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Cleanup of the Western Research Institute North Site

**Final Report
September 1996**

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EXECUTIVE SUMMARY

The WRI North Site Cleanup Project was completed under budget.

The WRI North Site Cleanup Project was completed within the schedule.

Phase I, Definition of Waste Streams

The work for Phase I, Definition of Waste Streams, resulted in the identification of 27 composites containing levels of hazardous substances exceeding U.S. Environmental Protection Agency (EPA) regulatory limits. Most of the materials we analyzed were found to be nonhazardous. The hazardous materials identified were oils, tars, and waters. Benzene was the most commonly identified contaminant, along with cresols and trichloroethylene. Numerous samples were found to contain metals (arsenic, selenium, cadmium, chromium and lead) exceeding the regulatory levels. Two composites of distillates had flash points of less than 140°F and were hazardous because of ignitability in addition to exceeding the toxicity levels for Toxicity Characteristic Leaching Procedure (TCLP) components. One drum of monoethanolamine was sufficiently alkaline to be deemed corrosive. Numerous composites had volatile organics, as well as excessive metals concentrations. We generally had very good agreement between the analyses conducted at WRI and the quality control samples analyzed by EPA contract laboratories: Pace Laboratories for volatile organics and Silver Valley Laboratories for metals. In the two instances in which the laboratories did not both find substances to be either hazardous or nonhazardous, we used the result which indicated the material to be hazardous.

No listed wastes were found

Phase II, Disposal of Hazardous Wastes

As part of Phase II, Disposal of Hazardous Wastes, we shipped the hazardous materials to disposal sites during the period from June to November 1994. The shipments included 257 drums of various tars and oils, about 8600 gallons of bulk shale oil, and 8000 gallons of bulk water. The oils were either blended into fuels or were incinerated. The water, which was originally classified as hazardous, was made nonhazardous by removing trichloroethylene by air stripping in the tank in which the water was originally collected. The nonhazardous water was disposed of by injection into a deep well.

Phase III, Disposal of Nonhazardous Materials

Our strategy for Phase III, Disposal of Nonhazardous Materials, called for consumptive disposal of all the materials that could be used as fill for road construction, treated and discharged from a wastewater treatment facility, or incinerated. No liquids were committed to long-term storage or landfill. Combustible solids were either used as fuel or incinerated.

The weight and volume of nonhazardous materials disposed of during Phase III greatly exceeded the weight and volume of hazardous materials disposed of during Phase II. Thus, the emphasis for Phase III was on finding methods to move about 2000 tons of oil shale, tar sand, coal, and smaller quantities of numerous materials, including 16 drums of water. These wastes were contained in about 600 drums and seven large piles (piles were oil shale, spent oil shale, and spent tar sand). We had about 2300 cubic yards of raw oil shale, an additional 250 cubic yards of spent oil shale, about 75 cubic yards of river rock, and about 100 cubic yards of mixed spent oil shale and spent tar sand. One pile of oil shale contained pieces that had major dimensions of 5 to 6 feet. These large blocks were broken by using a "spear" mounted on a back hoe to reduce the size for loading. We also broke about two dozen blocks composed of coal, tar sand, or oil shale encapsulated within concrete and refractory.

We hauled about 125 drums of coal to a cement plant and a power plant where it was burned as part of the fuel. About 2000 tons of oil-bearing shale as well as spent shale and spent tar sand was used as fill for road construction

Phase IV, Soil Sampling and Disposal of Buried Wastes

In Phase IV, Soil Sampling and Disposal of Buried Wastes, geophysical techniques were used to survey the North Site for suspected burial areas. A total of 10 empty buried hydrogen and nitrogen gas cylinders, two sets of metal plates, and an empty drum were located using ground penetrating radar, proton precision magnetometry, and electronic metal detection. The cylinders were confirmed to be empty and given to a metal salvage company, along with the metal plates. The rusty drum was transported to the local landfill.

In Phase IV 116 soil samples were collected, and 39 composite soil samples were prepared and analyzed by WRI personnel. Chain-of-custody procedures were followed. Field trip blanks and an equipment blank were analyzed, as were splits of the composite samples. We

analyzed for the eight metals that are regulated under the Resource Conservation and Recovery Act (RCRA) and the semivolatile and volatile organic compounds that are either listed as target compounds for the U.S. EPA's Contract Laboratory Program or regulated under the Toxicity Characteristic.

The results of our analyses showed that the soils from the various locations are not hazardous based on toxicity, and therefore, do not require special disposal or management practices and do not pose a threat to groundwater quality. The data generated in Phase IV do not show the need for removal of soil from any of the sampling locations.

Phase V, Decontamination and Disposal of Equipment

In Phase V, Decontamination and Disposal of Equipment, we removed the remains of the former evaporation pond, the 150-ton retort along with ancillary equipment, five shale oil storage tanks, and the 10-ton retort, along with the associated effluent recovery system. The equipment was tested and cleaned as necessary to provide for safe and environmentally acceptable disposal.

Two of the shale oil tanks were 500-barrel tanks, one was a 300-barrel tank, and the other two had capacities of about 25 barrels. One of the 500-barrel tanks contained about 7000 gallons of shale oil and about 7000 gallons of water. The water in the 500-barrel tank was contaminated with trichloroethylene (TCE) at a concentration exceeding the RCRA level for hazardous wastes. The second 500-barrel tank contained about 6 inches of heavy, oily sludge in the bottom. Both tanks required thorough steam-cleaning before disposal. One 300-barrel tank contained about 2000 gallons of shale oil. This 300-barrel tank was also steam-cleaned before disposal. We also cleaned and disposed of a 25-barrel mix tank and a 25-barrel horizontal accumulation tank that contained large piles of ash or dust mixed with oil in the bottom.

Phase Va, Groundwater Monitoring

The results of Phase Va, Groundwater Monitoring, showed no evidence of contamination of the groundwater collected from the wells situated updip and downdip from the former location of the 150-ton oil shale retort and the shale oil storage tanks.

The North Site groundwater is not hazardous based on metal toxicity. The North Site groundwater contains no contamination from the TCLP or Contract Laboratory Program (CLP) target compound list semivolatile organic compounds, volatile organic compounds, or

pesticides/polychlorinated biphenyls (PCBs). The groundwater from the two wells on the east and west boundaries of the former retorting site meets all of the EPA water use suitability criteria.

Phase VI. Preparation of a Materials Inventory Database

In Phase VI, Preparation of a Materials Inventory Database, we prepared a database for use in controlling inventories of various materials. The database permits tracking of materials from the time of acquisition or generation until final disposition. It can include properties and characteristics of the materials. The database features the use of a wand-type bar code reader that can be used to scan containers for identifying numbers or characteristics. Identification can also be entered into the system manually.

BACKGROUND

The Western Research Institute (WRI) North Site was established in 1968 when the Laramie Energy Research Center (LERC) of the U.S. Bureau of Mines sought to conduct large-scale tests simulating underground retorting of oil shale for possible use with retorting of oil shale deposits that were to be fractured using nuclear devices. The 150-ton retort was constructed in 1968 on land leased from Upland Industries (the real estate arm of the Union Pacific Railroad). In 1969, the 10-ton retort was relocated from the main LERC facility at 9th and Lewis Streets in Laramie to the North Site location. A control room, shops, an office building, and a laboratory were also built during the first year. Several small storage buildings were added over the years.

In the late 1970s, at what was then the Laramie Energy Technology Center (LETC) operated first under the Energy Research and Development Administration (ERDA), then under the U.S. Department of Energy (DOE), a core storage building and the in-situ processing laboratory were added to the facilities. The underground storage building was also added during that period. Two buildings were relocated from the LETC tar sand test site near Vernal, Utah, to the North Site during 1982. One of these buildings is currently used as a coal processing laboratory, and the other is used for storage materials. In 1989, the core storage building was converted to house the mild gasification pilot plant.

Various materials and equipment had accumulated at the Western Research Institute North Site facility since its construction and commissioning. These materials were stored in drums, tanks, and open piles. There was also evidence that some materials, probably gas cylinders, had been buried on site. The materials varied from oil shale, tar sand, and coal feedstocks to products and wastes generated from simulations of in-situ and surface process developments associated with these feedstocks. The majority of these materials were associated with DOE activities and work performed prior to DOE-WRI cooperative agreement contracts at the North Site facility.

Before this North Site cleanup project started, 3-gallon through 55-gallon containers of materials were stored throughout the WRI North Site facility. Most of these containers were stored outside on pallets and were exposed to the weather. These containers were inventoried in 1991 and recorded in the North Site Material Handling Data Base using a bar code system. That inventory was updated periodically. Each container was marked with a unique bar code tag, and all containers were checked visually for condition at least weekly. There were approximately 900

containers on inventory. The data base was expanded to contain results of sampling and analyses as part of the Phase I work in this project.

As a part of the North Site facility cleanup, these materials were evaluated and properly disposed of or stored in accordance with current local, state, and federal regulations.

The work for the North Site cleanup project was originally divided into five phases:

Phase I, Definition of Waste Streams

Phase II, Disposal of Hazardous Wastes

Phase III, Disposal of Nonhazardous Materials

Phase IV, Soil Sampling and Disposal of Buried Wastes

Phase V, Decontamination and Disposal of Equipment.

Phase Va, Groundwater Monitoring, was added later by the U.S. DOE following a request from the U.S. Environmental Protection Agency. Phase VI was added to adapt a materials inventory data base for the DOE.

The inventory data base contains information including, but not limited to, the following:

Bar code ID number

Description of material (common name)

Location where stored

Container type/volume

WRI use

Disposition

Waste stream ID, when known

As part of the documentation for Phase II of the project, we updated the data base inventory to show disposition of the materials disposed of during Phase II.

Other materials at the North Site Facility included open piles of raw oil shale, spent oil shale, and oil shale blocks from 150-ton and 10-ton retort tests, low void reactor tests and block reactor tests. Also, two storage tanks contained approximately 16,000 gallons of shale oil and water. Three other storage and mixing tanks did not contain liquid, but the inner walls were

coated with residue. Approximately 200 gallons of samples (shale oil, coal liquids, tar sand product oil, and other substances) in small containers (<1 gallon) were also on the site.

The WRI North Site was audited by the U.S. Department of Energy Tiger Team in late spring 1991 as part of an audit of DOE fossil energy test sites in Wyoming. Numerous questions were raised relating to storage and disposition of potential wastes, practices used to control storage of the materials, control of stormwater flow across the site, and monitoring of the water supply used at the site.

STATEMENT OF WORK

The following is the stated objective of the project and a summary of the statement of work we used to set the scope of work for the project.

*The **OBJECTIVE** for this project is to clean up the WRI North Site in an environmentally sound and cost-effective manner.*

Phase I. Definition of Waste Streams

The work defined as Phase I will include the following activities:

- WRI project managers and principal investigators will be polled to determine which test materials will be kept.
- The unwanted test materials will be grouped to form composites having chemical similarities.
- The composites will be sampled and the representative samples analyzed to characterize the materials and to determine which are hazardous and which can be disposed of as useful materials.
- Strategies for recycling and useful consumption will be formulated for each composite group based upon the properties of each composite group.

Phase II. Disposal of Hazardous Wastes

We will use a strategy of consumptive disposal while disposing of the liquid hazardous wastes in an environmentally acceptable manner. We do not want any of these wastes to exist after disposal so that no possibility of future problems can arise from them. This will be accomplished by incinerating some of the wastes that have little fuel value and by blending the

wastes having fuel value. Fuels produced from those blended wastes will be burned in fully permitted facilities. We will use experienced commercial disposal contractors to find the most favorable costs for disposal.

Phase III, Disposal of Nonhazardous Materials

We will dispose of the nonhazardous materials in environmentally acceptable and cost-effective manners. The materials include unprocessed oil shale, coal, tar sand, spent shale and processed coals and tar sands. Many of these materials are stored outdoors in open piles, which makes the weather a factor to consider when handling the material. We will control the work schedule to avoid moving these materials when the snow is deep or the ground is muddy. We have about 125 drums of coal that will be burned in either a cement plant or a power plant. We also have about 2000 tons of oil-bearing shale, spent shale, and spent tar sand that will be used as fill for road construction.

Phase IV, Soil Sampling and Disposal of Buried Wastes

We will conduct a soil sampling program using the information from the James M. Montgomery report (personal communication to DOE, June 17, 1991), an EPA audit of the North Site, and our knowledge of past activities at the site. We will also contact former employees to seek information about past activities at the site. We will locate and dig up any remaining empty gas cylinders or other foreign materials that may have been buried at the site.

Phase V, Decontamination and Disposal of Equipment

We will clean, dismantle and remove from the site the five shale oil storage tanks that remain. The dirt from the berms around the shale oil storage tanks will be spread across the location of the former oil shale piles and will be seeded to prevent future erosion. The 150-ton retort will be dismantled and the scrap metal will be recycled. We will also remove the metal sidewalls from a no-longer-used evaporation pond. We will remove the above-ground portions of the foundations along with the buried pipes from the 150-ton retort. The 10-ton retort will be dismantled and removed from the site.

Phase Va, Groundwater Monitoring

We will install two wells, one directly updip from the shale oil tank farm and the other downdip from the shale oil storage tank area. The wells will be drilled, cased with steel casing, and cemented to the top of the Casper Formation. The wells will be flushed and a sampling and analysis program will be instituted. We will sample both wells in the fall, winter, spring, and summer to obtain a year-long profile of the composition of the water. Samples will be taken following accepted EPA protocols, and chain of custody records will be maintained. The samples, along with trip blanks and method blanks, will be analyzed for metals, pesticides, semivolatiles, and volatiles. In addition, the water will be analyzed to ensure that it meets the complete spectrum of water use parameters issued by the EPA and adopted by the state of Wyoming.

Phase VI, Preparation of Database

We will prepare a database to serve as an inventory control device. The database will be capable of maintaining records and properties of materials from the delivery or generation to the final disposition. It will include a hand-held bar code reading device capable of scanning labeled containers. We will work with the DOE to help place the data base into service.

SUMMARY OF RESULTS OF CLEANUP WORK

Results of Phase I, Definition of Waste Streams

WRI defined the waste streams by sampling and analyzing materials shown on the inventory list in the Phase I Plan during the period from September 1993 through January 1994. The materials that were found to contain hazardous substances at levels exceeding the regulatory levels (U.S. Environmental Protection Agency list for toxicity characteristics based on Toxicity Characteristic Leaching Procedure extractions) or that had hazardous properties (ignitable, corrosive, or reactive) were used as the basis for the plan for Phase II, Disposal of Hazardous Wastes. The materials that did not contain levels of hazardous substances exceeding the regulatory levels became the basis for the cleanup plan for Phase III, Disposal of Nonhazardous Wastes.

The activities conducted during Phase I of this project are described in the final report, "Phase I of the Cleanup of Western Research Institute's North Site-Definition of Waste Streams." The report (WRI-94-R008) contains a description of the methods used for sampling and analyses, composites used to reduce the number of samples and analyses, results of analyses, and quality control activities conducted to ensure good quality results.

The work for Phase I resulted in the identification of 27 composites containing levels of hazardous substances exceeding U.S. Environmental Protection Agency (EPA) regulatory limits. The hazardous materials identified were oils, tars, and waters, which were stored in about 170 drums (mostly 55-gallon drums totaling about 7000 gallons) and two tanks (containing about 16,000 gallons of shale oil and water). Benzene was the most commonly identified contaminant, although we did find hazardous levels of cresols and trichloroethylene. Numerous samples contained levels of metals exceeding the regulatory levels. (Arsenic, selenium, cadmium, chromium, and lead were found.) Two composites of distillates had flash points of less than 140°F and were hazardous because of ignitability as well as exceeding the toxicity levels for Toxicity Characteristic Leaching Procedure (TCLP) components. One drum of monoethanolamine was sufficiently alkaline to be deemed corrosive. Numerous composites had both volatile organics and excessive metals concentrations.

We generally had very good agreement between the analyses conducted at WRI and the quality control samples analyzed by EPA contract laboratories: Pace Laboratories for volatile organics and Silver Valley Laboratories for metals. In the two instances in which the laboratories did not both find substances to be either hazardous or nonhazardous, we used the result which indicated the material to be hazardous.

Criteria for Hazardous Waste

The information in Table 1 and the following criteria for ignitability, corrosivity, and reactivity were used to determine which materials contained toxic substances in concentrations exceeding the acceptable EPA limits and which had hazardous properties. We also consulted the EPA K, F, P, and U lists but did not find any of the items on those lists to be applicable. The toxicity limits for Toxicity Characteristic Leaching Procedure (TCLP) extracts are shown in Table 1. We also examined some materials for corrosivity, ignitability, and reactivity (two composites of hydrocarbon distillates were found to be ignitable because they had flash points less than 140°F).

Table 1. Toxicity Characteristic Constituents and Regulatory Levels

EPA HW No.	Constituent	Regulatory Level mg/L
D004	Arsenic	5.0
D005	Barium	100.0
D018	Benzene	0.5
D006	Cadmium	1.0
D019	Carbon Tetrachloride	0.5
D021	Chlorobenzene	100.0
D022	Chloroform	6.0
D007	Chromium	5.0
D023	o-Cresol	200.0
D024	m-Cresol	200.0
D025	p-Cresol	200.0
D026	Cresol	200.0
D027	1,4-Dichlorobenzene	7.5
D028	1,2-Dichloroethane	0.5
D029	1,1-Dichloroethylene	0.7
D030	2,4-Dinitrotoluene	0.13
D032	Hexachlorobenzene	0.13
D033	Hexachloro-1,3-butadiene	0.5
D034	Hexachloroethane	3.0
D008	Lead	5.0
D009	Mercury	0.2
D035	Methyl ethyl ketone	200.0
D036	Nitrobenzene	2.0
D037	Pentachlorophenol	100.0
D038	Pyridine	5.0
D010	Selenium	1.0
D011	Silver	5.0
D039	Tetrachloroethylene	0.7
D040	Trichloroethylene	0.5
D041	2,4,5-Trichlorophenol	400.0
D042	2,4,6-Trichlorophenol	2.0
D043	Vinyl chloride	0.2

Characteristic of Toxicity: Method 1311 Toxicity Characteristic Leaching Procedure

To test a waste for the characteristic of toxicity, an extract from a representative sample of the waste was generated using EPA Method 1311, the Toxicity Characteristic Leaching Procedure (U.S. EPA 1990). TCLP extracts containing regulated contaminants listed in Table 1 at a concentration equal to or greater than the regulatory level are classified as hazardous based on toxicity.

Characteristic of Ignitability

We tested distillates and several high-vapor-pressure liquids that were suspected to be sufficiently volatile to have flash points meeting the following criteria:

The material is a liquid other than an aqueous solution containing less than 24% alcohol by volume and has a flash point less than 60°C (140°F), as determined by a Pensky-Martens Closed Cup Tester, using the test method specified in ASTM Standard D-93-79 or D-93-80, or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D-3278-82 (1982), or as determined by an equivalent test method approved by the EPA administrator under procedures set forth in 40 CFR 260.20 and 260.21. We found that two of the composites had flash points below 140°F and were ignitable based on the above EPA criteria.

Characteristic of Corrosivity

We tested about half a dozen materials for pH. We suspected that they were either so strongly acidic or basic that it would be necessary to neutralize them before disposal. The criteria for corrosivity are:

The material is aqueous and has a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using either an EPA test method or an equivalent test method approved by the EPA administrator under the procedures given in 40 CFR 260.20 and 260.21. The EPA test method for pH is specified as Method 5.2 in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods," EPA publication SW846.

The material is a liquid and corrodes steel (SAE 1020) at a rate greater than 6.35 mm (0.250 inch) per year at a test temperature of 55°C (130°F) as determined by the test method specified in NACE (National Association of Corrosion Engineers) Standard TM-01-69 as

standardized in "Test Methods for the Evaluation of Solid Waste, Physical/Chemical Methods," EPA Publication SW846 or an equivalent test method approved by the EPA administrator under the procedures set forth in 40 CFR 260.20 and 40 CFR 260.21.

We found about half a dozen pH values for materials in the 7 to 10 range, but found only one material (one drum of monoethanolamine) that was classified as corrosive.

Characteristic of Reactivity

We examined several liquids for evolution of H_2S upon having the pH lowered by adding acid. None generated a sufficient volume of gas to be deemed reactive. We also examined the inventory of materials for any that might be unstable, react violently with water or form potentially explosive mixtures of gases or emit cyanide or sulfide-containing gases. None was found. WRI has used these types of chemicals in the laboratory at 9th and Lewis but seldom at the North Site. The laboratory chemical disposal policy has been used to control and dispose of such materials before the North Site cleanup started.

Most of the materials we analyzed were found to be nonhazardous. Several dozen TCLP analyses and about a dozen pH determinations found the materials to contain no hazardous substances exceeding the regulatory levels. No listed wastes were found.

Results of Phase II, Disposal of Hazardous Wastes

As part of Phase II, Disposal of Hazardous Wastes, we shipped the hazardous materials to disposal sites during the period from June to November 1994. The shipments included 257 drums of various tars and oils, about 8600 gallons of bulk shale oil, and 8000 gallons of bulk water. The oils were either blended into fuels or were incinerated. The water, which was originally classified as hazardous, was made nonhazardous by removing trichloroethylene by air stripping in the tank in which the water was originally collected. The nonhazardous water was disposed of by injection into a deep well.

WRI has submitted the final report describing the activities in Phase II to DOE. The report (WRI-95-R007) is entitled: "Final Report for Phase II of the WRI North Site Cleanup: Disposal of Hazardous Wastes."

Results of Phase III, Disposal of Nonhazardous Materials

Our strategy for Phase III called for consumptive disposal of all the materials that could be used as fill for road construction, treated and discharged from a wastewater treatment facility, or incinerated. No liquids were committed to long-term storage or landfilling. Combustible solids were either used as fuel or were incinerated.

The weight and volume of nonhazardous materials disposed of during Phase III greatly exceeded the weight and volume of hazardous materials disposed of during Phase II. Thus, the emphasis for Phase III was on finding methods to move about 2000 tons of oil shale, tar sand, coal, and smaller quantities of numerous materials, including 16 drums of water.

These wastes were contained in about 600 drums and seven large piles. The piles were made up of oil shale, spent oil shale, and spent tar sand. We had about 2300 cubic yards of raw oil shale, an additional 250 cubic yards of spent oil shale, about 75 cubic yards of river rock, and about 100 cubic yards of mixed spent oil shale and spent tar sand. One pile of oil shale contained pieces that had major dimensions of 5 to 6 feet. These large blocks were broken by using a "spear" mounted on a backhoe to reduce the size for loading. We also broke about two dozen blocks composed of coal, tar sand, or oil shale encapsulated within concrete and refractory.

The oil shale, spent shale, and tar sand were donated to the Albany County Road and Bridge Department for use as fill in construction of roads. We hauled 125 drums of coal to a local cement plant and a local power plant, where it was burned.

The disposal of these nonhazardous materials is the subject of the report entitled "Phase III of the Cleanup of the Western Research Institute North Site: Disposal of Nonhazardous Materials." Inventories of the nonhazardous materials and the methods of disposition are described in the report (WRI-95-R035) for Phase III.

Results of Phase IV, Soil Sampling and Disposal of Buried Wastes

In Phase IV, buried cylinders and other buried materials were located and removed. Three geophysical techniques were used to survey the suspected North Site burial areas. These were ground-penetrating radar, proton precision magnetometry, and electronic metal detection. A total of 10 empty buried hydrogen and nitrogen gas cylinders were located, excavated, confirmed to be

empty, and given to a metal salvage company. Two sets of buried metal plates and an empty drum were also located and excavated. The plates were given to a salvage company, and the drum was transported to the local landfill.

Phase IV also involved selecting soil sampling locations, collecting soil samples, preparing composite samples for analysis, and analyzing the composite samples. Sampling and analysis were performed by WRI personnel. Chain-of-custody procedures were followed to ensure the integrity of the samples from time of collection to data reporting. In addition, for quality assurance/quality control purposes, field trip blanks and an equipment blank were analyzed, as were splits of the composite samples. The composite soil samples were analyzed for the eight metals that are regulated under the Resource Conservation and Recovery Act and the semivolatile and volatile organic compounds that are either listed as target compounds for the U.S. EPA's Contract Laboratory Program or regulated under the Toxicity Characteristic. One hundred and sixteen soil samples were collected, and 39 composite soil samples were prepared and analyzed. Included among these were soil samples to provide data on background concentrations of the North Site soil.

Results from analysis of the composite soil samples show that soils from the sampling locations contain concentrations of metals and semivolatile organic compounds that are above North Site soil background concentrations. However, from the data generated in this study it can be concluded that the soils from the various locations are not hazardous based on toxicity, and therefore, require no special disposal/management practices and should not pose a threat to groundwater quality. The data generated in phase IV do not show the need for removal of soil from any of the sampling locations.

The North Site Materials Handling Data Base was used to track soil samples that were collected and analyzed in phase IV of this project. The data base includes information on the soil samples collected, the composite samples that were prepared from them, and the results from analysis of the composite soil samples. The data base allows generation of quick and accurate reports on the status of phase IV and the quality of the soil at the North Site burial sites and storage/spill areas.

A final report, "Phase IV of the Cleanup of the Western Research Institute North Site: Location and Disposal of Buried Wastes," has been completed and submitted to the US DOE.

The Phase IV report (WRI-94-R031) describes the methods used to locate and recover buried hydrogen cylinders and to sample and analyze the soil on the site.

Results of Phase V, Decontamination and Disposal of Equipment

Phase V of the North Site Cleanup Project involved the removal of the remains of the former evaporation pond, the 150-ton retort and ancillary equipment, the shale oil storage tanks, and the 10-ton retort and the associated effluent recovery system. The equipment was tested and cleaned as necessary for safe and environmentally acceptable disposal.

We were able to locate a contractor who dismantled the evaporation pond containment ring and removed the posts at no cost to the project in return for the scrap value of the metal.

We found a rancher who wanted the 10-ton retort vessel intact for use on the family ranch. He removed the retort and the supporting structural steel at no cost to the project in return for the value of the retort.

Strategy

We set the following priorities for Phase V: (1) to clean and remove the five shale oil tanks; (2) to remove the 150-ton retort; (3) to remove the metal containment ring left from the old evaporation pond if funding was sufficient; and (4) if funding was adequate, to remove the 10-ton oil shale retort. We were able to have the tanks and retort removed for lower costs than we had estimated, so funding was available to remove the containment ring and the 10-ton retort.

Shale Oil Storage Tanks

We cleaned and disposed of five shale oil tanks. Two were 500-barrel tanks, one was a 300-barrel tank, and the other two had about 25-barrel capacities. The two 500-barrel tanks were of bolted steel construction, complete with ladders, platforms, and internal heaters. One of the 500-barrel tanks contained about 7000 gallons of shale oil and about 7000 gallons of water. The water in the tank was contaminated with trichloroethylene (TCE) at a concentration exceeding the RCRA level for hazardous wastes. The second 500-barrel tank contained about 6 inches of heavy, oily sludge in the bottom. Both tanks required thorough steam-cleaning before disposal. One insulated 300-barrel steel tank of welded construction contained about 2000 gallons of shale

oil. This 300-barrel tank was also steam-cleaned before disposal. We also cleaned and disposed of a 25-barrel mix tank and a 25-barrel horizontal accumulation tank. The accumulation tank contained large piles of ash or dust mixed with oil in the bottom.

I discussed the deposition of these tanks with Mr. Tom Rinehart of the Wyoming Department of Environmental Quality. He reported that no permit was necessary because the tanks were above ground and had been used for crude shale oil and not for refined products. No permit was needed for WRI to dispose of these tanks for reuse after steam cleaning.

Our approach to emptying the 500-barrel tank full of shale oil and water was to first separate the oil layer and remove it. Then we air-stripped the remaining water layer to remove the trichloroethylene so that the water could be disposed of as a nonhazardous waste. (Disposal of the shale oil and water is described in the report for Phase II.)

Removing the shale oil was complicated because the oil was dispersed in layers on top, within, and under the water. Also, the shale oil contained large clumps of semi-solid oil that resembled grease. Separation of the shale oil layer from the water in the tank was a tedious process. After nearly all of the oil was removed, by skimming from the top and draining from the bottom, we began to blow a stream of dispersed air through the water. The air served to agglomerate the remaining oil layer and concentrate it on top of the water layer in addition to stripping the trichloroethylene (TCE) from the water layer. We found that the TCE concentration in the water layer did not decrease rapidly until all of the oil was removed from the tank. Then the TCE was more rapidly removed by air stripping. Finally, the tank was dismantled, and the sections were steam-cleaned before the tank was given to a rancher for use as a water tank. The rancher loaded the tank and hauled it away with no cost to the project.

Cleaning the second 500-barrel tank was less complicated, because that tank contained only a layer of heavy, oily sludge. There was no water layer in the tank. The sludge was so thick that we shoveled it out of the tank and put it into drums for disposal. This second tank was also dismantled and steam-cleaned. It was also given to the rancher for use as a water tank. The rancher loaded the tank and hauled it away with no cost to the project.

We avoided working within the confined space within the tanks by removing as much of the contents as possible working from outside the tanks. We then removed the tops and the upper

section of the side walls before cleaning the floors of the tanks. By working in this manner, no entry into confined spaces was needed.

The shale oil in the 300-barrel tank was relatively easy to remove, as the oil was free-flowing, and there was no water in the tank. We drained the oil into a bulk truck for disposal as fuel. The 300-barrel tank was cut into two sections for steam-cleaning. After cleaning, it was hauled away at no cost to the project.

The two 25-barrel tanks were cleaned by removing the flanged ends and scraping out the oil-saturated ash. These tanks were relocated to the WRI North Site surplus equipment storage area for possible future use.

150-Ton Retort

The 150-ton retort system included a 13-ft diameter by 50-ft high steel vessel lined with refractory, the supporting structural steel, condensers, a hydraulically operated bottom grate, a winch to hoist rock to the top of the structure, and an incinerator, plus pipes, valves, conduit, lights, etc.

Prior to dismantling the 150-ton retort system we conducted several tests to ensure safe working conditions and the proper disposal of the equipment. In response to concerns expressed by the disposal contractor, the shell of the retort and the oil-handling system were tested for radioactivity. The radioactivity level was found not to be above the background level for Laramie. We also tested two samples of refractory from opposite sides of the lower part of the retort where contact with oil was thought to have been heavy. The samples of refractory passed the TCLP extraction test for RCRA substances. We tested several samples of insulation for asbestos using X-ray diffraction. No asbestos-containing minerals were found to be present. The WRI safety committee reviewed the procedure to be used for dismantling and determined that several nearby work areas would be vacated during the time when the top three layers were being removed from the retort.

The contractor dismantled the 150-ton retort by first removing the valuable items, such as motors and winches. Then the retort and supporting structure were cut into pieces. The contractors used cutting torches with tips about 8 feet long. This permitted workers to cut the metal into removable pieces without a great deal of climbing or erecting scaffolding to gain access. The metal was loaded onto a truck and sold for scrap to be recycled into new steel.

Evaporation Pond Containment Ring

A metal containment ring 8-feet high and about 80-feet in diameter remained from an abandoned evaporation pond. The material that had been in the bottom of the pond before the liner was removed passed the TCLP extraction, so no contamination was associated with the containment ring. We disposed of the residue as part of Phase III. We also disposed of the liner from the pond during Phase III work.

After removal of the dried residue and the liner from the pond, the metal ring that remained consisted of 8-ft high bolted metal plates supported by 4-in. pipes that were set in concrete at 10-ft intervals around the ring. We were able to locate a contractor who dismantled the evaporation pond containment ring and removed the posts at no cost to the project in return for the scrap value of the metal.

10-Ton Retort

The 10-ton retort consisted of a 6-ft diameter by 15-ft high steel vessel lined with refractory, the supporting structural steel, and the effluent gas condensers and separators. Removal of the 10-ton retort was our last priority in Phase V and was removed only when sufficient funds were found to be remaining after the other work.

We tested samples of the refractory lining from the retort by TCLP extraction and found that they did not contain any RCRA-regulated components (Table 1) in concentrations exceeding regulatory levels.

We found a rancher who wanted the 10-ton retort vessel intact for use on the family ranch. He removed the retort and the supporting structural steel at no cost to the project in return for the value of the retort. Removal of the 10-ton retort was fairly simple. The rancher cut off the anchor bolts using a cutting torch. He then attached a cable to the top of the frame and pulled the structure over. When the retort vessel and the structural steel support were lying on the ground, he used a winch to pull the entire structure onto a flatbed truck for hauling.

The effluent piping, condensers, and separators were removed by WRI employees. The components of the effluent recovery system were retained by WRI for use on future projects.

The work done in Phase V of the project is describe in the report (WRI-96-R029) entitled, "Final Report for Phase V of the North Site Cleanup: Decontamination and Removal of Equipment."

Results of Phase Va, Groundwater Monitoring

In phase Va, groundwater from two North Site wells was sampled five times over the period from November 2, 1994 to April 2, 1996. The water samples were characterized for concentrations of the eight metals regulated under the Resource Conservation and Recovery Act; the semivolatile and volatile organic compounds and pesticides/PCBs that are listed as target compounds for the EPA Contract Laboratory Program (CLP); the semivolatile and volatile organic compounds and pesticides/polychlorinated biphenyls (PCBs) that are regulated under the Toxicity Characteristic Leaching Procedure; and the EPA underground water use suitability constituents. Analyses of the water samples for RCRA metals and the semivolatile organic compounds, volatile organic compounds, and pesticides/PCBs on the TCLP and CLP target compound list were performed by CLP laboratories with full CLP quality assurance/quality control. Complete chain-of-custody procedures were followed during each of the sampling episodes. In addition, trip blanks consisting of deionized, distilled water were taken to the North Site during sampling and accompanied the groundwater samples to the laboratories for analysis.

The results of our sampling and analyses showed no evidence of contamination of the groundwater collected from the wells situated updip and downdip from the former location of the 150-ton oil shale retort and the shale oil storage tanks.

The North Site groundwater is not hazardous based on metal toxicity. The North Site groundwater contains no contamination from semivolatile organic compounds, volatile organic compounds, or pesticides/PCBs listed on the TCLP or CLP target compound lists. The groundwater from the two wells on the east and west boundaries of the former retorting site meets all of the EPA water use suitability criteria.

The report, "Phase Va of the Cleanup of the Western Research Institute North Site--Groundwater Monitoring," was recently submitted to the DOE. The report (WRI-96-R025) for Phase Va describes the results of sampling and analyses of groundwater from beneath the North Site.

Results of Phase VI, Preparation of a Materials Inventory Data Base

The report, "Phase VI of the Cleanup of the Western Research Institute North Site—Preparation of a Materials Inventory Data Base," describes the preparation of a database for use in controlling inventories of various materials. The database permits tracking of materials from the time of acquisition or generation until final disposition. It can include properties and characteristics of the materials.

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