sustainable Management Criteria for the Spadra Basin**																					
		Task 7 Define Sustainable Management Criteria														**$33,544**					**$0**		**$33,544**
		Determine the relevant Sustainability Indicators for the Spadra Basin	2.0	2.0	2.0	2.0	2.0	2.0						1	12	$2,928				$0		$2,928	
		Describe what causes Undesirable Results for each Sustainability Indicator	2.0	2.0	2.0	2.0	2.0	2.0						1	12	$2,928				$0		$2,928	
		Estimate Minimum Thresholds for each Sustainability Indicator	2.0	2.0	2.0	2.0	2.0	2.0						1	12	$2,928				$0		$2,928	
		Establish Measurable Objectives for each Sustainability Indicator	2.0	2.0	2.0	2.0	2.0	2.0						1	12	$2,928				$0		$2,928	
		Delineate Management Areas, if appropriate	2.0	2.0	2.0	2.0	2.0	2.0						1	12	$2,928				$0		$2,928	
		Define the monitoring network and monitoring program	1.0	2.0		8.0	4.0		6.0					1	21	$4,593				$0		$4,593	
		Prepare administrative draft TM #3 - Sustainable Management Criteria		4.0		16.0	2.0	4.0	20.0					1	46	$9,296				$0		$9,296	
		Perform internal technical review of administrative draft TM3	4.0							2.0				1	6	$1,404				$0		$1,404	
		Prepare draft TM3 based on internal technical review		1.0		3.0			3.0					1	7	$1,458				$0		$1,458	
		Distribute TM3 to GSA staff and stakeholders for review and comment							0.1					1	0.1	$16				$0		$16	
		Prepare for and attend public GSA/stakeholder meeting to review TM3 and receive feedback												1	0	$0				$0		$0	
		Receive GSA/stakeholder comments; prepare appendix of GSA/stakeholder comments and responses-to-comments		1.0		2.0			2.0					1	5	$1,061				$0		$1,061	
		Prepare final TM3 with comments/responses as an appendix		0.5		2.0			2.0	1.0				1	5.5	$1,060				$0		$1,060	
		Publish final TM3 to GSA website and notify all stakeholders							0.1					1	0.1	$16				$0		$16	
		Phase II Subtotals	**15**	**19**	**10**	**41**	**16**	**14**	**33**	**3**	**0**	**0**	**0**		**151**	**$33,544**		**$0**	**$0**		**$0**		**$33,544**

Table 5-3
Work Breakdown Structure and Line-Item Cost Estimate
Development of a Groundwater Sustainability Plan for the Spadra Basin

Map to RFP Tasks	Map to Grant Projects (P) and Tasks (T)	Task and Subtask Descriptions	Labor Hours and Cost Estimate														Reimbursable Expenses				Total Project Costs	
			Wildermuth Environmental								West Yost					Labor Cost						
			Principal III (Wildermuth)	Principal II (Malone)	Modelers (Wang/Hwang/Chiang)	Supervising II (Gaiser)	Supervising I (Blazevic, Weamer)	Senior I (Sanchez)	Staff I/II	Editor/Admin	Vice President (Dopudja)	Senior Engineer (Whatley)	Engineer (Connell)	Task Repetition Multiplier	Person Hours	Sub-Task	Task and Phase	Travel	Sub	Total Sub-Task	Total Task and Phase	Sub-Task	Task and Phase
4	P1	**Phase III Evaluate the Sustainability of Future Baseline Conditions**																				
4	P1-T4	**Task 8** Develop and document the Baseline Scenario															**$13,742**				**$0**	**$13,742**
		Establish the planning period (60 years)												1	0	$0				$0		$0	
		Collect, compile, and review water demands, water-supply plans, and wastewater disposal plans for all water management entities in the basin						12.0	24.0					1	36	$6,180				$0		$6,180	
		Develop a projected time history of land use changes						6.0	12.0					1	18	$3,090				$0		$3,090	
		Document draft Baseline Scenario (summary of water demand and supply plans and associated pumping and managed aquifer recharge projections)		2.0	2.0			8.0	4.0					1	16	$3,228				$0		$3,228	
		Distribute draft baseline scenario description to water-supply agencies for review and comment							0.1					1	0.1	$16				$0		$16	
		Finalize draft baseline scenario description based on comments from water-supply agencies		0.5				4.0	2.0					1	6.5	$1,228				$0		$1,228	
4	P1-T4	**Task 9** Conduct modeling evaluation of the Baseline Scenario															**$39,388**				**$0**	**$39,388**
		Refine surface water model sub areas and routing scheme from calibration period to reflect planning period (routing sequence, link-node data)						4.0						1	4	$772				$0		$772	
		Develop precipitation, applied water and ET projections for each surface water model sub area incorporating DWR guidance for representing climate change			2.0			12.0						1	14	$2,822				$0		$2,822	
		Prepare input files and get surface water model to run			2.0			12.0						1	14	$2,822				$0		$2,822	
		Use the surface-water model to estimate future deep infiltration of precipitation and applied water, sub-surface boundary inflows, streambed infiltration, and surface-water inflows			4.0			16.0						1	20	$4,100				$0		$4,100	
		Estimate future managed artificial recharge of storm, imported, and recycled water						4.0						1	4	$772				$0		$772	
		Assemble groundwater pumping projections and assign it model layers cells in the layers that wells are screened (well by well basis).			6.0									1	6	$1,518				$0		$1,518	
		Conduct internal technical review of all projected recharge and discharge terms for Baseline Scenario	2.0	2.0	4.0			2.0						1	10	$2,502				$0		$2,502	
		Update and finalize projected recharge and discharge terms			2.0			2.0						1	4	$892				$0		$892	
		Develop groundwater model input files for the Baseline Scenario and get the model to run			18.0									1	18	$4,554				$0		$4,554	
		Prepare initial water budget table and perform final check of all recharge and discharge stresses that are independent of the model computations; finalize model input file preparation	2.0		8.0			2.0						1	12	$2,980				$0		$2,980	
		Update model files and get the model to run			6.0									1	6	$1,518				$0		$1,518	
		Prepare tables, charts and maps to document the Baseline Scenario (groundwater-level time histories at individual wells, groundwater-level and change maps, water budget tables, etc)	2.0	1.0	4.0			6.0	16.0					1	29	$5,583				$0		$5,583	
		Prepare tables, charts and maps to compare basin response to Sustainable Management Criteria	0.5	0.5	2.0	2.0		2.0	6.0					1	13	$2,606				$0		$2,606	
		Evaluate sustainability of the Baseline Scenario and identify impediments to sustainability		1.0	2.0	2.0	1.0	4.0						1	10	$2,247				$0		$2,247	
		Conduct internal review of basin response and sustainability evaluation	2.0	2.0	2.0	2.0	2.0	2.0						1	12	$2,928				$0		$2,928	
		Update and finalize basin response and sustainability evaluation						4.0						1	4	$772				$0		$772	
9	P1-T5	**Task 10** Prepare Technical Memorandum 4 - Sustainability of Baseline Management Plan (TM4)															**$15,340**				**$0**	**$15,340**
		Prepare administrative draft of TM4			4.0			24.0	16.0					1	44	$8,220				$0		$8,220	
		Perform internal technical review of admin draft TM4	4.0	2.0		2.0				2.0				1	10	$2,410				$0		$2,410	
		Prepare draft TM4 based on internal technical review		1.0				4.0	3.0					1	8	$1,522				$0		$1,522	
		Distribute draft TM4 to GSA staff and stakeholders for review and comment							0.1					1	0.1	$16				$0		$16	
		Prepare for and attend public GSA/stakeholder meeting to review TM4 and receive feedback												1	0	$0				$0		$0	
		Receive GSA/stakeholder comments; prepare appendix of GSA/stakeholder comments and responses-to-comments	1.0	1.0				2.0	2.5					1	6.5	$1,341				$0		$1,341	
		Prepare final TM4 with comments/responses as an appendix		1.0				4.0	4.0	1.0				1	10	$1,815				$0		$1,815	
		Publish final TM4 to GSA website and notify all stakeholders							0.1					1	0.1	$16				$0		$16	
		Phase III Subtotals	**14**	**14**	**68**	**8**	**3**	**136**	**90**	**3**	**0**	**0**	**0**		**335**		**$68,469**	**$0**	**$0**		**$0**		**$68,469**

Table 5-3
Work Breakdown Structure and Line-Item Cost Estimate
Development of a Groundwater Sustainability Plan for the Spadra Basin

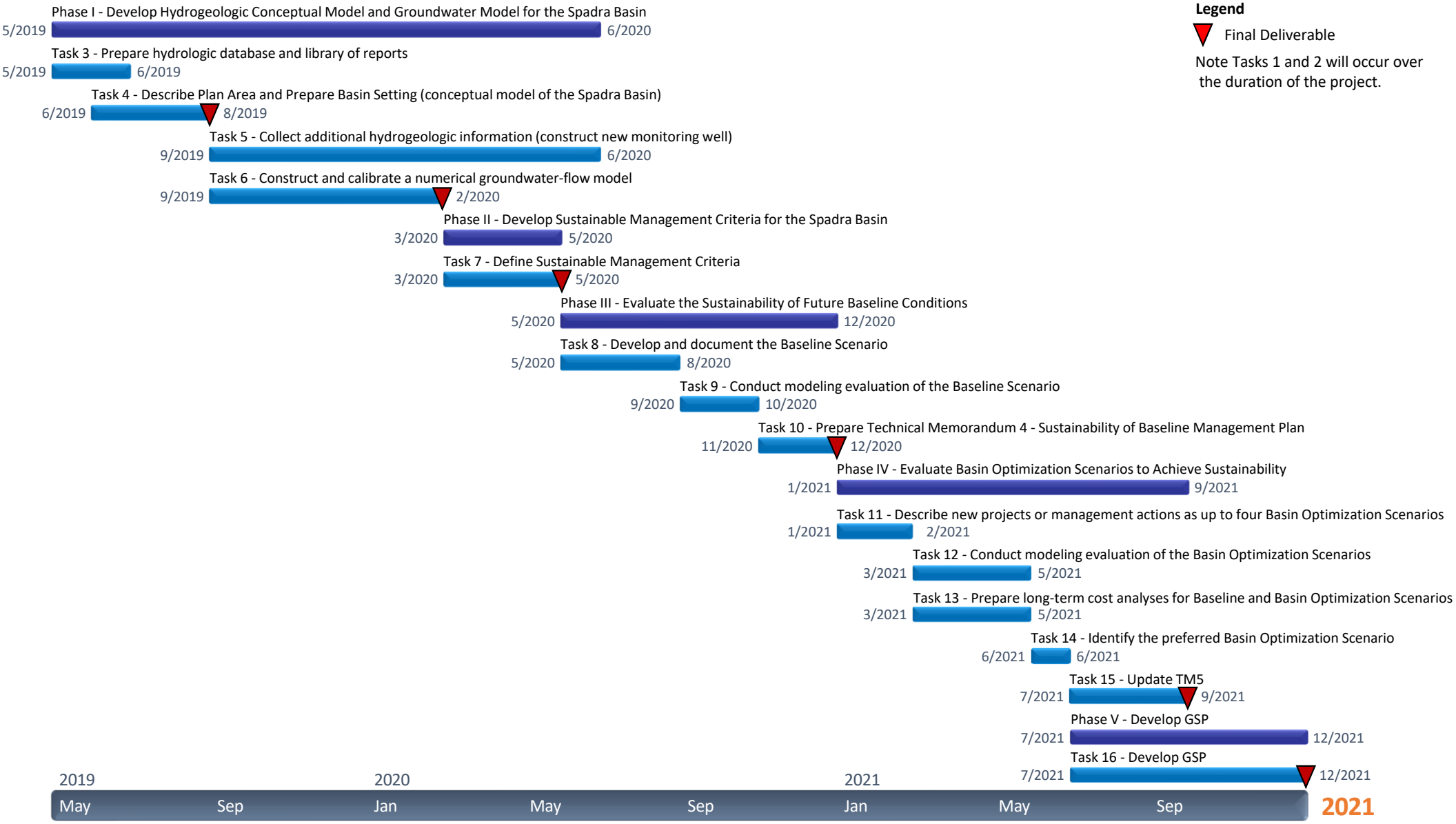
Map to RFP Tasks	Map to Grant Projects (P) and Tasks (T)	Task and Subtask Descriptions	Labor Hours and Cost Estimate														Reimbursable Expenses				Total Project Costs	
			Wildermuth Environmental							West Yost					Labor Cost							
			Principal III (Wildermuth)	Principal II (Malone)	Modelers (Wang/Hwang/Chiang)	Supervising II (Gaiser)	Supervising I (Blazevic, Weamer)	Senior I (Sanchez)	Staff I/II	Editor/Admin	Vice President (Dopudja)	Senior Engineer (Whatley)	Engineer (Connell)	Task Repetition Multiplier	Person Hours	Sub-Task	Task and Phase	Travel	Sub	Total Sub-Task	Total Task and Phase	Sub-Task	Task and Phase
		Phase IV Evaluate Basin Optimization Scenarios to Achieve Sustainability																				
7	P2-T1	**Task 11** Describe new projects or management actions as up to four Basin Optimization Scenarios														**$43,425**				**$500**		**$43,925**
		Collect and compile data/information on new projects and management actions						3.0				8.0	8.0	1	19	$3,707				$0	$3,707	
		Prepare for and attend a field trip and meetings with stakeholders to discuss new projects, ask/answer questions, collect additional data, and visit sites						16.0				16.0	16.0	1	48	$9,344			$250	$250	$9,594	
		Prepare tables that describe planning criteria for design, operation, financial, and cost assumptions; obtain consensus with stakeholders on planning criteria	0.5					1.0				8.0	8.0	1	17.5	$3,464				$0	$3,464	
		Prepare feasibility-level designs and operating assumptions for new facilities	0.5					2.0			1.0	16.0	20.0	1	39.5	$7,711				$0	$7,711	
		Prepare cost estimates for capital improvements and O&M for new facilities	0.5					2.0			1.0	8.0	12.0	1	23.5	$4,583				$0	$4,583	
		Prepare administrative draft TM5-1 that defines four Basin Optimization Scenarios (updated water demands and water-supply plans and associated pumping and managed aquifer recharge projections that include the new projects/actions)	4.0	2.0		2.0		12.0	4.0			8.0	16.0	1	48	$9,490				$0	$9,490	
		Distribute draft TM5-1 to GSA staff and stakeholders for review and comment							0.1					1	0.1	$16				$0	$16	
		Prepare for and attend a public GSA/stakeholder meeting to describe memorandum and receive feedback										6.0	8.0	1	14	$2,660			$250	$250	$2,910	
		Receive and catalog comments on draft TM5-1 and finalize the Basin Optimization Scenarios for modeling	1.0					4.0			1.0	2.0	4.0	1	12	$2,451				$0	$2,451	
8	P2-T2	**Task 12** Conduct modeling evaluation of the Basin Optimization Scenarios														**$60,519**				**$0**		**$60,519**
		Assemble the groundwater management plan for each Basin Optimization Scenario (pumping and managed aquifer recharge projections)		0.5		0.5		3.0						4	16	$3,322				$0	$3,322	
		Refine surface water model sub areas and routing scheme from Baseline Scenario to reflect Basin Optimization Scenarios (routing sequence, link-node data)						4.0						2	8	$1,544				$0	$1,544	
		Prepare input files for each Basin Optimization Scenario and get surface-water model to run						4.0						2	8	$1,544				$0	$1,544	
		Use the surface-water model to project, for each scenario, future deep infiltration of precipitation and applied water, sub-surface boundary inflows, streambed infiltration, and surface-water inflows/outflows						4.0						2	8	$1,544				$0	$1,544	
		Estimate future managed artificial recharge of storm, imported, and recycled water for each scenario						4.0						2	8	$1,544				$0	$1,544	
		Assign groundwater pumping and recharge projections to model layers cells in the layers that wells are screened (well by well basis) for each scenario			3.0			1.0						4	16	$3,808				$0	$3,808	
		Conduct internal technical review of all projected recharge and discharge terms for each scenario			1.0	1.0		1.0						4	12	$2,728				$0	$2,728	
		Update and finalize projected recharge and discharge terms						2.0						4	8	$1,544				$0	$1,544	
		Develop groundwater model input files for each scenario and get the model to run			8.0									4	32	$8,096				$0	$8,096	
		Prepare initial water budget table and perform final check of all recharge and discharge stresses that are independent of the model computations; finalize model input file preparation	1.0		4.0	1.0		2.0						4	32	$7,676				$0	$7,676	
		Update model files and get the model to run			4.0									4	16	$4,048				$0	$4,048	
		Prepare tables, charts and maps to document the basin response for each scenario (groundwater-level time histories at individual wells, groundwater-level and change maps, water budget tables, others)			2.0	0.5		3.0	4.0					4	38	$7,388				$0	$7,388	
		Prepare tables, charts and maps to compare basin response to Sustainable Management Criteria and to the results of the Baseline Scenario		0.3	1.0	0.3		1.0	2.0					4	18	$3,575				$0	$3,575	
		Evaluate sustainability of the Basin Optimization Scenarios and improvements in basin conditions relative to the Baseline Scenario		1.5	3.0	6.0		6.0						1	16.5	$3,734				$0	$3,734	
		Conduct internal review of basin response and sustainability evaluation	4.0	4.0	4.0	4.0	2.0	4.0						1	22	$5,396				$0	$5,396	
		Update and finalize basin response and sustainability evaluation			4.0	2.0		8.0						1	14	$3,028				$0	$3,028	

Table 5-3
Work Breakdown Structure and Line-Item Cost Estimate
Development of a Groundwater Sustainability Plan for the Spadra Basin

Map to RFP Tasks	Map to Grant Projects (P) and Tasks (T)	Task and Subtask Descriptions	Labor Hours and Cost Estimate														Reimbursable Expenses				Total Project Costs	
			Wildermuth Environmental								West Yost					Labor Cost						
			Principal III (Wildermuth)	Principal II (Malone)	Modelers (Wang/Hwang/Chiang)	Supervising II (Gaiser)	Supervising I (Blazevic, Weamer)	Senior I (Sanchez)	Staff I/II	Editor/Admin	Vice President (Dopudja)	Senior Engineer (Whatley)	Engineer (Connell)	Task Repetition Multiplier	Person Hours	Sub-Task	Task and Phase	Travel	Sub	Total Sub-Task	Total Task and Phase	Sub-Task	Task and Phase
8	P2-T2	**Task 13** Prepare long-term cost analyses for Baseline and Basin Optimization Scenarios															**$8,498**				**$0**	**$8,498**
		Prepare long-term cost estimate of the aggregate water-supply for each agency over the Baseline Scenario	1.0					12.0						1	13	$2,601					$0	$2,601	
		Prepare long-term cost estimate of aggregate water-supply for each agency for each Basin Optimization Scenario	0.3					6.0						4	25	$4,917					$0	$4,917	
		Prepare time-series chart for projected cost of aggregate water-supply for each agency for each Scenario	0.5					1.0	4.0					1	5.5	$980					$0	$980	
8	P2-T2	**Task 14** Identify the preferred Basin Optimization Scenario															**$5,877**				**$0**	**$5,877**
		Recommend a preferred Basin Optimization Scenario with associated Measurable Objectives and Sustainable Yield	1.0	1.0	1.0	4.0	1.0	8.0						1	16	$3,523					$0	$3,523	
		Prepare for and attend a stakeholder meeting to describe recommended Basin Optimization Scenario and receive feedback										4.0		1	4	$936					$0	$936	
		Document feedback and finalize the preferred Basin Optimization Scenario	0.5	1.0		1.0		4.0						1	6.5	$1,418					$0	$1,418	
9	P2-T3	**Task 15** Update TM5 to Document Model Results and the Preferred Bsain Optimization Scenario															**$18,832**				**$0**	**$18,832**
		Prepare administrative draft TM5		4.0	2.0	10.0		24.0	10.0					1	50	$10,176					$0	$10,176	
		Perform internal technical review of admin draft memorandum	4.0							4.0				1	8	$1,668					$0	$1,668	
		Prepare draft TM5 based on internal technical review		2.0		2.0		4.0	4.0					1	12	$2,422					$0	$2,422	
		Distribute revised TM5 to GSA staff and stakeholders for review and comment							0.1					1	0.1	$16					$0	$16	
		Prepare for and attend a public GSA/stakeholder meeting to describe memorandum and receive feedback										4.0		1	4	$936					$0	$936	
		Receive GSA/stakeholder comments; prepare appendix of GSA/stakeholder comments and responses-to-comments		1.0		1.0		1.0	3.0					1	6	$1,179					$0	$1,179	
		Prepare final TM5 with comments/responses as an appendix		1.0		2.0		4.0	4.0	2.0				1	13	$2,419					$0	$2,419	
		Publish final TM5 to GSA website and notify all stakeholders							0.1					1	0.1	$16					$0	$16	
		Phase IV Subtotals	**23**	**21**	**106**	**47**	**3**	**224**	**53**	**6**	**3**	**80**	**92**		**657**		**$137,149**	**$500**	**$0**		**$500**		**$137,649**
GSP	**P3-T3**	**Phase V Develop Groundwater Sustainability Plan (GSP)**																					
		Task 16 Develop Groundwater Sustainability Plan (GSP)															**$46,712**				**$0**	**$46,712**
		Prepare Section 1: Introduction, GSA Description, Purpose, Sustainability Goal	1.0	2.0		8.0								1	11	$2,707					$0	$2,707	
		Prepare Section 2: Plan Area and Basin Setting (documented in TM1 and TM2)												1	0	$0					$0	$0	
		Prepare Section 3: Management Goals and Objectives (documented in TM 3)												1	0	$0					$0	$0	
		Update long-term monitoring and reporting program documented in TM3, as necessary		2.0		3.0	3.0							1	8	$1,932					$0	$1,932	
		Describe GSP database management system					6.0							1	6	$1,380					$0	$1,380	
		Prepare Section 4: Projects and Management Actions (documented in TMs 4 and 5)												1	0	$0					$0	$0	
		Prepare Section 5: Prepare GSP implementation plan	2.0	8.0		24.0	4.0	24.0	16.0			4.0	4.0	1	86	$18,062					$0	$18,062	
		Prepare Section 6: References						1.0	4.0					1	5	$837					$0	$837	
		Prepare Appendix A: Summarize notice and communication activities for the GSP				2.0		2.0	6.0					1	10	$1,824					$0	$1,824	
		Prepare Executive Summary		2.0		8.0			4.0					1	14	$3,066					$0	$3,066	
		Prepare internal draft of GSP and perform internal technical review	2.0	4.0	2.0	4.0	2.0	4.0	12.0	8.0				1	38	$7,308					$0	$7,308	
		Prepare administrative draft of GSP and distribute to stakeholders				2.0			4.0					1	6	$1,116					$0	$1,116	
		Prepare for and attend a public meeting to review administrative draft; receive feedback												1	0	$0					$0	$0	
		Receive public comments; prepare appendix of public comments and responses-to-comments	1.0	2.0		2.0		2.0	4.0					1	11	$2,321					$0	$2,321	
		Prepare draft GSP and distribute to stakeholders and public		2.0		4.0		2.0	6.0	2.0				1	16	$3,094					$0	$3,094	
		Prepare for and attend a public meeting to describe draft GSP; receive feedback												1	0	$0					$0	$0	
		Receive public comments; prepare appendix of public comments and responses-to-comments	0.5	1.0		2.0		1.0	2.5					1	7	$1,477					$0	$1,477	
		Prepare Final GSP for adoption				4.0			4.0					1	8	$1,588					$0	$1,588	
		Phase V Subtotals	**7**	**23**	**2**	**63**	**15**	**36**	**63**	**10**	**0**	**4**	**4**		**226**		**$46,712**	**$0**	**$0**		**$0**		**$46,712**
		Project Totals	**75**	**261**	**351**	**327**	**181**	**693**	**743**	**34**	**3**	**84**	**96**		**2846**		**$591,773**	**$2,616**	**$109,000**		**$111,616**		**$703,389**

6. Project Schedule

The figure on the following page presents the schedule to complete the project over the period of May 1, 2019 through December 31, 2021. For each phase and task, the schedule shows the start and end date of the task and the dates for finalizing each deliverable.


Phase I - Develop Hydrogeologic Conceptual Model and Groundwater Model for the Spadra Basin
5/2019
6/2020
Task 3 - Prepare hydrologic database and library of reports
5/2019
6/2019
Task 4 - Describe Plan Area and Prepare Basin Setting (conceptual model of the Spadra Basin)
6/2019
8/2019
Task 5 - Collect additional hydrogeologic information (construct new monitoring well)
9/2019
6/2020
Task 6 - Construct and calibrate a numerical groundwater-flow model
9/2019
2/2020
Phase II - Develop Sustainable Management Criteria for the Spadra Basin
3/2020
5/2020
Task 7 - Define Sustainable Management Criteria
3/2020
5/2020
Phase III - Evaluate the Sustainability of Future Baseline Conditions
5/2020
12/2020
Task 8 - Develop and document the Baseline Scenario
5/2020
8/2020
Task 9 - Conduct modeling evaluation of the Baseline Scenario
9/2020
10/2020
Task 10 - Prepare Technical Memorandum 4 - Sustainability of Baseline Management Plan
11/2020
12/2020
Phase IV - Evaluate Basin Optimization Scenarios to Achieve Sustainability
1/2021
9/2021
Task 11 - Describe new projects or management actions as up to four Basin Optimization Scenarios
1/2021
2/2021
Task 12 - Conduct modeling evaluation of the Basin Optimization Scenarios
3/2021
5/2021
Task 13 - Prepare long-term cost analyses for Baseline and Basin Optimization Scenarios
3/2021
5/2021
Task 14 - Identify the preferred Basin Optimization Scenario
6/2021
6/2021
Task 15 - Update TM5
7/2021
9/2021
Phase V - Develop GSP
7/2021
12/2021
Task 16 - Develop GSP
7/2021
12/2021
2019
2020
2021
May
Sep
Jan
May
Sep
Jan
May
Sep
2021
Legend
Final Deliverable
Note Tasks 1 and 2 will occur over the duration of the project.

Appendix A

Project Descriptions

Development and Application of High-Resolution Models to Recalculate the Chino Basin Safe Yield and Follow-on Model Applications

Chino Basin Watermaster

Project Dates:
Jan 2012 – Sep 2018

Reference:
Peter Kavounas
General Manager
Chino Basin Watermaster
909-484-3888
pkavounas@cbwm.org

Relevance:
WEI staff has the technical know-how and resources to build and apply coupled surface and groundwater models to meet challenging technical and legal requirements. The Chino Basin Groundwater Model has been proven to be highly reliable and accurate and has been accepted by peer reviewers, stakeholders, and the Court. It has supported the development and implementation of basin management plans and satisfied the requirements of CEQA and the SGMA, among others.

Participating Team Members:
Mark Wildermuth
Wenbin Wang
Jeff Hwang
Andy Malone
Eric Chiang

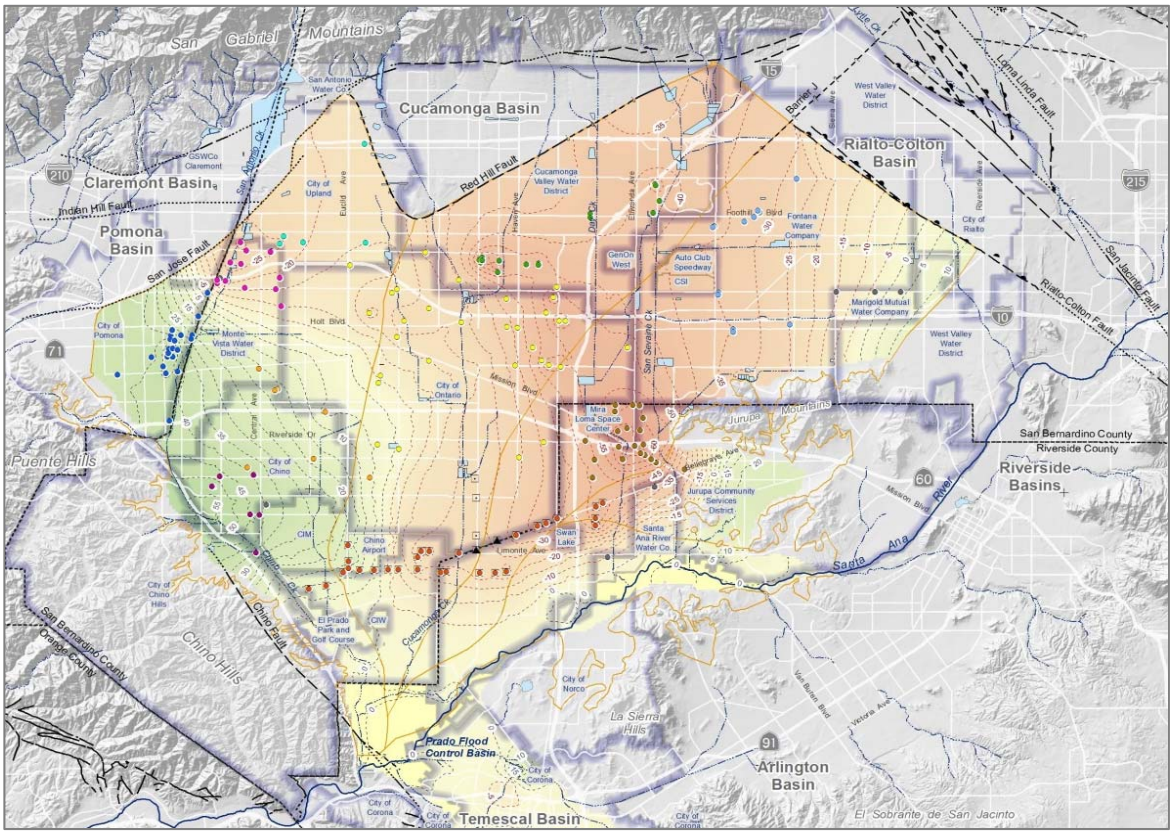
The Chino Basin adjudication was settled in 1978 through a stipulated agreement. Through other agreements, the Chino Basin Watermaster was required to recalculate the safe yield and other hydrologic items in 2011. WEI developed and implemented a methodology based on scientific principles and the use of detailed numerical models to develop a complete hydrologic description of the Chino Basin over the 1960-2011 calibration period and the 2012-2071 planning period. Watermaster was also required to calculate net Santa Ana River recharge and how the net Santa Ana River recharge changes with groundwater pumping and storage management. Working with Watermaster staff and legal counsel, WEI staff participated in a series of workshops and two-day peer review sessions to thoroughly review the WEI methodology, assumptions, data, and computational results. The resulting model was praised during the peer review process as one of the most comprehensive and thoughtfully developed groundwater models ever built to manage a groundwater basin. Watermaster and the Court accepted the technical work and the recalculated safe yield. See the final model report here.

More specifically, WEI completed the following:

- Updated the hydrogeologic conceptual model of the Chino Basin, based on new borehole, well-construction, geochemistry, and groundwater-level data that was made available after the initial 2007 model construction.
- Applied advanced geostatistical methods to estimate aquifer properties from borehole lithology and geophysical data.
- Developed high-resolution estimates of agricultural pumping and areal recharge using WEI's Rainfall, Runoff, Routing, and Root Zone (R4) model that simulates irrigation and rainfall-runoff processes on a daily time step. The R4 model was used to estimate these recharge terms for the 1920-2011 calibration period and the planning period of 2012-2071. The R4 model estimates:
  - agricultural water demand and groundwater pumping
  - the deep infiltration of precipitation and applied water
  - streambed recharge
  - recharge in stormwater and conservation basins
  - subsurface inflow from mountain boundaries
- Applied advanced methods in parameter estimation, including the use of sensitivity analyses, application of the PEST code using WEI's PEST-nest array (24 PCs in a custom rack optimized for running PEST); and performing residuals analyses.

- Developed the planning hydrology, based on future land use and projected water management activities, such as stormwater recharge, groundwater storage management plans, and projected future groundwater production.
- Prepared comprehensive water budget tables, estimates of future net recharge, estimates of Santa Ana River recharge and rising groundwater, and estimates of safe yield for various base periods.
- Participated in public workshops and peer review meetings.

The model is currently being used to develop a storage framework (management) plan for up to 500,000 acre-feet of water banking activities, to develop an updated salt and nutrient management plan for the basin, and to estimate the impacts of groundwater management activities on surface water discharge and riparian habitat in the Prado Reservoir area and upstream habitat areas along the Santa Ana River. Future modifications will include the addition and calibration of a subsidence module to support the development and evaluation of subsidence management plans for portions of the basin.



This map shows the change in groundwater levels across the Chino Basin, based on the 1960-2011 calibration of the 2013 high-resolution Chino Basin groundwater model. It shows the water service areas of the municipal agencies that overlie the basin and their wells, allowing the agencies to see where groundwater levels have changed in relation to their wells.

Watermaster Engineer Services and Groundwater Management Planning for the Six Basins

Six Basins Watermaster

Project Dates:
2011 – Present

Reference:
Darron Poulsen
City of Pomona
President of the Six Basins Watermaster Board
909-620-2253
darron_poulsen@ci.pomona.ca.us

Relevance: Demonstrates WEI's experience, qualifications, and capacity in performing technical and administrative services for an adjudicated basin, including preparing annual engineering reports on production and assessments, leading a facilitated process for a committee of stakeholders to improve groundwater basin management, and developing and using numerical groundwater and surface-water models to evaluate proposed groundwater basin management plans.

Participating Team Members:
Andy Malone
Carolina Sanchez

The Six Basins are a group of adjacent groundwater sub-basins, located in eastern Los Angeles and western San Bernardino Counties. The pumping rights from the Six Basins were adjudicated in 1998 through a stipulated judgment, which established the Six Basins Watermaster to implement the Judgment. The Judgment prescribes a physical solution for the coordinated management of the Six Basins with the objective that the parties can reliably pump their respective rights and maximize the beneficial use of groundwater. WEI was retained in 2011 to perform technical and administrative services for the Watermaster, including conducting monthly Board meetings, implementing groundwater and surface-water monitoring programs, managing environmental data, coordinating recharge activities, calculating the annual change in storage, setting the annual operating yield and pumping rights, preparing the annual budget and assessments, performing financial management, complying with CASGEM and the SGMA, and preparing an annual report to the Court summarizing the activities of the Watermaster and compliance with the Judgment.

Field Services. A critical component of the physical solution is the monitoring of groundwater and surface-water within the Six Basins for the purposes of setting the annual operating yield of the basin, mitigating the threat of high groundwater, calculating storage, and compliance reporting. The monitoring programs include collecting and storing production, groundwater-level, water-quality, surface-water discharge, diversions for recharge, supplemental-water recharge, and precipitation data. WEI staff collects these data directly in the field or from cooperating entities, such as the Watermaster parties, the US Army Corps of Engineers, the County of Los Angeles, and groundwater remediation sites.

In 2016-17, WEI designed and implemented an expanded groundwater monitoring program, which included the installation of continuous recording transducers at 21 wells that record water-levels once every 15 minutes. In addition, WEI is coordinating with the parties to collect their SCADA information on production and water levels at wells. The intent of monitoring program is to:

- Improve the hydrogeologic conceptual understanding of the aquifer system(s) and the fault barriers, which can be used to improve basin management. For example, conditions of high and low groundwater are periodic challenges in the Six Basins. The monitoring program will provide information to develop mitigation or management strategies to minimize or abate conditions of high and low groundwater.

- Support the location and design of capital facilities, such as new wells and treatment facilities.
- Support any monitoring and mitigation requirements associated with new wells or other facilities.

Database Management. All environmental data collected and needed to perform Watermaster functions is managed by WEI using HydroDaVE—a practical, visionary solution for the collaborative management and utilization of watershed-scale environmental datasets. HydroDaVE was developed by WEI to enhance our consulting services. HydroDaVE is a hosted, industry-standard, relational database that is implemented with Microsoft SQL Server and resides in the cloud. The database is accessed through cloud-connected Windows applications that allow for secure, remote database access for data checking, upload, management, visualization, analysis, export, and reporting. WEI uses HydroDaVE for the Watermaster to:

- aggregate and manage all data necessary to perform Watermaster functions,
- visualize and analyze the data through an online, intuitive, map-driven interface that contains several customized analytical tools,
- export the data to other software applications for data analysis and modeling,
- fulfill data requests from the Watermaster parties, consultants, and interested stakeholders,
- prepare quick, custom reports, such as water-quality MCL exceedance reports, and
- communicate and explain data to the Watermaster Board.

Compliance Reporting. The Watermaster's annual reports include the accounting for: water rights, transfers, supplemental water recharge, storage accounts, obligations to replace over-production of rights, and changes in groundwater storage. WEI has continually improved the annual report into a more efficient, accurate, and concise report. In 2015, the annual report was augmented and improved and is now submitted to the State of California to comply with the Sustainable Groundwater Management Act's reporting requirements for adjudicated basins. In addition, twice per year, WEI uses a custom report in HydroDaVE to export groundwater-level data for a set of wells in the exact format required by the State of California for CASGEM compliance.

Website Maintenance. WEI maintains a website at www.6bwm.com that is used extensively by the Watermaster Board and interested stakeholders. Information posted on the website includes: Watermaster's governing documents; monitoring data, charts, and maps; meeting agendas, packets, and presentations; and other Watermaster-related information and reports.

Facilitating Stakeholder Initiatives. In 2012, the Watermaster parties expressed concerns to WEI about the physical solution in the Judgment and their desire for a better approach to basin management. The parties collectively agreed to enhance basin management and retained WEI to develop the *Strategic Plan for the Six Basins*. The goals of the Strategic Plan are to: maintain or improve basin yield; maintain or improving groundwater quality, especially in areas where beneficial uses are constrained by poor quality; minimize losses due to rising groundwater or subsurface outflow; and optimize basin management so all Watermaster parties can reliably pump their share of the basin yield. Various projects were conceived in the Strategic Plan to achieve the stated goals. In 2015, WEI completed the planning phase of the Strategic Plan, which described a series of initiatives and projects to achieve the goals of the Strategic Plan:

- Pump a Temporary Surplus during wet years
- Enhance storm-water recharge

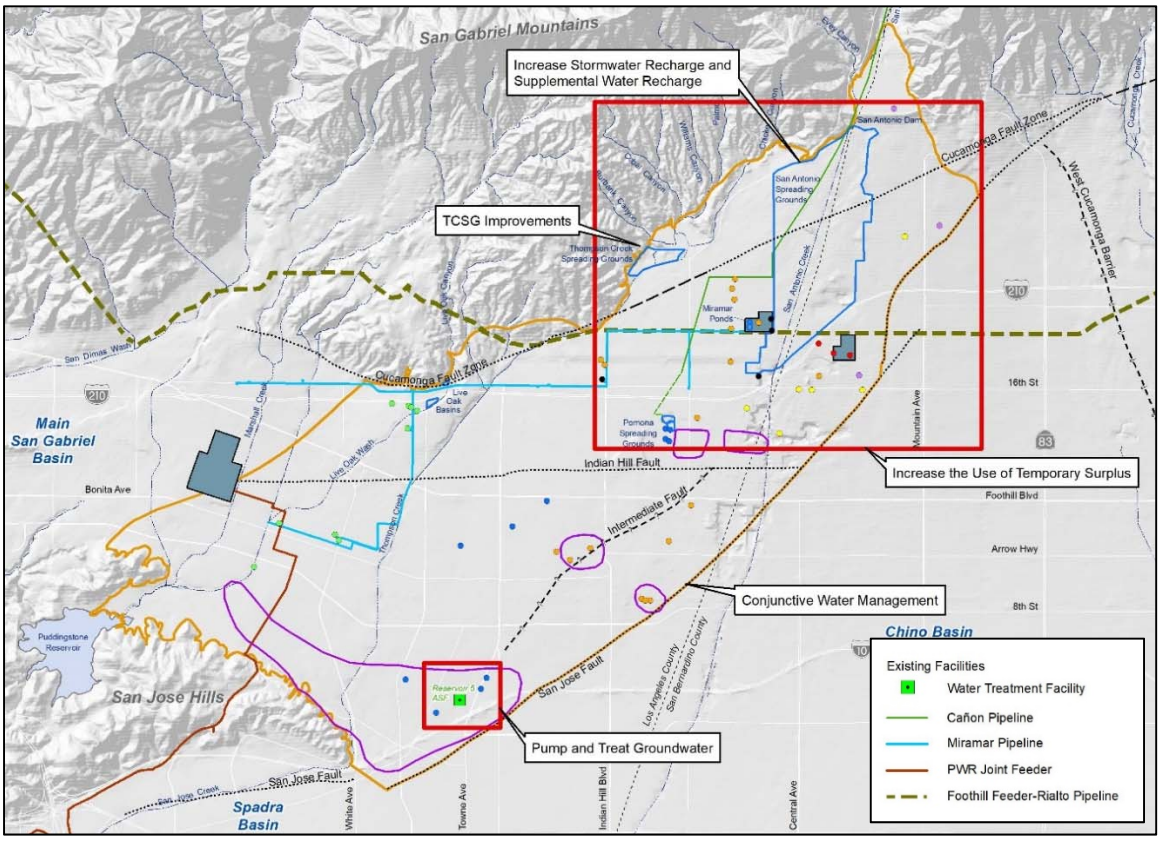
- Recharge and recovery of supplemental water
- Pump and treat groundwater in the Pomona Basin
- Conjunctive water management in the Six Basins

As part of the planning process, WEI constructed, calibrated, and used a numerical groundwater-flow model to evaluate the Strategic Plan. Each project was described and evaluated based on its nexus to the Strategic Plan goals, groundwater basin response, yield enhancement, and cost.

Strategic Plan implementation is proceeding in a phased approach. The first phase has commenced, which includes:

- Expanding the surface-water and groundwater monitoring programs
- Researching grant and low-interest loan opportunities
- Deciding on the appropriate CEQA process
- Updating the Watermaster's governing documents to support Strategic Plan implementation

A Notice of Preparation for the Strategic Plan was issued in fall 2018. Subsequent phases of Strategic Plan implementation include: developing MOUs with entities to implement the projects, preparing preliminary design reports, completing CEQA, developing a financing plan and implementation agreements, obtaining permits, finalizing design of facilities, and constructing improvements.



WEI developed the operating plans and Level-5 design for a conceptual conjunctive water management program in the Six Basins. The program concept consists of recharge improvements, new wells, new groundwater treatment plants, a storage and recovery program that includes in-lieu recharge operations, and regional conveyance facilities to provide water to multiple water agencies in times of drought.

Determination of the Native Safe Yield of the Coldwater Basin

City of Corona and Elsinore Valley Municipal Water District

Project Dates:
2006 - 2017

Reference:
John Vega
General Manager
EVMWD
(951) 674-3146
jvega@evmwd.net

Tom Moody
General Manager
Corona DWP
(951) 279-3660
Tom.Moody@ci.corona.ca.us

Relevance:
WEI has the experience and capacity to: develop conceptual hydrogeologic models and apply them to estimate basin yield; perform annual reporting of water rights accounting; and lead facilitated processes of stakeholder groups.

Participating Team Members:
Andy Malone
Mark Wildermuth
Carolina Sanchez

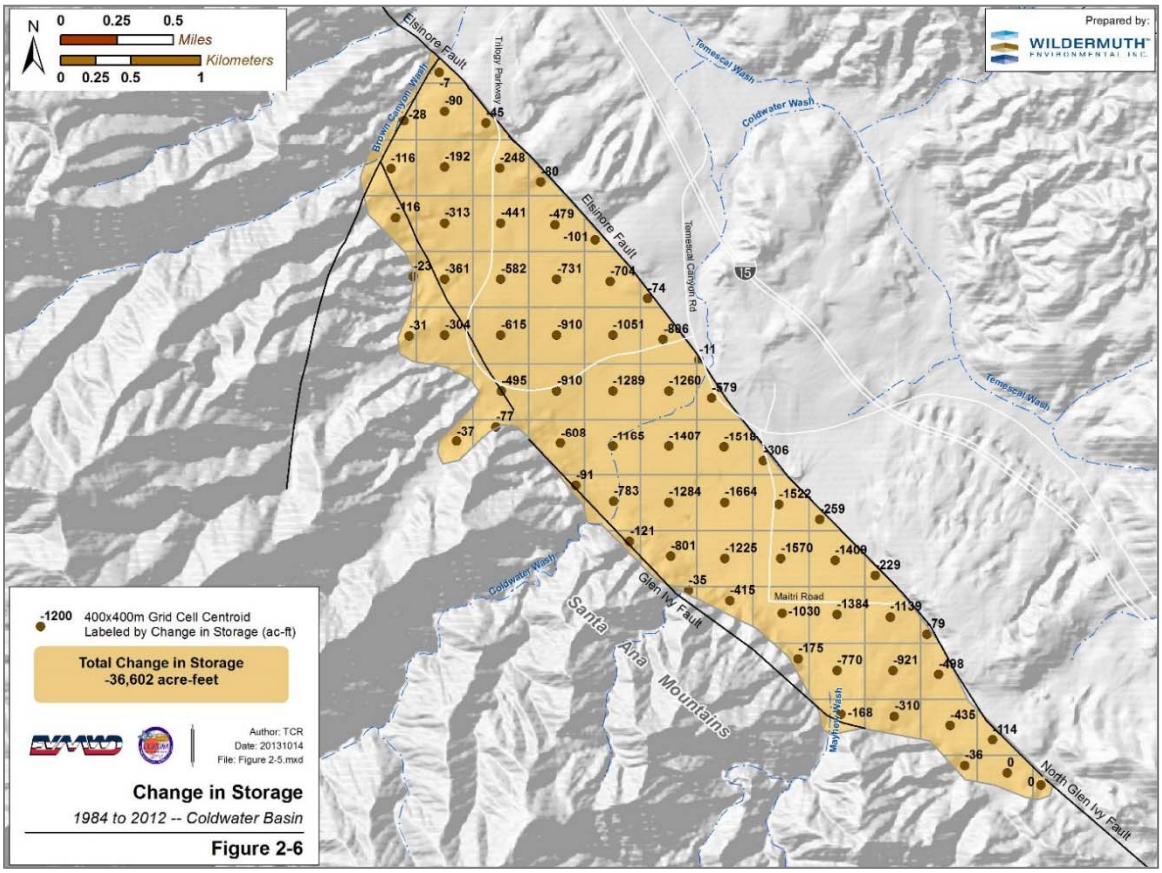
The Coldwater Basin is a fault-bounded groundwater basin located along the eastern Santa Ana Mountains in Riverside County, California. Groundwater quality is excellent, and groundwater is pumped for municipal drinking water and non-potable uses.

The City of Corona Department of Water & Power is a municipally owned utility that provides electric service, public water service, and water reclamation for the City of Corona (Corona). Elsinore Valley Municipal Water District (EVMWD) is a public non-profit agency with powers that include public water service, water supply development and planning, wastewater treatment and disposal, and recycling. As of 2016, the district had over 42,000 water, wastewater, and agricultural service connections.

In 2006, WEI performed an analysis to estimate the native safe yield of the Coldwater Basin and to establish the relative pumping rights of the two major pumpers of the basin—Corona and the EVMWD. A water-rights agreement was executed between Corona and EVMWD based on this analysis.

The method used to determine the native safe yield estimates the average annual yield of groundwater developed from the Coldwater Basin over a period of record—in this case 1984-2004. This computation of "developed yield" is intended to reflect groundwater recharge, groundwater discharge, and the change in groundwater storage that occurred over the period. The method solves a modified version of the continuity equation and uses the following information: length of the time period, change in groundwater levels over the period, storage characteristics of the Coldwater Basin aquifer system, change in groundwater storage over the period, total groundwater pumping that occurred over the period, and the total return flows from imported water that occurred over the period.

WEI performs ongoing annual reporting on the Coldwater Basin as required by the agreement for Corona and the EVMWD, which includes the accounting of pumping, storage, and water-rights. The agreement also requires the re-determination of the native safe yield once every five years, based on the monitoring data collected to date. WEI performed the work to re-determine the native safe yield in fiscal year 2013/2014, which resulted in revised pumping rights for the next five years.



WEI developed and used a hydrogeologic conceptual model and water budget of the Coldwater Basin to determine the native safe yield of the groundwater basin. The map above displays the computational results of change in groundwater storage from 1984-2014, which was a factor used to re-determine the native safe yield over that period.

Water Rights Compliance, Groundwater Management, and Monitoring and Reporting Programs

San Juan Basin Authority

Project Dates:
2010 – Present

Reference:
Daniel R. Ferons
General Manager
Santa Margarita Water District
and SJBA Administrator (2012-2017)
949-459-6590
danf@smwd.com

Norris Brandt
SJBA Administrator (2017 to present)
949-293-6236
Norris.brandt@sjbauthority.com

Relevance: Demonstrates WEI's experience, qualifications, and capacity to: develop and implement complex monitoring and reporting programs for regulatory compliance and basin management, analyze and report on complex hydrologic data sets, and implement its SNMP.

Participating Team Members:
Mark Wildermuth
Wenbin Wang
Jeff Hwang
Carolina Sanchez
Veva Weamer

The San Juan Basin is a narrow alluvial basin adjacent to the Pacific Ocean in south Orange County, CA, which, from a water rights perspective, is regulated by the State Water Resources Control Board (SWRCB) as flow of an underground stream. The San Juan Basin Authority (SJBA) holds a Permit for Diversion and Use of Water, No. 21074 (Permit 21074), issued by the SWRCB Division of Water Rights. Permit 21074 outlines numerous terms and conditions under which the SJBA may extract and use water from the San Juan Basin, including: limits on pumping; monitoring protocols for groundwater pumping, levels, storage, and quality, and for riparian vegetation; protection against seawater intrusion; and maintenance of water levels that support riparian vegetation.

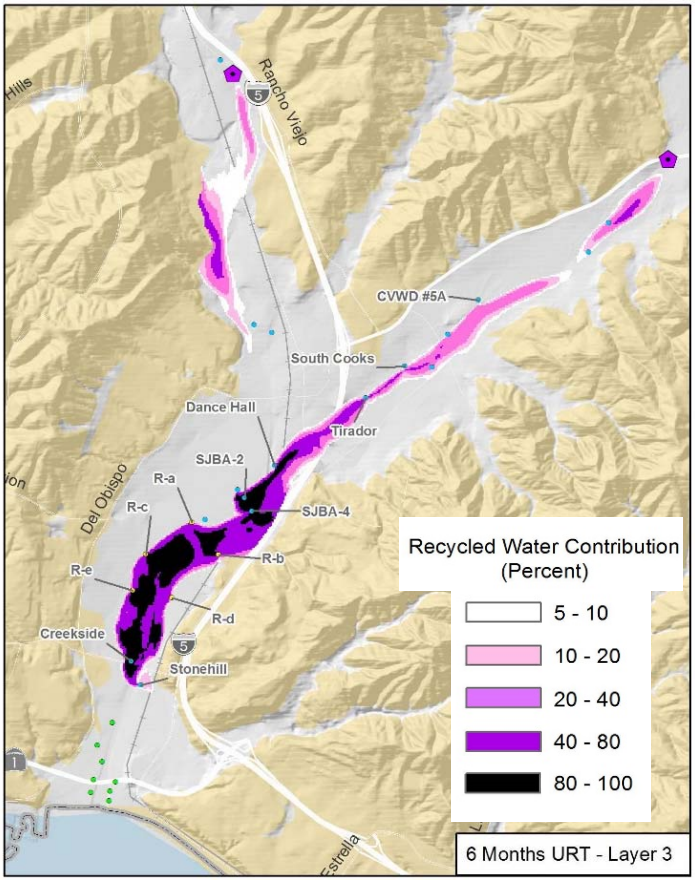
Water Rights Compliance Monitoring and Reporting. WEI was retained in 2010 to implement the SJBA's water rights monitoring and reporting program in compliance with Permit 21074. WEI's tasks include: implementing and adapting field groundwater and surface-water monitoring programs, collecting environmental datasets from numerous cooperating entities, managing and analyzing data using HydroDaVE^{sm}, preparing annual reports, submitting water-level data to the DWR in compliance with CASGEM, managing biology sub-consultants, participating in the SJBA Technical Advisory Group through preparation of meeting materials and attendance at meetings, and preparing presentations to the Board of Directors.

In 2013, the SJBA completed an update to its *San Juan Basin Groundwater Management and Facilities Plan* (SJBGFMP), which expanded the monitoring and reporting program beyond what is required by Permit 21074 to improve water resources management. The objectives of the expanded program are to collect and analyze the data needed to (1) comply with the SJBA's water rights diversion permit, (2) estimate groundwater storage and set annual production limits, (3) evaluate the threat of seawater intrusion, and (4) assess the health of the riparian vegetation.

In 2014, water levels were declining significantly due to a combination of prolonged drought and pumping. As a result of the expanded basin management monitoring program and the timely upload and review of data using HydroDaVE, WEI was able to detect the onset of seawater intrusion and work with the SJBA Technical Advisory Group to make recommendations for measures to stop and reverse it. In 2016, WEI developed the *2016 Adaptive Pumping Management Plan*, a first of its kind report for the San Juan Basin that set annual pumping limits

based on current basin storage and climate conditions to ensure compliance with the SJBA's water rights permit, protecting against seawater intrusion and negative impacts to riparian vegetation. It includes monitoring protocols that allow for adaptation during the year and over time.

Development and Implementation of the San Juan Basin Groundwater Management and Facilities Plan. In 2013, WEI completed the SJGFMP, the objective of which was to characterize the storage, water quality, and yield of the basin, and to develop management strategies for maximizing the yield of the basin. WEI was the prime consultant and teamed with Carollo Engineers and Michael Brandman Associates to complete this work. The plan was adopted by the SJBA in 2014. WEI assisted the SJBA in securing a grant through Metropolitan's Foundational Action Funding program to begin the *San Juan Basin Desalination and Optimization Program*, which was the first phase of SJBGFMP implementation. WEI worked together with facilities engineers from Black & Veatch to develop conceptual facilities layouts and operations for each Program Element of the recommended SJBGFMP management program and to evaluate their physical and economic feasibility. The Program Elements being evaluated include increasing recharge with storm and recycled waters, implementing a seawater intrusion barrier, and optimizing production schemes to adaptively manage groundwater storage in wet and dry climate cycles.

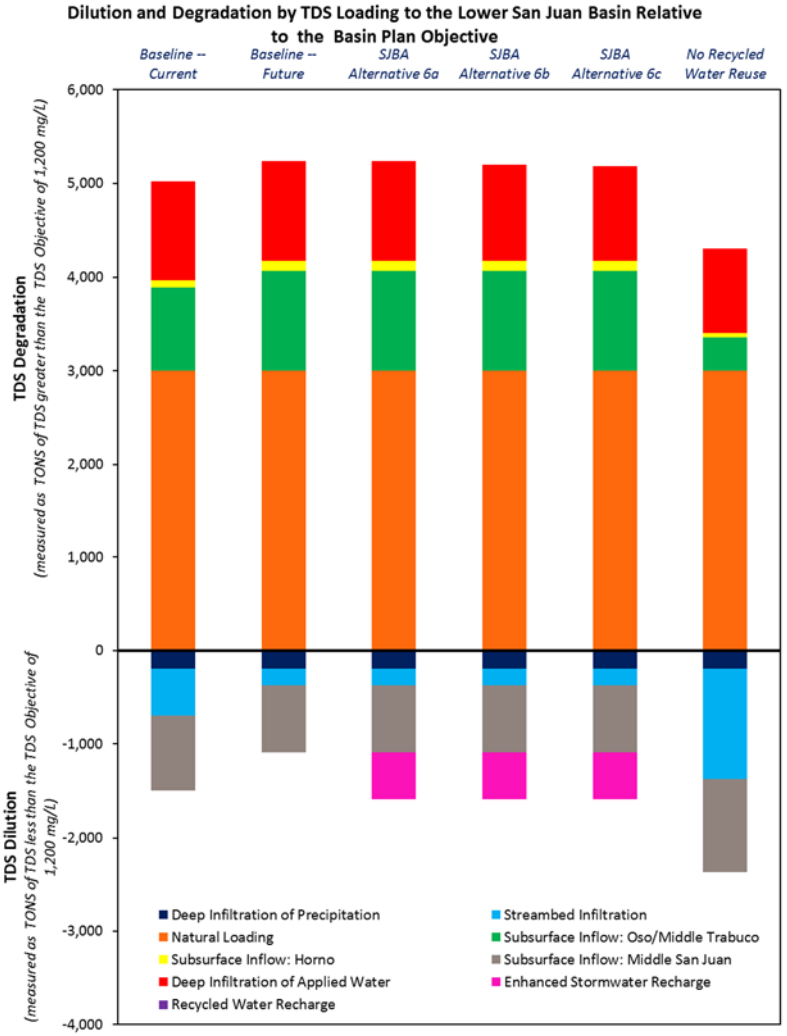


Specifically, WEI completed the following:

- Developed operational plans for each Program Element.
- Updated and improved an existing groundwater-flow model to simulate groundwater responses, including flow gradients, stream-aquifer interaction, ET by riparian vegetation, and seawater intrusion.
- Developed and implemented an MT3D model to simulate the fate and transport of storm and recycled water recharged from the proposed projects, specifically to estimate underground retention time (URT) and the recycled water contribution (RWC) and to identify challenges with Title 22 GRRP regulations.
- Developed and simulated a baseline (no-project) alternative and four planning alternatives, comparing the alternatives to the baseline, and evaluated the impacts to each well, municipal pumpers, and the new yield created by the alternatives.
- Participated in San Juan Basin Authority technical advisory group meetings, Board meetings, and public workshops.

Salt and Nutrient Management Plan Implementation. The South Orange County Wastewater Authority (SOCWA) led the regional stakeholder effort to develop the SNMP for South Orange County, specifically for the San Juan Creek Watershed. HDR Engineering and WEI teamed to perform the technical analyses and design the SNMP. The 2014 SNMP was designed in accordance with the State Board's 2009 Recycled Water Policy and included the following elements:

- Characterization of the groundwater resources of the Basin,
- The recycled water reuse and stormwater capture goals of the stakeholders and a description of future groundwater and stormwater projects,
- Evaluation of existing groundwater quality and assimilative capacity,
- Identification of salt and nutrient loading in the watershed,
- Modeling of future groundwater quality to demonstrate how much assimilative capacity will be used up in meeting the recycled water and stormwater goals of the stakeholders,
- An antidegradation analysis to support expanded recycled water reuse, and
- An implementation plan.



The San Juan Basin Authority has assumed responsibility of the comprehensive watershed-wide monitoring, data collection, and reporting program recommended in the SNMP and contracted with WEI to design and implement it. In 2016, WEI designed the *Salt and Nutrient Management Plan Monitoring and Data Collection Program Work Plan*. The plan was developed in collaboration with all of the regional agencies serving recycled water in the San Juan Creek Watershed. WEI's tasks included: canvassing the San Juan Watershed for existing monitoring efforts, verifying site details and accuracy, and identifying new groundwater and surface water monitoring sites. The goal of the monitoring program is to collect the information required to (1) evaluate "current" groundwater quality, (2) project future changes in groundwater quality, (3) determine the impact of recycled water reuse on current and future groundwater quality, and (4) determine if current or future groundwater quality exceeds the groundwater quality objectives established in the Water Quality Control Plan. WEI began implementing the monitoring plan in September 2016.

Application of High-Resolution Models to Develop a Storage Management Strategy for a 500,000 Acre-foot Water Bank

Chino Basin Watermaster

Project Dates:
Jul 2017 – Sep 2018

Reference:
Peter Kavounas
General Manager
Chino Basin Watermaster
909-484-3888
pkavounas@cbwm.org

Relevance: WEI staff has the technical know-how and resources to respond to the most challenging water management problems and to build and apply surface and ground water models to meet the most challenging technical and legal requirements.

Participating Team Members:
Mark Wildermuth
Eric Chiang
Jeff Hwang
Wenbin Wang
Carolina Sanchez

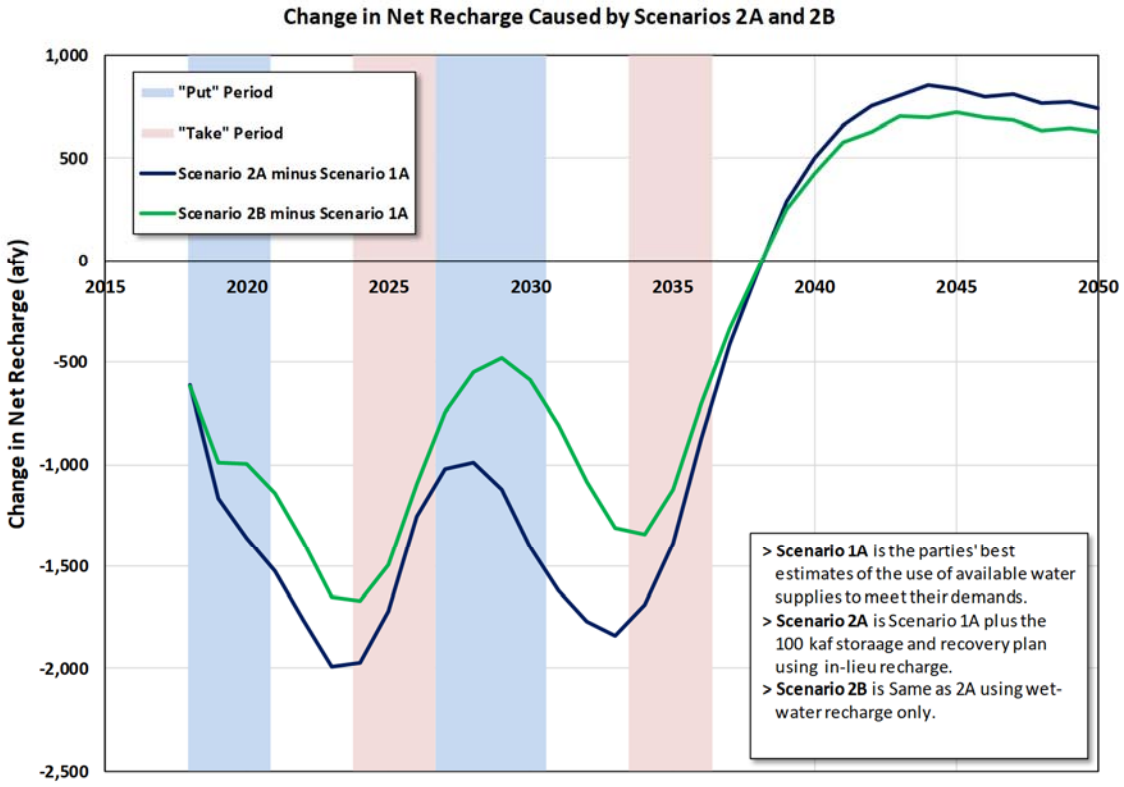
The Chino Basin adjudication was settled in 1978 through a stipulated agreement (Judgment). The stipulating parties were aware that the groundwater overdraft prior to 1978 had created about 2 million acre-feet (af) of unused storage space in the basin. The Judgment includes features to manage this unused storage space. There were concerns regarding the use of this storage space that include increasing groundwater outflow with increasing storage and the subsequent reduction in safe yield and degradation in downstream surface water quality. And, there were concerns that the facilities that would be constructed and operated to recover stored water could cause new land subsidence and reduce pumping sustainability.

WEI was retained to investigate these and other concerns regarding the planned use of unused storage space in the basin and to develop recommendations to avoid and/or mitigate undesirable results. WEI developed a series of metrics to evaluate each of these concerns and subsequently applied advanced groundwater modeling tools to evaluate the metrics. WEI updated its Chino Basin groundwater model[1] to present conditions (July 2017) and worked with all the pumpers in the basin to develop a series of alternative baseline groundwater pumping and recharge scenarios that bracket future groundwater management. WEI developed control surfaces that extend throughout the basin that define the groundwater elevation below which pumping capacity would be impaired and developed a similar control surface to define the groundwater elevation below which new land subsidence would occur in the western Chino Basin. WEI then evaluated the groundwater basin response to the bracketing baseline scenarios to project the net recharge (safe yield) and groundwater outflow to the Santa Ana River and used the projected groundwater elevations to test for pumping sustainability and the occurrence of new land subsidence.

WEI worked with the Chino Basin parties to develop conjunctive-use operating scenarios that define, for increasing amounts of storage, recharge and recovery operating cycles and the associated timing, location, and magnitude of recharge and pumping. WEI is applying the updated Chino Basin groundwater model to evaluate groundwater impacts from progressively larger conjunctive-use plans, the largest using 500,000 af with a 125,000 afy recharge capacity and a

[1] The Chino Basin groundwater model is a series of high-resolution surface and groundwater models that enable the Watermaster and stakeholders to evaluate complex management strategies. This model was praised during the peer review process as one of the most comprehensive and thoughtfully developed groundwater models ever built to manage a groundwater basin.

167,000 afy recovery capacity. WEI is using its deep understanding of the basin hydrology and hydrogeology to develop recharge and recovery facility plans for each progressively larger storage and recovery plan. Early results of this work indicate that storage and recovery programs implemented in the basin will reduce net recharge annually by about 1 to 2 percent of the water in storage.



This figure shows the projected time history of net recharge (safe yield) in the Chino Basin due to the implementation of a 100 kaf storage and recovery project. This chart is an example of the conversion of complex numerical model results to information that can be used by decision makers. The blue vertical bands indicate periods in which 100 kaf was recharged (put), the pink vertical bands indicate periods where 100 kaf was recovered (take), and the white bands between them indicate years between the recharge and recovery periods. The change in net recharge is relative to a baseline scenario. The magnitude of the reduction in net recharge averages about 1.4 percent of the stored water per year over each operational cycled. The cumulative reduction in net recharge over the two operational cycles was 28 kaf.

Review of Geothermal Project Impacts on Mammoth Community Water Districts Water Supply

Mammoth Community Water District

Project Dates:
Jul 2013 – Present

Reference:
Patrick Hayes
Mammoth Community Water District
General Manager
760-934-2596
phayes@mcwd.dst.ca.us

Relevance: WEI staff has the technical know-how and resources to conduct complex hydrogeologic investigations (e.g. groundwater-geothermal fluid interaction) and to engage in complex technical and legal issues/strategy and NEPA/CEQA.

Participating Team Members:
Mark Wildermuth
Mike Blazevic
Wenbin Wang

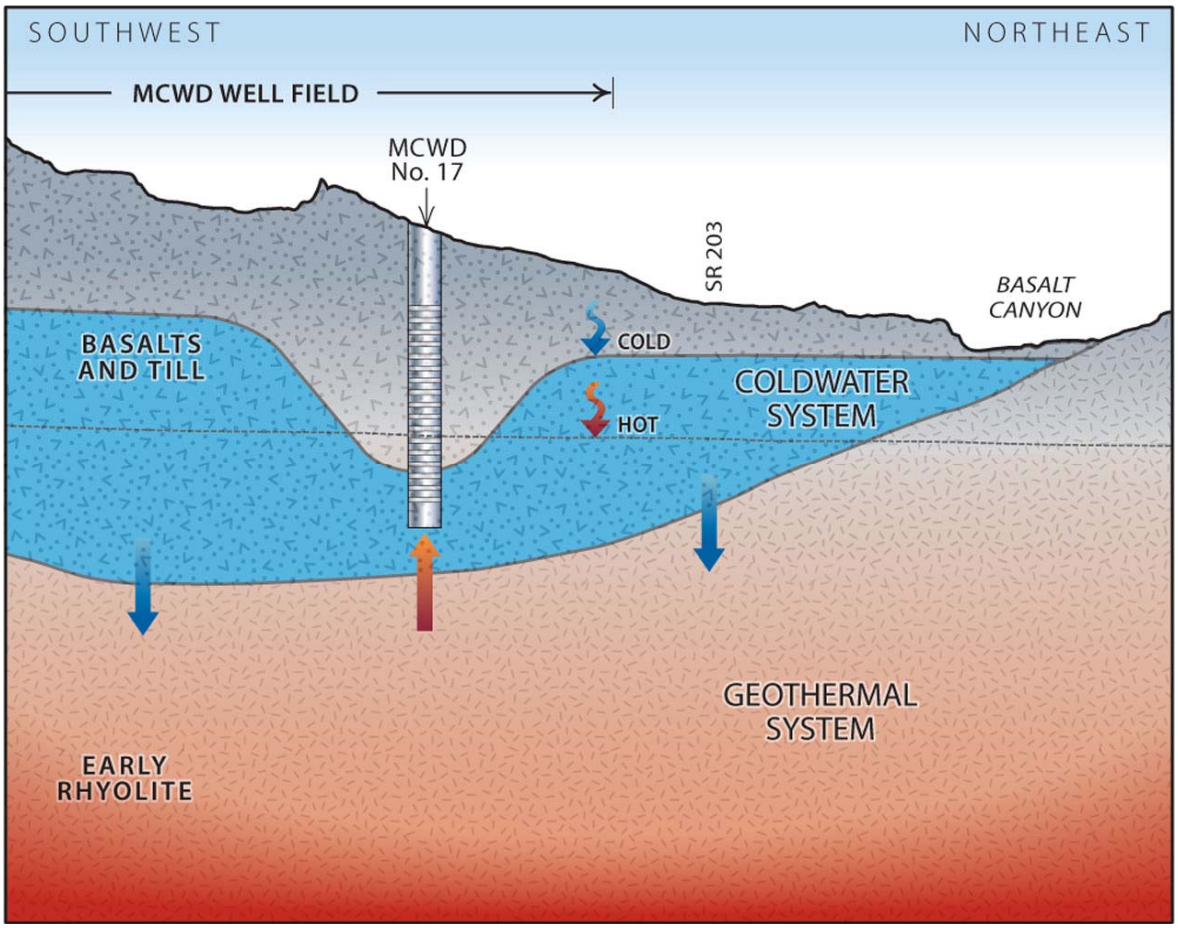
The Mammoth Community Water District (District) provides municipal water supply and sewer services to the Town of Mammoth Lakes, California. The primary water sources used by the District include surface water diversions from Lake Mary, a lake on Mammoth Creek, and groundwater from the Mammoth Basin. Surface water diversions are limited by a water right and water demand which are often out of sync with each other. The District augments the surface water diversion with groundwater. During drought periods the District is completely dependent on its groundwater supply.

A large geothermal resource exists in the Town of Mammoth Lakes area. The geothermal reservoir underlies the groundwater basin that the District uses for water supply. In 2013, Ormat Technologies proposed a 50-percent expansion of its geothermal power plant that would require the construction of up to fourteen new geothermal wells in the vicinity of the Town of Mammoth Lakes. The Bureau of Land Management and the Great Basin Unified Air Pollution Management District (GBUAPCD) were lead agencies for a joint EIS/EIR for the proposed geothermal power plant expansion. A fundamental assumption in the EIS/EIR was that the shallow groundwater system used by the District and the underlying geothermal reservoir were completely isolated and therefore the expansion of the geothermal power plant would have no impact on the District's groundwater supply. No monitoring or mitigation measures were included in the draft EIS/EIR.

WEI was retained to conduct a thorough review of the draft EIS/EIR, provide comments to the District, and work with the District's legal counsel to provide comment on the draft EIS/EIR and to support subsequent legal challenges on the Final EIS/EIR. The primary concerns identified by WEI include a reduction in the sustainable yield of the District groundwater supply and water quality deterioration caused by geothermal fluid intrusion near geothermal fluid injection wells. The District was unsuccessful in challenging the EIS/EIR.

The District has nonetheless continued to oppose the project in its current form and is pursuing all available means to make sure that the proposed geothermal expansion project includes monitoring, transparent data sharing, and mitigation measures that ensure their groundwater supplies are not impacted. The District has retained WEI to assist them and their legal counsel in this pursuit. Recently, WEI conducted a new investigation based on new monitoring data that was developed after the EIS/EIR was finalized and not available for use in the EIS/EIR (http://www.mcwd.dst.ca.us/assets/groundwaterwei2018.pdf). This investigation conclusively demonstrated that geothermal fluid has intruded into the largest District production well and one

monitoring well and refuted the EIS/EIR assumption that the shallow groundwater system used by the District and the underlying geothermal reservoir were completely isolated. Based on this report, the District is pursuing legal and administrative remedies available to it to reopen the EIR and force the GBUAPCD to include a thorough hydrogeologic assessment of the proposed geothermal project (http://www.mcwd.dst.ca.us/ormat.html). WEI accompanied District staff to Washington DC to support their position against the proposed project with members of the House and Senate.



This figure conceptually illustrates the relationship of the cold groundwater system used by the District and the underlying geothermal system near District well no. 17. A fall in piezometric head in the geothermal system caused by the proposed project will induce groundwater to flow downward into the geothermal system and reduce the sustainable yield of the District's groundwater supply.

Subsidence Management Plan for the Chino Basin

Chino Basin Watermaster

Project Dates:
1999 – present

Reference:
Peter Kavounas
General Manager
Chino Basin Watermaster
909-484-3888
pkavounas@cbwm.org

Relevance: WEI has the experience and capacity to devise and implement complex hydrogeological and modeling investigations, including the drilling and construction of monitoring wells and extensometers, conducting monitoring and testing programs, and utilizing the technical findings to develop groundwater management plans to avoid undesirable results.

Participating Team Members:
Andy Malone
Mark Wildermuth
Mike Blazevic
Wenbin Wang

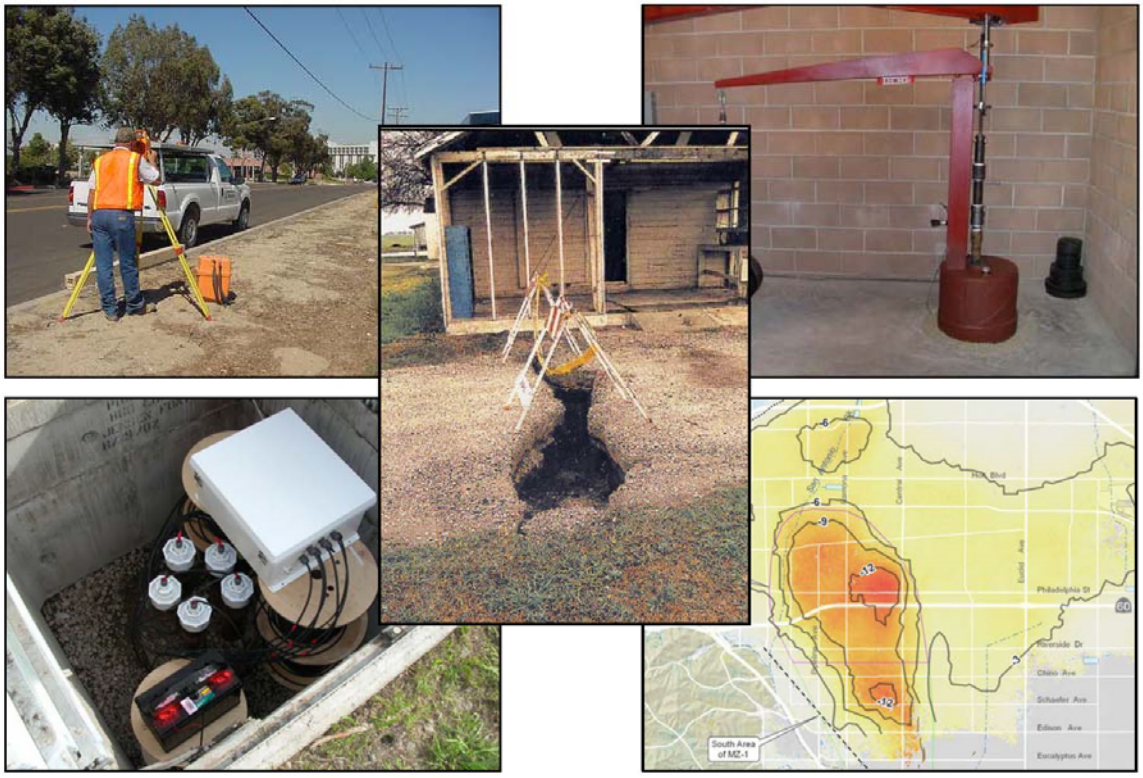
The Chino Basin is a large alluvial groundwater basin located in Southern California with storage exceeding five million acre-feet. The basin has a long history of groundwater development for various uses dating back to the early 1900s. As a result, piezometric heads declined basin-wide during the past century—in some areas by more than 200 feet. Declines of this magnitude typically cause irreversible aquifer-system compaction, which in turn results in subsidence at the ground surface. In portions of Chino Basin, land subsidence has been differential and accompanied by ground fissuring, which damaged existing infrastructure and poses concerns for new and existing development.

Chino Basin Watermaster, the agency responsible for groundwater basin management, has recognized that land subsidence and ground fissuring should be minimized to the extent possible. At the same time, Watermaster is implementing aggressive groundwater-supply programs that include controlled overdraft and the possibility of causing head declines in areas prone to subsidence and fissuring. The groundwater-supply programs must also address the subsidence and fissuring phenomena.

WEI conducted a technical investigation for the Watermaster to characterize the extent, rate, and mechanisms of subsidence and fissuring. The investigation employed remote-sensing studies (InSAR), ground-level surveying of benchmarks to monitor ground-surface deformation, and borehole extensometers and piezometric monitoring to establish the relationships between groundwater production, piezometric levels, and aquifer-system deformation. (Click here to view the final investigation report.)

Based on the results of the investigation, Watermaster developed: (i) a subsidence-management plan for the areas experiencing acute subsidence and fissuring and (ii) an adaptive management program to minimize the potential for future subsidence and fissuring across the entire Chino Basin. The science-based program includes ongoing monitoring, which now includes sophisticated fissure-monitoring techniques, data analysis, annual reporting, and adjustment to the program as warranted by the data.

(Click to view the 2015 Chino Basin Subsidence Management Plan and the 2016 annual report.)



WEI has been the lead engineer in the development and implementation of a Subsidence Management Plan for the Chino Basin, which includes:

- *Remote-sensing studies using Interferometric Synthetic Aperture Radar (InSAR) and ground-level surveying of benchmarks to monitor ground-surface deformation.*
- *Construction, calibration, and monitoring of borehole extensometers.*
- *Development and implementation of monitoring and testing programs to establish the relationships between groundwater production, piezometric levels, and aquifer-system deformation.*
- *Computer-simulation modeling of aquifer-system deformation under future groundwater production and recharge estimates to evaluate subsidence management strategies.*
- *Adaptation of the management plan and monitoring program through a stakeholder process, based on ongoing monitoring and data interpretations.*

The photos shown above are:

- *A ground fissure that opened due to differential land subsidence (center).*
- *Leveling surveys of elevation at benchmarks (upper left).*
- *A borehole extensometer that measures aquifer-system compaction (upper right).*
- *InSAR results showing differential land subsidence in Chino Basin (lower right).*
- *A depth-specific monitoring well cluster at the extensometer site.*

TDS and Nitrate Concentration Projections in the Temescal Basin

City of Corona Department of Water and Power

Project Dates:
Nov 2014 – Jun 2015

Reference:
Tom Moody
General Manager
City of Corona
951-279-3660
Tom.moody@ci.corona.ca.us

Relevance to the SCWA:
Demonstrates WEI's numerical groundwater modeling abilities to predict future groundwater quality (TDS and nitrate concentrations) in support of watershed-wide salt and nutrient management plans.

Participating Team Members:
Veva Weamer
Wenbin Wang
Mark Wildermuth

In January 2008, the Santa Ana Regional Water Quality Control Board (Regional Board) and several water-supply agencies in the Santa Ana River Basin signed the *Cooperative Agreement to Protect Water Quality and Encourage the Conjunctive Uses of Imported Water in the Santa Ana River Basin* (Cooperative Agreement) as a compromise to having the Regional Board regulate the conjunctive use of imported water under general waste discharge requirements. The purpose of the Cooperative Agreement is "to allow the Parties to monitor and improve water quality within the Santa Ana Region in a manner that is consistent both with adopted [salinity] water quality objectives and with the needs of the inhabitants of the Region for a reliable supply of water."

As signatories to the Cooperative Agreement, the parties are required to develop 20-year projections of ambient TDS and nitrate concentrations for groundwater basins every six years using professionally accepted modeling techniques. The objective of the projections is to compare the trajectory of groundwater quality TDS and nitrate objectives with and without imported water recharge activities.

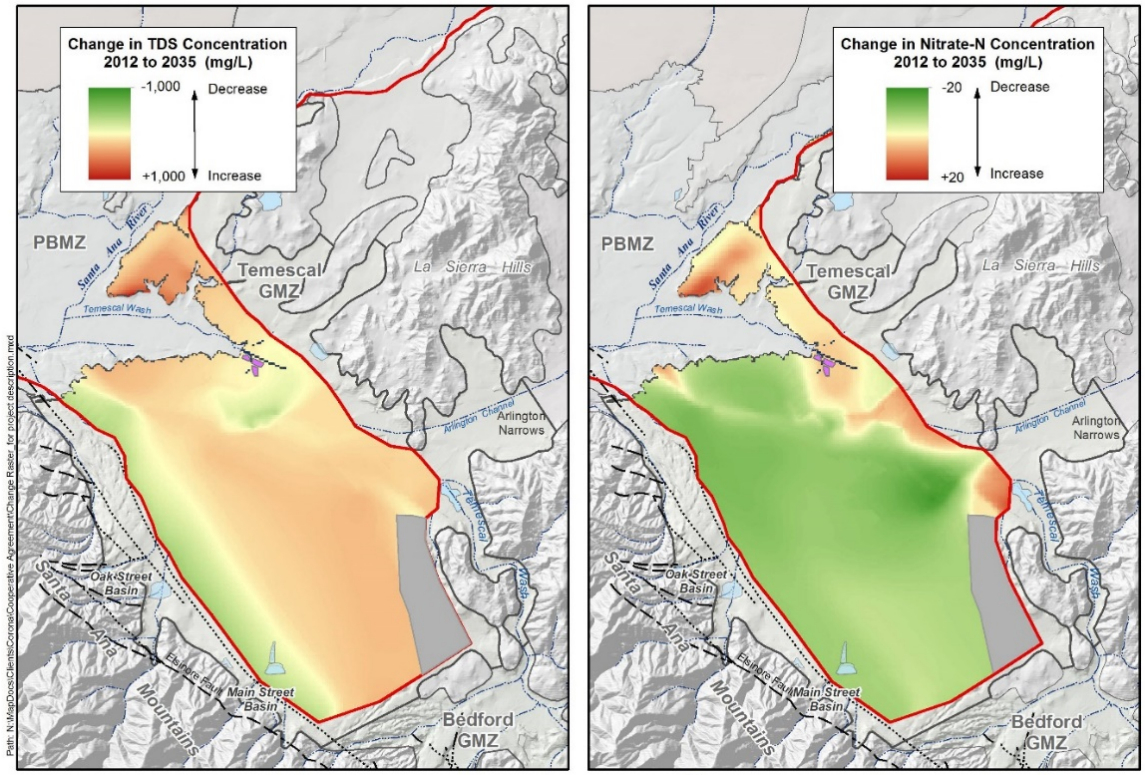
The City of Corona, as a signatory to the Cooperative Agreement and the primary water purveyor in the Temescal Basin, is the party responsible for preparing TDS and nitrate concentration projections for the Temescal Basin. In 2014, the City retained WEI to prepare the 20-year TDS and nitrate concentration projections for the Temescal Basin pursuant to the Cooperative Agreement.

To develop the 20-year TDS and nitrate concentration projections, WEI used the existing, calibrated MODFLOW groundwater-flow model of the Chino and Temescal Basins—developed by WEI for the Chino Basin Watermaster—in conjunction with a new uncalibrated MT3D fate-and-transport model. The MT3D model uses the grid-related aquifer properties and hydrologic flux terms from the MODFLOW model to simulate the fate and transport of TDS and nitrate. The planning period for the study was 2012 through 2035. WEI developed the model-estimated, annual volume-weighted ambient TDS and nitrate concentrations for the Temescal Basin for 2012 to 2035 with the following approach:

- Estimated the initial conditions for the TDS and nitrate concentrations from the spatial-temporal estimates of ambient TDS and nitrate concentrations for 2012.
- Defined the water supply plans of the agencies that overly the groundwater-flow model domain to project the time history of groundwater production, imported water use, recycled water reuse, and discharge.
- Applied the R4 model to estimate areal distribution of precipitation, irrigation requirements, the deep infiltration of precipitation and applied water, and subsurface inflows from boundary areas.

- Applied the MODFLOW groundwater model to estimate the groundwater system response to all the hydrologic components.
- Assigned TDS and nitrate concentrations to all hydrologic components.
- Applied the MT3D model to project changes in TDS and nitrate for the 2012-2035 period.

WEI produced a draft report describing the modeling approach, results, and a comparison of the results to the TDS and nitrate objectives. WEI presented the results to the Imported Water Recharge Committee and prepared the final report that incorporated pertinent feedback from the Committee and the Regional Board.



This map displays a color-shaded raster of the change in TDS concentration (left) and the change in nitrate concentration (right) from 2012 to 2035 for the Temescal Basin within the Chino and Temescal Basin MODFLOW model domain.

2010 Chino Basin Recharge Master Plan Update, 2013 Amendment, and Subsequent Implementation

Chino Basin Watermaster and Inland Empire Utilities Agency

Project Dates:
2009 – Present

References:
Peter Kavounas
General Manager
Chino Basin Watermaster
904-484-3888
pkavounas@cbwm.org

Chris Berch
Assistant General Manager
IEUA
(909) 993-1762
cberch@ieua.org

Relevance to the SCWA: This project demonstrates WEI's experience and ability to: update water demands and supply plans for retail water agencies; build, calibrate, and use surface-water models; and evaluate and optimize stormwater recharge as part of larger groundwater management planning efforts. Client confidence is demonstrated through continuity of service.

Participating Team Members:
Mark Wildermuth
Jeff Hwang
Carolina Sanchez

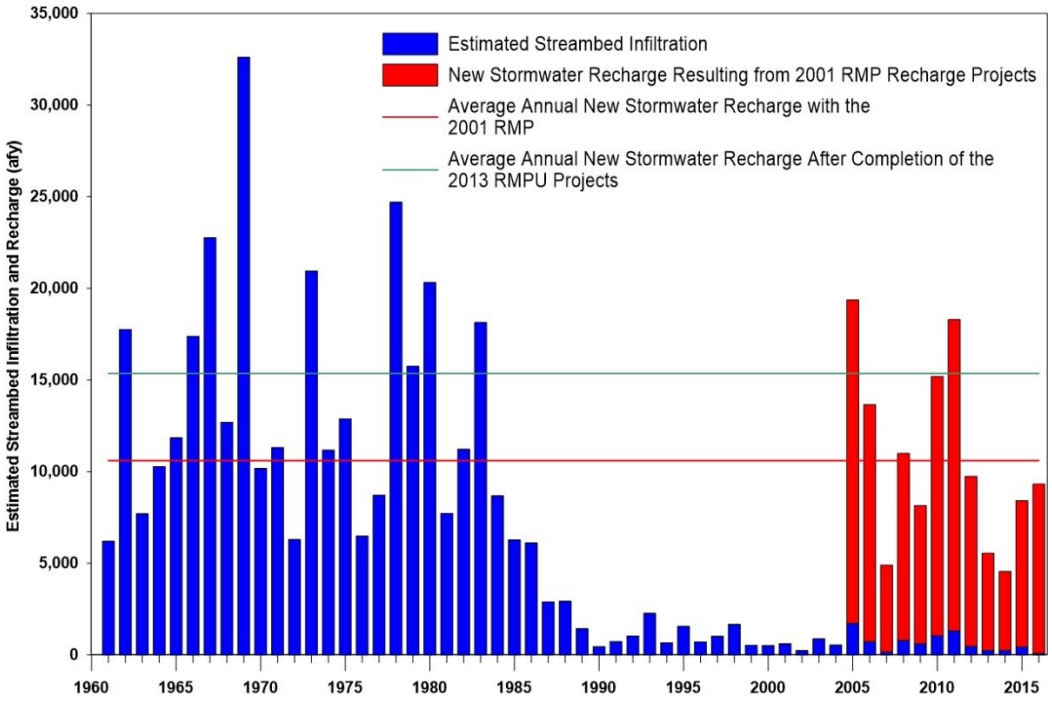
The Chino Basin Watermaster and the Inland Empire Utilities Agency (IEUA) retained WEI to update its recharge master plan (RMP), which was originally developed by WEI and Black & Veatch in 2001. The content of the 2010 RMP update was developed by WEI within a stakeholder process and under a Court order directing the Watermaster to complete the RMP update and submit it to the Court by July 1, 2010. WEI developed a work plan (scope of work, schedule, budget, and outline of the RMP report) to complete the 2010 RMP update. The Watermaster, the IEUA, and the Court approved the work plan and directed WEI to execute it, which included:

- Updating demands and water-supply plans for water agencies that pump groundwater from the Chino Basin.
- Updating the surface-water modeling tools to estimate stormwater discharge and recharge in flood-control and conservation basins on a daily time step over a 58-year hydrologic period and to characterize the availability and capacity of the basins for the recharge of imported and recycled waters.
- Based on the modeling work above, developing a series of new recharge facility proposals to increase storm, imported, and recycled water recharge in the Chino Basin.
- Using the surface-water models to evaluate the efficacy and practicality of the proposed recharge facilities.
- Working with subconsultants to develop construction cost opinions for the proposed facilities.
- Working with subconsultants to develop imported and recycled water facility plans and cost opinions.
- Working with subconsultants to characterize potential imported water purchases and developing a decision-support financial model.
- Developing recommendations and an RMP update implementation plan.
- Preparing a forensic hydrologic analysis on the decline in safe yield due to urbanization and conducting surface-water modeling to estimate the potential increase in stormwater recharge due to the implementation of the 2010 MS4 permit.
- Leading stakeholder workshops to explain interim results and receive feedback and maintaining a project website for the stakeholders.
- Preparing final report and submitting it to the Court on time.

WEI was retained to amend the 2010 RMPU to include considerations that would improve the balance of recharge and discharge in the Chino Basin and to revise the water demands of the retail agencies to comport with their 2010 Urban Water Management Plans. WEI developed the work plan and completed the project on time. The report is called: 2013 Amendment to the 2010 Recharge Master Plan Update (2013 RMPU).

Following the approval of the 2013 RMPU, WEI was retained to assist the Watermaster and the IEUA with its implementation. This ongoing work involves additional modeling of stormwater recharge of design alternatives and guidance on the development and refinement of the specific projects identified in the 2013 RMPU. WEI has supported the development of project development reports (PDRs) and design specifications for the RMPU projects. WEI also updated the net new recharge benefit estimates for the 2013 RMPU projects, given updated information from the design documents. This involved updates in basin geometry, basin operations, infiltration rates, basin hydraulics, and other information relevant to stormwater recharge.

Most recently, WEI completed the 2018 RMPU, that was developed through a stakeholder process. Watermaster convened workshops with the Steering Committee over the course of developing the report to present important assumptions and interim work products of the RMPU. The report included the technical documentation demonstrating that Watermaster has sufficient recharge capacity to meet expected future replenishment obligations through 2050.



This chart illustrates the estimated stormwater recharge in the Chino Basin (dark blue bars) for the Santa Ana River tributaries that flow south over the Chino Basin. The lining of these channels almost eliminated stormwater recharge in the Chino Basins after 1984. The red bars indicate the estimated increase in stormwater recharge due to the construction of stormwater recharge improvements from the 2002 Recharge Master Plan. The horizontal green bar indicates the expected average stormwater recharge after the completion of the projects identified in the 2013 RMPU, expected in 2020.

Monitoring for Impact of Groundwater Management Plans on Critical Riparian Habitat

Chino Basin Watermaster and Inland Empire Utilities Agency

Project Dates:
2014 – present

Reference:
Peter Kavounas
General Manager
Chino Basin Watermaster
909-484-3888
pkavounas@cbwm.org

Chris Berch
Assistant General Manager
IEUA
909-993-1762
cberch@ieua.org

Relevance: WEI has demonstrated experience to develop and implement multi-faceted monitoring and mitigation programs to support the implementation of groundwater management plans. This program included: the design and construction of monitoring wells, designing and conducting complex monitoring programs to answer specific regulatory questions, annual reporting of monitoring results with recommendations for program adaptation, and leading stakeholder processes.

Participating Team Members:
Veva Weamer
Andy Malone
Mark Wildermuth

The Chino Basin is a large alluvial groundwater basin in southern California with storage exceeding five million acre-feet. Groundwater in the Chino Basin generally flows from the forebay regions in the north towards the Prado Flood-Control Basin in the south (Prado Basin). Depth to groundwater is relatively shallow in the Prado Basin area, which allows for groundwater/surface-water interaction. The largest riparian forest in southern California has developed in the Prado Basin, which is critical habitat for several threatened or endangered species. Groundwater losses in the Prado Basin occur via evapotranspiration by riparian vegetation and rising-groundwater discharge to the Santa Ana River.

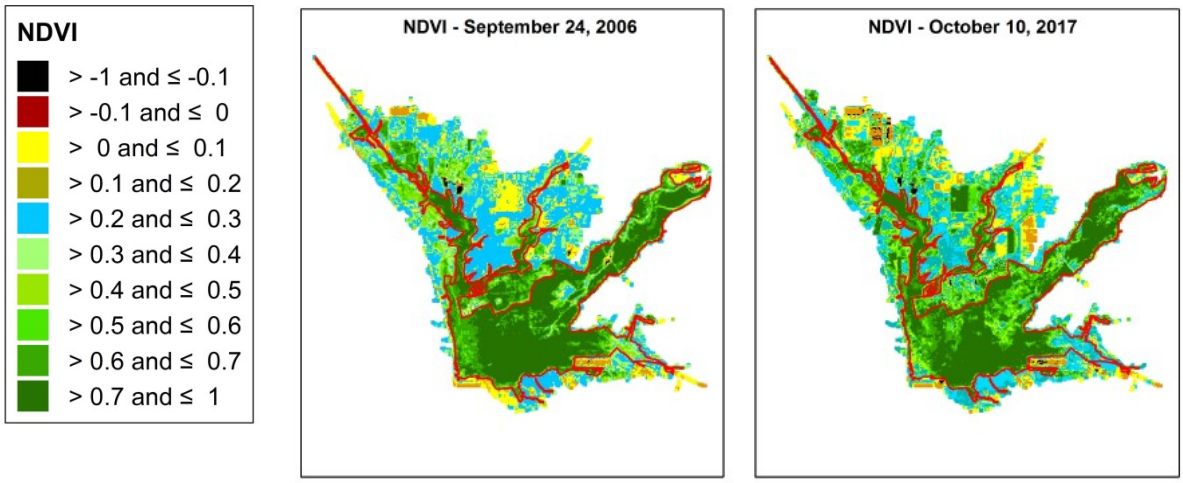
The Chino Basin Watermaster, the agency responsible for groundwater basin management, is implementing aggressive groundwater-supply programs that include controlled overdraft and the possibility of causing groundwater-level declines in the basin. The EIR for the groundwater-supply program identified the lowering of groundwater levels as a potential adverse impact to the riparian vegetation in the Prado Basin that consumptively uses shallow groundwater.

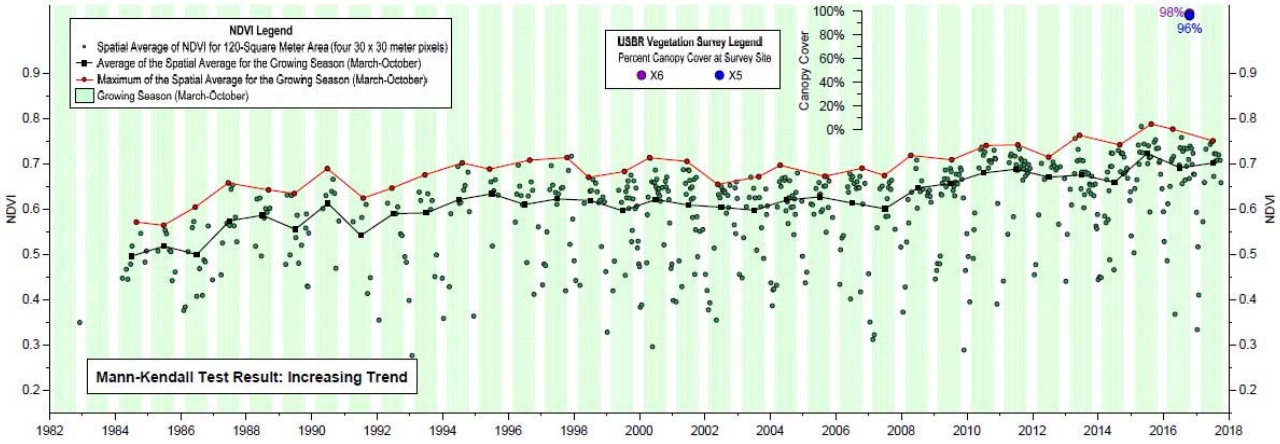
To ensure that the riparian habitat will not incur unforeseeable significant adverse effects, the EIR included a mitigation measure to develop and implement an adaptive management program (AMP) that includes: (i) convening a committee of stakeholders to supervise the AMP, (ii) conducting a comprehensive monitoring program, (iii) annual reporting on the results and conclusions of the monitoring program, and (iv) adapting the AMP and the monitoring program as appropriate to ensure habitat sustainability. WEI prepared the AMP through a stakeholder process. (Click here to view the AMP report.)

WEI developed the monitoring and reporting program and has recently begun its implementation. The first step was to design, drill, construct, and develop 16 monitoring wells located near the riparian habitat to track changes in groundwater levels within the shallow or perched aquifer systems. The monitoring program also includes chacterization of the extent and quality of the riparian habitat over time, which required the acquisition and analysis of remote-sensing data from the Landsat program, high-resolution areal photography, and field vegetation surveys. The program also involves the monitoring of all factors that could potentially impact the habitat (not only changes in groundwater levels), including surface-water

discharge, precipitation, temperature, wildfire, and pests, among others. Lastly, the program includes the use of groundwater-flow model projections of future drawdown to identify areas of prospective impacts on riparian habitat.

In 2017, the Watermaster published the first annual report, which identified no current or future adverse impacts to the riparian habitat and recommended certain refinements to the monitoring program.





The Normalized Difference Vegetation Index (NDVI), derived from remote-sensing measurements from the Landsat Program, is a measure of greenness correlated with photosynthesis. WEI uses NDVI to characterize the extent and quality of riparian vegetation in the Chino Basin, both spatially and over time.

Biennial State of the Basin Reports for the Chino Basin

Chino Basin Watermaster

Project Dates:
2002 – Present

Reference:
Peter Kavounas
General Manager
Chino Basin Watermaster
909-484-3888
pkavounas@cbwm.org

Relevance: WEI has the experience, competency, and tools to develop conceptual hydraulic and hydrogeologic models, conduct comprehensive basin-wide monitoring programs, summarize and describe complex datasets for groundwater and surface water, and prepare explanatory, easy-to-understand data graphics for managers and decision makers.

Participating Team Members:
Andy Malone
Veva Weamer
Mark Wildermuth
Carolina Sanchez
Eric Chiang

Pursuant to the November 15, 2001 Court Order, the Chino Basin Watermaster must prepare a "State of the Basin" report every two years. State of the Basin reports are used to document how the Chino Basin has changed since the implementation of the its comprehensive groundwater management plan in September 2000, the so-called Optimum Basin Management Plan (OBMP).

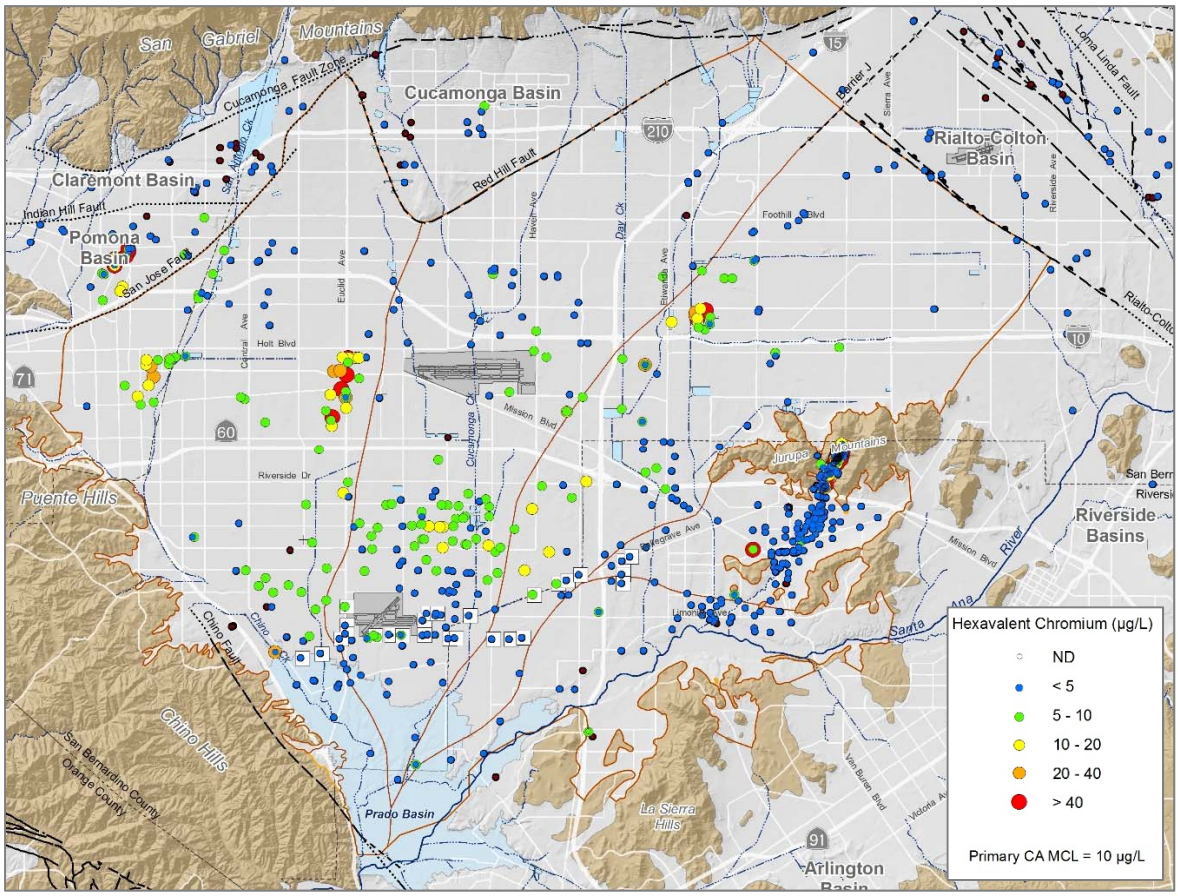
The scope of the report includes a characterization of the time histories of hydrology, groundwater levels, groundwater quality, storage, production, recharge (replenishment and other recharge), land subsidence, state of hydraulic control of groundwater outflow, desalter planning and engineering, and production-meter installation in agricultural areas.

As Watermaster's Engineer, WEI prepares the State of the Basin reports, which include the following tasks:

- Compile and analyze production data for the two-year period and prepare exhibits showing production activities by major groups of pumpers and historical trends in production.
- Compile and analyze recharge and recycled water reuse data for the two-year period and prepare exhibits showing groundwater recharge trends.
- Compile and analyze surface water, climate, and land use data, and prepare exhibits that show general hydraulic conditions in the Basin.
- Compile and analyze basin-wide groundwater quality data and prepare maps that show five-year maximum concentrations for constituents of concern in the Basin and historical trends in TDS and nitrate by management zone.
- Prepare rasters depicting the current extent of the VOC contaminent plumes and a series of associated maps.
- Compile and analyze basin-wide groundwater-level data and prepare exhibits that show historical trends in groundwater levels at wells by management zone.
- Prepare groundwater-elevation contour maps for the current period and prepare maps showing the spatial change in groundwater elevation over time.
- Compile and analyze ground-motion data and prepare maps showing vertical ground motion and time-series charts of groundwater pumping, recharge, and groundwater levels that explain the trends in ground motion.

WEI prepares a final report in digital format for Watermaster and the Watermaster parties, which is posted to Watermaster's website. Additionally, 15 hard copies of the final State of the Basin Report are published as a map atlas.

To download the most recent 2016 State of the Basin report, click here.



This map shows the areal distribution of the hexavalent chromium concentration in the Chino Basin. In July 2014, hexavalent chromium became a regulated drinking water contaminant in California with a Primary MCL of 10 µg/L. In 2016, this mandated MCL was challenged, and as of September 2017, the maximum contaminant level for hexavalent chromium is no longer in effect.

From 2011 to 2016, 884 wells in the Chino Basin were sampled for Hexavalent Chromium, with 777, or 89%, having detectable concentrations. Of these wells, 92, or 12%, have a five-year maximum concentration exceeding 10 µg/L. The five-year maximum hexavalent chromium concentrations range from 0.01 to 14,000 µg/L with average and median concentrations of 59 and 2.6 µg/L respectively. The highest observed concentrations of hexavalent chromium are in areas with known point-source discharges to groundwater.

Development of a Salt and Nutrient Management Plan for the Chino Basin

Chino Basin Watermaster and Inland Empire Utilities Agency

Project Dates:
2017 – present

Reference:
Peter Kavounas
General Manager
Chino Basin Watermaster
909-484-3888
pkavounas@cbwm.org

Chris Berch
Assistant General Manager
IEUA
909-993-1600
cberch@ieua.org

Relevance: Demonstrates WEI's experience in estimating TDS and nitrogen loads to groundwater and associated groundwater impacts, and groundwater flow and quality modeling.

Participating Team Members:
Mark Wildermuth
Jeff Hwang
Eric Chiang
Wenbin Wang
Carolina Sanchez
Veva Weamer

From 2002-2003, Wildermuth Environmental, Inc. (WEI) led the development of a salt and nutrient management plan (SNMP) for the Chino Basin. The water-quality constituents of concern in this SNMP were total dissolved solids (TDS) and nitrate. The SNMP was subsequently incorporated into the Basin Plan in 2004. The key elements of the Chino Basin SNMP—developed by WEI, the Chino Basin stakeholders (including numerous agriculture pumpers) and Regional Board staff—included:

- A detailed articulation of the stakeholders' plans for water-supply and water-quality-management activities, including irrigated agriculture and dairies. WEI collected and compiled these plans to estimate TDS and nitrate discharges to groundwater and, later, used models to demonstrate whether or not the implementation of these plans would impair beneficial uses.

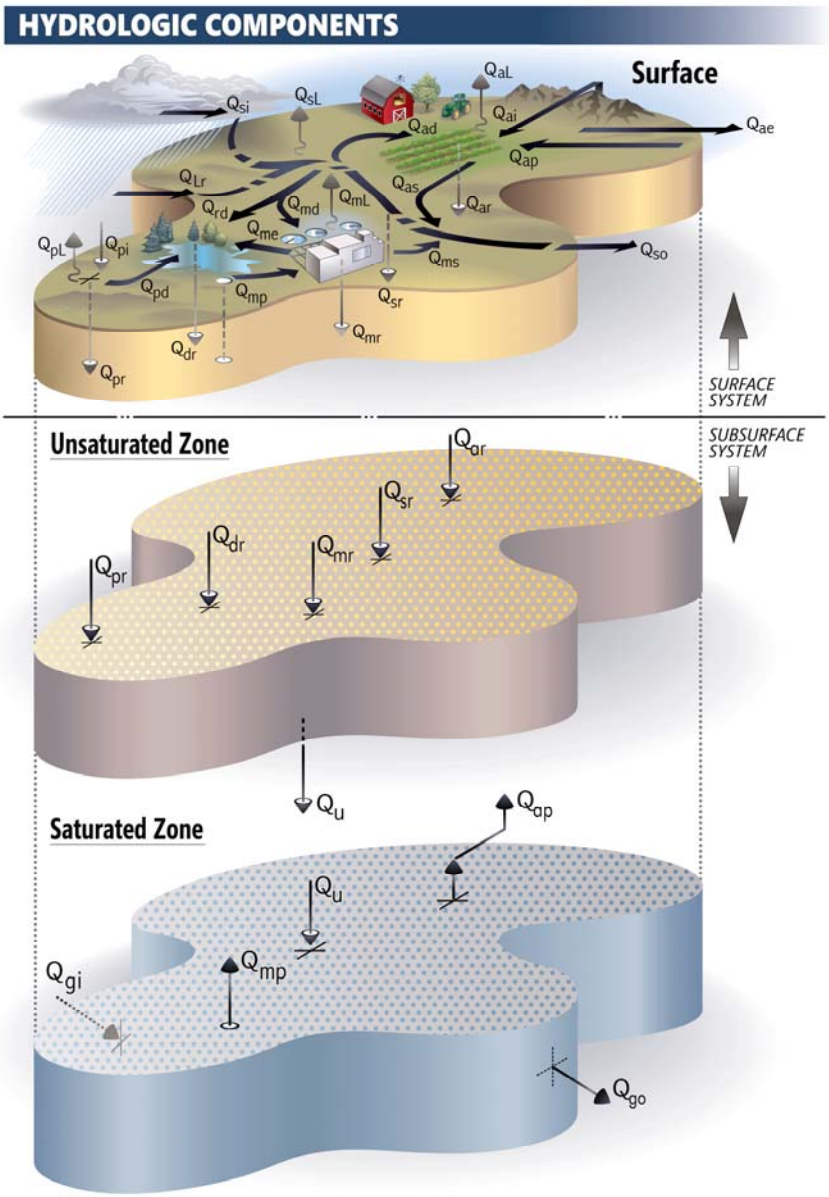
- Collaboration with the Regional Board to determine appropriate TDS and nitrate objectives, based on the model projections and demonstrations that raising the TDS and nitrate objectives provided for the maximum benefit to the people of California.

- Commitments to the implementation of a series of management actions that ensure the protection of beneficial uses of groundwater in the Chino Basin, which included (among other things): implementing monitoring programs, constructing recharge basins to increase the recharge of recycled, storm and imported waters, constructing desalters, and the implementation of a recycled water quality improvement program when recycled water concentrations exceed a specific trigger concentration.

In 2015, the 12-month running average TDS concentration in recycled water produced by the IEUA approached the trigger concentration that would require the IEUA and Watermaster to submit a plan and schedule to improve recycled water TDS concentrations. Research performed by the IEUA found that the primary driver for the increasing TDS concentration in its recycled water was the increase in the TDS concentration of the water supply, which was directly related to drought conditions that had persisted since 2012. Although the 12-month running average TDS concentration declined from the 2015 peak before the trigger was exceeded, it was an important indicator that the TDS concentration of recycled water is likely to trigger the requirement for recycled water quality improvements during the next prolonged dry period. Given the potential cost of implementing recycled water quality improvements for what might only be short-term exceedances of the 12-months running average limitation, the IEUA and Watermaster retained WEI to support the development of a proposal to the Regional Board to revise the averaging period for recycled water compliance to a longer term period (5 or 10 years), to project future TDS concentrations in recycled water, to project the impacts of future recycled water reuse and discharge on groundwater and the Santa Ana River, and to recommend changes to the SNMP to address conservation and drought impacts on TDS concentration.

As part of this work, WEI is developing the most detailed and sophisticated surface and groundwater flow modeling system ever developed in the Santa Ana Watershed for the purpose of estimating TDS and nitrate impacts to surface and ground waters from agriculture, dairy, municipal, and industrial discharges.

Figure 1 graphically illustrates a free-body diagram of all the potential water sources and discharges that are being addressed in our work. Examples of the salinity loading and fate and transport factors included in this evaluation are: the source waters used for irrigation; estimated applied water, evapotranspiration, runoff, and deep infiltration beyond the root zone; salt and nutrient loads from fertilizer application and liquid and solid dairy wastes; TDS and nitrate loads from atmospheric deposition and precipitation; nitrogen loss to the atmosphere, uptake, and leaching beyond the root zone; and precipitation of salts in the vadose zone. Vadose zone routing studies were conducted for several locations in the basin to develop spatially distributed estimates of solute travel time from the root zone to groundwater.



WEI also developed the most detailed characterization of current TDS and nitrate concentration ever developed in the Chino Basin, representing current conditions for the modeling work. In the first half of 2019, WEI will use the information described above, its calibrated groundwater flow model, and a newly developed MT3D solute transport model to project the TDS and nitrate impacts of recycled water reuse under a range of salinity management plan alternatives.

As was done for the development of the initial SNMP in 2003, WEI is implementing a collaborative process with Watermaster, the IEUA, and the Regional Board to discuss progress of the work and to get buy in on all technical and regulatory assumptions and computations.

This figure shows the various hydrologic components considered in modeling groundwater quality impacts. In the surface system, TDS and nitrate concentrations are assigned to each source. The TDS and nitrate concentrations are modified through mass additions (e.g. fertilizer application) and consumptive use (e.g. ET) as the water moves from the source through use to discharge either to surface water or the vadose zone. TDS and nitrate concentrations in deep infiltration in the vadose zone are modified by sorption/desorption, precipitation, and microbial processes. The models used in this project include R4, Hydrus-2d, MODLFOW, and USGS-MT3D.

Water Supply Reliability Assessment and Support for Urban Water Management Plans (UWMPs)

Mammoth Community Water District

Project Dates:
2009 – 2016

Reference:
Patrick Hayes
General Manager
Mammoth Community Water District
760-934-2596
phayes@mcwd.dst.ca.us

Relevance: WEI staff has the technical know-how and resources to develop and use groundwater models, conduct scientifically defensible water-supply assessments, optimize supplies, and support UWMP development.

Participating Team Members:
Mark Wildermuth
Michael Blazevic
Wenbin Wang

The Mammoth Community Water District provides municipal water supply and sewer services to the Town of Mammoth Lakes, California. The primary water sources used by the District include surface water diversions from Lake Mary, a lake on Mammoth Creek, and groundwater from the Mammoth Basin. Surface water diversions are limited by a water right and water demand, which are often out of sync with each other. The District augments its surface water diversion with groundwater. During drought periods, the District is completely dependent on its groundwater supply.

In 2009, WEI developed the first ever groundwater model of the Mammoth basin to assist the District in understanding how their basin worked and its pumping limitations and to characterize its safe yield. Subsequently, in 2010 and 2016, the District retained WEI to assist them in the preparation of their Urban Water Management Plans.

In these efforts, WEI developed statistical characterizations of surface-water availability and alternative surface diversion scenarios, which were subsequently used to create groundwater pumping scenarios that would fully satisfy water demands. The surface-water availability assessment considered historical snow-pack measurements starting in 1940, historical surface-water discharges measured at USGS gaging stations, actual diversions, and water demands. Historical demands, which limit diversions, have grown over time with development and are planned to grow in the future. WEI removed historical diversions from the surface-water discharge record, created a revised non-stationary historical surface-water discharge record (without surface diversions), and subsequently used the non-stationary record to assess surface water availability to meet future water demands. Differences between total demand and projected surface-water diversions were projected to be met with groundwater. WEI updated the Mammoth groundwater model to the then present year (2010 and 2015) and simulated the groundwater basin response to the pumping scenarios. Pumping sustainability was subsequently analyzed at all wells, and conjunctive-use based groundwater pumping plans were recommended to ensure sustainability. The District prepared its UWMPs based on this work. WEI provided review comments on the UWMP.

Figure 3
Cumulative Frequency Curves for Annual MCWD Surface-Water Diversions
Based on 2015, 2025, 2030, and 2035 Potable Water Demands*

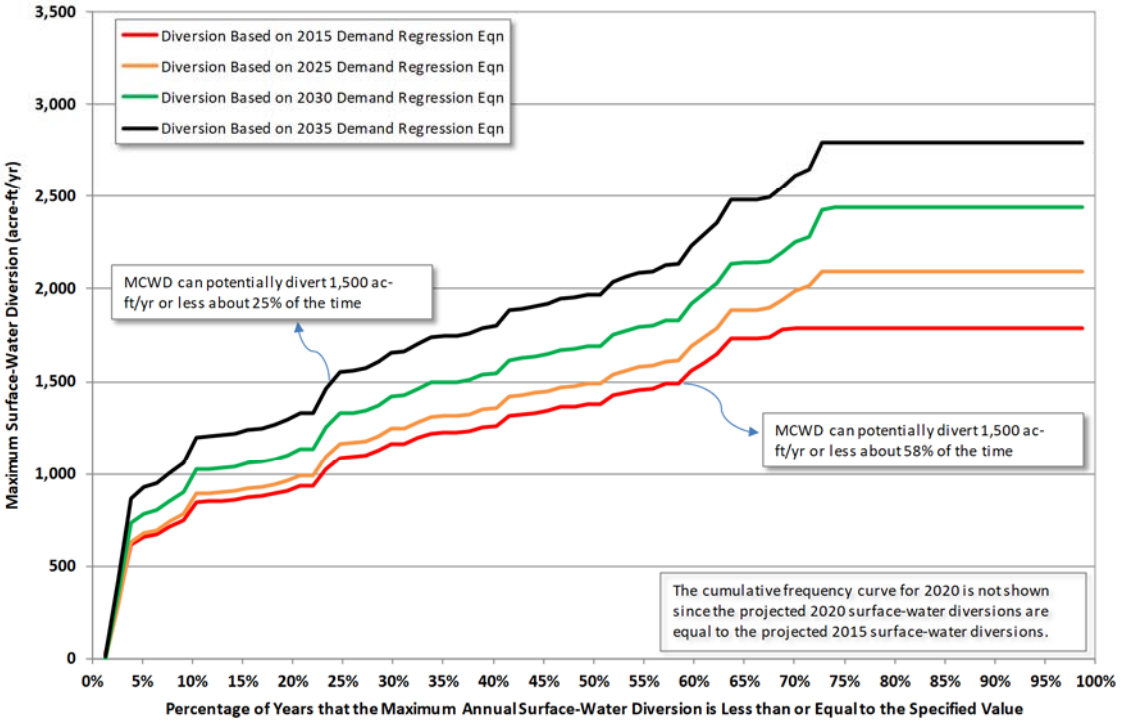
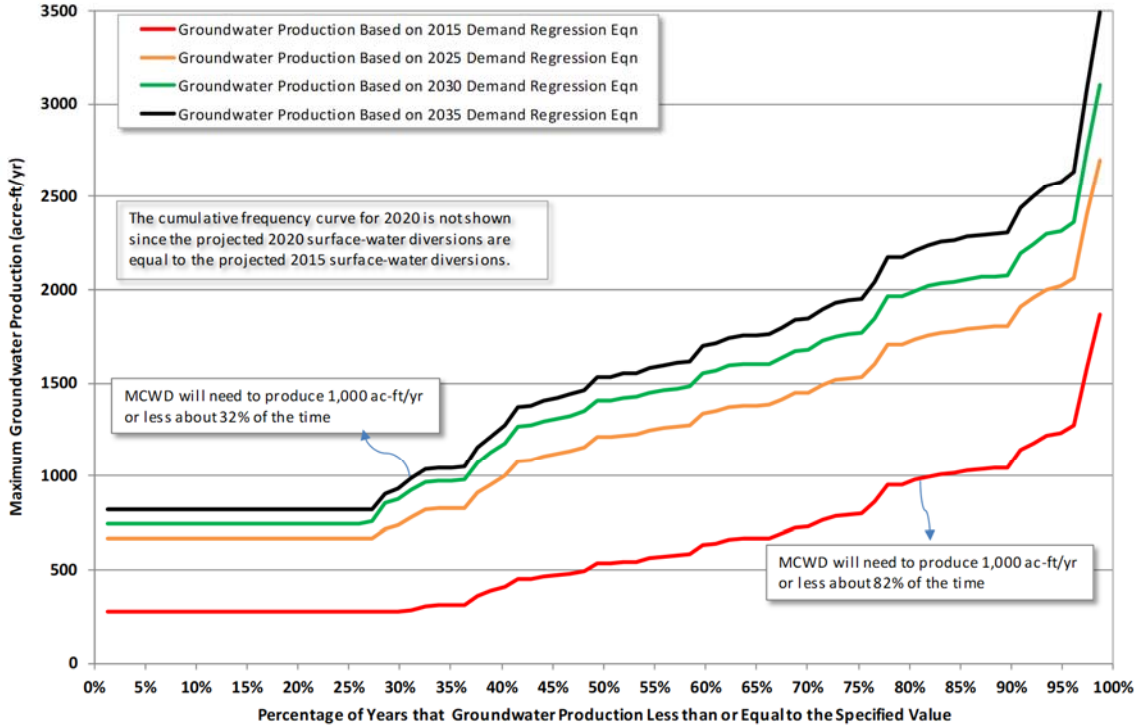


Figure 4
Cumulative Frequency Curves for Annual MCWD Gross Groundwater Production
Based on the Surface-Water Diversions Scenarios



Live Oak Well 7 Completion

CITY OF LIVE OAK, CA

Team: Kristen Whatley (Project Engineer), AJ Connell (Staff Engineer)

West Yost completed the preliminary and final design for a new well, water treatment, chlorination system, gravity sewer main, and potable water transmission main. Well equipping included the design of vertical turbine pumping equipment with a variable frequency drive motor for a 1,000 gpm production well. Water treatment plant included design and coordination with manufacturer for an Adsorption/Catalytic Oxidation treatment plant using vertical steel pressure vessels with a proprietary media (AS-700 by ATEC) to treat arsenic and manganese. A sodium hypochlorite chlorination system was designed to achieve raw water chemical oxidation and to provide disinfectant residual after treatment. In addition, chemical facilities were designed to provide potassium permanganate and ferric chloride to the water treatment plant. The City of Live Oak well and treatment plant site was laid out with locations identified for future expansion to add an additional production well and to expand the treatment plant if it is determined that additional treatment will be required.

Caption for photo below: A Prop 84-funded well designed by West Yost is currently under construction in Live Oak, California.

North Well 2 Equipping Design

Western Municipal Water District, Murrieta, CA

Team: Kristen Whatley (Project Engineer), AJ Connell (Staff Engineer)

West Yost is currently working with Western Municipal Water District (WMWD) to replace the North Well in their Murrieta Division. The North Well is a 650-foot-deep production well that yielded approximately 2,400 gallons per minute (gpm) upon installation in 1985. By late 2016, the yield of the North Well declined to approximately 500 gpm, due in part to declining groundwater levels in the area, and it was removed from service due to sand production and casing failure. WMWD contracted West Yost for hydrogeologic and engineering services to abandon the No rth Well in place and design and install a replacement well to restore groundwater production capacity in the area. The replacement well will be drilled on the same parcel as the North Well and deeper to restore lost capacity. Other deeper water supply wells in the area experience elevated levels of arsenic.

The scope of work includes destruction of the existing well and above grade facilities, design of a replacement drain line for well waste discharge, preliminary design of a new 1,000-foot-deep, 1,000-gpm production well, bid support, engineering services during well construction and final well design, well equipping, and design of above grade facilities including a CMU building to house electrical equipment and chemical facilities. West Yost developed a preliminary well design and specifications for drilling, testing, and construction to characterize the vertical distribution of water quality and yield at the location with the intent of constructing a well that will meet arsenic drinking water standards without the need for treatment. The project is currently in the design phase with an anticipated completion date of late 2019.

Caption for photo below: The West Yost team designed a replacement well for an existing site within a residential neighborhood. The design required careful attention to construction and staging activities even during design so as to minimize impact on surrounding property.

Appendix B

Resumes

Andy Malone, PG

Vice President, Principal Geologist

Expertise:	Mr. Malone is a Principal Geologist, Vice President, and Partner at Wildermuth Environmental, Inc. (WEI). He has over 23 years of professional experience in water resources consulting and the geologic sciences. His technical expertise includes sedimentary geology, tectonics, basin characterization, hydrogeologic and hydrologic analyses, aquifer mechanics, Geographic Information Systems, and database design and implementation. At WEI, Mr. Malone develops investigative strategies for hydrologic and hydrogeologic studies, works to increase the technical expertise of the company, manages projects and staff, and mentors junior staff, guiding them as they develop into WEI's next generation of expert water-resources professionals. At present, Mr. Malone is the WEI project manager for engineering services for the Chino Basin Watermaster, where he attends all meetings as the Watermaster Engineer, and is leading sophisticated hydrogeologic investigations for pumping-induced land subsidence, groundwater/surface-water interactions, and the monitoring of groundwater-dependent riparian habitat. Mr. Malone is also leading an effort with the Six Basins Watermaster to develop and implement an improved water-resources management program in the Six Basins. An emphasis of this program is to maximize the beneficial use of the groundwater basin—a local, renewable resource. Earlier in his career at WEI, Mr. Malone was the lead geologist in the development of a hydrogeologic conceptual model of the Chino Basin that was subsequently translated into a very well calibrated numerical groundwater-flow model. Mr. Malone continues to work with the modeling team at WEI to refine the conceptual model based on new geologic and monitoring data and to use the model to inform numerous basin-management initiatives. And, in his early career at WEI, Mr. Malone worked on re-defining groundwater sub-basin boundaries for the entire Santa Ana River Watershed, based on current hydrogeologic understanding, and recalculating TDS and nitrogen groundwater quality objectives to support the Regional Board's revision of its Water Quality Control Plan in 2004. Prior to joining the firm in 1996, Mr. Malone's professional experience included employment as a field geologist for the Indiana State Geological Survey and as a Geology instructor at Saddleback College in Southern California.
Education:	M.S., Geological Sciences, Indiana University at Bloomington, 1991 (Mr. Malone's M.S. thesis was published in a regional geological journal and won the journal's Best Paper Award in 1992.) B.A., Geological Sciences, University of California at Santa Barbara, 1987 B.A., Environmental Studies, University of California at Santa Barbara, 1987
Licenses:	Professional Geologist, California GEO 8700
Professional History:	WEI – 1996 to Present

Professional Experience:

Watermaster Engineering Services, Chino Basin Watermaster

WEI has served as the Engineer for the Chino Basin Watermaster since the early 1990s. Mr. Malone has worked on or managed various tasks for the Watermaster since joining WEI in 1996. Since 2015, Mr. Malone has been the project manager for WEI at the Watermaster and is responsible for coordinating and directing staff and reporting to the Watermaster and its Board on the progress and results of WEI's project work, which has an annual budget of about $2.5 million dollars. Described below are various technical projects and programs that Mr. Malone manages for the Watermaster:

Land Subsidence Management Programs: Mr. Malone is conducting ongoing investigations to determine the extent, rate, and mechanisms of land subsidence and ground fissuring in the Chino Basin. A common cause of ground fissuring within alluvial basins is the removal of subsurface fluids, which results in the compaction of poorly consolidated aquifer materials and land subsidence. Mr. Malone supervised the construction of multiple-depth piezometers and a dual-borehole extensometer, a highly-sophisticated monitoring facility that records the data necessary to establish relationships between pore-pressure changes and aquifer-system compaction in the area of acute subsidence and historical ground fissuring. Though this is an ongoing project, its results were used to develop an adaptive management plan in the Chino Basin that will minimize and/or abate permanent land subsidence and ground fissuring in the future.

Prado Basin Habitat Sustainability Program: Mr. Malone is conducting ongoing investigations to determine whether the groundwater management plan in the Chino Basin is having adverse impacts on a groundwater-dependent riparian habitat in the downgradient portion of the basin. The investigation is a monitoring and mitigation requirement of the EIR for the groundwater management plan. The intent of this investigation is to characterize the historical, current, and future extent and quality of riparian habitat, and if degradation of the riparian habitat is documented, to provide information on the cause(s) of that degradation. If the cause(s) of degradation are attributed to the implementation of the groundwater management plan, the data from the investigation will aid in the development of efficient and effective mitigation measures. Mr. Malone and his team designed the monitoring program and investigation, and they are now implementing it. The investigation includes: remote-sensing and field surveys of the riparian habitat, the construction of monitoring wells and ongoing monitoring of water levels and quality, monitoring of surface water discharge and quality, monitoring of climatic trends, and analysis of other factors that can affect riparian habitat such as pests and wildfire. These data are analyzed and reported on annually to a Watermaster sub-committee, which is led by Mr. Malone. The annual reports include recommendations for modifications to the monitoring program and a proposed budget for the following fiscal year.

Hydraulic Control Monitoring Program: Mr. Malone is conducting ongoing investigations to determine the state of groundwater outflow from the Chino Basin as rising groundwater in the Santa Ana River. Crucial groundwater

management practices, such as the recharge of recycled water, are dependent upon the demonstration that basin producers are controlling groundwater outflow. Through an extensive literature review and analyses of geologic, geophysical, and hydrologic data, Mr. Malone generated a conceptual hydrogeologic model of the Chino Basin near the river. Based on this model, he developed a detailed groundwater monitoring program that included the construction of nine nested, multiple-depth monitoring wells. The data derived from this monitoring program has characterized: the three-dimensional hydraulic gradients in this part of the basin over time and in response to specific management practices and the hydraulic relationships between the groundwater basin and the river.

Technical and Administrative Services, Six Basins Watermaster

Mr. Malone and Ms. Carolina Sanchez manage and direct the technical and administrative services for the Six Basins Watermaster. In this role, Mr. Malone and Ms. Sanchez perform the following functions: prepare for and lead Board meetings; conduct monitoring programs; database management; coordinate recharge activities; review and revise Watermaster governing documents; prepare annual reports, annual budgets and assessments; determine the annual operating safe yield; perform water rights and storage accounting; and perform other tasks requested by the Board.

Mr. Malone is also managing the development of a Strategic Plan for the Watermaster Board. The objective of the Strategic Plan is to develop a water-resources management program that sustains and enhances the water supplies available to the Six Basins in a cost-effective manner and in accordance with the Judgment. This effort began in 2012 and included defining the goals and objectives of the stakeholders: maintaining or improving the yield of the Six Basins, maintaining and/or improving groundwater quality—especially in areas where beneficial uses are constrained by poor quality, minimizing losses due to rising groundwater and/or subsurface outflow, and optimizing the management of the Six Basins such that all Watermaster parties can reliably pump their shares of the basin yield. This effort also included a description of the water demands and supplies of the Six Basins and the physical nature of the Six Basins, such as surface-water availability and quality, recharge, groundwater production, groundwater quality, groundwater levels, basin boundaries and groundwater barriers, aquifer geometry and aquifer properties, groundwater flow, storage, and yield. From this information, impediments to achieving the stakeholders' goals were identified, which assisted in the development of concepts for improved basin management that will remove impediments and achieve the goals.

Subsequently, Mr. Malone directed an effort to develop and evaluate the potential components of the Strategic Plan (e.g. project alternatives). This included: describing the so-called "Baseline Alternative," the parties' operations without the Strategic Plan; developing and describing multiple Project Alternatives in enough detail to estimate the expected yield and the associated capital and operating costs; developing and using computer-simulation tools to evaluate the physical impacts of the project alternatives; evaluating and ranking the Project Alternatives based on yield and cost; and developing a plan for the implementation of the preferred alternative(s). Currently, the stakeholders in the Six Basins are moving forward to project implementation and

financing for the Strategic Plan. Mr. Malone is assisting this effort by leading the technical work to support the preparation of a program EIR for the Strategic Plan.

Coldwater Basin Safe Yield Studies, Coldwater Basin Operating Committee

In 2006, Mr. Malone conducted an analysis of the native safe yield of the Coldwater Basin in Riverside County to establish the relative pumping rights of the two major pumpers of the basin—the City of Corona and the Elsinore Valley Municipal Water District. A water-rights agreement was executed between the City and the District based on this analysis. Mr. Malone directs the ongoing annual reporting on the Coldwater Basin as required by the agreement, which includes the accounting of pumping, storage, and water rights. The agreement also requires the re-determination of the native safe yield once every five years, based on the monitoring data collected to date. Mr. Malone and his staff performed the work to re-determine the native safe yield in 2013, which resulted in revised pumping rights for the next five years.

Arlington Basin Desalter Expansion Studies, Western Municipal Water District

Mr. Malone managed and conducted a feasibility study to expand the Arlington Desalter facility in western Riverside County. The study included hydrogeologic investigations, groundwater and surface water monitoring programs, and the development and calibration of a numerical, computer-simulation, groundwater-flow model of the Arlington Basin aquifer system. This model was used to predict the hydrologic impacts of an expanded desalter and the ability of the aquifer system to supply the expanded desalter with the required volumes of raw groundwater over the life of the facility (at least 30 years) without causing unacceptable impacts at the desalter wells, within the groundwater basin, or within neighboring basins. The model results indicated that the desalter expansion was feasible but that new wells would need to be constructed and that the drawdown caused by pumping these new wells would impact the neighboring Riverside Basin. Additional feasibility studies and model runs were conducted, which included the artificial recharge of supplemental waters in the Arlington Basin. The objectives of artificial recharge are to temporarily store supplemental water supplies, increase the yield of the Arlington Basin, and mitigate the regional drawdown impacts that would be caused by increased desalter pumping.

Nitrogen/Total Dissolved Solids Studies, Santa Ana Watershed Project Authority – N/TDS Task Force

Mr. Malone conducted studies to revise the water quality objectives for groundwater sub-basins throughout the Santa Ana River Watershed. The result of this study was a comprehensive update to the salt and nutrient management plan for the entire Santa Ana River Watershed. For this effort, Mr. Malone developed revised sub-basin boundaries—based on a reassessment of hydrogeology, groundwater flow paths, and groundwater quality—to create “management zones” for more effective management and stewardship of these groundwater systems. This effort also included the development and testing of sophisticated statistical techniques to set new TDS and nitrate groundwater quality objectives based on historical water quality data. He has since directed four subsequent recomputations of ambient water quality in the groundwater management zones, which were then compared to the objectives and

used by the Regional Board to assess the existence and magnitude of assimilative capacity.

Wasteload Allocation for the Santa Ana River Watershed, Santa Ana Watershed Project Authority – Basin Monitoring Program Task Force
Project Manager and Principal Geologist: Mr. Malone managed a study of the existing wasteload allocation for the Santa Ana River Watershed. The purpose of the study was to evaluate whether the existing wasteload allocation for POTW (Public-Owned Treatment Works) discharge of TDS and TIN was compliant with the water quality standards in the Water Quality Control Plan for the Santa Ana Basin (Basin Plan). To conduct this study, Mr. Malone and WEI's modeling team updated and used the Wasteload Allocation Model (WLAM)—a numerical computer-simulation model of surface-water discharge, quality, and streambed recharge. The WLAM simulated updated plans for wastewater discharge and storm-water conservation and used a set of elegant procedures and explanatory data graphics to evaluate the existing wasteload allocation with respect to the surface-water and groundwater standards in the Basin Plan. The Regional Board uses the results of the wasteload allocation studies to review and revise the Basin Plan and POTW discharge permits if necessary.

Investigation of the Cause(s) of Recent Exceedances of the TDS Concentration Objective for Reach 3 of the Santa Ana River, Santa Ana Watershed Project Authority – Basin Monitoring Program Task Force ***Project Manager and Principal Geologist:***

Mr. Malone conducted a study to characterize the causes of an increasing trend in the TDS concentration of Reach 3 of the Santa Ana River (SAR). The increasing trend had resulted in summertime exceedances of the TDS objective for Reach 3 in the Basin Plan. The purpose of the investigation was to provide the Regional Board with insight as it reviews and revises its approach to regulating SAR water quality. The study employed a mass-balance analysis and sensitivity study of the inflows and outflows to Reach 3 during the summertime months of 2004-2012. The investigation showed that the observed summertime increase in the TDS concentration of the SAR from 2004-2012 was correlated with a decrease in POTW discharges with relatively low TDS concentrations. In other words, the TDS concentration of the SAR is diluted by these POTW discharges. The decrease in summertime POTW discharge resulted from increased recycled-water reuse, decreased wastewater influent due to the economic recession that began in 2008, and the implementation of indoor water-conservation measures.

Recharge Master Plan for the Temescal Basin, City of Corona

Project Manager and Principal Geologist: Mr. Malone directed the development of a recharge master plan for the Temescal Basin, which underlies the City of Corona. The City is the main groundwater pumper in the Temescal Basin, which is experiencing overdraft conditions. The objectives of the City were to mitigate the overdraft, improve groundwater quality, and potentially reduce the City's reliance on imported water.

The recharge master planning process used in this investigation included the following tasks: define the goals for artificial recharge and develop planning criteria, characterize potential source waters for artificial recharge, characterize the universe of potential

sites for artificial recharge, develop alternatives for artificial recharge, and evaluate and rank alternatives for artificial recharge. This effort required the development of conceptual-level facility-improvement plans and cost estimates to convey and recharge storm water and/or recycled water. A surface-water model was applied to evaluate the efficacy and practicality of the proposed recharge facilities. A groundwater model was applied to evaluate potential groundwater mounding near the recharge areas and the potential for groundwater re-capture. And, a cost analysis was applied to evaluate the various project alternatives.

Mark Wildermuth, PE

President, Principal Engineer

Expertise:	Mr. Wildermuth has 42 years of experience in water resources engineering and planning, including: surface and groundwater hydrology; hydraulics and water quality; surface and ground water modeling; groundwater management, including recharge master plans; water resources systems planning, operation, and optimization; water rights; evaluation of receiving water impacts; and flood control facility design. Mr. Wildermuth has extensive expertise in the development of water resource management plans for groundwater basins and watersheds in Southern California, and he has provided expert witness testimony and opinions for litigation support and mediation in several important cases—the most recent being the recalculation of the Chino Basin safe yield and Phase 3 trial in the Antelope Valley groundwater adjudication. Mr. Wildermuth is a recognized expert in the hydrology of the Santa Ana Watershed, having developed groundwater models at some time in his career for all of the groundwater basins in the upper watershed and highly integrated surface and groundwater models for the Santa Ana River and its tributaries and underlying basins. These models are in active use to manage the Chino, Cucamonga, Six Basins, Temescal, and Mammoth Basins. Mr. Wildermuth developed the recharge master plan concept, utilizing detailed surface water models and powerful statistical techniques to determine expected new recharge and cost. Mr. Wildermuth designed and subsequently led the process to develop the salt and nutrient management plan for the Santa Ana River Watershed and subsequent updates. His work has withstood rigorous peer review and has been relied on in adjudicated basins and regulatory processes. Mr. Wildermuth directs WEI's technology program, which conducts research and development of models, database/visualization tools, methodologies to estimate the sustainable yields of groundwater systems, and methodologies to evaluate the impacts of climate change on surface and ground water resources.
Education:	M.S., Engineering, University of California, Los Angeles, 1976 B.S., Engineering, University of California, Los Angeles, 1975
Licenses:	Professional Engineer, California, No. 32331
Professional History:	WEI – 1990 to Present James M. Montgomery, Consulting Engineers [JMM] (now called MWH) – 1987 to 1990 Camp Dresser & McKee, Inc. (now called CDM/SMITH) – 1980 to 1987 TetraTech – 1976 to 1980
Professional Experience:	**Development of a Groundwater Storage Management Plan for the Chino Basin** Mr. Wildermuth is the project manager and lead technical analyst for the development of the Chino Basin storage management plan (formally referred to as the Storage Framework). The purpose of the management plan is to determine how the unused storage space can be used to store surplus supplemental waters during wet periods

without causing undesirable results. After determining the amount of unused storage space that could be used by local pumpers pursuant to the Chino Basin Judgment, Mr. Wildermuth investigated the hydrology and challenges in using increasing blocks of unused storage and the undesirable results that come from increasing storage in the basin. Mr. Wildermuth led a team of engineers and modelers: to create management "surfaces" that represent groundwater level constraints to ensure no new land subsidence would occur and to ensure pumping sustainability; to use groundwater models to test various storage management scenarios to assess new land subsidence and pumping sustainability, impacts on safe yield, riparian habitat, and other critical management criteria; and to develop measures to mitigate undesirable results.

Development of Salt and Nutrient Management Plan for the Chino Basin and its 2018 Update

Mr. Wildermuth was the project manager and lead technical analyst for the development of the Chino Basin salt and nutrient management plan in 2003 that was included in the Santa Ana River Basin Plan. The goal of the SNMP was to determine the TDS and nitrate objectives for the Chino and Cucamonga basins and associated management plan that would maximize the use of recycled water, minimize the cost of compliance for existing municipal and agricultural dischargers and protect the beneficial use of these groundwater basins. Mr. Wildermuth applied a groundwater quality model to evaluate various planning scenarios involving the use of imported and recycled waters and, from this work, recommended new, higher TDS and nitrate objectives that were protective of beneficial uses and created assimilative capacity for TDS and nitrate. Mr. Wildermuth assisted the local water agencies in the development of commitments to improve monitoring and management of these basins in return for the Regional Board agreement to increase TDS and nitrate objectives. The estimated present value net benefit of the Chino Basin SNMP is estimated to be $900 million and has, by 2018, increased the use of recycled water from 500 afy to 37,000 afy. Because of the success of this program, WEI was asked and subsequently developed similar SNMPs for the West San Jacinto, Upper Temescal Valley, Beaumont, San Timoteo, and Yucaipa Basins. And, WEI is in the process of developing a similar SNMP for the Elsinore Basin.

Mr. Wildermuth is the principal in charge and technical advisor for the update of the Chino Basin SNMP. In his role, Mr. Wildermuth designs and monitors the implementation of complex soil, vadose zone, and groundwater modeling tools to track the fate of TDS and nitrate from source waters through their use and discharge, and to predict surface and ground water impacts from various salt and nutrient strategies. This work will be completed in 2019.

2015 Safe Yield Recalculation for the Chino Basin, Chino Basin Watermaster

Mr. Wildermuth served as the project manager and lead technical analyst for an investigation to recalculate the safe yield of the Chino Basin pursuant to the Peace Agreement and Watermaster rules and regulations. Mr. Wildermuth led WEI scientists and stakeholders through a detailed process that included: documenting historical and projected cultural conditions; developing historical and projected future estimates of recharge and discharge for all recharge and discharge components in the basin, including complex groundwater and surface water interaction and water consumed by riparian habitat; developing, calibrating, and applying complex and robust surface and ground water simulation models; and estimating net recharge and subsequently safe

yield. This work was subjected to peer review and received substantial praise for its completeness and quality. Mr. Wildermuth has participated in subsequent discussions among the Watermaster parties regarding the drafting of agreements to implement the new Safe Yield, providing the scientific basis for future safe yield reset processes and developing recommendations for its implementation. The Court with continuing jurisdiction accepted the safe yield estimate or ordered it implemented.

Elsinore Basin Groundwater Management Investigations, Elsinore Valley Municipal Water District

Mr. Wildermuth was the principal in charge for three recent groundwater management investigations for the Elsinore Basin. These investigations included the development of the recharge and discharge components and their associated TDS and nitrate concentrations; a review and assessment of future water supply, wastewater management, and groundwater management plans; and modeling future groundwater impacts and groundwater quality projections. The second investigation assessed how the existing conjunctive-use program implemented by the Elsinore Valley Municipal Water District impacts groundwater quality and the ongoing assessment of ambient water quality. The third investigation, currently ongoing, is developing new water quality objectives that will reduce the cost of existing and planned recycled water reuse and the expansion of conjunctive use.

Clean Water Factory Feasibility Analysis, City of San Bernardino Municipal Water Department

Mr. Wildermuth designed and led a comprehensive investigation to determine the feasibility of upgrading the City's reclamation plant and implementing recycled water recharge to supplement the City's water supply and improve its reliability. The investigation included projecting the water demands and supply plans for all retail agencies that use the San Bernardino Basin Area as a supply; projecting wastewater production; estimating stormwater recharge at the Devil Canyon, Waterman, and Twin Creek spreading grounds, and the recharge capacity for recycled water at these basins; determining the new treatment requirements to meet surface discharge; direct reuse and indirect potable reuse; and the preparation of cost opinions for various alternatives. WEI acquired the most current groundwater model of the SBBA—utilized by the City, the San Bernardino Valley Municipal Water District, and the Western Municipal Water District—and applied that model to assess the groundwater response and specifically the hydraulic response in the area of recharge, the depth to groundwater in areas that have historically experienced high groundwater challenges, and compliance with Title 22 regulations for indirect potable reuse. This project is currently in advanced planning and is a recipient of grant funding from the Bureau of Reclamation.

2010 Recharge Master Plan Update and 2013 Amendment, Chino Basin Watermaster

Mr. Wildermuth served as the project manager and lead technical analyst for the development of the 2010 Recharge Master Plan. This investigation was ordered by the Court and had a Court imposed deadline for completion. Mr. Wildermuth designed the investigation and the report, which were approved by stakeholders and submitted to the Court on schedule. The Court subsequently approved Mr. Wildermuth's investigation plan and scope.

For the 2010 RMPU, Mr. Wildermuth managed the overall execution of the investigation, which included three other consultants and close collaboration with Watermaster staff, the Parties, and the staffs of the Inland Empire Utilities Agency, the Chino Basin Water Conservation District, and San Bernardino County Flood Control District. Mr. Wildermuth lead nine workshops over a 15-month period and completed the final report one month prior to the Court appointed deadline. The product of this work has been highly praised for its completeness, technical sophistication, and the transparent process in which the work was conducted. Draft sections of the report were posted on the project website, which was developed and maintained by WEI. State-of-the-art surface water models were used to estimate stormwater recharge in spreading basins and in localized recharge facilities that will be constructed to comply with the 2010 MS4 permits. The investigation also determined the existing recharge capacity for imported and recycled waters and the future supplemental water recharge capacity requirements. The report included conclusions and recommendations for future recharge projects and future supplemental water supply sources, including non-Metropolitan imported water supplies.

Prior to implementation of the 2010 RMPU, the Court ordered that Watermaster and the IEUA perform subsequent investigations to refine projections of future water demands and supplemental water replenishment requirements. Mr. Wildermuth served as the project manager and lead technical analyst for the development of the 2013 Amendment to the 2010 RMPU. This investigation had a Court imposed deadline for completion.

For the 2013 Amendment, Mr. Wildermuth managed the overall execution of the investigation, which included close collaboration with Watermaster staff, the Parties, and the staffs of the Inland Empire Utilities Agency, the Chino Basin Water Conservation District, and San Bernardino County Flood Control District. The work was completed on time and within budget and was subsequently approved by the Court. Watermaster and the IEUA are currently implementing the 2010 RMPU and 2013 Amendment and plan to increase stormwater recharge by about 6,000 acre-ft/yr and supplemental water recharge capacity by 7,000 acre-ft/yr by 2020.

In addition to these recharge master planning efforts, Mr. Wildermuth led WEI engineers to support the 2000 Chino recharge master plan effort led by Black and Veatch. The recharge facilities included in that master planning effort were subsequently constructed and are in use today.

Phase II Investigation to Develop the Cucamonga Basin Groundwater Management Plan, Development and Application of Groundwater Flow and Transport Models, Cucamonga Valley Water District

Mr. Wildermuth was the project manager for the development of groundwater flow and transport models of the Cucamonga Basin. The groundwater flow model was used to estimate the sustainable yield of the basin under historical and future groundwater management scenarios. The nitrate transport model was developed to evaluate the impacts of legacy agriculture, current and projected water management scenarios that included onsite wastewater disposal systems, and groundwater nitrate treatment alternatives. Complex surface water models (HSPF, R4, and WLAM) were used to develop the recharge terms and concentrations for the groundwater models. The

nitrate transport modeling effort was used to support a Proposition 1 Groundwater Sustainability Grant application that was successful in obtaining $2 million.

Evaluation of Geothermal Resource Development on the Overlying Cold Groundwater System in Long Valley, Mammoth Community Water District

WEI was retained to review the environmental documents and provide comments on a CEQA/NEPA document prepared by the US Forest Service and the Great Basins Air Quality Management District for a substantial expansion of a geothermal power plant located in the Mammoth Lakes area of California. The WEI team, led by Mr. Wildermuth, has been providing technical consulting services to the MCWD in support of their opposition to the geothermal plant expansion and will continue to provide consulting services until the project proponent can demonstrate that the expansion of the geothermal production will not adversely impact the cold groundwater system used by the MCWD for municipal supply.

Chino Basin Dry-Year Yield Program, Chino Basin Watermaster

Mr. Wildermuth served as the project manager for WEI's involvement in the development of the Chino Basin Dry-Year Yield (DYY) Program. WEI assisted Watermaster and the Inland Empire Utilities Agency in the development of the 100,000 acre-ft DYY program (2004) and the expansion of that plan to 150,000 acre-ft (2009). WEI completed a thorough reassessment of the hydrogeologic conditions of the Chino Basin and assisted other consultants with facility planning, including well siting, water quality evaluations, and specialized mapping. WEI developed and applied a sophisticated set of surface and ground water models to evaluate the DYY's impacts on groundwater levels, contaminant plume movement, and surface and ground water interaction in the Santa Ana River and its tributaries, and to investigate how conjunctive use would impact compliance with the Santa Ana River Judgment.

Large-Scale Conjunctive-Use Planning for the Chino Basin, Metropolitan Water District of Southern California and the Department of Water Resources

Mr. Wildermuth was the project engineer responsible for applying the SIMYLD model to develop planning-level time-histories of the available surplus supplies in the Sacramento Delta that could be conveyed to the Chino Basin for a large-scale conjunctive use program. The SIMYLD model utilizes a network representation (arcs and nodes) and integer and dynamic programming techniques to operate and optimize the movement of water through a system. The model incorporated the four-rivers flow estimate into the Sacramento Delta, the Harvey Banks Pumping Plant, the State Water Project capacity available to Metropolitan Water District through Lake Silverwood, the Rialto pipeline and turnouts in the Chino Basin area, the projected demands on this part of Metropolitan's system, and the availability of recharge and production facilities in the Chino Basin. The result was a monthly time history of surplus water available for recharge in the Chino Basin and a time-history of demand signals from Metropolitan to make use of the stored water during dry periods.

Santa Ana River Conservation and Conjunctive-Use Program, Dudek for the Santa Ana River Watermaster Action Team

Mr. Wildermuth served with a team of consultants to assist the Santa Ana River Watermaster Action Team in the development of the watershed-scale management program. SARWAT members included the Eastern Municipal Water District, Inland

Empire Utilities Agency, Orange County Water District, San Bernardino Valley Municipal Water District, and Western Municipal Water District. The results of this work were incorporated into a Proposition 84 grant application that was subsequently awarded to SARWAT.

San Juan Basin Groundwater Management Plan and Facilities Plan Update, San Juan Basin Authority

Mr. Wildermuth served as the project manager, facilitator, and lead technical analyst for the update of the San Juan Basin Groundwater Management Plan and Facilities Plan. The original plan was developed in the early 1990s and resulted in the construction of a groundwater desalter and monitoring. Since that time, significant development has occurred, and there is increasing pressure to optimize the use of all resources, specifically groundwater. Mr. Wildermuth and his team completed the most comprehensive "state of the basin" assessment ever done for the basin and evaluated the hydrology of the basin to estimate a sustainable yield that is protective of habitat and prevents seawater intrusion. Under Mr. Wildermuth's direction, WEI subsequently developed and evaluated a series of groundwater management alternatives based on the Management Plan, and the Santa Margarita Water District is currently (March 2018) conducting a CEQA process on one of the management plan alternatives.

Review of Groundwater Conditions and Flow Systems near a Fuel Storage on Oahu, Hawaii, Confidential Client

Mr. Wildermuth conducted an extensive literature review and site visits to characterize groundwater flow systems in the Honolulu Bay area on the island of Oahu, Hawaii. The purpose of the assignment was to determine the effectiveness of current monitoring practices and to evaluate the appropriateness of certain modeling and database tools to assess the threat to municipal and domestic water supplies posed by a large fuel storage facility.

Phase I Investigation to Develop the Cucamonga Basin Groundwater Management Plan, Cucamonga Valley Water District and San Antonio Water Company

Mr. Wildermuth serves as the project manager, facilitator, and lead technical analyst for the Cucamonga Basin Groundwater Management Plan. The major pumpers in the basin have developed a series of management principles around the concept of sustainability. Mr. Wildermuth and his team completed the most comprehensive "state of the basin" assessment ever done for the basin and evaluated the hydrology of the basin to estimate sustainable yield. Water quality degradation from past agricultural land use and current onsite waste disposal practices limit production.

2012 Anti-Degradation Investigation for the Beaumont Basin, Cities of Banning and Beaumont, the Beaumont Cherry Valley Water District, and the Yucaipa Valley Water District

Mr. Wildermuth was the project manager in an investigation to predict the TDS and nitrogen concentrations in the Beaumont Management Zone that will result from future groundwater management and recycled water management plans. WEI staff developed and applied a "constantly-stirred reactor" model to estimate the TDS and nitrogen in the water supplies of each municipal pumper in the basin, the TDS and

nitrogen added through use, the impact of evapotranspiration, etc., to estimate the TDS and nitrogen concentrations in the groundwater and at recycling plants at the end of each time period. Twelve management alternatives were evaluated. The results are being used by the Regional Board to prepare a Basin Plan amendment and to write new recycling permits for the client agencies. The work was done in a stakeholder process.

2010 Expert Witness, Antelope Valley Adjudication, Phase III Trial, Law Offices of Lagerlof, Senecal, Gosney and Kruse LLP

Mr. Wildermuth provided expert witness testimony in the Phase III trial where the safe yield of the Antelope Valley Groundwater Basin was decided. Mr. Wildermuth conducted extensive research, developed a methodology to compute natural recharge, and provided testimony regarding this work. Mr. Wildermuth's testimony was a significant part of the case presented by the municipal water purveyors and the US Government. The municipal water purveyors and the US Government prevailed in this phase of the trial.

Preparation of Problem Statement and Estimate of Recharge, Antelope Valley Groundwater Adjudication Process, Lagerlof and Senecal

Mr. Wildermuth participated with a panel of experts to estimate the natural recharge in the Antelope Valley adjudication area. Mr. Wildermuth's responsibilities were to estimate the change in groundwater storage during the base period and use the change in storage estimates with production estimates and artificial recharge estimates to compute natural recharge. Mr. Wildermuth and WEI staff exhaustively analyzed groundwater level records and well completion reports to develop a comprehensive groundwater storage change model. Mr. Wildermuth's work was reviewed and approved by the panel of experts and included in their report.

2009 Production Optimization and Evaluation of the Peace II Project Description, Chino Basin Watermaster

In 2007, WEI conducted the Peace II Agreement engineering work for Watermaster. This work considered future groundwater production projections through 2060, the effective period of the Peace Agreement. This work concluded that the projected groundwater production patterns of the stakeholders coupled with the existing recharge assets available to Watermaster would lead to unacceptable groundwater depressions in the Chino Basin. Part of the reason for these depressions is the uncoordinated siting and pumping of wells by the stakeholders. WEI examined the projected groundwater production patterns and associated recharge plans to determine if changes could be made in the siting of future wells and if production could be redistributed among wells to reduce the magnitude of changes in groundwater levels. WEI investigated the use of different groundwater recharge schemes to balance groundwater production and recharge in the basin. WEI applied state-of-the-art groundwater models (developed by WEI for Watermaster in 2007) iteratively to optimize groundwater production and recharge patterns in the basin. These revised groundwater production and recharge patterns were then incorporated into an analysis of modifications to the Optimum Basin Management Program, which are required to expand the desalter production facilities and to meet other requirements of the OBMP. Under Mr. Wildermuth's direction, WEI staff used a series of groundwater models to

estimate future groundwater elevations across the basin, groundwater elevation time histories at every municipal and many private wells, subsidence potential, impacts on riparian vegetation, impacts to stream flow, and the impact on the transport of several contaminant plumes. The resulting work was accepted by Watermaster and the Inland Empire Utilities Agency and was subsequently incorporated into the 2010 Peace II Subsequent Environmental Impact Report.

Optimum Basin Management Plan (OBMP), Chino Basin Watermaster

Mr. Wildermuth serves as the project manager and lead technical analyst, providing as-needed engineering services to the Chino Basin Watermaster. Activities include reviewing water rights applications, storage losses from over-year groundwater storage accounts, and groundwater monitoring; estimating salt offset credits and the replenishment volumes required for proposed groundwater treatment project(s); and coordinating with the San Bernardino County Flood Control and Conservation District regarding recharge and with the Metropolitan Water District regarding water rates and seasonal storage service.

As the project manager, Mr. Wildermuth developed and implemented the scope of work for the Chino Basin OBMP, which was ordered by the San Bernardino Superior Court. Specifically, Mr. Wildermuth developed the process used in developing the OBMP scope of work and authored the engineering and institutional scopes of work. WEI, under the direction of Mr. Wildermuth, completed engineering and scientific investigations and developed the resulting management plan. The engineering scope of work included the problem definition, the development of goals, developing evaluation tools (groundwater and financial models), developing and analyzing management components, the integration of management components, financial analysis, the development of an implementation plan, and the preparation of expert testimony as required for court approval.

Optimum Basin Management Plan Implementation, Chino Basin Watermaster

Mr. Wildermuth has been the project manager for WEI's involvement in the implementation of the OBMP since its inception in 2000. WEI's efforts include: large-monitoring (surface water discharge and water quality, groundwater level and water quality, groundwater recharge, InSAR, and extensometer) and data management; scientific and engineering investigations (land subsidence, safe yield, recharge master plan updates, water quality and riparian habitat); design/construction and operation of state-of-the-art land subsidence instrumentation; and administrative and expert witness support.

Chino Basin Dry-Year Yield Program, Chino Basin Watermaster

Mr. Wildermuth serves as the project manager for WEI's involvement in the development of the Chino Basin Dry-Year Yield (DYY) Program. WEI assisted the Watermaster and the Inland Empire Utilities Agency in the development of the 100,000 acre-ft DYY program. WEI completed a thorough reassessment of the hydrogeologic conditions of the Chino Basin and assisted other consultants with facility planning, including well siting, water quality evaluations, and specialized mapping. WEI developed and applied a sophisticated set of surface and ground water models to evaluate the DYY's impacts on groundwater levels, contaminant plume movement, and

surface and ground water interaction in the southern part of the basin. Currently, WEI is expanding this analysis to investigate groundwater storage programs of up to 500,000 acre-ft.

Recharge Master Plan, Chino Basin Water Conservation District, Chino Basin Watermaster, and the San Bernardino County Flood Control District

Mr. Wildermuth was the project manager and lead technical analyst for the recharge master plan of the Chino Basin. The objectives of the master plan were to develop a plan of recharge to meet future groundwater replenishment requirements—utilizing storm water, recycled water, and imported water—and to evaluate the change in groundwater recharge caused by the construction of San Sevaine Creek and East Etiwanda Creek flood control improvements. This study utilized a daily runoff model to estimate the magnitude and temporal distribution of storm water recharge.

Under the master plan, recycled water and imported water are recharged during periods that ensure minimum conflict with storm water recharge. New facilities and modifications to existing facilities were recommended. A second phase of the recharge master plan was completed as part of the Chino Basin OBMP, in which WEI collaborated with the Black and Veatch Corporation. Upon completion, the Chino Basin Watermaster, the Inland Empire Utilities Agency, and the Chino Basin Water Conservation District began converting 19 flood retention basins into spreading basins and began building two new recharge facilities. The total cost of the recharge improvements was about $45 million.

Salt and Nutrient Management Plan Development, Nitrogen and TDS Task Force (administered by the Santa Ana Watershed Project Authority)

Mr. Wildermuth was the architect and technical leader for the development of a comprehensive salt and nutrient management plan for the Santa Ana Watershed. Working with stakeholders and another consultant, Mr. Wildermuth designed the stakeholder process and comprehensive work plan for a multiphase multi-year investigation that would result in a complete rewrite of the salt and nutrient management plans in the Santa Ana Watershed Basin Plan. In this investigation, the Basin Plan objectives for TDS and nitrogen were reset—based on the best available data and scientific methods—and new procedures were developed to assess the availability of assimilative capacity. Phase 1 involved the development of procedures for evaluating TDS and nitrogen impacts from recycling projects in the Santa Ana Watershed, a massive data collection and validation effort, watershed characterization, and an initial assessment of TDS and nitrogen loads to surface water and groundwater from municipal recycled water treatment plants and non-point sources.

Phase 2A involved delineating new basin/management zone boundaries, developing groundwater storage estimates for each management unit, estimating TDS and nitrogen statistics at wells, computing volume-weighted TDS and nitrate concentrations for the new basin/management zones, and completing a new wasteload allocation analysis for the Santa Ana River and selected tributaries.

Phase 2B involved the development and implementation of a sophisticated modeling system to evaluate the then current TDS and total inorganic nitrogen (TIN) wasteload allocations for municipal recycled water plants that discharge to the Santa Ana River

and its tributaries. A daily stream flow simulation model was used to estimate TDS and TIN concentrations in the Santa Ana River and its tributaries in response to recycled water discharges, storm water runoff, non-tributary discharges, and groundwater interaction. The resulting SNMP was incorporated into the Basin Plan in 2004 without opposition.

San Timoteo Watershed Management Program, San Timoteo Watershed Management Authority

Mr. Wildermuth was the project manager and lead technical analyst in the development of a watershed management program for the San Timoteo Watershed. This effort involved designing the investigation; conducting a stakeholder process; a baseline water resource inventory and characterization; establishing the issues, needs, and wants of the stakeholders; articulating the program goals and impediments to those goals; the development of "program elements" for a watershed-scale management program to remove impediments to those goals; and the development of an implementation plan and cost estimates.

Beaumont Basin Adjudication, San Timoteo Watershed Management Authority

Mr. Wildermuth provided engineering and hydrogeologic support services to the Cities of Banning and Beaumont, the Beaumont Cherry Valley Water District, the South Mesa Water Company, the Yucaipa Valley Water District, and other groundwater pumpers in the Beaumont Basin adjudication. Mr. Wildermuth developed the physical solution incorporated into the stipulated agreement in 2004.

Hot Creek Fish Hatchery Spring Flow, Mammoth Community Water District

Mr. Wildermuth was the project manager and lead technical analyst for an investigation of groundwater pumping impacts on Hot Creek Fish Hatchery spring flow. This investigation, which was completed in 1995, showed that existing groundwater production had negligible impacts on spring discharge. Subsequently, WEI reviewed newly obtained data for the 1995 through 2001 period, verifying its 1995 findings and paving the way for increased groundwater production to support new development. This work was revisited in 2003 due to concerns that increased groundwater production might impact springs in the Valentine Reserve. Subsequent analyses by WEI demonstrated that no impacts would occur as a result of production.

Groundwater Management Plan, Eastern Municipal Water District

Mr. Wildermuth developed a groundwater management plan for the West San Jacinto Basin, consistent with the long-term water resource management goals of the Eastern Municipal Water District and agricultural water users. The plan was developed under the then recently enacted California groundwater management statute (AB 3030) and was subsequently implemented. This plan received the Edmund G. Brown award from the State of California in 1995.

Planning-level Design of Groundwater Desalter Well Fields, Montgomery Watson (for the Santa Ana Watershed Project Authority)

Mr. Wildermuth provided hydrologic and groundwater-modeling services for the design of two 8-mgd well fields and a 12-mgd well field in the Chino Basin. These well fields were intended to feed the desalting facilities to be owned by the Santa Ana

Watershed Project Authority. Mr. Wildermuth assisted the Chino Basin Watermaster in the development of replenishment sources for the Chino desalting facilities and in the determination of salt extraction credits for agricultural interests in the basin.

Groundwater Contamination Superfund Site, Confidential Client

WEI conducted a study to determine the potential source(s) of a groundwater plume that contains volatile organic compounds (VOCs), primarily trichloroethene (TCE) and tetrachloroethene (PCE). Mr. Wildermuth was responsible for the development of groundwater flow and transport models to determine the source(s) of these contaminants and the approximate period of loading.

Surface and Groundwater Studies from Discharge of Recycled Water, City of San Bernardino Municipal Water Department

Mr. Wildermuth conducted numerous studies to evaluate receiving water impacts in surface water and groundwater from the City of San Bernardino's recycled water discharge to the Santa Ana River. These studies involved surface and ground water modeling to determine the nitrogen and TDS impacts of various recycled water discharge alternatives on surface water and the groundwater basins that are recharged by those surface waters.

Saline Plume Management Alternatives, Kaiser Steel Resources

Mr. Wildermuth developed saline plume management alternatives in the Chino Basin for Kaiser Steel Resources. This work involved groundwater modeling and water quality sampling. Solutions included pump and treat alternatives and a salt-offset alternative. In addition to developing the salt-offset alternative, Mr. Wildermuth assisted Kaiser in moving this solution through the regulatory process, saving Kaiser over $40 million.

Menifee Basin Desalter, Eastern Municipal Water District

Mr. Wildermuth conducted hydrogeologic investigations and groundwater modeling to support the design of a 3-mgd well field for the Menifee Basin Desalter. The desalter was subsequently constructed and is in operation today.

Wenbin Wang, PhD, PG, CHG

Principal Engineer, Chief Groundwater Modeler

Expertise:	Dr. Wang, a principal hydrogeologist at WEI, has 28 years of professional experience in the field of hydrogeology. His technical expertise includes the development of hydrological-hydrogeological conceptual models for complex surface and subsurface water systems; site/basin scale characterization; numerical modeling of multiphase flow and contaminant transport in saturated and unsaturated porous and fractured mediums; developing flow and transport codes; estimating hydraulic parameters via direct and indirect methods; applying statistics, geostatistics, and stochastic methods in hydrogeology; sensitivity and error analysis; and designing Windows-based software. Dr. Wang is an expert in various models, including TOUGH2/ITOUGH2, MODFLOW, PEST, MT3D, PATH3D, MODPATH, FLOWPATH, HYDRUS-1D/2D, UNSAT, HEC, GSLIB, ROSETTA, AQTESOLV, PHREEQC, and MINTEQ. He is highly proficient in several major programming languages, including Fortran, Visual Basic, Java, and C#. Dr. Wang has developed multiple groundwater flow and transport codes and is the author of U-Win software—a user-friendly, unsaturated flow code that is applied in heap leach mining. He has developed and applied several groundwater models to solve complex water resource challenges, including: the Antelope Valley, Arlington Basin, Beaumont Basin, Chino Basin, Cucamonga Basin, Mammoth Basin, San Bernardino Basin Area, Six Basins, Strand Ranch, and Temescal Basin. Prior to joining WEI, Dr. Wang served as a hydrogeologist with the China Geological Survey, as an associate Professor of Hydrogeology at the Chengdu University of Technology, and as a hydrogeologist at an Arizona-based water resources consulting firm.
Education:	Ph.D., Subsurface Hydrology/ Mathematics, University of Arizona, Tucson, 2002 M.S., Hydrogeology, Chengdu University of Technology (CDUT), China, 1989 B.S., Hydrogeology, CDUT, China, 1984
Licenses:	Professional Geologist, California No. 8609 Certified Hydrogeologist, California No. 939
Professional History:	WEI, Chief Groundwater Modeler and Lead Hydrogeologist – 2004 to Present Water Management Consultants, Tucson, Arizona – 2002 to 2004 University of Arizona, Department of Hydrology and Water Resources – 1997 to 2002 Chengdu University of Technology (CDUT), Department of Hydrogeology and Engineering Geology, China – 1986 to 1996 China Geological Survey, China – 1984 to 1986
Professional Experience:	**Development of a Groundwater Storage Management Plan for the Chino Basin, Chino Basin Watermaster** Dr. Wang is the project scientist for the development of the Chino Basin storage management plan. The objectives of this project are to develop minimum sustainability thresholds by identifying groundwater levels that protect against new land subsidence

and ensure pumping sustainability, to develop a relationship of storage to net recharge, and to develop a storage framework that identifies operation and mitigation parameters (if needed) for the safe storage and recovery of water at various levels of storage. Dr. Wang applied the Chino Basin groundwater model, which he developed, to evaluate a series of planning scenarios to assess the groundwater basin's response to increasing levels of storage, ranging from 100 kaf to 500 kaf above the storage being used by Chino Basin pumpers. Specifically, he applied the groundwater model: to assess new land subsidence; pumping sustainability; and impacts on safe yield, riparian habitat, and other critical management criteria; and to develop measures to mitigate undesirable results.

2015 Safe Yield Recalculation for the Chino Basin, Chino Basin Watermaster

Dr. Wang was a project scientist for an investigation to recalculate the safe yield of the Chino Basin pursuant to the Peace Agreement and the Watermaster rules and regulations. Dr. Wang conducted a rigorous review of all the geologic information available for the Chino and Temescal Basins, updated the conceptual and numerical models, and calibrated them. He applied state-of-the-art methods to assess the adequacy of the numerical model to accurately answer the questions that Watermaster was currently considering and anticipated future questions. The model was carefully calibrated using sensitivity analyses and inverse modeling with PEST. He subsequently developed a planning hydrology based on existing and projected cultural conditions and prepared estimates of net recharge to the basin. This work was subjected to peer review and received substantial praise for its completeness and quality. The Court, with continuing jurisdiction, accepted the safe yield estimate and ordered it implemented. The model has also been used to determine increased basin discharge to the Santa Ana River from groundwater storage programs and the effect of storage on the safe yield.

Development of Salt and Nutrient Management Plan (SNMP) for the Chino Basin and its 2018 Update, Chino Basin Watermaster

Dr. Wang is the project scientist for the update of the Chino Basin SNMP. In his role, Dr. Wang is responsible for the vadose zone and groundwater models for the flow and transport of TDS and nitrate. The models are part of complex series of modeling tools to track the fate of TDS and nitrate from source waters through their use and discharge and to predict surface and ground water impacts from various salt and nutrient strategies. This work will be completed in 2019.

Chino Basin Dry-Year Yield Program, Chino Basin Watermaster

Dr. Wang was the project scientist for WEI's involvement in the expansion of the Chino Basin Dry-Year Yield (DYY) Program. WEI assisted Watermaster and the Inland Empire Utilities Agency in the expansion of the 100,000 acre-ft DYY program (developed in 2004) to 150,000 acre-ft (2009). Dr. Wang completed a thorough reassessment of the hydrogeologic conditions of the Chino Basin and assisted other consultants with facility planning, including well siting, water quality evaluations, and specialized mapping. Dr. Wang developed and applied a sophisticated set of surface and ground water models to evaluate the DYY's impacts on groundwater levels, contaminant plume movement, and surface and ground water interaction in the Santa Ana River and tributaries, and to investigate how conjunctive use would impact compliance with the Santa Ana River Judgment.

Phase II Investigation to Develop the Six Basins Groundwater Management Plan, Six Basins Watermaster

Dr. Wang was the project scientist for the development of groundwater flow and transport models of the Six Basins. Dr. Wang developed the hydrogeologic conceptual model and subsequently developed, calibrated, and applied numerical groundwater flow and transport models. Dr. Wang used sensitivity analysis and guided calibration with PEST code. The groundwater flow model was used to estimate the safe yield of the basin and sub-basins, and to evaluate the groundwater basins' response to several groundwater management plan scenarios.

Clean Water Factory Feasibility Analysis, City of San Bernardino Municipal Water Department

Dr. Wang was the project scientist in an investigation to determine the feasibility of upgrading the City's reclamation plant and implementing recycled water recharge to supplement the City's water supply and improve its reliability. WEI acquired the most current groundwater model of the SBBA utilized by the City, San Bernardino Valley Municipal Water District, and Western Municipal Water District. Dr. Wang: updated the numerical solvers in the model to enable it run in a timely manner; updated the planning hydrology to include updated groundwater production, recharge, and other groundwater management activities, including new recycled water recharge; and applied the model to assess the groundwater's response across the basin and specifically its hydraulic response in the area of recharge, the depth to groundwater in areas that have historically experienced high groundwater challenges, and compliance with the Title 22 regulations for indirect potable reuse. This project is currently in advanced planning and is a recipient of grant funding from the Bureau of Reclamation.

Development and Application of Groundwater Flow and Transport Models, Cucamonga Valley Water District

Dr. Wang was the project scientist for the development of groundwater flow and transport models of the Cucamonga Basin. Dr. Wang developed the hydrogeologic conceptual model and subsequently developed, calibrated, and applied numerical groundwater flow and transport models. Dr. Wang used sensitivity analysis and guided calibration using PEST code. The groundwater flow model was used to estimate the sustainable yield of the basin under historical and future groundwater management scenarios. The nitrate transport model was developed to evaluate the impacts of legacy agriculture, current and projected water management scenarios that included onsite wastewater disposal systems, and groundwater nitrate treatment alternatives. Complex surface water models (HSPF, R4, and WLAM) were used to develop the recharge terms and concentrations for the groundwater models. The nitrate transport modeling effort was used to support a Proposition 1 Groundwater Sustainability Grant application that was successful in obtaining $2 million.

City of Corona Recharge Master Plan

Dr. Wang was the project scientist for this project, which evaluated the groundwater's response to recycled water recharge pursuant to Title 22 regulations and the

cumulative groundwater response to recycled and storm water for both existing management conditions and for a series of proposed recharge improvements.

TDS and Nitrate Projection in Temescal Basin, City of Corona

Dr. Wang was the project scientist for the development of a hydrogeological conceptual-numerical model of the Temescal Basin. He calibrated the groundwater flow model, developed a N/TDS MT3DMS model, and projected nitrate and TDS under the selected strategic plan.

Developed Hydrogeologic Model around Strand Ranch Water Banking Facility, Irvine Ranch Water District/AECOM

Dr. Wang reviewed and interpolated the 9 pumping tests in the Strand Ranch area and developed a groundwater model that covers the area from Bakersfield to the Buena Vista Aquatic Recreational Area. The model was used to evaluate the various recharge and extraction scenarios in Strand Ranch and Rosedale areas.

Updated the Chino Basin Groundwater Model and Applied it to the Evaluation of Production Sustainability in the Jurupa Community Services District's Service Area, Chino Basin Watermaster

Dr. Wang developed the conceptual model, lithological model, and model calibration. The recharge master plans were then implemented in this cutting-edge high-accuracy and -resolution groundwater model. The report included conclusions and recommendations for future recharge projects and future supplemental water supply sources, including non-Metropolitan imported water supplies. The report also optimized every well's production under the various hydraulic constraints and water right agreements.

2010 Alternative Dispute Resolution, Evaluation of Well Pump Test Data in the Cadiz Area

Dr. Wang reviewed disputed aquifer tests and different explanations, analyzed related geologic-hydrogeologic information and various pumping test data in the unconfined alluvium and deep carbonate aquifer system, and estimated hydraulic parameters.

2010 Strand Ranch Groundwater Model Development, IRWD

Dr. Wang developed a reconnaissance-level groundwater model of the Strand Ranch area, used it to analyze several pumping tests in the unconfined and semi-confined aquifer systems, and estimated various hydraulic parameters. He subsequently developed hydrogeologic conceptual and numerical models to evaluate various artificial recharge and pumping scenarios.

Chino Basin 2009 Production Optimization and Evaluation, Chino Basin Watermaster

To improve water management in the Chino Basin and to efficiently use water resources to meet increasing water demands, a series of numerical flow and transport models were developed and calibrated using historical data. These models were then used to design optimum basin management scenarios and to evaluate each proposed scenario and alternative that met the water demand of the cities in alignment with the maximum benefit over the next 30 years.

The proposed water replenishment and production scenarios had to meet a set of restrictions, including the water demands of 23 water appropriators, the facility capacity of 17 recharge basins, the pumping limitations of hundreds of water supply and desalter wells, the availability of imported water, and related water codes and regulations. Each planned alternative was evaluated to determine changes in groundwater levels, changes in basin outflow, the effectiveness of hydrological control, changes in the safe yield, changes in water quality, and potential subsidence and environmental problems.

The final selected plan maximizes water resources and financial benefits, minimizes discharge from the basin, protects water resources from pollution and degradation, optimizes the pump-and-treat system for site remediation, avoids possible potential subsidence, and will not impair the downstream beneficial uses of the Santa Ana River.

2008-2009 Chino Basin Hydraulic Control Report, Chino Basin Watermaster

Dr. Wang evaluated different artificial recharge and production scenarios, including water banking or the Dry-Year Yield program, to maximize water recharge from the Santa Ana River, to avoid potential material damage due to production, and to reach hydrologic control with the minimization of groundwater outflow.

Regional Groundwater Model Development, Palmdale Water District

Dr. Wang developed regional hydrogeological conceptual and numerical models to evaluate various scenarios of recharge, pumping, and water banking over the next 50 years.

2007 Chino Basin Groundwater Model Build in Support of the Peace II Agreement, Chino Basin Watermaster

Dr. Wang redeveloped the regional hydrological-hydrogeological conceptual model and numerical models; developed solute transport models for PCE, TCE, TDS, and nitrate; calibrated hydraulic parameters using WEI's 26-processor computer system; assisted in the design of various scenarios related to imported water and water banking over the next 100 years; and drafted the model documentation.

Contaminated Groundwater Remediation, Chino Basin Watermaster

Dr. Wang developed MT3D models for existing groundwater contamination plumes (PCE, TCE, TDS) in the Chino Basin; designed hydrological control and contaminant remediation pumping strategies for the Chino Airport plume, the Ontario plume, the GE plumes, and the Kaiser Steel Fontana plume; and conducted various PCE, TCE, and TDS plume movement simulations.

Mammoth Basin Groundwater Flow Model Development, Mammoth Community Water District

Dr. Wang developed regional hydrological-hydrogeological conceptual models (surface water and groundwater) and numerical models, calibrated hydraulic parameters using PEST, conducted various modeling scenarios to optimize water resources management, and drafted the project report. Dr. Wang has updated this model in 2010 and 2015 to determine basin yield when managed conjunctively with Mammoth Creek water and the overall reliability of the Mammoth water supply.

RIX Expansion, Carollo Engineers

Dr. Wang developed site-scale variable saturated flow and transport models, developed local hydrogeological conceptual and numerical flow models along the Santa Ana River, and drafted the project report.

Arlington Basin Groundwater Flow Model Development, Western Municipal Water District

Dr. Wang was the project scientist. Dr. Wang developed regional groundwater flow and solute transport models for the Arlington Basin, conducted inverse modeling, designed various water/recycled water input planning scenarios, and drafted the project report.

Beaumont Basin Groundwater Flow Model, Beaumont-Cherry Valley Water District

Dr. Wang developed a regional unsaturated and saturated zone groundwater flow and solute transport models; conducted inverse modeling using PEST parallel computing; designed and evaluated various future water/recycled water input scenarios with/without sewer systems; developed and ran solute transport models for TDS, nitrate, and other constituents; evaluated various future planning scenarios; and drafted the project report.

Contaminant Source Investigation: Newmark Groundwater Contamination Superfund Site, Confidential Client

Dr. Wang developed regional and local hydrogeological conceptual models for the unsaturated and saturated zones, conducted various flow and contaminant transport simulations in the unsaturated zone of the Cajon Landfill Site and regional solute transport simulations in the San Bernardino Basin, determined the source of the Newmark contamination plume, and drafted the project report.

Chino and Ontario Airport Plume Simulation and Remediation, Chino Basin Watermaster

Dr. Wang conducted flow and transport modeling based on existing contamination plumes, developed a regional flow model, and determined optimum remediation scenarios.

Title 22 Engineering Report, Chino Basin Watermaster

Dr. Wang conducted various recycled water input/movement simulations in the Chino Basin and determined the optimum scenario for distributing recycled water in various recharge basins.

RIX Expansion Engineering Support, Carollo Engineers

Dr. Wang estimated the unsaturated and saturated hydraulic properties of the RIX site, characterized site hydrogeology, developed conceptual models, conducted unsaturated and saturated flow modeling, and determined the optimum scenario of infiltration and extraction.

Jeffrey Hwang, PhD

Principal Engineer, Chief Surface Water Modeler

Expertise:	Dr. Hwang has 35 years of experience in water resources engineering, including hydrology, hydraulic design, surface and groundwater modeling, statistical analysis, GIS applications, water resources planning and management, and software development. Dr. Hwang has developed and applied numerous procedures and computer models to solve water resources problems, including the Wasteload Allocation Model (WLAM); the Rainfall-Runoff-Router-Root zone model (R4); recharge basin performance evaluation procedures, hydraulic design of recharge basins, and specialized programs used in the 2010 Chino Basin Recharge Master Plan Update and 2013 Amendment; an uncertainty analysis program for stream water quality simulation (SNSIME); a goodness-of-fit test program for common probability distribution models (GOF); mathematical and computer simulation models for estimating oxygen transfer rates from steady and non-steady wastewater treatment operations; and others. In addition, Dr. Hwang has extensive experience with several public-domain simulation models, including the HSPF surface water model and its derivatives, the US EPA's surface water quality simulation models (QUAL2E, SWMM, Plume models), and the USGS's groundwater simulation models (MODFLOW, MT3D, MODPATH, and others). Dr. Hwang has spent the last 30 years developing and applying surface water models on the Santa Ana River and its tributaries to support wastewater dischargers, the Nitrogen/TDS and Basin Monitoring Program Task Forces, and numerous recharge and modeling investigations in the Arlington, Chino, Elsinore, and Temescal Basins, and the San Bernardino Basin Area.
Education:	Ph.D., Water Resources Engineering, University of California, Los Angeles, 1983 M.S., Water Resources Engineering, University of California, Los Angeles, 1979 B.S., Mineral and Petroleum Engineering, Seoul National University, Korea, 1972
Professional History:	WEI – 1996 to Present Montgomery Watson – 1988 to 1993 National Council of the Paper Industry for Air and Stream Improvement, Inc. – 1984 to 1988 University of California, Los Angeles – 1977 to 1984
Professional Experience:	**2015 Safe Yield Recalculation for the Chino Basin, Chino Basin Watermaster** Dr. Hwang served as the project engineer and lead surface water modeler for an investigation to recalculate the safe yield of the Chino Basin pursuant to the Peace Agreement and the Watermaster rules and regulations. Dr. Hwang developed and calibrated the R4 model to estimate the deep infiltration of precipitation and applied water in the Chino Basin Watershed, stormwater recharge in unlined channels, stormwater recharge in stormwater management facilities, and subsurface inflow from adjacent mountain boundaries. This work required extensive research, including the precise determination of the time history of cultural conditions and facility improvements, the estimation of future cultural conditions and integration of facility

plans into existing water systems, and the application of the R4 model to estimate how cultural conditions and water management facilities affect recharge. This work contributed to the development and calibration of the 2013 Chino Basin Watermaster model that was subsequently used to estimate historical and projected net recharge and safe yield. This work was subjected to peer review and received substantial praise for its completeness and quality.

Development of a Groundwater Storage Management Plan for the Chino Basin, Chino Basin Watermaster

Dr. Hwang is the project engineer and lead surface water modeler for the development of the Chino Basin storage management plan. The objectives of this project are to develop minimum sustainability thresholds by identifying groundwater levels that protect against new land subsidence and ensure pumping sustainability, to develop a relationship of storage to net recharge, and to develop a storage framework that identifies operation and mitigation parameters (if needed) for the safe storage and recovery of water at various levels of storage. Dr. Hwang applied surface water models to provide estimates of storm water recharge and the deep infiltration of precipitation and applied water for use in groundwater model projections. In this work, he updated historical and projected land use and cultural conditions and provided alternative DIPAW estimates for a range of potential future water conservation alternatives. The Chino Basin groundwater model was subsequently used by a WEI colleague to evaluate a series of planning scenarios to assess the groundwater basin's response to increasing levels of storage and recovery ranging from 100 kaf to 500 kaf above the storage being used by Chino Basin pumpers.

Development of Salt and Nutrient Management Plan (SNMP) for the Chino Basin and Its 2018 Update, Chino Basin Watermaster

Dr. Hwang is the is the project engineer and lead surface water modeler for the update of the Chino Basin SNMP. In this role Dr. Hwang is responsible for estimating the TDS and nitrate loads from land uses, using WEI's R4 model, which he developed. This model simulates soil processes—including irrigation, infiltration, evapotranspiration, storage, and leaching from the root zone—and chemical additions from atmospheric deposition, fertilizer application, volatilization, vegetation uptake, and export (vegetation harvest). Dr. Hwang is developing estimates of root zone discharge and associated TDS and nitrate concentrations for subsequent use in vadose zone and groundwater flow and transport models. The models are part of complex series of modeling tools to track the fate of TDS and nitrate from source waters through their use and discharge and to predict surface and ground water impacts from various salt and nutrient strategies. This work will be completed in 2019.

2010 Chino Basin Recharge Master Plan Update and 2013 Amendment, Chino Basin Watermaster

Dr. Hwang was the project engineer and lead surface water modeler for the development of the 2010 Recharge Master Plan. This investigation was ordered by the Court and had a Court imposed deadline for completion. Dr. Hwang developed, calibrated, and applied surface water models to estimate daily inflow to existing retention and conservation basins, and he proposed basins to estimate their recharge performance and to design improvements to these facilities to increase stormwater recharge and to estimate recharge in localized recharge facilities that will be

constructed to comply with the 2010 MS4 permits. This systematic approach allowed tradeoffs to be evaluated among upstream and downstream facilities to maximize recharge and minimize cost. Dr. Hwang also conducted a detailed hydraulic analysis of the diversion works, outlet works, and conveyance facilities to size them and develop cost opinions on their construction. The product of this work has been highly praised for its completeness, technical sophistication, and the transparent process in which the work was conducted. Draft sections of the report were posted on the project website, which was developed and maintained by WEI. The investigation also determined the existing recharge capacity for imported and recycled waters and future recharge capacity requirements. The report included conclusions and recommendations for future recharge projects and future supplemental water supply sources, including non-Metropolitan imported water supplies.

Dr. Hwang was also the project engineer and lead surface water modeler for the 2000 Chino Basin recharge master plan effort, performing the same role as in the 2010 and 2013 efforts. The recharge facilities included in the 2000 master planning effort were subsequently constructed and are in use today.

Development and Application of Groundwater Flow and Transport Models, Cucamonga Valley Water District

Dr. Hwang was the project engineer and lead surface water modeler for the development of groundwater flow and transport models of the Cucamonga Basin. Dr. Hwang developed and applied complex surface water models (HSPF, R4, and WLAM) to estimate the recharge terms and concentrations for the groundwater models. The groundwater flow model was used to estimate the sustainable yield of the basin under historical and future groundwater management scenarios. The nitrate transport model was developed to evaluate the impacts of legacy agriculture as well as current and projected water management scenarios, which included onsite wastewater disposal systems and groundwater nitrate treatment alternatives. The nitrate transport modeling effort was used to support a Proposition 1 Groundwater Sustainability Grant application that was successful in obtaining $2 million.

Phase II Investigation to Develop the SIX Basins Groundwater Management Plan, Six Basins Watermaster

Dr. Hwang was the project engineer and lead surface water modeler for the development of groundwater flow and transport models of the Six Basins. Dr. Hwang developed and applied complex surface water models (HSPF, R4, and WLAM) to estimate the recharge terms for the groundwater model. The groundwater flow model was used to estimate the safe yield of the basin and sub-basins and to evaluate the groundwater basins response to several groundwater management plan scenarios.

Chino Basin Dry-Year Yield Program, Chino Basin Watermaster

Dr. Hwang was the project engineer and lead surface water modeler for WEI's involvement in the development of the Chino Basin Dry-Year Yield (DYY) Program. WEI assisted the Chino Basin Watermaster and the Inland Empire Utilities Agency in the development of the 100,000 acre-ft DYY program (2004) and was the lead surface-water modeler for the technical work to expand that program to 150,000 acre-ft (2009). WEI completed a thorough reassessment of the hydrogeologic conditions of the Chino Basin and assisted other consultants with facility planning, including well siting, water

quality evaluations, and specialized mapping. WEI developed and applied a sophisticated set of surface and ground water models to evaluate the DYY's impacts on groundwater levels, contaminant plume movement, and surface and ground water interaction in the Santa Ana River and its tributaries, and to investigate how conjunctive use would impact compliance with the Santa Ana River Judgment.

Eric W.H. Chiang, PhD

Principal Engineer I

Expertise:	Dr. Chiang has more than 30 years of professional experience in hydrogeologic engineering. At Wildermuth Environmental, Inc. (WEI), Dr. Chiang's mission is to develop cutting-edge software tools to support the work of WEI staff and clients. His areas of expertise include hydrology, groundwater modeling, statistical analysis, numerical computer modeling, and software development. Dr. Chiang is proficient in major programming languages (C/C++/C#, FORTRAN, JavaScript, Visual Basic), relational database design, and the development of client-server applications. One of his most significant contributions since joining WEI is the development and deployment of HydroDaVESM (Hydrologic Database and Visual Explanations), which enables professionals to remotely visualize and analyze groundwater, surface water, climatic data, and model results that are either stored in the HydroDaVESM Management Service Platform maintained by WEI or stored in national databases that are accessible through public web services, such as USGS Water Services or the NWQMC Water Quality Portal. Dr. Chiang developed Processing Modflow, a groundwater modeling software package that supports MODFLOW, MT3DMS, RT3D, PHT3D, PEST, and other numerical models. He has applied Processing Modflow on a number of groundwater modeling projects and has developed groundwater flow and transport models for landfills, mines, and regional groundwater resource management. Dr. Chiang has also developed two-dimensional and three-dimensional visualization applications, seamlessly integrating measured environmental data with digital maps and numerical groundwater modeling results. Prior to joining the WEI team, Dr. Chiang was a Professor at the University of the Free State, South Africa where he authored and published 3D Groundwater Modeling with PMWIN, a text book that covers Processing Modflow and computer codes for groundwater flow and contaminant transport simulation. In addition, Dr. Chiang served as a University Instructor at the University of Bremen, Germany where he taught Applied Groundwater Modeling short courses from 1996 to 2004. Dr. Chiang received a B.S. in Civil Engineering from National Central University, Taiwan in 1983, an M.S. in Civil Engineering from the University of Stuttgart, Germany in 1989, and a Ph.D. in Civil Engineering from the University of Kassel, Germany in 1998.
Education:	Ph.D., Civil Engineering, University of Kassel, Germany, 1998 M.S., Civil Engineering, University of Stuttgart, Germany, 1989 B.S., Civil Engineering. National Central University, Taiwan, 1983
Professional History:	WEI – 2006 to Present Integrated Environmental Services, Inc. – 2002 to 2006 University of the Free State, South Africa – 1999 to 2001 Geological Survey of Hamburg, Germany – 1993 to 1998 Department of Civil Engineering, University of Kassel, Germany – 1989 to 1993

Professional Experience:

Wildermuth Environmental, Inc.

As a Principal Engineer at Wildermuth Environmental, Inc. (WEI), Dr. Chiang is responsible for the development of cutting-edge software applications, such as HydroDaVESM, for water resources, including simulation modeling and relational database management systems/geographic information systems (RSBMS/GIS). Dr. Chiang developed a computer application (Seer3D) for the 3D visualization and animation of regional groundwater models and model results, including model boundary conditions, groundwater levels, flow vectors, flow lines, and plume migration. And, he is involved in the development of a Relational Database Management System and client-service applications for storing and visualizing regional groundwater and surface water data, utilizing cloud computing technology.

Storage Framework, Chino Basin Watermaster

The objectives of this project are to develop minimum sustainability thresholds by identifying groundwater levels that protect against new land subsidence and ensure pumping sustainability, to develop a relationship of storage to net recharge, and to develop a storage framework that identifies operation and mitigation parameters (if needed) for the safe storage and recovery of water at various levels of storage. For this project, several groundwater model scenarios were developed, based on estimated future pumping and associated recharge plans. Dr. Chiang developed the new land subsidence sustainability metric based on historical observed groundwater level data and groundwater model results. Using the *Processing* MODFLOW software, authored by Dr. Chiang, several animation videos were developed to depict the contours of groundwater depth above the pumping and new land subsidence sustainability metrics, based on the results of various scenarios of the Chino Basin Groundwater Flow Model.

Maximum-Benefit Demonstration for the Elsinore Groundwater Management Zone, Elsinore Valley Municipal Water District

Dr. Chiang serves as the lead groundwater modeler for developing a maximum-benefit demonstration to raise the total dissolved solids (TDS) and nitrate concentration objectives for the Elsinore Groundwater Management Zone (GMZ) in the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan). The District is seeking new, maximum benefit-based TDS and nitrate concentration objectives such that it can have the flexibility to develop and invest in a water resources plan that optimizes the management and use of all its water supply assets to achieve a reliable water supply in an environmentally sound manner. The District's maximum-benefit proposal is designed to facilitate the maximum reuse of recycled water, to protect the beneficial uses of groundwater in the Elsinore GMZ and downstream GMZs for future generations, and to be consistent with Executive Order 68-16, Water Code section 13241, and State Board orders and policies that promote recycled water reuse. Dr. Chiang is responsible for developing a numerical groundwater model to develop TDS and nitrate concentration projections for the Elsinore GMZ, based on the EVMWD's Integrated Resources Supply Plan. The groundwater model is being developed with the Processing Modflow software, authored by Dr. Chiang.

Recomputation of Ambient Water Quality, Santa Ana Watershed Project Authority

As the principal engineer, Dr. Chiang provided high-level technical support for the Recomputation of Ambient Water Quality for the Santa Ana Watershed for the 1987-2006, 1990-2009, and 1993-2012 periods. In this study, the ambient water quality determinations in Santa Ana River Watershed groundwater management zones were compared to water quality objectives and used by the Regional Board to assess assimilative capacity as part of the basin monitoring program required by the Santa Ana Region Basin Plan. Dr. Chiang was responsible for developing software code to generate the twenty-year statistics of TDS and nitrate data for all of the wells in the watershed. He was responsible for finding outliers in the data based on the methodology in the RFP, computing ambient water quality statistics, and the final computation of ambient water quality.

2015 Safe Yield Redetermination and Reset for the Chino Basin, Chino Basin Watermaster

Dr. Chiang obtained all historical precipitation and temperature data from surface stations and radar estimates, PRISM, and spatially disaggregated and bias-corrected projections of precipitation and temperature from NASA for the available GCM projections. This information was stored in WEI's HydroDaVE^{SM} system. Dr. Chiang compared historical and GCM projected precipitation information at various locations in the Upper Santa Ana Watershed to determine the reliability of using GCM-based projections of precipitation to compute stormwater recharge and the deep infiltration of precipitation and applied water. This information was used in the estimation of Safe Yield in the Chino Basin.

Review of Groundwater Conditions and Flow Systems near a Fuel Storage on Oahu, Hawaii, Confidential Client

Dr. Chiang was a principal researcher involved in the compilation of reports and disparate databases to enable the characterization of flow conditions for part of the Island of Oahu. He conducted an extensive literature review and site visits to characterize groundwater flow systems in the Honolulu Bay area. The purpose of the assignment was to determine the effectiveness of current monitoring practices and to evaluate the appropriateness of certain modeling and database tools to assess the threat to municipal and domestic water supplies posed by a large fuel storage facility.

Preparation of Problem Statement and Estimate of Recharge, Antelope Valley Groundwater Adjudication Process, Lagerlof and Senecal

Dr. Chiang developed software tools to estimate the column-weighted specific yield at about 2000 boreholes in the Antelope Valley area of adjudication. These column-weighted specific yield estimates corresponded to part of the borehole column where the change in groundwater level historically occurred. This information was used to estimate the historical change in storage and subsequently to estimate natural recharge. Dr. Chiang's work was reviewed and approved by a panel of experts and included in their report. This work was used to estimate the safe yield of the Antelope Valley area of adjudication and was subsequently approved by the Court.

Recycled Water Groundwater Recharge Feasibility Study, Palmdale Water District

Dr. Chiang was the principal Engineer on this project. This study focuses on the initial siting of potential groundwater recharge areas, the development of a recycled water recharge feasibility report, the review of existing hydrogeologic conditions within the Palmdale Water District service area, the development of storage volume changes across the study area as a result of groundwater production, the determination of ambient groundwater quality and estimations of groundwater quality changes as a result of recycled water recharge, and the development of groundwater recharge basin size requirements for various recycled water recharge volumes.

Dr. Chiang developed a database and software code to automate the calculation of the changes of storage volume across the study area. The calculation was based on the lithology logs and groundwater level records of the wells in the study area. The primary calculation result is temporal specific storage changes at those wells. Those values were then gridded and multiplied with the grid area to obtain changes in storage volume.

Integrated Environmental Services, Inc. – 2002 to 2006

Dr. Chiang developed Processing Modflow Pro to support the USGS's groundwater flow model (MODFLOW) and related groundwater transport models (RT3D/MT3DMS/PHT3D). The developed code and documentation are published in 3D-Groundwater Modeling with PMWIN (2nd Edition).

Dr. Chiang provided groundwater flow and transport modeling support and assisted in RCRA/CERCLA procedures for various projects. This included the use of analytical solution and two-dimensional screening models, his own 3D visualization code, and commercial software, such as SURFER, to evaluate specific site conditions. When complex 3D numerical groundwater modeling was required, Dr. Chiang used Processing Modflow in conjunction with MODFLOW-2000, MT3DMS, RT3D, and PEST.

University of the Free State, South Africa

Dr. Chiang published *3D Groundwater Modeling with PMWIN*, a textbook that includes the Processing Modflow user interface, computer codes for groundwater flow and contaminant transport simulation, and over sixty documented modeling examples. The textbook and companion modeling software are the result of long-term collaboration with colleagues from many countries—including Australia, Canada, Germany, the Netherlands, South Africa, Taiwan, and the USA—and are used by many major universities and consulting firms across the world. The foundation for *3D Groundwater Modeling with PMWIN* and the Processing Modflow user interface was laid in 1989 as part of a research project.

Geological Survey of Hamburg, Germany

Dr. Chiang developed several groundwater models for contaminated sites in the City of Hamburg, including landfills and industrial contamination sites—several of which were bounded by the Elbe River and, therefore, subject to tidal influences.

In most of cases, the groundwater models were used to determine pump-and-treat well locations and for designing other remedial measures, such as locations and depths of slurry walls or drainages to interrupt pollution migration. And, in other cases, they

were used to show that no action was required due to natural attenuation or to verify threats to water resources and rivers posed by subsurface contamination.

Department of Civil Engineering, University of Kassel, Germany

Dr. Chiang was responsible for the "Remediation of the Landfill Emden of Volkswagen AG." This research project required the use of both finite-element and finite-difference groundwater models to design remedial measures and stochastic modeling to analyze potential risks associated with the designed measures. Furthermore, this project included the design and programming of a three-dimensional finite element (FE) groundwater flow model with a graphical user interface, the design and programming of Processing Modflow as a graphical pre- and postprocessor for the USGS's three-dimensional finite difference groundwater flow model (MODFLOW), the programming of computer codes for stochastic modeling with the FE and FD models, and the application of models and computer codes on the Landfill Emden of Volkswagen. Dr. Chiang was involved in further developing the 3D FE Groundwater flow model as a part of the publication of Computational Methods and Models: *Handbook for Superfund Sites of the Federal State Niedersachsen of Germany.*

Selected Publications / Presentations

Chiang, W. H. (2005). *3D-Groundwater Modeling with PMWIN – A Simulation System for Modeling Groundwater Flow and Pollution Processes* (2nd Ed.). New York: Springer-Verlag Berlin Heidelberg.

Kinzelbach, W., Aeschbach, W., Alberich, C., Goni, I. B., Beyerle, U., Burner, P., Chiang, W. H., Rueedi, J., & Zoellmann, K. (2002). *A Survey of Methods for Analyzing Groundwater Recharge in Arid and Semi-arid Regions.* United Nations Environmental Programme. ISBN 92-807-2131-3.

Affiliations / Organizations

Groundwater Resources Association of California

National Ground Water Association

Carolina Sanchez, PE

Senior Engineer I

Expertise:	Ms. Sanchez has five years of professional experience in the water resources industry. Her skills include groundwater monitoring, numerical analysis, water resources, and GIS. As a Staff Engineer at Wildermuth Environmental, Inc. (WEI), Ms. Sanchez is involved in a variety of projects. Her tasks include: analysis of groundwater level and water quality data; data management; CASGEM compliance; developing charts and contour maps to characterize groundwater flow systems and associated water quality; conducting hydrologic and hydraulic analyses of groundwater recharge using imported, recycled, and storm waters; modeling groundwater production trends; creating tables, charts, and maps to analyze and characterize surface water discharge and associated water quality; and preliminary design of surface water management facilities.
Education:	M.S. C.E.E. Environmental Fluid Mechanics and Hydrology, Stanford University, Stanford, 2013 B.S., Civil Engineering, Loyola Marymount University, Los Angeles, 2012
Licenses:	Professional Civil Engineer, California, No. 85598
Professional History:	WEI – 2014 to Present Stanford Woods Institute – Water in West, Stanford University – 2012 to 2013
Professional Experience:	**Water Rights Compliance, Basin Management, and Salt and Nutrient Management Plan: Monitoring, Data Collection and Reporting Program, San Juan Basin Authority** Ms. Sanchez is the project engineer responsible for data collection and management for the San Juan Basin Authority's (SJBA) monitoring and reporting program. The monitoring program includes: the measurement of groundwater levels, water quality sampling, the collection of monthly production totals at wells throughout the basin, and the collection of precipitation and other hydrologic data. Ms. Sanchez collects, processes, and analyzes water level and water quality data on a monthly basis, and provides updates to the San Juan Basin Authority Technical Advisory Group and Board on a periodic basis. Ms. Sanchez is also responsible for the San Juan Basin Authority's CASGEM compliance and for preparing annual reports summarizing the findings of the monitoring program to ensure compliance with water rights permit conditions. In 2016, Ms. Sanchez assisted in the development of the 2016 Adaptive Pumping Management Plan by analyzing historical production data, coordinating with the groundwater modelers, and analyzing modeling results. And, Ms. Sanchez is responsible for the implementation of the monitoring and data collection work plan, which is an addendum to the *Salt and Nutrient Management Plan for the South Orange County Aliso Creek, San Juan Creek, and Portions of Other Basins* (SNMP). The SNMP was developed for the South Orange County Wastewater Authority by HDR and WEI in 2014. The work plan, which is required by the San Diego Regional Water Quality Control Board as part of the State Board's Recycled Water Policy, was developed in collaboration with all of the regional agencies that serve recycled water in the San Juan Creek Watershed. Ms. Sanchez is responsible for coordinating the field

monitoring programs and for collecting, compiling, and checking recycled water, surface water, and groundwater data. Data collected through the SNMP monitoring program will be used to evaluate "current" groundwater quality, project future changes in groundwater quality, determine the impact of recycled water reuse on current and future groundwater quality, and determine if current or future groundwater quality exceeds the groundwater quality objectives.

Technical and Administrative Services, Six Basins Watermaster

Ms. Sanchez is the senior engineer and co-project manager for the team that manages and directs technical and administrative services for the Six Basins Watermaster. In this role, Ms. Sanchez organizes Watermaster Board meetings, collects and compiles all groundwater and surface-water data required by the adjudication, reviews and responds to data requests, tracks minimal producers, prepares the Watermaster annual, report and coordinates spreading activities. As part of organizing Watermaster Board meetings, Ms. Sanchez prepares monthly reports, summarizing the climate conditions and water level responses of the basin, prepares meeting minutes, and maintains the Six Basins Watermaster website. In 2016, the scope of work for Ms. Sanchez and her team was expanded to include reporting in compliance with the Sustainable Groundwater Management Act and the implementation of an expanded basin-wide groundwater monitoring program to support and improve Basin management activities. Ms. Sanchez is also responsible for CASGEM compliance and for managing the groundwater level monitoring program, which consists of measuring water levels and downloading high frequency data at 27 wells and collecting high-frequency production and water level data for 10 and 30 wells, respectively, from the Six Basins Parties.

2018 Recharge Master Plan and Implementation of the 2013 Amendment to the 2010 Recharge Master Plan Update (RMPU), Chino Basin Watermaster

Ms. Sanchez is a project engineer for the implementation of the 2013 Amendment to the 2010 RMPU. The 2010 RMPU utilized state-of-the-art surface water models, developed by WEI, to estimate stormwater recharge in spreading basins and in localized recharge facilities that will be constructed to comply with the 2010 MS4 permits. The investigation also determined the existing recharge capacity for imported and recycled waters and future recharge capacity requirements. Subsequent to the approval of the 2010 RMPU, the 2010 UWMPs were released, and the groundwater production projections were substantially less than assumed in the 2010 RMPU. A Stakeholder Committee (Steering Committee) was formed to conduct further analysis of the projects recommended in the 2010 RMPU, to introduce and analyze new yield enhancement and production sustainability projects, and to develop a finance and implementation plan for the recommended projects. The 2013 Amendment was approved by the stakeholders and the Court. Ms. Sanchez is responsible for the preliminary hydrologic and hydraulic design work to refine recharge projects and for reviewing interim submittals from design contactors.

Mr. Sanchez served as a senior engineer for the 2018 recharge master plan update. Mr. Sanchez worked with Watermaster Staff, led Steering Committee meetings and workshops, and incorporated stakeholder feedback to complete the report, which was approved by stakeholders and submitted to the Court on schedule in October 2018.

Coldwater Basin Safe Yield Studies, Coldwater Basin Operating Committee

Ms. Sanchez is the project engineer for Coldwater Basin annual water rights compliance reporting. In 2006, WEI conducted an analysis of the native safe yield of the Coldwater Basin in Riverside County to establish the relative pumping rights of the two major pumpers of the basin—the City of Corona and the Elsinore Valley Municipal Water District. A water-rights agreement was executed between the City and the District based on this analysis, which requires annual reporting and the re-determination of the native safe yield once every five years, based on the monitoring data collected to date. Ms. Sanchez's responsibilities include collecting and analyzing groundwater level, groundwater production, groundwater quality, and imported water delivery data; the accounting of pumping, storage, and water-rights; and preparing the Annual Report.

MS4 Data Collection and Database Development, Chino Basin Watermaster

Ms. Sanchez is the project engineer responsible for coordinating Chino Basin Watermaster's efforts to collect, compile, and review Municipal Separated Storm Sewer System (MS4) project information. In 2014, the Court ordered Watermaster to furnish MS4 project-related information to help determine the amount of net new stormwater recharge created by MS4 projects or other local storm water management projects within the Chino Basin. Since July 2014, Watermaster annually requests MS4-related data. Ms. Sanchez developed a database of MS4 projects within the Chino Basin. The database is used to check the datasets for completeness, to analyze the data, and to prepare reconnaissance-level estimates of the potential new recharge of these projects

San Juan Basin Groundwater and Desalination Optimization Program, San Juan Basin Authority

Ms. Sanchez served as the project engineer for the San Juan Basin Groundwater and Desalination Optimization Program. In this project, WEI evaluated the physical and economic feasibility of projects to increase recharge in the basin with storm and recycled waters, implemented a seawater extraction barrier, and optimized production schemes to adaptively manage groundwater storage in wet and dry climate cycles. Other key components of the feasibility study were to evaluate the regulatory challenges of implementing the recycled water recharge projects as they will explore new frontiers and issues associated with recharging water in an impaired basin. Ms. Sanchez was involved in performing the surface water modeling to calculate new yield, coordinating with the groundwater flow modelers, analyzing MT3D groundwater quality modeling results, and calculating recycled water underground retention time. She was also involved in preparing preliminary designs and operating plans for a new in-stream rubber dam system to turn a stream into 2.5-mile long recharge basin.

Development of a Strategic Plan for the Six Basins, Six Basins Watermaster

Ms. Sanchez was the project engineer for the development of the Strategic Plan for the Six Basins Watermaster. The objective of the Strategic Plan is to develop a water-resources management program that sustains and enhances the water supplies available to the Six Basins parties in a cost-effective manner and in accordance with the Six Basins Judgment. This effort began in early 2012 and included the preparation of a comprehensive "state-of-the-basin" report and the articulation of the issues, needs,

and wants of the Watermaster Parties—individually and collectively as a group. This information was used to define Strategic Plan project alternatives. The evaluation of the alternatives required the use of surface water and groundwater computer-simulation models. Ms. Sanchez developed a project economic forecasting tool to estimate the annual water supply cost for each party for the "no strategic" plan, or baseline case, and for alternative management plans being considered in Strategic Plan development. She was responsible for analyzing water production trends; hydrologic and hydraulic modeling of increased stormwater diversion and recharge at the San Antonio and Thompson Creek Spreading Grounds; and the preparation, of maps, charts, and tables to communicate the results of groundwater model simulations of the Strategic Plan alternatives. She also worked on the final report, documenting the development of the Strategic Plan, and a planning proposal for the implementation of the Strategic Plan. Currently, she is working on the implementation of the Strategic Plan, which includes preparing the input files to run the R4 model to estimate the deep infiltration of precipitation and applied water based on precipitation and land-use. It also includes developing planning scenarios for the Six Basins Parties, coordinating with groundwater modelers, and developing the scope of work for a Programmatic Environmental Impact Report.

Upper Temescal Valley Salt and Nutrient Management Plan, Elsinore Valley Municipal Water District and Eastern Municipal Water District.

Ms. Sanchez served as a project scientist for the Upper Temescal Valley SNMP. The Santa Ana Regional Board required the EVMWD and EMWD to prepare an SNMP to support their recycled water discharge and reuse plans in the Upper Temescal Valley. The objectives of this project were to establish technically based antidegradation objectives for the Upper Temescal Valley groundwater management zones (these objectives currently do not exist), estimate current ambient water quality and assimilative capacity, project future total dissolved solids and nitrogen concentrations based on the water resources management plans of the local water supply agencies, identify the regulatory challenges posed by the recycled water reuse and discharge plans of the EVMWD and EMWD, and develop a salt and nutrient management plan that addresses these challenges. Ms. Sanchez was responsible for collecting, organizing and managing the data compilation and management efforts, and analyzing data to estimate historical and future irrigation return flows and associated TDS and nitrate concentrations from historical and projected land use and period-appropriate irrigation and fertilizer practices.

Total Dissolved Solids Studies, Santa Ana Watershed Project Authority

Ms. Sanchez worked as a project engineer on a TDS study to characterize the volume-weighted summertime TDS concentration of POTW recycled water discharges above Prado Dam. The objective of this study was to evaluate the causes of recent exceedances of the Santa Ana River Reach 3 TDS concentration objective and to characterize the relative magnitude of each factor contributing to the exceedance of the summertime surface water objectives. Ms. Sanchez was responsible for collecting and compiling data and preparing charts and graphics to support data analysis.

Erik Gaiser, PG

Supervising Geologist

Expertise:	Mr. Gaiser joined Wildermuth Environmental, Inc. (WEI) in July 2018. He brings with him 20 years of professional experience in the environmental and water resources consulting and drilling industries. His technical expertise includes: environmental site assessment (Phase I & II, adaptive design, and real-time data collection); well siting, design and rehabilitation; hydrogeology; depositional facies interpretation; conceptual site model development; fate and transport analysis; and environmental permit compliance. He has a long record of leading and contributing to the success of large-scale, complex projects throughout California and the United States. At WEI, Mr. Gaiser is taking a lead role in the on-call hydrogeologic services contract with the Coachella Valley Water District.
Education:	B.S., Geology, California State University, Fullerton, 2011
Licenses:	Professional Geologist, California No. 8879
Professional History:	WEI – 2018 to Present Yellow Jacket Drilling Services – 2015 to 2018 Tetra Tech – 2013-2015 ARCADIS – 2008 to 2013 Geoscience Support Services, Inc. – 2007 to 2008 ARCADIS – 2006 to 2007 Wayne Perry, Inc. – 1998 to 2006
Professional Experience:	**Large Plume Monitoring and Optimization, Edwards Air Force Base, CA** Mr. Gaiser was the lead hydrogeologist for the groundwater monitoring program at Edwards Air Force Base in Southern California. In this role he managed the monitoring and optimization program for 3,000+ wells across 13 Operable Units, supervised field staff, reviewed all reports, developed responses to comments provided by regulatory agencies, and represented the client in meetings with EPA and Regional Water Quality Control Board. He instituted the transition of all plume maps into a 3-dimensional modeling environment to more accurately understand contaminant distribution and lead efforts to refine conceptual site models using hydrostratigraphic analyses. Mr. Gaiser also designed and led a high-resolution adaptive design investigation in support of a 5-year Review Document. The investigation resulted in the successful delineation of two plumes in a 2-month period, identified a previously unknown extension of a local fault, and lead to the client receiving written accolades from regulatory agencies on the innovative and effective use of investigatory technologies to map contaminants under compressed time constraints. **Fate and Transport Study of Per- and Polyfluoroalkyl Substances (PFAS), Cape Canaveral Air Force Station, FL and Barksdale Air Force Base, LA** The primary objectives of this study were to assess the fate and transport of PFAS in the environment and provide samples for academic studies examining if bioremediation was a relevant attenuation mechanism for these emerging compounds.

As the lead geologist Mr. Gaiser designed and implemented field investigations using high-resolution methodologies, coordinated multifaceted field scopes under challenging logistical conditions, and regularly interfaced with Air Force Base personnel, members of academia, and AFCEC. The work required the application of his expertise in hydrostratigraphy and facies analyses to provide optimum data density for the depositional environments and client objectives. Data from the investigations provided valuable insight into the fate and transport potential of PFAS in various subsurface conditions and allowed the Air Force to better project the probable environmental liability should PFAS become regulated.

Shell Oil Products Program, California

Mr. Gaiser served as the Client Manager for two Shell Oil Products Environmental Engineers. In this role he was responsible for setting and managing budgets for approximately 120 retail gas station sites with a total annual expenditure between $5-8 MM. He regularly communicated project status and budget updates with clients, oversaw application for, and compliance with, a variety of environmental permits including NPDES, POTW, and CEQA negative declarations. Mr. Gaiser simultaneously served as the project manager for 30 retail sites where he planned, permitted and managed all site characterization activities and successfully designed and implemented numerous feasibility studies for remediation systems including soil vapor extraction, hi-vacuum dual-phase extraction, and in-situ bio-augmentation.

Extraction Well Design and Installation, Fillmore, CA

Mr. Gaiser served as the hydrogeologist in charge of re-designing and implementing dewatering activities during construction of a residential development in the Santa Clarita River floodplain. He designed, installed, and operated an extraction well network consisting of 7 wells pumping at 1,500 gpm each to overcome a substantial increase in transmissivity and lower ambient groundwater levels 20 feet below grade. The re-designed extraction array replaced an ineffective third-party array and allowed the on-time completion of a 100-year flood levee for the development.

Regional Recharge and Recovery (R^3) Project, Mojave Water Agency, CA

Mr. Gaiser was the senior hydrogeologist on a team during the initial phases of planning and investigation for MWA's R^3 Project. He assisted with the third-party evaluation and calibration of Mojave Basin Groundwater Model constructed by Schlumberger. Conducted initial sighting for and field evaluations of preliminary recharge and recovery locations within the project area. Project work resulted in approval of preliminary recharge and recovery locations by MWA and other stakeholders and served as the basis for procurement of additional Bond funding.

Antidegradation Analysis, Mono County, CA

The objective of this project was to conduct an antidegradation analysis in support of a CEQA Environmental Impact Report update. As the senior geologist, Mr. Gaiser researched basin groundwater-quality data, estimated groundwater flux based on limited regional data, and calculated groundwater-quality impacts from wastewater discharge from the proposed project under two separate buildout scenarios.

Veva Weamer

Supervising Scientist

Expertise: Ms. Veva Weamer joined the Wildermuth Environmental team in 2008. Her technical expertise includes data analysis, database management, water quality analysis, salt and nutrient analysis, hydrogeology, Geographical Information Systems (GIS), and ground and surface water monitoring program implementation and evaluation.

As a Supervising Scientist, Ms. Weamer is involved in overseeing several ongoing regulatory compliance programs, including the Chino Basin Maximum Benefit Monitoring Program and the Prado Basin Habitat Sustainability Program.

Ms. Weamer graduated from California State University, Fullerton in 2005 with a B.S. in Geological Sciences. In 2007, she completed an M.S. in Environmental Studies from California State University, Fullerton with an emphasis in water resources management. Her Master's research involved the quantification of groundwater movement and aquifer characterization of the Harper Lake Basin, Mojave Desert, California, using GIS tools and bore log data. Ms. Weamer was awarded the 2006 Prem K. Saint award for outstanding work in hydrogeology for her research.

Education: M.S., Environmental Studies, California State University, Fullerton, December 2007

B.S., Geological Sciences, California State University, Fullerton, June 2005

Professional History: WEI – 2008 to Present

Professional Experience:

Watermaster Engineering Services, Chino Basin Watermaster

WEI has served as the Chino Basin Watermaster's Engineer since the early 1990s. Ms. Weamer has worked on or managed various tasks for the Watermaster since joining WEI in 2008. Described below are various projects and programs that Ms. Weamer manages for the Watermaster:

Chino Basin Watermaster Groundwater and Surface Water Database: Ms. Weamer is responsible for overseeing the management and maintenance of the Chino Basin Watermaster's database with updated groundwater elevation, groundwater quality, groundwater production, surface water discharge, and surface water quality data. She manages a team of WEI staff scientists and field technicians that collect, compile, and upload all field program and publicly available datasets online, and coordinates with public and private entities within the Chino Basin on a routine basis to keep the database up-to-date. Ms. Weamer is responsible for the review and QA/QC all data collected and uploaded to the database. The Chino Basin Watermaster database is critical to support a variety of Watermaster functions, such as reporting for various regulatory requirements and analyses to understand changes in the basin as groundwater management strategies are implemented over time.

Prado Basin Habitat Sustainability Program, Prado Basin Habitat Sustainability Committee: Ms. Weamer manages the Prado Basin Habitat Sustainability Program (PBHSP), developed and implemented by the Prado

Basin Habitat Sustainability Committee (PBHSC), which is comprised of Chino Basin Stakeholders, pursuant to requirements of the Peace II Agreement Subsequent Environmental Impact Report. The key element of the PBHSP is an adaptive monitoring program intended to characterize the historical, current, and future extent and quality of the riparian habitat in the Prado Basin Management Zone in the southern portion of the Chino Basin, and to provide information on the cause(s) of riparian habitat degradation if documented. Data from the monitoring program will aid in the development of efficient and effective mitigation measures if the cause(s) of degradation are conclusively attributed to Peace II Implementation. The monitoring program consists of integrated programs for the monitoring of riparian habitat and monitoring of factors that can potentially affect riparian habitat, which include groundwater, surface water, weather, and climate. Data from the monitoring program is analyzed, interpreted, and reported on annually. The annual reporting and analysis forms the basis to adjust the monitoring program, if necessary, to achieve the objectives of the PBHSP. Ms. Weamer is responsible for managing all components of the monitoring program for the PBHSP. Ms. Weamer is also responsible for writing an annual report that discusses and interprets the monitoring data and any related groundwater-modeling results, describes recommended measures to mitigate significant adverse impacts to the riparian habitat (if applicable), and recommends activities for the subsequent year monitoring program. Ms. Weamer presents the annual report contents to the PBHSC to facilitate Stakeholder input and suggested revisions for the recommendations for the monitoring program and mitigation measures if necessary. Ms. Weamer is also responsible for preparing the subsequent fiscal year budget for the PBHSP based on the recommendations for modifications to the monitoring program in the annual report.

Regulatory Support for California's Sustainable Groundwater Management Act (SGMA) reporting for Adjudicated Basins: Ms. Weamer provides regulatory support services for the Chino Basin Watermaster for compliance with adjudicated basins reporting requirements pursuant to the SGMA. The SGMA requires that Watermaster or a local agency of an adjudicated basin identified in Water Code Section 10720.8(a) submit specific data and information for the previous water year annually to the DWR by April 1 each year. Ms. Weamer attends meetings and workshops with the DWR and other adjudicated basin agencies and coordinates with the DWR on various matters concerning the annual reporting requirements to ensure that Watermaster is complying with the requirements of SGMA legislation. Ms. Weamer helped develop the process for the Watermater to satisfy their annual reporting requirements for the first year in 2015 and the years following. This includes compilation of all required data and information from the Watermaster parties, coordination with modeling staff at WEI to calculate an annual change in storage for the Chino Basin, preparation of a Memorandum for Watermaster parties to describe the data and information to be submitted each year for their

approval, and submittal of the annual reporting requirements to the DWR by April 1.

Chino Basin Optimum Basin Management Program State of the Basin Report: The Chino Basin State of the Basin Report is a court-ordered document, prepared pursuant to the Chino Basin Optimum Basin Management Plan and subsequent implementation plans and agreements. The State of the Basin Report demonstrates: the current state of the Chino Groundwater Basin in regard to basin production, recharge, groundwater levels, groundwater quality, land subsidence, and the progress made since July 2000 when the Chino Basin Watermaster commenced several investigations and monitoring programs and management practices were established in the Optimum Basin Management Program. The report features detailed exhibits that characterize Chino Groundwater Basin hydrology, production, recharge, recycled water reuse, groundwater levels, groundwater quality, and subsidence monitoring and management. Ms. Weamer prepared the groundwater quality section of the 2008 State of the Basin Report and was the project manager for the preparation of the 2010, 2012, 2014, and 2016 reports.

Maximum Benefit Monitoring Program: Ms. Weamer manages the Chino Basin Watermaster's Maximum Benefit Monitoring Program. The objective of this program is to demonstrate that the management of the Chino Basin's groundwater resources prevents poor quality groundwater with high TDS and nitrogen concentrations from impacting downstream beneficial uses. To receive the assimilative capacity afforded by the maximum-benefit objectives for TDS and nitrogen in the Chino-North Groundwater Management Zone, the Regional Board requires that the Chino Basin Watermaster and Inland Empire Utilities Agency implement a set of projects and programs known as the Chino Basin Maximum Benefit Commitments. Ms. Weamer is responsible for managing the surface and groundwater monitoring programs that produce the data required to demonstrate hydraulic control of Chino-North groundwater, managing the collection of all other data needed to demonstrate compliance with the Maximum Benefit Commitments, and writing an annual report that demonstrates compliance to the Regional Board.

Chino Basin Recycled Water Groundwater Recharge Program: Ms. Weamer reviews monitoring data and the various documents submitted to the Santa Ana Regional Water Quality Control Board on behalf of the Chino Basin Recycled Water Groundwater Recharge Program, pursuant to a recharge permit with co-permittees—the Inland Empire Utilities Agency and Chino Basin Watermaster. The program is part of a comprehensive water supply program to enhance water supply reliability and improve groundwater quality in Chino Basin by increasing the recharge of storm water, imported water, and recycled water. Required reporting for this program includes quarterly and annual monitoring reports, basin startup reports, and five-year engineering reports. Ms. Weamer also collects, reviews, and maintains the program monitoring data in support of other Chino Basin analyses and reports.

Watermaster Annual Report*:* Ms. Weamer assisted with the preparation of Watermaster's Annual Report to the Court in compliance with the Judgment. From 2016 to 2017, Ms. Weamer helped complete three Annual Reports. She helped developed the narratives for the report's content, describing important achievements over the last year and the status of various management and monitoring programs, and assisted with the collection and compilation of data for the report appendices.

Engineering Support for Tracking the Mitigation of Point-Sources of Concern, Chino Basin, California: Ms. Weamer provides assistance to the Chino Basin Watermaster in their efforts to track the status of various point sources of concern in the Chino Basin. Tasks include: coordinating with responsible party consultants for updated monitoring data and information, maintaining up-to-date well and monitoring data, reviewing reports prepared by the responsibility party, reviewing regulatory orders and related correspondence from the Regional Water Quality Control Board, as-needed analyses of monitoring data, plume delineation using data collected by the responsible party and through Watermaster sampling programs, and producing supporting documents for negotiations with the responsible parties and their consultants to achieve mutually beneficial solutions. Ms. Weamer prepares semi-annual and annual summary reports for select point sources of concern for the Watermaster Pools, Advisory Committee, and Board meetings.

Regulatory Support for California Statewide Groundwater Elevation Monitoring (CASGEM) Program: Ms. Weamer has provided regulatory support and services for the Chino Basin Watermaster for compliance with the CASGEM program since California legislature passed Senate Bill SBx7-6 in November 2009. Ms. Weamer manages the on-time submittal of all CASGEM requirements to the DWR, including: the development of the initial Chino Basin CASGEM Monitoring Plan and the twice-a-year (Spring and Fall) data submittals. Ms. Weamer assisted with the design of custom reporting templates from WEI's database software HydroDaVE^{SM} for the easy compilation of groundwater elevation data to upload into the DWR's online CASGEM submittal system. Ms. Weamer also coordinates with the DWR on various matters concerning the CASGEM program and the Watermaster, attends DWR meetings and workshops, and reviews and revises the Chino Basin CASGEM Monitoring Plan as necessary.

Database Management and Analysis of Groundwater and Surface Water Data using HydroDaVE^{SM}, Various Clients

Ms. Weamer is responsible for the management of various groundwater and surface water data collection programs using WEI's relational database software, HydroDaVE. This includes well information data, groundwater-quality data, groundwater-level data, production data, surface water station information, and surface water quality and flow data. The data is obtained through various field monitoring and cooperative collection programs and from publicly available datasets available online. Ms. Weamer performs administrative tasks to maintain database integrity. The data are reviewed thoroughly,

processed into HydroDaVE format, and uploaded into the database. The data are thoroughly checked for quality control and assurance upon upload. Ms. Weamer performs sophisticated analyses of data in HydroDaVE for various groundwater management issues and executes the analysis of data extracted from the database in support of client reports and investigations. She has managed data for numerous clients, including the Chino Basin Watermaster, San Gabriel Water Quality Authority, Elsinore Valley Municipal Water District, Mammoth Community Water District, Santa Ana Watershed Project Authority, Cucamonga Valley Water District, City of Beaumont, and San Juan Basin Authority.

Maintenance and Use of the Groundwater Data for the Evaluation of Water Quality Conditions in the San Gabriel Basin, San Gabriel Basin Water Quality Authority

The objective of this project is to help San Gabriel Basin Water Quality Authority (WQA) obtain access to all groundwater data in the San Gabriel Basin collected by others and use the data to prepare various groundwater quality graphics for the various needs of the WQA. Ms. Weamer manages this task and helped facilitate the coordination with the Environmental Protection Agency to collect their comprehensive groundwater database in the basin and to migrate and routinely maintain the data into the database software HydroDaVE^{SM} for the WQA. Ms. Weamer lead the team to develop water-quality data graphics to support the WQA in their mission to coordinate, plan, and implement programs to efficiently remediate groundwater contamination in the region. Three different animations of the Baldwin Park Operable Unit (BPOU) area were prepared to show the changes in the BPOU contaminant plume from 1990 to 2018 for trichloroethene (TCE) + tetrachloroethene (PCE), perchlorate, and total contaminants of concern. One animation of the entire San Gabriel Basin was prepared to show the changes in the concentrations of total contaminants of concern for all operable unit areas in the San Gabriel Basin.

Upper Temescal Valley Salt and Nutrient Management Plan, Elsinore Valley Municipal Water District and Eastern Municipal Water District

The Santa Ana Regional Board required the EVMWD and EMWD to prepare a Salt and Nutrient Management Plan (SNMP) to support their recycled water discharge and reuse plans in the Upper Temescal Valley. The objectives of this project were to establish technically based antidegradation objectives for the Upper Temescal Valley groundwater management zones; estimate current ambient water quality and assimilative capacity; project future TDS and nitrogen concentrations based on the water resources management plans of local water supply agencies; identify the regulatory challenges posed by the recycled water reuse and discharge plans of the EVMWD and EMWD; and develop a salt and nutrient management plan that addresses these challenges. Ms. Weamer assisted with the data collection efforts and analysis required to estimate current ambient water quality and assimilative capacity for the Upper Temescal Valley groundwater management zone.

Total Dissolved Solids and Nitrate Concentration Projections for the Temescal Groundwater Management Zone, City of Corona Department of Water and Power

The objective of this project was to prepare TDS and nitrate concentration projections for the Temescal Groundwater Management Zone pursuant to the requirements in the

"Cooperative Agreement to Protect Water Quality and Encourage the Conjunctive Uses of Imported Water in the Santa Ana River Basin" (Cooperative Agreement). The Cooperative Agreement requires that signatory parties within the watershed monitor and analyze water quality to determine whether the conjunctive use of imported water has a significant impact on compliance with water quality objectives. Twenty-year TDS and nitrate projections for the Temescal Groundwater Management Zone were prepared using an existing calibrated MODLFOW groundwater-flow model for the Chino and Temescal Basins in conjunction with a MT3D fate-and-transport model. Ms. Weamer served as the project manager for this study and was responsible for the collection and compilation of updated planning data for the groundwater flow model; the compilation of water-quality data for the fate-and-transport model; working with modeling staff on the implementation of model; the preparation of a technical report, summarizing the results; and the presentation of the results to the established Imported Water Recharge Committee in the watershed.

Total Dissolved Solids and Nitrate-Nitrogen Projections for the Elsinore Groundwater Management Zone, Elsinore Valley Municipal Water District

The objective of this project was to prepare total dissolved solids (TDS) and nitrate-nitrogen concentration projections for the Elsinore Groundwater Management Zone to demonstrate the impact of recycled water reuse within the Elsinore Valley Municipal Water District's (the District) service area. The Regional Board required the District to develop and provide these projections prior to renewing its waste discharge permit to allow the use of high-TDS recycled water for irrigation. Ms. Weamer served as the project scientist for this study and was responsible the collection and compilation of hydrogeologic and planning data, the presentation of information used to develop model scenarios, the design and implementation of a constantly stirred reactor model, and the preparation of a technical report, summarizing the results and recommendations of the analysis.

Triennial Recomputation of Ambient Water Quality, Santa Ana Watershed Project Authority

Ms. Weamer assisted in the Recomputation of Ambient Water Quality for the Santa Ana Watershed for the 1987-2006 and 1990-2009 periods and was the project manager for 1993-2012 period effort. In this study, ambient water quality determinations in Santa Ana River Watershed's Groundwater Management Zones are calculated and compared to water quality objectives, which are used by the Regional Water Quality Control Board, Santa Ana Region (Regional Board) to assess assimilative capacity as part of the basin monitoring program required by the Santa Ana Region Basin Plan. This study involves a thorough and stringent technical approach to collect, QA/QC, and analyze data to quantify ambient total dissolved solids (TDS) and nitrogen concentrations in Groundwater Management Zones. For the 1993-2012 effort, Ms. Weamer was responsible for overseeing the collection, compilation, and QA/QC of the data used in the analysis; managing the development of water quality contours and spatiotemporal estimates of TDS and nitrogen; calculating the ambient TDS and nitrate concentrations for every Groundwater Management Zone in the Santa Ana Watershed; preparing descriptive technical maps on how and where ambient water quality is changing; and preparing a technical report documenting the results of the analysis.

Triennial Reporting for the Eastern Municipal Water District's Municipal Salinity Management Plan.

In October 2010, the Santa Ana Regional Water Quality Control Board adopted Resolution R8-2010-0039 to amend the Basin Plan and incorporate less stringent maximum-benefit water quality objectives for TDS and nitrogen in the San Jacinto Upper Pressure groundwater management zone. The application of the maximum-benefit objectives allows the Eastern Municipal Water District to reuse recycled water in the San Jacinto Upper Pressure groundwater management zone and thereby achieve its water supply management goals for the Hemet/San Jacinto Water Management Area. To support the maximum-benefit TDS and nitrogen objectives the Regional Board requires the Eastern Municipal Water District implement specific salinity monitoring and management programs termed the maximum-benefit commitments. One of the maximum-benefit commitments is to develop a salinity management plan to control TDS concentrations of source water and recycled water in the Eastern Municipal Water District's service area to ensure that groundwater quality is protected from degradation, and report on the progress every three years. The initial maximum-benefit Salinity Management Plan was submitted to the Regional Board on April 23, 2013. The maximum-benefit Salinity Management Plan provides a comprehensive overview of the regulatory environment, the EMWD's water and wastewater supply operations and associated water quality, the nexus of these source waters to groundwater quality, and the EMWD's existing and planned salinity management activities. Ms. Weamer assisted with the preparation of the 2015 triennial update report to maximum-benefit Salinity Management Plan, and is the project manager for the preparation of the 2018 triennial update report.

State of the Basin Assessment for the San Juan Basin, San Juan Basin Authority

Ms. Weamer was a project scientist for the comprehensive "state of the basin" assessment of the San Juan Basin. The "state of the basin" assessment describes the hydrology, geology, groundwater levels, groundwater quality, groundwater production, groundwater storage, and yield of the San Juan Basin. Ms. Weamer compiled and reviewed recent reports and updated WEI's groundwater databases with well data: groundwater levels, groundwater quality, and groundwater production. The data collected and compiled have supported the development of a hydrogeologic setting for the basin. The "state of the basin" assessment was the most comprehensive assessment done on the basin to date and was used to evaluate the hydrology of the basin to estimate a sustainable yield that is protective of habitat and prevents seawater intrusion. WEI is currently evaluating alternatives to increase the sustainable yield and conducts a comprehensive monitoring program to evaluate the impacts of groundwater production on riparian habitat and seawater intrusion.

State of the Basin Report for the Six Basins, Six Basins Watermaster

Ms. Weamer was a project scientist for the development of a comprehensive "state of the basin" report for the Six Basins. The "state of the basin" report is the first part in the development and implementation of the Strategic Plan for the Six Basins. The objective of the Strategic Plan is to develop a water-resources management program that sustains and enhances the water supplies available to the Six Basins in a cost-

effective manner and in accordance with the Judgment. The state of the basin report articulates the issues, needs, and wants of the Watermaster parties—individually and collectively as a group. This information is being used to define and evaluate Strategic Plan project alternatives. The evaluation of the alternatives required the use of surface water and groundwater computer-simulation models. The Strategic Plan was completed in 2015.

State of the Basin Assessment for the Cucamonga Basin, Cucamonga Water District

Ms. Weamer worked with a team to prepare a "state of the basin" assessment of the Cucamonga Basin to describe the water resources of the basin, including groundwater storage, safe yield, and water quality. A comprehensive "state of the basin" assessment had not been done previously; this assessment was used to evaluate the hydrology of the basin to estimate the sustainable yield. Ms. Weamer's role included the collection and analysis of all historical water quality data and the development of a description of historical water quality. Water quality degradation from past agricultural land use and current onsite waste disposal practices limit production. The major pumpers in the basin have developed a series of management principles around the concept of sustainability. WEI is about to start the second phase of this work, which involves the development of a new high-resolution groundwater model and the development and evaluation of groundwater management concepts to enable expanded production.

Phase I Salinity Management Program Study, Santa Ana Watershed Project Authority

The objective of this study was to perform a planning-level analysis of the salt budget of the Santa Ana Watershed region to develop recommendations for optimal salt removal strategies that maximize the efficiency of the region's salt removal needs. Ms. Weamer was responsible for the collection and compilation of hydrogeologic and planning data for the region, the development of 50-year water supply and demand projections for 30 regional water supply entities, and implementing a series of constantly stirred reactor models to project groundwater storage, wastewater disposal requirements, and the amount of salt in storage for each management zone in the watershed.

Maximum Benefit Monitoring Program, City of Beaumont

Ms. Weamer maintained and implemented the Maximum Benefit Monitoring Program of the City of Beaumont. She was responsible for implementing and managing the surface and groundwater monitoring requirements of the program, overseeing the collection of data from municipal water agencies and Publicly Owned Treatment Works, and preparing annual reports for the Regional Water Quality Control Board. These monitoring programs are required as part of the commitments made to the Regional Board by the City to gain access to the assimilative capacity afforded by the maximum benefit based objectives for total dissolved solids and nitrogen in the Beaumont and San Timoteo Management Zones.

Maximum Benefit Monitoring Program, Yucaipa Valley Water District

Ms. Weamer maintained and implemented the Maximum Benefit Monitoring Program of the Yucaipa Valley Water District (YVWD). She was responsible for overseeing the collection of data from municipal water agencies and Publicly Owned Treatment Works

and preparing annual reports for the Regional Water Quality Control Board. These monitoring programs are required as part of the commitments made to the Regional Board by the YVWD to gain access to the assimilative capacity afforded by the maximum benefit based objectives for total dissolved solids and nitrate in the Yucaipa and San Timoteo Management Zones.

Hydrogeology GIS Lab, California State University, Fullerton – 2003 to 2008:

Development of Digital Resources and GIS Database for the Mojave Water Agency

Research Assistant: Ms. Weamer contributed to the development of a digital well log inventory and a comprehensive bibliographic resource for the Mojave Water Agency management area. Her work included an extensive field well survey, using GPS, gamma-ray logging, and down-hole video.

Groundwater Investigations of Potential Recharge Areas throughout the Southern Mojave Desert Area.

Research Assistant: Ms. Weamer assisted in drilling, logging, and analyzing a 1,600-foot deep multi-port monitoring well in the vicinity of the Oro Grand Wash.

Water Resource Evaluation and Mapping of Various Sub-basins in the Mojave Water Agency Management Area

Research Assistant: Ms. Weamer prepared comprehensive hydrogeologic reports for numerous sub-basins in the Mojave Water Agency region. These reports were prepared to serve as references for the Mojave Water Agency, interdependent water districts, and associated consulting companies.

Mike Blazevic, PG, CHG

Supervising Hydrogeologist

Expertise:	Mr. Blazevic joined the Wildermuth Environmental team in December 2008, bringing with him over six years of professional experience in the geological and hydrogeological sciences. His technical expertise includes aquifer sedimentology, stratigraphy, and the application of Geographic Information Systems (GIS) to complex hydrological and hydrogeological problems. He has worked throughout Southern and Central California, drilling and testing water supply and monitoring wells; collecting and interpreting basin-wide geologic, hydrogeologic, and hydrogeologic data; and preparing technical reports. And, he has played an important role in many of WEI's surface water and groundwater modeling projects. Mr. Blazevic received a B.S. in Geological Sciences from California State University, Fullerton in 2005 and an M.S. in Geological Sciences from California State University, Fullerton in 2008. His M.S. thesis received the "Best Paper Award" in physical sciences at the 2007 Southern California Academy of Sciences annual meeting and was accepted by the *Journal of Sedimentary Geology* for publication in 2009.
Education:	M.S., Geology, California State University, Fullerton, 2008 B.S., Geology, California State University, Fullerton, 2005
Licenses:	Professional Geologist, California No. 8785 Certified Hydrogeologist, California No. 1010
Professional History:	WEI – 2008 to Present Hromadka & Associates – 2007 to 2008
Professional Experience:	**Drafting Technical Specifications for a New Groundwater Extraction Well in Mammoth Lakes, Mammoth Community Water District** Mr. Blazevic served as the project manager and Supervising Hydrogeologist on this project. The objective of this project was to develop technical specifications for the construction, installation, and testing of a new groundwater extraction well for the MCWD. Mr. Blazevic was responsible for developing a preliminary well design—based on anticipated groundwater production, materials, and local hydrogeology, recommending appropriate drilling methods—and for providing bid support to MCWD. The technical specifications will be used by the MCWD to construct a new well in Spring/Summer 2018. **Bedrock Barrier Investigation, San Juan Basin Authority** Mr. Blazevic served as the project manager and Supervising Hydrogeologist on this project. The objectives of this investigation were to perform exploratory drilling using the resonant sonic drilling method to characterize the lateral extent, depth, and lithologic characteristics of a near-surface rise in the Capistrano Formation (FM) and/or landslide deposits (i.e., displaced or re-worked Capistrano FM) that, if proven to be laterally extensive, would effectively serve as a groundwater-flow barrier between two agencies' well fields. Mr. Blazevic was responsible for drafting the technical

specifications, executing the exploratory drilling plan and technical specifications, and logging and interpreting the lithologic cores. He was also responsible for the exploratory drilling technical summary report.

Drafting Technical Specifications for Four Groundwater Monitoring Wells Near Laurel Pond in Mammoth Lakes, Mammoth Community Water District:

The objective of this project was to develop technical specifications for the construction, installation, and water quality testing of four new groundwater monitoring wells for the MCWD. Mr. Blazevic was responsible for siting the well locations and developing a preliminary well design based on the monitoring well objectives, local hydrogeology, and site conditions. The technical specifications will be used by the MCWD to construct the new monitoring wells in Summer/Fall 2018

Watermaster Engineering Services, Chino Basin Watermaster

WEI has served as the Chino Basin Watermaster's Engineer since the early 1990s. Mr. Blazevic has worked on or managed various tasks for the Watermaster since joining WEI in 2008. Described below are various projects and programs that Mr. Blazevic manages for the Watermaster:

Drafting Technical Specifications for Two Dual-Nested Piezometers for the Pomona Extensometer*:* Mr. Blazevic served as the Supervising Scientist on this project. The objective of this project was to develop technical specifications for the drilling and construction of two dual-nested piezometers for the Pomona Extensometer Facility in the City of Pomona, CA. In the area near the Pomona Extensometer Facility, from 1992 through 2015, up to 1.2 feet of subsidence was measured using InSAR and ground-level surveys, an average rate of about 0.05 ft/yr. The Pomona Extensometer Facility will house four depth-specific piezometers and cable extensometers, and will be constructed to help understand the subsurface lithology in the area of greatest subsidence, provide depth-specific piezometric and aquifer-system deformation data, and help understand the cause-and-effect relationships regarding the subsidence.

Drilling, Construction, and Testing of One Dual-Nested Piezometer: Land Subsidence Monitoring Program*:* Mr. Blazevic provided construction oversight for a single dual-nested piezometer that will be used to house two cable extensometers. Mr. Blazevic was involved in all phases of the well drilling, construction, development, and testing of the new piezometers, including executing field work, such as well construction oversight, logging borehole lithology, and well/annular construction. He was also responsible for the completion of the well construction oversight technical report.

San Juan Watershed Project, Santa Margarita Water District

The Santa Margarita Water District, in conjunction with South Coast Water District, is proposing to implement the San Juan Watershed Project, which would develop facilities to manage surface water resources to enhance groundwater resources of the San Juan Basin. Mr. Blazevic served as the Supervising Hydrogeologist on this project and was responsible for re-developing the San Juan Basin hydrogeologic conceptual model. This work involved: collecting, reviewing, and analyzing new borehole lithology,

aquifer-test, and groundwater level data, and coordinating a geotechnical (CPT) investigation. This information was used to generate hydrogeologic cross-sections that illustrate the updated San Juan Basin hydrogeologic conceptual model. Mr. Blazevic also worked closely with WEI's Engineers and Groundwater Modeler to develop and refine the surface water and groundwater models for the watershed and basin. Both models will be used to assist Santa Margarita Water District in predicting how much storm water and dry-weather discharge will be recharged and recovered by the project, and how existing groundwater production plans will be modified to recover the new recharge.

City of San Bernardino Municipal Water Department:

Drilling, Construction, and Testing of a Groundwater Extraction Well (PW-4) at the RIX Expansion Site in the City of Colton. The City of San Bernardino Municipal Water Department (SBMWD) is currently investigating the feasibility to develop a source of supplemental water to be discharged to the Santa Ana River (SAR) at the Rapid Infiltration and Extraction Facility (RIX) Outfall during temporary RIX shutdown events in order to maintain surface flow in the SAR. One source of supplemental water identified by the SBMWD is to drill a new extraction well at the RIX Expansion Site (RIXES) and convey the pumped groundwater to the RIX Outfall structure. Mr. Blazevic's role in this project was to provide construction oversight during well construction and development phases and to conduct an aquifer test at the new groundwater extraction well. He was also responsible for the completion of the well construction oversight technical report.

Characterization of the Santa Ana River Surface-water and Groundwater Response to RIX Expansion Site Groundwater Production During RIX-temporary Shutdown Events. The objectives of this investigation were to assess flow requirements from the proposed supplemental groundwater wells needed to maintain continuous surface flow in the Santa Ana River between the RIX Outfall and approximately 3,430 ft downstream of Riverside Ave during RIX-temporary shutdowns, determine whether the existing RIXES wells have sufficient capacity to support the pumping required to maintain continuous flow in the river during shutdown events, and assess the effect on the local groundwater basin from proposed supplemental groundwater pumping. Mr. Blazevic worked closely with WEI's Principal Engineer and Hydrogeologist to develop the methodology and to execute the analysis needed to ensure a continuous surface flow in the Santa Ana River during anticipated RIX-temporary shutdown events. The results of this study are currently being implemented by the SBMWD with the construction and installation of a new RIXES extraction well: PW-4.

Analysis of Dry-Weather Discharge and Depth and Historical Characterization of the Santa Ana River from RIX to the MWD Crossing. The objectives of the Santa Ana River analysis were to understand the current depth-discharge relationship under normal and low flow conditions as well as the historical hydrology of the river between the SBMWD's and RIX Outfall and the Metropolitan Water District of Southern California Crossing. Mr. Blazevic was

responsible for coordinating and acquiring high-resolution river channel geometry LiDAR data, collecting and measuring discharge data, and analyzing historical aerial photos. These datasets were used to assist WEI's principal engineers in the development of a hydraulic model in HEC-RAS and to analyze historical discharge-depth relationships along the Santa Ana River.

Cucamonga Valley Water District:

SGMA Adjudicated Basin Reporting for the Cucamonga Basin, *Supervising Hydrogeologist:* The Sustainable Groundwater Management Act (SGMA) established a process for adjudicated or local agencies to report information to the CA Department of Water Resources. Mr. Blazevic was responsible for analyzing the groundwater level measurements, generating groundwater level contour maps, and estimating the annual change in groundwater storage within the Cucamonga Adjudicated Basin boundary. This work involved utilizing geographic information system (GIS) tools and workflows to calculate annual storage change.

Well-Siting Study of Potential Well Sites in the Cucamonga and Chino Basins, *Project Manager and Senior Hydrogeologist:* The objective of this project is to identify and rank a number of potential well sites in the Cucamonga and Chino Basins. For well-siting studies, WEI employs a process that identifies the universe of potential well sites and then applies ranking criteria based on the hydrogeology, spatial distribution of groundwater quality, the proximity to existing potable-water infrastructure, and other related criteria. The goal of the ranking criteria is to filter out the undesirable well locations and rank the best potential sites for new production wells.

State of the Basin Assessment for the Cucamonga Basin, *Senior Hydrogeologist:* The objective of this project was to describe the water resources of the Basin area, including recent changes in groundwater storage, safe yield, and water quality. Mr. Blazevic compiled and reviewed recent reports and updated WEI's groundwater databases with well data: groundwater levels, groundwater quality, and groundwater production. The data collected and compiled has supported the development of a hydrogeologic setting for the Basin. Mr. Blazevic, based on these new data and previous reports, developed new hydrostratigraphic sections and a description of historical groundwater levels.

Depth-Specific Water Quality Sampling from the Summerly Well, Lake Elsinore, Elsinore Valley Municipal Water District

Mr. Blazevic served as project manager and Senior Scientist for this project. The objective of the project was to conduct depth-specific water quality sampling using a dual-packer assembly in a non-potable well to understand and characterize how groundwater flow and water quality changes with depth. Mr. Blazevic was responsible for coordinating with the pump and testing contractors, monitoring the packer testing installation and water quality field parameters, collecting depth-specific water quality samples, and interpreting the downhole spinner surveys. The results of the testing

were used by the EVMWD to determine if the well was drilled and constructed properly.

Feasibility Investigation (Phase 1) to Develop a Potable Water-Supply from the Bedford Basin, Elsinore Valley Municipal Water District/City of Corona/Lee Lake Water District

Mr. Blazevic served as a project manager and Senior Scientist for this project. The Bedford Basin is a relatively small and narrow groundwater basin located within the Upper Temescal Valley and has historically been pumped by private and public water suppliers for non-potable uses. The objectives of the investigation were to characterize and describe the physical structure of the Bedford Basin and how it functions as a groundwater reservoir, specifically with respect to recharge, groundwater flow, discharge, storage, and water quality; to characterize the yield of the Bedford Basin; and to provide recommendations for the Phase 2 investigation. Mr. Blazevic was responsible for collecting, reviewing, and analyzing climate data, surface-water data, geologic and hydrogeologic data, and groundwater level, production, and quality data, and for summarizing the results into a hydrogeologic report. This investigation will assist in developing and describing potential water-supply alternatives for the Bedford Basin.

Hydrogeologic Investigation of the Flagler 3A Well, Elsinore Valley Municipal Water District

Mr. Blazevic served as a project manager and Senior Scientist and for this project. The objectives of this investigation were to provide a hydrogeologic assessment of the Elsinore Valley Municipal Water District's (EVMWD) Flagler 3A groundwater well and to determine if groundwater pumped from Flagler 3A is under the direct influence of surface water from the nearby Temescal Creek. Flagler 3A is an agricultural well located in the northern portion of the Bedford Basin Management Zone along the Temescal Wash. Mr. Blazevic was responsible for coordinating and collecting borehole lithology, groundwater level and quality, and surface water discharge and quality data; reviewing and analyzing groundwater level, surface water, and water quality trends at Flagler 3A; determining the origin of groundwater captured by the well; and summarizing the results into a hydrogeologic report for the EVMWD. The Flagler 3A hydrogeologic assessment will assist the EVMWD in its decision of whether or not to pursue converting Flagler 3A from an agricultural well to a potable supply well.

Design and Construction of Groundwater Extraction Facilities: Strand Ranch Water Banking Facility, CA, Irvine Ranch Water District/AECOM/DJA

Mr. Blazevic served as a Staff Scientist on this project. He provided oversight construction for three triple-nested piezometers and seven extraction wells used to monitor, recharge, and extract up to 17,500 acre-feet of water per year. Mr. Blazevic was involved in all phases of the well drilling, construction, development, and testing of the new wells; including executing field work, such as well construction oversight, logging borehole lithology, and conducting aquifer tests. The data collected in the Strand Ranch area by Mr. Blazevic was used to identify hydrogeologic units, develop a conceptual model, and ultimately create a numerical flow model to estimate the water

level changes resulting from future Strand Ranch extraction well pumping. He was also responsible for the completion of all well construction oversight technical reports.

San Timoteo Management Zone Well Field, City of Beaumont

Mr. Blazevic served as staff scientist on this project. He provided construction oversight and conducted aquifer tests for two artesian wells (a production well and a dual-nested piezometer) in the San Timoteo Management Zone (STMZ). These wells were installed as part of a groundwater monitoring program within the STMZ to provide additional water quality data because there was were insufficient data to perform the triennial recomputation of ambient water quality as required by the Santa Ana Regional Water Quality Control Board to keep it's "Maximum Benefit" status. He was also responsible for the completion of all well construction oversight technical reports.

Application of the Wasteload Allocation Model to Characterize the TDS Impact on the Santa Ana River from Elsinore Valley Water District Recycled Water Discharge, MWH

Mr. Blazevic served as a project manager and Staff Scientist for this project. The objectives of this study were to estimate the mass of TDS discharged to Temescal Creek in excess of EVMWD's TDS permit limit and to use the existing Wasteload Allocation Model (WLAM) to estimate the theoretical impact of EVMWD recycled water discharge to the Santa Ana River. Mr. Blazevic was responsible for analyzing discharge, TDS concentrations, and conductivity data in order to refine the TDS concentration in the EVMWD discharge in excess of their permit limit. He was also responsible for assisting WEI's principal engineers in applying and calibrating the WLAM to estimate the TDS concentration impacts on the Santa Ana River.

WEST YOST ASSOCIATES

Stephen Dopudja, PE

Stephen Dopudja is an engineer with experience managing water resources projects. His experience also includes residential land development and roadway infrastructure improvements, including storm drains. His capabilities range from the planning and computer modeling of water and sewer systems, serving as an Owner's Advisor, to the design and construction of water resource facilities including pump stations, reservoirs, and pipelines. He is experienced in using a variety of project delivery methods including Design-Build, traditional Design-Bid-Build and Public Private Partnerships. Throughout his career, Stephen has worked for private engineering firms in the Southern California area, ranging in size from four employees to 46,000. He has also worked on several international projects.

EXPERIENCE

OWNER'S ADVISORY SERVICES

Public Private Partnership Transaction Services, City of Rialto, CA:
Principal-in-Charge of exploring the feasibility of entering into a 30- year concession agreements or long-term operation agreements for the City of Rialto's domestic water, recycled water, and wastewater collection systems. The City of Rialto wanted to investigate alternatives for procurement of water and wastewater capital delivery and operations services. Services included preparing the RFP, technical appendices, and assistance in preparing the draft and final contract documents. As part of this investigation, Stephen helped evaluate the potential financial impacts of the concession and long-term management alternatives. The financial planning work included preparation of water and wastewater pro forma projections. Additional responsibilities included oversight of the rate impacts and community messaging. Stephen continues in his role to provide ongoing oversight support services for this assignment.

La Bonita Park Water Infrastructure Facilities, City of La Habra, CA:
Project Manager for the preparation of a detailed preliminary design report for the pump and discharge piping for a newly drilled 850 gpm well. In addition, the project included a 16-inch water line to transport import source water to a new 0.25 mg buried concrete reservoir. The well and import source water blend within the tank and are pumped by an 8,000 gpm booster pump station which discharges to a new 24-inch distribution main serving the City's municipal system. The preliminary design was used for the procurement of a final design/build contractor. The project scope included design coordination with the City of La Habra Public Works and Planning Departments and various vendors and subcontractors. Services also included construction management and specialty inspection support to the City of La Habra during construction of the pipeline, well, reservoir, and booster facilities. Numerous civil inspections included concrete and rebar, piping and pipe welding, pump and motor, HVAC, electrical, and geotechnical.

Staff Title: Vice President

Years of Experience: 29

Professional Registrations

- Professional Civil Engineer, California No. 65187

Education

- BS, Civil Engineering, University of Southern California, Los Angeles

Professional Affiliations

- American Water Works Association
- Association of California Water Agencies
- CalDesal
- California Association of Sanitation Agencies
- Colorado River Water Users Association
- Independent Special District of Orange County
- Orange County Water Association
- Trabuco Canyon Water District - Director
  - Engineering Committee
  - Finance Committee Chair
  - South Orange County Wastewater Authority Representative
  - Municipal Water District of Orange County Representative
- Urban Water Institute
- Water Advisory Committee of Orange County

InfoSWMM Conversion and San Diego Creek Interceptor Capacity Project, Irvine Ranch Water District, Irvine, CA: Principal-in-Charge for an update to IRWD's InfoSWMM model of its collection system. The update included reconciling the separate model developed for the Great Parks area with the InfoSWMM model, updating the alignment and slope of the critical San Diego Creek Interceptor, and performing a hydraulic capacity evaluation of the San Diego Creek Interceptor after the update was completed and confirmed.

Lynwood Recycled Water Pipeline Design Services, Central Basin Municipal Water District, Lynwood, CA: Principal-in-Charge for the preparation of plan, profile, and details for the design of approximately 9,250 linear feet of 8-inch and 12-inch diameter recycled water pipeline within existing streets in the City of Lynwood to expand Central Basin MWD's regional recycled water system. The pipeline will connect to several existing services to supply the Lynwood Linear Park, proposed City Hall, and Lynwood Park with recycled water for irrigation purposes. In addition, the pipeline was extended under the 105 Freeway at three locations, which required coordination with Caltrans for approval. The project is located in an area with extensive existing utilities which include oil, low and high pressure gas, potable water, sanitary sewer, large diameter storm drains, and high voltage electric. Several existing utilities were pot-holed during the design phase to provide greater confidence at critical utility crossings. Geotechnical borings were completed to determine soil characteristics and suitability for use as backfill material. Traffic control plans were completed in the design phase of the project to expedite permitting. The project had a short timeframe due to Prop 84 grant funding requirements.

New Model Colony Water and Wastewater Master Planning Peer Review Services, Brookfield Homes, City of Ontario, CA: Principal-in-Charge for conducting peer reviews of several existing water and wastewater master planning reports and available local data for the client to identify inconsistencies within and between reports. Water use and wastewater generation rate comparisons were conducted to determine system planning criteria adjustments based on existing surrounding utility systems. Several inconsistencies and errors within the Master Plans were identified which identified potential efficiencies within the proposed infrastructure sizing.

New Model Colony Wastewater Infrastructure Peer Review Services, Richland America Homes, City of Ontario, CA: Principal-in-Charge conducting peer reviews of the backbone wastewater collection system design criteria for the City of Ontario. The efficiencies identified in the peer review resulted in several million dollars of potential savings for the client.

El Paseo Project Water Supply Assessment (WSA), City of Fresno, CA: Principal-in-Charge for the preparation of a water supply assessment to meet the requirements of SB 610. The El Paseo Project is a 538-acre mixed-use commercial development proposed in the northwest part of Fresno. The City of Fresno did not have a current Urban Water Management Plan at the time, and preparation of the WSA required extensive investigation and understanding of the City's complex surface, ground, and recycled water supplies.

Irvine Lake Pipeline Zone C to Zone B Conversion and Bottom Drain Modifications, Irvine Ranch Water District: Principal-in-Charge for engineering design plans for a conversion of the Irvine Lake Pipeline (ILP) to distribute recycled water. Our design plans included existing modifications to the existing 54-inch diameter ILP to connect to the proposed Eastwood Regional Recycled Water Booster Pump Station Site, tie-over of the ILP to the existing 16-inch diameter Zone B recycled water pipeline near the existing Portola Springs Zone A-C+ Booster Pump Station Site, and modifications to seven bottom drains at various locations along the ILP. Our design included traffic control and permitting through the City of Irvine.

Concession Agreement and Concession Oversight and Potable Water, Recycled Water, and Sewer Master Planning, City of Rialto: Principal Engineer for owners advisory services to the City of Rialto during the preparation and negotiation of a concession agreement to lease the operations and maintenance services of the City's water, wastewater, and recycled water utilities to a private operator for a 25-year period. The preparation of the concession agreement required the identification and prioritization of a 5-year capital facilities plan for the water and wastewater utilities. The concession agreement required the operator to implement the proposed 5-year capital facilities plan water and sewer CIP projects. Upon implementation of the concession agreement by the City, West Yost staff has provided on-going oversight of the systems operator for day to day operations and maintenance and planned CIP project implementation. West Yost recently completed a tri-annual inspection of the water and sewer systems to evaluate the performance of the operator as a requirement of the concession agreement.

WATER/WASTEWATER DESIGN AND CONSTRUCTION MANAGEMENT

Montebello Hills Recycled Water Pipeline and Temporary Pump Station, Central Basin Municipal Water District (CBMWD), Commerce, CA: Principal-in-Charge for the design of a 16-inch recycled waterline and a 2,500 gpm temporary pump station to serve recycled water needed for grading operations for the initial phases of the Montebello Hills development. The project will tie-into an existing 30-inch diameter CML&C pipeline

which is owned and operated by CBMWD. This project is located in an area with numerous existing utility crossings including oil, gas, potable water, storm drains, electric, and fiber optics. Potholing was completed to locate existing utilities along the proposed pipeline alignment. The project scope included design coordination with CBMWD, San Gabriel Water Company, and the City of Montebello. The temporary pump station is a prefabricated pump station, supplied by Grundfos, which contains three constant-speed 1,250 gpm end suction centrifugal pumps. These pumps will pump water through a temporary, above-ground HDPE water main to a temporary water tank used for grading operations.

North Well Replacement Project, Western Municipal Water District, Murrieta, CA: Principal-in-Charge for hydrogeologic services and engineering design to replace the North Well in Western Municipal Water District's Murrieta Division. The existing well was removed from service due to sand production and casing failure. The scope of work includes the destruction of the existing well and above-grade facilities, replacement of the waste drain line for the well, design and equipping of a new 1,000-foot-deep, 1,000 gpm production well, and design of above-grade facilities including a concrete masonry unit building to house electrical equipment and chemical facilities.

Jeffrey Road Waterlines, Irvine Company and Irvine Ranch Water District, Irvine, CA: Principal-in-Charge for the design and construction of approximately 5,000 linear feet of 30-inch, 5,000 liner feet of 16-inch and 3,300 linear feet of 6-inch reclaimed waterline; and 5,000 linear feet of 12-inch potable waterline, between Irvine Boulevard and Portola Parkway. The project designs required extensive coordination with existing utilities, Irvine Ranch Water District, the Irvine Company, and the City of Irvine.

Lake Forest Drive Waterlines, Irvine Company and Irvine Ranch Water District, Irvine, CA: Principal-in-Charge for the design and construction of approximately 5,000 linear feet of 12-inch domestic water main and 5,000 inear feet of 24-inch reclaimed water main. The design included an emergency connection to the Aufdenkamp Turnout facility. The project scope included design and construction support for IRWD, and required coordination with several engineering consultants and various subcontractors.

Lake Forest Drive Temporary Invasion Line, Irvine Company, Irvine, CA: Principal-in-Charge for the design of a 24-inch temporary HDPE and PVC recycled water main. The design included connections with existing water mains, transitions from above to below ground, above ground concrete pipe restraints, and concrete slope anchors. The project scope included design coordination with IRWD, several engineering consultants and various subcontractors. The pipeline design was completed in an expedited frame and is currently in service.

Planning Area 18 Pump Stations, Irvine Ranch Water District, Irvine, CA: Principal-in-Charge for the preliminary planning of IRWD's Zone 3-4 domestic water booster pump station and Zone B-C reclaimed water booster pump station. The planning consisted of site selection, preliminary facility layout, and conceptual design. Plans included multiple site alternatives and improvements, grading alternatives, mechanical equipment, plan and profile of pipelines, electrical design and architectural layouts.

Eastern Municipal Water District (EMWD) Turnout #5, EMWD and Elsinore Valley Municipal Water District, Lake Elsinore, CA: Principal-in-Charge for the design and construction of a 54-inch by 30-inch turnout facility. Responsible for all aspects of the project, including traffic control plans, coordination with Southern California Edison, extensive coordination with the City of Lake Elsinore and respective water agencies.

Shady Canyon Development, Irvine Ranch Water District, Irvine, CA: Project Manager for the preliminary planning and design of the District's capital water facilities. The project included a 0.75 MG reinforced concrete reservoir, 24-, 16-, and 12-inch domestic water pipelines, 24-, 16-, 8-, and 6-inch reclaimed water pipelines, a domestic water pump station, and five domestic water pressure reducing stations. Due to the exclusiveness of this proposed community, considerable effort was given to minimize the visual impact of these facilities on the community.

Quail Hill Development, Irvine Ranch Water District, Irvine, CA: Project Manager for the planning, design and construction of the District's domestic water reservoirs and booster pump station. The project included a 3.5 mg buried pre-stressed concrete reservoir, a 0.6 mg above-ground pre-stressed concrete reservoir and a 2,750 gpm buried booster pump station.

Yucaipa Pump Station, San Bernardino Valley Municipal Water District, San Bernardino, CA: Project Engineer for the design of an 80 cfs pump station with two 900-hp motors and one 1,750-hp motor. Plans included extensive site improvements, mechanical equipment, structural details, reservoir design, surge analysis, plan and profile of pipelines, electrical design and architectural layouts. Due to the unusually large size of the equipment, the masonry building reaches twenty-eight feet at its highest peak. Structural design and architectural impacts, therefore, were critical factors. The structural integrity of the building proved to be the ideal location to incorporate an emergency operations center from which the District could perform its most critical functions

after an earthquake or other natural disasters. The project required extensive coordination between the District, subconsultants and reviewing agencies.

Greenspot Phase II Pump Station, San Bernardino Valley Municipal Water District, San Bernardino, CA: Project Engineer for the design of an 80 cfs pump station with two 600-hp motors and one 1,200-hp motor. This pump station was designed to operate in series with the Yucaipa Pump Station. An interesting aspect of the design was the fact that the Phase II facility with its 3:12 pitched roofs and the existing Phase I facility, 2% sloped roof, had to tie into each other and architecturally appear to be a single pump station.

Foothill Pump Station, San Bernardino Valley Municipal Water District, San Bernardino, CA: Project Engineer for the design of a 120 cfs pump station. Responsibilities included coordination between the District, sub-consultants and reviewing agencies, and scheduling of design phases to ensure project was completed on time.

Markridge Pump Station, Crescenta Valley Water District, La Crescenta, CA: Project Engineer in the design of a 3,500 gpm pump station. Primary responsibilities were coordination with District personnel, electrical engineer, survey crews, and the design of all suction and discharge piping to three separate pressure zones.

Culver Drive Improvements, Irvine Ranch Water District, Irvine, CA: Project Manager for the preliminary planning, final design and construction management for approximately one mile of 16-inch and 12-inch domestic water pipeline.

Southerly Development Infrastructure Improvements, Elsinore Valley Water District, Lake Elsinore, CA: Project Manager for the design and construction of approximately 6,000 linear feet of 24-inch domestic waterline and 16,000 linear feet of 30-inch reclaimed waterlines.

Planning Areas 1 and 2, Irvine Company, Newport Beach, CA: Project Engineer responsible for the conceptual design of domestic water facilities, reclaimed water facilities, and sewer system facilities for this proposed development in the hills of east Irvine. The conceptual design included reservoirs, pump stations and all capital pipelines. Multiple alternatives were considered to determine the most cost effective design to serve the area.

Newport Coast Planning Areas 5 and 6, Irvine Company, Newport Beach, CA: Project Engineer responsible for the conceptual study and design of domestic water facilities, reclaimed water facilities, and sewer system facilities for this proposed development in the coastal hills of Newport Beach. The conceptual design included all capital pipelines and a sewage lift station. This project was complicated due to construction scheduling of surrounding projects on the coast and the impact to existing facilities due to the reduction of housing densities in the area. Stephen's analysis resulted in substantial cost savings and improved system operational characteristics.

Newport Coast Phase 3, Irvine Company, Newport Beach, CA: Project Engineer responsible for the design of domestic water facilities, reclaimed water facilities, and sewer system facilities for this proposed development in the coastal hills of Newport Beach.

South Reservoir Rehabilitation & North Reservoir Painting, City of Azusa, CA: Project Engineer and Construction Manager for the rehabilitation of a 2.5 MG pre-stressed concrete reservoir. Due to the age of the reservoir (approximately 70 years), no original plans existed. Responsibilities included design of repairs, technical specifications, plan coordination and preparation, pre-bid meeting with contractors, shop drawing review, and construction management.

Marshall Canyon Reservoir, City of La Verne, CA: Project Engineer for the design and layout of grading and drainage plans for partially buried 2.5 mg reinforced concrete reservoir. Design includes several AC paved access roads and parking areas for maintenance vehicles.

Portola Parkway Improvement, Irvine Ranch Water District, CA: Project Engineer for the design of approximately 5,300 linear feet of 16-inch reclaimed waterline, 5,300 linear feet of 20-inch potable waterline, and 1,800 linear feet of 18-inch gravity trunk sewer between Jamboree Road and Culver Drive. Plan and profile designs required extensive coordination with Caltrans and the Transportation Corridor Agency to ensure all requirements were met for the bridge crossing over the Eastern Transportation Corridor. Due to the construction schedule of the transportation corridor, potable and reclaimed water pipelines within the corridor right-of-way were completed on a fast track schedule.

Portshead Reservoir, Los Angeles County Waterworks District No. 29, CA: Responsible for the design of a grading plan with an A.C. access road around reservoir to ensure proper drainage to existing 36-inch square drop inlet. This was accomplished while meeting several existing grades on an adjoining dirt access road. Plan was designed to maximize the use of drop inlet while minimizing erosion of the dirt road.

Sierra Madre Reservoir Site Rehabilitation, City of Azusa, CA: Project Engineer for site and grading improvements for a 1½ acre reservoir site. Improvements began with a soil percolation and stormwater runoff analysis to determine if existing drainage facilities had

enough capacity to accommodate a 20-year storm with extensive AC paving of the site. After it was determined that costly drainage improvements would be required, a design was utilized using crushed aggregate over a non-woven geotextile material. Concrete gutters were designed at specific elevations above finished grade of the soil, but below finished grade of the aggregate cover. This design allowed the site to retain and percolate the initial storm peak while extended overflows were diverted by the existing drains without flooding the site.

On-Call Plan Check Services, Irvine Ranch Water District, Irvine, CA: Project Manager for the review of water and sewer plans for the District to check compliance with their standards and construction feasibility.

On-Call Assistance Services, Irvine Ranch Water District, Irvine, CA: Project Manager to provide the District with any project management or staffing needs.

MASTER PLANNING

Water, Wastewater, Recycled Water and Asset Management Master Plans, City of Rialto, CA: Principal-in-Charge for the Water, Wastewater, and Recycled Water Master Planning services for the City of Rialto in support of their concession agreement. Each Master Plan report addressed comprehensive planning, engineering criteria, flow/demand projections, hydraulic modeling, regulatory requirements, operations and maintenance activities, and recommendations for improvements. The potable water master plan also specifically addresses supply sources and storage volume evaluations. The City's water system serves several industrial complexes and consists of multiple pressure zones. The scope also includes an Asset Management task to determine the funding level needs to replace and refurbish system assets and a schedule for planning the replacement and refurbishment of system assets.

Wastewater Master Plan Update, City of Rialto, CA: Project Manager for the GIS collection, computer modeling and master planning of the City's backbone sewer collection system. The GIS collection was required due to the minimal existence of any accurate atlas plans or system as-built plans. All system manholes were located in the field using survey GPS and entered into the GIS database. The backbone system was then modeled under multiple scenarios to determine existing and future deficiencies. A master plan with recommended improvements and associated cost was also prepared and presented to the client.

Montebello Hills Water Master Plan, Cook Hill Properties, Montebello, CA: Principal-in-Charge for the Domestic Water System and Recycled Water System Planning and assisted the developer in negotiating with the local water company for updated planning and design criteria for a new development that consisted of approximately 400 acres and 1,200 homes. This project involved careful preparation with the environmental impact report as well as the preparation of a master plan and cost estimates.

On-Site Domestic Water System Report by R.W. Beck, Cook Hill Properties, Newport Beach, CA: Stephen Dopudja provided detailed domestic water master planning for the Montebello Hills development. The preparation of the water system report included land use and water demands, water system description and planning criteria, system analysis for fire flow and redundancy, and a cost summary. Stephen worked with San Gabriel Valley Water Company to obtain concensus on planning for system expansion to serve the project.

Southerly Development Water Master Plan, Elsinore Valley Water District, Lake Elsinore, CA: Project Manager for the Domestic Water System update for the Southerly Development. The update included the modeling of a proposed well field and treatment system.

El Toro Road Sewer Capacity Analysis, Irvine Ranch Water District, Irvine, CA: Project Manager for a complete sewer system analysis and hydraulic model of the District's El Toro Road Sewer. The project evaluated the impact of abandoning the El Toro Road Sewage Lift Station, and determining the effects and the downstream sewer system and upstream tributary area.

Water Master Plan, Crescenta Valley Water District, La Crescenta, CA: Project Manager, responsible for planning and computer modeling of the District's complex distribution system. The master plan involved a detailed modeling to analyze all of the distribution systems piping. This master plan was unique due to complexity and age of the system. A total of eleven pressure zones were modeled.

Ladera Sewer Feasibility Study, Santa Margarita Water District, Santa Margarita, CA: Project Engineer for the conceptual/ feasibility study for this development in southern Orange County. The study analyzed numerous alternatives to determine the most cost effective methods for sewering the development. Such alternatives included the construction cost versus operational cost, for gravity lines versus lift stations.

Sewer Master Plan, City of La Verne, CA: Project Engineer responsible for the computer modeling of the City's five sewer system zones, and preparation of the report. The master plan included analysis of the City's collection system and the Los Angeles County Sanitation District's trunk mains.

LAND DEVELOPMENT SERVICES

Planning Area 17 Quail Hill Development, Irvine Company, Newport Beach, CA: Project Manager for the Tentative Map, Phase 1 and 2 Rough Grading Plans, storm drain infrastructure and construction phase services for the Irvine Company's master planned village known as Quail Hill. The project required the excavation and grading of approximately 15 million cubic yards of dirt for the development of 2,500 units.

Portola Parkway Infrastructure Improvements, Irvine Company, Newport Beach, CA: Construction Manager/Support for the construction of all assessment district facilities for the above mentioned project. Project included the construction a primary highway, storm drain facilities, and the water and sewer facilities listed above.

Planning Area 12 Oak Creek Infrastructure Improvements, Irvine Company, Newport Beach, CA: Project Engineer and Construction Manager/ Support for the design and construction of all assessment district facilities. Project included the widening of Alton Parkway, a primary highway, and construction of numerous secondary highways within the development. The project also included the construction of storm drain facilities, domestic water pipelines and pressure reducing station, reclaimed water pipelines and sewer facilities

Ritter Ranch Feasibility Analysis and Cost Estimate, Sage Community Group, Newport Beach, CA: Senior Project Engineer for the Feasibility Analysis and $500 Million dollar cost estimate for a 10,000 acre master planned community. Project included a comprehensive analysis of grading and all infrastructure to support the proposed development.

WEST YOST ASSOCIATES

Kristen Whatley, PE

Kristen Whatley is an engineer with experience working on and managing water resource projects. Her capabilities range from the planning and computer modeling of water systems, designing and bidding of water resources including wells, water treatment, booster pump stations, reservoirs, and pipelines. Project experience includes serving as the project manager on major water resources and wastewater design and permitting projects and residential land development projects; water storage, treatment, and distribution projects; and master planning efforts on several land development projects including coordination with regulatory agencies.

EXPERIENCE

North Well 2 Equipping Design, Western Municipal Water District, Murrieta, CA: Project Engineer for the equipping design of a replacement production well, CMU building and Chloramination facilities. Well equipping includes the design of 1,000 gpm vertical turbine pump with a variable frequency drive and discharge piping , valving, and appurtenances. Design of Chloramination equipment included chemical storage tanks, pumping systems and analyzers.

Live Oak Well 7, City of Live Oak, CA: Project Manager for the preliminary and final design for a new well, water treatment, chlorination system, gravity sewer main, and potable water transmission main. Well equipping included the design of vertical turbine pumping equipment with a variable frequency drive motor for a 1,000 gpm production well. Water treatment plant included design and coordination with manufacturer for an Adsorption/Catalytic Oxidation treatment plant using vertical steel pressure vessels with a proprietary media (AS-700 by ATEC) to treat Arsenic and Manganese. A sodium hypochlorite chlorination system was designed to achieve raw water chemical oxidation and to provide disinfectant residual after treatment. In addition, chemical facilities were designed to provide Potassium Permanganate and Ferric Chloride to the water treatment plant. The well and treatment plant site was laid out with locations identified for future expansion to add an additional production well and to expand the treatment plant if it is determined that additional treatment will be required.

Well No. 23 & Arsenic Water Treatment Plant Design and Bidding, Sahuarita Water Company, Sahuarita, AZ: Project Manager for the design, project bidding services and construction administration to construct a new 1,600 gpm well (Well 23) with a 5,000 gallon surge tank and air compressor, and a centralized arsenic treatment facility for Sahuarita Water Company. The new centralized facility will treat source water from two existing wells and one new well. The treatment plant consisted of a chlorination facility, static mixer, cartridge filters, filter vessels, and a modulating control valve. The modulating control valve at the treatment plant controls the amount of raw groundwater that will bypass the treatment plant and blend with the treated water. In addition, the modulating control valve controls the raw water bypass flow to achieve a target arsenic concentration in the blended water and to optimize the

Staff Title: Senior Engineer II

Years of Experience: 16

Professional Registrations

- Professional Civil Engineer, California No. 84665, Arizona No. 45171
- California Grade 2 Water Distribution and Treatment Operator
- Arizona Grade 2 Water Distribution and Treatment Operator

Education

- BS, Environmental Engineering, Northern Arizona University, Flagstaff

Professional Affiliations

- American Water Works Association
- California Water Environment Association
- Orange County Water Association
- Arizona Water Association

usage of adsorption media. Adsorption media within the filter vessels reduce the arsenic concentration in the raw groundwater to achieve a target setpoint of 7 ppm. The treatment plant is equipped with two parallel adsorption trains. Each train consists of two adsorption units or vessels, operating in series. The second adsorption unit in each train provides finishing treatment or break-through protection. The blended water then flows to adjacent reservoirs. A tablet feed chlorinator was designed to provide a chlorine solution at the inlet and outlet of the treatment plant. The chlorine solution oxidizes As3 to As5 in the raw groundwater water before entering the adsorption trains. The chlorinator also maintains the chlorine residual in the treated water as it leaves the treatment plant. The treatment plant utilized a newly manufactured regenerable adsorptive media which met both NSF and Arizona Department of Environmental Quality requirements.

Extensive coordination was required with many design professionals, water company staff, vendors, contractors, and regulators to accomplish this project. This facility was the first adsorptive plant to implement the regenerable media and pilot testing was conducted to verify the overall performance against existing disposable media. The project was partially funded by American Recovery and Reinvestment Act grants and low interest loans. The timeframe for design, bidding, and construction on this project was constrained and required weekly coordination meetings to insure the project remained on schedule and outstanding issues were resolved in a timely manner. The project was successfully completed and is currently in service. **The project won an award from the Arizona Water Organization for "Water Treatment Plant of the Year."**

Community Water Wells 10 and 11 Well, Reservoir, Booster Pump Station, Arsenic Treatment, and Pipeline Design, Community Water of Green Valley, Pima County, AZ: Project Manager for the design and project coordination for construction of the Community Water Well Nos. 10 and 11 sites, including arsenic treatment facilities, new 300,000-gallon forebay reservoirs, , 5,000 gallon surge tank and air compressors, and 2,500 gpm booster pump stations at each well site. Community Water of Green Valley required replacement source capacity due to sulphur contamination in existing wells. The newly equipped wells were designed to pump through a coagulation filtration arsenic treatment process into an onsite forebay reservoir. Treated potable water is then pumped from the reservoir through a booster station and distributed to existing floating reservoirs. In addition, several miles of 16-inch water main was designed and constructed. The pipeline design required coordination with Arizona Department of Transportation to obtain a permit to cross Interstate 19. Extensive coordination was required with many design professionals, water company staff, vendors, contractors, and regulators to accomplish this project. The time frame for design and construction on this project was constrained and required weekly coordination meetings to insure the project remained on schedule.

Red Rock Nitrate Treatment Plant Design, Red Rock Utilities, Pinal County AZ: Project Manager for the design and project coordination to construct a Nitrate treatment facility to treatment water from a new well. The nitrate treatment facility, located at the Red Rock Water Plant No. 1 site, was designed to remove nitrate from source groundwater. The well pumps through an ion exchange nitrate treatment process into an existing onsite forebay reservoir. The nitrate treatment facility was installed at the discharge of the wellhead to treat the half of the full flow of 800 gpm to an approximate final blended (half treated, half bypassed) Nitrate concentration of 8 ppm or less. The Nitrate treatment facility consists of four steel filtration vessels which contain a chloride form of anion exchange resin media. Nitrate ions are exchanged onto the media releasing chloride ions resulting in a reduced concentration of Nitrate in the treated water. The media is then backwashed with a sodium chloride brine solution to remove the nitrate ions and replace them with fresh chloride ions. The spent brine backwash water is sent to a holding tank for continuous low flow disposal to the public sewer system. Extensive coordination was required with many design professionals, water company staff, vendors, contractors, and regulators to accomplish this task.

Red Rock Potable Well, Reservoir and Booster Pump Station Design, Bidding, and Construction Support, Red Rock Utilities, Pinal County, AZ: Project Manager for the design and project coordination to construct two new wells, a forebay reservoir, booster pumping station, and surge tank and air compressor to serve Phase I of Red Rock, a master planned development in Pinal County. The two wells were designed with a capacity of 750 gpm and pump directly to the 900,000 gallon forebay reservoir. The new 2,000 gpm booster pump station pulls water from the reservoir and discharges to the distribution system. The booster pump station was designed to be expandable to serve future buildout conditions. Kristen also provided technical support during the construction phase of this project.

La Bonita Park Potable Water Reservoir, Well, Booster Pump Station, and Pipeline Preliminary Design, Procurement and Construction Support, City of La Habra, CA: Project Manager for a detailed preliminary design report for the pump and discharge piping for a newly drilled 850 gpm well. In addition, the project included a 16-inch water line to transport CDWC source water to a new 0.25 MG buried concrete reservoir. The well and CDWC source water blends within the tank and is pumped by a 8,000 gpm booster

pump station which discharges to a new 24-inch distribution main to serve Zone 1 of the City's municipal water system. The preliminary design was used for our procurement of the final design/build Contractor. The project scope included design coordination with the City of La Habra Public Works and Planning Departments and various vendors and subcontractors. The project was successfully completed on time and on budget and has been constructed. Kristen also provided construction management and special inspection support to the City of La Habra Public Works during construction of the pipeline, well, reservoir, and booster facilities. Kristen was responsible for coordinating numerous civil inspections which include concrete and rebar, piping and pipe welding, and geotechnical. In addition, Kristen provided assistance to the City for plan and shop drawing reviews.

Water Services Rate Study Capital Facilities Assessment, City of Garden Grove, CA: Project Manager/QA/QC for the Capital Facilities Plan Assessment for the Garden Grove Water Services Rate Study. The project included a review of the City's current Water Master Plan and other available documents and coordination with City and public works staff to identify CIP project priorities necessary to develop an immediate and long-term capital plan. Factors prioritizing the capital improvements included the revenue requirements for existing operations, water consumption, system reliability, capital improvements and what would be considered an acceptable rate increase to the community. A summary report was prepared to describe the basis for prioritization. In addition, escalated cost estimates were prepared to implement the projects identified in the Capital Facilities Plan, which were used in the water rate study.

Concession Agreement and Potable Water, Recycled Water, and Sewer Master Planning, City of Rialto, CA: Project Engineer/QAQC for owners advisory services to the City of Rialto during the preparation and negotiation of a concession agreement to lease the operations and maintenance services of the City's water, wastewater, and recycled water utilities to a private operator for a 25-year period. The preparation of the concession agreement required the identification and prioritization of a 5-year capital facilities plan for the water and wastewater utilities. The concession agreement required the operator to implement the proposed 5-year capital facilities plan water and sewer CIP projects. Upon implementation of the concession agreement by the City, West Yost staff has provided on-going oversight of the systems operator for day to day operations and maintenance and planned CIP project implementation. West Yost recently completed a tri-annual inspection of the water and sewer systems to evaluate the performance of the operator as a requirement of the concession agreement.

New Model Colony Water and Wastewater Master Planning Peer Review Services, Brookfield Homes, City of Ontario, CA: Project Manager for conducting reviews of several existing water and wastewater master planning reports and available local data for the client to identify inconsistencies within and between reports. Water use and wastewater generation rate comparisons were conducted to determine system planning criteria adjustments based on existing surrounding utility systems. Several inconsistencies and errors within the current City of Ontario, New Model Colony Master Plan were identified, which could result in significant planned infrastructure sizing revisions and potential cost savings. Kristen also evaluated existing wastewater design criteria and compared this to criteria used by existing surrounding utility systems to identify the criteria as overly conservative.

WEST YOST ASSOCIATES

Andrew J. (AJ) Connell, EIT

AJ Connell is a civil engineer-in-training with experience in water resource evaluation, water and sewer system modeling, Civil 3D water and sewer pipe design, and asset management program review.

EXPERIENCE

North Well 2 Equipping Design, Western Municipal Water District, Murrieta, CA: Staff Engineer responsible for utility location and conflict identification. Project includes the equipping design of a replacement production well, CMU building and Chloramination facilities. Well equipping includes the design of 1,000 gpm vertical turbine pump with a variable frequency drive and discharge piping , valving, and appurtenances. Design of Chloramination equipment included chemical storage tanks, pumping systems and analyzers.

Live Oak Well 7, City of Live Oak, CA: Staff engineer for the preliminary and final design for a new well, water treatment, chlorination system, gravity sewer main, and potable water transmission main. Primarily responsible for the layout and design of the potable transmission main connection well to the collection system. Well equipping included the design of vertical turbine pumping equipment with a variable frequency drive motor for a 1,000 gpm production well. Water treatment plant included design and coordination with manufacturer for an Adsorption/Catalytic Oxidation treatment plant using vertical steel pressure vessels with a proprietary media (AS-700 by ATEC) to treat Arsenic and Manganese. A sodium hypochlorite chlorination system was designed to achieve raw water chemical oxidation and to provide disinfectant residual after treatment. In addition, chemical facilities were designed to provide Potassium Permanganate and Ferric Chloride to the water treatment plant. The well and treatment plant site was laid out with locations identified for future expansion to add an additional production well and to expand the treatment plant if it is determined that additional treatment will be required.

Murrieta Retail Area Water Master Plan Update, Western Municipal Water District, Murrieta, CA: Project Engineer for the Murrieta Retail Area Water Master Plan Update completed for Western Municipal Water District (WMWD). This project included using a hydraulic model to update the pumping, storage, and transmission infrastructure recommendations based on recently refined development, demand, and supply information. Water supplies from several wells were integrated into the distribution system. As project engineer, AJ completed all the hydraulic modeling for the area and developed CIP's and recommendations for upgrades to the transmission system. AJ also identified locations for new storage facilities and developed ways to connect those proposed storage facilities to the existing system, as well as sizing and completing cost estimates for the construction of those facilities.

Montebello Hills Feasibility Study and Design of On-Site and Domestic Recycled Water Pipeline, Pump Station, and Reservoirs, San Gabriel Valley Water Company (SGVWC), Montebello, CA: Project Engineer

Staff Title: Engineer I

Professional Registrations

- Engineer-in-Training, California No. 162792

Education

- BS, Civil Engineering, San Diego State University, California

for a domestic and recycled water planning project to serve a new residential development within the City of Montebello. As part of the project scope, West Yost coordinated directly with SGVWC and Central Basin Municipal Water District to establish planning criteria and to estimate proposed infrastructure sizing. Provided utility coordination for the design of the on-site backbone domestic and recycled water pipelines, three domestic water and one recycled water booster pump station, and two domestic water storage tanks to serve the development.

Moulton Niguel Water District Hazard Mitigation Grant Program Support, Moulton Niguel Water District, Laguna Niguel, CA: Project Engineer for the development of grant applications for Moulton Niguel Water District. AJ developed cost estimates and a project schedule for the seismic retrofit of 18 potable water reservoirs of different sizes and dimensions. Retrofits at each reservoir included replacing inlet/outlet and drain couplings with flexible, seismically sound couplings. Retrofits also included the widening of the ring wall foundation.

SCE Electrical Impact Study, Irvine Ranch Water Company, Irvine, CA: Project engineer for the Electrical Impact Study completed on Irvine Ranch Water District's recycled water system for SCE. The purpose of this project was to analyze the energy consumption of the pumps and assess the feasibility of shifting pumping periods to better align with daily and seasonal overgeneration periods, when electricity is more abundant. AJ was involved with developing the two alternatives to the existing pumping operations. AJ created an excel tool designed to simulate an entire year of operating under each of the two alternatives using output results from a 10-day hydraulic model simulation. The excel tool became one of the most important parts of the project, as it calculated the yearly energy consumption results that were used to create the conclusion of the project.

North Davis Meadows Water System Consolidation, Yolo County, CA: Staff Engineer for the design potable water pipeline to serve the North Davis Meadows residential community. Provided drafting design of plan and profile drawings for the pipelines. The North Davis Meadows project included the plan and profile design of approximately 12,800 linear feet of PVC pipeline to connect the North Davis Meadows water service area with the City of Davis water system to supply potable water. The project also replaced water services and meters to existing customers. Provided drafting design for individual lot layouts to identify the replacement of existing potable water meter services to 95 homes.

S1 Wastewater Treatment Plant Improvements Project, City of Rialto, CA: Provided engineering support for the S1 Wastewater Treatment Plant (WWTP) Improvements Project by reviewing audio meeting logs and meeting minutes to confirm the documentation and implementation of action items agreed upon during meetings at each stage of the project. The project involved major upgrades to the treatment process of the City's only WWTP.

2012-2015 Triennial Inspections Review, City of Rialto, CA: Staff engineer for the Triennial Inspections Report, which included the review of inspection records and performance data to determine operator compliance with the 2012 City of Rialto Concessions Agreement. AJ reviewed data and records as part of the report, including the concession agreement between the City of Rialto and Rialto Water services, all applicable National Pollutant Discharge Elimination System and South Coast Air Quality Management District permits, Oracle Utilities: Work and Asset Management computerized maintenance management system, California Regional Water Quality Control Board notices of non-compliance, monthly operating reports, annual operating reports, list of capital projects, daily capital project construction reports, facility inspection reports, and all applicable emergency plans and procedures.

Washington Park Reservoir Improvements Project, Portland Water Bureau, Portland, OR: Staff Engineer for the Washington Park Reservoir Improvements, which included the demolition of a historic open reservoir in a new distribution system and the replacement of the reservoir with a buried reinforced concrete reservoir in challenging seismic conditions. Reviewed plans and specifications from multiple sources and subconsultants to ensure consistency across all submittals.

Lynwood Recycled Water Pipeline Design, Central Basin Municipal Water District, Lynwood, CA: Staff Engineer completing the utility coordination and research for the project, which included the design of 950 linear feet (lf) of 8-inch-diameter recycled water main and 8,300 lf of 12-inch-diameter recycled water line to expand recycled water service within the City of Lynwood. This project is located in Fernwood Avenue and Bullis Road, with extensions across Interstate 105 freeway underpasses at Atlantic Avenue, Harris Avenue, and Bullis Road. The project ties into an existing Central Basin Municipal Water District (CBMWD) recycled water pipe in Wright Road. These project alignments include numerous existing utility crossings including: oil; low- and high-pressure gas; potable water; sanitary sewer; large-diameter storm drains; and high-voltage electric. Potholing will be completed to field locate several potential utility conflicts prior to construction. Geotechnical borings were completed to determine soil characteristics and suitability for use as backfill. Traffic control plans were completed in the design

phase of the project. The project scope included design coordination with local utility representatives, CBMWD, the City of Lynwood, and several subconsultants.

Wastewater Collection System Master Plan, Dublin San Ramon Services District, Dublin, CA: As part of the long-term management evaluation, used flow monitoring data to evaluate inflow and infiltration (I/I) and R-value trends for 15 sub-basins within the District. Using preliminary hydraulic CIP results, identified potential areas for I/I reduction that could eliminate hydraulic deficiencies. Developed GIS maps for basin I/I characteristics, pipe age, material, and groundwater influence.

On-Call District Engineer (Engineering Support), Castro Valley Sanitary District, Castro Valley, CA: Project engineer for the development of GIS figures for sanitary system inflow and infiltration characterization.

Irvine Lake Pipeline Zone C to Zone B Conversion and Bottom Drain Modifications, Irvine Ranch Water District, Irvine, CA: Staff Engineer for a conversion of the Irvine Lake Pipeline (ILP) to distribute recycled water. Completed the utility coordination and research for the project. The design plans included modifications to the existing 54-inch-diameter ILP to connect it to the proposed Eastwood Regional Recycled Water Booster Pump Station Site, tie-over of the ILP to the existing 16-inch-diameter Zone B recycled water pipeline near the existing Portola Springs Zone A-C+ Booster Pump Station Site, and modifications to seven bottom drains at various locations along the ILP. The design included traffic control and permitting through the City of Irvine.

Whittier Alley Sewer Replacement, City of Whittier, CA: Staff Engineer for the design of approximately five miles of gravity sewer replacement and upsizing within the City of Whittier. Completed the utility research and coordination for the project. The project replaced three existing 6-inch-diameter gravity sewer segments with 8-inch-diameter gravity sewer located in the alley west of Washington Avenue between Hadley Street and Walnut Street and the alley west of Newlin Avenue between Hadley Street and Wardman Street.

PROFESSIONAL CONSULTANT SERVICES AGREEMENT

1. IDENTIFICATION

This PROFESSIONAL CONSULTANT SERVICES AGREEMENT, hereinafter referred to as "Agreement," made and entered into this 20th day of March 2019, by and between Walnut Valley Water District, a public corporation organized and existing under the provisions of the California Water Code, hereinafter referred to as "WVWD," and Wildermuth Environmental, Inc., hereinafter referred to as "Consultant".

2. RECITALS

2.1 WVWD has requested proposals from professional consulting firms to provide professional services in support of developing a Groundwater Sustainability Plan (GSP) for the Spadra Basin, at a not-to-exceed cost of $703,389.

2.2 Consultant has submitted proposal and WVWD has approved the award of the work to the Consultant subject to preparation and execution of a formal agreement.

2.3 WVWD and Consultant desire to enter into a contract for the preparation of the proposed services subject to the terms and conditions of this Agreement.

3. AGREEMENT

NOW THEREFORE, in consideration of the promises and covenants hereinafter contained, it is mutually agreed as follows:

3.1 WVWD hereby retains Consultant to perform the services as set forth in Exhibits A and B. Consultant agrees to perform such services in a timely and professional manner and with due diligence. The services are not subject to modification unless Consultant obtains written authorization from WVWD.

3.2 The Principal Hydrogeologist for the Consultant shall be Mr. Andy Malone, who shall manage and direct the technical effort of the Consultant and be the Consultant's liaison with the WVWD.

3.3 Consultant, at its sole cost, shall procure and maintain at all times during this Agreement: (a) statutory Workers' Compensation Insurance coverage per provisions of Section 3700 of the California Labor Code together with employer's liability coverage of $1 Million, (b) General Liability Insurance (insuring against bodily injury and property damage) with a minimum coverage of $1 Million for each occurrence and a $2 Million aggregate, and naming the WVWD as an additional insured, (c) Automobile Liability Insurance with a minimum coverage of $1 Million per accident for bodily injury and property damage, and (d) Professional Liability Insurance with a minimum coverage of $1 Million per claim and annual aggregate.

The policy or policies of insurance so provided shall contain a contractual liability endorsement covering the liability assumed by the Consultant by the terms of this Agreement. The above-referenced insurance policy (or policies) shall be furnished at the Consultant's expense, in a form and with insurance companies

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authorized to do business and have an agent for service of process in California and have an "A-" policyholder's rating and a financial rating of at least Class VII in accordance with the most recent Best's Insurance Guide, or as otherwise approved by the WVWD. If Best's is no longer published, comparable ratings must be provided from a service acceptable to WVWD. Such insurance policies shall have provisions providing that insurance furnished thereunder shall be considered primary as to Consultant's services with respect to any policies of insurance maintained by WVWD. Said policy(ies) shall also contain provisions requiring that the coverage cannot be reduced or canceled without giving WVWD thirty (30) days prior written notice.

Before performing any work, the Consultant shall furnish certificates of insurance evidencing the foregoing insurance coverage.

3.4 Consultant shall indemnify and hold harmless the WVWD, its Board members, appointed officers, agents, and employees from and against any and all claims, demands, costs, expenses, losses, or liabilities in law or in equity, including, but not limited to injury to or death of any person, and damages to or destruction of property of any person, arising out of:

a. The wrongful misconduct or negligent acts, errors or omissions of Consultant, so long as such claims, demands, costs, expenses, losses or liabilities do not result from the sole negligence or willful misconduct of WVWD or any of its board members, officers, employees, agents, or volunteers, provided that if such claims, demands, costs, expenses, losses or liabilities arise from the negligence of the WVWD or any of its board members, officers, employees, agents or volunteers (other than its or their sole negligence), then Consultant's obligation hereunder shall be allocated in accordance with comparative negligence principles under California law;
b. The violation of governmental laws or regulations, compliance with which is the responsibility of the Consultant.

Consultant shall pay and satisfy any judgment, award or decree that may be rendered against the WVWD or any of its elected board, appointed officers, agents, volunteers and employees in any and all such aforesaid suits, actions or other legal proceedings.

Consultant shall reimburse WVWD or any of its board members, officers, employees, agents, or volunteers for any and all legal expenses and costs incurred by each of them in connection therewith.

Consultant's obligation to indemnify shall not be restricted to insurance proceeds, if any, received by the WVWD or its elected Board members, appointed officers, agents, volunteers or employees.

3.5 WVWD shall have the right to terminate this Agreement at any time upon five (5) days written notice to Consultant. In the event of such termination, WVWD shall compensate Consultant through the notice date for services actually performed hereunder in accordance with the rates set forth in Exhibit B, but in no event shall WVWD be obligated to pay more than the maximum compensation set forth in Exhibit B (or as said Exhibit B may be amended).

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3.6 WVWD shall pay Consultant the compensation in the amount, time, and manner set forth on the attached Exhibit B.

3.7 This Agreement shall not be assigned by Consultant without the written consent of WVWD.

3.8 To the extent there is any conflict or inconsistency between the terms of this Agreement and the terms of the Consultant's proposal as set forth in Exhibit A, the terms of this Agreement shall govern.

3.9 Consultant shall procure, at their expense; all permits required by governmental authorities and shall comply with all applicable local, state and federal regulations and statutes including Cal-OSHA requirements.

3.10 Consultant shall comply with Labor Code Section 1775. In accordance with said Section 1775, the Consultant shall forfeit as a penalty to the WVWD, a penalty in such amount as the Labor Commissioner shall determine for each calendar day or portion thereof for each worker paid less than the stipulated prevailing rates for such work or craft in which such worker is employed for any work done under this Agreement by them or by any sub-Consultant under them in violation of the provisions of the Labor Code and, in particular, Labor Code Sections 1770 to 1780, inclusive. In addition to said penalty and pursuant to said Section 1775, the difference between such stipulated prevailing wage rates and the amount paid to each worker for each calendar day or portion thereof for which each worker was paid less than the stipulated prevailing wage rate shall be paid to each worker by the Consultant.

3.11 Consultant shall not discriminate against any employee or applicant for employment because of race, sex (including pregnancy, childbirth or related medical condition), creed, national origin, color, disability as defined by law, disabled veteran status, Vietnam veteran status, religion, age, medical condition, marital status, ancestry, or sexual orientation.

3.12 WVWD will make available to the Consultant such materials from its files as may be required by the Consultant to perform these services. Such materials shall remain the property of the WVWD while in Consultant's possession. Upon termination of the Agreement or completion of work under the Agreement, Consultant shall turn over to the WVWD any WVWD property or materials in its possession and any calculations, notes, reports, electronic files or other materials prepared by Consultant in the performance of these services.

WVWD may utilize any material prepared or work performed by the Consultant in any manner, which WVWD deems proper without additional compensation to the Consultant. Consultant shall have no responsibility or liability for any revisions, changes or corrections made by WVWD or any use or reuse pursuant to this paragraph unless Consultant accepts such responsibility in writing.

3.13 Consultant shall not make public information releases or otherwise publish any information obtained or produced by it as a result of, or in connection with, the performance of services under the Agreement without prior written consent of the WVWD.

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3.14 Consultant shall not publish or use any advertising, sales promotion or publicity in matters relating to services, equipment, products, reports, and material furnished by the Consultant in which WVWD's name is used or its identity is implied without prior written approval by the WVWD.

3.15 This Agreement shall not be assigned by the Consultant without the written consent of WVWD.

3.16 In the event any action or proceeding is brought by either party to enforce any term or provision of this Agreement, the prevailing party shall recover its reasonable attorneys' fees and costs.

3.17 Written notices shall be deemed to have been given when mailed by the United States mail, postage prepaid, addressed to the parties to this Agreement.

3.18 At all times during the term of this Agreement, Consultant shall be deemed to be an independent contractor and not an employee of WVWD.

3.19 This Agreement contains the entire agreement between the parties hereto and supersedes any prior or concurrent written or oral agreement between said parties concerning the subject matter contained herein.

3.20 The validity, interpretation, and performance of this Agreement shall be controlled by and construed under the laws of the State of California. The parties hereto do hereby consent to the jurisdiction of the California courts in the event any dispute arises in conjunction herewith.

3.21 If any provision of this Agreement, or the application thereof under certain circumstances, is held invalid, the remainder of this Agreement, or the application of such provision under other circumstances, shall not be affected thereby and shall remain valid and enforceable.

3.22 The signatories to this Agreement represent that they have the authority to execute this Agreement.

3.23 This Agreement has been prepared jointly by the parties. Any uncertainty or ambiguity shall not be construed for or against any party based on attribution of drafting to any party.

The parties hereto have caused this Agreement to be duly executed by its authorized officers.

WALNUT VALLEY WATER DISTRICT

By _____
Erik Hitchman, General Manager

Date April 4, 2019

WILDERMUTH ENVIRONMENTAL, INC.

By _____

Its President

Date 4-2-2019

Exhibit "A"

SCOPE OF WORK

The Consultant shall perform the work necessary for the provision of professional services in support of developing a Groundwater Sustainability Plan (GSP) for the Spadra Basin, as described in their proposal to the WVWD dated February 26, 2019, copy on file with the WVWD.

Exhibit "B"

METHOD OF COMPENSATION

Payment for this work shall be on a time and material basis with a pre-approved, not-to-exceed limit based on the proposal amount of $703,389 submitted by Consultant and awarded by the WVWD. Additional funds will only be authorized for work requested by the WVWD and clearly beyond the scope of work identified herein. All additional work to be performed must have prior written approval by the WVWD. Monthly progress payments will be made based on the Consultant's invoice and the WVWD's concurrence with the project's progress. Each invoice must delineate work completed relative to costs billed, include the percentage of progress completed to date, and be submitted to the WVWD by the first work day of each calendar month in order to be considered for payment authorization in that month. Payments will normally be made on or about the third Tuesday of said month and will be for work completed in the previous month. Said payments shall include full compensation for furnishing all labor, services, material, equipment, supplies, insurance, and all other items and facilities necessary to complete the work specified.

Regarding the WVWD's right to audit: (1) Consultant shall be responsible for ensuring the accuracy and propriety of all billings and shall maintain all supporting documentation for the project, (2) for a period of three years following completion of performance of the services specified in the Scope of Work, WVWD will have the right to audit Consultant's and sub-contractor's invoices and all supporting documentation for purposes of compliance with this Agreement, and (3) Consultant shall cooperate fully with any audit of its billings conducted by the WVWD and permit access to its books, records, and accounts as may be necessary to conduct such audits.