EVAPORITES

AND RESPEC

INTEGRATING FOR THE FUTURE

For 55 years, RESPEC has used our differentiating strength of integrating diverse disciplines to deliver the best combination of technologies for high-order solutions. Our worldwide clients choose RESPEC because we are global problem solvers. Our reputation for transforming and conquering client challenges and providing integrated solutions comes from our talented professionals.

RESPEC BY THE NUMBERS

$105+ MILLION

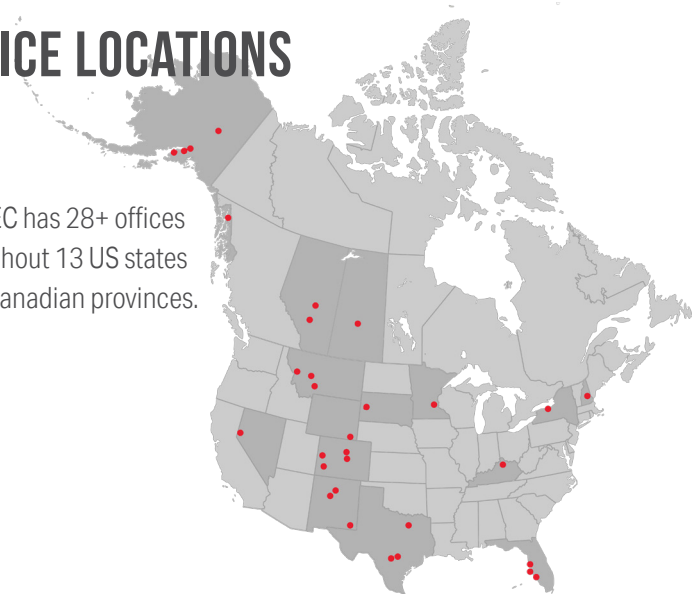
In 2022, RESPEC surpassed $105M in gross revenue for the first time in company history.

550+

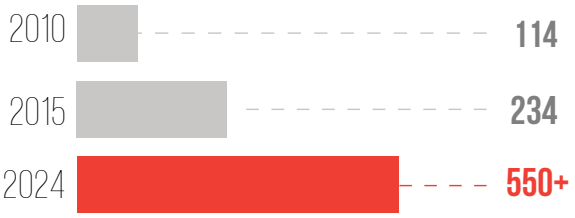
Our staff is over 550 employees throughout the US and Canada.

OFFICE LOCATIONS

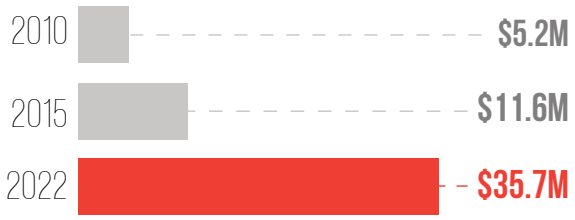
RESPEC has 28+ offices throughout 13 US states and 2 Canadian provinces.



COMPANY EMPLOYEE GROWTH



MINING & ENERGY REVENUE GROWTH



50+ YEARS

Founded in 1969 in Rapid City, South Dakota, our company has withstood the test of time. We have 50 years of experience in customizing our capabilities to meet client needs.

131 PROFESSIONAL ENGINEERS

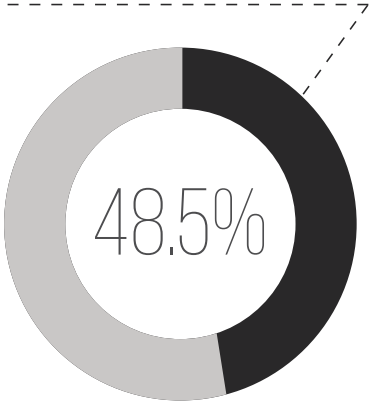
19 PROFESSIONAL GEOLOGISTS

15 DOCTORATE DEGREES

MARKETS WE SERVE:

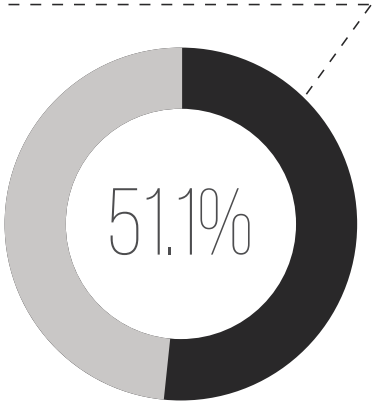
Community Design Solutions | Data & Technology | Energy | Facilities | Mining | Transportation | Water & Environment

MINING & ENERGY CLIENTS – 266



48.5% of RESPEC's total active clients (548) are Mining & Energy (266) clients.

MINING & ENERGY PROJECTS – 769



51.1% of RESPEC's total active projects (1,505) are Mining & Energy (769) projects.

PARTNERING IS OUR LEGACY.

THE POWER OF KNOW-HOW

Historically, RESPEC's principal area of business has been in the field of rock mechanics; more specifically, rock mechanics of evaporates—salt mechanics. Salt mechanics gained importance as an engineering disciple when the hydrocarbon storage industry began constructing caverns in salt and the U.S. Government undertook studies of radioactive waste disposal in salt formations. RESPEC's long-term involvement in radioactive waste disposal programs, the solution-mining industry, and the salt- and potash-mining industries has afforded us unique experiences and qualifications that make us ideally suited for all challenges.

We are one of the few organizations that provides services throughout the full mine life cycle. This approach to engineering problems has given us a deeper understanding of client needs and an appreciation of the critical need for interaction between these three technically related areas. Our technical staff comprises engineers and scientists with backgrounds in rock, solid, and fracture mechanics; mechanical, mining, civil, and electrical engineering; and geology, hydrogeology and geological engineering.

175+ CLIENTS
in our Mining & Energy Storage industries each year

50+ YEARS
in the evaporite industry

25+ YEARS
of experience in potash and salt exploration geology and drilling

20+ DRILLING PROJECTS
in evaporite basins

GLOBAL EXPERIENCE

Evaporite Sites That RESPEC Has Assessed

30+ CONVENTIONAL UNDERGROUND MINES

30+ SOLUTION-MINED FACILITIES

23+ GREENFIELD PROJECTS

50+ CAVERN STORAGE FACILITIES ENCOMPASSING 1,000+ CAVERNS

PROVIDING FULL MINE LIFE-CYCLE SERVICES

THE COMBINATION OF RESPEC'S PRAGMATIC APPROACH WITH TECHNICAL EXPERTISE ACHIEVES RESULTS-ORIENTED SOLUTIONS FOR OUR CLIENTS.

A MULTIDISCIPLINARY FORCE in geoscience, engineering, information systems, and technology, RESPEC offers life-of-mine services from greenfield assessments to operating mine settings. These services include:

- **Geology, Exploration, and Drilling**
- **Resource and Reserve Estimation and Reporting**
- **Rock and Materials Testing**
- **Spatial and Laboratory Data Management**
- **Mine Design, Planning, and Optimization**
- **Blasting and Explosives Engineering**
- **Rock and Soil Mechanics**
- **Hydrogeology and Groundwater Management**
- **Environmental Permitting and Remediation**
- **Instrumentation and Monitoring**
- **Asset Retirement and Reclamation**
- **Cavern Solution Mining, Storage, and Disposal**
- **Geothermal Exploration and Development**

EXPLORATION
FINDING & DEFINING DEPOSITS

- Environmental & Drill Permitting
- Exploration Drilling, Planning, & Management
- Core Logging & Field Services
- GeoSequel® Data Management System
- Geological & Resource Modeling
- Hydrologic Evaluation & Modeling
- Geomechanical Assessment
- NI 43-101, JORC Reporting, & SEC Rule S-K 1300

MINE DEVELOPMENT
PLANNING & BUILDING

- Due-Diligence Investigations
- Prefeasibility and Feasibility Studies & Reserve Estimation
- Financial Modeling, Evaluations, & Risk Assessments
- Life-of-Mine & Strategic Planning
- Mine Plan Design & Optimization
- Project & Construction Management

OPERATIONS
EXTRACTING & OPTIMIZING

- Operational Assessments & Optimization
- Fleet Management
- Mine Plan Optimization & Support
- Drilling & Blasting Services
- Geotechnical & Rock-Mechanics Analyses
- Instrumentation & Monitoring
- Mine Inflow Control & Mitigation

CLOSURE & RECLAMATION
RESTORING & MAINTAINING

- Mine Reclamation Planning & Engineering
- Water Quality Management & Restoration
- Reclamation Bonding Services
- Tailings Dam Design, Evaluation, & Support
- Long-Term Environmental Monitoring

GEOLOGY, EXPLORATION, AND DRILLING

RESPEC'S INTEGRATED GEOLOGY and engineering team serves the global mining industry with unsurpassed experience in commodity exploration and mining.

EXPLORATION | MINE DEVELOPMENT | OPERATIONS | CLOSURE/RECLAMATION

EXPLORATION PROGRAM DESIGN AND MANAGEMENT

RESPEC is an expert in full-procurement drilling and efficiently budgets, manages, and operates projects in a variety of commodities. Our dynamic team works with national and international clients to design and manage exploration programs that range from grassroots exploration assessment to operating mine settings. Our experts understand reporting guidelines from NI 43-101 to SEC. We ensure that the data collected meet or exceed the industry standards, such as CIM, then create valuable project insight by gathering, evaluating, and interpreting data. RESPEC develops well designs that reduce costs and achieve project objectives by collaborating closely with clients to meet all project requirements,

A reliable geosciences and engineering expert, RESPEC provides clients with well-site support, core logging, and data analysis to determine resource potential and reduce exploration risks. RESPEC leads the mining industry in geology desktop studies and geological modeling and is an expert in creating computerized representations of the earth's surface and subsurface.

100

drilling management and advisement projects completed

33

full procurement and drilling & completions projects completed

CAPABILITIES:

- Site Investigation
- Exploration Planning
- Drilling Management and Full Procurement
- Permit and Well Licenses
- Well-Site Support and Core Logging
- Disposal Well Planning and Workovers
- Database Management
- Geological 3D Modeling
- Resource Modeling and Estimation
- Technical Reporting
- Due-Diligence and Litigation Support

EXPLORATION & DRILL MANAGEMENT

HIGH PERFORMANCE MODELING AND DRILLING IN POTASH

Since Rio Tinto and North Atlantic Potash formed a joint venture for the southern Saskatchewan Albany Potash project in 2014, RESPEC has worked closely with CanPacific to maximize their potash resource with innovative engineering. RESPEC and CanPacific collected drilling data, created a three-dimensional (3D) geological resource and reserve model, and developed a new cavern solution-mining scheduling tool that optimizes future mining plans.

Since 2016, RESPEC has completed three characterization boreholes. In 2021, we completed a disposal well for CanPacific's greenfield potash project near Sedley, Saskatchewan. The RESPEC drilling team managed all aspects of the drilling process, including hole placement, permitting and land acquisition, safety training, well-planning and program development, bid collection and cost estimate, subcontractor coordination, drill-program execution, and reclamation. We successfully completed drilling under budget, on schedule, and without any incidents. Our geologists finalized the geological work and input the results into a model. The team then completed a resource and reserve model for the cavern field design.

WELL CONTROL FOR SALT DOME STRUCTURAL MAPPING

RESPEC obtained and reviewed well files, historical aerial photographs, and published technical literature to locate the wells more accurately than current state records.

- Performed a quality control check for several hundred wells to establish final verified coordinates
- Reviewed geophysical logs for many of the wells and created a database of depth to caprock and salt
- Combined well and seismic data to produce a more accurate salt dome structure map than previously published

OBSERVATION WELLS

In 2020, RESPEC managed the full-procurement drilling of an exploration well with vibrating wire piezometers (VWPs) near Lanigan, Saskatchewan. RESPEC designed the drilling program to ensure that all of Nutrien's data-collection requirements were met while maintaining cost efficiency. The following briefly summarizes the scope of work:

- Obtained the drilling license, completed the site survey, and coordinated the surface preparation
- Solicited bids for all services and provided an authorization for expenditure cost estimate to Nutrien
- Managed subcontractors and paid invoices on behalf of Nutrien
- Tracked the costs and schedule
- Obtained 99 meters of core from the Dawson Bay and Prairie Evaporite with 98 percent recovery
- Determined core was intact and suitable for assay testing
- Acquired geophysical logging and DST data
- Installed 16 VWPs and confirmed they worked correctly.

Zero safety and environmental incidents occurred during this project.

RESOURCE AND RESERVE ESTIMATION AND REPORTING

EMPHASIZING geologic basics for a sound project beginning, RESPEC's mineral resource and reserve estimation experts support your ultimate goal—to mine a deposit after a thorough de-risking process of drilling, mapping, and modeling.

EXPLORATION | MINE DEVELOPMENT | OPERATIONS | CLOSURE/RECLAMATION

A GLOBAL FORCE IN MINING AND MINERALS

RESPEC, a world-renowned integrated solutions partner with state-of-the-art laboratories, partners with international clients to perform reserve analyses and mine design. We assist clients in exploration management, underground and open-pit development, and continued advancement in understanding the geological and geotechnical data of current operations.

By using database validation, geostatistical analysis, block modeling, and interactive geological modeling, our professionals are adept at resource estimation and appraisal and regulatory compliance. Our 3D modeling services include solid, grid, and hybrid models. We also offer block modeling with geostatistical analyses, including variography, kriging, and simulation. Outcomes include resource estimation and classification, uncertainty quantification, and other geostatistically derived results.

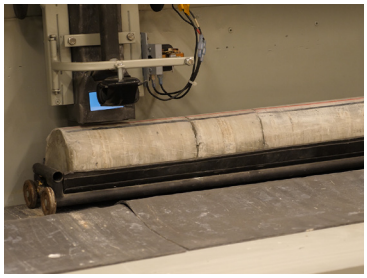
35+
YEARS
of experience in potash evaporite geology and drilling

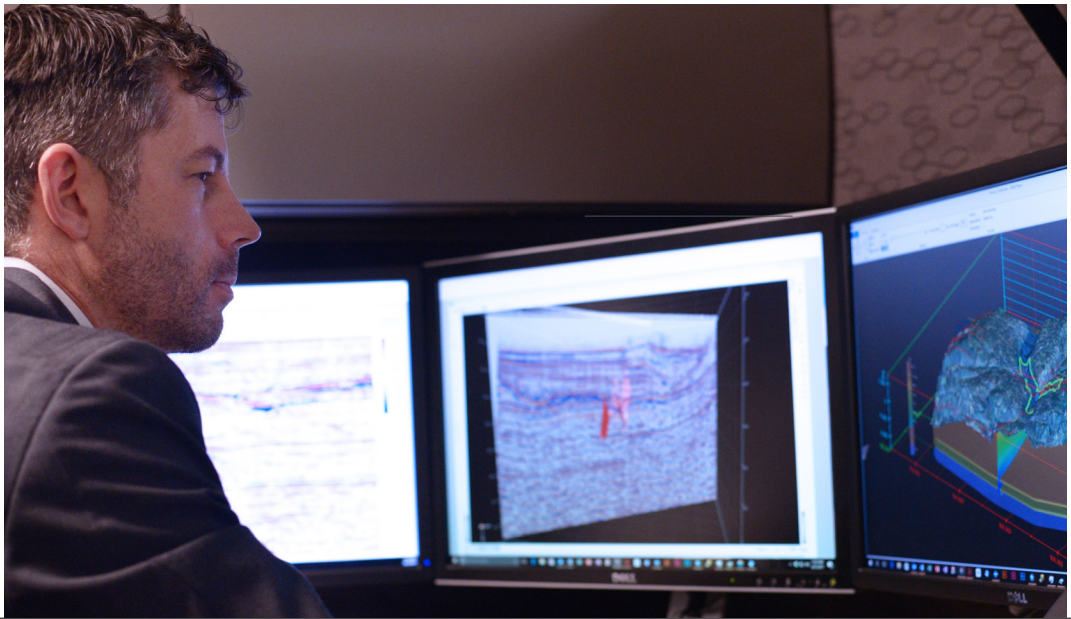
200+
evaporite projects completed

100+
technical reports delivered

CAPABILITIES:

- Site Investigation
- Exploration Management
- Data Assessment and Validation
- 3D Geological Modeling
- Resource Estimation and Classification
- Underground and Open-Pit Mine Optimization and Design
- Ore-Reserve Estimation
- Prefeasibility and Feasibility Reporting
- Qualified and Competent Persons in a Variety of Commodities
- NI 43-101/JORC Reporting Standards
- Due Diligence for Financial Groups
- SEC Compliance
- Preliminary Economic Assessment and Exploration Target





RESOURCE AND RESERVE ESTIMATION

MERGERS AND ACQUISITIONS

RESPEC has provided comprehensive due diligence services to equity firms, banks, mining companies, and insurers for more than 50 years. We completed over 25 technical due diligence reviews in the last decade and reviewed over $24 billion in successful financial transactions in the last five years. Most recently, RESPEC was part of a multidisciplinary due diligence team that reviewed the last two acquisitions in the salt industry. The effort encompassed a technical review of both conventional and underground mines as well as solution brine evaporation facilitates. A team of over 20 RESPEC engineers and geologists completed the review and conducted site visits. In both reviews, RESPEC was the technical advisor to the successful bidder.

MINE FINDER ANALYSIS

RESPEC developed a geographic information system-based (GIS) decision-support tool and cost analysis model to determine how to most efficiently serve markets. The tool supports business-related decisions, including suitability analysis, to find optimal greenfield sites based on development factors, such as geology, slope, and land use and contiguous areas that were needed for development, such as the proximity of various product transportation modes, existing competitor locations, and exclusions based on proximity to sensitive areas. The network analysis considers supply chain costs using multiple transportation modes, from facilities and markets of interest. The network analysis evaluates the supply chain costs of all existing facilities (including competitors') as well as those of the proposed optimal facilities to service the market demand as determined by the historical marketing data. Using the results of this analysis, we selected the most cost-effective mode of transportation for each facility and then calculated market share for each facility based on its ability to most efficiently serve the markets and dollars available. This allowed web-based access to maps for non-GIS users to visualize market data, transportation networks, and geologic resource information together. In addition, RESPEC established an ArcGIS Online account for the client for data storage, analysis, and visualization.

FULL SERVICE EXPLORATION SUPPORT

RESPEC has extensive experience in taking projects from concept to production. Many of the potash projects in Sakatchewan, including the BHP Jansen Mine and the K+S potash solution mine, have RESPEC's fingerprint on them in some capacity. Our team of geologists has worked on the exploration wells to outline the deposit and estimate the resource and reserve tonnages for technical reports. RESPEC has worked with CanPacific Potash since 2016, providing significant support for development of their potash asset in Saskatchewan. This work has expanded from a grassroots exploration project to a pre-feasibility-level project. Currently, we are working with a team of engineers toward a development decision using an innovative drilling-and-completion design.

Our team has provided CanPacific geology, drilling, and engineering services to assist with the field exploration and geology and provide highly specialized engineering services for creating a functional and realistic KCl Brine Production Scheduling tool. In the fall of 2021, our drilling team drilled and completed the disposal well that they will use for their pilot test in the first half of 2022.

ROCK AND MATERIALS TESTING

AS THE FOUNDATION of RESPEC's Mining & Energy business unit, our rock-testing and research team gathers and provides the quality data necessary to conduct advanced engineering analyses.

EXPLORATION | MINE DEVELOPMENT | OPERATIONS | CLOSURE/RECLAMATION

WORLD-CLASS TESTING SERVICES

RESPEC provides global clients with advanced rock-materials testing and core-logging services. Our environmentally controlled laboratory testing space with redundant power was built for comprehensive testing and logging programs for any type of rock. RESPEC's state-of-art laboratory features 16 multiaxial, thermocoupled, hydraulic load frames for long-term creep tests, 4 MTS multiaxial, thermocouple, hydraulic load frames capable of multiple custom testing scenarios, and a custom-build high load capacity direct shear machine.

RESPEC conducts standardized testing in accordance with ASTM, ISRM, and API standards to provide clients with the best-quality data. We develop customized test programs to simulate project-specific conditions.

10,000 FT^2
of environmentally controlled testing space with redundant power

20
computer-controlled hydraulic load frames for multiaxial, thermocoupled, tests.

1,000+
salt strength tests conducted

1,000+
rock mechanics creep tests conducted

CAPABILITIES:

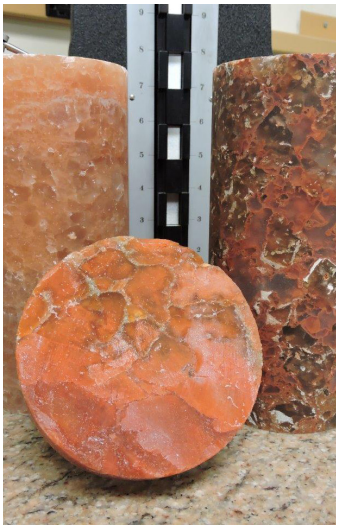
- Long-Term and Cyclic Behavior
- Thermal Properties Measurements
- Mechanical and Hydrological Properties Measurements
- Rock/Fluid Interaction Studies
- Constitutive Model Development
- Specialty Specimen Preparation
- Customized Testing
- Brine Mineralogy Insoluble Content Analyses

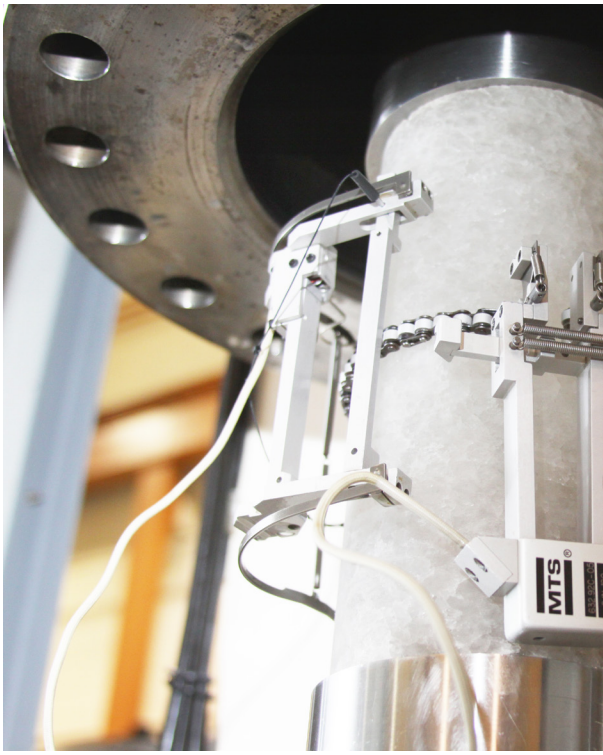
TESTING SERVICES:

- Long-Term and Cyclic Creep Tests
- Direct Shear, Triaxal, Unconfined, and Tensile Strengths
- Thermal Expansion, Conductivity, Diffusivity, and Heat Capacity
- Water Content, Porosity, and Permeability
- Ultrasonic Velocity and Dynamic Elastic Constants
- Consolidation and Compaction

LOGGING SERVICES:

- Lithologic Characterization
- XRD and Mass-Spectrometry for Mineralogy
- Laser Particle Grain-Size Analysis
- Spectral Gamma Analysis
- Core Storage





SALT TESTING

DISSOLUTION TESTING

Dissolution testing is critical to understand how solution mined caverns within evaporite deposits grow over time. The characteristic rate of dissolution depends on the mineralogical composition of the material being dissolved and the chemical makeup of the solvent that varies with respect to temperature. Analyzing the dissolution rate is a key component of mine planning for solution mined cavities. The rate directly impacts the brine grades composition and inherently dictates how the cavern will develop in the future, which is paramount in life of mine planning and cavern sequencing that ultimately drives the project's economics. Fortunately, RESPEC's capabilities include in-house dissolution testing on collected rock core samples and different materials with varying solvent compositions and temperatures to replicate potential cavern performance.

A NEW UNDERSTANDING IN SALT STRENGTH

RESPEC was commissioned by the US Department of Energy (DOE) and the National Energy Technology Laboratory to develop a new stress-based criterion to predict the onset of damage in salt surrounding conventionally mined excavations and solution mined cavities. To meet this challenge, RESPEC conducted 34 laboratory tests to investigate the effects shear stress, mean stress, pore pressure, temperature, and Lode angle has on the strength and creep characteristics of salt. The new criterion improves the predictive ability of dilation in salt. Using this new criterion in geomechanical assessments of storage caverns has enabled RESPEC to confidently recommend lower allowable minimum gas pressures in caverns at shallower depths at hundreds of sites, which would not have been allowed based on previous performance criteria. This reduced the minimum base gas required to be maintained in the caverns for stability, increasing the allowable amount of working gas that storage operators can use.

CONVENTIONAL UNDERGROUND MINES

AS A GLOBAL LEADER IN ROCK-SALT MECHANICS, RESPEC knows successful solutions start with quality data. We deliver expertise in rock mechanics to determine the strength of a rock mass and its capability to resist applied forces.

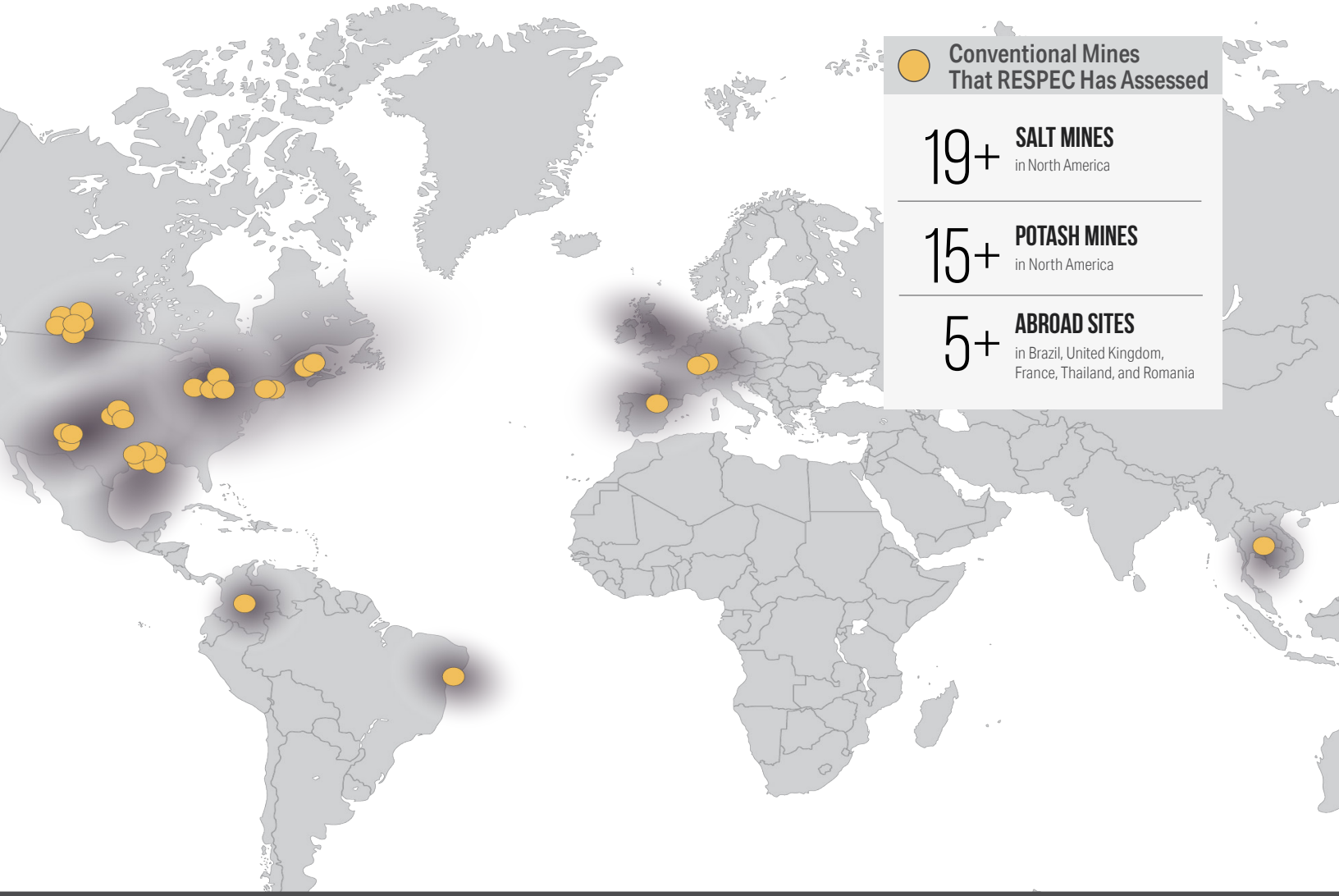
EXPLORATION | MINE DEVELOPMENT | OPERATIONS | CLOSURE/RECLAMATION

ROCK-SALT AND POTASH MECHANICS

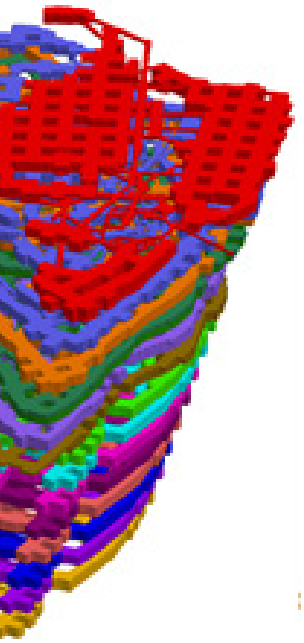
Our natural world has been modified to such an extent that the "easy" mining projects are becoming fewer and fewer. As mining projects continue to advance into more difficult territory where excavations are larger, mines are deeper, and grades are lower, requirements are generally becoming more complex. Simple engineering and "rule of thumb" processes don't apply as engineering projects advance. The highest levels of theory, observation, and expertise must work together to create the safest and most innovative rock mechanics solutions in mining As a global leader in rock-salt mechanics, RESPEC's engineering team is a combined force of integrated backgrounds in geosciences enable us to successfully tailor analyses that fit each client's need and provide advanced modeling through both in-house and commercially available software packages.

CAPABILITIES:

- Excavation Design
- Underground Stability
- Slope Stability
- Field Assessments
- Ground Support
- Mine Monitoring



GEOMECHANICAL ASSESSMENTS



MINE LAYOUT AND OPERATIONAL CONSIDERATIONS

Salt, potash, and trona clients asked RESPEC to perform numerical mine analyses to guide decisions regarding the mine design, layout, and sequencing. RESPEC has conducted studies to assess the stability and expected response of nearly all the planned underground workings at the mine, including shaft pillar excavations, maintenance shops, storage and surge bin excavations, and production panels. The results have been used to guide decisions regarding the excavation and pillar dimensions, identify appropriate room length and widths to ensure stable ground conditions while access is required, and evaluate the long-term stability and utility of the shaft pillar area to ensure adequate headroom and rib-to-rib clearance around infrastructure during the operation life.

MULTI-SEAM AND MULTILEVEL MINING

RESPEC has worked for confidential clients and performed more than 10 mine plan evaluation studies to assess reserves in stacked ore zones or in domal deposits that often have limited interburden thicknesses. RESPEC has assessed the stress concentrations and rock damage caused by mining one ore zone and the likelihood of the existing work creating problems for subsequent ore zones or levels. We have also evaluated the response of a stacked ore body under multiple scenarios. Results have been used to define a set of design criteria, an optimal sequence of ore zone extraction (i.e., top-down, bottom-up, or alternating), and to identify adequate time delays between multiple ore zone extractions to limit adverse interactions between ore zones sequencing of new workings and declines to help ensure stable conditions while access is required and assess the long-term stability and utility of existing workings.

BULKHEAD DESIGN

EVAPORITE BULKHEAD DESIGN

RESPEC has been contracted by a confidential client to evaluate the geomechanical aspects of a concrete bulkhead that was being considered to minimize the impact of inflowing brine in the back end of a panel. The intent of the bulkhead was to contain the brine inflow and allow the mine to be operated for at least an additional 50 years. To aid in the decision process for selecting the most appropriate bulkhead location and design, RESPEC performed 3D finite-difference calculations to predict the time-dependent structural response of the salt formation at the salt mine, assuming an excavation history, bulkhead to successfully implement the barrier pillar location, and pressurization scenario. These analyses predicted the following three responses: (1) normal stress redistribution along the bulkhead/salt interface, (2) potential for salt dilation surrounding the bulkhead, and (3) structural integrity of the concrete bulkhead. The first two items are paramount for circumventing the brine flow through enhanced permeability zones surrounding the bulkhead. The final item addresses the potential for shear failure and tensile fracturing of the bulkhead and/or survivability of the bulkhead under the model-predicted conditions.

SUBSIDENCE ENGINEERING

DELINEATION OF MINE-INDUCED SURFACE SUBSIDENCE

RESPEC helped more than two dozen salt and potash mines assess their near and long-term mine plans to understand the anticipated ground displacements and evaluate if the mine-induced subsidence might have an adverse impact on ground surface, surface structures, surface and subsurface infrastructure, and water drainage. The subsidence predictions were used to identify surface benchmark locations where a comparison of measured and predicted subsidence patterns would reveal the most information about actual mine and overburden behavior. The subsidence results also provided the required data for a hydrology assessment on the impact that future surface displacements would have on surface-water drainage. The data are often compared to the results of subsidence predictions to delineate regions that can be attributed to mining-induced subsidence and other regions that may be attributed to natural disturbances (e.g., natural sinkholes).

INCREASING MINEABLE RESERVES

RESPEC has been engaged by several confidential clients to evaluate their mine plans and assess potential impacts that mine-induced ground-surface subsidence may have on surface structures and infrastructure. The data are used to pursue additional mineral leases and increase available mineable reserves. The studies often identify stand-off distances and panel extraction sequences that maximize available reserves, minimize the ground-surface disturbances, and maintain displacements, tilts, and strain magnitudes below the threshold values that identify the onset of negligible to slight damage.

ASSESSING POTENTIAL ADVERSE IMPACTS OF MINE-INDUCED SUBSIDENCE

A confidential client asked RESPEC to evaluate anticipated subsidence above and surrounding their potash mine if they mined specific reserves in their permitted boundary. The concern with the mine plan was that mining-induced subsidence may compromise the integrity of existing and proposed nearby oil and gas wells and allow gas to escape. The results delineated areas that were susceptible to damage and identified potential adverse effects on the planned wells. The results were also used to outline a subsidence-monitoring program to implement as mining approached the wells.

GROUND CONTROL

GROUND CONTROL SUPPORT

RESPEC has reviewed or aided in the design of ground-support plans at more than 20 evaporite sites to ensure that it effectively addresses anticipated conditions while considering the bolt type and spacing; anchorage method, depth, and capacity; and effective bolt length. These plans support designs for critical infrastructure, long-term installation, and short-term production areas. Efforts have encompassed inspecting scope holes, installing instrumentation, and other investigative activities to identify potential hazards and gather data to define design requirements and installation practices that can extend the functional life of the ground support. The goal of ground support in these situations is not to contain the rock and prevent it from moving; rather, an effective design must move along with the rock and support any fully detached slabs while the area is accessible or until additional remediation measures can be undertaken.

FORENSIC INVESTIGATIONS

Since 1983, RESPEC has provided continuous field support at the Waste Isolation Pilot Plant (WIPP), the only active US nuclear repository located in New Mexico. Notably, RESPEC has been instrumental in developing and reviewing a long-term ground-control plan for the WIPP underground facility. The objectives include an ongoing geotechnical assessment of the current ground conditions throughout the entire underground facility. RESPEC works with on-site personnel to develop and review various ground-control components and systems, measuring performance with geotechnical monitoring systems that include over 130 closure stations, extensometers, and other instruments to prioritize rehabilitation activities. RESPEC has also formulated mining alternatives to improve the ground conditions at the site and regularly presents updates to the operations lead, technical lead, and the owner, US DOE.

MINE SHAFT

SHAFT INSPECTIONS TO MAINTAIN INTEGRITY

Along with observational site visits, shaft inspections include reviewing monitoring and LiDAR data and available reports to better understand the geological and hydrogeological setting. The goal is to determine whether the current shaft conditions are discernibly different compared to the previous inspections. Particular attention is given to identifying cracks in the concrete liner, regions of concrete degradation, damp patches on the concrete surface, buildup of salt plumes, and the significance of measured seepages through the liner.

The visual observations and measurements taken at a shaft inspection are used to assess the physical stability and integrity of the shaft liner. They also reveal the conditions behind the liner by showing the amount of and change in collected brine volumes. The results are compared to previous inspections to determine whether there's a difference in the current shaft condition. We report to the client whether reestablishing the shaft integrity is necessary to maintain long-term stability and address identified hazards that pose a risk to on-site personnel or impact hoisting operation.

SHAFT SEAL DESIGN FOR A POTASH MINE

RESPEC developed the seal design and construction specifications for a potash mine shaft. The work effort encompassed inspecting the open shaft to access current conditions, identifying remedial actions to seal the shaft, and developing detailed design drawings with a complete schedule and estimated bill of materials. Our complete shaft closure and construction methods were carried out in four phases: The first phase was to prepare the shaft for the seals. It encompassed securing timber sets above the plug location; removing and demolishing existing timber and debris in the proposed plug one; and removing the shaft liner and in situ rock surrounding the liner via RESPEC's drilling and blasting method as described in the drill-and-blast plan. Once a safe work environment was reestablished, the shaft plug was constructed and grouted, and monitoring instruments were installed. The remainder of the shaft was then backfilled to the surface. During the last phase of the project, a permanent concrete cap and foundation were poured. During the construction phase, test sampling was performed to ensure that the material specifications were met and conformed to the design standards specified by RESPEC.

SOLUTION MINING AND CAVERN STORAGE

AS THE CAVERN INDUSTRY'S PREMIER technical services provider, RESPEC provides expertise in storage, well design and waste disposal, and solution mining for projects all over the world.

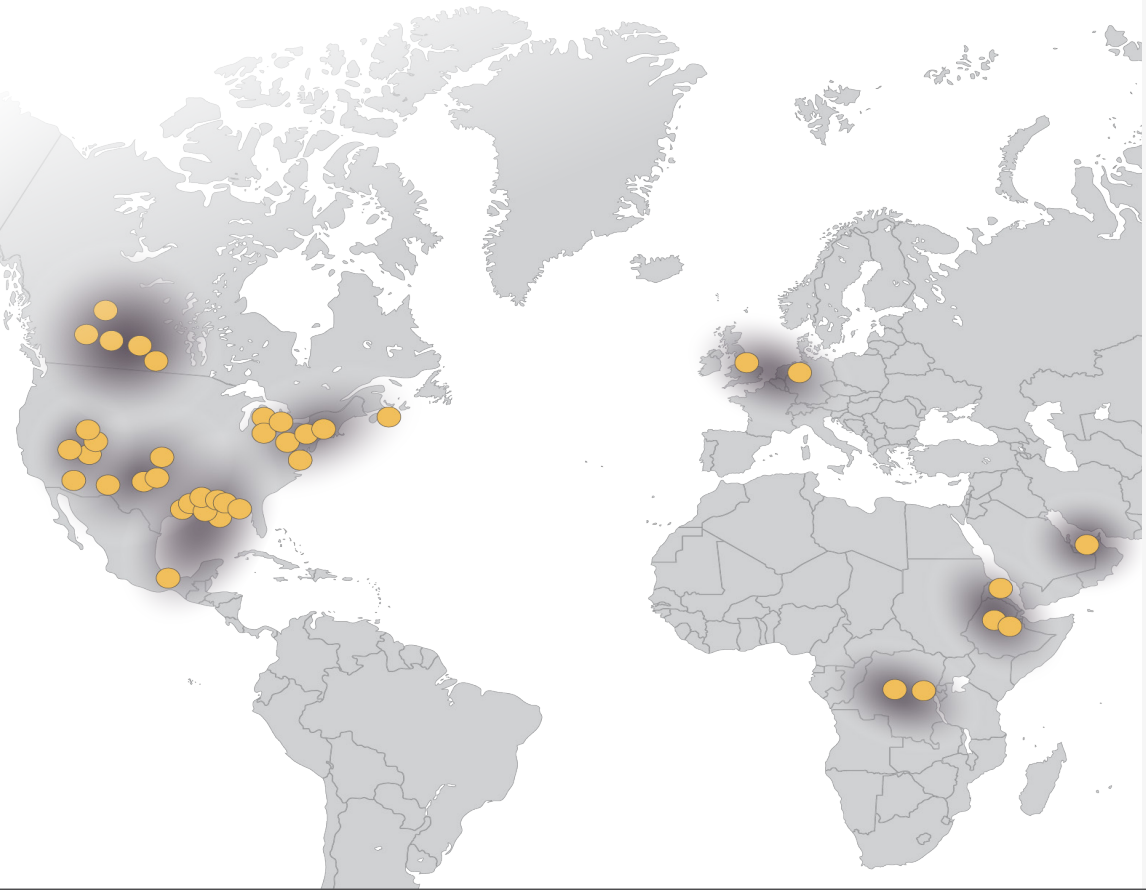
EXPLORATION | MINE DEVELOPMENT | OPERATIONS | CLOSURE/RECLAMATION

CAVERN ENGINEERING WORLDWIDE

With more than 50 years of experience in the industry, RESPEC assists in nearly all areas of cavern operations, from initial greenfield geologic exploration to cavern plugging and abandonment. Serving both private- and public-sector clients across the globe, our professionals specialize in storage of liquid hydrocarbons, natural gas, compressed air and hydrogen; well design and waste disposal; and brine, potash and trona production. Our engineers and scientists have a dedicated focus on the geological, hydrological, geomechanical, and thermodynamic aspects of cavern operations. By combining our diverse capabilities of geologic studies, rock-core testing, computer modeling, and field testing, RESPEC helps cavern operators to plan new cavern developments, optimize existing caverns, comply with regulatory requirements, and ensure the continued safety and successful operation of cavern facilities.

CAPABILITIES:

- Drilling Management and Procurement
- Geologic Coring and Characterization
- Rock Testing
- Hydrologic Characterization
- Solution-Mine Design and Scheduling
- Subsidence Analyses
- Geomechanical, Thermal, Thermodynamic, and Hydrological Analyses
- Field Instrumentation and Testing
- Disposal Well Design
- Conventionally Mined Storage (Mine Design, Blast Design, Ground Control, Costing)



Cavern Facilities Assessed by RESPEC

60+ GULF COAST
More than 60 cavern facilities assessed in Texas, Louisiana, Mississippi, Alabama, and Veracruz, Mexico.

15+ PERMIAN
More than 15 cavern facilities assessed in Kansas, Oklahoma, Texas, and New Mexico.

5+ BASIN AND RANGE
More than 5 cavern facilities assessed in Arizona, Utah, Colorado, and Wyoming.

20+ ELK POINT
More than 20 cavern facilities assessed in Alberta and Saskatchewan.

10+ APPALACHIAN, MICHIGAN, AND MARITIMES
More than 10 cavern facilities assessed in Ontario, Nova Scotia, Michigan, Ohio, New York, and Virginia.

3 EUROPEAN
Three cavern facilities assessed in the United Kingdom and The Netherlands.

SOLUTION MINING DESIGN

SOLUTION MINING CAVERN DESIGN

After completing exploration planning and development, field services support and core interpretation, geological and geophysical analysis, and resource modeling and reporting, the RESPEC team began work to progress the project toward mine planning and development. The proposed solution mined project targets potash beds deep beneath the surface, where our team is designing the wellfield and cavern configuration and layout while modeling and evaluating the potential cavern performance to optimize the design to meet production goals. In this assessment, both single and dual well vertical caverns, along with horizontally drilled and developed caverns, are being analyzed for performance and compared to the feasibility and project economics. The wellfield design and cavern modeling are just one component of the overall Preliminary Economic Assessment, with additional cavern modeling anticipated as the project progresses.

SECONDARY SOLUTION MINING

RESPEC has extensive experience in the primary (mechanical) and secondary (solution) mining of potash in New Mexico and Utah for Intrepid Potash. Our expertise includes the practical aspects of ventilation and geotechnical operations support, the theoretical estimation of mineral resources from exploration data, and the conversion of resources to reserves through applying modifying factors, including mine planning, recovery, and economic evaluation.

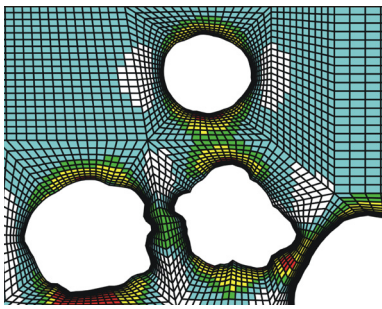
BRINE PRODUCTION CAVERNS IN A CHALLENGING GEOLOGICAL SETTING

RESPEC has assisted a solution-mining operator in locating and developing brine-production caverns in challenging geological settings where the salt strata contain complex evaporites with varying solubilities and numerous nonsalt interbeds. This effort required managing potassium, magnesium, and calcium content that result in unfavorable brine quality and sodium chloride concentrations. RESPEC assisted the solution-mining operator by developing geophysical-logging and coring programs to identify ideal solution-mining intervals and define key parameters in the solution-mining design, such as the flow rate, leaching duration, tubing depths, and leaching circulation method to ensure high salt concentrations, maximize salt-extraction ratios, and maintain cavern performance. Our personnel have dedicated months of time on-site at the facility to quickly help with maintenance and operations. RESPEC performs monthly leaching program reviews to ensure that the solution mining and brine production are performing to plan and advise on adjustments needed to the leaching program.

CAVERN GEOMECHANICS

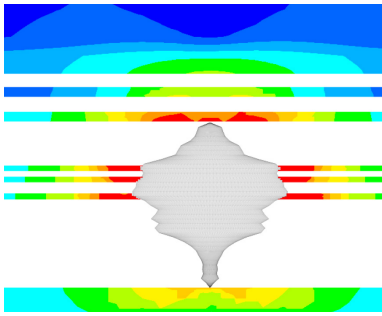
CAVERN GROWTH ANALYSIS

RESPEC evaluated the geomechanical behavior associated with the continued enlargement of solution-mined caverns in an urban environment. We performed core logging and rock-mechanics testing of salt and nonsalt core obtained from the facility. We developed cavern growth models, based on historical operations, that captured continued cavern enlargement. With the models, RESPEC performed geomechanical modeling to evaluate the current and future stability of the cavern field. Minimum and maximum cavern spacing and diameters that can be safely achieved during continued cavern growth were provided to the operator.



CAVERN FIELD EXPANSION PROJECT

In support of expanding a brinefield with more than a dozen new cavern wells, RESPEC evaluated the geomechanical behavior and ground subsidence associated with the proposed expansion. Services encompassed core logging and rock-mechanics testing of salt and nonsalt core that were recovered from the facility and geomechanical modeling of the planned brinefield expansion to evaluate the impact on cavern roof stability, nonsalt interbed failure, hydraulic integrity, and ground surface subsidence in an anisotropic stress field. The modeling provided the solution-mining operator with confirmation that the brinefield expansion will not adversely affect subsurface stability and subsidence behavior. We performed 3D geomechanical modeling of the planned brinefield expansion to optimize the location of the new caverns and maximize the available salt reserves. The operator was given confidence in drilling the caverns in the best possible location.



INSTRUMENTATION AND MONITORING

FOR MONITORING SOLUTIONS that are accurate, reliable, and easy to use, RESPEC specializes in measuring everything from stress and convergence in underground mines, to slope stability and subsidence, to water levels and flow rates.

EXPLORATION | MINE DEVELOPMENT | OPERATIONS | CLOSURE/RECLAMATION

INSTRUMENTATION SOLUTIONS

With a broad range of geoscience technologies and industry applications, RESPEC's instrument designs are tailored to address specific client needs. Our team develops and builds high-quality, customizable instrumentation and employs the latest in data collection, communication, and delivery technologies to provide our clients with the most accurate and actionable information possible. In RESPEC's state-of-the-art fabrication and development shop, we custom-build specialized equipment and tools and customize the software and hardware used for instrumentation and monitoring in diverse types of mines. For every phase of the mine life cycle, RESPEC gets the data you need when you need it.

CAPABILITIES:

- Underground Convergence and Tilt
- Landslide, Subsidence, and Slope-Stability Monitoring
- Real-Time Early-Warning Systems
- Surface-Water Measurements
- Cloud-Based Data Delivery and Visualization Options
- Inflow Monitoring and Control
- Integrated Custom Hardware and Software
- 3D Data Collection and Modeling
- High-Resolution Video Monitoring
- Blast and Vibration Monitoring

INSTALLED
200+
dataloggers in locations throughout the world.

10 YEARS
as a Campbell Scientific Partner

Collecting, analyzing, and reporting more than
50,000+
DATA POINTS PER DAY

INSTRUMENTATION, MONITORING, & DATA VISUALIZATION

DATA DASHBOARD DEVELOPMENT

RESPEC has developed web-based dashboards to track and manage operating parameters and monitoring data for cavern operators and salt and potash producers. RESPEC's Cavern Management Dashboard standardizes the tracking of critical operational data and provides quality control measures to improve reporting reliability and efficiency while avoiding critical errors in managing cavern assets. For one confidential client, the Cavern Management Dashboard compiled operational data that resided in complicated Excel spreadsheets encompassing more than 200 caverns and thousands of operating parameters. The Cavern Management Dashboard is hosted in a secure cloud server that is accessible from anywhere and any device, which eliminates the cumbersome and error-prone Excel method. RESPEC has developed similar mine monitoring applications for underground salt and potash producers that provide framework to efficiently identify abnormal trends in the mine monitoring data, which includes hundreds of convergence stations and extensometer. Incorporating alerts into the dashboard has proven to be an effective method to convey critical information to the mine engineers. The alerts ultimately enhance personnel safety by identifying areas where unexpected or accelerated ground-control problems are developing underground.

USING LIDAR TO MONITOR GROUND SURFACE RESPONSE

RESPEC has been using aerial Light Detection and Ranging (LiDAR) since 2018 to acquire Digital Elevation Model (DEM) data to supplement conventional subsidence surveys and provide nearly full aerial coverage. This data has successfully been used to identify and delineate unique surface depressions on the ground surface and differentiate sinkhole activity from general subsidence over evaporite mines. RESPEC tracks changes in surface-depression characteristics (e.g., size, volume, growth rate, etc.) over time in a georeferenced database classified as active surface depressions, potential emerging surface depressions, inactive surface depression, surface erosion, and surface water. This information helps clients better understand the evolution of sinkhole volume and growth rate, which is beneficial for remedial efforts, and the impact that mining has on ground-surface disturbances.

RESPEC also uses the DEM data to create full coverage contours of the change in elevation between subsequent LiDAR surfaces, providing an indication of subsidence attributed to the convergence of the underground mine in addition to heat maps, which illustrate the difference between the predicted and measured subsidence.

NAPOLEONVILLE SALT DOME SINKHOLE MONITORING

RESPEC provided field services support at a developing sinkhole on the western flanks of the Napoleonville salt dome in Louisiana. RESPEC geoscientists deployed a real-time early-warning system to monitor the effects around the developing sinkhole continually. The system consisted of research-grade dataloggers, tiltmeters, inclinometers, and water-level transducers. Data were continuously collected and transferred in real time via spread-spectrum radio to a base station that sends data over a cellular network to a secure server. The network telemetry allows two-way communication so data can be gathered remotely, and the dataloggers and sensors in the field can be reprogrammed or reconfigured from the office. Data from the inclinometers, tiltmeters, and water-level gauges are combined with InSAR data and traditional elevation survey data to create subsidence-rate contours over the large areal extent. Water-level data are compared to microseismic monitoring data to indicate the onset of rapid subsidence events

EVAPORITE **EXPERIENCE**

AS A GLOBAL LEADER in mine planning and operational excellence, RESPEC leverages our expertise with a comprehensive, detail-oriented approach to developing the best solutions to address our clients' needs.

EXPLORATION | MINE DEVELOPMENT | OPERATIONS | CLOSURE/RECLAMATION

EXCEEDING EXPECTATIONS

RESPEC's commitment to our clients is to provide high-quality mine plans that meet their financial and production requirements and exceed their expectations by optimizing resource recovery while maximizing economic returns for clients, we serve clients with all types of surface and underground operations across a spectrum of commodities around the world.

Following the same high standards, RESPEC's team prepares short, medium, long, and life-of-mine plans for international operations. Our approach is comprehensive and detail-oriented. Our expertise is broad and deep; from geology to equipment productivity and costs and from health and safety to environmental concerns, RESPEC's experts have the technical knowledge and operational experience to meet any challenge. We are sensitive to all facets of an operation and understand the intricacies of addressing a high-quality mine plan.

CAPABILITIES:

MINE DESIGN AND PLANNING

- Detailed Short- and Long-Term Mine Plans
- Mine Design and Layout
- Equipment Selection
- Production Sequencing
- Grade Controls and Optimization
- Explosives Engineering

OPTIMIZATION

- Fleet Management
- Operating Cost Evaluations
- Operational Audits
- Project Execution, Construction, and Contractor Management
- Health-and-Safety Audits

OPERATIONS ASSISTANCE

MODELING OF SOLAR EVAPORATION OF SALT PONDS

Salt production using evaporation pond processes can take an extended amount of time. If a sales team knows the expected salt quantity production, they have an accurate number of items they can sell in advance of the actual salt being produced. Cargill turned to RESPEC to better understand their salt evaporation plant operations and processes in Newark, California. With an extended forecast, RESPEC was asked to provide a range of expected salt productions for a target season given historical climate patterns that encompassed wet, normal, and dry years.

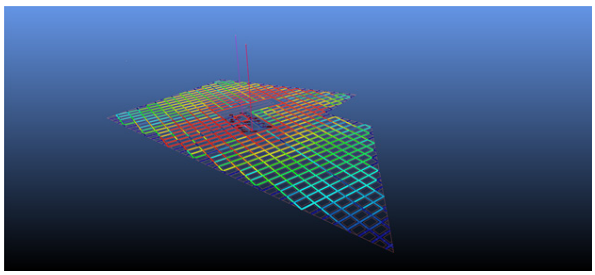
The Newark plant operation consisted of a system of 20 concentration ponds. RESPEC was provided a model that the US Geological Survey developed called SPOOM, which is a spreadsheet model that was hard-coded to a specific set of pond configurations in the Bay area near the Newark project site. The existing model was not easy to use with other sites and pond configurations. Using the SPOOM equations for salt concentration and crystallization, RESPEC developed a new spreadsheet model that can easily adapt to different sites and pond configurations. Using daily meteorological input and rainfall data, the model recorded the brine evaporation in each pond and the brine transfer from pond to pond. The model was calibrated on a daily timestep using two seasons of known plant operations and climatic conditions. The output predicts the quantity of salt production (in tons) that can be produced for a given set of meteorological input and plant operation constraints.

TAILINGS STACK PROJECTS

In addition to the more typical tailings design that supports the industrial minerals sector through exploration, laboratory testing, slope stability analyses, and instrumentation, RESPEC has experience reviewing critical aspects of phosphogypsum stack performance for a private client. Phosphogypsum stacks, often hundreds of feet high, are a byproduct of phosphate processing and composed of slurry-placed material that is weakly radioactive and very acidic (a water pH of approximately 2). The scopes of work for these confidential projects encompassed advanced applications of scientific principles and frequent use of cutting-edge technology in disciplines spanning geology, geotechnics, hydrogeology, and geophysics.

VENTILATION

RESPEC has evaluation, design, and operations support expertise in all aspects of subsurface facility ventilation. We're experienced in providing quality airflow solutions for a range of operations — from typical mining layouts to challenging large opening mines and caverns. Our capabilities include the full spectrum of ventilation services, including surveys of airflow quality, pressures, and quantities, personnel training, simulation, fire modeling, shaft and fan selection, regulatory compliance assistance, Mine Safety and Health Administration and Occupational Safety and Health Administration representation.



HYDROGEOLOGY AND GROUNDWATER MANAGEMENT

FEATURING OUR COLLECTIVE experience, educational background, and operational understanding, RESPEC provides unsurpassed knowledge of hydrogeologic systems and interpretation of data sets to support mining project solutions.

EXPLORATION | MINE DEVELOPMENT | OPERATIONS | CLOSURE/RECLAMATION

HYDROGEOLOGY AND GROUNDWATER MANAGEMENT

RESPEC provides expertise in groundwater and reservoir fate and transport modeling, hydraulic test design, and implementation and interpretation. Our team is experienced in disposal and injection well services and hydrogeologic services for mines and storage caverns. We also perform data interpretation and modeling services. RESPEC has a global reputation for being unsurpassed in expertise and work related to mine inflows for evaporite mines. We have a long history of demonstrating our capability to analyze and interpret any complex dataset.

Serving mining and other environmental projects, our multidisciplined team performs groundwater modeling to evaluate impacts associated with stressors on groundwater systems.

Inflow management and hydrogeology support for

20+

SALT AND POTASH MINES

Successfully managed mine inflows as great as

50,000

GALLONS/MINUTE

CAPABILITIES:

MINE INFLOW SERVICES

- Mitigation and Remediation
- Contingency Plans
- Risk Analysis
- Multidisciplinary Data Interpretation, Including Hydrogeology, Rock Mechanics, Chemistry, and Geophysics

DATA ANALYSIS AND MODELING

- Machine Learning
- Univariate and Multivariate Statistics
- Signal Processing
- Wavelet Analysis
- 2D and 3D Temporal and Spatial Data Analysis and Modeling

HYDROGEOLOGY & MINE INFLOW

INFLOW ABATEMENT SUPPORT

RESPEC has been directly involved with efforts to abate an inflow at a confidential mine since 1987. Our involvement has varied and evolved over this long-term project but has encompassed litigation and court case support, rock-mechanics testing and modeling, subsidence analyses, instrumentation support, data control and maintenance, hydrogeology, inflow support, microseismic analyses, and brine-disposal support. Over the past 15 years, RESPEC has been intimately involved with surface-grouting operations, including regional and local groundwater modeling, disposal modeling, grouting and chemical analyses, and data analyses of interdisciplinary mine inflow datasets.

RESPEC conducted hydrogeology studies and investigations for several underground salt mines for a confidential client. Some of these mines have active mine inflows, and some have concerns or threats of inflow. At mines with active inflows, RESPEC provides mine-inflow support, including groundwater modeling, data interpretation, and review. At mines with threat of inflow, RESPEC is involved in reviewing holistic datasets, including closures, seismic, and microseismic.

MODELING FOR DISPOSAL WELLS

RESPEC designed, implemented, and interpreted hydraulic tests for a confidential underground evaporite mine with an inflow. This data were used to develop groundwater models to help understand and predict sustainable inflow rates. Groundwater models were also used to design far-field injection wells. The work was used to help provide guidance for future hydrogeology work and if mitigation efforts are warranted. RESPEC was also involved in designing and implementing a grouting program including grouting, field services, 3D seismic, and microseismic monitoring.

ENVIRONMENTAL AND ASSET RETIREMENT

WITH DECADES OF PERMITTING and regulatory experience, RESPEC's wide-spectrum knowledge of the US' strict regulations feeds new solutions for agencies in different countries.

EXPLORATION | MINE DEVELOPMENT | OPERATIONS | CLOSURE/RECLAMATION

GLOBAL PERMITTING AND REMEDIATION EXPERTS

Whether developing a greenfield operation or decommissioning current operations, RESPEC's professional team fully grasps that the process requires understanding the regulations that limit or define the full life cycle and that these regulations may be imposed by federal, state, and/or local agencies. Multiple agencies also commonly have jurisdiction over the same mine. We identify and secure permits from appropriate agencies, along with required biological assessments, geologic and hydrogeologic investigations, and wetland delineations to ensure project compliance with permit conditions. With extensive knowledge in environmental studies, permitting processes, and the SMCRA, RESPEC offers diverse environmental services that are vital to protecting natural resources. Under the NEPA, our team prepares Environmental Assessments and Environmental Impact Statements that evaluate the potential consequences associated with a proposed action. Our team considers factors such as current mine configurations, operational methods and costs, postmining land-use requirements, closure requirements, water monitoring and treatment, and bond-release requirements has a long history of management, consulting, inventory, investigation, design, and construction management services for projects in remediation, reclamation, and restoration throughout the US and abroad. RESPEC compares reasonable alternatives to the proposed action to reach an environmentally acceptable and defensible action.

CAPABILITIES:

- Site Investigation
- SMCRA Expertise
- Obtaining Permits
- Permit Identification
- Permit Compliance
- NPDES and Section 404
- Environmental Studies
- Resource Characterization and Management Plans (Water Quality, Wetlands, Groundwater)
- Impact Assessments (NEPA, Biological, Threatened and Endangered Species)

ASSET RETIREMENT OBLIGATION

To ensure the proper estimation of the Asset Retirement Obligation, RESPEC's professional team fully grasps the mining operation, including site reclamation. We know that the process also requires understanding the regulations that limit or define the final reclamation plan and that these regulations may be imposed by federal, state, and/or local agencies. Multiple agencies also commonly have jurisdiction over the same mine. Our partners benefit from RESPEC's in-depth knowledge of the full mine life-cycle process. We consider factors such as current mine configurations, operational methods and costs, postmining land-use requirements, closure requirements, water monitoring and treatment, and bond-release requirements.

CAPABILITIES:

- Site Investigation
- Regulatory Knowledge
- Reclamation Design
- Cost Estimating

MINE FLOODING & ABANDONMENT

INTENTIONAL FLOODING OF A SALT MINE

RESPEC evaluated alternative abandonment scenarios for a confidential client after unacceptable mining-induced subsidence began to threaten surface structures during active mining. The objective of the study was to identify an abandonment scenario that provided an immediate response to reduce the mine closure and surface subsidence rates while searching for an ultimate means to stabilize the mine in the long-term to mitigate further impacts to the facility. RESPEC evaluated alternative methods to flood the mine by assessing the potential for severe local dissolution at and near the discharge point to create a substantial void, dissolve or undercut pillars, or otherwise create a local situation that increased the likelihood of a collapse or other significant failure. Years later, RESPEC performed an updated geomechanical assessment using a 3D finite-difference model to assess the future stability of the abandoned mine. The efforts focused on determining anticipated post-flooding surface subsidence rates, evaluating the competency of the mine level pillars, identifying potential indications of sudden or progressive collapse, and estimating future brine discharge flow rates. RESPEC continues to review annual surface elevation surveys to calculate subsidence rates at benchmarks located directly above and adjacent to the mine. These data are compared to a historical baseline to identify any deviation from a typical response, which could be indicative of developing instabilities.

FUTURE ABANDONMENT OF AN EVAPORITE MINE

RESPEC performed multiple studies related to the closure and abandonment of confidential mines for various clients. The studies focused on the expected continued surface subsidence and the unexpected possibility of a catastrophic underground failure manifesting on the surface. Our team developed feasible designs to abandon the mine in a manner that minimizes the risk of short-term instability and reduces the continued subsidence rates and long-term mine closure while considering costs and time constraints. We analyzed design considerations, including the brine-salt saturation level and the anticipated salt dissolution, location and quantity of injection points, flooding rates, and backfill sources, to form hypotheses about the risks or hazards of various methods of abandonment. We reported our conclusions and recommendations regarding the relative merits and risks of the flooding options to our clients.

KEY **PERSONNEL**

RESPEC'S EVAPORITE TEAM is a full-service group with technical personnel including engineering, geomatics, geological, mineral processing, and information technologies (IT) professionals.

OUR EXPERTS

BRYAN HATHAWAY, PE
PROJECT MANAGER

Education: BS in Mining Engineering
Years of Experience: 8

Bryan Hathaway is a mining engineer with cross-disciplinary experience in the civil, geotechnical, and mining fields. He performs operational roles in underground and surface mines, underground construction, hydraulic structures, and commercial buildings, ranging from engineer to project manager. Bryan's construction management responsibilities include contract review and negotiation, cost estimating, means and methods analysis, procurement, production tracking, project scheduling, and on-site quality assurance/quality control (QA/QC). His geotechnical projects incorporate excavation-stability evaluation, ground-failure investigation, ground support design, in situ stress determination, and laboratory rock mechanics property testing. Bryan also conducts a broad span of mining tasks, such as capital cost estimates, mine design and development, mine pre-feasibility and feasibility study participations, and reserve and resource model updates. He uses AutoCAD, Clarson, FLAC3D, Microsoft Project, MinePlan (MineSight), Primavera P6, InEight Estimating (Hard Dollar), and the Rocscience Suite to navigate these tasks.

VALUE *Bryan's exposure to managing multidisciplinary teams of various scopes and project constraints has led him to develop a project management approach that revolves around the understanding that there is no one correct approach. Instead, he promotes giving a voice to all stakeholders, fostering transparent communication, identifying potential risks, and aligning project teams in a common direction executed with data-driven decisions.*

CODY VINING
ROCK MECHANICS

Education: MS in Mine Engineering and Management, BS in Mechanical Engineering
Years of Experience: 15

Cody Vining has more than 15 years of consulting experience in geotechnical engineering, primarily in salt and rock mechanics, including pillar and excavation design, ground control, and surface-subsidence engineering. He has gained experience working almost exclusively in salt and potash mines and salt caverns in bedded and domal salt formations throughout North America, South America, Europe, and Southeast Asia. He has visited or consulted at more than 20 salt and potash mining operations combining field observations, mine instrumentation, laboratory testing, and numerical modeling to provide comprehensive assessments of underground excavations. His practical experience includes developing an understanding of how the rock that remains within and around an excavation reacts to removing the ore and then applying this understanding of rock mechanics to mine design to address issues ranging from short-term, local issues with ground control to long-term, mine-wide issues that address the overall mine stability and suitable management of the resource. With his background, Cody understands both the underground mining environment and the criteria that affect conventional underground mines and caverns.

VALUE *As RESPEC's subject matter expert, Cody brings more than 15 years of extensive rock mechanics behavior modelling of evaporate deposits. Pairing the theoretical behavior of the interburdens with his understanding of operational requirements, he can produce the optimized outcome within RESPEC's multi-level mining designs for the project.*

KEY PERSONNEL

NEEL GUPTA, PHD
PROJECT ENGINEER

Education: PhD in Mining Engineering, B.Tech & M. Tech in Mining Engineering
Years of Experience: 8

Dr. Neel Gupta is a project engineer in RESPEC's Mining & Energy business unit, based out of Rapid City, South Dakota. Neel has been involved in many projects that require numerical modelling software to conduct analyses in salt, potash, and marble mines. He has expertise in processing x-ray-computed tomography images and is familiar with software such as FLAC3D, ImageJ, Bruker CTAn, and MATLAB. Neel is proficient in English and Hindi.

VALUE *Neel has developed and validated pillar stability to ensure long-term safety and mine longevity within evaporate deposits. He can help to identify any strategic locations within a development to monitor the stability performance of an excavation.*

TABETHA STIRRETT, P.GEO., CPG
PRINCIPAL RESOURCE GEOLOGIST

Education: BS in Geology
Years of Experience: 26

With more than 25 years of exploration and mining experience, Tabetha Stirrett has managed numerous potash projects. On RESPEC's Canadian team, Tabetha is the Vice President of the Mining & Energy group. She works closely with clients as well as geology and engineering teams to provide technical assistance for geological modeling and resource/reserves estimation.

VALUE *Tabetha has a long history of working with potash, from the actively explored areas within the Elk Point Basin and beyond. Her understanding of the stratigraphy and modifying factors necessary to define resources and reserve estimates ensures that proper data is always collected and incorporated.*

ABIGAIL SCISSONS, P.GEO
POTASH GEOLOGIST

Education: BS in Geology
Years of Experience: 9

Abigail Scissons lends her talents to both the geological and geomatics divisions. Her geological experience includes GIS mapping, core logging, core photography, geophysical wireline interpretation, and assay sampling. Abigail has provided geological and technical support on potash projects within Saskatchewan and performed wellsite geology and core-retrieval supervision. She has undertaken many advanced GIS tasks to complete detailed mapping demands using various software packages. By working within both geology and geomatics, Abigail has gained well-rounded knowledge and experience while seeing projects through from the initial project scoping and data collection stages to the completion of final reports and mapping products.

VALUE *Abigail's experience planning potash exploration projects ensures that we identify all necessary data gaps required to execute the our projects. She ensures that datasets are suitable for modelling and provides all necessary mapping requirements for our evaporite projects.*

CHRISTOPHER JOHNSON
HYDROGEOLOGY LEAD

Education: MS, BS in Geological Engineering
Years of Experience: 18

Chris Johnson has 18 years of experience in geotechnical engineering, primarily in subsurface flow and hydrogeological analyses for surface and underground mines. Since 2001, he has developed and used analytical and numerical models to analyze problems involving fluid flow and mechanical behavior in geological materials. His project experience also includes groundwater fate-and-transport modelling for surface and underground mines and a hydraulic containment study for an unlined storage cavern. His areas of focus include salt and potash mine inflows, including hydrogeological characterization and modeling, geomechanics, grouting aspects, and microseismic analyses. Chris is well-versed in data analyses, which helps extract as much useful information as possible from any dataset. He has experience in signal processing, neural network models, wavelet analysis, statistical methods, and visualization methods for temporal and spatial datasets. Chris also has experience in geomechanical modelling at a salt storage cavern and an underground salt mine.

VALUE *Chris has a wide range of experience working on mine inflow in the potash industry. He can ensure that the understanding of inflow at project sites is developed holistically through an understanding of all datasets relevant and related to mine inflow.*

KEY PERSONNEL

ERIK WALEGA, PE, PG
HYDROGEOLOGICAL ENGINEER

Education: MS in Geology and Geological Engineering, BS in Geological Engineering
Years of Experience: 8

Erik Walega has more than 8 years of experience in environmental and engineering hydrogeology. He uses his experience in numerical and analytical flow modelling, hydrogeological investigations, hydrogeologic field test design, and data analysis to help clients meet their objectives efficiently and effectively. He also processes large datasets through statistical, spatial, temporal, and spatiotemporal analyses on many multidisciplinary projects that require an understanding of hydrogeology, geochemistry, rock mechanics, and geophysics, among other geoscience sub-disciplines to help clients have the information they need to make important decisions.

VALUE *Erik has been afforded many unique opportunities to work on very challenging projects. He is often selected for the most rigorous, problem-based projects that require assessment of a situation, determination of what needs to be known—or learned—to best resolve the problem, and then develop an approach to meet the final objectives based on the use of sound science and engineering principles.*

ERIK HEMSTAD, PE
GEOLOGICAL ENGINEER

Education: MBA, MS in Civil-Geotechnical Engineering, BS in Geological Engineering
Years of Experience: 15

Erik Hemstad has more than 15 years of professional experience in project management and geological and geotechnical engineering. He has an established breadth of knowledge and experience across the geological, civil, and mining engineering and geology fields, coupled with project, business, and personnel management capabilities and effective decision-making and judgment. He applies these skills to projects of all sizes to meet client needs and specific project objectives. Erik excels at undertaking diverse and complex projects and tasks in nonroutine environments and creating and managing solutions focused on project execution and client satisfaction. His primary roles include project development, execution, and management for RESPEC's Mining & Energy business unit. He also contributes to overall marketing and business development for current and prospective clients.

VALUE *Erik brings to the team an array of skillsets complimentary to the feasibility study of multi-level mining. He contributes to evaporite projects through geophysics data interpretation, geologic modelling, project management, bid documents, and capital investment analysis.*

SUSAN PATTON, PHD, PE, RM-SME
PRINCIPAL MINING ENGINEER

Education: PhD in Mining/Environmental Engineering, MS in Mineral Engineering, BS in Mining Engineering
Years of Experience: 40

Dr. Susan Patton is a principal consultant within RESPEC's Mining & Energy business unit. She is a diverse technical mining professional and project manager with expertise in underground mine engineering, mine ventilation, project assessment, project evaluations, and reserve reporting. Susan frequently leads scoping, pre-feasibility, and feasibility studies; due diligence; productivity and material handling analysis; operating and capital cost estimates; and financial evaluations. She is a Qualified/Competent Person for economic analysis and mineral reserve reporting for brine deposits and bedded deposits using dry or solution mining extraction techniques. Susan has extensive ventilation expertise in coal, metal, and nonmetal mines and mined caverns, including troubleshooting, modeling, design, and shaft sizing. She has project management expertise for wide-ranging potash and trona underground mechanical and solution mining projects.

VALUE *Susan's depth and breadth of experience in underground mining of bedded deposits leeds to robust evaluations of design alternatives based on sound operating principles.*

KEY **PERSONNEL**

ALYSSA KENDIR, PE
MINING ENGINEER

Education: MEng in Mining, Geological, and Geophysical Engineering, BS in Mining Engineering
Years of Experience: 8

Alyssa Kendir is a licensed professional mining engineer with cross-disciplinary experience in mining, geological, and civil engineering. She has filled positions ranging from engineer to project manager with surface mining and civil design. Mining tasks have incorporated short-, mid-, and long-range mine planning, production scheduling, open pit and haul road design, waste and overburden storage design and calculations, reserve and resource calculations and reporting, developing geologic databases, ore control, drill and blast design, and fragmentation and blast dynamics. She uses AutoCAD, Carlson Mining, Map 3D, Civil 3D, MinePlan (MineSight), BMM Explorer, and Microsoft Project to navigate these tasks.

VALUE *Alyssa's experience with mine planning, scheduling, and design ensures that obstacles our clients need to overcome are adequately planned and accounted for. She is familiar with the challenges that could hinder the full recovery of reserves and has experience with the problem-solving processes necessary to overcome them.*

JAKE HORAZDOVSKY, PE
CIVIL/STRUCTURAL ENGINEER

Education: MS, BS in Civil Engineering
Years of Experience: 13

Jake Horazdovsky has established himself as a team player and go-to problem solver. Jake enjoys providing designs tailored to the needs of our clients. He has actively evaluated, assessed, and analyzed existing and new structures and conducted lateral analyses for wind and earthquake loads for private, commercial, and government clients. His commercial and government projects have ranged from construction administration on Alaska Department of Transportation & Public Facilities maintenance shops and sand storage facilities to school renovations in rural Alaska. His military projects have spanned across Alaska and the Pacific Rim. Even in the world's most remote corners, Jake is always ready to provide his expertise and offer our clients top-notch solutions.

VALUE *Jake has a wide range of experience in structural engineering. He works with our mining group to tailor structural aspects of the project to deal with the movement associated with the underground environment. Most recently, Jake provided the structural design for a salt loading facility in New Mexico.*

KEY PERSONNEL

ERIC BRIDGMAN, PE
ELECTRICAL ENGINEER

Education: BS in Electrical Engineering
Years of Experience: 14

Eric Bridgman is an integral part of the electrical engineering team at RESPEC. He has specialized power systems design experience, including short circuit analysis, coordination, and arc flash analysis. Eric has completed specialized training with SKM software to analyze power systems. He has also provided electrical support in energy analysis. Eric has designed telecom, power, and lighting systems for a wide variety of different types of projects, including several mining projects. His responsibilities include engineering analysis, computer modeling, and electrical engineering design.

VALUE *Eric has a wide range of experience working on various mining projects and is familiar with the mining process. He provides practical solutions to fit each individual project. Eric works closely with all stakeholders to ensure that the electrical design is efficient and well-coordinated across all disciplines.*

BENJAMIN HAVEMAN, PG
PROJECT GEOLOGIST

Education: BS in Geology
Years of Experience: 11

Benjamin Haveman has more than a decade of experience planning and executing mineral exploration programs. The majority of his work involves industrial minerals, with a dominant focus on evaporites. Benjamin has provided planning and oversight for vast geochemical sampling programs, to include quality control, quality assurance, and sample data mangement. He has extensive experience logging core and cuttings for a diverse range of mineral endeavors and has proven himself as a reliable on-site manager for remote field campaigns. Benjamin has overseen many geophysical wireline applications and has experience administering downhole tests to measure in situ horizontal stresses. He has contributed to the compilation of numerous technical reports that adhere to NI 43-101 and SEC SK-1300 standards.

VALUE *Benjamin's experience and familiarity with evaporite minerals and depositional environments will help advance the understanding of any potash deposit and will support efforts in exploration, geological modeling, and technical report generation.*

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