NASA – WHITE SANDS TEST FACILITY

New Mexico

Resource Conservation and Recovery Act Facility Investigation/ Corrective Measures Study

Alberto A. Gutiérrez served as principal in charge of this project while serving as President of GCL, predecessor to Geolex, Inc.

GCL provided the NASA-White Sands Test Facility (WSTF) with environmental engineering services, including remedial investigations, closure plan development and cost estimation, hazardous/solid waste management planning, and Federal (Environmental Protection Agency) and state (New Mexico Environment Department) regulatory liaison and permitting for specialized aerospace-related facilities. This $3 million per year multi-disciplinary program utilized GCL specialists in the areas of hydrology, chemistry/geochemistry, risk assessment, environmental engineering, civil engineering, mechanical engineering, and hazardous waste management. GCL performed site characterization, risk assessment, and corrective measures implementation activities pursuant to Resource Conservation and Recovery Act (RCRA) criteria. NASA-WSTF was required to perform a RCRA Facility Investigation (RFI), a health risk assessment (HRA), a Corrective Measures Study (CMS), and a Corrective Measures Implementation (CMI) by virtue of a 8008(h) Corrective Action Order between NASA and EPA Region VI. Specific task assignments illustrating GCL's RFI, health risk assessment (HRA), and CMS capabilities are summarized below.

Contamination Assessment/Unit Closures and RFI/CMS Implementation

GCL was initially contracted for the completion of contamination assessment and closure plans at several waste management units and submittal of RCRA Part B permit applications for the NASA-WSTF site. The contamination assessment consisted of data review, soil-gas surveys, and regulatory negotiations. Over 1,600 soil-gas sample points were collected over 10 square miles, seismic investigations were performed to evaluate bedrock and fault configurations, RCRA and multi-port monitor wells were installed as deep as 1,800 feet; over 100 soil borings were collected for lithologic logging and sample analyses; and over 500 soil and surface water locations were sampled. More than 20,000 chemical analyses have been performed in support of contamination assessment activities.

Data derived from the contamination assessment were evaluated and analyzed using computer models to predict the potential transport of hazardous constituents detected in soils and groundwater. Geostatistical procedures, such as kriging and block averaging, in addition to two- and three-dimensional groundwater flow and transport models were used to prepare final contamination assessment reports. Contamination assessments provided the basis for selection and design of environmentally sound and cost-effective closure options for each of four primary areas selected for closure.

Major Project Elements:

- Remedial design/ Remedial action
- RCRA
- Groundwater modeling
- Hazardous waste management
- Program/Project management/QAQC
- Environmental data management
- Environmental risk assessment
- OSHA compliance/ IH services
- Regulatory compliance/ Permitting
- RFI/CMS/CAD
- Hydrology/Hydrogeology

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Data obtained during the contamination assessment also provided the technical basis for negotiating NASA-WSTF's 3008(h) Corrective Action Order. This process was initiated by U.S. EPA Region VI in response to groundwater contamination that had migrated off-site. Due to the extensive database developed by GCL over the prior three-year period, NASA-WTSF was able to propose and defend a cost-effective and reasonable schedule for completing required RFI/HRA/CMS activities.

RFI Implementation – Aquifer Testing and Vadose Zone Characterization

GCL installed the facility's eight original RCRA groundwater monitor wells. Groundwater contamination was detected in these wells prompting the development of a comprehensive groundwater contamination assessment. Contamination was detected over three miles west (downgradient) of the facility boundary. GCL installed more than 90 monitor wells, piezometers, and exploratory boreholes ranging in depth from 150 to over 2,000 feet. The major contaminant plume extended over 3.5 miles in length and at least 0.75 miles in width. Major contaminants of concern included a number of chlorinated solvents, freons, and other by-products of rocket engine testing. Data gathered during the RFI was used in groundwater modeling and health risk assessment efforts and provided the basis for the CMS.

To supplement RFI site characterization activities, five major aquifer tests were performed – one testing fractured andesite bedrock adjacent to facility waste impoundments; one located in the deep off-site alluvial basin from which NASA drew its domestic and industrial water supply; one in the bedrock aquifer; one in the paleochannel near propulsion testing areas; and one off-site in the thin alluvial paleochannel transition into the major alluvial aquifer. The major alluvial aquifer test utilized an 850-foot deep, 10-inch diameter pumping well screened over 300 feet of the aquifer. Four piezometers were also installed as temporary observation points. The off-site test was performed for 100 hours with an average discharge rate of 300 gpm. A pilot-scale cascade air stripper was used to treat groundwater prior to discharge. Thus, information necessary for both the RFI and CMS were collected. The facility supply well test was run for 72 hours at a pumping rate in excess of 500 gallons per minute (gpm). Water-level data were collected using a three-tiered system using manual measurements and measurements gathered by two digital logging systems. Hydraulic conductivity values and storage coefficients calculated from observation wells suggested the aquifer was responding as a partially confined system. The bedrock aquifer tests typically use four-inch monitoring wells. Aquifer tests in bedrock were run at low flow rates over long periods of time (as great as 30 days) in order to obtain responses in nearby observation wells. Evaluations of bedrock pumping test data suggested that groundwater was propogated along major faults and fractures and that fracture communication controlled well response.

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Groundwater Modeling

Groundwater modeling was done to support the identification of data gaps in plume characterization, to support the pathway and exposure concentration analysis for the health risk assessment, and to assist in the evaluation of remedial alternatives for the CMS. Groundwater modeling work used a telescoped approach wherein regional flow was evaluated initially and modeling subgrids were defined. A detailed site-specific model was then developed for the study of the intricacies of contaminant transport. Regional modeling studies focused on ascertaining the degree of population grown and associated groundwater use over a thirty-year period. The groundwater flow fields generated from the regional study were used to define boundary conditions for further model subgrids used to focus in more closely on groundwater flow and transport in the immediate vicinity of the facility. GCL used accepted public domain two- and three-dimensional groundwater flow and solute transport codes (MOC, MODFLOW, PATH3D, and MT3D) in order to evaluate groundwater flow in alluvial and bedrock aquifer systems at this site. Groundwater modeling was complicated at this site due to the presence of as many as six aquifer lithologies, steep hydraulic gradients on-site transitioning to very flat hydraulic gradients in the basin, and poor knowledge of contaminant release time frames. Therefore, three-dimensional flow and solute transport models were developed, calibrated, and used in support of RFI, HRA, and CMS activities.

Baseline Health Risk Assessment

Results of the RFI and groundwater modeling efforts were used as the basis for the baseline health risk assessment performed for the site. The health risk assessment initially evaluated all constituents detected at the site to define constituents of concern with respect to human health and environmental risks. The contaminant identification phase narrowed the list of contaminants of concern from over 50 to less than 10. Of all constituents released into groundwater at this site, an exotic by-product of propellants used in engine testing, n-nitrosodimethylamine (NDMA), became the risk driver due to its carcinogenicity, even though maximum concentrations detected in groundwater were typically less than 50 parts per billion. This finding helped focus CMS efforts toward dealing with NDMA as opposed to focusing on the more well-known chlorinated solvents. Additionally, the baseline health risk assessment was used to develop a less stringent cleanup standard for this compound, as the current recommended maximum contaminant level was the practical quantification limit. The risk assessment also incorporated present and future land use patterns to establish whether or not there was potential for receptors to be exposed to contaminated groundwater. In this case, a possible future private supply well located southwest of the leading edge of the plume was evaluated. Together with groundwater modeling, the baseline risk assessment demonstrated that this potential supply well would be at risk between 20 and 30 years in the future. NASA-WSTF supply wells were also evaluated with respect to long-term risks – no risks to these wells were identified over the 30-year period evaluated.

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The baseline risk assessment and groundwater modeling efforts were used by NASA-WSTF in facility planning (location of additional supply wells) and land acquisition (acquiring private land with the potential for future exposure) efforts. The health risk assessment was continually revised and updated to examine potential risk reductions achieved by proposed CMS technologies.

Corrective Measures Study: Bench- and Pilot-Scale Technology Evaluations

The CMS was charged with identifying potential technologies capable of reducing site contaminants to acceptable cleanup levels. Once potential technologies were identified, a series of remedial strategies, ranging from no action to site-wide remediation were evaluated. The CMS relied on the RFI and HRA for input in order to focus the evaluation of remedial technologies that would achieve the greatest reduction in risk. To this end, groundwater ingestion was identified as the principal exposure pathway and medium of concern. NDMA, trichloroethene and perchloroethene were the principal contaminants of risk. Therefore, at a minimum, technologies considered needed to be capable of reducing concentrations of these contaminants to regulatorily acceptable levels (in the case of NDMA, the acceptable level was below detection limits).

GCL evaluated potential remedial technologies at the bench- and pilot-scale levels in order to identify promising technologies. Bench-scale testing was done for aqueous-phase granular activated carbon, in situ bioremediation, solar/ultraviolet (uv) photocatalysis, and u-v photolysis. Each of these technologies had the potential for remediating NDMA and chlorinated solvents. GCL developed bench-scale testing partnerships with universities and technology vendors in order to cost-effectively accomplish initial feasibility testing to identify whether or not a technology is promising. Pilot-scale testing was performed for innovative applications of existing technologies. One such technology, cascade air stripping, was pilot tested in conjunction with an RFI pumping test as a means of treating groundwater prior to surface discharge while at the same time obtaining performance, operation, and cost data to support the CMS. The air stripper was designed as a mobile, temporary unit that could be moved around the facility, as needed, to perform other tests or interim remedial activities.

At the conclusion of CMS activities, GCL prepared a summary RFI/HRA/CMS report for submission to NASA-WSTF and to EPA Region VI. This report summarized site characterization, health risk assessment, and remedial technology evaluations, and provided recommendations for Corrective Measures Implementation.

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