

SPECTRUM ENGINEERING

STATEMENT OF QUALIFICATIONS

**Spectrum Engineering
1413 4th Avenue North
Billings, Montana 59101
Phone: 406-259-2412**

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Introduction

Spectrum Engineering's business is helping our clients make (save) money by developing innovative concepts and solutions and then working together to ensure that the solutions are properly implemented.

Spectrum has saved electric utility clients money by pointing out ways to audit and manage cost pass through fuel supply agreements with their coal suppliers. Spectrum has helped negotiate complex long term cost reimbursement contracts totaling several billion dollars.

Spectrum has saved our mining clients substantially by showing them how to optimize the mining and reclamation practices so that the mining and reclamation are coordinated, minimizing the distance material is moved and the number of times it is moved. Spectrum uses earthwork optimization knowledge to design work plans and to spec out contract provisions for all our projects.

Spectrum has saved our government clients money by designing efficient mine and smelter reclamation plans, preparing innovative construction bid documents and effectively managing the contractors. Spectrum saved the Montana DEQ \$millions on the Zortman project where the earthwork and reclamation on a design build basis was performed via a governor-declared emergency.

Spectrum's reputation in the mine and land reclamation business has led us to become one of the most successful abandoned mine reclamation consulting firms in the USA. During the past decade, Spectrum has engineered the remediation of over 5,000 mine sites involving hazardous openings, subsidence, acid mine drainage, and milling and smelting wastes polluting rivers and neighborhoods. Since much of

Spectrum's work involves collecting and analyzing 3-D spatial data, Spectrum has developed the expertise to provide our clients with quality GPS mapping and GIS services also.

Spectrum gives you a management team that works well with other scientists, such as soils, vegetation, wildlife, and fisheries biologists to create workable, economical, "green" reclamation solutions for mining, superfund, industrial, agricultural, and domestic projects. Spectrum prides itself on the ability to find the most qualified experts to work with/for us. By associating with highly qualified and local subcontractors, Spectrum is able to produce high quality work, faster, for a lower cost than the typical "full service" consulting firm.

The principals of Spectrum Engineering have worked together as consultants since the late 1970's when the current principals came together to explore, design, and permit several of the coal mines in the Powder River Basin. Spectrum continues to provide this type of expertise for our mining, utility, and government clients. The majority of our work is repeat business because the work is managed by our principals, who are highly motivated to provide a high standard of excellence and personal commitment.

When you use Spectrum Engineering to fulfill your consulting or reclamation requirements, you can be assured that Spectrum will do whatever it takes to effectively solve your problems with innovation, integrity, common sense, and promptness.

Contact:

Donald Sutton P.E.
Phone 406-259-2412, ext 1 or,
Email sutton@spectrum-eng.co

Spectrum Engineering Project Summary

This matrix summarizes major projects completed by Spectrum Engineering. It does not include any of the varied projects completed by our staff prior to joining us.

		Mine Engineering	Resource Evaluation	Reclamation & Permitting	Environmental Engineering	Civil Engineering	Hydraulic Engineering	Management & Litigation	Mapping & GIS
CLIENT	TASK SUMMARY								
Arizona Public Service	Audit Navajo and McKinley Coal Mining & Reclamation Costs. Help Develop Fuel Supply Strategy for Cholla and Four Corners Power Plants.	■	■	■	■	■		■	
ARCO	Silver Bow Creek Superfund Tailings Removal Construction and Engineering Oversight, Litigation Support	■	■		■	■	■		
Belco Petroleum	Coal Land Exchange	■	■						■
Catchpole Trucking	Hazmat Cleanup, Design & Implementation				■		■		
Cimarron Coal	La Plata Mine Design & Permit	■	■	■					■
CMM (Cable)	Placer Gold Mine Plan & Permit (Subcontract)	■		■					
Commonwealth Edison	Big Horn, Black Butte, Decker Mine & Reclamation Audits and Litigation	■	■	■				■	
Consolidation Coal	Glenharold Mine Hydrology & Dam Design			■			■		
Cordero Mining Company	Cordero Mine Hydrology, Dam Design & Construction Management			■			■	■	
Delzer Construction	Fort Union Mine Design and Permit	■	■	■		■	■		■
Detroit Edison	Decker And Spring Creek Mines Audits and Litigation	■	■	■				■	
Dorchester Coal	Dorchester Coal Mine Hydrology, Slurry Pipeline Design						■		
Echo Bay Exploration	Gold Mine Access Road Design					■			
Exxon Coal	El Cerrejon Coal Dragline Feasibility Project		■						
Fort Peck Reservation	Lignite Mine Design	■	■						
Garnet Mining	Open Pit Gold Exploration	■	■						
Great Plains Resources	Dutchman Mine Design & Permit	■	■	■		■	■		■
Idaho Power	Jim Bridger And Black Butte Mine Audit	■	■					■	
Idaho State DEQ	Cyanide Mine Permit Evaluation		■		■				
Idaho State DEQ	Bunker Hill Superfund Remediation Design, Tailings Removal, Hydrology, Riverbank Stabilization, Construction Management, Mapping & GPS			■	■	■	■		■
Inter-Fluve (MT DNRC)	Broadwater Power Project Fisheries Design & Construction Management					■	■		
Inter-Fluve (Dupont)	Acid Brook Superfund Remediation Design				■	■	■		
Inter-Fluve (Union Carbide)	Raritan River NJ Hazardous Waste Disposal			■	■	■	■		
Inter-Fluve (USFS)	Maloney Creek, Chimney Rock, York Canyon						■		
Kansas City Power & Light	Coal Mine Contract Audit							■	
Kansas Dept of Health & Environment	Field Investigations, Surveying, Design, Construction Bid Documents for the Reclamation of 4 Abandoned Coal Mines near Pittsburgh KS.		■	■	■	■	■		■
Kellogg (US Army Corp of Eng.)	Tennessee Tombigbee Construction Dispute, Cost Estimating, Testimony					■		■	
Kennecott Energy	Antelope Mine Engineering/Resource Evaluation	■	■						
Lower Colorado River Authority	Decker Mines Audit and Litigation Support	■	■	■				■	
Meridian Land &	Coal Mine Feasibility Studies	■	■						

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CLIENT	TASK SUMMARY								
Minerals									
Mobil Coal	Caballo Rojo Mine Hydrology and Hydraulic Engineering Designs						■		
Montco	Montco Mine Design and Permit	■	■	■	■	■	■		
Montana DEQ	Abandoned Mine Reclamation Design and Construction Management Land Ownership Determination	■	■	■	■	■	■	■	■
Montana DEQ	Operate and Maintain 2 Water Treatment Plants to Treat ARD				■			■	
Montana DEQ	Reclaim Zortman and Landusky Gold Mines Engineering, Mapping, Economics, Design-Build, and Construction Management	■	■	■	■	■			
Montana DEQ	Technical Studies and SEIS for Golden Sunlight Mine	■	■	■	■		■		
MT. Dept of Natural Resources	Tongue River Dam Economic Analysis	■	■						
State of Montana	Clark Fork River Superfund Remediation			■	■	■	■		
Montana Talc	Johnny Gulch Mine Reclamation Bonding	■		■				■	
Moulton Bellingham Law Firm	River Encroachment Dispute, Litigation Support			■	■	■	■	■	
Mountain, Inc	Underground Coal Mine Design And Permit	■	■	■					
Murphy & Kirkpatrick Law Firm	Expert Witness Re: Dam Failure & Hydrology				■	■	■	■	
Rotem Amfert Negev Phosphates (Israel)	Management Consulting. Design 3 Phosphate Mines. Prepare Geologic and Feasibility Studies for 3 New Projects. Mining Equipment Selection, Management Training	■	■	■	■	■	■	■	
Northern Indiana Public Service	Medicine Bow and Cyprus Shoshone Mine Contract Audit		■	■					■
Northern States Power	Absaloka Mine and Rosebud Mine Audits and Contracts. Evaluate Fuel Supply Options and Proposals	■	■	■				■	
Northwestern Resources	Mine Economics Software							■	
NRG Energy (NSP)	Coal Waste Co-Generation Evaluation	■	■						
Otter Tail Power	Knife River Mine Contract Audit	■						■	
PAMA (Israel)	Oil Shale Mine Geology, Design, Economics, and Operation	■	■	■		■			
Powder River Coal (Peabody)	Rochelle Mine Design, Reclamation Design Hydrology & Permits	■	■	■		■	■		
Powder River Coal (Peabody)	North Antelope Mine & Reclamation Design, Hydrology & Permits	■	■	■		■	■		
Peabody Coal	Big Sky Mine & Reclamation Design, Hydrology & Permits	■	■	■	■	■	■		
Rainier Bank	Litigation Support Re: Coal Mining Economics	■	■					■	
Santa Fe Mining	Lee Ranch Mine Permits and Hydrology Divide Project Geologic Evaluation	■	■	■	■	■	■		■
Shell Oil	Buckskin Coal Mine Design and Permit	■		■					
Southern California Edison	Coal Quality And Contact Issues Involving Mohave Generating Station	■	■	■				■	
Sunbelt Mining	Bisti Federal Coal Land Exchange	■	■						

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CLIENT	TASK SUMMARY								
Tongue River Railroad	Railroad Feasibility Design					■	■		■
Transystems	Mine Design, Permits, Economics	■	■						
Union Carbide	Landfill Cap, Riverbank Stabilization, Design				■	■	■		
Union Pacific Resources	Mine Economics Software Development								
Utah Division of Oil, Gas	Abandoned Mine Reclamation (+5000 Sites) Land Ownership Determination	■		■	■				■
Wesco Resources	Geology, Mine Feasibility Studies, Mapping, Mine Permitting	■	■						
Western Energy	Rosebud Mine Reclamation Dispute – Arbitrator	■	■	■				■	
Wisconsin Power & Light	Coal Contract Audits	■	■					■	
Womack (Molloy Law Firm)	Riverbank Stabilization, Litigation, Forensic Engineering					■	■	■	
MT DEQ, USFS	East Boulder EIS (Stillwater Mine Expansion)	■	■	■	■				
Wyoming DEQ	Abandoned Mine Reclamation Design, Coal Mine Fires	■		■	■		■	■	■
Yellowstone Coal	Underground Coal Mine Design & Permit	■	■	■	■		■		

Spectrum Capabilities Check List

The list below summarizes Spectrum Engineering's areas of demonstrated expertise.

Abandoned Mine Reclamation

- Field assessments and investigations
- Courthouse record searches
- Reclamation of abandoned mine and mill sites (engineering, management, and construction)
- Reclamation of bankrupt mines and smelters
- Streambank stabilization, including fisheries & wildlife habitat restoration
- Surveying and mapping
- Bid document preparation
- Management of construction contractors

Environmental Engineering

- Site investigation
- Regulatory compliance
- Hazardous waste (Superfund)
- Abandoned mine environmental reviews
- Environmental Assessments (EA)
- Environmental Impact Statements (EIS)
- Health and safety plans & work plans
- Sampling and analysis plans

Mine Engineering & Planning

- Optimization of mine reclamation
- Mine design and layout
- Mining method analysis
- Equipment optimization and selection
- Site grading and access
- Grade and quality control/analysis
- Waste dump design & optimization
- Roads, dams, embankments
- Stockpile design and placement
- Geotechnical analysis

Permitting

- Exploration permits
- New mine permit applications
- Mine permit renewals
- Electronic mine permitting

Mine Reclamation

- Mine reclamation design & permitting
- Post-mining topography optimization/design
- Bid document preparation
- Construction management

Management Consulting / Electric Utilities

- Mine operation and management
- Mine budgeting
- Operational audits
- Reclamation audits
- Coal contract analysis
- Coal contract negotiation
- Litigation support
- Dispute resolution
- Arbitration support
- Damage computations
- Expert witness testimony

Site Investigations and Geology

- Property mapping
- Mineral and surface ownership
- Exploration - data collection
- Computer modeling - data evaluation
- Feasibility studies and evaluation
- Geologic database management
- Evaluation of property submittals
- Calculation of resources and reserves
- Environmental analysis

Water Resources Engineering & Hydrology

- Dams and diversion systems
- Sediment transport and control
- Flood hydrology
- Surface water control plans
- Surface water modeling and profiling
- Ground water modeling
- Embankment stability analysis

Geographic Information System Services (GIS) and Mapping

- ArcView
- AutoCAD Map
- Property ownership mapping
- Spectrum owns survey grade (± 1.0 cm) and mapping grade (± 1 ft) GPS equipment that we use for surveying, mapping, and construction management

Our Principals

Spectrum Engineering is owned by three engineers who have worked together in the natural resource consulting business since the late 1970's. In 1984, Spectrum Engineering was formed.

Donald Sutton, P.E., Mining Engineer, President

Mr. Sutton has a bachelor's degree in mining and mineral processing and two years post graduate studies in Mineral Engineering Management (towards MBA). He has worked as an underground miner, a surveyor, a mine foreman, a mill foreman, mine planning engineer, maintenance planning engineer, computer programmer and assistant to the president of a major mining company (Cominco), where he was responsible for monthly budgets and performance of several mines. After his post graduate studies, he managed coal exploration projects and mine development projects in Canada and the Eastern USA for Consolidation Coal Company. He was manager of exploration for Consol when he moved to Montana to become Director of Engineering for IntraSearch Engineering. In this capacity, he managed the exploration, design and permitting of several Powder River Basin Coal Mines in the late 1970's and early 80's, and several large mines in Israel.

In 1984, he and his partners formed Spectrum Engineering. He provided high level consulting services to a dozen electric utilities and mining companies involving the economics of the mining and reclamation in long term cost reimbursed and BLS indexed contracts. Many of his consulting assignments involved computing mining and reclamation costs, auditing cost and financial accounting data, and testifying in complex commercial litigation.

During this period, Spectrum was retained as an arbitrator to settle a commercial dispute involving mining costs and liabilities between a coal mine and an electric utility. He was retained by the US Army Corps of Engineers as an expert witness involving earthwork and construction costs on the Tombigbee Waterway.

Mr. Sutton also worked on many of Spectrum's superfund projects, providing technical assistance, oversight, and costing guidance.

Mr. Sutton was one of the principal engineers on the Bunker Hill and Butte Superfund projects, providing reclamation, earthmoving, construction, and cost estimating advice and calculations.

He continues to consult in the mining and electric utility industries concerning contracting and cost estimating issues, and continues to provide mining and reclamation consulting services for mining companies and government agencies.

William Maehl P.E., Mining Engineer, Vice President

Mr. Maehl has a bachelor's degree in mining engineering with an emphasis in management. His continuing education includes a variety of accounting, management, and personal development courses. Mr. Maehl has managed most of Spectrum's abandoned mine land reclamation projects and is the manager of the Zortman and Landusky reclamation project.

Prior to joining IntraSearch Engineering, he worked in coal exploration for Consolidation Coal where he became familiar with field data collection, data management, and land and mineral ownership. He continued to provide this service to IntraSearch's customers, and helped explore, design, and permit several mines in Montana, Wyoming, and New Mexico.

He worked on several complex commercial lawsuits, assisting attorneys with the discovery and deposition process, and working on the economics of large scale land reclamation.

In 1983, he began managing abandoned mine reclamation projects for the State of Montana, and has performed so well that the state has continuously awarded Spectrum Engineering work every year since. As our work expanded into Utah, the Utah Division of Oil, Gas, & Mining has awarded Spectrum annual contracts since 1989, which he has managed.

Bill has assembled expert teams and managed the site investigations, engineering, planning, and construction of several thousand mine sites ranging from hazardous shafts and adits to more than 1,100 acres of acid generating dumps, leach pads, and highwalls. He has successfully managed a staff of up to 30 heavy equipment operators and a large complement of engineers, hydrologists, geochemists, and biologists who developed plans and implemented the reclamation of the Zortman and Landusky gold mines. This work has received considerable praise from the EPA, the BLM, and the State of Montana.

David Murja, Mining Engineer, Vice President

Mr. Murja has a bachelor's degree in mining engineering. Prior to joining IntraSearch, he worked in several capacities for W.R. Grace's vermiculite mine near Libby, MT, including engineering, drilling, sampling and analysis.

As a consultant, he has prepared detailed mine and reclamation plans for a variety of surface mines in the USA and Israel. He specializes in optimizing the mining and reclamation so that the maximum amount of work can be accomplished for the minimum cost.

Mr. Murja has worked on the engineering, field investigations, cost estimating, bid document preparation, and construction management of hundreds of the abandoned mine reclamation sites Spectrum has investigated and reclaimed, including providing most of the detailed engineering and cost estimating for the Zortman and Landusky projects.

Abandoned Mine Reclamation

Spectrum Engineering has been continuously working as a consultant to various state regulatory agencies that have primacy over their reclamation programs since 1984. Spectrum has inventoried over 5,000 mine sites, and designed closures for more than 2,000 hazardous mine openings in Montana, Wyoming, Kansas, Idaho, and Utah. Our reclamation prowess and efficiency has led us to become one of the premier abandoned mine land reclamation (AML) consulting firms in the USA. The AML program is administered by the Office of Surface Mining and funded by a fee levied on all coal mined in the USA. The money is allocated to the states in proportion to the fees collected in each state, and used to reclaim all types of old mining hazards and environmental problems.

Spectrum has engineered and managed the reclamation of coal, gold, silver, copper, uranium, chromium, platinum, gravel and scoria mines in Montana; iron ore and coal fires in Wyoming; and hardrock gold, silver, copper, lead, zinc, uranium, phosphate, gilsonite, and alunite mines in Utah.

Abandoned Mine Reclamation Capabilities

- Mine reclamation design
- Geomorphology
- Superfund sites
- Hazardous waste sites
- Reclamation optimization and costs
- Reclamation audits
- Stormwater permits
- Site inventories and investigations
- Engineer's cost estimates
- Surface & mineral ownership
- Secure landowner consents
- Public contacts and meetings
- Bid document preparation
- Site showings
- Surveying and mapping
- Pre-bid and pre-construction meetings
- Quantity surveys
- Construction management & inspection
- NCP compliance
- Final report & project close-out

Abandoned Mine Reclamation Example Projects

Zortman/Landusky Gold Mines

The State of Montana retained Spectrum Engineering in 1999 to manage the closure of the Zortman and Landusky gold mines in north central Montana (approximately 1,100 acres of disturbance). These two large open pit heap leach gold operations defaulted on their reclamation bonds (\$78 million) when their parent, Pegasus, went bankrupt.

When Spectrum took over, the actual operating cost of the two water treatment plants substantially exceeded the bonding amount. Spectrum was able to reduce the operating costs substantially (almost 50%), and has been able to work

successfully with a variety of interests to successfully manage the reclamation and the operation of the two water treatment plants.

This is a large, complex reclamation project involving acid rock drainage, high nitrates and selenium, and a large amount of regrading and backfilling. The reclamation desired by some of the interested parties substantially exceeds the available funding, so Spectrum and our sub-contractors developed an effective method to rank and characterize all the sites and sub-sites to ensure that the most beneficial work was completed first, and so that sufficient funding remained for long term O&M.

Spectrum developed a water and metal loading mass balance for each mine that received praise from several agencies including some of the EPA's technical staff. Spectrum designed a large land application disposal area to temporarily manage approximately 100 million gallons per year of high selenium and nitrate laden leach pad water. Spectrum retained a sub consultant who developed a biological treatment process that lowered selenium and nitrates to safe drinking water standards.

Spectrum has successfully reclaimed a portion of the two mines for a remarkably low cost. This cost savings allowed DEQ to perform additional reclamation with the limited funds.

State of Montana DEQ

Every year since 1984, Spectrum has provided abandoned mine services to the State of Montana. Abandoned mine reclamation tasks have included initial site investigations; landowner identification and deed searches, claim ownership research, and securing landowner consents; public contact and public meetings; detailed field investigations including sampling, surveying and mapping, quantity testing, photo documentation and lab testing; OSM grant narratives; developing preliminary and final reclamation designs and engineer's cost estimates; site showings, pre-bid and pre-construction meetings; construction management, oversight and inspection; final reporting and project close-out. Projects have included numerous coal fires; OSM emergency projects; maintenance projects; coal, gravel, scoria, and hardrock sites; and environmental cleanup sites.

State of Wyoming DEQ

The Good Fortune project was designed by Spectrum Engineering to regrade an open pit iron ore mine in a steep drainage, rebuild and riprap the stream channel, establish vegetation and fence the reclaimed area.

The Colorado Fuel and Iron (CF&I) iron ore mine near Guernsey, Wyoming operated from the late 1880's until 1980.

The mine permit encompassed an area of about 1,940 acres. After Chapter 11 bankruptcy, the Wyoming DEQ AML Program stepped in to address the hazards present. Spectrum was awarded a contract in 1994 which lasted 4 years. Spectrum developed 7 bid packages addressing various phases of the work during this time period. Our total project management, engineering, and construction management totaled almost \$1 million in fees. The Sunrise Project won the Office of Surface Mining's 1998 Best AML Project Award.

Sunrise West, Wyoming AML Project B Field inventory, site assessment, closure design and bid package preparation for a group of 56 hardrock openings located near Guernsey. A total of 18 adits, 29 shafts, and 9 bat grates were completed.

Sunrise Security Fencing, Wyoming AML Project B Designed fencing plan to enclose 3 large subsidence openings. A bid package with specifications for chain link fence, an observation deck, and a viewing panel were written. Work included 14,102 feet of fence, 4 single panels, 80 double panels, and 7 gates.

Shafts and Adits Guernsey-Hartville, Wyoming AML Project - Site assessment, closure design and bid package preparation for a group of 37 hardrock shaft and adit openings located near Sunrise, Wyoming. The work included placing 1,570 yards of backfill in 13 shafts and 24 adits and placing 11 bat grates into adit entrances.

Sunrise Shafts and Adits, Wyoming AML Project - Site assessment, closure design and bid package preparation for a group of 38 hardrock shaft and adit openings located near Sunrise, Wyoming. The work included backfilling 14 adits and 18 shafts and installing 6 bat grates.

Sunrise Chicago Mine, Wyoming AML Project - Designed reclamation plan for the abandoned open pit iron ore mine at

Sunrise, Wyoming. Used QuickSurf software to develop plans and bid quantities for regrading waste rock dumps and mining benches around the pit area. Plans and specifications were also developed to backfill and cap a 150-foot deep shaft and to demolish concrete structures associated with the shaft. The construction included hauling 52,000 cubic yards of coversoil to the Sunrise site for future use; construction of 6,880 feet of drainage ditch and channels; placement of 124 yards of riprap; grading mine dumps, mining benches and roads requiring 569,100 cubic yards of earthwork; spreading 78,926 yards of coversoil; and revegetating 79 acres.

Sunrise Asbestos Abatement, Wyoming AML Project B Prepared bid package for abatement of asbestos and lead paint in 16 buildings associated with the Sunrise Iron Ore Mine. Construction management and final report documentation was also provided.

Sunrise Environmental Remediation, Wyoming AML Project - Assisted in the preparation of a bid package which was used to bid tank closures, contaminated soil remediation, and disposal of RCRA regulated waste materials. Construction management was provided and a final close-out report was prepared.

The completed work consisted of decommissioning seven underground petroleum storage tanks (USTs); cleaning 9 sumps that amounted to 20 cubic yards of petroleum contaminated material; excavation, transportation and disposal of 3,204 cy of petroleum contaminated

material; pumping and disposal/recycling of fuels, oil, and oily water; disposal of RCRA regulated wastes including previously containerized lead paint chips; packaging and disposal of two containers of hazardous corrosive liquid; excavation, packaging, transportation and disposal of hazardous solid materials (535 drums or approximately 144.6 cubic yards) consisting of lead and organic halogen-contaminated soil plus four drums of hazardous liquid; backfilling and grading of the excavations, sealing off contamination with concrete where complete removal of the material was not feasible; and, excavation and disposal of the mine's mercaptan tank.

State of Utah DOGM

Spectrum has been awarded 24 abandoned mine land contracts in Utah since 1989. These have included addressing 5,000 hardrock mine sites and 10 coal fires. Abandoned mine reclamation tasks have included data collection form development; literature review; preparation of health and safety plans; initial site investigations; landowner identification and deed searches, patented and unpatented claim ownership research, claim map preparation, and contacting landowners regarding consent; detailed field investigations including GPS surveying and mapping, quantity measurements, photo documentation; master database compilation; developing preliminary and final reclamation designs and engineer=s cost estimates; and developing construction bid packages; final reporting and project close-out.

The following press release shows the appreciation of our client, the Montana DEQ.



1520 East Sixth Avenue PO Box 200901 Helena, MT 59620-0901 (406) 444-2544 www.deq.state.mt.us

News Release, February 18, 2000

1999 Budget Shortfall for Zortman, Landusky water treatment lower than expected

HELENA—In June of last year, the Montana Department of Environmental Quality (DEQ) projected cost overruns of \$500,000 for water treatment at the bankrupt former Pegasus Gold Corporation's Zortman and Landusky gold mines. Final figures for 1999 show that water treatment costs exceeded the bond by only \$245,000. The DEQ credits **Spectrum Engineering**, the site manager hired by DEQ in June 1999, for much of those savings. DEQ awarded **Spectrum Engineering** the engineering contract for reclamation at Zortman and Landusky in May 1999.

"We are very pleased with these savings," DEQ Director Mark Simonich said. "Back in June 1999, we were bracing for a big hit to the department's budget. Spectrum Engineering entered the reclamation process at Zortman and Landusky under tough circumstances and has done a great job of making sure money is spent responsibly."

The sureties that bonded water treatment facilities for the former Pegasus mine sites are required to pay DEQ \$731,321 per year for continued operation and maintenance. Those dollars are earmarked for specific water treatment costs like labor, electricity and supplies.

Spectrum Engineering and Environmental Protection Agency engineers are working on other cost savings measures that the DEQ could implement this year. Any further savings on water treatment will be relatively small until the water volumes that need treatment are reduced when the mines are reclaimed.

The Bureau of Land Management (BLM) owns half the land on which the two mines were located. BLM has committed to help DEQ cover financial shortfalls at the water treatment plants this year. That money will come from the BLM's Abandoned Mine Lands Fund.

The Fort Belknap Indian Community, BLM, EPA, DEQ and **Spectrum Engineering** have been working for nearly a year on reclamation issues at the Zortman and Landusky mines. A technical working group has been evaluating reclamation options and site management needs. Among the group's goals is to determine the most effective way of spending available reclamation funds.

The technical working group agreed last fall on interim reclamation measures for mine pit regrading, leach pad resloping and access road relocation. Regrading and shaping work has taken place in 1999 on a portion of the mine pit and some leach pads at the Zortman site. By working together, all participants are voicing their ideas about the ultimate reclamation plan for the site.

At the time of the Pegasus bankruptcy, the DEQ and BLM had requested \$8.6 million more reclamation bond to fund the preferred mine closure plan (Alternative 3) from the March 1996 EIS. The agencies received only \$1 million from the bankruptcy court settlement to go towards that plan. The Department of Interior's Board of Land Appeals has rescinded BLM's record of decision selecting Alternative 3. The Board has ordered BLM to consult with the Fort Belknap Indian Community concerning implications of the reclamation plan on their water resources.

The agencies have been meeting with the Fort Belknap Indian Community and other area residents, and have identified reclamation tasks that all parties agree need to be done. To date, the working group has identified five possible reclamation approaches for the Zortman Mine, with preliminary cost estimates ranging from \$9.6 million to over \$41 million. The reclamation bond for the Zortman site is approximately \$10 million, so some reclamation options would require supplemental funding to be implemented. Development of reclamation options for the Landusky Mine are under development and should be forthcoming in the next few months.

Environmental Engineering and EIS/Related Document Development

Spectrum has been selected to perform the engineering design for the reclamation of Superfund projects based on our mine reclamation track record. Our goal is that there should be no evidence of human involvement after reclamation is complete.



Spectrum relates successfully with diverse groups including landowners, environmental groups, mining associations, and state and federal regulators. Since we regularly work on both sides of the fence, (regulators and industry), we understand the system, and have developed a credibility with all parties.

Our experience includes the preparation of mine environmental impact statements.

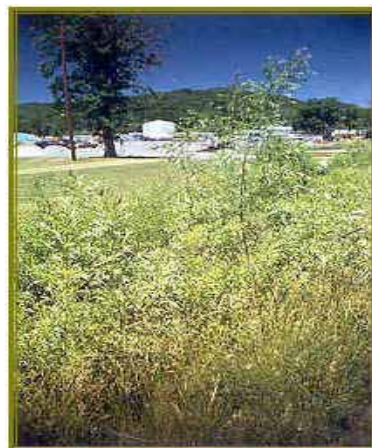
Spectrum has conducted remedial site investigations, risk assessments, feasibility studies, and sampling programs. Spectrum has evaluated sites for classification as Hazardous Waste Sites pursuant to SARA and CERCLA as well as prepared NCP documents (Field Investigation Work Plans, Sampling and

Analysis Plans, Community Relations Plans, and Health and Safety Plans).

All of our engineers and construction supervisors have completed the 40-hour OSHA certification for Hazardous Materials Handling (29 CFR 1910.120) and all keep current with their yearly 8-hour refresher courses. They have also completed the 8-hour Management and Supervision of Hazardous Waste Operations training; basic first aid and CPR; and Mine Safety and Health Administration (MSHA) hazard training pursuant to Public Law 91-173.

Environmental Engineering and EIS Capabilities

- Environmental assessments
- Environmental impact statements
- Contaminant transport modeling investigations
- Remedial investigations and feasibility studies (RI/FS)
- Development of remedial objectives
- Surface water hydrology and monitoring
- Surface water contamination characterization
- Detailed engineering and cost effectiveness analysis
- Soil zone contamination characterization
- Coordination with all responsible and concerned parties
- Earthwork and grading design
- Slope-stability analysis
- Specifications writing
- Construction supervision



Environmental Project Examples
Inter-Fluve, Acid Brook Project for
DuPont (Superfund), Pompton Lakes,
New Jersey

Spectrum worked as a subcontractor to Inter-Fluve to perform engineering for this Superfund project. The problem was that soils throughout the brook were impregnated with lead from centuries of munitions manufacturing. The approach in areas downstream from the factory was to remove contaminated soils near residences, replace with clean fill and rebuild a stable (geotechnically and geomorphologically) stream. Spectrum used geotextiles and revegetation techniques rather than asphalt and concrete to rebuild the stream - yielding a very aesthetically pleasant finished product. In the areas within the factory property boundaries, a more conventional approach was applied. Here, the design was to subexcavate in the immediate area and rebuild the stream cross section using clean fill, geotextile filter, and graded rock as a finish course.

Actual tasks included: making a DTM of the project from survey data; running a backwater profile using HEC-2; conducting sediment transport and armoring analyses; designing reinforced earth retaining walls; sizing riprap and armoring materials; and writing and editing construction specifications.

InterFluve, River Road Landfill Remedy
on Raritan River, Bound Brook NJ for
Union Carbide.

Spectrum Engineering provided the hydraulic engineering, engineering construction documents and onsite construction engineering for approximately 3,000 lineal feet of bank stabilization to protect a hazardous waste landfill. The photos show the before, during and after sequences. This project was awarded the International Erosion Control Association's 1996 Award for Excellence in Design.



Raritan River Before Construction



Raritan River During Construction



Raritan River After Construction

This was a team effort, with Inter-Fluve, who managed the bioscience aspect of this very successful project for Union Carbide. Working with another geotechnical engineer, Spectrum helped design the cover for the landfill, and produced all the construction bid documents.

Montana Department of Environmental Quality, Abandoned Mine Reclamation Program, Montana

Environmental Assessments (EA's) were prepared for the Pryor Mountain 89 uranium project, the Benbow Mine and Mill chrome project, and the Mouat Mine chrome project. NCP documents (Field Investigation Work Plan, Sampling and Analysis Plan, Community Relations Plan, and Health and Safety Plan) were prepared for the Bannack State Park, the Bannack Mining District and the West Butte HMO hardrock projects.

Montana Department of Environmental Quality, Abandoned Mine Reclamation Program, Montana

A preliminary evaluation of reclamation alternatives of the Colorado Tailings in Butte was completed in 1983 prior to EPA involvement (after 9 additional years of study and \$8 MM later, the EPA decided to implement in principle the Colorado Tailings Plan that we recommended).

State of Montana Governors Office, Clark Fork Demonstration Project Montana

The objective was to determine if fish kills from heavy metals (copper) leaching into a one mile stretch of the Clark Fork River could be prevented by treating the tailings in situ. It was hoped that amending the pH would bind the heavy metals and allow vegetation to reestablish. The vegetation would reduce the erosion. Spectrum performed the reclamation design and hydraulic engineering, provided plans for temporary erosion control, estimated quantities, and wrote the special provisions and technical specifications for the bid documents. The project was successful.

State of Idaho (TerraGraphics)

We worked very closely with the Army Corps of Engineers and their contractor (M-K) on the removal of tailings and the reconstruction of the South Fork of the Coeur D'Alene River portion of the Bunker Hill Superfund project.

M-K excavated until the tailings were removed, and Spectrum Engineering surveyed the resulting landforms and designed the river floodplain, wetlands, and floodplain as they were uncovered.

Several Mining Clients in PRB

For our mining clients, our engineers have designed and supervised the construction of roads, railroad spurs, facilities and site plans.

Spectrum's knowledge of geomorphology and hydrology is used to design post mining topography, diversions, sediment control structures, and reservoirs. Spectrum has prepared detailed designs, specifications, and engineer's estimates for use in competitive bidding, contractor selection, and construction administration.

Woodward-Clyde (State of Montana & USFS), East Boulder Mine

Spectrum prepared the mine engineering, geology; and geotechnical analysis of roads and tailings embankments for the East Boulder EIS. We also drafted several of the EIS exhibits.

State of Montana and BLM, Zortman and Landusky Mines

Spectrum developed the Supplemental Environmental Impact Statement to assess all potential reclamation alternatives developed out of a lengthy consultation process involving the EPA, Fort Belknap Indian Reservation, the BLM, and the State of Montana for two large bankrupt gold mines.

State of Montana and BLM, Golden Sunlight Mine

Spectrum developed the Supplemental Environmental Impact Statement to address all potential reclamation alternatives for a large open pit gold mine. The work involved developing technical assessments and conducting a consultation process with the opposing environmental groups, EPA, BLM, DEQ, and the mining company.

Mine Engineering and Planning

Spectrum Engineering will save you money by helping you improve the efficiency of your mining and reclamation practices.



How can Spectrum help you? During the past 20 years, Spectrum has investigated, critiqued, and improved the mining and reclamation costs and practices of many mines as consultants for the coal buyers and as consultants for the mine operators. Spectrum has learned that many mining operations do not consider the entire cost of mining and reclamation in their daily operations, and in the crunch to meet daily or monthly production goals, do things that have adverse long term cost consequences.

The mining and reclamation concepts must be developed jointly with the production staff that will implement the plans. Often plans are not followed because the production department either does not understand the plan, or because the plan is not feasible. A good plan must be feasible, and must involve the people who will implement it.

Spectrum saves our clients money by working with their engineering and production staff to develop simple, yet sophisticated, plans showing how the overburden moves, and how to properly regrade this overburden to a stable

landform with the minimum amount of work. Generally, the goal is to find ways to move material the shortest distance, and to move it only one time. Rehandle is costly and inefficient.

Spectrum offers expertise in computer related mining services such as geologic modeling, mine planning and scheduling, equipment simulation, cost analysis, budgeting, and detailed economic and financial analysis. Spectrum also recognizes that mine planning and permitting must be performed together if both processes are to work in an efficient and cost effective manner.

Mine Engineering and Planning Capabilities

- Mine and reclamation plans and costs
- Coal contract/litigation support
- Mine permitting support
- Bonding calculations
- Pit development
- Facilities layout
- Equipment selection & optimization
- Detailed equipment costing
- Detailed economic models
- Post-mining topography/reclamation
- Quality and grade models
- Graphics and cartography
- Project management

Our engineers have worked on a variety of mine planning and modeling assignments, both as consulting engineers and as operations engineers, in underground hardrock mines, industrial minerals, coal, exploration engineer/geologists, and exploration manager. As consultants, our staff has designed and permitted coal, oil shale and phosphate mines, and performed various design and permitting tasks for other precious metal and industrial mineral operations.



While there is no substitute for the wisdom of experience, effective engineering must be imaginative.

Spectrum can help you reduce your costs by determining the true cost of an operation rather than its apparent cost. To do this, Spectrum looks at the whole system, not just a single task.

For example, most mines keep detailed records on drill bit cost per foot, and can quickly tell you the best bit for their mine.

However, frequently the bit with the lowest cost per foot does not drill the most feet per hour. Since the drill bit is

attached to a drill that may cost more than \$100/hour to operate, a different conclusion may be reached if one considers the total drilling cost per cubic yard or ton. Most of the time, the bit that drills the fastest is the best choice, even if it is many times more expensive than the cheap bit. This analogy carries forward to how the blasting costs affects dragline, loader and hauler productivity and maintenance, and can have a profound affect on the entire mining costs.

Many coal mines “optimize” their coal mining operation and incur higher overburden mining and reclamation costs as a consequence. Is this the best economic strategy? Do you have the data to make an intelligent management decision? Spectrum can help you make informed decisions.

Mine Engineering and Planning Example Projects

Montco Mine Project, Montana

Completed coal exploration program, feasibility study, portions of the mine permit application and EIS, haul road and rail loop design for a proposed coal mine in southeast Montana.

Negev Phosphate's Arad, Zin, and Zohar Phosphate Projects, Israel

Spectrum's principals completed mine management consulting, geologic consulting, computer modeling, training, economic evaluations, mine planning, haul road design, and equipment selection for three active phosphate mines and two exploration projects.

PAMA Oil Shale Project, Israel

Exploration planning, computer modeling, feasibility studies, and detailed mine plans for a large open pit oil shale mine.

Powder River Coal Co., Gillette, Wyoming

Provided long range planning and permitting for the Rochelle and North Antelope coal mines. We optimized the mine plans and designed the post-reclamation topography.

Big Sky Coal Co., Colstrip Montana

Perform mine planning, reclamation design, reclamation optimization, surface water hydrology, design dams and ponds.

Echo Bay Exploration, Washington

Haul road design for a proposed hardrock mine in the North Ferry area.

Santa Fe Mining, Lee Ranch Mine, New Mexico

Prepared haul road designs, detailed access road designs, arroyo crossings, signing and guard rails, facility area grading, topsoil stockpiles, rail loop design, intermediate level railroad spur design and economics, and drainage crossing designs.

Yellowstone Coal Company

Developed a mine plan for a 0.5-million TPY room and pillar underground coal mine which included a subsidence analysis, conducted an inventory of springs and wells, supervised a core drilling program, and provided an analysis of the alluvial aquifers and the head and flow in the deep aquifers.

Permitting

Spectrum's engineers have a proven record in permitting - having completed mining and reclamation plans for eight approved coal mine permits and a portion of an ninth. We have assisted clients with placer gold permits, and have a good working relationship with state and federal regulators. We have permitted, designed and supervised the construction of MSHA dams and impoundments, and are qualified to design and permit any type of impoundment.

Since many of the regulatory agencies use Spectrum as consultants for their abandoned mine reclamation programs, Spectrum has developed a good rapport and reputation with them.

When working on mine permit applications, Spectrum subcontracts the biologic, socio-economic and cultural tasks, and performs the mine planning, reclamation, and hydrology ourselves. Since the mine design and reclamation plan are performed by the same group, Spectrum can develop a more efficient plan from both an operating and a permitting perspective.

Permitting Capabilities

- Bonding calculations
- Analysis of agency review procedures
- Post-mining topography
- Permit renewals
- Identify environmental sensitivities
- Annual reports of various agencies
- NPDES permits
- Interface with regulatory agencies
- Surface and groundwater permits
- Negotiation of permit requirements
- Document preparation for licenses
- Electronic permits
- Solid waste permits and approvals
- Stormwater permits
- County weed control plans
- Graphics and cartography
- AutoCAD designs

Permitting Example Projects

Coal and Hardrock Mines, Montana, Wyoming, and New Mexico

Peabody's Big Sky, North Antelope and Rochelle Mines; Montco Mine; Shell Buckskin Mine; Great Plains Resources Dutchman Mine; Delzer's Fort Union Mine; Cimarron's La Plata Mine; and Cable Mountain Mining have used our permitting expertise to assist them in complying with permit application requirements.

Services have included post-mining topography, groundwater evaluations, surface water hydrology controls, topsoil removal design, disposal of unfavorable overburden, mine design and other miscellaneous permit application reclamation requirements.

Electronic Mine Permits

Spectrum submitted one of the first electronic mine permit applications to the Wyoming DEQ. Rochelle Coal Co. was awarded the permit in 9 months, setting a permitting speed record. Shortly thereafter, the OSM requested that Spectrum present papers at different symposia regarding electronic permitting.

Mine Reclamation

Spectrum Engineering's reclamation experience began with the permitting of Powder River Basin coal mines in the late 1970's and early 1980's. Spectrum helped several PRB mines with engineering, reclamation planning, and permitting, and continue to perform this service.

The new reclamation laws and regulations required voluminous permits, and proof that the mines could be reclaimed during and after mining. These laws created new costs, and the mining companies passed these costs through to their customers, the electric utilities. Spectrum was retained by many of the electric utilities to review the actual and budgeted reclamation costs of a variety of large mines to determine if the estimates and billing were reasonable. During these reviews, it became apparent that the mining method profoundly affected the reclamation costs, and that with prudent planning the total mining and reclamation costs could be substantially reduced. Spectrum then used this knowledge to attempt to design

mining and reclamation plans that minimized the total mining costs. Our philosophy is to incorporate the reclamation planning into the overburden mining with the goal of minimizing the total cost.

As the mining becomes more complicated and moves into deeper cover, the cost savings resulting from our knowledge and experience are enormous. Our credibility with the regulators and our expertise with hydrology and geomorphology allow us to create efficient, geomorphologically stable landforms that are easy to permit and construct.

Spectrum's expertise gained from mining reclamation has had direct application to other types of projects such as Superfund sites and rivers silted up by logging and mining wastes. Spectrum's experience and capabilities in these areas are summarized in the Environmental Engineering section.

Mine Reclamation Example Projects

Powder River Basin

Prepared detailed mining and reclamation plans for North Antelope and Rochelle Coal Mines.
Prepared first reclamation plans for Buckskin and Ft. Union coal mines.
Prepared reclamation plans for Big Sky.

Reclamation Reviews

Reviewed coal mine reclamation plans and costs for Black Butte, Black Mesa, Medicine Bow, Seminoe, Jim Bridger, Big Horn, East and West Decker, Spring Creek, Cyprus Shoshone, Black Thunder, Beulah, Absaloka, Navajo and Rosebud mines.

Management Consulting to Electric Utilities and Coal Mines

Since the early 1980's, Spectrum has helped mining companies and utilities resolve contract issues involving coal fuel supply agreements. Beginning in the early 80's, a variety of contentious issues arose related to coal contract pricing escalation and increased costs caused by new environmental and reclamation laws.

Spectrum's experience with mine permitting, reclamation planning, and mine accounting was put to good use, allowing us to readily identify and quantify the issues. Some of Spectrum's clients were able to renegotiate the contracts; others were forced to resort to arbitration and litigation.



In the current era of deregulation, Spectrum is convinced that the win/lose model of the 70's and 80's must change to a win/win strategy. Spectrum's experience with a variety of contracts and philosophies places us in a good position to help mining companies and utilities develop winning contracting strategies for the new millennium. This paradigm will be important for captive operations, and

relationships where the spot market is not an option.



Spectrum consulted for the board of directors of a mid-eastern mining company to help them understand and successfully correct organizational and operational problems, thus adding at least another 20 profitable years to the company's life.

Spectrum has worked closely with major accounting and legal firms in a variety of cases providing expert advice on damage computations, audits, contract language, contract negotiation, arbitration, and litigation. Spectrum provided advice on lawsuits involving mining and mineral property valuation, and has consulted to attorneys concerning discovery, depositions, damage computations, and expert witness testimony.

Management Consulting Capabilities

- Operational audits
- Mine closing costs
- Budgets and economic studies
- Inflation/escalation analysis
- Equipment productivity studies
- Labor productivity analysis
- Coal contract evaluations
- Expert witness testimony
- Damage calculations
- Reclamation costs
- Litigation support
- Mine valuation
- Coal contract audits
- Contract negotiations

Management Consulting Example Projects

Arizona Public Service, Four Corners Power Plant, Navajo Coal Mine, New Mexico

Audit pass-through reclamation costs. Review contract provisions. Assist in evaluation of long term contract extension and revision.

Commonwealth Edison, Big Horn Mine, Wyoming

Performed a cost claim analysis involving a coal mine. Equipment costs, labor requirements, and productivity requirements were assessed. Also assisted in the claim negotiations.

Commonwealth Edison, Black Butte Mine, Wyoming

Performed various reclamation analyses of this coal mine. Analyses included volumetrics, equipment costs and productivity, inflation indices, contract wording, and base date versus current requirements.

Commonwealth Edison, East Decker Mine, Montana

Completed a preliminary reclamation claim analysis involving this coal mine. The problem involved determining the cost differential caused by changing from dragline to a truck/shovel mining method.

Commonwealth Edison, Montana and Wyoming

Assisted Commonwealth in a Force Majeure claim regarding the failure to take coal shipments from several Western coal mines. Determination of lost profits, reclamation costs and the market price of coal were made in order to assess damages. Provided expert witness testimony.

Detroit Edison, Decker Mines, Montana

Assisted Detroit Edison in the discovery process, attended depositions and testified in an arbitration hearing concerning increased mining costs resulting from changes in laws and regulations. Made independent estimate of life-of-mine reclamation costs.

Idaho Power, Jim Bridger Mine, Wyoming

Reviewed the contract documents and advised Idaho Power on certain aspects of a coal deferral agreement with this coal mine.

Lower Colorado River Authority, Decker Coal Mines, Montana

Assisted LCRA in arbitration involving these coal mines. Spectrum prepared alternative damage calculations and critically examined basic assumptions involved in the dispute. Expert witness testimony was provided in an arbitration hearing. Also assisted LCRA in discovery and deposition processes in a litigation involving certain actions which have resulted in the termination of a long term coal supply contract.

Northern States Power, Absaloka Mine, Montana

Evaluated a reclamation cost claim involving this coal mine, including labor costs, equipment productivity, operating costs, and reclamation responsibility.

Northern States Power and Western Energy, Rosebud Mine, Montana

Evaluated a labor and equipment productivity and reclamation cost claim involving this coal mine. Reserves were verified, economics generated, and the mine plan was reviewed. Alternative contract indices were studied to better handle inflation adjustments and future changes in law.

Northern States Power, Montana and Wyoming

Evaluated coal mine fuel supply contract proposals. Reserves, coal quality, mine permit applications, and ownership were reviewed for their ability to meet the coal quality specifications, tonnage requirements, and mineability. An independent pricing estimate was prepared for each prospective mine.

Northern Indiana Public Service, Wyoming

Performed a contract and volumetric review regarding a coal purchase deferral. Both the tonnage and ownership of the dedicated reserves were reviewed.

Otter Tail Power, Knife River Mine, North Dakota

Reviewed reasonableness of reclamation cost pass throughs from a lignite mine.

Rainier Bank

Expert witness testimony regarding valuation of mineral properties.

Southern California Edison

Helped resolve coal quality problems and fuel supply dedication issues involving Black Mesa Mine. Assisted in the renegotiation of the contact extension and other contracting details.

U.S. Army Corps of Engineers (subcontractor to Kellogg Corp.)

Evaluated contractor claim against the Corp. of Engineers on the Tennessee Tombigbee Waterway Project (largest earthmoving project to date in U.S.): expert witness, evaluated maintenance records, performed computer vehicle simulation time and motion studies.

Wisconsin Power and Light

Assisted the internal audit department in evaluating all of the cost provisions of a long term fuel supply contract.

Site Investigations and Geology

The evaluations of a mineral deposit, a Superfund site, or a small oil spill all require certain similar investigatory skills. If the initial sampling program is flawed, then erroneous conclusions will result. Most of the mining industry has learned the importance of accurate sampling and correct methods for evaluating the samples and attempting to model the distribution and grade of the metals or variables of economic interest.



Spectrum's staff has managed coal, phosphate, and hardrock exploration programs. This experience provides a practical basis for the evaluation of new and existing

projects. Spectrum has performed every phase of mineral resource evaluation including landowner identification and drilling agreements; development of property ownership maps; state and federal exploration permits; drill hole layout; drilling and geophysical logging,

drill site reclamation; geologic modeling; resource estimations; and finally, mine design and construction. Spectrum Engineering uses state of the art computer programs to model and evaluate mineral prospects, and to develop final mine plans and economics.



Spectrum has the expertise to conduct evaluations (or due diligence) of coal, industrial minerals, and hardrock properties, including recommendations based on location, geology, royalty, lease or purchase agreements, and mining feasibility. Spectrum can perform unpatented mining claim staking, property surveys, topographic mapping, and complete exploration programs ranging from reconnaissance through definition drilling.

Site Investigations and Geology Example Projects

Rotem Amfert Negev, Zin, Arad, Zohar Phosphate Projects

Taught Rotem's geologists and engineers computer modeling and field data collection methods at 3 large phosphate mines in southern Israel. Prepared geological evaluations and feasibility studies for 2 additional phosphate properties for Rotem.

Santa Fe Mining, Divide Project, New Mexico

Developed a geologic model for this coal project. The project included data

preparation for 630 drill holes and construction of a geologic computer model.

Montco, Montco Mine Project, Montana

Developed a geologic and coal quality model for this 640 drill hole project and construction of a geologic computer model.

PAMA, Oil Shale Project, Israel

Resource evaluation included drill hole data verification including top and bottom picks and quality information, and then modeling of the geology on CPS and SURPAC software packages.

Water Resources Engineering and Hydrology

Spectrum Engineering provides technical consulting services in a number of areas relating to water resources engineering. These include:

- **Engineering Hydrology**
 - Statistical hydrology
 - Hydrologic computer modeling
 - Storm frequency analysis
 - Rainfall-runoff estimation
 - Flood routing
 - Watershed analysis
- **Hydraulic Engineering**
 - Earth dams
 - Spillways
 - Drop structures
 - Flow diversion facilities
 - Inverted siphons
 - Culverts
 - Reservoir and pond sizing
 - Water surface profiles
 - Leachate & water supply dams
- **Mining Applications and Permitting**
 - Mining hydrologic control plans
 - Sediment control pond
 - Diversion structure
 - Channel redesign
 - Stable post mining drainage design
 - Tailings dams
 - Alluvial valley floor analysis
- **Hazardous Waste and Superfund Project Applications**
 - Stream bank and flood plain reconstruction
 - Flood plain analysis

Water Resource Capabilities

A thorough understanding of engineering hydrology and hydraulic engineering principals and practices is vital to the successful completion of most natural resource projects.

Rather than taking the traditional approaches to erosion protection, such as concrete retaining walls and sheet piling, Spectrum uses a softer design.

Spectrum attempts to use regrading and vegetation techniques as much as possible, relying only on hard structures when geometry constraints prohibit natural features. Using knowledge of hydrology, hydraulic engineering, geomorphology and sediment transport, Spectrum is able to specify non-traditional materials for construction. Spectrum always tries to integrate passive controls such as land use and vegetation for sediment control and wildlife habitat.

Landowner cooperation and integration is critical to the successful completion of most projects. Spectrum listens. Frequently, local individuals provide insights and information that are beneficial to the project at hand.

Spectrum has prepared dozens of construction bid packages for state agencies, using illustrations, drawings, and photographs to effectively communicate the work. Spectrum has developed specifications for stream relocations, biodegradable bank revetments and stabilization techniques, fabric reinforced bank construction, riprap, and so forth.

Spectrum is proud of the fact that some government clients have adopted Spectrum's construction bid package format and drawing styles as their standards. These agencies include: the MT Department of Environmental Quality and the MT Department of Natural Resources and Conservation.

Spectrum's bid documents are clear and easily understood by the contractors, resulting in few change orders or contract disputes. Our clients and the construction contractors have praised us for the clarity of our plans and the smooth flow of the entire construction projects we have managed.

Spectrum manages all phases of construction administration including contractor selection, construction supervision, and contract management, including payment preparation and approval.

Engineering Hydrology

Engineering hydrology is a key component of most natural resource projects. In cases where stream flow data are available, we use a large nationwide stream database and Log Pearson type III analysis to estimate flows. In areas where there are no flow records or where the flow records are incomplete, Spectrum utilizes hydrologic computer modeling, storm frequency analysis, and rainfall-runoff estimations.

Mining Applications and Permitting

Spectrum has designed and supervised the construction of major stream diversions, Mine Safety and Health Administration (MSHA) reservoirs, sewer facilities, water systems, and sediment ponds. Spectrum uses erosion and hydraulic theory to design post mining

stream reconstruction and earthwork grading. The hydraulic engineering work includes hydrologic control plans for active and post-mining operations and conditions.

As part of the hydrologic control plans for various types of surface mining operations, Spectrum designs: diversion structures, material stockpiles, culverts, pipelines, and ditches. Spectrum also designs hydrologically stable post mining reclamation topography - requiring knowledge and experience of sediment transport, geomorphology, hydrology, open-channel hydraulics, mining methods, and most important--mine economics.

Spectrum designed a permanent wetland for a PRB coal mine using statistical hydrology, rainfall-runoff modeling and flood plain delineation methods.

Hazardous Waste and Superfund Project Applications

Spectrum has designed and modeled the rehabilitation of streams and rivers that are within Superfund and hazardous waste projects. The tasks included statistical hydrology, flood plain delineation, flood plain and channel redesign, stream bank reconstruction and flood plain reconstruction. Two of these assignments dealt with evaluating techniques to stabilize or remove mine tailings that were dumped in rivers.

Geographic Information Systems and Mapping

Spectrum Engineering has worked with large 3-D data sets and computer models, such as drill hole databases containing geological information and property maps since 1978. This data is then modeled in 3-D to produce geologic maps, detailed earthwork and mining plans, and detailed reclamation and revegetation plans and maps.



Since Spectrum is always dealing with complex land and mineral ownership, Spectrum developed special expertise in solving complex property ownership maps. This expertise includes preparing surface and mineral ownership mapping of more than a million acres of property in Pennsylvania, Ohio, and West Virginia, and identifying thousands of property owners of patented and unpatented mineral claims in Montana, Wyoming, and Utah.

Our staff is able to efficiently handle most types of mineral and surface ownership determinations, including the preparation of accurate maps and data.

Spectrum's technology has evolved from stand alone database and modeling software, to AutoCAD, to AutoCAD Map (a bridge to ArcView), to ArcView. Spectrum has the skills and technology to manage most common data formats.

Spectrum owns survey grade (sub centimeter) and map grade GPS surveying equipment that we use for small to medium sized jobs, or tasks that require on the ground data collection.

Spectrum has broad expertise using ESRI's ArcView GIS software.

GIS and Mapping Capabilities

- Vegetation mapping
- Abandoned Mine Inventory Mapping
- Basic road centerlines
- Structures and utilities
- Conversions between various data types, and other digital data formats into and out of ArcView
- Development of extensive databases attached to the GIS files with the ability to create hot links to link a specific point, line or polygon to a table or photograph with a simple click
- Integrate and layer various types of data from varied sources to create professional quality maps