AP - 27

STAGE 1 & 2 REPORTS

DATE:
July 19, 2006

Whole Earth Environmental, Inc.
2103 Arbor Cove
Katy, Tx. 77494
281.394.2050
whearth@msn.com

July 19, 2006

NMOCD
1220 South Saint Francis Dr.
Sante Fe, NM 87505

Attn: Wayne Price

Dear Mr. Price:
I want to first of all thank you for all of the time and attention shown Carolyn and me today. We were quite honored in your showing an interest in our remote unit. As promised, this is a brief description of the remote reverse osmosis system we discussed at lunch. We are quite proud of the concept and have spent a lot of time developing the idea into a reliable, low-cost method of treating groundwater situated in remote locations.

A brief overview of the main system components starts with the basic skid. It's made from 1020 carbon steel and is designed to be off-loaded either with a forklift, oilfield gang truck or even through block & tackle equipment from the bed of a pickup. The basic unit weighs 2,255 lbs. but is designed to easily support a "wet weight" of 6,250 lbs. once the integral 500 gallon tank is filled. All structural welds are stress relieved and the unit is primed and painted with an epoxy based, corrosion resistant coating. The skid system consists of a tank, battery bank, control panel, central process computer, pump controller, reverse osmosis system, conductivity sensors and in our newer versions, a remote SCADA system.

The unit is has two power sources. The first is a series of four BP SX-170 Multi-Crystalline photovoltaic panels each rated to 170 watts configured in two series providing a maximum operating voltage of 70.8 VDC. The output of the panels is conditioned through an Outback charge regulator with battery temperature compensation.

The second power source is a Southwest Whisper 100 turbine, again run through a custom controller. We've included an Incaloy immersion heater into the storage tank to dissipate excess energy thus protecting the batteries from overcharging.

The energy storage system consists of 16 Trojan lead acid batteries wired in eight series to two parallel arrays for a 48 volt buss and center tapped for a 24 volt buss. The two respective busses are paralleled with a 24/48 DC to DC power converter that passively equalizes energy potential differences that may occur in the battery bank. A temperature sensor located within the battery bank automatically kicks in a cooling fan should the temperatures near the manufacturer's operating limits.

The collection point for the power systems is a NEMA 4 gray metal enclosure that includes an over current protection system for all electronic components.

Process functions are constantly monitored by multiple system inputs and sensors. If the temperature within the instrument enclosure exceeds 60^0 C, the processor will switch on circulation fans to cool the electronics. If temperatures continue to increase above acceptable limits, the controller will stand down power on a hierarchal basis to limit the exposure of the various electronic components to damaging heat. Additional sensors will detect if the down-hole pump is running dry, the primary or secondary storage tanks are full, the reverse osmosis filters are clogged, or if there is an unacceptable power output from the battery bank. In our newest version, all operating parameters may be monitored remotely through a SCADA system.

The down-hole pump is a positive displacement helical progressive cavity pump. This unit is extremely energy efficient, has superior corrosion resistance and is quite tolerant of suspended solids. The piping is comprised of 304 stainless steel, low silicone bronze or polyethylene tubing. Similarly all fasteners are austenitic stainless steel.

The reverse osmosis system is designed to continuously process potable and concentrated waste streams. The primary controller monitors pressure and salinity from multiple points within the system. Our initial application was for a salt-water spill having only minor amounts of hydrocarbons. In this service, the normal interval for exchanging the primary filters is 2,000 hours. If free product is contained within the source stream, the service interval will be more frequent. In our present application of 35,000 ppm chlorides, we've throttled the system back to process approximately 200 gallons of fluids per day. The filter replacement is quite simple and can easily be done by your pumper or other field personnel.

The system takes a couple of days to put in place and obviously requires a 4" source well to be drilled beforehand. Similarly, the client will be required to provide additional storage tanks and ancillary plumbing. Our manufacturing costs for the described unit are around $40,000.00. As the system is quite portable and has an indefinite service life, we've taken the approach that it would be in everyone's interest that we lease the units. The one described in this transmittal is presently on lease for $2,000.00 per month.

We are now looking at simpler applications including simple oil-water separation and polishing, air sparging, and a waste minimization application for fracting wells.

Thank you again for your interest in the system. I very much look forward to the opportunity of working with you on any potential application you may have.

Warmest personal regards,

Mike Griffin
President
Whole Earth Environmental, Inc.


08.29.2005 11:29


08.29.2005 11:29


WARNING!
OutBack
08.27.2005 18:07


OutBack
Power Systems
08.27.2005 18:07


08.29.2005 11:29

NMOCD 2006 Environmental Merit Award

Dually Presented to Rice Engineering, Inc. and Whole Earth Environmental, Inc.

For the innovative application of renewable energy technologies and a portable reverse osmosis filtration system in the groundwater remediation project at the Blinebry-Drinkard Salt Water Disposal System Facility.

The portion of the facility under remediation is referred to as the E-15 Junction Box Site and is located in Unit Letters D and E of Section 15, Township 22 South, Range 37 East in Lea County, New Mexico.

Background

The original accidental discharge of produced salt water was discovered on March 29, 2000 – 300 barrels of salt water was recovered for disposal and 2,000 cubic yards of contaminated soil was excavated and sent to a disposal facility.

The long term remediation and abatement of the site is permitted by the Oil Conservation Division under AP-027, issued May 3, 2001 and requires an annual progress update.

Test holes were drilled to delineate the extension of the plume. The determination was made for two monitor wells to detect the presence of chlorides and other contaminants. Subsequently, two additional monitor wells were installed with all four wells being tested quarterly.

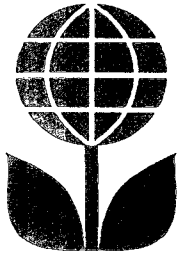
In January 2002, the plume area was excavated to a depth of 35 feet with an approximate volume of 29,000 cubic yards and then bottom-lined with clay and a polyethylene liner was installed to encapsulate the contents.

Progress slowed during 2003-05 while some landowner issues were being resolved.

March 2006 saw the design of a more or less permanent reverse osmosis remediation unit for the project whereby renewal energy systems would power the pumping and process units to filter the contaminated water.

The unit, installed in June 2006, consists of two renewable energy power sources. The first is a series of four photovoltaic panels providing a maximum of 70.8 volts DC. The second is a Whisper 100 wind turbine with both systems running though a custom power controller and conditioner.

All controls and electronic equipment is housed in a metal enclosure where process functions are constantly monitored by multiple system inputs and sensors. Temperature within the enclosure is cooled as needed by automatic fans.



Whole Earth Environmental, Inc.

Qualifications Manual

Whole Earth Environmental Inc.
2103 Arbor Cove
Katy. TX 77494
281.394.2050
www.vadose.us

Executive Summary

Whole Earth Environmental is a company working exclusively in the remediation of hydrocarbon and brine contaminated soils and water. By concentrating our efforts within this narrow spectrum of services, we are able to provide our clients with a level of experience, expertise and dedicated equipment unique to the environmental services industry.

Experience
The four principals of the company have over a century of combined experience working in or around the oilfield. We understand the processes, procedures and equipment used in the extraction, refining, transportation and storage of hydrocarbons. We have a keen understanding of the various state regulatory requirements and have established excellent, long term working relationships within the various agencies allowing us to provide our clients with the highest level of flexibility in meeting the mandated requirements.

Over the years, we have developed an understanding of the efficacy and cost of a myriad of remediation options. We are generally able to provide our clients with a series of alternatives for each location and are often able to offer low cost, creative alternatives to traditional methods.

This experience extends to all aspects of the project – from creation of the protocols to the actual excavation and construction phases of the job. We've supervised literally hundreds of thousands of man hours of heavy equipment operations without experiencing a lost time work related injury. We know the capabilities of each piece of construction equipment, and know when it is being operated safely and efficiently.

Equipment
We own and operate an extensive array of instruments to accurately measure TPH, volatile organic compounds, pH, BTEX, electrical conductivity, chlorides, soil moisture, radiation, and microbial activity – in the field – in real time at a fraction of the time and cost of comparable laboratory analysis.

This instrumentation gives us the ability to "measure as we go". This is an incredibly powerful process that allows us to make every step of the remediation process as efficient as possible.

Communications

We strive to make each remediation project as transparent as possible. Before we begin work, we provide our clients with a detailed cost estimate and protocol explaining each step of the proposed operation. Once on location, the client is e-mailed at the end of each day and advised of our progress, daily and cumulative costs, and of any landowner or regulatory contacts. The e-mails will contain digital photos, diagrams or sketches as necessary to as to provide as complete a picture as possible.

Communications extend to the actual work site. Each person on location is routinely provided with a two way radio. This allows us not only to efficiently direct the work of the individual equipment operators but also allows the operators to speak directly with one another without having to shut down and have a meeting.

Brine Remediation

Whole Earth has successfully completed the remediation of over one hundred sites contaminated by produced water. Our on-site analytical capabilities, coupled with the development of our own proprietary software, allows us to provide the precise treatment required for each site.

Example of a reserve pit in South Texas treated for brine contamination. After the impoundments were drained, the soils were mixed with substrait materials and treated with flocculents, and liquid cationic amendments.

Example of a mixed waste site in North Dakota. Originally a flare pit, the site was excavated, mixed and blended with the surrounding soils to achieve an average TPH of <1,000 ppm then topically treated for chloride contamination reducing the SAR values from 47 to 8.

Facilities

Whole Earth has remediated and restored over fifty facilities comprising over one million barrels of storage capacity. Our range of services include soil remediation, erection of containment berms, blasting and painting, compaction, liner installation and contouring.

Detail of containment berm construction.

After the site has been remediated, new chip base materials are added to the surface, watered in and compacted providing a dense surface.

All surfaces are blasted to white metal, primed and painted with epoxy paint formulated to last for many years.

Partially buried redwood tank area after demolition.

Tank area at point of final excavation.

Site at point of final remediation, and surface contouring.

Groundwater Remediation

Whole Earth has developed many innovative approaches to effective groundwater remediation. We start with effective sampling of the vadose zone using either direct coring or passive electro-magnetic surveying equipment to determine the locations and concentrations of the contaminant plume. This information is fed into one of several modeling programs to predict future migration paths and to develop an effective remediation strategy for dealing with the contaminant source. Once delineated, water samples are collected and analyzed for constituents of concern.

In shallow aquifers, many hydrocarbon plumes may simply be allowed to naturally attenuate under close monitoring. More complex impacts may often be treated through the introduction of oxygenation agents or microbes to enhance biodegradation. In cases where free product or brine is present, the water can be brought to surface and treated economically by separation and reverse osmosis.

Example of our remote R.O. Treatment system. Powered exclusively by sun and wind, the unit pumps water from the aquifer into a storage tank. The fluid is treated through reverse osmosis producing up to 95% clean, potable water and 5% super-saturated brine.

The unit is designed for use in remote areas and is equipped with a variety of sensors to insure safe and efficient operations. Combined with a SCADA capability, it provides the operator with real-time analysis of all stages of the process. A typical application may be viewed in "real time" at www.greenflaginc.com/status.

Injection

For difficult to reach areas, we employ an injection system to remediate both hydrocarbon and brine contamination. Through injection, we can introduce blends of flocculents, surfactants, nutrients, oxygenates and water directly into the contaminant plume.

Many sites are difficult to approach through traditional excavation methods due to either a lack of space or the presence of buried lines. Whole Earth designed and built an injection trailer with an especially small "footprint" yet capable of injection amendment materials, fertilizer, and water up to 10' bgs at a pressure of 4,000 psig. We can control the ratio of amendments to water in increments of tenths of ounces per gallon and introduce solid oxygenates (such as magnesium oxide) directly into the zones of interest.

Leaks and Spills

Surface leaks and spills are quite common within the petroleum extraction industry and usually result in little or no long term damage to the environment. Whole Earth Environmental has a variety of remedial tools we employ in their cleanup including simple aeration and dilution, composting, and bioremediation.

Example of a flowline spill covering approximately two acres in West Texas. The site was remediated through aeration and dilution within one week.

An example of a more complex site in which a main trunk line ruptured and contaminated approximately 23 acres. Whole Earth remediated the site to Texas Railroad Commission Rule 91 standards for less than $3.00 per cubic yard.

An example of an especially congested line leak area adjacent to a highway crossing.

Microbial Remediation

Microbial remediation has proven to be useful and effective in three basic applications. The first involves the remediation of contaminated soils in areas situated adjacent to tanks, manifolds, wellheads or pipelines. Manual excavation of these areas is often a slow, tedious and expensive operation using non-ferrous tools to minimize the possibility of sparking. Alternatively, we are able to inject a mixture of microbes, nutrients, surfactants, flocculents and oxygenates directly into the zones of interest in sufficient volume to insure an initial minimum concentration of one million colony forming units (CFU's) of bacteria per gram of soil.

The second general area of utility is landfarm applications. Here, relatively inexpensive microbial augmentation may be used to dramatically speed up the remediation process. Typically, the contaminated materials are spread to a maximum depth of 18" above the ground surface and over-sprayed with microbial amendments. The soil is then disked to blend and aerate the mixture and tested to insure that optimum growth conditions are achieved.

The third effective use of microbial amendments is for hydrocarbon spills into ponds, tanks or other aqueous environments. The surface of the impoundment is simply over-sprayed with amendments and left to work on their own. The results are often quite dramatic achieving non-detectable TPH concentrations within twenty-four hours. It's an especially cost effective technique in removing the unsightly and difficult to get to hydrocarbon ring on the soils at the water's edge.

Example of a microbial injection adjacent to a storage tank area in South Texas. In this example, TPH concentrations at a depth of 10' below ground surface went from 187,000 ppm to <10,000 ppm within thirty days.

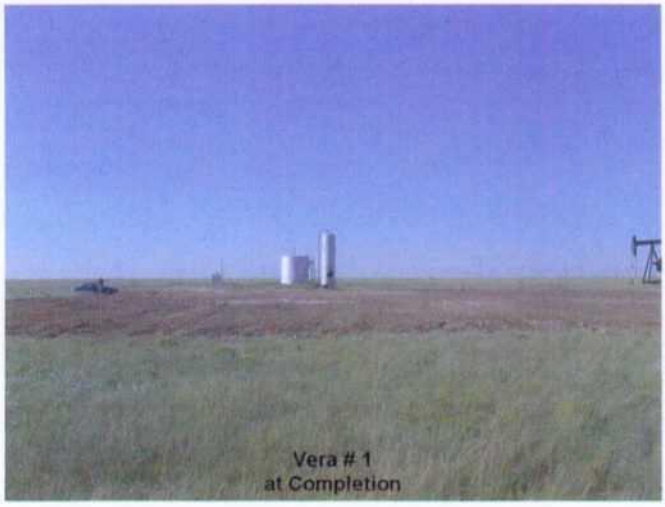
Pit Closures

Surface impoundment closures are among the most difficult environmental projects within the oil and gas industry. Each site must be carefully characterized to determine the plume shape and contaminant concentrations. Regulatory standards and intended land use must be considered in order to design the most efficient and cost effective closure protocol. Whole Earth Environmental has successfully closed over 600 surface impoundments.

Overall Site
View to East

Before and after view of a reserve pit on the Texas Gulf Coast. Whole Earth employed in-situ solidification using quick lime and a pH buffer to restore the site to its full agronomic potential.

Many impoundments may be closed by means of encapsulating the contaminated soils within a high-density polyethylene liner. Typically, a water monitoring well is installed immediately down gradient from the site to insure liner integrity.



An example of a site in which the contamination from a pit impacted a shallow aquifer. We were able to drill a recovery well in the center of the impoundment, install a windmill complete with down-hole oil / water separator and pump the free product directly into a temporary storage tank at a fraction of the cost of traditional pump and treat methods.

Evaporation pit complex in Southeast New Mexico. The site covered nine acres and was used to dispose of over 89 million barrels of produced water. Whole Earth closed the facility in ninety days at a cost of under $4.00 per cubic yard.

Wellsite Surveys

Many of the most vexing oilfield environmental problems are hidden from view where most typical Phase I or II surveys cannot find them. Whole Earth Environmental has developed a comprehensive inspection and remediation program designed to discover and correct these future liabilities. Whole Earth has excavated and remediated over 6,500 well sites.

An example of a ring gasket failure at a CO_2 injection well in West Texas. The leak resulted in the formation of ice at the junction of two buried flange faces. Note the characteristic sulfide embrittlement on the surface of the casing head.

Sub-surface contamination at a temporarily abandoned water injection well in Southeast New Mexico. The resulting plume was found to be only ten feet above the interface zone of the Ogallala Aquifer.

Example of corroded surface casing on a production well in South Texas. Ultrasonic measurement of the intermediate string indicated an 85% loss in thickness.

Hardness plays a critical role in the development of stress corrosion cracking. Whole Earth employs rebound measurement devices to accurately record the hardness of even the most difficult to reach areas of a wellhead.

Back and side view of a producing well after inspection, site remediation and equipment refurbishment. Typically included within the project package are individual site plat maps showing the location and direction of all electrical and flow lines, anchors, lease roads, and an inventory of all artificial lift or ancillary equipment on site.

Mike Griffin

EXPERIENCE

1995 to Present Whole Earth Environmental	**PRESIDENT**. Responsible for overall operations of an environmental remediation firm specialized in hydrocarbon and brine contamination.
1989 to 1995 NOVA Group, Inc.	**PRESIDENT.** Established a wholly owned subsidiary of Seaboard Arval to conduct field metallurgical testing of oilfield equipment in sour gas applications. The company evolved to incorporate on-site remediation of hydrocarbon contaminated soils. Purchased assets of NOVA to form Whole Earth.
1985 to 1989 Seaboard Arval	**VICE PRESIDENT – OPERATIONS.** Responsible for all manufacturing and materials management activities of two wellhead manufacturing plants in Houston and Mexico City. Additional duties included the presidency of Steam Drilling, a small geo-thermal drilling company and IBDECO, an import brokerage firm - both wholly owned subsidiaries of EPN, the parent company of Seaboard.
1982 to 1985 Griffin Associates	**PRESIDENT.** Import brokerage company specialized in the import of machined castings and forgings for oilfield equipment manufacturers.
1980 to1982 Winn Valves, Inc.	**PRESIDENT.** Established the U.S. office of an English butterfly valve manufacturing firm.
1975 to 1980 ACF Industries	**DIRECTOR - INTERNATIONAL PROCUREMENT.** Responsible for the international sourcing and procurement of raw materials for a diversified manufacturing firm.
1972 to 1975 W-K-M	**SENIOR BUYER.** Responsible for the procurement of all castings and forgings for a wellhead manufacturer. Additional positions within the company included Sales Manager of the Nuclear Group, Director of Value Engineering Group.
1969 to 1972 Dresser Industries	**BUYER.** Responsible for the procurement of all castings and forgings for a safety relief valve manufacturer. Additional positions included factory floor expeditor, manufacturing engineer.

EDUCATION

1968 - 1969	Louisiana State University

ORGANIZATIONS

1989 – 2003	National Association of Corrosion Engineers
1989 – 2003	Society of Petroleum Engineers
1990 - 2003	National Association of Environmental Professionals Registered Environmental Manager

Darrell Glueck

SUMMARY

Broad experience with operations, engineering, and administration.
Recent environmental administration experience includes technical
Support to engineering and operations and liaison/interface with agencies

EXPERIENCE

1999 to 2002
(Enterprise Products)

SENIOR ENVIRONMENTAL ENGINEER. Primary contact for four natural gas plants and two fractionators in Louisiana for environmental and regulatory matters. Coordinated agency compliance affairs, permitting and reporting for water, waste, and air. Offered environmental training for operations and engineering staff. Provided internal auditing and audit item resolution efforts. Offered training and leadership in incident investigation and analysis. Provided notifications to agencies in response to environmental non-compliance events. Led development of resource environmental manuals. Collaborator in ISO 1400 environmental management systems development for company in general and for six Louisiana facilities in particular. Developed environmental reference manual for Louisiana plant and pipeline operations.

1992 to 1999
(Coral Energy, Tejas, Shell Midstream Enterprises)

SENIOR ENVIRONMENTAL SPECIALIST. Primary contact for natural gas plants in Louisiana for environmental regulatory matters. Coordinated agency compliance affairs, permitting and reporting for water, waste, and air. Offered environmental training for operations and engineering staff. Provided internal auditing and audit item resolution efforts. Offered training and leadership in incident investigation and analysis. Provided notifications to agencies in response to environmental non-compliance events. Subject matter specialist in waste and water issues and provided compliance guidance for specific State air programs.

1989 to 1992
(Shell)

DIVISION GAS PRODUCTION COORDINATOR. Responsible for coordinating delivery of Western Division's natural gas production to several pipelines under several contracts including working interest owners in multiple fields in three States. Interfaced with other producers, gas transporters, shoppers, marketers, processors, and finance/accounting departments. Developed computer programs to assist daily dispatch and accounting of gas volumes to provide timely communication with all concerned with 1/3 the staff of similar departments.

1982 to1992
(Shell)

FACILITIES ENGINEERING. Extensive background in field operations and facilities engineering resulting form responsibilities in field surveillance and project engineering. Aggressively pursued multiple simultaneous facilities modifications to accommodate field wide improvements. A 100% increase in production was handled for 10% of the cost of similar facilities saving approximately $450,000. Successfully developed field facilities from surplus equipment with a 75% cost savings over typical new-facilities costs. Developed and implemented alternative processes for existing field facilities, which reduced operating costs by 25%.

1976 to 1982 (Shell)	**CHEMICAL / CORROSION ENGINEERING.** Served as the Rocky Mountain Division's chemical and corrosion specialist during which time emulsion and corrosion treating chemical costs were reduced by 50% over five years. Duties included evaluation of most cost effective and appropriate chemicals for specific applications and design and optimization of cathodic protection for both vessels and tanks (internal) and pipeline and structures (external).
1975 to 1976 (Shell)	**ONSHORE LEASE OPERATOR & OPERATIONS SPECIALIST.** Operated multiple leases including hydraulically-, and submersible-, and rod-pumped producing wells and water injection facilities, and gas-conditioning facilities. Back-filled operations foremen during absences.
Summers of 1969, 1971, and 1972 (Shell)	**MAINTENANCE MAN IN EAST TEXAS PRODUCTION UNIT.** Employed during summer vacation from college

EDUCATION

1980 – 1982	University of Houston Masters Curriculum in Petroleum Engineering
1975 - 1976	Dawson College Glendive, Montana Continuing Education in Civil Engineering
1974	East Texas State University M.S., Ecology Thesis: "A Vegetative Analysis of Beaver Habitats Along the South Sulphur River"
1971	Texas A&M University B.S., Zoology / Botany

ORGANIZATIONS

1971 – 2003	The Wildlife Society Associate Wildlife Biologist Member of Habitat Restoration Working Group
1972 – 1978	The Ottawa Field Naturalist Club Contributing Member
1978 -1983	National Association of Corrosion Engineers
1979 – 1985	American Institute of Chemical Engineers
1982 – 1983	American Society of Mechanical Engineers
2000 – 2003	Air, Water, Waste Management Association

Graciela Rodriguez Marin

SUMMARY

Specialized experience in the study of the process of water and solutes through the vadose zone and the application of computer models to the process.

EXPERIENCE

2001 - 2004

Senior Hydrogeologist
RT Hicks Consultants
Albuquerque, New Mexico, USA

Simulations of over 2000 different produced water release scenarios to determine the fate of chloride in the vadose zone and shallow aquifers in support of a project for the American Petroleum Institute. Ground water flow simulations with MODFLOW in support of litigation. Ground water contamination by DNAPLs.

1998 - 2001

Research Associate of Hydrology
New Mexico Tech
Socorro, New Mexico, USA

Research on ground water recharge in arid regions. Field work, laboratory measurements, and application of models HYDRUS1D and 2D for data analysis. Preparation of scientific publications. Teaching laboratory exercises for vadose zone hydrology using HYDRUS1D and other models.

1993 - 1997

Senior Hydrogeologist

Canagro International SNC-Lavalin, CANADA
Stationed at Valera (Venezuela) in a water resource evaluation project financed by the Venezuelan Ministry of the Environment.

Team leader. Inventory and hydrogeological data base, water balance, pumping tests, evaluation of groundwater resources. Responsible for laboratory of water chemistry.

1988 - 1993

Hydrogeologist

National Geological Survey (INGEOMINAS), Bogotá, Colombia.

Groundwater Evaluation Project. Departamento del Cesar. Project leader. Inventory, pumping test, location of new water wells, water sampling, hydrogeological mapping (1992-1993).

Hydrogeological Study in Morroa Aquifer. Departamento de Sucre. Project leader. Inventory, water balances, water demand calculations, hydrogeological mapping conceptua hydrogeological model, explotation schemes for managment of water quantity in the field well. (1991-1992).

Quantitative Evaluation of Groundwater Resources in the Sabana de Bogota. Groundwater recharge calculations, water balances. (1990-1991).

Geochemical Evolution of Ferralitic Environment of Los Llanos Orientales de Colombia. Water balances. (1989-1990).

Hydrogeological Study in Riohacha, Guajira. Pumping tests. (1988)

Software. Development of computer programs for hydrology and hydrochemistry graphics in Basic for Hewlett Packard 3000. (1988-1989).

1985 Hydrogeologist

HIDROCERON. Bogotá. Colombia. Well drilling supervisor.

1984 Geologist

IFI - CONCESION SALINAS, Bogotá
Geology and structure of a saline deposit. Geoelectrical Survey.

EDUCATION

M.S.	2001	New Mexico Tech Socorro, NM, USA Major: Hydrology
M.S.	1989	University of Birmingham Birmingham, United Kingdom Major: Hydrogeology
B.S.	1983	Universidad Nacional de Colombia Medellín, Colombia Major: Geological Engineering

TEACHING

1992 Hydrogeology for undergraduate students at Caldas University. Colombia.

1990 - 1992 Short training courses at INGEOMINAS. Colombia.

1992 Teaching assistant for numerical methods for graduate students in Hydrogeology. Universidad Nacional de Colombia.

2000 Computer laboratory of Vadose Zone Hydrology Workshop at Universidad Nacional de Colombia at Medellin.

2001 Computer laboratory of Vadose Zone Hydrology Workshop at Universidad Technologica de Panama at Panama City.

Short Courses

1986 Hydrology (six months)
University of Padua
Padua, ITALY

1985 Hydrogeology (six months)
Universidad Complutense de Madrid
Madrid, SPAIN

1983 Groundwater Evaluation. INGEOMINAS - TNO (The Netherlands). Bogotá Colombia, January. Geophysic methods applied in hydrogeology. INGEOMINAS - TNO (The Netherlands). Bogotá, Colombia, May.

1991 Field techniques for groundwater contamination studies and aquifer management. Sao Paolo University. Brazil, November.

Selected Reports

Rodriguez Marin, G., J.F. Martinez (1983). Geological survey and structure of the saline deposit in Upin Restrepo, Departamento del Meta, Colombia. IFI - CONCESION SALINAS.

Rodriguez Marin, G. (1989). Pumping test analysis in the field well Riohacha Guajira. INGEOMINAS, Colombia.

Rodriguez Marin. (1989). Programs in Basic for Hydrology Hydrochemestry. INGEOMINAS, Bogotá, Colombia.

Rodriguez Marin, G. (1989). Soil moisture blances and hydrochemestry in the ferralitic environments of los Llanos Orientales..INGEOMINAS, Bogotá, Colombia.

Rodriguez Marin, G.,O. Bermoudes (1991). Soil Moisture balance model to recharge calculations in the Sabana de Bogotá. INGEOMINAS - CAR. Colombia.

Bermoudes O., G. Rodriguez (1991). Hydrometeorology in the Sabana de Bogotá, INGEOMINAS-CAR, Colombia.

Bermoudes O., G. Rodriguez (1991-1992). Calculations of rainfall recharge in the Sabana de Bogotá, INGEOMINAS - CAR. Colombia.

Rodriguez Marin, G. (1992). Hydrogeological evaluation in Morroa Aquifer. Departamento del Sucre. INGEOMINAS-CORPES, Colombia.

Rodriguez Marin, G. (1994). Inventory report in la planicie del Motatán. CANAGRO INTERNATIONAL- ERSHT. Valera, Venezuela.

Rodriguez Marin, G. (1994). Hydrogeological data base for la Planicie del Motatán. CANAGRO INTERNATIONAL- ERSHT. Valera, Venezuela.

Publications

Rodriguez Marin, G. 1983. Hydrogeological Evaluation in Luruaco. Thesis. Universidad Nacional-INGEOMINAS, Medellin, Colombia.

Rodriguez Marin, G. 1986. A 2-dimiensional mathematical model for predicting water levels in Luruaco Colombia. Thesis. International center of hydrology. Padova University, Italy.

Rodriguez Marin, G. 1988. Mathematical model to predict the effective stress distribution in an slope and the effect of drains. M.Sc. thesis. Birmingham University, England.

Rodriguez-Marin, G. 2001. Water flow through indurated calcic horizons in arid New Mexico. Independent M.S. Study, Dept. of Earth & Environmental Science, New Mexico Tech, Socorro, NM.

Rodríguez-Marín, G., J.B.J. Harrison, J. Šimunek, and J.M.H. Hendrickx. 2003. Simulation of water flow through indurated calcic horizons. *In*: I. Simmers (Editor), Understanding water in a dry environment. Hydrological processes in arid and semi-arid zones. International Association of Hydrogeologists, International Contributions to Hydrogeology, Volume 23:182-188.

Rodríguez-Marín, G., J.B.J. Harrison, B. Borchers, and J.M.H. Hendrickx. 2006. Occurrence of dissolution pipes through indurated calcic horizons. Submitted to Vadose Zone Journal.

Presentations

Prediction of the effective stress distribution in an slope and drain effect. III Colombian Symposium in hydrogeology. Bogota 1988.

Modeling of rainfall recharge in the Sabana de Bogota. I Latinoamerican Hydrogeology Symposium. Merida Venezuela, 1992.

Rodriguez-Marin, R., B. Harrison, and J.M.H. Hendrickx. Focused ground water recharge through pipes in calcic horizons. Soil Science Society of America, Annual Meeting, Salt Lake City, Utah, October 31-November 4, 1999.

Rodriguez_Marin, R., J. Simunek, J.B.J. Harrison, and J.M.H. Hendrickx.Localized Ground Water Recharge Through Pipes in Calcic Horizons. Soil Science Society of America, Annual Meeting, Minneapolis MN, 2000.

Rodriguez-Marin, R., J. Simunek, J.B.J. Harrison, and J.M.H. Hendrickx. Localized Ground Water Recharge Through Pipes in Calcic Horizons. AGU Fall Meeting 2000, San Francisco.

Lloyd E. Deuel, Jr., PhD

EXPERIENCE

2006 to Date

Soil Chemist, Whole Earth Environmental, Inc. Serve as director of remediation services. Duties include developing remediation procedures using innovative technologies to restore E&P impacted land and water resources. Serve as a consultant to an industry panel convened to provide alternatives to proposed rules governing pit utilization and closure in New Mexico.

2003 to 2006

Served as 'Technical Advisor' to contractors developing on site remediation processes as alternatives to 'dig and haul' in association with the Texas abandoned oil and gas site restoration program. Soil scientest in field investigations involving environmental impact assessment of historic and recent oil and gas operations and other industries on land resources and development of restoration plans that conserve natural resources. Research Soil Chemist actively involved in evaluating alternative restoration procedures and processes including lime stabilization and bioremediation of petroleum hydrocarbon impacted soil, halophyte restoration of salt impacted soil, converting oil-field wastes into reuseable solid resourses, and converting highly eroded, salt scalded landscapes into shallow surface water impoundments. Taught a short course on Soil Remediation for the Petroleum Extraction Industry on a yearly basis to government agencies and private sector.

1998 to 2003

Research Soil Chemist, Soil Analytical Services, Inc. Principal activities included procedural development, analyses and associated quality control and assurance involved with service analyses. Other duties involved development of experimental design, data interpretation and written reports for contracted research. Soil scientist in field investigations involving first impact spill remediation and long-term waste management.

Served as consultant and specialist contractor to the Groundwater Protection Research Foundation to conduct a statistical and scientifically defensible evaluation of the data generated under the Louisiana 29-B Emergency Rule.

1994 to 1998

Research Soil Chemist, Soil Analytical Services, Inc. Principal activities included procedural development and associated quality control and assurance involved with service analyses. Other duties involved development of experimental design, data interpretation and written reports for contracted research. Functioned as a soil scientist in field investigation involving first impact spill remediation and long-term waste management.

Served on Louisiana 29-B Ad-Hoc Laboratory Committee convened to update the "Laboratory Practices Manual"

Served as a member of the Land Application Committee, Oklahoma Corporation Commission, convened to review and consider important changes to Corporation Commission Rules regarding the application of oil field drilling wastes to soils.

Served on a technical review committee for the American Petroleum Institute charged with critiquing "Metals Criteria for Land Management of Exploration and Production Wastes: Technical Support Document for API Recommended Guidance Values".

1983 to 1994

Research Soil Chemist, Soil Analytical Services, Inc. Principal activities include procedural development and associated quality control and assurance involved with service analyses. Other duties involve development of experimental design, data interpretation and written reports for contracted research. Soil scientist in field investigation involving first impact spill remediation and long-term waste management.

Served as consultant and specialty contractor to the American Petroleum Institute (API) for development of sampling protocol and collection of exploration and production (E&P) wastes. Served on ad hoc committee sponsored by the Louisiana Office of Conservation, formed to evaluate laboratory performance for procedures regulated under Louisiana Statewide Order 29-B. Developed analytical protocol for total barium in E&P wastes and conducted research to justify raising the 29-B regulatory threshold.

Served on an Oklahoma Water Resources Board steering committee for surface impoundment, land application and groundwater monitoring rule changes which were promulgated in 1992.

Chosen by the Society of Petroleum Engineers for their Distinguished Lecture Series addressing past and future methods of exploration and production waste disposal

1976 to 1983

Research Scientist, Texas A&M University. Directed research to evaluate overburden materials from potential strip-mine operations as a surface soil substitute. Developed methodology for bench scale laboratory assessment of environmental impact of sulfur components on overburden materials, with emphasis on sulfide oxidation as related to potential acidity. Investigated management techniques for abatement of surface and groundwater pollution by mining activities.

Directed research to investigate the decomposition rate and residue levels of complex API pit waste components applied to soils contained within field lysimeters. Designed laboratory studies to evaluate modes of decomposition and inactivation including volatilization, photodecomposition, adsorption, chemical alteration, and biological degradation. Developed methodology for fragmenting waste into components to aid in GC-MS identification. Employed column leaching studies and soil thin layer techniques for assessing relative mobility of waste and degradation products in soils as related to surface and groundwater quality impact.

Directed research to investigate the environmental impact of the use of sulfur in highway pavements. The assessment includes fumes, dusts, and run-off products from formulation of

paving materials to weathering of sulfur extended asphalt. An accelerated hydrolysis technique was developed to estimate solubilized constituents from long-term weathering.

1973 to 1976

Research Associate, Texas A&M University. Conducted laboratory experiments and directed the analytical effort in assessing the feasibility of land cultivation of industrial effluents. Developed and directed procedures for collecting, handling, and analysis of soil and water samples screened for pesticides employed in flooded rice culture. Conducted laboratory experiments assessing probable modes of dissipation in the field, and impact of residual activity on irrigation return flow.

1971 to 1973

Laboratory Technician, Texas A&M University. Determined pesticide residue levels in cotton gin trash and cottonseed. Evaluated and prepared report on statistical interpretation of the data. Determined pesticide residue levels in soils, plants, and animal (adipose) tissue.

1967-1971

Graduate Research Assistant, Texas A&M University. Determined adsorption isotherms and hydration enthalpies for kaolinite and montmorillonite clay minerals with respect to cation saturation and initial degree of hydration.

Conducted research to determine the parameters affecting the magnitude, composition, and nature of soil acidity. Work was culminated in the development of a universal method for determining lime requirements.

Investigated the accumulation, migration, and plant response from the use of arsenicals in agriculture. Conducted greenhouse studies to evaluate the effect of arsenic on cotton and soybeans. Conducted field studies to evaluate the mobility of arsenicals under natural conditions. Developed and conducted experiments to evaluate arsenic solubility under anaerobic soil conditions. Conducted bench scale studies to evaluate pesticide residue extraction efficiencies from soils.

CONSULTING

1. Texaco, Port Arthur, TX. Tank bottom sludge disposal.
2. Dow Chemical, Freeport, TX. Proprietary.
3. Shell Development Company, Houston, TX. Organic mobilities.
4. Dames and Moore, Houston, TX. Strip-mine reclamation.
5. Shell Western E&P, New Orleans, LA. Drilling and production wastes on-site disposal. Expert witness services.
6. Southwestern Electric Power Co., Shreveport, LA. QA/QC program for overburden analysis.
7. Exxon Company USA, New Orleans, LA. Soil impact salt and crude oil spill damage. Expert witness services.

8. Central and Southwest Services Inc., Dallas, TX. Overburden chemistry and reclamation of disturbed land.
9. Exxon Pipeline Company, LaPorte, TX. Soil impact brine spill damage.
10. Mid-Continent Oil and Gas Assoc. Public testimony regarding non-hazardousoilfield wastes.
11. Matador Pipeline Company. Breckenridge, TX. Crude oil spill, impact and restoration.
12. Reliable Production Serv. Lavonia, LA. Land treatment of non-hazardous oilfield wastes.
13. Shell Mining Company. Houston, TX The evaluation of overburden chemistry and reclamation of mined land.
14. Chevron USA, Inc. Houston, TX. On-site disposal of non-hazardous oilfield wastes. Expert witness services.
15. Gulf Coast Wastewater Treatment Authority. Pascagoula, MS. Field assessment of engineering design.
16. Shell Western E&P, Houston, TX. On-site disposal of oil and gas exploration and production wastes. Expert witness services.
17. Mobil Oil Co., Dallas, TX. Sampling and environmental investigations for Mobil Oil Indonesia.
18. Apache Corporation, Houston, TX. Site characterization, development of remediation plans in compliance with state regulations and acceptable to the courts. Expert witness as to the extent of drilling fluids contamination and impact on land and water resources.
19. Oryx Energy Company, Houston, TX. On-site disposal of oil and gas exploration and production wastes. Expert witness services.
20. Samedan Oil Corporation, Ardmore, OK. Site characterization and remediation. Expert witness to the extent of environmental impact and necessary remediation.
21. Texaco, Denver Division. Site characterization, development of remediation plans in compliance with state regulations and acceptable to the courts, and implementation monitoring as pertaining to salt damage and E&P wastes. Expert witness pertaining to the impact on the environment and production agriculture.
22. Northern Natural Gas Company, Houston, TX. Site characterization, pit closure recommendations and onsite disposal of oil and gas E&P waste. Site reclamation associated with condensate spill. Expert witness pertaining to the fulfillment of negotiated cleanup standards in compliance with state regulations.
23. Teikoku Oil De Venezuela, C.A., Caracus, Venezuela. Development of procedures manual to address site characterization, pit closure recommendations and onsite disposal of oil and gas E&P waste. Site reclamation associated with large production pits.
24. Mobil Oil Company, Houston, TX. Site characterization, development of remediation plans in compliance with state regulations and acceptable to the courts. Expert witness as to the extent of drilling fluids contamination and impact on land and water resources
25. BP Amoco, LA. Site characterization, development of remediation plans in compliance with state regulations. Expert witness as to the impact of earthen pits and E&P wastes on land and water resources
26. Petrobras, Aracujuz, Brazil. Field evaluation of exploration and production waste management. Site characterization, development of remediation plans for on-site waste utilization and treatment.

27. Merit Energy, Dallas, TX. Development of field wide remediation plan in compliance with AOGB and ADEM regulations.

28. Technical Advisor to Corrigan Consulting, Inc. Site data review, development of remediation plans for on-site waste management associated with the Pure Environmental Facility to be restored under the Texas abandoned site program.

Professional Accomplishments

1. CONTRACTED RESEARCH

   a. Title: Research Scientist

      Research: Development of management guidelines to prevent pollution by irrigation return flow from rice fields.

      Sponsor: EPA

      Status: Completed, 1976.

      Accomplishments: Made field and laboratory assessments of modes of dissipation of pesticides used in rice culture. New methodology in analyses, and elucidation of parameters affecting residue levels.

   b. Title: Co-principal Investigator

      Research: Land treatment of an industrial effluent.

      Sponsor: Jefferson Chemical Company

      Status: Completed, 1977

      Accomplishments: Meshed concepts of waste disposal with waste constituent utilization. Demonstrated the utility of land treating a chemical process waste high in organic bound nitrogen.

   c. Title: Co-principal Investigator

      Research: Core analysis of overburden at potential mine site in Grimes County, Texas.

      Sponsor: Texas Municipal Power Agency

      Status: Completed, 1978

      Accomplishments: Field plot research designed to demonstrate the feasibility of utilizing a mixed overburden as a topsoil substitute. Identified management inputs necessary to establish a land resource equal to or better than the native soil agronomic potential.

   d. Title: Co-principal Investigator

      Research: Feasibility of revegetating mixed overburden at proposed Angelina County lignite mine.

      Sponsor: Sunoco Energy Development Company

      Status: Completed, June 1979

Accomplishments: Core analyses and demonstration of revegetative suitability of mixed overburden. With fertilizer inputs, mixed overburden forage production equal to native soil.

e. Title: Co-principal Investigator

Research: Soil disposal of API separator sludge.

Sponsor: EPA

Status: Completed, September 1980

Accomplishments: Developed methodology for monitoring soil degradation of complex petrochemical wastes. Utilized component fractionation and GLC techniques to differentiate degradation rates relative to soil resource, management inputs, and time. Saturates and light end aromatics degraded most rapidly but with some potential for leaching out of the zone of incorporation. Loading rates and texture interact to attenuate migrating constituents. Higher molecular weight PNA's not readily degraded biologically are condensed in soil to nonextractable forms.

f. Title: Principal Investigator

Research: Environmental and safety aspects of the use of sulfur in highway pavements.

Sponsor: Federal Highway Administration

Status: Completed, September 1980

Accomplishments: Used bench scale laboratory studies to differentiate fumes, dusts, and runoff products relative to mix design and environmental conditions. The possibility of accidental events such as fire and chemical spills were investigated and revealed short term adverse impact associated with noxious fumes and elemental sulfur.

g. Title: Co-principal Investigator

Research: Impact of surface lignite mining on surface and groundwater quality.

Sponsor: Center for Energy and Mineral Resources

Status: Completed, September 1980

Accomplishments: Utilized field studies to show that reclaimed spoils, properly managed, do not differ significantly in surface run-off quality from native soils.

h. Title: Co-principal Investigator

Research: Feasibility of utilizing uranium leach tail water for irrigation of agronomic crops.

Sponsor: Mobil Oil Company

Status: Completed, December 1979

Accomplishments: Developed a solution-adsorption equilibrium technique for evaluating significant changes in soil matrix and exchange complex. Marginal water could be utilized for irrigation provided an adequate calcium level is present.

i. Title: Research Scientist

Research: Produced waters survey.

Sponsor: American Petroleum Institute

Status: Completed, September 1980

Accomplishments: Analyzed fresh and highly saline waters produced in association with oil and gas for RCRA metals, color, pH, EC, chloride and sulfate.

j. Title: Principal Investigator

Research: Demonstration of drilling mud-wetland soil compatibility.

Sponsor: Shell Oil Company

Status: Completed, August 1982

Accomplishments: Study of soil chemical and physical properties, comparing tidal marshland soil to spent drilling mud-soil mixtures. Study included plant succession and community development in relation to spent drilling mud properties. Soil and plant metal analyses included Ag, Ba, Cd, Cr, Cu, Fe, Ni, Pb, and Zn. Plant uptake was differentiated by specie and correlated to soil pH, redox (Eh), total, and available metal fraction.

k. Title: Principal Investigator

Research: Evaluation of subsurface landfarm contamination after long term use.

Sponsor: EPA

Status: Completed, April 1982

Accomplishments: Compared salt, metal, and organic distribution for treatment facilities to native background soil with respect to depth. Results showed oily refinery wastes loaded onto soils degraded over time without appreciable migration of reactants or products. Metals were recovered in the application zone. The impact of salt loading from land treatment of refinery waste sludge is attenuated with depth at properly managed sites.

l. Title: Research Scientist

Research: Analysis of oil and gas production pit materials for surface soil disposal.

Sponsor: Shell Oil Company

Status: Completed, December, 1983

Accomplishments: Developed testing protocol and management criteria guidelines commensurate with land resource impacted, and intended post closure land-use. Guidelines take into consideration salt management, heavy metals and organics associated with drilling mud, additives, and cuttings.

m. Title: Co-principal Investigator

Research: Determination of lime requirement for acid overburden materials and evaluation of three limiting materials.

Sponsor: Central and Southwest Services, Inc.

Status: Completed, January 1984

Accomplishments: Actual lime requirements were determined by "in-situ" titration of overburdens using CaO, $CaCO_3$, and fly-ash. Actual LR values were compared to predicted values from laboratory derived indices. Subterranean clover was used as a plant indicator for correlation to overburden characteristics determined by chemical analysis.

n. Title: Research Soil Chemist

Research: Vegetative growth potentials comparing topsoils, overburdens, and mixed growth media.

Sponsor: Subcontractor to Morrison-Knudsen Company

Status: Completed, March 1984

Accomplishments: Greenhouse tests, using bermuda grass, klein grass, and grain sorghum showed that mixtures involving topsoil, subsoil and selected overburden offer the potential of enhanced productivity above that of existing surface soil resources in Fayette County, Texas.

o. Title: Research Soil Chemist

Research: Analysis and characterization of overburden cores from the Shelby County lignite project.

Sponsor: Shell Mining Company

Status: Completed, October 1984

Accomplishments: Determined that overburden materials offer the potential for a more productive post-mine land surface. Overburdens will require management inputs such as lime and fertilizer to fulfill the expected potential.

p. Title: Research Soil Chemist

Research: Column leach study to evaluate overburden percolates on ground water quality.

Sponsor: Subcontractor to Morrison-Knudsen Company

Status: Completed, February 1985

Accomplishments: Designed and implemented column leach study to evaluate water quality with respect to overburden material, water management scheme, and weathering. Results are proprietary.

q. Title: Research Soil Chemist

Research: Long term storage effects on overburden parameter characterization.

Sponsor: Central and Southwest Services, Inc.

Status: Completed, August 1986

Accomplishments: Soil pH, EC, clay, CEC, exchangeable cation distribution, acidity parameters, and sulfur balance were performed on overburden cores, segmented by lithologic units, immediately following extraction, and following 2 years storage in an air dry, ground condition. Considerable oxidation of reduced sulfur occurred over time, causing a marked decrease in pH, with corresponding increase in acidity and salinity

r. Title: Research Soil Chemist

Research: Drilling and production waste characterization in parallel with EPA.

Sponsor: American Petroleum Institute

Status: Completed, July 1987

Accomplishments: Developed and implemented sampling protocol for collecting representative drilling and production wastes. Analyzed samples by Louisiana 29-B protocol for comparison to independent API and EPA test results using EPA contract laboratories and SW-846 protocol.

s. Title: Research Soil Chemist

Research: Total barium methods development

Sponsor: Soil Analytical Services, Inc.

Status: Completed, February 1988

Accomplishments: Developed methodology for controlling source variability in barium analyses. Method was evaluated and adopted by the Louisiana Office of Conservation 29-B ad hoc committee convened for rule clarification and procedural development.

t. Title: Research Soil Chemist

Research: Reusable materials leachate test protocol development.

Sponsor: Soil Analytical Services, Inc.

Status: Completed, February 1988

Accomplishments: Developed leachate test protocol for application to reusable materials criteria. Leachate test was evaluated by comparison to batch extraction and column leach test results. Method disseminated to public through Louisiana Office of Conservation 29-B ad hoc committee for rule clarification regarding analytical protocol.

u. Title: Research Soil Chemist

Research: Land treatment of oilbase mud within sulfur spoil/wasteland.

Sponsor: Chevron USA, Inc.

Status: Completed, September 1989

Accomplishments: Effectively raised sulfur spoil land pH (pH 0.5 to pH 6.5) by addition of lime and alkaline oilfield waste solids. Neutralization reaction employed to reduce sulfuric acid and phytoxic aluminum levels. E&P hydrocarbon and metals attenuated by biological degradation and reversion to insoluble, soil bound forms, respectively.

v. Title: Research Soil Chemist

Research: Evaluation of limiting constituents suggested for land disposal of E&P wastes.

Sponsor: API

Status: Completed, March 1990

Accomplishments: Document provides definition, technical justification, and applications guidance for salinity and petroleum hydrocarbon threshold values established for land disposal of E&P wastes.

w. Title: Research Soil Chemist

Research: Earthen pit utility for the receipt of water base drilling fluid during operation and disposal of solids after closure.

Sponsor: Petroleum Environmental Research Forum

Status: Completed, December 1992

Accomplishments: Designed and installed pit monitoring devices for measuring the wetting front and constituent mobility and/or attenuation. Test statistics include pH, EC, Na, Cl, As, Ba, Cr, Pb, Zn, Mn, Se, Hg, Cd, benzene, toluene, ethyl benzene, xylenes, naphthalene, anthracene, phananthrene, fluorene, benzo(a)anthracene, benzo(b)anthracene, benzo(k)fluoranthene, and benzo(a)pyrene. Sources of variability included pit section, depth, and time relative to operational phase.

x. Title: Research Soil Chemist

Research: Laboratory bench scale studies designed to establish benzene, toluene, ethyl benzene, and xylene partition coefficients between soils, water and refined petroleum products.

Sponsor: Soil Analytical Services, Inc. in technical support of the Oklahoma Corporation Commission rules addressing land application of petroleum hydrocarbon.

Status: Completed, October 1990

Accomplishments: Used batch equilibrium adsorption isotherm models to evaluate the effect of product concentration, soil, and oil treated soil on adsorption and transport of refined petroleum products in soil. BTEX associated with refined petroleum products is not partitioned by water but remains in the free product phase and is sequestered along with the product by the adsorbed oil. Adsorption maxima increased exponentially as a function of the oil treatment.

y. Title: Research Soil Chemist

Research: Field study to evaluate methodologies associated with monitoring the extent of biodegradation and to investigate the effectiveness of spill remediation treatments. A comparison of in-situ treatment with selected strains of commercially available biodegradation augmentation products was incorporated into a field plot experimental design. Parameters evaluated included biodegradation with respect to treatment, depth, time and analytical method.

Sponsor: Soil Analytical Services, Inc., with partial sponsorship by Exxon Pipeline Company.

Status: Completed, November 1993

Accomplishments: The importance of source management and the incorporation of substrate extenders was evaluated by means of measuring the extent of degradation over time. It was demonstrated that native microflora is sufficient to degrade crude oil in a field situation with a half-life of 43 weeks as measured by infrared spectroscopy (TPH-IR) or 33 weeks as measured by gas chromatography (TPH-GC). Residence time for TPH-IR is inflated due to non-petroleum artifacts associated with cellulose-based amendments and naturally occurring soil humus. This phenomenon accounts for the difference in methodologies since less of the co-extracted non-petroleum hydrocarbon sources pass through the GC column and thus quantitated compared to the bulk matrix analysis by IR.

z. Title: Research Soil Chemist

Research: Laboratory study to determine chemical partitioning of arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, and zinc in waste drilling fluids representative of the major oil & gas production provinces in the Continental United States and Alaska. The 8 metals were partitioned into exchangeable, bound to carbonates, bound to Fe-Mn oxides, bound to organic matter, and residual fractions using a sequential extraction procedure. The distribution of metals in the 5 operationally defined fractions provide insight into the mobility and biological availability of metals in drilling fluids, and acceptable land application standards.

Sponsor: Soil Analytical Services, Inc.,

Status: Completed, October 1996.

Accomplishments: The sequential chemical extraction of E&P waste solids representaive of major production provinces in the contiguous Unitied States and Alaska showed that metals in waste drilling fluids are bound in chemically stable, insoluble fractions, and thus are not mobile or bioavailable.

aa. Title: Research Soil Chemist

Research: A microcosm study was conducted to determine the degradation rate of acenapthylene, anthracene, fluorene, fluoranthene, naphthalene, phenanthrene, and pyrene exposed to the natural elements.

Sponsor: Soil Analytical Services, Inc.,

Status: Terminated January 2001

Accomplishments: Materials were added to 1 kg Tabor fine sandy loam soil (Udertic Paleustalfs) contained in shallow glass pots. Treatments were made to fresh soils, and maintained in a moist state throughout the course of the study. Preliminary data shows that degradation rates general follow in the order of their molecular weights and solubility in water.

ab. Title: Research Soil Chemist

Research: A field study conducted to evaluate the impact of elemental sulfur as an amendment to abate saline-sodic condition of a Gulf Coast Vertisol.

Sponsor: Soil Analytical Services, Inc.,

Status: On-going

Accomplishments: Sulfur amendments were applied to heavy clay soils with salinity in excess of 35 mmhos/cm and exchangeable sodium percentage > 25 %. Soil structure is weak massive with little or no permeability to water. A split plot design is being used to assess physical treatments in concert with chemical (sulfur) treatment.

ac. Title: Research Soil Chemist

Research: A review of Louisiana emergency rule data.

Sponsor: Underground Injection Practices Research Foundation.

Status: Completed, June 1999.

Accomplishments: The purpose of the study is to validate data collected under the Louisiana 29-B Emergency Rule provisions and evaluate the utility of the measurements in assessing future waste manangement practices. During the emergency rule and extension period a total of 2,036 unique testing batches were generated and analyzed for oil & grease, reactive sulfide, toxiicity characteristic leaching procedure (TCLP) benzene, barium, arsenic, cadmium, chromium, lead, mercury, selenium, and silver. Waste types that failed TCLP had a free hydrocarbon phase that was analyzed neat and added to the aqueous TCLP extract. These materials are readily managed to pass TCLP by blending with low hydrocarbon waste or mixing with a sorbent to dry the free hydrocarbon.

ad. Title: Research Soil Chemist

Research: Lime stabilization of free hydrocarbon in E&P waste

Sponsor: SASI

Status: Completed August, 2001.

Accomplishments: Reacted agricultural lime ($CaOH_2$) with 18% oil base drilling mud to evaluate the impact on gas range organic and diesel range organics. The study conducted under laboratory microcosm conditions revealed that lime up to 20%, on a dry weight basis, significantly increased degradation of diesel range organics. The focus now is on defining the mechanism for the lime contribution to degradation and evaluation of less alkaline bases ($CaCO_3$ and $MgCO_3$) on TPH degradation. Subsequent bench scale studies showed $CaCO_3$ and $MgCO_3$ as effective as $CaOH_2$ in degrading petroleum hydrocarbon. Issued a patent assigned to Scott Environmental Services on process of treating E&P waste solids to reuscable status using lime (incorporating study results) and organic matter.

ae. Title: Research Soil Chemist

Research: A Critical Review of Groundwater Quality Necessary for Agricultural Purposes

Sponsor: Underground Injection Practices Research, Research Foundation

Status: Completed June, 2000

Accomplishments: This paper provides a scientific literature foundation for establishing water quaility criteria for groundwater used in agriculture. It was determined that a value of 3,000 mg/liter TDS is a reasonable standard for USDW classification, requiring protection under the Underground Injection Control (UIC) program.

af. Title: Research Soil Chemist

Research: Laboratory bench scale study to determine biodegradation suitability of petroleum hydrocarbon sources using a 'Macro' Warburg oxygen consumption appratus.

Sponsor: Kerr-M^{c}Gee Corporation

Status: Completed February 2001

Accomplishments: The purpose of the research was to determine what types of petroleum hydrocarbon can be expected to degrade in-situ in subsurface soils and if there is a substrate threshold for degradation to occur. Laboratory studies were designed to statistically evaluate treatments to be used in a field demonstation. The study showed the oxygen uptake is a reliable, bench scale technique for determining treatability of oil-impacted soils. The study showed

biological acitivty of oil-impacted soil is stimulated by the application of nutrient amendments and adding sufficient moisture to support microbial life processes.

ag. Title: Research Soil Chemist

Research: Laboratory analyses of carbonate and ferro-manganese nodules in subsurface horizons of wet Vertisols.

Sponsor: SASI

Status: Completed 2003

Accomplishments: The purpose of this research was to determine the level of heavy metals in subsurface horizons of native soils as a natural occurrence. Concretions were segregated by location, horizon and type. Metal analyses included arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver, zinc, iron and manganese. Found elevated trace metals as a natural occurrence in concretions formed by redoxymorphic processes. Concluded that these bodies sequester metals and prevent their transport to deeper strata.

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