

EUREKA_005

Dale C. Bugenig

Dale C. Bugenig, Consulting Hydrogeologist, LLC.

Hydrogeologist/Owner

Education

M.S., Hydrology and Hydrogeology,
University of Nevada, Reno

B.A., Geology, Humboldt State
University, Arcata, California

Registration

Registered Geologist, No. G1045,
Oregon

Employment History

September 2015 to present –
Quincy Engineering: Senior
Hydrogeologist (part time)

September 2010 to present – Dale
C. Bugenig Consulting
Hydrogeologist, LLC.: Owner

March 2000 to September 2010 –
ECO:LOGIC Engineering: Chief
Hydrogeologist

December 1994 to March 2000 –
Consulting Engineering Services,
Inc.: Senior Hydrogeologist

December 1977 to December 1994
– William E. Nork, Inc.: Senior
Hydrogeologist

June 1977 to December 1997 –
Hydro-Search, Inc.: Staff
Hydrogeologist

January 1976 to June 1977 –
Contract Hydrogeologist with
Hydro-Search, Inc.

September 1974 to June 1977 –
Desert Research Institute: Graduate
Research Assistant

Dale Bugenig is currently the owner/sole proprietor of Dale C. Bugenig, Consulting Hydrogeologist, LLC. Additionally, he works part-time for Quincy Engineering as a Senior Hydrogeologist. He has conducted groundwater investigations in the western U.S. for over 40 years, including projects related to the exploration and development of low- to moderate-temperature geothermal resources. Prior to going into business for himself, he was accountable for all phases of groundwater-related projects undertaken by his previous employers and for hydrogeological support to their engineering staff. Dale has been responsible for design, construction oversight and testing of literally thousands of wells. These include municipal and industrial water-supply wells, geothermal production and re-injection wells, de-watering wells, and monitoring wells. The wells have been drilled in alluvial and fractured-rock terrain using construction methods as diverse as cable-tool, direct mud-rotary, air-rotary, reverse-rotary, dual-tube reverse air-rotary, flooded dual-tube reverse-rotary, Odex/Tubex, rotary-vibratory (sonic), and hollow-stem auger. Well depths have exceeded 3,000 feet and borehole diameters have been as large as 48 inches. His wells have yielded as much as 20,000 gpm with specific capacities as high as 550 gpm/ft. He is highly skilled with respect to rigorous and comprehensive analysis of pumping-test data from complex fractured-rock terrain and alluvial aquifers. His skill and experience has led him to be engaged by agencies to evaluate analyses of pumping-test data performed by others.

Dale is also experienced with the application of surface geophysical techniques to groundwater investigations. His experience ranges from planning and implementing the surveys through integrating the interpretations of the data into the groundwater investigations. He has employed a number of techniques including vertical electrical soundings (VES), frequency-domain electromagnetics (FDEM), very-low frequency electromagnetics (VLFEM), controlled source audio-magneto tellurics (CSAMT), time-domain electromagnetics (TDEM), and seismic refraction. Where practicable, he has been able to utilize geostatistical analysis techniques to incorporate the survey data into 3-D solids models of the geologic materials in the subsurface, which in turn have been used to guide exploration drilling projects, map leachate plumes, and develop numerical groundwater models to support water-resource exploitation.

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Publications

Bugenig, D.C., C.A. Ringstad, and M.A. Ringstad, 2000. *Application of TDEM to well-field development in an arid basin in the western United States: 23rd Congress of the European Geophysical Society, Nice, France.*

Bugenig, D. C., 1990. *Problems with disposal of heat-spent thermal effluent and their influence on development of low-to-moderate-temperature geothermal reservoirs: 1990 International Symposium on Geothermal Energy, Kona, Hawaii.*

Ringstad, C.A. and D.C. Bugenig, 1984. *Electrical resistivity study to delimit zones of acceptable groundwater quality: Second National Symposium and Exposition of Ground Water Instrumentation, Las Vegas, Nevada.*

Presentations

Bugenig, Dale. 2015. *Water Well Drilling Project Case History: Nevada Water Resource Association Well Design, Construction, and Regulation Workshop, Reno, NV.*

Bugenig, Dale. 2015. *Change of Use and Change of Location: From Agricultural Irrigation and/or to Another Part of the Basin. Law Seminars International Hydrology and the Law Seminar, Reno, NV.*

Dale has directed projects to investigate augmenting recharge to aquifers using spreading basins and injection wells. This work has included installation of injection wells and studies to evaluate the effectiveness of rapid infiltration basins.

Dale is experienced with numerical groundwater flow models, in particular MODFLOW, developed by the USGS and the most widely used groundwater model. He also has experience with MODFLOW SURFACT, which is widely used by the mining industry in Nevada. His models have been used as the basis for groundwater appropriations in Nevada and Oregon and he has also been engaged to review models developed by others. His models have also been used to support litigation.

Dale has qualified as an expert witness in the fields of hydrogeology and groundwater modeling for administrative hearings in Nevada on at least five occasions and in the State of Oregon. He has also provided expert testimony in California Superior Court and U.S. District Court in Nevada.

Specific Project Experience

Groundwater Resource & Well Construction Projects

Eureka County Board of County Commissioners - Eureka County, Nevada. Principal Hydrogeologist. Currently provides hydrogeological services related to various topics of interest to the County in coordination with the Eureka County Natural Resources Department. A representative listing of topics include:

- **Eureka County Water Resource Master Plan** – Assisted the Eureka County Board of Commissioners with preparation of a comprehensive water resource master plan. The planning area involves portions of 16 hydrographic basins in northeastern Nevada. GIS was utilized to catalog and analyze geologic, well, water rights, and surface-water data for all the basins. The plan, which was adopted by the County, developed a range of policy alternatives for the County to consider.
- **Mt. Hope Mine EIS Review - Eureka County, Nevada.** The Mt. Hope Mine is a proposed molybdenum mine located in Eureka County. The mine sought to appropriate 11,300 acre-feet of groundwater from the Kobeh Valley hydrographic basin located in eastern Lander and western Eureka Counties for mining and milling purposes. Work involved review of the numerical groundwater flow model prepared in support of the EIS for the project plus review and comment on two administrative drafts of the EIS



Bugenig, Dale. 2008. *Variability in Estimates of Groundwater Recharge: So What?* Lorman Continuation Education Seminar, Reno, Nevada

Colwell, N.T, D.C. Bugenig, & T. W. Butler II. 2010. *Fundamentals of Groundwater and Wells*. Short Course conducted on behalf of the California Rural Water Association – Escondido, Sacramento, Palmdale, and Visalia, California.

- **Diamond Valley Groundwater Management** – Roughly half the residents of Eureka County derive their water supply from wells tapping the alluvial aquifer in the Diamond Valley Hydrographic Area. Predecessors to the current Nevada State Engineer have allowed groundwater resources in the Valley to be grossly over-appropriated. Water rights vastly exceed the available resource and approximately double the estimated safe yield of the basin is being consumed. This overdraft has resulted in continuing large long-term declines in the water table and a reduction or complete cessation of the discharge from major springs. The current use is unsustainable and the area is the first basin in Nevada to be designated as a Critical Management Area (CMA) under Nevada law. A 50 to 60 percent in water use will amount to a socio-economic catastrophe. Dale provides technical support to the stakeholders in the basin by collecting and analyzing data to help formulate management strategies. A major stratagem is the ability to banking water from an annual water allocation. Banking efficiency was analyzed using a groundwater flow model.
- **Litigation and Administrative Hearing Support** - Eureka County's policies and the County Code requires it to an active role in assuring a sustainable water supply to its residents. To this end, the County commonly participates in administrative hearings before the Nevada State Engineer. His principal role has been to quantitatively assess potential conflicts with existing rights and to provide expert testimony, when needed.

North Valleys Water Importation Project - Washoe County, Nevada. Project Hydrogeologist. The \$100 million project was the culmination of many years of resource evaluation and exploratory drilling and testing. Responsible for design of the well field, which comprised six wells with a combined peak capacity of 18,000 gallons per minute and which was permitted to pump 8,000 acre-feet per year, with a potential to increase output to 13,000 afy. The entire production-well drilling and testing program was completed within a 100-day period. The project also included the groundwater investigations in support of the Environmental Impact Statement for the 30-mile pipeline required to transport the water from the well field to the place of use north of Reno, Nevada.

Groundwater Exploration and Municipal Well Development Project - Lincoln, California. Project Hydrogeologist. The work entailed several related projects involving the installation, testing, and evaluation of exploratory wells; installation and implementation of a water-level monitoring well network; installation and testing of two new municipal water-supply wells; testing of existing water supply



wells; and analysis of aquifer yield and the potential impacts of aquifer exploitation on existing wells. The exploratory drilling and monitoring program included a grant to evaluate the application of advanced borehole geophysical logs normally reserved for the petroleum industry to groundwater exploration and development. The work resulted in the completion of two new municipal wells with a combined capacity of 5.8 MGD. Dale worked with the local governmental entities to assess whether the City's wells would adversely affect nearby residential and agricultural wells.

City of Lincoln (California) Groundwater Management. Project Hydrogeologist. Specific tasks included conducting aquifer-stress tests of existing wells to characterize the aquifer over a large area, provide recommendations regarding the spacing of production wells, and develop a monitoring network to monitor water levels in the aquifer to evaluate the response of the aquifer to development and impacts on existing users. It also included a geochemical evaluation to characterize the source(s) of recharge to the aquifer as well as an assessment of the potential for intrusion of saline water into the fresh-water aquifer.

Alameda County (California) Flood Control District Zone 7 Water Agency Well Master Plan. Project Hydrogeologist. The project involved five individual work tasks related to installation of multiple monitoring wells, installation and testing of exploration wells and culminated in the installation and testing of two municipal wells with a combined yield of 7.2 MGD. A hallmark of the program was its comprehensive aquifer-stress (pumping) test program. Rigorous analysis of test data from a large monitoring well network provided insight into a very complex aquifer system and the testing results enabled a defensible assessment of long-term well performance, potential cross-interference with nearby existing production wells, and settled the issue of the potential for groundwater under the influence of surface water. The well field is part of a conjunctive use strategy by the Agency to recharge the aquifer with surface water delivered to former gravel pits, which will serve as recharge basins.

City of Redmond (Oregon) Municipal Water-supply Wells. Project Hydrogeologist. The project involved the design, installation and testing of three municipal water supply wells over a multi-year period. The drilling program incorporated the cable-tool drilling method because of very difficult down-hole conditions arising from the presence of lava tubes and large, non-cohesive gravels. The 18-inch diameter wells each produced more than 3,000 gpm with specific capacities as high as 550 gpm/ft. Rigorous controls in effect during the drilling program resulted in wells that are straight and plumb, in contrast to other wells in the area drilled by more common rotary methods.



City of Dixon (California) Investigation of Potential New Wastewater Disposal Sites. Project Hydrogeologist for a reconnaissance investigation to identify sites where the land application of treated municipal effluent potentially will not degrade the groundwater so as to comply with the current zero degradation policies of the Central Valley Regional Water Quality Control Board. The study incorporated “direct-push” methods which facilitated collecting background water and soil samples from numerous sites over a large area at relatively low cost.

Squaw Valley Public Services District - Placer County, California. Project Hydrogeologist for a series of projects completed for the District. These include an assessment of the vulnerability of the District wells to contamination; locating, drilling, and testing highly efficient water-supply wells; and water quality investigations to evaluate variations in the chemical quality of the aquifer.

Installation/Sampling of Monitoring Wells at Wastewater Treatment Facilities in California. Project Hydrogeologist. Treatment facilities were located at Woodbridge, Mendota, Colusa, Esparto, Dixon, Camp Far West (South Sutter Water District), Live Oak, and San Andreas.

Placer County (California) Water Agency Aquifer-Stress Tests Data Analysis. Consultant to the Placer County Water Agency responsible for comprehensive analysis of data from extended-duration aquifer-stress tests in Martis Valley near Truckee, California. The purpose of the test was to establish the reliable long-term yield of municipal water-supply wells in a structurally complex groundwater basin. Data analysis revealed the presence of multiple boundaries which influenced the long-term yield of production wells, while minimizing interference in wells in different “structural blocks” within the groundwater basin. The results of the analysis clearly demonstrated that the long-term yield of the wells was significantly less than estimates based on short-term testing and which did not account for the presence of discharge boundaries.

Surface Water Sources Analysis - Southwest Truckee Meadows Area of Washoe County, Nevada. Hydrogeology Team Leader for an analysis of the contribution of surface water sources to the shallow aquifer that domestic well owners depend on for their water supply. The study showed the relative importance of secondary recharge from irrigation, leaky irrigation ditches, and the relatively minor contribution from the perennial streams in the study area. The study also suggested the reduction in recharge from irrigation was allowing geothermal fluids to migrate into the potable water aquifer.

Suburban Water Supply District - Lakeview, Oregon. Project Hydrogeologist responsible for an analysis of the potential for a new municipal well to impact flows on a nearby stream. The analysis entailed a numerical groundwater flow model linking surface water



and groundwater. The model incorporated field measurements of stream-bottom hydraulic conductivity, observed vertical hydraulic gradients and clearly showed groundwater withdrawals would have no significant interference with stream flows.

Washoe County (Nevada) Department of Water Resources Aquifer Storage and Recovery Project. Hydrogeology Team Leader for an interdisciplinary group of engineers, geologists, and geochemists working on an aquifer storage and recovery project. A pilot ASR test was conducted and the results indicated poor recovery of the injected water. Analysis of the results suggested that large hydraulic gradients in the aquifer caused the injected water to migrate away from recovery well such that long term water banking was not efficient, but seasonal storage was practical.

Douglas County (Nevada) Department of Community Development Multiple Projects. Project Hydrogeologist. The projects included an evaluation of groundwater quality in northern Douglas County; an assessment of the performance of a well field in the Johnson Lane area; construction and testing of several new exploration and production wells, and testing and evaluation of wells acquired by the County from private parties.

Whisky Flat Groundwater Resource Evaluation – Mineral County, Nevada. Project Hydrogeologist for a groundwater resource evaluation of the Whisky Flat groundwater basin for Mineral County, Nevada. The project applied Time Domain Electromagnetic (TDEM) geophysical prospecting techniques to groundwater exploration to identify well sites that were validated through the construction of wells. The combined geophysical and hydrogeologic data formed the basis of a numerical groundwater model of the basin which was used in support of groundwater appropriations.

In-situ Arsenic Removal Pilot Study - South Truckee Meadows G.I.D. and the Washoe County (Nevada) Regional Water Planning Commission. Project Hydrogeologist responsible for planning and implementing a project to test the hypothesis by Richard Glansman (formerly of the USGS) that the solubility of arsenic minerals in the aquifer might be changed and the process might reduce the concentration of arsenic in groundwater produced from a well.

Washoe County (Nevada) Department of Water Resources. Hydrogeology Team Leader for an interdisciplinary group of engineers, geologists, and geochemists working on an aquifer storage and recovery (ASR) project for the Washoe County Department of Water Resources. Its purpose was to evaluate the feasibility of ASR in the southwest Truckee Meadows near Reno, Nevada. The project culminated in a pilot study to evaluate conjunctive use of surface water and groundwater wherein surface water will be injected during the winter when water demand is low



and seasonally extracted via wells when water demand is high.

Geophysical Investigations

Lake County (Oregon) Landfill FDEM Survey. Project Hydrogeologist. The project entailed a frequency-domain electromagnetic survey to help delineate a leachate plume that occurred as a result of the landfill operator penetrating the liner with equipment. Responsible for developing a 3-dimensional solids model that clearly documented the extent of the plume. Survey results were used to locate additional monitoring wells.

Whisky Flat (Nevada) TDEM Survey. Project Hydrogeologist. The project entailed a time-domain electromagnetic survey to map permeable deposits and locate barriers to groundwater flow. Responsible for planning the survey and developing a 3-D solids model of the subsurface based on the numerical inversions of the data from each survey point. The data interpretation was verified through the drilling of exploration wells and a production well. The 3-D solids model provided a basis for a numerical groundwater model of the hydrographic basin which was used to guide future water resource development.

Martis Valley (California) TDEM Survey. Project Hydrogeologist. The project entailed a time-domain electromagnetic survey to locate potential barriers to groundwater flow and areas of secondary permeability in the underlying bedrock targeted for well drilling. Responsible for planning the survey and developing a 3-D solids model of the subsurface based on the numerical inversions of the data from each survey point. The data interpretation was validated through an aquifer-stress test that clearly showed the presence of faults acting as groundwater flow barriers and the completion of a high-yield well in fractured andesite rocks indicated by the 3-D model.

Fish Springs Ranch (Nevada) Resistivity Survey. Project Hydrogeologist. The project entailed vertical electrical soundings to investigate the depth to bedrock as part of a program to develop the groundwater resources of a buried basalt aquifer.

Jackpot (Nevada) CSAMT Survey. Project Hydrogeologist. The project entailed a controlled-source audio-magneto-telluric survey to locate fractures in bedrock that control the flow of infiltrated effluent from a waste-water treatment facility. The ultimate goal was to locate potential well sites to recover the effluent for secondary uses such as irrigation.

Spanish Springs Valley (Nevada) Resistivity Survey. Project Hydrogeologist. The project entailed vertical electrical soundings to located good-quality groundwater in an area where mineralization of the rocks degraded groundwater quality over a large area of the aquifer. The survey resulted in the completion of a water-supply



well that met the applicable drinking water standards.

Jack's Valley (Nevada) VLFEM Survey. Project Hydrogeologist. The project entailed a very low frequency electro-magnetic survey to locate possible fractures in granitic-rock terrain. Exploratory wells encountered fractured rock at depth, which yielded exploitable quantities of groundwater.

Smith Valley (Nevada) Seismic Reflection Survey. Project Hydrogeologist. The project entailed a developing a seismic reflection profile to map the extent of a buried pediment surface. The objective was to locate a well site beyond the obscured range-front fault to exploit a large thickness of the aquifer. An exploratory well was drilled to evaluate the yield of a production well at this site. The well validated the estimate of the thickness of alluvial deposits and the interpretation of the position of the range-front fault.

Representative Groundwater Modeling Projects

Diamond Valley, Nevada Water Banking Analysis. Project Hydrogeologist / Principal Investigator responsible for analyzing the banking of groundwater in the Diamond Valley Hydrographic Basin, eastern Nevada in collaboration with the Nevada Division of Water Resources. An existing 3-numerical groundwater model was modified to assess the ability to capture groundwater banked as an integral part of a groundwater management plan.

South Lake Tahoe (California) Groundwater Model. Project Hydrogeologist / Principal Investigator responsible for developing a 3-dimensional groundwater model for the aquifer south of Lake Tahoe that provided the source of water supply for the South Lake Tahoe Public Utilities District. The calibrated transient model incorporated the hydraulic connection between the aquifer, major streams, wetlands, and Lake Tahoe. The model results influenced locations of new water-supply wells and provided the basis for contaminant-transport modeling completed by others. The project resulted in a \$69 million settlement with the major oil companies for contaminating the aquifer with MTBE.

South Truckee Meadows Water and Wastewater Facilities Master Plan. Project Hydrogeologist for the South Truckee Meadows Water and Wastewater Facilities Master Plan prepared for the Washoe County Regional Water Planning Commission. The work included developing a 3-D numerical model of the aquifer in the south Truckee Meadows that was used to assess the reliable long-term water supply available from the municipal wells in the study area. The model results demonstrated the need for and benefits of conjunctive use of surface water and groundwater. The model was updated to investigate various water-demand scenarios and demonstrated the revised water-demands could be met by existing wells. It is currently being used to assess the potential effects on



more than 2,000 domestic wells arising from the municipal well pumping.

Whisky Flat (Nevada) Groundwater Model. Project Hydrogeologist for a proposal by Hawthorne Utilities to increase groundwater appropriations from the Whisky Flat Hydrographic Basin. The model, which incorporated geophysical data to help refine the distribution of aquifer materials, demonstrated to the Nevada State Engineer that sufficient groundwater resources existed in the basin for the utility to install additional water-supply wells.

Eureka Moly, Mt. Hope (Nevada) Regional Groundwater Flow Model. Consultant to Eureka County, Nevada responsible for technical review of hydrogeologic investigations and groundwater models developed in support of a proposed "world-class" molybdenum mine. The review identified a number of technical issues, many of which were addressed by the mine's consultants

Southern Nevada Water Authority Coyote Springs Valley Regional Groundwater Flow Model. Consultant to Nye County, Nevada and responsible for review of a regional groundwater flow model offered in support of applications to appropriate groundwater resources. Review of the model demonstrated that the applicant's groundwater extractions should be expected to incite inter-basin flow from adjacent hydrographic basins that already were over allocated instead of capturing natural discharge as opined by the applicant's consultant.

Geothermal Resource Projects

Modoc County Joint Unified School District - Alturas, California. Provided well-site construction management to Anderson Engineering and Surveying (Lakeview Oregon) for the drilling of Well AL-4, a 3,240 feet deep geothermal re-injection well. The well is presently used to return heat-spent thermal effluent from the School District's geothermal heating system to the geothermal reservoir. The system provides heat to three school campuses and a proposed expansion may include the municipal swimming pool and a new hospital

Town of Lakeview Geothermal Resource Exploration and Development, -Lakeview, Oregon. Project Hydrogeologist for three geothermal projects for the Town of Lakeview, working with Anderson Engineering and Surveying, Lakeview, Oregon. The first project entailed developing a source of heat to the State of Oregon Warner Creek Correctional Facility at Lakeview, Oregon. The project entailed installation and testing of an exploration well, and the construction and testing of the production and re-injection well. The second project entailed testing of existing wells south of Lakeview to evaluate the resource available to heat public facilities in the Town. For both projects, conceptual models of the resource



were developed and used to estimate the amount of heat that could be captured by wells and evaluate the effects of re-injection on the projects' production wells and existing users. The third project involved providing technical assistance in the preparation of the EA for the Town's proposed district space heating project.

Liskey Farms Aquifer Testing, Klamath Falls, Oregon. Project Hydrogeologist for a comprehensive aquifer-stress test to help identify possible re-injection well locations. An existing geothermal production well was test pumped and numerous existing wells were monitored. The test results provided evidence of horizontal anisotropy in the aquifer and helped to provide a location for a re-injection well that had small potential for heat spent thermal effluent to impact the temperature in the production well.

Yankee-Caithness Steamboat Power Plant Change in the Plan of Operations/Plan of Use – Steamboat KGRA, Washoe County, Nevada. Project Hydrogeologist for an analysis of the impacts due to increasing geothermal fluid production for the U.S. Bureau of Land Management. The analysis incorporated the impact of adding a binary plant to the existing flash plant and cumulative impacts of plans for an adjacent property at Steamboat to pump and re-inject 30,000 gpm.

Mills Addition Geothermal Effluent Recovery and Recharge Project, Klamath Falls, Oregon. Project Hydrogeologist. The project examined the feasibility of collecting the diffuse discharge from a large number of residential geothermal space-heating wells and re-injecting this thermal effluent into the aquifer to maintain the aquifer pressure. The project was constructed and water-level declines in the geothermal aquifer were abated.

