

February 19, 1999

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

ATOMIC SAFETY AND LICENSING BOARD PANEL

Before Administrative Judges:
Peter B. Bloch, Presiding Officer
Thomas D. Murphy, Special Agent

_____)	
In the Matter of:)	
)	
HYDRO RESOURCES, INC.)	Docket No. 40-8968-ML
2929 Coors Road, Suite 101)	ASLBP No. 95-706-01-ML
Albuquerque, NM 87120)	
_____)	

AFFIDAVIT OF V. STEVE REED

1. My name is Victor Stephen Reed. My professional career has spanned more than 31 years, 24 of which have been as a consulting ground water hydrologist. I have investigated ground water regimes on hundreds of industrial, commercial, mining, municipal and private sites throughout the United States. In addition to contaminant fate and transport studies, I have developed municipal and private water supplies and participated in well head protection activities. My curriculum vitae is attached.

2. In 1993, I was engaged by HRI Inc. to investigate the feasibility for maintaining hydrodynamic control during production and restoration of the Crown Point and Church Rock mines. In my evaluation, I utilized established hydrologic principles and techniques that I

developed during the previous 18 years studying similar sites. In situ technology has been used extensively in the uranium mining industry over the last 25 years. In Texas, where I am familiar with the use of in situ techniques in dozens of mines, I am not aware of any cases where a leachate excursion has occurred beyond a monitor well ring. To my knowledge, in situ leach mining has been very successful at maintaining hydrodynamic control.

3. Following my investigation of the Crown Point and Church Rock mines, I prepared a report presenting my findings titled, "Analysis of Hydrodynamic Control, HRI, Inc. Crown Point and Church Rock, New Mexico Uranium Mines." Since preparation of my report, I have had occasion to meet with representatives of the Nuclear Regulatory Commission, where I explained my evaluation and invited questions.

4. I have reviewed criticisms of my report by Mr. Michael Wallace contained within *Written Testimony of Michael G. Wallace* in the matter of Hydro Resources Inc., United States of America Nuclear Regulatory Commission Atomic Safety and Licensing Board Panel, and *Intervenors' Amended Written Presentation in Opposition to Hydro Resources, Inc.'s Application For a Materials License* filed in the same cause. I was frankly appalled by the nature of the criticism levied by Mr. Wallace which, in my opinion bordered on accusations of fraud. It is clear that Mr. Wallace is an advocate of his client. I prefer to be an advocate of the facts.

5. Mr. Wallace complains in three principal areas: 1) the geology is too complex to be represented by the model I selected; 2) the flow lines depicted in my report misrepresent the facts;

and 3) the ground water divides presented in my report misrepresent the facts. My response to these criticisms is set forth below.

6. Model Selection: I have used a form of the AQUASIM model to evaluate numerous in situ mines. The model is based on well established hydrologic principles. It has been shown to accurately reflect aquifer performance. I have successfully used this model to simulate more complex ground water reservoirs than exist in the Crown Point and Church Rock mines. The model is used as a predictive tool which allows the applicant and the regulators to evaluate the feasibility of hydrodynamic control. Actual production operations are always fine tuned to take into account heterogeneities not predicted by the model.

7. While it is true that the model presented in my report is for advective travel and does not include dispersion, in my experience advective transport is by far the dominant flow mechanism in ground water systems. Furthermore, I have never seen dispersion cause leachate excursions.

8. Flow Lines: Mr. Wallace is harshly critical of the manner in which I have drawn the flow lines in my report. The flow lines presented in my report represent the general flow vectors that will be experienced during mining. Far from being misleading, the diagrams in my report show that complete hydrodynamic control is not predicted, but expected travel times and distances are such that excursions will not occur. *See Geraghty & Miller, 1993, Figures 5 and 7.* This part of my presentation was apparently not considered by Mr. Wallace when he stated that my report “misrepresents” and “misleads”.

9. Ground Water Divides: I disagree with Mr. Wallace's contention that ground water divides are the same as flow lines and that "flow lines are also divide lines." See Intervenor's Amended Written Presentation at p.22. Ground water divides in the diagrams presented in my report generally represent a combination of two flow lines converging in an area where :1) there is almost no ground water movement and/or, 2) flow directions change. In fact, "path lines" or flow vectors are frequently oriented from 90° to sub-parallel to the axes of a divide. A ground water divide is not unlike a topographic ridge which contains a saddle. Water in the saddle moves slowly relative to the ridge flanks, and flow vectors in the saddle diverge or split. The divides presented in my report are geographic areas where stagnation and/or flow vectors change, effectively providing hydrodynamic control. I should also point out that HRI will maintain a well defined, industry-standard monitoring program to demonstrate that excursions will not occur. As with all in situ facilities, the operator will continuously fine tune his injection/production activities in response to data collected in the operations and monitoring programs.

10. It is my professional opinion that Mr. Wallace's criticisms are unfounded and reflect a lack of experience with and knowledge of in situ leach mining technology and the hydrology associated with ISL mining. Moreover, Mr. Wallace's opinions disregard the successful history of the in situ industry and, in the case of HRI's license application, the rigorous agency review process which included direct discussions with agency personnel. It is curious that although Mr. Wallace is critical of my groundwater model, he has failed to produce his own rebuttal.

FURTHER AFFIANT SAYETH NOT.

I swear under penalty of perjury that the foregoing is true and correct to the best of my knowledge.

Dated this 18 day of February 1999.

V Steve Reed

Voluntarily signed and sworn to before me this 18 day of February 1999, by the signer, whose identity is personally known to me or was proven to me on satisfactory evidence.



Theresa R. Young
NOTARY PUBLIC

Residing at: Denver, Colorado
My Commission expires: May 12, 2001

VICTOR STEPHEN REED

Education

Master of Geology, Northern Arizona University, 1976
Bachelor of Geology, Northern Arizona University, 1970

Professional Registrations

Registered Professional Geologist in Arizona, Oregon and Missouri
Certified Professional Geological Scientist, American Institute of Professional Geologists

Professional Associations

Geological Society of America
National Ground Water Association
Society of Economic Paleontologists & Mineralogists
Underground Injection Practices Council
American Arbitration Association

Board Memberships

Bellevue Foundation, Board of Directors ARCADIS
Priority Foundation, Board of Directors ARCADIS

Mr. Reed has more than 23 years experience in the environmental consulting arena, serving in both technical and senior management roles. He has performed hydrogeologic studies throughout the United States and its territories. He has conducted a number of environmental workshops, including a Paris-based training session for world-wide managers of a large international firm. He coordinated a soil and ground water study to determine the impact of the largest domestic fuel spill. His current primary focus is in litigation support and expert testimony, and regulatory agency negotiations. He has testified in cases before both state and federal courts, before several state agencies and has been involved in negotiations with numerous state agencies and several EPA regions. Mr. Reed has served as Office Manager, Regional Vice President and Director of National Accounts for Geraghty & Miller. His relevant project experience includes:

RCRA/CERCLA

Mr. Reed has managed or participated in several RCRA projects. He has performed pre-RFA studies to reduce the number of SWMUs identified in RFAs, and has directed RFIs and provided hydrologic support for CMSs. He has been involved in Consent Decree and 3008h negotiations. Specific projects include ground water contamination delineation, compliance and detection

monitoring programs, ACL demonstrations, and soils and ground water remediation. He has also successfully negotiated significant reductions to civil penalties. He has performed ground water studies and remedial designs for CERCLA sites.

Deep Well Injection

Mr. Reed has sited studies, designed, permitted, and constructed Class I disposal wells. Disposal well projects have included both industrial and commercial facilities. He has designed and supervised mechanical integrity tests and well rehabilitation programs. He has also evaluated the performance and feasibility of Class II disposal wells.

Landfills

Mr. Reed has performed studies on municipal landfills, some sites which involved litigation, to determine the actual or potential impact on surface and ground waters. He has provided technical support for landfill closure design. He is currently involved in a study to determine the feasibility of various reuse scenarios for a closed municipal landfill.

Environmental Permitting

Mr. Reed has prepared applications for Part B permits, and Class I and Class III injection permits. He successfully permitted several in situ uranium operations and the only in situ sodium sulfate mine in the United States. He has testified before state agencies in support of permit applications.

Expert Testimony/Litigation Support

Mr. Reed has been involved in litigation support throughout most of his consulting career. He has testified in cases before both state and federal courts, as well as several state agencies. He has also provided internal litigation support and training.

Water Resources Evaluations/Development

Mr. Reed has evaluated ground water resources for municipalities and private concerns. He has assessed reservoir performance, obtained water rights and designed and constructed municipal well fields. He has estimated reserves, safe yields and well efficiencies for both municipal and private clients.

In Situ Projects

Mr. Reed has evaluated and designed several in situ mining projects, including reservoir studies, and extraction well system design and construction. He has supplied expert testimony for several permit applications.

Litigation/Negotiation Experience

Administrative Hearings Testimony

Railroad Commission of Texas, TX

Class II injection well-pressure limitations

Drilling mud disposal permit

Hydrocarbon free-phase recovery program

Water flood fresh water makeup

Texas Natural Resources Conservation Commission, TX

Landfill permit

Class I industrial disposal well applications

Class III in situ uranium mine applications

Part B permit application

New Mexico Oil Conservation Division, NM

Commercial salt water disposal application

Waste disposal permit application

New Mexico Environment Improvement Division, NM

Waste disposal permit application

Administrative testimony includes, but is not limited to, the following cases:

Testimony in support of Class III uranium mining permits. On at least four occasions, following detailed hydrologic studies and ground water modeling, testimony was provided showing that the proposed in situ uranium mines could be safely operated with no adverse ground water impact. Permits were granted in three of the cases in spite of well organized opposition. The fourth application is pending and a permit is expected. Testimony was before Texas and New Mexico agencies.

Testimony has been provided in support of Class I industrial waste disposal wells. Testimony included opinions as to the nature of the disposal and confining zones and the ability of the operator to inject wastewater without adverse impact on health or the environment. Testimony was before a Texas state agency, and permits were granted.

Testimony for original permits and permit modifications was provided on two proposed commercial brine disposal operations in New Mexico, the first two permits of this type to be granted in the state. Testimony on at least five occasions resulted in permits or modifications to permits.

Testimony was provided in a show-cause hearing on overpressuring caused by injection well activity. Although an adverse ruling resulted, soon thereafter the state agency modified operational requirements that eliminated overpressuring problems.

Testimony before Texas state agency regarding impact from SWMUs, in hearing on Part B Permit. Testimony supported lack of impact to soils and offsite ground water.

Agency Negotiations

Many of these negotiations have resulted in hundreds of thousands to millions of dollars in savings to the client. As an example, during consent decree negotiations, a state agency proposed a surface water monitoring program that would have cost the company in excess of ten million dollars. The agency was convinced that monitoring was unnecessary based on the dynamics of the surface water system.

Negotiations with state and federal agencies include the following:

Colorado Department of Health
EPA Regions III, VI and VII
Kentucky EPA
Louisiana Department of Environmental Resources
Minnesota Pollution Control
Missouri Department of Natural Resources
New Mexico Environment Improvement Division
New Mexico Oil Conservation Division
Pennsylvania Department of Environmental Resources
Texas Department of Health
Texas Natural Resources Conservation Commission
Texas Railroad Commission
Washington Department of Ecology
Wyoming Department of Environmental Quality
Litigation Testimony
Gabriela C. Aquirre et al v. Browning Ferris Industries Inc., et al,
156th Judicial District Court, San Patricio County, Texas
Case involves alleged contamination from a landfill.
Grady Weeks et al v. T.J. Guido et al.
State of Louisiana State Court, and U.S. District Court Western District of Louisiana.

Case involved alleged soil and ground water contamination from oil field production activities.

United States v. Interco
U.S. District Court, Texas
Alleged ground water contamination from landfill. An industrial client was

sued over alleged soil and ground water contamination. Testimony showed that soil contamination was limited to a small area, and that ground water neither had been nor would be affected. Primary chemical of concern was methyl ethyl ketone.

Charles Johnson v. Diamond Shamrock
U.S. District Court, Texas

Alleged ground water contamination by oil field brines. A landowner, after drilling an irrigation well, found that the salt concentration in the produced water was above that in the ground water in the region, making the water unfit for irrigation. Testimony included information on the source of the contaminants and the impact of the source on the area ground water supplies.

Vanderberg v. Phillips Petroleum, et al.
State of Texas District Court

Alleged ground water contamination by gas field. Natural gas had contaminated domestic water wells. An investigation determined the origin to be a leaking gas well. Testimony was provided on the source and expected duration of impact.

State of Texas v. Liberty Waste, et al.
State of Texas District Court

Alleged ground water contamination from landfill. A state agency sued the landfill operator for ground water contamination and monitoring violations. Testimony included an opinion that the monitoring system was adequate for the time it was installed, and that the shallow ground water system had not been contaminated to levels above drinking-water standards. Testimony included an opinion that area supply wells were unaffected. After testimony was given, the case was settled without civil penalties.

Trafalgar Holding Ltd., Inc. et al. v. Stop N Go Market et al. v. Conoco Inc. et al.

151st Judicial District Court
Harris County, Texas

Dispute in valued nature and timing of gasoline spill resulting in ground water contamination of adjacent property. Testimony also provided on appropriate remedy.

International Paper Timberlands Operating Company, Limited, and International Paper Company v. Denmiss Corporation, et al.

State of Louisiana District Court

Alleged ground water contamination from landfill. This suit, among other issues, alleged ground water contamination had occurred as a result of two landfill operations. Testimony included a demonstration of investigation deficiencies by the opposition that falsely indicated ground water contamination had occurred. The testimony showed that, indeed, ground water contamination had not occurred.

Industrial Metals v. Mangus, et al.

State of Texas District Court

Alleged PCB contamination of soils and ground water. This testimony consisted of an opinion as to the nature and cost of a PCB contaminated soil remediation program. The project involved intense negotiation with the state agency.

Barnes Ranch v. Mid-Continent Pipeline

State of Oklahoma District Court

Testimony involved impact analysis of crude oil spill and evaluation of appropriate remediation (natural biodegradation).

Snyder General Corporation v. The Continental Insurance Company, et al.

U.S. District Court, Texas

This project involved a determination of the nature, timing and impact of a 20-year old trichloroethene source. Testimony involved an opinion as to the nature of the spill as determined from a large volume of existing data.

The Southland Corporation v. Occidental Petroleum and Oxy USA.

U.S. District Court, Texas

This litigation concerned environmental costs arising out of a sale of several hundred service stations. Testimony supported conclusion that much of damage occurred prior to sale.

Gust Tsevas v. Travelers et. al.

State of Wisconsin Circuit Court

Involved dispute over cause of heating oil tank rupture. Testimony demonstrated failure was not caused by overfilling.

FMC v. Liberty Mutual, et. al.

State of California Superior Court Santa Clara County

Involved cost recovery under insurance policies for several sites throughout the United States. Testimony was in two trials.

Michael and Linda Odem v. Ciba Geigy Corp., Reichold Inc. and Lamar Harrison

U.S. District Court, Southern District of Alabama

Dispute concerned alleged discharge of 1,1,1 TCA into unlined trenches, and impact to local ground water.

Pocol Holdings Limited v. Texas Instruments Inc.

United States District Courts, District of Colorado

Dispute involves identification of source and remediation costs for TCA ground water plume on manufacturing site.

Ken Gronvold Construction, Inc. v. Time Oil Co.

Superior Court of Washington for King County

Case involved substantial compliance and due diligence issues related to cost recovery for remediation of UST contaminated soils.

A.A.F. McQuay s.k.a. Snyder General Corporation v. Northbrook Property and Casualty Insurance Company et al,
U.S. District Court, Eastern District of Texas, Texarkana Division
Solvent contaminants affecting soils and ground water.

Mike Adalis et al. v. Neighborhood Development Corp. et al.
State of Texas District Court, Harris County.
Dispute involves alleged liability for ground water contamination of a municipal water well.

Washington Water Power Company v. Underwriters at Lloyds
State of Washington, Superior Court, Spokane County
Case involves identification of source and timing of Fuel Oil #6.
Current Active Cases

Valley Isle Produce, Inc. dba VIP Food Service v. Shell Oil Co. et al.
United States District Court, District of Hawaii
Case involves alleged offsite damages from petroleum releases.
Washington Water Power Company v. Underwriters at Lloyds
State of Washington, Superior Court, Spokane County
Case involves identification of source and timing of Fuel Oil #6.

Mike Adalis et al. v. Neighborhood Development Corporation et al.
State of Texas District Court, Harris County
City of Vancouver v. Judith Griffee et al.
State of Washington Superior Court, Clark County

International Paper Timberlands Operating Company, Limited, et al., v.
Denmiss Corporation, et al.
Chancery Court of Hinds County, Mississippi - First Judicial District

AAF - McQuay f/k/a Snyder General Corp v. Northbrook Property and Casualty Insurance Company et al.
United States District Court, Eastern District of Texas

Three Birds and Eagle Lincoln Mercury v. Texas Instruments , Inc.
United States District Court, North District of Texas.

Grady Weeks et al v. T.J. Guido et al.
State of Louisiana State Court, and U.S. District Court Western District of Louisiana.

Proctor v. Lockheed
California Superior Court, Santa Clara County

Gabriela C. Aquirre et al v. Browning Ferris Industries Inc., et al,
156th Judicial District Court, San Patricio County, Texas

General Projects

Wyoming

Texaco Inc.

Prepared conceptual design for in situ remediation of ground water affected by uranium mill tailings. Concept was accepted by NRC. Bench/pilot studies were conducted.

Texas

The Anaconda Company

Successfully obtained a waiver of title transfer with the NRC by designing secure landfill for uranium mill tailings. NRC agreed that long-term maintenance by the state would not be required.

New Mexico

Sandia Laboratories

Performed hydrogeologic study for proposed Waste Isolation Pilot Plant nuclear repository near Carlsbad, New Mexico.

Texas

Confidential Clients

Performed ground water studies to determine shallow ground water impacts near three large uranium tailings ponds. In one case, was able to demonstrate that most of the "impact" was natural.

Texas

Confidential Client

Investigated ground and surface water impact of closed municipal landfill. Determined that trace hazardous constituents were present in ground water but no impact of nearby surface water (stream). Facility is in monitor-only status.

Pennsylvania

Ashland Petroleum

Managed a project to delineate soil and ground water contamination resulting from a 3.8 million-gallon diesel spill in Pennsylvania. Reviewed remedial technologies, selected principal technology, supervised remedial programs and interfaced with multiple regulatory agencies.

Texas, New Mexico

VRI, Inc., Chevron, Union Carbide, others

Performed numerous hydrologic studies in support of in situ uranium mine permits. Projects involved detailed ground water modeling for design and analysis, and testimony in support of applications.

Confidential Site

Confidential Client

Investigated source of oil field brine contamination of fresh water aquifers.

Texas

Confidential Client

Manager of a project to pilot test, design and implement a soil vapor extraction system in Texas. The extraction system, which removed TCE from a deep, unsaturated zone, has had a pronounced positive effect on underlying ground water.

Pennsylvania

Confidential Client

Conducted an environmental audit of a 130 year-old manufacturing facility in Pennsylvania, working with both buyer and seller. Project involved reconstruction of past manufacturing programs, ground water and soil studies.

Texas

TRW, Inc.

Managed soil and ground water studies to determine the extent of TCE contamination on a manufacturing site in Texas. Designed soil and ground water remediation program including soil excavation and pumping and air stripping of ground water. Assisted in negotiations with state agency to settle \$200 million lawsuit.

Texas

Central Power and Light

Managed a project involving the evaluation of an existing ground water recovery system adjacent to an 1,100-acre cooling pond. Supervised ground water modeling effort and proposed major changes to the recovery system. The revised system has overcome the deficiencies in the previous system.

Texas

Central Power and Light

Supervised ground water and soil investigation in the area of an underground waste storage tank. Remedial activities included soil gas extraction, soil excavation, ground water pumping and air stripping. Produced ground water is reinjected.

US and Canada

Dowell Schlumberger

Coordinated with multiple Geraghty & Miller offices as Project Officer on a nationwide environmental audit program of over 90 facilities.

Texas

U.S. Navy, hospital

Managed project to dewater the basement of a large structure founded on wooden piers. The system had to be designed to tolerances less than one

foot in order to dewater the basement without saturating the soils adjacent to the piers.

Texas

Central Power and Light

Identified significant area of structural weakness during a routine annual dike inspection. Designed and implemented underwater dike repair. In the same facility, designed a structure to collect and control seepage from cooling water reservoir and prohibit dike failures due to gopher burrows. Initial phase of construction has been initiated.

Texas

Union Texas Petroleum

Managed an investigation to determine the volume and extent of a natural gasoline plume in a drinking water aquifer. Designed remedial alternatives, obtained approval from state agency and implemented pilot recovery program.

Pennsylvania

Ashland Petroleum

Designed a ground water remediation program for a Pennsylvania facility which involved recovery of free and dissolved product by recovery wells and a trench drain system. Negotiated with multiple state agencies for plan approval. Was actively involved in Consent Decree negotiations.

Arizona

Kennecott Copper Company

Performed hydrologic test evaluation and modeling of deep in situ copper mine in fractured rock.

Texas

Gold Fields Inc.

Performed ground water investigation and dewatering studies for underground gold mine.

Texas

Ozark Mahoning

Permitted three in situ sodium sulfate mines. Was able to demonstrate to state agency that hydraulic control was established.

North Dakota

Ozark Mahoning

Investigated shallow ground water study for a sodium sulfate mine in North Dakota. Determined that previously unrecognized overpressured shallow aquifer would require significant fluid handling.

RCRA/CERCLA Projects

Texas

Hussman Corporation

Investigated impact of metal plating lagoon on ground water. Negotiated monitoring only states with state agency.

Missouri

Hussman Corporation

Managed the preparation and implementation of corrective action work plans for a site in Missouri with soil and ground water contaminated by TCE.

Corrective action program is now implemented and involves pumping and air stripping ground water and vapor extraction from the soils. Negotiated with multiple agencies leading to Consent Decree.

Confidential Site

Confidential Client

Designed a ground water investigation for Edwards aquifer contaminated by TCE. Plume was contained in geologically complex area with numerous faults and secondary porosity. Supervised construction of an analytical ground water model to predict the performance of the ground water pumping and treating system employed.

Texas

TXI, Inc.

Reviewed existing data to evaluate impacts of large SWMUs on soils and ground water. Testified in Part B Permit hearing.

Texas

IT Corporation

Designed a ground water extraction system for low permeability aquifer on a large CERCLA site.

Eastern United States

Oxy USA, Occidental Petroleum

Investigated 90 UST sites to determine age and origin of the source, and to determine reasonableness and appropriateness of investigation and remedial activities.

Texas

Envirosafe

Performed ground water studies and designed monitoring program for commercial landfill permit application.

Texas

Interco

Investigated ground water and soil impacts from disposal of MEK and MIBK. Presented soil remediation concepts and determined that ground water was not impacted sufficiently to require remediation.

Alabama

CIBA Geigy Corp.

Determined source and pathway for ground water contaminated by 1,1,1 TCA. Using ground water modeling determined that little off-site impact would occur.

Oregon

Northwest Industries, Inc.

Identified source of TCE ground water plume. Previous investigators had been unable to locate source.

Arkansas

Confidential Client

Performed feasibility study for injection well site. Determined that site was unsuitable for deep injection.

Confidential Site

Confidential Client

Determined nature and extent of three 1,1,1 TCA and TCE ground water plumes which had contaminated or threatened to contaminate a major aquifer. Designed remedial systems which have cleaned the ground water to MCLs on two sites and significantly reduced contaminants on a third.

Injection Wells

Texas

City of Sinton

Performed evaluation of integrity and reliability of Class II injection wells.

Confidential Site

Confidential Client

Performed environmental audit for a commercial hazardous waste disposal facility in Texas. Project included evaluation of the integrity and operational history of a deep injection well.

Texas

The Anaconda Company, U.S. Steel, Tenneco, IEC Corp. others

Designed, permitted and constructed several Class I disposal wells for both industrial and commercial applications.

Landfill Projects

Confidential Site

Confidential Client

Investigated ground water impacts from active municipal landfill. Designed long-term ground water monitoring program. Negotiated favorable position with state agency.

Louisiana, Mississippi
International Paper Inc.

Determined that ground water was not affected by municipal landfill and testified to same in landowner-initiated litigation.

Texas
Liberty Waste

Investigated impact of industrial landfill in response to nearby landowner lawsuits. Determined off-site ground water was not impacted and testified to same.

Kentucky
Lexington Fayette Urban Co. Government
Negotiated landfill closure with a state agency resulting in considerable cost savings. In process of designing final closure to accommodate various reuse scenarios including a light manufacturing complex.

Permitting

New Mexico
Parabo

Successfully permitted first non-playa commercial oil field brine disposal facility in New Mexico. Facility has been in operation since 1978 and is a major brine disposal site.

New Mexico
Loco Hills Disposal Co.

Designed and performed site feasibility studies and permitted a commercial oil field-produced water disposal facility.

Texas
Envirosafe

Provided a hydrogeologic assessment for a commercial waste disposal facility application. Also prepared the application for commercial deep-well injection.

Water Resources

California
Burlington Industries

Investigated availability and long term sustained yield supporting large manufacturing operation.

Texas
City of Corpus Christi

During a severe drought, evaluated potential of aquifers, leased water rights, and designed and constructed well fields to supplement surface water supplies. Approximately 25 million gallons per day (MGD) of emergency

capacity was developed over 12 months for this municipality. An additional 40 MGD in reserves was identified using ground water models.

Texas

Rovi Texas

Estimated reserves, determined safe yields and well efficiencies for a potential buyer of a rice farm. On the strength of the study the property was purchased.

Texas

City of Sinton

Developed a reliable ground water supply for a municipality. Project involved ground water reserve and quality assessments, design and construction of new wells and rehabilitation of existing wells.

In Situ Mining Projects

Confidential Site

Tenneco, URI Inc., Chevron, U.S. Steel,, ARCO, Union Carbide, others
Performed hydrogeologic investigation in support of Class III uranium mining permits. Investigations included interpretation of pumping tests, geologic interpretations and the use of ground water models to determine the ability to maintain hydraulic control of mining fluids. Evaluated core leach studies and constructed ground water models to determine the feasibility of ground water restoration following mining. Testified before public hearing in support of the mining permit applications.

Texas

US Steel Co.

Conducted pumping tests using more than 100 observation wells to evaluate the effects of geologic faults and stratigraphic variations on mining. These large-scale tests provided data for design and operation of a large in situ uranium operation.

Arizona

Kennecott Copper Company

Evaluated the feasibility for using in situ leaching techniques to mine copper ore contained within an igneous complex. Pump test interpretation showed that mining of this 2000-foot deep ore body with in situ technology was feasible.

Publications (Partial List)

Batson, R. M., K. B. Larson, V. S. Reed, R. L. Sutton, and R. L. Tyner,

"Apollo 16 Lunar Surface Photography in Apollo 16 Final Report," U.S.G.S., Prof. Paper, 1982.

Batson, R. M., K. B. Larson, V. S. Reed, and R. L. Tyner, "Preliminary Catalog of Pictures Taken on the Lunar Surface During the Apollo 16 Mission," U.S.G.S. Interagency Report: Astrogeology 50, 1972.

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Beus, Stanley S., Richard R. Rawson, Russel O. Dalton, Gene M. Stevenson, V. Stephen Reed, and Thomas M. Daneker, "Preliminary Report on the Unkar Group (Precambrian) in Grand Canyon, Arizona," T. N. V. Karlstrom, G. A. Swann, and R. L. Eastwood, eds., Geology of Northern Arizona, Part I, pp. 34-53, 1974.

G. A. Swann and V. S. Reed, "A Method for Estimating the Absolute Ages of Small Copernican Craters and the Application to the Determination of Copernican Meteorite Flux," W. A. Gose, ed., Proceedings of the Fifth Lunar Science Conference, Houston, Supp. 5, Geochim. et Cosmochim. Acta, Vol. I, Mineralogy and Petrology, pp. 151-158, 1974.

Larson, K. B., R. M. Batson, V. S. Reed, and E. W. Wolfe, "Preliminary Catalog of Pictures Taken on the Lunar Surface During the Apollo 17 Mission," U.S.G.S. Interagency Report: Astrogeology 70, 1973.

Muehlberger, W. R., R. M. Batson, E. A. Cernan, V. L. Freeman, M. H. Hait, H. E. Holt, K. A. Howard, E. D. Jackson, K. B. Larson, V. S. Reed, J. J. Rennilson, H. H. Schmitt, D. H. Scott, R. L. Sutton, D. Stuart-Alexander, G. A. Swann, N. J. Trask, G. E. Ulrich, H. G. Wilshire, and E. W. Wolfe, "Preliminary Geologic Analysis of the Apollo 17 Site," Apollo 17 Preliminary Science Report: NASA SP-330, pp. 6-1 to 6-91, 1973.

Muehlberger, W. R., R. M. Batson, E. A. Cernan, V. L. Freeman, M. H. Hait, H. E. Holt, K. A. Howard, E. D. Jackson, K. B. Larson, V. S. Reed, J. J. Rennilson, H. H. Schmitt, D. H. Scott, R. L. Sutton, D. Sturat-Alexander, G. A. Swann, N. J. Trask, G. E. Ulrich, H. G. Wilshire, and E. W. Wolfe, "Preliminary Geologic Analysis of the Apollo 17 Site," U.S.G.S. Interagency Report, Astrogeology 72, 1973.

Muehlberger, W. R., R. M. Batson, E. L. Boudette, C. M. Duke, R. E. Eggleton, D. P. Elston, A. W. England, V. L. Freeman, M. H. Hait, T. A.

Hall, J. W. Head, C. A. Hodges, H. E. Holt, E. D. Jackson, J. A. Jordan, K. B. Larson, D. J. Milton, V. S. Reed, J. J. Rennilson, G. G. Schaber, J. P. Schafer, L. T. Silver, D. Sturat-Alexander, R. L. Sutton, G. A. Swann, R. L. Tyner, G. E. Ulrich, H. G. Wilshire, E. W. Wolfe, and J. W. Young, "Preliminary Geologic Investigation of the Apollo 16 Landing Site," Apollo 16 Preliminary Science Report, NASA SP-315, 1973.

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