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Volume I
Phase I of the North Site Cleanup: Definition
of Product Streams

Topical Report

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SUMMARY

Various materials and equipment have accumulated at the Western Research Institute (WRI) North Site Facility since its commissioning in 1968. This facility was built by the U.S. Bureau of Mines, transferred to the U.S. Energy Research Development Administration (ERDA) in 1976, and transferred once again to the U.S. Department of Energy (DOE) shortly thereafter. In 1983, the North Site Facility became part of WRI. The materials that have accumulated over the years at the site have been stored in drums, tanks, and open piles. They vary from oil shale, tar sand, and coal feedstocks to products and materials associated with in situ simulation and surface process developments associated with these feedstocks. The majority of these materials have been associated with DOE North Site activities and work performed at the North Site under DOE-WRI cooperative agreement contracts. In phase I of the North Site Facility cleanup project, these materials were sampled and evaluated to determine their chemical characteristics for proper disposal or use in accordance with current local, state, and federal regulations.

Phase I of the North Site Facility cleanup project involved dividing the stored materials into product streams and dividing each product stream into composite groups. Composite groups contain materials known to be similar in composition, source, and process exposure. For each composite group, materials, which are representative of the composite, were selected for sampling, compositing, and analysis.

Sampling was performed by WRI personnel. The sampling methods and equipment that were used varied depending upon the nature of the material. To reduce analytical costs, many of the samples were composited prior to analysis. Most of the sample composites and individual samples were characterized for toxicity by the Toxicity Characteristic Leaching Procedure (TCLP) or by direct analysis for the TCLP regulated analytes. Samples were analyzed at WRI. However, to verify WRI results and for Quality Assurance/Quality Control (QA/QC) purposes, many samples were also analyzed by a Contract Laboratory Program (CLP) laboratory currently under contract with the U.S. Environmental Protection Agency (EPA).

In phase I, chain-of-custody procedures were followed to ensure the integrity of the samples from time of collection to data reporting. In addition, for QA/QC purposes, field trip blanks and equipment blanks were analyzed, as well as, TCLP equipment and method blanks. Split samples were also prepared and analyzed as a check on data quality.

Data from analysis of the North Site samples provide information on the identity and composition of the materials in each of the product streams, as well as, their hazard classification. Sixty-nine composite or individual samples were characterized. Forty-one of these were determined to be nonhazardous, and 28 were determined to be hazardous based on the hazard characteristic of toxicity. Two of the composite groups that fail toxicity also fail the hazard characteristic of ignitability. Most of the composite groups that were determined to be hazardous are oily materials that contain high concentrations of benzene. This information will now be used in phases II and III of the North Site cleanup project, which involve disposal or use of the North Site materials.

To track materials in the North Site cleanup project, the North Site Materials Handling Data Base was created. This data base contains an inventory of the materials requiring disposal or use, as well as, the product stream to which the material belongs, composite information, sampling and analytical information, analytical data, and hazard classification. This data base allows tracking of a material listed in the North Site inventory through the sampling and analytical processes, to a decision on hazard classification, and finally, when the project is completed, it will contain information on disposal or use of the material.

INTRODUCTION

Background

The Western Research Institute (WRI) North Site Facility was established in 1968 when the U.S. Bureau of Mines sought to conduct large-scale tests simulating underground retorting of oil shale. A 150-ton retort was constructed in 1968 on land leased from Upland Industries (the real estate arm of Union Pacific Railroad). A control room, shops, an office building, and a laboratory were also built during that first year. A 10-ton retort was relocated from the center to the North Site in 1969, and several small storage buildings have been added over the years.

In 1976, the facility was transferred to the U.S. Energy Research Development Administration (ERDA) as part of the Laramie Energy Research Center (LERC), and then shortly thereafter, it was transferred to the U.S. Department of Energy (DOE) and became the Laramie Energy Technology Center (LETC). In 1983, the North Site Facility became part of WRI as LETC was defederalized and became a corporation of the University of Wyoming. Over the years, a core storage building and an in situ processing laboratory were added to the North Site Facility, along with two buildings which were relocated from the LETC tar sand site near Vernal, Utah. One of these buildings is currently used as a coal processing laboratory, and the other is used for storage of materials. In 1989, the core storage building was converted to house the mild gasification pilot plant. Over the years, in addition to buildings being added to the North Site, various materials and equipment have accumulated and now require disposition or use as part of the North Site cleanup project.

North Site Materials

Materials that have accumulated over the years at the North Site are stored in drums, tanks, and open piles and are distributed throughout the site. They vary from oil shale, tar sand, and coal feedstocks to products and materials associated with these feedstocks. Containers of the various materials range in size from less than one gallon to 55 gallons. Most of these are stored outside on pallets and are exposed to the weather. In addition, there are a storage tank containing approximately 13,000 gallons of oil/water mixture and four other storage/mixing tanks that do not contain liquid but their inner walls are coated with residue. Also, the 150-ton and 10-ton in situ simulation retorts remain on site and require decontamination and disposal. The majority of the materials described above have been associated with DOE North Site activities and work performed at the North Site under DOE-WRI cooperative agreement contracts. The WRI North Site was audited by the U.S. DOE Tiger Team in 1991 as part of an audit of DOE Fossil Energy test sites in Wyoming. Numerous questions were raised relating to storage and disposition of the materials. The Tiger Team emphasized the need to initiate a North Site cleanup activity. As a result, a five-phase project is being performed to cleanup the WRI North Site Facility. The subject of this report is phase I of the cleanup, which involves defining the North Site product streams.

In 1991, the North Site materials were inventoried and each container, tank, pile, etc. was given a serial number, which was entered into a data base. At the start of phase I of this project, an inventory of the materials requiring disposition or use was prepared and entered into the North Site Materials Handling Data Base for tracking of the materials throughout the phases of this project.

DESCRIPTION OF THE WORK

Phase I Objective

The objective of phase I of the North Site cleanup project was to define the various product streams requiring disposal or use. This was accomplished by sampling and analyzing the materials to obtain information for: (1) use in determining which materials can be useful products and which can not be used; (2) use in determining which materials are hazardous and which are not hazardous; and (3) use in determining what methods of disposition can be used for each respective material.

Phase I Plan

The plan for phase I of the North Site Facility cleanup project (Merriam and Sorini 1993) called for the following activities to be performed.

1. Dividing the North Site materials inventory into product streams and composite groups
2. Sampling the product streams
3. Preparing composite samples
4. Analyzing composite samples and individual samples from the North Site product streams
5. Determining hazardous/nonhazardous classification for each of the materials
6. Developing and using a materials handling data base

North Site Product Streams and Composite Groups

The inventory of North Site materials requiring disposal or use is given in Appendix A (Appendices can be found in Volume II). The materials listed in this inventory were divided into product streams and composite groups. The composite groups contain materials known to be similar in composition, source, and process exposure. The North Site product streams and their composite groups are listed in Table 1.

Table 1. North Site Cleanup Product Streams and Composite Groups

Product Stream	Composite Groups
Unprocessed Tar Sands	Tar Sand Tar Sand Sludge
Unprocessed Coals	Unprocessed Western Coal Unprocessed Eastern Coal
Raw Oil Shales	Raw Western Oil Shale Raw Eastern Oil Shale Raw Shale Pile
Spent Oil Shale, Processed Tar Sand, Activated Charcoal	Spent Oil Shale-1 Spent Oil Shale-2 Spent Oil Shale Pile Spent Tar Sand Activated Charcoal Unused Activated Charcoal MG Fines, Char
Miscellaneous Materials	Oily Insulation Tank Bottom Liner Evaporation Tank Bottom Dirt Oily Dirt Sulfur Crushed KC Rock Fly Ash
Waters	Retort Water Graham Water Tank Cleanout Water Water Scavenger Water, Coal Fines, Oil Unidentified UCG Water Hoe Creek Water RM1 Water CROW Water Tank Bottom Water Sludgy Water Treolite Distillates Free & Distilled Water

**Table 1. North Site Cleanup Product Streams and Composite Groups
(continued)**

Product Stream	Composite Groups
Tars, Oils, & Hydrocarbon Liquids	Tank Bottom Heavy Oil Solid Oil Pitch Shale Oil-1 Shale Oil-2 Shale Oil-3 Shale Oil Distillates Tar Sand Heavy Oil Heavy Oil Plus Coal Dirty Oil & Sludge Coal Tar Heavy Oil Heavy Fuel Oil Heavy Crude Oil Tank Bottom Tank Water Tank Oil Distillate Light Oil Tank Cleanout Tank Cleanout Oil Oily Material Plus Water Tank Bottom Heavy Oil
Unknown Materials	Pellets Unknown Liquid Unknown Material SAI Comp Material-Liquid SAI Comp Material-Solid Artic 75/90 Chlorinated Solvents
Chemicals	Monoethanloamine Tretolite Caustic Soda Boiler Water Treatment Dry Water Treatment-1 Dry Water Treatment-2 Soda Ash

North Site Sampling

Materials Sampled

For each composite group, materials, which are representative of the composite, were selected for sampling. As shown in Appendix A, each container, tank, pile, etc. of material stored at the North Site has a serial number. Listed in Tables 2 through 10 are the serial numbers of the containers that were sampled for each composite group, along with the serial numbers of the containers that are represented by each composite group.

Table 2. Composite Groups, Containers Sampled, and Containers Represented in the North Site Unprocessed Tar Sand Stream

Composite Groups	Containers Sampled	Containers Represented
Tar Sand	19, 28, 45, 51, 57, 65, 235, 1159	14-48, 50-54, 56-63, 65, 221-223, 226-240, 862-885, 1159, 1160
Tar Sand Sludge	49	49

Table 3. Composite Groups, Containers Sampled, and Containers Represented in the North Site Unprocessed Coal Stream

Composite Groups	Containers Sampled	Containers Represented
Unprocessed Western Coal	83, 213, 217, 372, 1163	83-94, 97-114, 116, 117, 119-138, 213-220, 372, 553-560, 567-569, 573, 574, 812-814, 939-942, 983, 988, 990, 1070, 1071, 1161-1166
Unprocessed Eastern Coal	2, 115, 810, 1212	1-4, 95, 96, 115, 201-212, 810, 811, 1212

Table 4. Composite Groups, Containers Sampled, and Containers Represented in the North Site Raw Oil Shale Stream

Composite Groups	Containers Sampled	Containers Represented
Raw Western Oil Shale	139, 247, 395, 460	139-161, 241-277, 374-406, 409-421, 424-434, 436-473, 547-549, 815, 816
Raw Eastern Oil Shale	196, 200, 358, 1167	162-180, 182, 183, 185-200, 337-343, 354-362, 407, 408, 855, 856, 1167
Raw Shale Pile	1260, 1262-1264	1260, 1262-1264

Table 5. Composite Groups, Containers Sampled, and Containers Represented in the North Site Spent Oil Shale, Processed Tar Sand, Activated Charcoal Stream

Composite Groups	Containers Sampled	Containers Represented
Spent Oil Shale-1	330, 367, 541, 546, 818 818	328-332, 363-367, 541-546, 818
Spent Oil Shale-2	1080, 1081	1080, 1081
Spent Oil Shale Pile	1259, 1261	1259, 1261
Spent Tar Sand	370, 373	368-371, 373
Activated Charcoal	684, 690, 700, 826, 830, 835, 840, 845, 850, 1170	684-702, 826-838, 840-852, 1170, 1226, 1227
Unused Activated Charcoal	859	859, 860
MG Fines, Char	1204, 1205, 1217, 1223, 1257	1204-1211, 1213-1219, 1221-1225, 1257

Table 6. Composite Groups, Containers Sampled, and Containers Represented in the North Site Miscellaneous Material Stream

Composite Groups	Containers Sampled	Containers Represented
Oily Insulation	948	948, 949
Tank Bottom Liner	820, 823	820, 821, 823
Evaporation Tank Bottom Dirt	1244, 1245	933, 1244, 1245
Oily Dirt	645, 655, 999	645-655, 999
Sulfur	950	950
Crushed KC Rock	1121	1121
Fly Ash	891-912	891-912

Table 7. Composite Groups, Containers Sampled, and Containers Represented in the North Site Water Stream

Composite Groups	Containers Sampled	Containers Represented
Retort Water	350, 1079, 1122	350, 1079, 1122
Graham Water	1113, 1120	1113-1120
Tank Cleanout Water	931, 944	931, 944
Water Scavenger	494	493-495
Water, Coal Fines, Oil	1198	1198
Unidentified UCG Water	1271	1271
Hoe Creek Water	1273	1273
RM1 Water	1272	1272
CROW Water	1267, 1268	1267, 1268
Tank Bottom Water	824, 889, 947	824, 825, 889, 947
Sludgy Water	550	550
Treolite Distillates	618	618
Free & Distilled Water	1201	1201

Table 8. Composite Groups, Containers Sampled, and Containers Represented in the North Site Tar, Oil, and Hydrocarbon Liquid Stream

Composite Groups	Containers Sampled	Containers Represented
Tank Bottom Heavy Oil Solid	55, 643, 890	55, 643, 890
Oil Pitch	953, 975, 976, 1258	951-956, 975, 976, 1258
Shale Cil-1	279, 282, 293, 298, 301, 319, 322	279, 282, 293, 294, 295, 298, 299, 301, 319, 320, 322
Shale Oil-2	344, 346	344, 346-348
Shale Oil-3	776, 777, 779, 781, 783	776-784
Shale Oil Distillates	614, 615, 656	614, 615, 656
Tar Sand Heavy Oil	64, 498, 577, 599, 1139, 1141	64, 498, 577-599, 1139, 1141
Heavy Oil Plus Coal	474, 476, 500, 502	474-477, 500-502
Dirty Oil & Sludge	785, 795, 858	785, 794, 795, 858
Coal Tar	482, 959, 961, 963, 965, 967, 969, 973, 1135-1138	482, 959-974, 1135-1138
Heavy Oil	66, 305, 489, 490, 937	66, 305, 489, 490, 491, 937
Heavy Fuel Oil	6, 7, 9, 10, 11, 12	6, 7, 9, 10, 11, 12
Heavy Crude Oil	787, 792, 793	787, 792, 793
Tank Bottom	943, 957, 958, 978	943, 957, 958, 978
Tank Water	1265	1265
Tank Oil	1266	1266
Distillate Light Oil	1199, 1200	1199, 1200
Tank Cleanout	623	623
Tank Cleanout Oil	619	619, 620
Oily Material Plus Water	600, 602, 604, 606, 609	600-610, 945
Tank Bottom Heavy Oil	627, 888, 929	627-642, 886-888, 929, 930

Table 9. Composite Groups, Containers Sampled, and Containers Represented in the North Site Unknown Material Stream

Composite Groups	Containers Sampled	Containers Represented
Pellets	518, 519, 520	518, 519, 520, 552
Unknown Liquid	496	496
Unknown Material	992, 993	992, 993
SAI Comp Material-Liquid	1067	1067, 1068
SAI Comp Material-Solid	1140	1140
Artic 75/90	853	853, 854
Chlorinated Solvents	Not Sampled	1074

Table 10. Composite Groups, Containers Sampled, and Containers Represented in the North Site Chemical Stream

Composite Groups	Containers Sampled	Containers Represented
Monoethanolamine	487	487
Tretolite	352, 617	352, 617
Caustic Soda	803	803, 804
Boiler Water Treatment	805	805
Dry Water Treatment-1	806	806
Dry Water Treatment-2	807	807, 808
Soda Ash	92	92

Sampling Methods and Equipment

A variety of physical forms of materials required sampling as part of phase I of this cleanup project. These included liquids, viscous liquids, multiphasic liquids, and solids stored in a variety of ways (i.e., various sized drums, piles, tanks, etc.). The first step in preparing for sampling was to visually inspect the materials to determine the type of sampling method and type of equipment to be used. Sampling equipment and methods were selected or designed based on specific site and material conditions. Information presented in Chapter 9 of SW-846 (U.S. EPA 1986) was used as guidance for selecting appropriate sampling equipment, and guidance given in American Society for Testing and Materials (ASTM) methods for sampling various matrices was used in sampling the North Site materials.

If possible, contents of containers were mixed prior to sampling. Some of the materials were difficult to mix, such as hard or sticky materials packed in 55-gallon drums. The sampling devices used to collect individual samples and samples used to prepare composite samples for the various North Site product streams are listed in Table 11. Copies of the pages from the sampling logbook describing the sampling activities are contained in Appendix B.

Disposable glass coliwassas and disposable, sterile sampling scoops were the sampling equipment that was most often used. These were very suitable because of their appropriateness to the material matrices and storage containers, ease of use under the environmental sampling conditions, and disposable characteristic, which prevents cross-contamination from one sample to the next.

The coliwasa is a device for sampling free-flowing liquids and slurries contained in drums, shallow tanks, pits, and similar containers. It is especially useful for sampling materials consisting of several immiscible liquid phases (Chapter 9, SW-846, U.S. EPA 1986). Disposable glass coliwassas were used to sample many of the materials listed in Table 11. In addition, Teflon liquid/sludge coliwasa tubes were used for some of the viscous and sludgy materials listed under the tar, oil, and hydrocarbon liquid stream. A coliwasa consists of a tube equipped with an end closure that can be opened and closed while the tube is submerged in the material.

Disposable scoops were used to sample most of the dry, sticky, and sludgy materials; however, a grain sampler (thief) was used to sample the fly ash materials. This device consists of two slotted concentric tubes, with the outer tube having a pointed tip to penetrate the material being sampled. The inner tube is rotated to open and close the sampler. These devices are best for sampling dry granules or powdered material having a very small particle size.

Table 11. Sampling Equipment Used in Phase I of the North Site Cleanup Project

Product Stream	Sample	Sampling Equipment
Unprocessed Tar Sands	Tar Sand	Disposable Scoop
	Tar Sand Sludge	Disposable Scoop
Unprocessed Coals	Unprocessed Western Coal	Disposable Scoop
	Unprocessed Eastern Coal	Disposable Scoop
Raw Oil Shales	Raw Western Oil Shale	Disposable Scoop
	Raw Eastern Oil Shale	Disposable Scoop
	Raw Shale Pile	Gloved Hand as Scoop
Spent Oil Shale, Processed Tar Sand, Activated Charcoal	Spent Oil Shale-1	Disposable Scoop
	Spent Oil Shale-2	Disposable Scoop
	Spent Oil Shale Pile	Disposable Scoop
	Spent Tar Sand	Disposable Scoop
	Activated Charcoal	Disposable Scoop
	Unused Activated Charcoal	Disposable Scoop
	MG Fines, Char	Disposable Scoop
Miscellaneous Materials	Oily Insulation	Disposable Scoop
	Tank Bottom Liner	Disposable Scoop (Sample was in large sheets, which were lifted out of the drum with the scoop and then cut into strips for addition to the sample bottle.)
	Evaporation Tank Bottom Dirt	Disposable Scoop
	Oily Dirt	Disposable Scoop
	Sulfur	Disposable Scoop
	Crushed KC Rock	Disposable Scoop
	Fly Ash	Grain Sampler (Thief)

Table 11. Sampling Equipment Used in Phase I of the North Site Cleanup Project (continued)

Product Stream	Sample	Sampling Equipment
Waters	Retort Water	Disposable Glass Coliwasa
	Graham Water	Disposable Glass Coliwasa
	Tank Cleanout Water	Disposable Glass Coliwasa
	Water Scavenger	Disposable Glass Coliwasa
	Water, Coal Fines, Oil	Disposable Glass Coliwasa
	Unidentified UCG Water ^a	Composite, Mix, & Pour ^a
	Hoe Creek Water ^a	Composite, Mix, & Pour ^a
	RM1 Water ^a	Composite, Mix, & Pour ^a
	CROW Water	Disposable Glass Coliwasa
	Tank Bottom Water	Disposable Glass Coliwasa
	Sludgy Water	Disposable Glass Coliwasa
	Treolite Distillates	Disposable Glass Coliwasa
	Free & Distilled Water	Drain from Drum Valve
Tars, Oils, and Hydrocarbon Liquids	Tank Bottom Heavy Oil Solid	Disposable Scoop
	Oil Pitch	Gloved Hand as Scoop (very hard material)
	Shale Oil-1	Disposable Glass Coliwasa
	Shale Oil-2	Disposable Glass Coliwasa
	Shale Oil-3	Disposable Glass Coliwasa
	Shale Oil Distillates	Disposable Glass Coliwasa
	Tar Sand Heavy Oil	Sludgy Samples- Disposable Scoop Liquid Samples- Teflon Coliwasa
	Heavy Oil Plus Coal	Disposable Scoop
	Dirty Oil & Sludge	Teflon Coliwasa
	Coal Tar	Sludgy Samples- Disposable Scoop Liquid Samples- Disposable Glass Coliwasa
	Heavy Oil	Sticky Samples- Disposable Scoop Viscous Samples- Teflon Coliwasa
	Heavy Fuel Oil	Disposable Glass Coliwasa

^a There are only small quantities of these, and they were contained in several small containers.

Table 11. Sampling Equipment Used in Phase I of the North Site Cleanup Project (continued)

Product Stream	Sample	Sampling Equipment
Tars, Oils, and Hydrocarbon Liquids (continued)	Heavy Crude Oil	Sticky Samples- Large Scoop
		Viscous Samples- Teflon Coliwasa
	Tank Bottom	Sludgy Samples- Disposable Scoop
		Liquid Samples- Disposable Glass Coliwasa
	Tank Water	Drain from Spigot
	Tank Oil	Stainless Steel Tube
	Distillate Light Oil	Pour from Drum Spigot
	Tank Cleanout	Disposable Glass Coliwasa
	Tank Cleanout Oil	Long-Handled Scoop
	Oily Material Plus Water	Solid Samples- Long-Handled Scoop
		Liquid Samples- Disposable Glass Coliwasa
	Tank Bottom Heavy Oil	Disposable Scoop
Unknown Materials	Pellets	Disposable Scoop
	Unknown Liquid	Disposable Glass Coliwasa
	Unknown Material	Disposable Glass Coliwasa
	SAI Comp Material-Liquid	Disposable Glass Coliwasa
	SAI Comp Material-Solid	Disposable Scoop
	Artic 75/90	Disposable Glass Coliwasa
Chemicals	Monoethanolamine	Disposable Glass Coliwasa
	Tretolite	Disposable Glass Coliwasa
	Caustic Soda	Disposable Glass Coliwasa
	Boiler Water Treatment	Disposable Glass Coliwasa
	Dry Water Treatment-1	Disposable Scoop
	Dry Water Treatment-2	Pour from Container
	Soda Ash	Disposable Scoop

Sampling QA/QC

To prevent cross contamination from one sample to the next, disposable sampling equipment (e.g., disposable glass coliwassas and disposable scoops) was used whenever possible. Sample equipment which was reused was thoroughly cleaned between uses. The following procedure was used to wash sampling equipment prior to reuse.

1. Wash with soapy water
2. Rinse with type II water
3. Rinse with 10% nitric acid
4. Rinse with type II water
5. Repeat steps 3 and 4 three times
6. Rinse with methanol or other appropriate solvent and dry

Sample storage containers were I-Chem Series 200 precleaned bottles, which are cleaned to meet U.S. Environmental Protection Agency (EPA) specifications. Samples for metals analysis were placed in I-Chem precleaned polyethylene containers; samples for analysis of semivolatile organic compounds were added to I-Chem precleaned glass containers; and samples for analysis of volatile organic compounds were placed in I-Chem precleaned vials having Teflon-lined septum caps. Samples requiring compositing prior to metals analysis were added to I-Chem precleaned polyethylene containers, and samples requiring compositing prior to organic analyses were added to I-Chem precleaned glass containers. The only exception to the activities described above is that because of the difficulty in sampling and collecting the oils, tars, and hydrocarbon liquids during the winter, many times a single I-Chem glass container of the material was collected. Samples for Toxicity Characteristic Leaching Procedure (TCLP) extraction were also placed in I-Chem precleaned glass containers. The composition of the sampling equipment and sample containers was selected to minimize loss of analytes due to adsorption or contamination caused by leaching. Precautions were also taken during sampling to prevent loss of volatile components from the samples.

An indelible label identifying the sample was filled out and secured to each sample container at the time of sampling. Each sample label contained the following information:

- Date and time of sampling (month/day/yr;time)
- Location of sampling (area)
- Description of sample
- Sample identification number (This includes material inventory serial number, WRI sampling logbook number, and sampling logbook page number where the information on the sample can be found.)
- Name of sample collector
- Type of preservation, if any
- Analytical requirements (i.e., TCLP, BNA, VOC, Metals)

Chain-of-custody procedures were used to ensure the integrity of the samples from collection to data reporting. This was accomplished by creating a paper trail

that identified the specific individuals responsible for the custody of a given sample at any point in time. The components of chain-of-custody, sample seals, a field (sampling) logbook, a chain-of-custody record, and a sample analysis request sheet, were used to document the history of each sample. Once a sample container was filled, a chain-of-custody seal was attached to the container in a manner such that the sample container could not be opened without breaking the seal. Each chain-of-custody seal contained the following information:

- Sample number (This was identical to the number on the sample label.)
- Name of collector
- Date and time of sampling

All information pertinent to sampling was recorded in a logbook. Sample documentation in the sample logbook was initiated at the time a sample was taken and includes the following:

- Project name
- Sample/custody seal number
- Date and time sampled
- Type of material
- Name of sampler
- Information describing the sample
- Sampling method
- Number of samples taken
- Analytical requirements
- Condition of custody seal upon delivery and name of receiving person
- Signatures of personnel responsible for observations
- Dates of all activities

When not in use, the sample logbook is securely and safely stored. All information is recorded in the sample logbook using ink.

To establish the documentation necessary to trace sample possession from the time of collection, a chain-of-custody record was filled out and accompanied the samples. The chain-of-custody record is a triplicate form. The original and yellow sheets accompanied the samples to the analytical laboratory; and the pink sheet was retained by the sampling personnel and placed in a permanent project file. The yellow sheet was returned by the laboratory personnel to the document coordinator to verify sample receipt, and the original was returned by the laboratory personnel with the remaining samples after analyses were completed. The chain-of-custody record contains the following information:

- Project name
- Sample number
- Signature of collector
- Date and time of collection
- Location of collection
- If the sample is a grab or composite sample
- Number of containers of the sample

- Signature of persons involved in the chain-of-possession
- Inclusive dates of possession

For samples requiring compositing after they were collected, two chain-of-custody records were prepared. One was prepared in the field by the sample collector and lists the samples that were collected at the North Site. A second chain-of-custody record was prepared when samples were composited in the laboratory to give a single sample for analysis. The pink sheet of the second form and original and yellow sheets of the first form document sample compositing for chain-of-custody purposes and were placed in the permanent project file. The original and yellow sheets of the second form were sent to the laboratory personnel and handled as described above.

A sample analysis request sheet was also sent with the samples to the laboratory. This lists the samples for analysis, sample description and source, and the analysis requested. A chain-of-custody form and sample analysis request form accompanied all samples to WRI's laboratory and to the outside laboratories. Copies of the chain-of-custody records and sample analysis request forms for the samples involved in phase I of this project are provided in Appendix C.

After the samples were collected, they were stored in a locked, refrigerated storage area until being extracted, analyzed, or shipped for analysis. Storage time was limited to meet analytical holding times.

Field trip blanks were prepared for the sampling activities. Each set of trip blanks consisted of deionized, distilled water added to the appropriate precleaned I-Chem container for metals, semivolatile organic, and volatile organic analyses. The trip blanks were taken to the North Site sampling areas by the sampling team. They were exposed to the same sampling and storage conditions as the actual samples and accompanied the samples to the laboratory for analysis. Analysis of the trip blanks verifies that none of the analytes of interest measured in the samples result from contamination of the samples in the field or during storage.

During the course of sampling, five sets of trip blanks were prepared and taken to the North Site. One set was for sampling some of the North Site water composite groups; one set was for sampling some of the tars, oils, and hydrocarbon liquids composite groups; a third set was for sampling materials requiring TCLP extraction; a fourth set was taken to the field for sampling the North Site chemical stream; and a fifth set of trip blanks was for sampling the oil pitch composite group for TCLP extraction. Table 12 lists the trip blank numbers and the corresponding composite groups that were sampled.

In addition to field trip blanks, two sets of field equipment blanks were also prepared. Glass coliwasa and plastic scoop equipment blanks were to show any contamination of the samples contributed by these sampling devices. The equipment blanks consisted of deionized, distilled water poured appropriately over or through the sample collection device, collected in an appropriate sample container for analysis of metals, semivolatile organic compounds, and volatile organic compounds, and submitted blind to the laboratory for analysis.

Table 12. North Site Sampling Field Trip Blanks and Composite Groups Sampled

Field Trip Blanks	Composite Groups Sampled
Set 1	Graham Water Tank Bottom Water Retort Water Sludgy Water Tank Cleanout Water Water Scavenger Treolite Distillate Free & Distilled Water
Set 2	Tank Bottom Heavy Oils Tank Water Tank Bottom Heavy Oil Plus Coal Tar Sand Heavy Oil Coal Tars Heavy Oils Heavy Fuel Oils Shale Oil Distillates
Set 3	Crushed KC Rock Raw Eastern Oil Shale Raw Oil Shale Pile Tank Bottom Heavy Oil Solid Pellets
Set 4	Monoethanolamine Tretolite Caustic Soda Boiler Water Treatment Soda Ash Dry Water Treatment-1 Dry Water Treatment-2
Set 5	Oil Pitch

Preparation of Composite Samples for Analysis

Composite Samples

To reduce analytical costs, many samples of the North Site materials were composited prior to analysis. Composite samples were prepared by mixing samples of materials in the composite groups listed in Table 1. As previously mentioned, the composite groups contain materials known to be similar in composition, source, and process exposure. Table 13 shows the composite samples that were prepared for each product stream and the serial numbers of the materials that were mixed to prepare them.

Table 13. Composite Samples Prepared for Analysis in Phase I of the North Site Cleanup Project

Product Stream	Composite Sample	Materials in Composite Sample
Unprocessed Tar Sands	Tar Sand	19, 28, 45, 51, 57, 65, 235, 1159
Unprocessed Coals	Unprocessed Western Coal	83, 213, 217, 372, 1163
	Unprocessed Eastern Coal	2, 115, 810
Raw Oil Shales	Raw Western Oil Shale	139, 247, 395, 460
	Raw Eastern Oil Shale	196, 200, 358, 1167
	Raw Shale Pile	1260, 1262-1264
Spent Oil Shale, Processed Tar Sand, Activated Charcoal	Spent Oil Shale-1	330, 367, 541, 546, 818
	Spent Oil Shale-2	1080, 1081
	Spent Oil Shale Pile	1259, 1261
	Spent Tar Sand	370, 373
	Activated Charcoal	684, 690, 700, 826, 830, 835, 840, 845, 850, 1170
	MG Fines, Char	1204, 1205, 1217, 1223, 1257

Table 13. Composite Samples Prepared for Analysis in Phase I of the North Site Cleanup Project (continued)

Product Stream	Composite Sample	Materials in Composite Sample
Miscellaneous Materials	Tank Bottom Liner	820, 823
	Evaporation Tank Bottom Dirt	1244, 1245
	Oily Dirt	645, 655, 999
	Fly Ash	891-912
Waters	Retort Water	350, 1079, 1122
	Graham Water	1113, 1120
	Tank Cleanout Water	931, 944
	CROW Water	1267, 1268
	Tank Bottom Water	824, 889, 947
Tars, Oils, & Hydrocarbon Liquids	Tank Bottom Heavy Oil	627, 888, 929
	Tank Bottom Heavy Oil Solid	55, 643, 890
	Oil Pitch	953, 975, 976, 1258
	Shale Oil-1	279, 282, 293, 298, 301, 319, 322
	Shale Oil-2	344, 346
	Shale Oil-3	776, 777, 779, 781, 783
	Shale Oil Distillates	614, 615, 656
	Tar Sand Heavy Oil-1 (liquid)	599, 1141, 498
	Tar Sand Heavy Oil-2 (mucky solid)	64, 1139, 577

Table 13. Composite Samples Prepared for Analysis in Phase I of the North Site Cleanup Project (continued)

Product Stream	Composite Sample	Materials in Composite Sample
Tars, Oils, & Hydrocarbon Liquids (continued)	Heavy Oil Plus Coal-1 (mucky solid)	474, 476
	Heavy Oil Plus Coal-2 (mucky solid)	500, 502
	Dirty Oil & Sludge	785, 795, 858
	Coal Tar-1 (liquid)	482, 959, 961, 963, 965, 967, 969, 973
	Coal Tar-2 (mucky solid)	482, 959, 961, 963, 965, 967, 969, 973
	Coal Tar-3	1135-1138
	Heavy Fuel Oil	6, 7, 9, 10, 11, 12
	Heavy Crude Oil	787, 792, 793
	Tank Bottom-1 (liquid)	978, 957
	Tank Bottom-2 (mucky solid)	958, 943
	Distillate Light Oil	1199, 1200
	Oily Material Plus Water-1 (liquid)	604, 606, 609
	Oily Material Plus Water-2 (hard solid)	600, 602
Unknown Materials	Pellets	518, 519, 520
	Unknown Material	992, 993
Chemicals	Tretolite	352, 617

Compositing Procedures

Composite samples were prepared in the laboratory with care to prevent loss of volatile constituents from the samples. Because all of the samples were refrigerated during storage, the materials were cold at the time of compositing, which helped prevent loss of volatile materials.

Materials in the unprocessed tar sand, unprocessed coal, raw oil shale, spent oil shale, processed tar sand, activated charcoal, and miscellaneous material streams that required compositing are all solids, as are the tank bottom heavy oil solid and oil pitch in the tar, oil, and hydrocarbon liquid stream and the pellets in the unknown material stream (Table 13). All of these materials were to be extracted by TCLP, which requires a particle size of 9.5 mm or less. The cold samples having a particle size greater than 9.5 mm were placed between sheets of Teflon-lined paper and crushed to reduce their particle size prior to compositing. One exception was the tank bottom liner, which consists of reinforced, rubber-like sheets. This material required cutting with scissors. Also, the pellets can be broken into smaller particles using a spatula. Solids requiring particle size reduction by crushing were three of the tar sand materials, the western and eastern raw oil shales, materials from the oil shale pile, and the oil pitch. For the materials requiring particle size reduction, the entire sample was reduced prior to compositing. To prepare the solid composite samples, equal masses of material were added to a large, cold, glass container. The container was sealed, and the material was thoroughly mixed. The mass of each solid material used to prepare a composite sample ranged from approximately 100 to 700 g. After mixing, the composite sample was added to an I-Chem precleaned glass container and submitted to WRI's laboratory for TCLP extraction.

Water samples for compositing were collected in 1-liter I-Chem polyethylene containers for metals analysis and in 1-liter I-Chem glass containers for semivolatile and volatile organic analyses. Water composite samples were prepared by mixing equal volumes of the waters from the polyethylene bottles (~800 mL) in a large, sealed, polyethylene container to give a composite for metals analysis, and by mixing equal volumes of the waters from the glass bottles (~800 mL) in a cold, sealed, glass container (i.e., volumetric/Erlenmeyer flask) to give a composite for organic analyses. After mixing, the composite for metals analysis was divided between two 1-liter I-Chem polyethylene bottles, one for analysis by WRI and one for analysis by a second laboratory. After the organic composite was prepared, it was divided between two 1-liter I-Chem glass bottles and four 40-mL I-Chem vials for semivolatile organic and volatile organic analysis, respectively. One 1-liter container and two of the 40-mL vials were submitted to WRI, and the other three containers were for analysis by an outside laboratory.

Oils, tars, and hydrocarbon liquid samples were to be collected in I-Chem polyethylene containers for metals analysis and in I-Chem glass containers for organic analysis. However, because of the difficulty in sampling and collecting these types of materials during the winter, many times a single I-Chem glass container of the material was provided for compositing. Oily liquid composite samples were prepared by mixing equal volumes of the liquids (generally 150 to 250 mL) in a cold, sealed, glass container, such as a volumetric or Erlenmeyer flask, and dividing the composite sample between appropriate sample containers for metals and organic analyses. Solid composite samples were prepared by mixing equal masses of the materials (generally 10-30 g for sticky solids, which were extremely difficult to remove from the sample container, and 150 g for mucky solids) in a cold, sealed, glass beaker and dividing the composite sample between appropriate sample containers for metals and organic analyses.

The oily material plus water composite sample was divided into two samples because materials 600 and 602 (see Table 13) required heating to remove them from their sample containers. As shown in Table 13, multiple composite samples were also prepared for some of the other composite groups in the tar, oil, and hydrocarbon liquid stream. This was due to the difficulty in sampling these materials, causing them to be sampled at different times, and because some of the materials that were to be mixed were solids and liquids.

There are three coal tar composite samples listed in Table 13 because solid and liquid phases of the coal tar materials were separated (for analytical purposes) to give two composite samples, and materials 1135-1138 were sampled at a later time to give a third composite. There are also two composites for the heavy oil plus coal composite sample because sampling was performed at different times. Three shale oil sample composites were prepared because of the large number of shale oil materials.

The unknown material composite sample listed in Table 13 under the unknown material stream was prepared by mixing 1000 mL of each material in a cold, 2-liter, capped volumetric flask. The composite sample was divided between a 1-liter I-Chem glass container for semivolatile organic analysis, a 1-liter I-Chem polyethylene bottle for metals analysis, and two I-Chem vials for volatile organic analysis. Analyses of this composite sample were performed by WRI only.

The tretolite composite sample listed in Table 13 under the chemical stream was prepared by mixing 1,500 mL of each material in a cold, 4000-mL, sealed Erlenmeyer flask. The composite sample was then divided between the appropriate sample containers and submitted for analyses by WRI.

In preparing the composite samples, contents of the sample containers, which had been refrigerated, were well mixed prior to removing material for the composite. This was done in a manner to prevent loss of volatile constituents. An exception to this was for the oily material plus water samples, 600 and 602, which as mentioned above required heating to remove the materials from their sample containers. This activity was noted for reference in evaluating data from analysis of the resulting composite sample. After the materials comprising a composite sample were added to the compositing container, they were thoroughly mixed. Sufficient mixing was performed to ensure that stratification did not occur and to give as homogeneous a sample as possible. For liquid matrices, the materials were swirled or shaken in cold, sealed containers to mix them and prevent loss of volatile organic constituents. For solid and semi-solid materials, mixing was accomplished by stirring the materials in cold, sealed containers, with care to prevent loss of volatile compounds. Compositing containers and any utensils used in preparing the composites were thoroughly cleaned between preparation of composite samples to prevent cross contamination. Information concerning preparation of composite samples is recorded in a WRI project notebook, which references the sample logbook and page number where specific sample collection is described. Copies of WRI notebook pages providing information on sample compositing are included in Appendix B.

Analysis of North Site Samples

Materials stored at the North Site were analyzed for their hazard classification using the Resource Conservation and Recovery Act (RCRA) (1984) definition for wastes. Some of these materials will be further identified as not being needed for additional research and may be reclassified as wastes depending on their potential for industrial use. RCRA controls disposal of wastes (liquids, solids, semi-solids, and containerized gases), and requires that wastes destined for land disposal be evaluated for their potential hazard to the environment. Wastes are divided into two classifications, nonhazardous and hazardous. Hazardous wastes are defined by the EPA (40 CFR 261, Subpart C, 1992) as wastes that demonstrate the characteristic of ignitability, corrosivity, reactivity, or toxicity, and they also include wastes listed in 40 CFR 261, Subpart D (listed wastes) (1992).

Analytical Approach

The analytical approach to this project is shown in Figure 1 and summarized in Table 14. Each material type was evaluated for exemption as a hazardous waste under 40 CFR 261, Subpart A (1992). Materials falling into one of the categories for an exempt waste are nonhazardous. If a North Site material was not exempt, it was evaluated based on being listed under 40 CFR 261, Subpart D (1992). Any listed waste is hazardous and requires no sampling or analyses. Materials that were not listed wastes were then evaluated for the hazard characteristic they were most likely to exhibit. The composite samples and individual samples for each product stream that required analysis in phase I are listed in Table 15.

Figure 1. North Site Material Characterization

Table 14. North Site Sample Characterization

Product Stream	Recommended Analysis	Rationale
Unknown Materials	<p>Quick screen EPA Methods 3580,8000 EPA Methods 3010/3050 & 6010 EPA Method 300.2</p> <p>Evaluate hazard characteristic: Total characterization for TCLP regulated analytes</p>	<p>Information on composition/ identity</p> <p>Classify as hazardous or nonhazardous</p>
Chemicals	<p>Quick screen EPA Methods 3580,8000 EPA Methods 3010/3050 & 6010 EPA Method 300.2</p> <p>Evaluate hazard characteristic: Total characterization for TCLP regulated analytes</p>	<p>Information on composition/ identity</p> <p>Classify as hazardous or nonhazardous</p>
Tars, Oils, and Hydrocarbon Liquids	<p>Evaluate hazard characteristic: Total characterization for TCLP regulated analytes</p>	<p>Classify as hazardous or nonhazardous</p>
Some Oils	<p>Btu analysis-ASTM D-240</p>	<p>Evaluate use as fuel</p>
Distillates	<p>Evaluate hazard characteristic: Flash Point-ASTM D-93</p>	<p>Classify as hazardous or nonhazardous</p>

Table 14. North Site Sample Characterization (continued)

Product Stream	Recommended Analysis	Rationale
Unprocessed Tar Sands Unprocessed Coals Raw Oil Shales Spent Tar Sands Spent Oil Shales Activated Charcoal Miscellaneous Materials	Evaluate hazard characteristic: Toxicity-EPA Method 1311	Classify as hazardous or nonhazardous
Unprocessed Tar Sands Unprocessed Coals Raw Oil Shales passing TCLP	Btu analysis-ASTM D-2015	Determine heat capacity for disposal
Waters	Evaluate hazard characteristic: Corrosivity-EPA Method 9040 or Reactivity-EPA 7.3.3.2 7.3.4.2 (SW-846, U.S. EPA 1986)	Classify as hazardous or nonhazardous
	Evaluate hazard characteristic: Total characterization for TCLP regulated analytes	Classify as hazardous or nonhazardous

Table 15. Composite Samples and Individual Samples Requiring Analysis in Phase I of the North Site Cleanup Project

Product Stream	Composite Sample	Individual Sample
Unprocessed Tar Sands	Tar Sand	Tar Sand Sludge
Unprocessed Coals	Unprocessed Western Coal Unprocessed Eastern Coal	
Raw Oil Shales	Raw Western Oil Shale Raw Eastern Oil Shale Raw Shale Pile	
Spent Oil Shale, Processed Tar Sand, Activated Charcoal	Spent Oil Shale-1 Spent Oil Shale-2 Spent Oil Shale Pile Spent Tar Sand Activated Charcoal MG Fines, Char	Unused Activated Charcoal
Miscellaneous Materials	Tank Bottom Liner Evaporation Tank Bottom Dirt Oily Dirt Fly Ash	Oily Insulation Sulfur Crushed KC Rock
Waters	Retort Water Graham Water Tank Cleanout Water Tank Bottom Water CROW Water	Water Scavenger Water, Coal Fines, Oil Unidentified UCG Water Hoe Creek Water RM1 Water Sludgy Water Treolite Distillates Free & Distilled Water

Table 15. Composite Samples and Individual Samples Requiring Analysis in Phase I of the North Site Cleanup Project (continued)

Product Stream	Composite Sample	Individual Sample
Tars, Oils, & Hydrocarbon Liquids	Tank Bottom Heavy Oil Solid	Tank Water
	Oil Pitch	Tank Oil
	Shale Oil-1	Tank Cleanout
	Shale Oil-2	Tank Cleanout Oil
	Shale Oil-3	
	Shale Oil Distillates	
	Tar Sand Heavy Oil	
	Heavy Oil Plus Coal	
	Dirty Oil & Sludge	
	Coal Tar	
	Heavy Oil	
	Heavy Fuel Oil	
	Heavy Crude Oil	
	Tank Bottom	
	Distillate Light Oil	
	Oily Material Plus Water	
	Tank Bottom Heavy Oil	
Unknown Materials	Pellets	Unknown Liquid
	Unknown Material	SAI Comp Material-Liquid
		SAI Comp Material-Solid
		Artic 75/90
Chemicals	Tretolite	Monoethanolamine
		Caustic Soda
		Boiler Water
		Treatment
		Dry Water Treatment-1
		Dry Water Treatment-2
		Soda Ash

Analysis of Unknown Materials and Chemicals

The unknown materials and chemicals were analyzed using quick screening methods to provide information on their composition and identity. EPA Method 3580 for waste dilution (U.S. EPA 1986) was used to prepare the unknown materials and chemicals for organic analysis by gas chromatography using EPA Method 8000 (U.S. EPA 1986). EPA Method 3010 or 3050 (U.S. EPA 1986) was used to digest the materials for metals analysis, and EPA Method 6010 (U.S. EPA 1986) was used to analyze the digestates. Some of these materials were also screened for anions using EPA Method 800.2 (U.S. EPA 1989). Materials that were not positively identified or determined to be hazardous were analyzed for their concentrations of the toxicity characteristic regulated analytes (U.S. EPA 1990). These analytes and the analytical methods required for their measurement are listed in Table 16 (U.S. EPA 1990). EPA Method 1311, the Toxicity Characteristic Leaching Procedure (TCLP) (U.S. EPA 1990) is most often used to determine toxicity. However, for cost and time effectiveness, it was decided to measure the levels of the regulated analytes in these materials, rather than perform both TCLP extraction and analysis.

Analysis of Tars, Oils, and Hydrocarbon Liquids

Tars, oils, and hydrocarbon liquids were to be analyzed by a total characterization to determine the levels of the toxicity characteristic regulated analytes present in these materials. As mentioned above, these analytes are listed in Table 16 and are used to evaluate the characteristic of toxicity. The TCLP is most often used to determine toxicity; however, there are many difficulties encountered when trying to apply this procedure to oily-type materials. The method is not designed for applicability to these types of materials. The TCLP states that if a total analysis of the material demonstrates that individual contaminants are not present, or that they are present, but in such low concentrations that the appropriate regulatory thresholds could not possibly be exceeded, the TCLP need not be run. This approach was to be taken for the tars, oils, and hydrocarbon liquids using the methods listed in Table 16 for the specific analytes. Any of these materials not meeting one of the criteria given above would be considered hazardous. However, difficulties were encountered in analyzing some of these materials. Because the tars and oils require high levels of dilution for total characterization of the TCLP regulated analytes, the method detection limits for the first set of samples analyzed were found to be higher than the TCLP regulatory levels. To handle this problem, the following approach was used. Samples from this product stream were analyzed first for regulated TCLP volatile compounds, specifically benzene, using the procedure described below. Those samples for which the procedure did not give TCLP volatile compounds greater than the action limits were then analyzed for their cresol content using SW-846 gas chromatography/mass spectrometry (GC/MS) methods. Gel permeation chromatography, SW-846 Method 3640 (U.S. EPA 1986), was used to cleanup the samples by removing high molecular weight compounds before GC/MS analysis.

Table 16. Toxicity Characteristic Constituents^a, Regulatory Levels, Analytical Method Numbers, and Hazardous Waste Numbers

EPA HW No. ^b	Constituent	Regulatory Level, mg/L	SW-846 Method No.
D004	Arsenic	5.0	6010 ^c /7060,7061 ^d
D005	Barium	100.0	6010/7080,7081
D018	Benzene	0.5	8020/8024
D006	Cadmium	1.0	6010/7130,7131
D019	Carbon Tetrachloride	0.5	8010,8240
D021	Chlorobenzene	100.0	8020,8240
D022	Chloroform	6.0	8010,8240
D007	Chromium	5.0	8010/7190,7191
D023	o-Cresol	200.0 ^e	8040,8250
D024	m-Cresol	200.0 ^e	8040,8250
D025	p-Cresol	200.0 ^e	8040,8250
D026	Cresol	200.0 ^e	8040,8250
D027	1,4-Dichlorobenzene	7.5	8010,8120
D028	1,2-Dichloroethane	0.5	8010,8240
D029	1,1-Dichloroethylene	0.7	8010,8240
D030	2,4-Dinitrotoluene	0.13	8090,8250
D032	Hexachlorobenzene	0.13	8090,8250
D033	Hexachloro-1,3-butadiene	0.5	8120,8250
D034	Hexachloroethane	3.0	8010,8240
D008	Lead	5.0	6010/7420,7421
D009	Mercury	0.2	----/7470,7471
D035	Methyl ethyl ketone	200.0	8015,8240
D036	Nitrobenzene	2.0	8090,8250
D037	Pentachlorophenol	100.0	8040,8250
D038	Pyridine	5.0	8090,8250
D010	Selenium	1.0	6010/7740,7741
D011	Silver	5.0	6010/7760,7761
D039	Tetrachloroethylene	0.7	8010,8240
D040	Trichloroethene	0.5	8010,8240
D041	2,4,5-Trichlorophenol	400.0	8040,8250
D042	2,4,6-Trichlorophenol	2.0	8040,8250
D043	Vinyl chloride	0.2	8010,8240

^a Regulated pesticides and herbicides are not listed.

^b EPA hazardous waste number

^c Method in 3rd edition of SW-846

^d Method in 2nd edition of SW-846

^e If o-, m-, and p-cresol concentrations can not be differentiated, the total cresol (D026) concentration is used. The regulatory level for total cresol is 200 mg/L.

Volatile Analysis of the Tars, Oils, and Hydrocarbon Liquids. These materials were treated as high-level samples. Extraction and analysis were by EPA Method 8240 (U.S. EPA 1986). One gram of sample, instead of four grams, was used in the extraction procedure. A 10 μ l aliquot of the extract was added to 5 mL of blank water, along with the internal standard. If results from this analysis did not show TCLP compounds greater than the action limits, a 100 μ l aliquot was analyzed.

Metals Analysis of the Tars, Oils, and Hydrocarbon Liquids. For metals determination, the samples were combusted prior to analysis using ASTM Method D-3684, Standard Test Method for Total Mercury in Coal by the Oxygen Bomb Combustion/Atomic Absorption Method (ASTM 1983). Following sample preparation, the combusted materials were analyzed by SW-846 Method 7470 for mercury, SW-846 Method 7060 for arsenic, and SW-846 Method 7740 for selenium (U.S. EPA 1986). EPA digestion Method 3050 and EPA Method 6010 were used to determine the concentrations of lead, cadmium, chromium, silver, and barium in the samples (U.S. EPA 1986).

Additional Characterization of the Tars, Oils, and Hydrocarbon Liquids. Some of the oils being stored at the North Site may be useful as fuels and were tested for their Btu (British thermal unit) content using ASTM Method D-240 (ASTM 1988), which is described in the Analytical Methods section of this report. Materials from the containers that were sampled for preparation and characterization of the heavy fuel oil composite were analyzed individually for their Btu content.

The three materials comprising the shale oil distillate composite and the distillate light oil composite were analyzed for their flash point using ASTM Method D-93, Standard Test Method for Flash Point by Pensky-Marten Closed Tester (ASTM 1988). This analysis was performed for ignitability testing.

Characterization of the North Site Waters

Waters were tested for pH (corrosivity) using EPA Method 9040 (U.S. EPA 1986). They were also analyzed for their total concentrations of the TCLP regulated analytes using the methods listed in Table 16. In most cases, the TCLP extract of a water sample is a filtrate of the water. In this project, to save the expense of performing solid content determinations and filtrations, the waters were analyzed and judged as hazardous or nonhazardous based on total concentrations.

Characterization of the Other North Site Product Streams

The remaining North Site materials were analyzed for toxicity using EPA Method 1311 (U.S. EPA 1990), which is described in the following Analytical Methods section. The unprocessed tar sand, unprocessed tar sand sludge, unprocessed western coal, unprocessed eastern coal, raw western oil shale, raw eastern oil shale, and material from the raw oil shale pile were also analyzed for their Btu content. ASTM Method D-2015 (ASTM 1983), which is also described in the Analytical Methods section, was used for this characterization.

Toxicity Testing

For toxicity testing, regulated pesticides and herbicides were not analyzed because of process knowledge. None of the North Site materials requiring disposal were associated with any agricultural processes, and as a result, analyses for regulated pesticides and herbicides were not required.

Originally, the planned North Site material characterization included semiquantitative screening of some materials for regulated volatile compounds prior to TCLP extraction. However, it was decided that full-scale TCLP characterization should be performed to provide information for proper disposal of the materials as wastes, if they are not needed for future research.

Analytical Methods

Characteristic of Ignitability

A solid waste exhibits the characteristic of ignitability if a representative sample of the waste has any of the following properties (40 CFR 261.21, 1992):

1. It 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 (ASTM 1988), or a Setaflash Closed Cup Tester, using the test method specified in ASTM Standard D-3278 (ASTM 1988), 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 (1992).
2. It is not a liquid and is capable, under standard temperature and pressure, of causing fire through friction, absorption of moisture, or spontaneous chemical changes and, when ignited, burns so vigorously and persistently that it creates a hazard.
3. It is an ignitable compressed gas as defined in 49 CFR 173.300 (1992) and as determined by the test methods described in that regulation or equivalent test methods approved by the EPA administrator under 40 CFR 260.20 and 260.21 (1992).
4. It is an oxidizer as defined in 49 CFR 173.151 (1992).

The characteristic of ignitability was tested using ASTM Method D-93, Standard Test Method for Flash Point by Pensky-Martens Closed Tester (ASTM 1988). In this test, the sample is heated at a slow, constant rate with continual stirring. A small flame is directed into the cup at regular intervals with simultaneous interruption of stirring. The flash point is the lowest temperature at which application of the test flame causes the vapor above the sample to ignite. As specified in 40 CFR 261.21 (1992), a waste exhibits the characteristic of ignitability if it has a flash point less than 60°C (140°F). Criteria for judging the acceptability of results are given in the precision and bias statements in the ASTM method. A solid waste that exhibits the characteristic of ignitability has the EPA Hazardous Waste Number D001.

The testing described above was used to examine the flash point of suspected materials that may be classified as wastes. The North Site materials were also considered for the applicability of the other ignitability properties listed above; however, based on knowledge of the materials, these were determined to be nonapplicable.

Characteristic of Corrosivity

A solid waste exhibits the characteristic of corrosivity if a representative sample of the waste has either of the following properties (40 CFR 261.22, 1992):

1. It 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 (1992). The EPA test method for pH is specified as Method 9040 in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846 (U.S. EPA 1986).
2. It 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 (NACE 1972) as standardized in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods," EPA Publication SW-846 (Method 1110-U.S. EPA 1986) 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 (1992).

For the North Site materials in the water stream, the characteristic of corrosivity was tested by measuring their pH values using SW-846 Method 9040 (U.S. EPA 1986). In this method, the pH of the sample is determined electrometrically using either a glass electrode in combination with a reference potential or a combination electrode. The measuring instrument is calibrated using a series of standard solutions of known pH. Information on the accuracy of the method at various pH units is given in the method performance section of the procedure. If a material has a pH less than or equal to 2 or greater than or equal to 12.5, it exhibits the characteristic of corrosivity and is given the EPA Hazardous Waste Number D002.

Characteristic of Reactivity

A solid waste exhibits the characteristic of reactivity if a representative sample of the waste has any of the following properties (40 CFR 261.23, 1992):

1. It is normally unstable and readily undergoes violent change without detonating.
2. It reacts violently with water.

3. It forms potentially explosive mixtures with water.
4. When mixed with water, it generates toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
5. It is a cyanide or sulfide bearing waste which, when exposed to pH conditions between 2 and 12.5, can generate toxic gases, vapors or fumes in a quantity sufficient to present a danger to human health or the environment.
6. It is capable of detonation or explosive reaction if it is subjected to a strong igniting source or if heated under confinement.
7. It is readily capable of detonation or explosive decomposition or reaction at standard temperature and pressure.
8. It is a forbidden explosive as defined in 49 CFR 173.51 (1992), or a Class A explosive as defined in 49 CFR 173.53 (1992), or a Class B explosive as defined in 49 CFR 173.88 (1992).

The various North Site materials were considered for reactivity testing based on the properties listed above. However, knowledge of the materials indicated that these reactive properties were not applicable to them.

Characteristic of Toxicity: Method 1311 Toxicity Characteristic Leaching Procedure

To test a material for the characteristic of toxicity, an extract from a representative sample of the material was generated using EPA Method 1311, the Toxicity Characteristic Leaching Procedure (TCLP) (U.S. EPA 1990). Materials for which their TCLP extracts contain any of the regulated contaminants listed in Table 16 at a concentration equal to or greater than the regulatory level, are classified as hazardous based on toxicity. Method 1311 can be found in Appendix II of 40 CFR 261 (1992). As mentioned, the methods specified for analysis of TCLP extracts are listed in Table 16 and can also be found in Tables 1 and 2 of Appendix III of 40 CFR 261 (1992). The method detection limits for analyzing TCLP extracts are given in the specific methods and are all well below the TCLP regulatory thresholds. The following QA/QC activities were performed for the North Site TCLP extractions.

- All data, including quality assurance data, are available for reference or inspection.
- A method blank for each batch of extraction fluid used was performed.
- A minimum of one blank (extraction fluid #1) for every ten extractions that were performed in an extraction vessel was employed as a check for memory effects from the extraction equipment.

- For each analytical batch (up to 20 samples), a matrix spike was performed to monitor the adequacy of the analytical method used on the TCLP extract and for determining any matrix interferences in analyte detection.
- All quality control measures described in the appropriate analytical methods were followed.
- TCLP extraction was performed within the following time period after sample collection: volatiles, 14 days; semivolatiles, 14 days; mercury, 28 days; and other metals, 180 days. Extraction of the samples was initiated as soon as possible. TCLP extracts were analyzed after generation and preservation within the following periods: volatiles, 14 days; semivolatiles, 40 days; mercury, 28 days; and other metals, 180 days. Preparative extraction for semivolatile organic compounds in the TCLP extracts was performed within 7 days after extract generation.

Heat of Combustion

Btu content of the heavy fuel oils was determined using ASTM Method D-240, Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (ASTM 1988). This ASTM method provides procedures for determining heat of combustion and is applicable to a variety of substances, but particularly to liquid hydrocarbon fuels of both low and high volatility. Heat of combustion is determined by burning a weighed sample in an oxygen bomb calorimeter under controlled conditions. The heat of combustion is calculated from temperature observations before, during, and after combustion, with proper allowance for thermochemical and heat transfer corrections. According to the method, duplicate results by the same operator should be considered suspect if they differ by more than 55 Btu/lb.

Btu determinations on the unprocessed coal, tar sand, and oil shale materials were performed to provide information necessary for their disposal. ASTM Method D-2015, Standard Test Method for Gross Calorific Value of Solid Fuel by the Adiabatic Bomb Calorimeter (ASTM 1983), which involves burning a weighed sample in an adiabatic oxygen bomb calorimeter under controlled conditions, was used for these determinations. The calorific value is calculated from temperature measurements as described above. Duplicate results by the same laboratory on different days, using the same operator and equipment, should not be considered suspect unless they differ by more than 50 Btu/lb on a dry weight basis.

Analytical QA/QC

Inorganic and organic Contract Laboratory Program (CLP) laboratories were used in phase I of this project to analyze samples and extracts of the North Site materials for verification of WRI's analytical results. CLP certification indicates that a high quality of data can be expected from the laboratory. The inorganic CLP laboratory was SVL Analytical, which is located in Kellogg, Idaho, and the organic CLP laboratory was Pace Laboratory, which is located in Lenexa, Kansas. There are no laboratories located in the nearby area that are both an inorganic and organic

CLP laboratory. For CLP verification, composite samples and individual samples were split; one portion was analyzed by WRI, and one portion was analyzed by the CLP laboratory. For samples requiring TCLP extractions, samples were split and extracted at WRI; extract from one split was analyzed by WRI, and the extract from the other split was analyzed by the CLP laboratory. Splits of samples were also sent to Pace Laboratory for flash point determinations.

The CLP laboratories encountered the same analytical problems as WRI in analyzing the oils and tars (i.e., dilution factors raising the method detection levels above regulatory values). Because analysis of these materials involved extensive analytical work and testing, many of the tars and oils were not analyzed by the CLP laboratories; however, materials, which were determined to contain levels of benzene exceeding the regulatory level, were sent to Pace Laboratory for verification of WRI's benzene data. Pace Laboratory and SVL Analytical also had similar difficulties in analyzing some of the materials that are listed under the water stream. Originally, it was planned that for decisions on classifying the North Site materials as hazardous or nonhazardous, WRI data and the CLP data must be in agreement (i.e., both showing the material to be hazardous or nonhazardous based on EPA criteria); however, due to the analytical difficulties, in some cases, only WRI data are available.

Splits of samples and extracts for the CLP laboratories were stored in a locked, refrigerated storage area until being shipped for analysis. Samples were shipped as soon as possible to meet analytical holding times. A chain-of-custody record and sample analysis request sheet accompanied the samples to the outside laboratories. Coolers containing ice substitute and packing material were used for shipping the samples. The chain-of-custody form and analytical request form were placed in a Ziplock bag and taped to the inside surface of the top of the cooler. A signed and dated custody seal was placed across the interface of the main body of the cooler and the cooler lid. Coolers were shipped to the laboratories via Federal Express. The person receiving the cooler at the CLP laboratory was requested to open the cooler, remove the enclosed sample documents, and record any problems on the chain-of-custody form. Items that were checked are:

- Presence/absence of the chain-of-custody record(s)
- Presence/absence of the analytical request form(s)
- Condition of samples (intact, broken, leaking, etc.)
- Presence/absence of sample labels

Consistency of information between the following documents was also checked:

- Chain-of-custody records
- Sample labels
- Analytical request forms

The sample receiver contacted the sample shipper if damaged samples or discrepancies were found. Yellow chain-of-custody forms were to be sent to WRI as verification of sample receipt, and after analyses were completed, the original copy of the chain-of-custody form was to be returned with the samples. In some cases, the

CLP laboratories deviated from these specifications of returning yellow copies at the time of sample receipt and original copies with the samples after analyses; however, during sample shipment, there was continuous communication with the laboratories by telephone to verify sample receipt and discuss any problems or discrepancies. After samples were received back from the CLP laboratory, they were added to their original product streams for appropriate disposal. Copies of the chain-of-custody records and sample analysis request forms for the samples and extracts, which were sent to the CLP laboratories, are included in Appendix C.

Analysis of Split Samples and Method Blanks. After preparation of the coal tar composite sample, the sample was split into four subsamples. Two of these were submitted to WRI for analysis, and two were submitted to the CLP laboratories for analysis. The splits were labeled such that the laboratories could not identify them as splits.

The tar sand sludge sample, crushed KC rock sample, and oil pitch composite sample were split, and each split was given to WRI extraction personnel for TCLP extraction as a blind sample. The extracts that resulted were also submitted blindly to WRI and the CLP laboratories for analysis.

In addition, as part of TCLP QA/QC, a method blank was performed for each batch of TCLP extraction fluid that was used. Method blanks are performed to show any contamination of the extract from the reagents, water, or extraction equipment. To save on shipping costs, the method blanks were analyzed by WRI. Also, during the TCLP extractions, two sets of TCLP equipment blanks were generated using the extraction vessels used in phase I TCLP testing. Equipment blanks provide a check for memory effects from the extraction equipment. In addition to these QA/QC activities, specific QA/QC requirements outlined in the analytical methods for TCLP extracts were performed as specified.

Analytical Chain-of-Custody Procedures and Notebooks. As mentioned earlier, chain-of-custody procedures are being used in this cleanup project to ensure the integrity of samples from the time of collection through analysis and final disposition. For WRI TCLP extractions and analyses, chain-of-custody procedures, as previously described, were followed. Chain-of-custody seals, chain-of-custody forms, and analytical request forms were used. After their preparation, composite samples, split samples and blanks for QA/QC, and TCLP extracts were sealed with a custody seal. For chain-of-custody forms, the original and yellow sheets accompanied samples to the extraction and analytical personnel. Then the yellow sheet was returned to the project coordinator to verify sample receipt, and the original sheet was returned by the laboratory personnel with the remaining samples after the extractions or analyses were completed. Custody forms and analytical request forms were prepared and handled in a similar manner for analysis of TCLP extracts. Copies of the WRI sample analysis request forms and chain-of-custody forms are also included in Appendix C.

All information concerning preparation of composite samples, split samples for QA/QC, and TCLP extracts, as well as information on their analyses, was recorded in WRI project notebooks. These notebooks cross reference each other and the

sampling logbook and page number describing sampling of the material. Copies of the notebook pages documenting sample compositing, splitting, and TCLP extraction are also included in Appendix B.

North Site Materials Handling Data Base

To track materials in the North Site cleanup project, the North Site Materials Handling Data Base was created. This data base provides a quick and accurate means for producing reports on the status of the cleanup project. The materials handling data base currently contains an inventory of the materials requiring disposal or use, as well as, the product stream to which the material belongs, composite information, sampling and analytical information, analytical data, and hazard classification. This data base allows tracking of a material listed in the North Site inventory through the sampling and analytical processes, to a decision on hazard classification, and finally, when the project is completed, it will contain information on disposal or use of the material.

The data base system is written in FoxPro 2.0. Five primary and two helper data base files were developed. At the beginning of phase I, information, such as location, quantity, container size and type, storage environment, date accumulated, and date last inspected, was entered into the data base for each of the materials. Then as the materials were divided into product streams and composite groups and sampling, compositing, and analysis started, information concerning these activities was added, along with results from the analyses. Based on the analytical results that are entered into the data base, hazard classifications are assigned to the materials. As the cleanup project proceeds, the data base will be expanded to include information concerning the activities in phases II, III, IV, and V.

Photographs

Photographs are a very useful record of field and laboratory activities. During phase I of this project, containers of the materials being stored at the North Site and the various activities involved in characterizing them were photographed. These photographs, which are included as Appendix D, show material storage, sampling activities, various steps involved in generating TCLP extracts, and various analytical activities and instrumentation involved in analyzing the North Site TCLP extracts and samples.

RESULTS AND DISCUSSION

Results from TCLP Extractions of Composite and Individual Samples

Composite and individual samples of materials from the North Site product streams were extracted using the TCLP (U.S. EPA 1990) to determine their hazard classification based on toxicity. The materials giving TCLP extracts that do not contain concentrations of any of the regulated analytes above their regulatory levels (listed in Table 16) pass the TCLP and are classified as nonhazardous based on toxicity. Conversely, any of the North Site materials that give TCLP extracts containing concentrations of one or more of the regulated analytes above their regulatory levels fail the TCLP and are classified as hazardous. Pass/fail results for the materials that were characterized by TCLP extraction are listed in Table 17. Results based on both data from WRI analyses of TCLP extracts and data from the CLP laboratory analyses are given. As shown in Table 17, all of the North Site materials tested by TCLP extraction pass and are nonhazardous based on toxicity. In addition, for all cases, WRI and CLP laboratory data give the same passing results.

Shown in Table 18 are the concentrations of the regulated metals in the TCLP extracts of the North Site materials, which were characterized by TCLP extraction (Table 17). Many of the concentrations of the regulated metals in the extracts are below the analytical detection limits; and the concentrations of those elements that are above the analytical detection limits are well below their TCLP regulatory values. In most cases, barium concentrations of approximately 0.04 mg/L were detected in the TCLP method blanks, indicating a small amount of barium contamination. This contamination is believed to originate from the chemicals used in preparing the TCLP extraction fluid and is not a problem for hazard classification because the action level for barium is 100 mg/L. There is generally good agreement between WRI data and the data generated by SVL Analytical. In some cases, SVL had a lower detection limit than WRI, and more elements were detected in the extracts at very low concentrations. The minimum attainable detection limit can vary from sample-to-sample because of concentration/dilution action that may be necessary for analysis. As a result, analytical detection limits vary between WRI and SVL and also between samples. Listed in Table 19 are the WRI and SVL analytical detection limits that were in effect for metals analysis of the majority of the North Site TCLP extracts. All metals data generated by WRI and SVL Analytical in analyzing the TCLP extracts of the North Site samples can be found in Appendix E.

As shown in Tables 17 and 18, the fly ash composite sample was not characterized by TCLP for the regulated organic compounds. This is because the materials comprising this composite group are to be disposed in a landfill, and because of process knowledge concerning their generation, only TCLP metals data are required. The fly ash materials were added to the disposal list at the end of phase I, and to save time, their TCLP extract was analyzed by WRI only.

Table 17. Characterization of North Site Composite and Individual Samples by TCLP Extraction

Product Stream/ Material	Characterization	WRI Data	CLP Data
<u>Unprocessed Tar Sand</u>			
Tar Sand	TCLP Metals	Pass	Pass
	TCLP BNA's^a	Pass	Pass
	TCLP Volatiles	Pass	Pass
Tar Sand Sludge	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Tar Sand Sludge Split	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
<u>Unprocessed Coals</u>			
Unprocessed Western Coal	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Unprocessed Eastern Coal	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
<u>Raw Oil Shales</u>			
Raw Western Oil Shale	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Raw Eastern Oil Shale	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Raw Oil Shale Pile	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass

^a Regulated semivolatile organic compounds, base, neutral, and acid (BNA's)

Table 17. Characterization of North Site Composite and Individual Samples by TCLP Extraction (continued)

Product Stream/ Material	Characterization	WRI Data	CLP Data
<u>Spent Oil Shale, Processed Tar Sand, Activated Charcoal</u>			
Spent Oil Shale-1	TCLP Metals	Pass	Pass
	TCLP BNA's^a	Pass	Pass
	TCLP Volatiles	Pass	Pass
Spent Oil Shale-2	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Spent Oil Shale Pile	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Spent Tar Sand	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Activated Charcoal	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Unused Activated Charcoal	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
MG Fines, Char	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
<u>Miscellaneous Materials</u>			
Oily Insulation	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Tank Bottom Liner	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Evaporation Tank Bottom Dirt	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass

^a Regulated semivolatile organic compounds, base, neutral, and acid (BNA's)

Table 17. Characterization of North Site Composite and Individual Samples by TCLP Extraction (continued)

Product Stream/ Material	Characterization	WRI Data	CLP Data
<u>Miscellaneous Materials (continued)</u>			
Oily Dirt	TCLP Metals	Pass	Pass
	TCLP BNA's ^a	Pass	Pass
	TCLP Volatiles	Pass	Pass
Sulfur	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Crushed KC Rock	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Crushed KC Rock Split	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Fly Ash	TCLP Metals	Pass	--- ^b
	TCLP BNA's	--- ^c	--- ^c
	TCLP Volatiles	--- ^c	--- ^c
<u>Tars, Oils, and Hydrocarbon Liquids</u>			
Tank Bottom Heavy Oil Solid	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Oil Pitch	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
Oil Pitch Split	TCLP Metals	Pass	Pass
	TCLP BNA's	Pass	Pass
	TCLP Volatiles	Pass	Pass
<u>Unknown Materials</u>			
Pellets	TCLP Metals	Pass	Pass
	TCLP BNA's	--- ^d	--- ^d
	TCLP Volatiles	--- ^d	--- ^d

^a Regulated semivolatile organic compounds, base, neutral, and acid (BNA's)

^b Sample not submitted for analysis

^c Analysis not required for landfill disposal due to process knowledge

^d Sample not submitted for analysis-Organic screening shows that the sample does not contain any organic compounds that are amenable to GC analysis.

Table 18. Concentrations of the Regulated Metals in the TCLP Extracts of the North Site Materials

Composite/ Individual Sample	As (5.0) ^a	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Tar Sand								
WRI	BDL ^b	0.25	BDL	0.01	BDL	BDL	BDL	BDL
SVL ^c	BDL	0.41	BDL	0.01	BDL	BDL	BDL	BDL
Tar Sand Sludge								
WRI	BDL	0.04	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.03	BDL	BDL	BDL	BDL	BDL	BDL
Tar Sand Sludge Split								
WRI	BDL	0.04	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.04	BDL	BDL	BDL	BDL	BDL	BDL
Unprocessed Western Coal								
WRI	BDL	0.73	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.80	BDL	BDL	BDL	BDL	BDL	BDL
Unprocessed Eastern Coal								
WRI	BDL	0.05	0.02	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.05	0.02	BDL	BDL	BDL	BDL	BDL
Raw Western Oil Shale								
WRI	BDL	1.23	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	1.20	BDL	BDL	BDL	BDL	BDL	BDL
Raw Eastern Oil Shale								
WRI	BDL	0.26	0.05	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.24	0.03	0.004	BDL	BDL	0.14	BDL
Raw Oil Shale Pile								
WRI	BDL	1.57	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	1.50	BDL	0.007	BDL	BDL	BDL	BDL
Spent Oil Shale-1								
WRI	BDL	0.14	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.17	BDL	BDL	BDL	BDL	BDL	BDL

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

^b Below analytical detection limit

^c SVL Analytical is the inorganic CLP laboratory that was used in phase I to verify WRI's analytical results.

Table 18. Concentrations of the Regulated Metals in the TCLP Extracts of the North Site Materials (continued)

Composite/ Individual Sample	As (5.0) ^a	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Spent Oil Shale-2								
WRI	BDL ^b	0.20	BDL	BDL	BDL	BDL	BDL	BDL
SVL ^c	BDL	0.22	0.003	BDL	BDL	BDL	BDL	BDL
Spent Oil Shale Pile								
WRI	BDL	0.10	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.09	BDL	0.005	BDL	BDL	BDL	BDL
Spent Tar Sand								
WRI	BDL	0.48	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.50	BDL	BDL	BDL	BDL	BDL	BDL
Activated Charcoal								
WRI	BDL	0.39	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.36	BDL	0.004	BDL	BDL	BDL	BDL
Unused Activated Charcoal								
WRI	BDL	0.41	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.36	BDL	BDL	BDL	BDL	BDL	BDL
MG Fines, Char								
WRI	BDL	1.18	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	1.28	BDL	BDL	BDL	BDL	BDL	BDL
Oily Insulation								
WRI	BDL	0.04	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.04	BDL	BDL	BDL	BDL	BDL	BDL
Tank Bottom Liner								
WRI	BDL	0.10	BDL	BDL	BDL	BDL	BDL	BDL
SVL	0.09	0.12	0.003	0.005	BDL	BDL	BDL	BDL
Evaporation Tank Bottom Dirt								
WRI	BDL	0.09	0.01	0.04	BDL	BDL	BDL	BDL
SVL	0.63	0.08	0.004	0.04	BDL	0.0005	0.33	BDL
Oily Dirt								
WRI	BDL	0.06	0.01	BDL	BDL	BDL	BDL	BDL
SVL	0.20	0.07	0.01	0.01	BDL	0.0003	BDL	BDL

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

^b Below analytical detection limit

^c SVL Analytical is the inorganic CLP laboratory that was used in phase I to verify WRI's analytical results.

Table 18. Concentrations of the Regulated Metals in the TCLP Extracts of the North Site Materials (continued)

Composite/ Individual Sample	As (5.0) ^a	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Sulfur								
WRI	BDL ^b	0.09	BDL	0.03	BDL	BDL	BDL	BDL
SVL ^c	BDL	0.10	BDL	0.04	BDL	BDL	BDL	BDL
Crushed KC Rock								
WRI	BDL	0.10	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Crushed KC Rock Split								
WRI	BDL	0.10	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.10	BDL	BDL	BDL	BDL	BDL	BDL
Fly Ash								
WRI	BDL	0.90	BDL	0.01	0.20	BDL	0.10	0.02
SVL ^d								
Tank Bottom Heavy Oil Solid								
WRI	0.41	0.11	0.02	BDL	BDL	BDL	BDL	BDL
SVL	0.51	0.11	0.01	0.009	BDL	0.0005	0.09	BDL
Oil Pitch								
WRI	BDL	0.48	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.51	BDL	BDL	BDL	BDL	BDL	BDL
Oil Pitch Split								
WRI	BDL	0.40	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.46	BDL	BDL	BDL	BDL	BDL	BDL
Pellets								
WRI	BDL	0.72	BDL	BDL	BDL	BDL	BDL	BDL
SVL	BDL	0.64	BDL	BDL	BDL	BDL	BDL	BDL

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

^b Below analytical detection limit

^c SVL Analytical is the inorganic CLP laboratory that was used in phase I to verify WRI's analytical results.

^d Extract was not analyzed by SVL.

Table 19. Analytical Detection Limits for Metals Analyses of the North Site TCLP Extracts, mg/L

Regulated Metal	WRI Detection Limit	SVL Detection Limit ^a
Arsenic	0.10	0.04
Barium	0.01	0.01
Cadmium	0.01	0.002
Chromium	0.008	0.003
Lead	0.10	0.04
Mercury	0.002	0.0002
Selenium	0.10	0.04
Silver	0.02	0.002

^a SVL Analytical is the inorganic CLP laboratory that was used in phase I to verify WRI's analytical results.

None of the semivolatile organic compounds, which are regulated under the toxicity characteristic, were detected in the TCLP extracts of the North Site materials at levels above their analytical detection limits. The detection limits that were generally in effect for WRI and CLP analyses are listed in Table 20. WRI's detection limits were well below the TCLP action levels, while Pace chose to set their detection limits at the regulatory levels. None of the regulated semivolatile organic compounds were detected in the TCLP method blanks. Semivolatile organic data from analysis of the North Site TCLP extracts are included in Appendix E.

The general WRI and Pace analytical detection limits for analysis of the TCLP regulated volatile organic compounds in the North Site TCLP extracts are listed in Table 21. As for the semivolatile organic analyses, WRI's detection limits were well below the TCLP action values, while Pace's detection limits were at the regulatory levels. As a result, WRI detected very low concentrations of some volatile compounds in the extracts, which were not reported by Pace. Methyl ethyl ketone, at concentrations less than 0.2 mg/L, was detected by WRI in extracts of the evaporation tank bottom dirt, oily dirt, MG fines, char, western raw oil shale, eastern raw oil shale, raw oil shale pile, and oil pitch; and concentrations of benzene, at levels less than 0.2 mg/L, were detected by WRI in extracts of the MG fines, char and oil pitch. These levels for both compounds are well below their regulatory values (Table 16). None of the regulated volatile organic compounds were detected in the TCLP method blanks. Volatile organic data from analysis of the North Site TCLP extracts are included in Appendix E.

Table 20. Analytical Detection Limits for Semivolatile Organic Analyses of the North Site TCLP Extracts, mg/L

Semivolatile Compound	WRI Detection Limit	Pace Detection Limit ^a
Pyridine	0.10	5.0
1,4-Dichlorobenzene	0.04	7.5
2-methylphenol	0.04	200.0
4-methylphenol/3-methyl phenol	0.04	200.0
Hexachloroethane	0.04	3.0
Nitrobenzene	0.04	2.0
Hexachlorobutadiene	0.04	0.5
2,4,5-Trichlorophenol	0.10	400.0
2,4,6-Trichlorophenol	0.04	2.0
2,4-Dinitrotoluene	0.04	0.13
Hexachlorobenzene	0.04	0.13
Pentachlorophenol	0.10	100.0

^a Pace Laboratory is the organic CLP laboratory that was used in phase I to verify WRI's analytical results.

Table 21. Analytical Detection Limits for Volatile Organic Analyses of the North Site TCLP Extracts, mg/L

Volatile Compound	WRI Detection Limit	Pace Detection Limit ^a
Vinyl Chloride	0.01	0.20
1,1-Dichloroethene	0.005	0.70
Methyl ethyl ketone	0.01	200.0
Carbon Tetrachloride	0.005	0.50
Chlorobenzene	0.005	100.0
Trichloroethene	0.005	0.50
Chloroform	0.005	6.0
1,2-Dichloroethane	0.005	0.50
Tetrachloroethene	0.005	0.70
Benzene	0.005	0.50

^a Pace Laboratory is the organic CLP laboratory that was used in phase I to verify WRI's analytical results.

TCLP QA/QC Results

TCLP QA/QC included TCLP method blanks, TCLP extraction of split samples, TCLP equipment blanks, field trip blanks for sampling materials for TCLP extraction, and analytical blank and matrix spike analyses. As mentioned above, none of the regulated TCLP analytes were detected above their analytical detection limits in any of the North Site TCLP method blanks, with the exception of barium at very low concentrations (~0.04 mg/L). This low level barium contamination is believed to originate from the chemicals used in preparing the TCLP extraction fluid. Because the action level for barium is 100 mg/L, this low level contamination does not pose a problem.

Blind splits of the tar sand sludge sample, crushed KC rock sample, and oil pitch composite sample were extracted by WRI, and the resulting TCLP extracts were analyzed by WRI and the CLP laboratories. Results from those analyses are listed in Tables 22, 23, and 24. As shown in Tables 22 and 23, barium is the only TCLP regulated analyte that was detected in any of the extracts of the tar sand sludge and crushed KC rock at a concentration above the analytical detection limits. This was due to contamination as discussed above. In the extracts of the oil pitch composite, only barium, methyl ethyl ketone, and benzene were detected above the analytical detection limits (Table 23). Because Pace used such high detection limits, they did not report the low levels of organics detected in the oil pitch TCLP extracts by WRI. The metals data that were generated by WRI and SVL are in close agreement, as are the data for the extracts from the original samples and their splits.

Two sets of TCLP equipment blanks were run in the extraction vessels used for the North Site TCLP testing. These were performed to check for any memory effects due to the extraction equipment. The equipment blanks consisted of TCLP extraction fluid rotated in the extraction vessels and filtered as specified in the TCLP. They were analyzed by WRI for the TCLP regulated analytes (Table 16). The equipment blanks generated in the zero-headspace extractors, which were used to generate TCLP extracts for analysis of volatile organic compounds, contained none of the TCLP regulated volatile organic compounds at levels above the detection limits given in Table 21. Blanks were also generated in the borosilicate glass bottles, which were used to generate TCLP extracts for analysis of metals and semivolatile organic compounds. These blanks contained none of the regulated metals or semivolatile organic compounds at levels above the detection limits given in Tables 19 and 20, with the exception of barium, which was present in all of the equipment blanks at levels of 0.03 to 0.04 mg/L. This correlates with the barium contamination that was detected in the TCLP method blanks.

As shown in Table 12, a field trip blank was taken to the field for sampling the crushed KC rock, raw eastern oil shale, raw oil shale pile, tank bottom heavy oil solid, and pellets for TCLP extraction. A second field trip blank was also taken to the field for sampling the oil pitch materials for TCLP extraction. These blanks were analyzed by WRI and contained none of the TCLP regulated analytes above the analytical detection limits listed in Tables 19, 20, and 21.

Table 22. Concentrations of the TCLP Regulated Analytes in TCLP Extracts of the Tar Sand Sludge Sample and Tar Sand Sludge Sample Split, mg/L

TCLP Analyte	Tar Sand Sludge WRI	Tar Sand Sludge CLP	Tar Sand Sludge Split WRI	Tar Sand Sludge Split CLP
Arsenic	<0.10	<0.04	<0.10	<0.04
Barium	0.039	0.029	0.043	0.044
Cadmium	<0.01	<0.002	<0.01	<0.002
Chromium	<0.008	<0.004	<0.008	<0.004
Lead	<0.10	<0.04	<0.10	<0.04
Mercury	<0.002	<0.0002	<0.002	<0.0002
Selenium	<0.10	<0.04	<0.10	<0.04
Silver	<0.02	<0.003	<0.02	<0.003
Pyridine	<0.25	<5.0	<0.25	<5.0
1,4-Dichlorobenzene	<0.10	<7.5	<0.10	<7.5
2-methylphenol	<0.10	<200.0	<0.10	<200.0
4-methylphenol/ 3-methylphenol	<0.10	<200.0	<0.10	<200.0
Hexachloroethane	<0.10	<3.0	<0.10	<3.0
Nitrobenzene	<0.10	<2.0	<0.10	<2.0
Hexachlorobutadiene	<0.10	<0.5	<0.10	<0.5
2,4,5-Trichlorophenol	<0.25	<400.0	<0.25	<400.0
2,4,6-Trichlorophenol	<0.10	<2.0	<0.10	<2.0
2,4-Dinitrotoluene	<0.10	<0.13	<0.10	<0.13
Hexachlorobenzene	<0.10	<0.13	<0.10	<0.13
Pentachlorophenol	<0.25	<100.0	<0.25	<100.0
Vinyl Chloride	<0.01	<0.20	<0.01	<0.20
1,1-Dichloroethene	<0.005	<0.70	<0.005	<0.70
Methyl ethyl ketone	<0.01	<200.0	<0.01	<200.0
Carbon Tetrachloride	<0.005	<0.5	<0.005	<0.5
Chlorobenzene	<0.005	<100.0	<0.005	<100.0
Trichloroethene	<0.005	<0.5	<0.005	<0.5
Chloroform	<0.005	<6.0	<0.005	<6.0
1,2-Dichloroethane	<0.005	<0.5	<0.005	<0.5
Tetrachloroethene	<0.005	<0.7	<0.005	<0.7
Benzene	<0.005	<0.5	<0.005	<0.5

Table 23. Concentrations of the TCLP Regulated Analytes in TCLP Extracts of the Crushed KC Rock Sample and Crushed KC Rock Sample Split, mg/L

TCLP Analyte	Crushed KC Rock WRI	Crushed KC Rock CLP	Crushed KC Rock Split WRI	Crushed KC Rock Split CLP
Arsenic	<0.10	<0.04	<0.10	<0.04
Barium	0.097	0.102	0.104	0.102
Cadmium	<0.01	<0.002	<0.01	<0.002
Chromium	<0.008	<0.004	<0.008	<0.004
Lead	<0.10	<0.04	<0.10	<0.04
Mercury	<0.002	<0.0002	<0.002	<0.0002
Selenium	<0.10	<0.04	<0.10	<0.04
Silver	<0.02	<0.003	<0.02	<0.003
Pyridine	<0.10	<5.0	<0.10	<5.0
1,4-Dichlorobenzene	<0.04	<7.5	<0.04	<7.5
2-methylphenol	<0.04	<200.0	<0.04	<200.0
4-methylphenol/ 3-methylphenol	<0.04	<200.0	<0.04	<200.0
Hexachloroethane	<0.04	<3.0	<0.04	<3.0
Nitrobenzene	<0.04	<2.0	<0.04	<2.0
Hexachlorobutadiene	<0.04	<0.5	<0.04	<0.5
2,4,5-Trichlorophenol	<0.10	<400.0	<0.10	<400.0
2,4,6-Trichlorophenol	<0.04	<2.0	<0.04	<2.0
2,4-Dinitrotoluene	<0.04	<0.13	<0.04	<0.13
Hexachlorobenzene	<0.04	<0.13	<0.04	<0.13
Pentachlorophenol	<0.10	<100.0	<0.10	<100.0
Vinyl Chloride	<0.01	<0.20	<0.01	<0.20
1,1-Dichloroethene	<0.005	<0.70	<0.005	<0.70
Methyl ethyl ketone	<0.01	<200.0	<0.01	<200.0
Carbon Tetrachloride	<0.005	<0.5	<0.005	<0.5
Chlorobenzene	<0.005	<100.0	<0.005	<100.0
Trichloroethene	<0.005	<0.5	<0.005	<0.5
Chloroform	<0.005	<6.0	<0.005	<6.0
1,2-Dichloroethane	<0.005	<0.5	<0.005	<0.5
Tetrachloroethene	<0.005	<0.7	<0.005	<0.7
Benzene	<0.005	<0.5	<0.005	<0.5

Table 24. Concentrations of the TCLP Regulated Analytes in TCLP Extracts of the Oil Pitch Composite and Oil Pitch Composite Split, mg/L

TCLP Analyte	Oil Pitch WRI	Oil Pitch CLP	Oil Pitch Split WRI	Oil Pitch Split CLP
Arsenic	<0.10	<0.04	<0.10	<0.04
Barium	0.477	0.512	0.403	0.457
Cadmium	<0.01	<0.002	<0.01	<0.002
Chromium	<0.008	<0.004	<0.008	<0.004
Lead	<0.05	<0.04	<0.05	<0.04
Mercury	<0.002	<0.0002	<0.002	<0.0002
Selenium	<0.10	<0.04	<0.10	<0.04
Silver	<0.01	<0.003	<0.01	<0.003
Pyridine	<0.25	<5.0	<0.25	<5.0
1,4-Dichlorobenzene	<0.10	<7.5	<0.10	<7.5
2-methylphenol	<0.10	<200.0	<0.10	<200.0
4-methylphenol/ 3-methylphenol	<0.10	<200.0	<0.10	<200.0
Hexachloroethane	<0.10	<3.0	<0.10	<3.0
Nitrobenzene	<0.10	<2.0	<0.10	<2.0
Hexachlorobutadiene	<0.10	<0.5	<0.10	<0.5
2,4,5-Trichlorophenol	<0.25	<400.0	<0.25	<400.0
2,4,6-Trichlorophenol	<0.10	<2.0	<0.10	<2.0
2,4-Dinitrotoluene	<0.10	<0.13	<0.10	<0.13
Hexachlorobenzene	<0.10	<0.13	<0.10	<0.13
Pentachlorophenol	<0.25	<100.0	<0.25	<100.0
Vinyl Chloride	<0.01	<0.20	<0.01	<0.20
1,1-Dichloroethene	<0.005	<0.70	<0.005	<0.70
Methyl ethyl ketone	0.026	<200.0	0.027	<200.0
Carbon Tetrachloride	<0.005	<0.5	<0.005	<0.5
Chlorobenzene	<0.005	<100.0	<0.005	<100.0
Trichloroethene	<0.005	<0.5	<0.005	<0.5
Chloroform	<0.005	<6.0	<0.005	<6.0
1,2-Dichloroethane	<0.005	<0.5	<0.005	<0.5
Tetrachloroethene	<0.005	<0.7	<0.005	<0.7
Benzene	0.19	<0.5	0.15	<0.5

The data from analyses of the TCLP method blanks, TCLP split sample extracts, TCLP equipment blanks, and trip blanks for sampling materials for TCLP extraction are included in appendix E of this report. QA/QC data from analyses of instrument blanks and matrix spike analyses are also included in Appendix E with the corresponding sample data.

Btu Characterization of the Unprocessed Tar Sand, Unprocessed Coal, and Raw Oil Shale Streams

In addition to TCLP characterization, the composite groups within the unprocessed tar sand, unprocessed coal, and raw oil shale streams were analyzed by WRI for their Btu content. Some of these materials, if not all of them, will most likely be disposed in a landfill, and landfills require Btu information for acceptance of these types of materials. The Btu values of the unprocessed tar sands, unprocessed coals, and raw oil shales are listed in Table 25.

Characterization of the North Site Waters

pH Values of the North Site Waters

The materials comprising the North Site water stream were measured for their pH values to determine if they would be classified as hazardous based on corrosivity. As mentioned, an aqueous material having a pH less than or equal to 2 or greater than or equal to 12.5, as determined by a pH meter using an approved method (40 CFR 261.22, 1992), exhibits the hazardous characteristic of corrosivity. The pH values of the North Site water individual and composite samples are listed in Table 26. None of these materials have pH values less than or equal to 2 or greater than or equal to 12.5. As a result, they are not hazardous based on their pH (corrosivity).

North Site Waters Characterization for TCLP Regulated Analytes

The North Site waters were analyzed for their total concentrations of the TCLP regulated analytes. As previously mentioned, in most cases, the TCLP extract of a water sample is a filtrate of the water, which is then analyzed for the regulated analytes. To save the time and expense of performing solid content determinations and filtrations, the waters were analyzed and judged as hazardous or nonhazardous based on their total concentrations. The concentrations of the regulated metals and organic compounds that were determined to be present in the North Site waters by both WRI and the CLP laboratories are listed in Tables 27-33. The only water that was not analyzed by the CLP laboratories is the CROW™ (Contained Recovery of Oil Wastes) water (Table 32), which was added to the disposal list late in phase I. Copies of the original data report forms that were received from the analytical laboratories for analysis of the North Site waters are included in Appendix E.

Table 25. Btu Content of Unprocessed Tar Sand, Unprocessed Coal, and Raw Oil Shale Samples

Composite/Individual Sample	Btu Value
Tar Sand	1,589 Btu/lb ^a
Tar Sand Sludge	7,885 Btu/lb
Tar Sand Sludge Split	7,411 Btu/lb
Unprocessed Western Coal	9,772 Btu/lb
Unprocessed Eastern Coal	10,880 Btu/lb
Raw Western Oil Shale	2,394 Btu ^b
Raw Eastern Oil Shale	2,928 Btu
Raw Oil Shale Pile	2,138 Btu

^a Heating value

^b Calorific value

Table 26. pH Values of the North Site Waters

Composite/Individual Water Sample	pH
Retort Water	9.2
Graham Water	9.1
Tank Cleanout Water	9.3
Water Scavenger	2.5
Water, Coal Fines, Oil	7.9
Unidentified UCG Water	8.1
Hoe Creek Water	8.3
RM1 Water	8.3
CROW Water	6.9
Tank Bottom Water	5.9
Sludgy Water	7.1
Treolite Distillates	5.0
Free & Distilled Water	7.0

Table 27. Concentrations of the TCLP Regulated Analytes in the North Site Retort Water and Graham Water, mg/L

TCLP Analyte	Retort Water WRI	Retort Water CLP	Graham Water WRI	Graham Water CLP
Arsenic (5.0) ^a	<1.0	0.995	<1.0	<0.04
Barium (100)	<0.1	0.033	<0.1	0.039
Cadmium (1.0)	<0.1	<0.002	<0.1	<0.002
Chromium (5.0)	0.09	0.005	<0.08	0.004
Lead (5.0)	<0.5	<0.04	<0.5	<0.04
Mercury (0.2)	0.0011	0.004	<0.0002	<0.0002
Selenium (1.0)	<1.0	0.234	<1.0	<0.04
Silver (5.0)	<0.01	<0.002	<0.01	<0.002
Pyridine (5.0)	<1.3	--- ^b	<0.1	--- ^b
1,4-Dichlorobenzene (7.5)	<0.5	<10	<0.04	<0.01
2-methylphenol (200)	17.0	<10	<0.04	<0.01
4-methylphenol/ 3-methylphenol (200)	18.0	<10	<0.04	<0.01
Hexachloroethane (3.0)	<0.5	<10	<0.04	<0.01
Nitrobenzene (2.0)	<0.5	<10	<0.04	<0.01
Hexachlorobutadiene (0.5)	<0.5	<10	<0.04	<0.01
2,4,5-Trichlorophenol (400)	1.3	<10	<0.1	<0.01
2,4,6-Trichlorophenol (2.0)	<0.5	<10	<0.04	<0.01
2,4-Dinitrotoluene (0.13)	<0.13	<10	<0.04	<0.01
Hexachlorobenzene (0.13)	<0.13	<10	<0.04	<0.01
Pentachlorophenol (100)	<1.3	<50	<0.1	<0.05
Vinyl Chloride (0.2)	<0.1	<10	<0.01	<0.01
1,1-Dichloroethene (0.7)	<0.1	<5	<0.005	<0.005
Methyl ethyl ketone (200)	13.0	<5	<0.01	<0.005
Carbon Tetrachloride (0.5)	<0.2	<5	<0.005	<0.005
Chlorobenzene (100)	<0.1	<5	<0.005	<0.005
Trichloroethene (0.5)	<0.1	<5	<0.005	<0.005
Chloroform (6.0)	<0.1	<5	<0.005	<0.005
1,2-Dichloroethane(0.5)	<0.1	<5	<0.005	<0.005
Tetrachloroethene(0.7)	<0.1	<5	<0.005	<0.005
Benzene (0.5)	<0.1	<5	<0.005	<0.005

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

^b No value reported

Table 28. Concentrations of the TCLP Regulated Analytes in the North Site Tank Cleanout Water and Water Scavenger, mg/L

TCLP Analyte	Tank Cleanout Water-WRI	Tank Cleanout Water-CLP	Water Scavenger WRI	Water Scavenger CLP
Arsenic (5.0) ^a	<1.0	1.46	<1.0	0.065
Barium (100)	0.12	0.040	<0.1	0.012
Cadmium (1.0)	0.37	0.080	<0.1	0.024
Chromium (5.0)	0.26	0.055	0.13	0.006
Lead (5.0)	<0.5	<0.04	<0.5	<0.04
Mercury (0.2)	0.004	<0.002	<0.002	<0.002
Selenium (1.0)	<1.0	0.087	<1.0	<0.04
Silver (5.0)	<0.01	<0.002	<0.01	<0.002
Pyridine (5.0)	<1.3	<10	<0.1	--- ^b
1,4-Dichlorobenzene (7.5)	<0.5	<10	<0.04	<0.01
2-methylphenol (200)	2.9	<10	<0.04	<0.01
4-methylphenol/ 3-methylphenol (200)	4.4	<10	<0.04	<0.01
Hexachloroethane (3.0)	<0.5	<10	<0.04	<0.01
Nitrobenzene (2.0)	<0.5	<10	<0.04	<0.01
Hexachlorobutadiene (0.5)	<0.5	<10	<0.04	<0.01
2,4,5-Trichlorophenol (400)	<1.3	<10	<0.1	<0.01
2,4,6-Trichlorophenol (2.0)	<0.5	<10	<0.04	<0.01
2,4-Dinitrotoluene (0.13)	<1.3	<10	<0.04	<0.01
Hexachlorobenzene (0.13)	<0.13	<10	<0.04	<0.01
Pentachlorophenol (100)	<0.13	<50	<0.1	<0.05
Vinyl Chloride (0.2)	<0.1	<1.0	<0.05	<0.01
1,1-Dichloroethene (0.7)	<0.05	<0.5	<0.025	<0.005
Methyl ethyl ketone (200)	0.830	<0.5	<0.05	<0.005
Carbon Tetrachloride (0.5)	<0.05	<0.5	<0.025	<0.005
Chlorobenzene (100)	<0.05	<0.5	<0.025	<0.005
Trichloroethene (0.5)	<0.05	<0.5	<0.025	<0.005
Chloroform (6.0)	<0.05	<0.5	<0.025	<0.005
1,2-Dichloroethane (0.5)	<0.05	<0.5	<0.025	<0.005
Tetrachloroethene(0.7)	<0.05	<0.5	<0.025	<0.005
Benzene (0.5)	<0.05	<0.5	<0.025	<0.005

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

^b No value reported

Table 29. Concentrations of the TCLP Regulated Analytes in the North Site Unidentified UCG Water and Hoe Creek Water, mg/L

TCLP Analyte	Unidentified UCG Water WRI	Unidentified UCG Water CLP	Hoe Creek Water WRI	Hoe Creek Water CLP
Arsenic (5.0) ^a	<0.1	<0.04	<0.1	<0.04
Barium (100)	0.180	0.181	0.198	0.173
Cadmium (1.0)	<0.01	0.010	<0.01	<0.002
Chromium (5.0)	0.062	0.055	<0.008	<0.004
Lead (5.0)	<0.05	<0.04	<0.05	<0.04
Mercury (0.2)	<0.002	<0.0002	<0.002	<0.0002
Selenium (1.0)	<0.1	<0.04	<0.1	<0.04
Silver (5.0)	<0.01	0.033	<0.01	<0.003
Pyridine (5.0)	<0.5	<5.0	<0.1	<5.0
1,4-Dichloro- benzene (7.5)	<0.2	<7.5	<0.04	<7.5
2-methylphenol (200)	51.0	<200	<0.04	<200
4-methylphenol/ 3-methylphenol (200)	56.0	<200	<0.04	<200
Hexachloroethane(3.0)	<0.2	<3.0	<0.04	<3.0
Nitrobenzene (2.0)	<0.2	<2.0	<0.04	<2.0
Hexachloro- butadiene (0.5)	<0.2	<1.0	<0.04	<1.0
2,4,5-Trichloro- phenol (400)	<0.5	<400	<0.1	<400
2,4,6-Trichloro- phenol (2.0)	<0.2	<2.0	<0.04	<2.0
2,4-Dinitro- toluene (0.13)	<0.13	<1.0	<0.04	<1.0
Hexachloro- benzene (0.13)	<0.13	<1.0	<0.04	<1.0
Pentachloro- phenol (100)	<0.5	<100	<0.1	<100
Vinyl Chloride (0.2)	<0.1	<0.2	<0.01	<0.2
1,1-Dichloro- ethene (0.7)	<0.05	<0.7	<0.005	<0.7
Methyl ethyl ketone (200)	0.840	<200	<0.01	<200
Carbon Tetra- chloride (0.5)	<0.05	<0.5	<0.005	<0.05
Chlorobenzene (100)	<0.05	<100	<0.005	<100
Trichloroethene (0.5)	<0.05	<0.5	<0.005	<0.5
Chloroform (6.0)	<0.05	<6.0	<0.005	<6.0
1,2-Dichloro- ethane (0.5)	<0.05	<0.5	<0.005	<0.5
Tetrachloroethene(0.7)	<0.05	<0.7	<0.005	<0.7
Benzene (0.5)	<0.05	<0.5	<0.005	<0.5

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

Table 30. Concentrations of the TCLP Regulated Analytes in the North Site Tank Bottom Water and Sludgy Water, mg/L

TCLP Analyte	Tank Bottom Water WRI	Tank Bottom Water CLP	Sludgy Water WRI	Sludgy Water CLP
Arsenic (5.0) ^a	15.0	8.47	1.69	14.0
Barium (100)	<0.1	0.063	1.63	3.42
Cadmium (1.0)	0.18	0.082	5.31	13.4
Chromium (5.0)	0.17	0.122	2.72	6.01
Lead (5.0)	<0.5	<0.04	0.73	2.99
Mercury (0.2)	<0.02	0.01	<0.0002	0.14
Selenium (1.0)	1.62	1.17	<1.0	<0.04
Silver (5.0)	<0.01	0.010	<0.01	0.027
Pyridine (5.0)	<2.5	<0.2	<0.31	<0.1
1,4-Dichlorobenzene (7.5)	<1.0	<0.2	<0.13	<0.1
2-methylphenol (200)	<1.0	<0.2	0.19	<0.1
4-methylphenol/3-methylphenol (200)	<1.0	<0.2	0.1	<0.1
Hexachloroethane (3.0)	<1.0	<0.2	<0.13	<0.1
Nitrobenzene (2.0)	<1.0	<0.2	<0.13	<0.1
Hexachlorobutadiene (0.5)	<0.5	<0.2	<0.13	<0.1
2,4,5-Trichlorophenol (400)	<1.0	<0.2	<0.31	<0.1
2,4,6-Trichlorophenol (2.0)	<2.5	<0.2	<0.13	<0.1
2,4-Dinitrotoluene (0.13)	<0.13	<0.2	<0.13	<0.1
Hexachlorobenzene (0.13)	<0.13	<0.2	<0.13	<0.1
Pentachlorophenol (100)	<2.5	<1.0	<0.31	<0.5
Vinyl Chloride (0.2)	<0.1	<20	<0.1	<1.0
1,1-Dichloroethene (0.7)	<0.1	<10	<0.05	<0.5
Methyl ethyl ketone (200)	2.0	<10	0.1	<0.5
Carbon Tetrachloride (0.5)	<0.1	<10	<0.05	<0.5
Chlorobenzene (100)	<0.1	<10	<0.05	<0.5
Trichloroethene (0.5)	<0.1	<10	<0.05	<0.5
Chloroform (6.0)	<0.1	<10	<0.05	<0.5
1,2-Dichloroethane (0.5)	<0.1	<10	<0.05	<0.5
Tetrachloroethene(0.7)	<0.1	<10	<0.05	<0.5
Benzene (0.5)	<0.1	<10	<0.05	<0.5

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

Table 31. Concentrations of the TCLP Regulated Analytes in the North Site Treolite Distillates and Free and Distilled Water, mg/L

TCLP Analyte	Treolite Distillates WRI	Treolite Distillates CLP	Free & Distilled Water WRI	Free & Distilled Water CLP
Arsenic (5.0) ^a	<1.0	<8.0	<1.0	0.311
Barium (100)	<0.1	<0.2	1.55	1.55
Cadmium (1.0)	<0.1	<0.4	<0.1	<0.002
Chromium (5.0)	<0.1	<0.6	1.0	0.74
Lead (5.0)	<0.5	<8.0	<0.5	<0.04
Mercury (0.2)	<0.02	<0.002	<0.02	<0.002
Selenium (1.0)	<1.0	<8.0	1.88	1.50
Silver (5.0)	<0.01	<0.40	<0.01	<0.002
Pyridine (5.0)	<2,500	<10	<625	<10
1,4-Dichloro- benzene (7.5)	<1,000	<10	<250	<10
2-methylphenol (200)	<1,000	<10	690	790
4-methylphenol/ 3-methylphenol (200)	<1,000	<10	860	<10
Hexachloroethane (3.0)	<1,000	<10	<250	<10
Nitrobenzene (2.0)	<1,000	<10	<250	<10
Hexachloro- butadiene (0.5)	<1,000	<10	<250	<10
2,4,5-Trichloro- phenol (400)	<2,500	<10	<625	<10
2,4,6-Trichloro- phenol (2.0)	<1,000	<10	<250	<10
2,4-Dinitro- toluene (0.13)	<1,000	<10	<250	<10
Hexachloro- benzene (0.13)	<1,000	<10	<250	<10
Pentachloro- phenol (100)	<2,500	<50	<625	<50
Vinyl Chloride (0.2)	<5.0	<10	<0.1	<10
1,1-Dichloroethene(0.7)	<5.0	<5.0	<0.10	<5.0
Methyl ethyl ketone (200)	<5.0	<5.0	53.0	<5.0
Carbon Tetra- chloride (0.5)	<10	<5.0	<0.20	<5.0
Chlorobenzene (100)	<5.0	<5.0	<0.1	<5.0
Trichloroethene(0.5)	<5.0	<5.0	<0.1	<5.0
Chloroform (6.0)	<5.0	<5.0	<0.1	<5.0
1,2-Dichloro- ethane (0.5)	<5.0	<5.0	<0.1	<5.0
Tetrachloroethene(0.7)	<5.0	<5.0	<0.1	<5.0
Benzene (0.5)	2.1	58.0	18.0	29.0

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

Table 32. Concentrations of the TCLP Regulated Analytes in the North Site RM1 Water and CROW Water, mg/L

TCLP Analyte	RM1 Water WRI	RM1 Water CLP	CROW Water WRI
Arsenic (5.0) ^a	<0.1	<0.04	<0.1
Barium (100)	0.061	0.053	2.45
Cadmium (1.0)	<0.01	<0.002	<0.01
Chromium (5.0)	<0.008	<0.004	<0.008
Lead (5.0)	<0.05	<0.04	<0.05
Mercury (0.2)	<0.002	<0.0002	<0.002
Selenium (1.0)	<0.1	<0.04	<0.1
Silver (5.0)	<0.01	<0.003	<0.01
Pyridine (5.0)	<0.1	<5.0	<0.25
1,4-Dichlorobenzene (7.5)	<0.04	<7.5	<0.1
2-methylphenol (200)	<0.04	<200	<0.1
4-methylphenol/ 3-methylphenol (200)	<0.04	<200	<0.1
Hexachloroethane (3.0)	<0.04	<3.0	<0.1
Nitrobenzene (2.0)	<0.04	<2.0	<0.1
Hexachlorobutadiene (0.5)	<0.04	<1.0	<0.1
2,4,5-Trichlorophenol (400)	<0.1	<400	<0.25
2,4,6-Trichlorophenol (2.0)	<0.04	<2.0	<0.1
2,4-Dinitrotoluene (0.13)	<0.04	<1.0	<0.1
Hexachlorobenzene ((0.13)	<0.04	<1.0	<0.1
Pentachlorophenol (100)	<0.1	<100	<0.25
Vinyl Chloride (0.2)	<0.01	<0.2	<0.05
1,1-Dichloroethene (0.7)	<0.005	<0.7	<0.025
Methyl ethyl ketone (200)	<0.01	<200	<0.05
Carbon Tetrachloride (0.5)	<0.005	<0.5	<0.025
Chlorobenzene (100)	<0.005	<100	<0.025
Trichloroethene (0.5)	<0.005	<0.5	<0.025
Chloroform (6.0)	<0.005	<6.0	<0.025
1,2-Dichloroethane (0.5)	<0.005	<0.5	<0.025
Tetrachloroethene (0.7)	<0.005	<0.7	<0.025
Benzene (0.5)	<0.005	<0.5	0.200

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

Table 33. Concentrations of the TCLP Regulated Analytes in the North Site Water, Coal Fines, Oil Sample, mg/L

TCLP Analyte	Water, Coal Fines, Oil WRI	Water, Coal Fines, Oil CLP
Arsenic (5.0) ^a	<2.0	<0.04
Barium (100)	0.153	0.115
Cadmium (1.0)	<0.1	<0.002
Chromium (5.0)	0.11	<0.004
Lead (5.0)	<0.5	<0.04
Mercury (0.2)	<0.02	<0.002
Selenium (1.0)	<1.0	<0.04
Silver (5.0)	<0.1	<0.003
Pyridine (5.0)	<0.5	<5.0
1,4-Dichlorobenzene (7.5)	<0.2	<7.5
2-methylphenol (200)	71.0	<200
4-methylphenol/ 3-methylphenol (200)	96.0	<200
Hexachloroethane (3.0)	<0.2	<3.0
Nitrobenzene (2.0)	<0.2	<2.0
Hexachlorobutadiene (0.5)	<0.2	<1.0
2,4,5-Trichlorophenol (400)	<0.5	<400
2,4,6-Trichlorophenol (2.0)	<0.2	<2.0
2,4-Dinitrotoluene (0.13)	<0.13	<1.0
Hexachlorobenzene (0.13)	<0.13	<1.0
Pentachlorophenol (100)	<0.5	<100
Vinyl Chloride (0.2)	<0.05	<0.2
1,1-Dichloroethene (0.7)	<0.025	<0.7
Methyl ethyl ketone (200)	14.0	<200
Carbon Tetrachloride (0.5)	<0.025	<0.5
Chlorobenzene (100)	<0.025	<100
Trichloroethene (0.5)	<0.025	<0.5
Chloroform (6.0)	<0.025	<6.0
1,2-Dichloroethane (0.5)	<0.025	<0.5
Tetrachloroethene (0.7)	<0.025	<0.7
Benzene (0.5)	0.16	<0.5

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

The concentrations of the TCLP regulated analytes in the retort water are listed in Table 27. The data generated by WRI show that this water does not contain any of the TCLP regulated analytes in concentrations above the TCLP action levels, and as a result, is not hazardous based on toxicity. The data generated by SVL Analytical also show this for the TCLP regulated metals. However, for many of the semivolatile and volatile organic analytes, the detection limits reported by Pace are above the regulatory levels, and no TCLP pass/fail decision can be made based on the Pace data. In error, Pace did not analyze the retort water for pyridine.

The concentrations of the TCLP regulated analytes in the graham water are also listed in Table 27. The data generated by WRI and the CLP laboratories show that the graham water does not contain any of the TCLP regulated analytes at levels above the TCLP regulatory values. The only analyte for which WRI data are not confirmed by the CLP laboratory is pyridine. In error, Pace did not analyze the graham water for pyridine. However, based on the data shown in Table 27, the graham water is also nonhazardous in terms of toxicity.

WRI data listed in Table 28 show that the tank cleanout water and the water scavenger do not contain any of the TCLP regulated analytes in concentrations above their TCLP action levels, and as a result, pass TCLP characterization for toxicity. The data generated by SVL Analytical (Table 28) verify that the tank cleanout water and the water scavenger pass TCLP for the regulated metals. However, once again, for many of the organic analytes in the tank cleanout water, the detection limits reported by Pace (Table 28) are above the regulatory levels, and no TCLP pass/fail decision can be made for this water based on the data from Pace. In addition, Pace once again did not analyze the water scavenger for pyridine.

WRI data listed in Table 29 show that the unidentified UCG and Hoe Creek waters do not contain any of the TCLP regulated analytes in concentrations above their TCLP action levels, and as a result, are not hazardous based on toxicity. The data generated by SVL Analytical (Table 29) verify that the unidentified UCG and Hoe Creek waters pass TCLP for the regulated metals. For most of the TCLP regulated semivolatile and volatile organic compounds, Pace used a detection limit equal to the regulatory level (Table 29) and verified WRI's results. However, for hexachlorobutadiene, 2,4-dinitrotoluene, and hexachlorobenzene, the Pace detection limits are above the regulatory levels and do not give information that can be used to decide if the waters pass TCLP for those compounds.

WRI and SVL data listed in Table 30 show that the tank bottom water fails TCLP characterization for arsenic and selenium, and as a result, this water is hazardous based on toxicity. The concentration of arsenic determined to be present in the tank bottom water by WRI is 15.0 mg/L, while SVL detected 8.5 mg/L. The toxicity characteristic regulatory level for arsenic is 5.0 mg/L. The concentrations of

selenium that were detected in the tank bottom water by WRI and SVL are 1.6 and 1.2 mg/L, respectively. Selenium has a regulatory value of 1.0 mg/L.

WRI and SVL data listed in Table 30 also show that the sludgy water fails TCLP characterization and is hazardous based on toxicity. WRI data show the concentration of cadmium (5.3 mg/L) in the sludgy water exceeding the TCLP regulatory level of 1.0 mg/L. In addition to showing cadmium (13.4 mg/L) at a concentration above 1.0 mg/L, SVL data show the concentrations of arsenic (14.0 mg/L) and chromium (6.0 mg/L) in the sludgy water to be above their regulatory value of 5.0 mg/L. Although arsenic and chromium were not detected above their regulatory levels by WRI, and the concentration of cadmium that was determined by the two laboratories vary, the water is shown to be hazardous by both laboratories. Data generated by WRI and/or Pace show that the concentrations of the regulated organic compounds in the sludgy water do not exceed TCLP regulatory levels.

Data resulting from analyses of the treolite distillates and free and distilled water for the TCLP regulated analytes are listed in Table 31. As shown by the organic data generated by WRI and Pace, both laboratories could not lower their analytical detection limits below TCLP regulatory levels for many of the semivolatile and volatile organic compounds. This was due to sample dilution, which was required to analyze these materials. SVL also had difficulty lowering their detection limits for analysis of the treolite distillates for arsenic, lead, and selenium. Despite the analytical difficulties, both of these materials were determined to be hazardous as wastes, based on their concentrations of benzene, which has an action level of 0.5 mg/L. WRI detected 2.1 mg/L of benzene in the treolite distillate, and Pace reported 58 mg/L. In the free and distilled water, 18.0 and 29.0 mg/L of benzene were reported by WRI and Pace, respectively. In addition, the free and distilled water also fails TCLP based on concentrations of cresol and selenium present in the material. WRI detected 1.9 mg/L selenium in the free and distilled water, while SVL reported finding 1.5 mg/L. The TCLP action level for selenium is 1.0 mg/L. 1,550 mg/L total cresol (2-, 3-, 4-methylphenol) was reported by WRI to be present in the free and distilled water, while Pace detected 709 mg/L. The concentrations of the organic analytes detected by WRI and Pace vary considerably. This may be due to nonhomogeneity and difficulty of the analyses.

WRI data listed in Table 32 show that the RM1 and CROW waters do not contain any of the TCLP regulated analytes in concentrations above their TCLP action levels, and as a result, are not hazardous based on toxicity. As mentioned earlier, the CROW water was added to the disposal list very late in phase I and was analyzed by only WRI. The data generated by SVL Analytical (Table 32) verify that the RM1 water passes TCLP for the regulated metals. For most of the TCLP regulated semivolatile and volatile organic compounds, Pace used a detection limit equal to or below the appropriate regulatory level (Table 32) and verified WRI's results. However, for hexachlorobutadiene, 2,4-dinitrotoluene, and

hexachlorobenzene, the Pace detection limits are above the regulatory levels and do not give information that can be used to decide if the RM1 water passes TCLP for those compounds.

WRI data listed in Table 33 show that the water, coal fines, oil material does not contain any of the TCLP regulated analytes in concentrations above their TCLP action levels, and as a result, is not hazardous based on toxicity. The data generated by SVL Analytical (Table 33) verify that the water, coal fines, oil material passes TCLP for the regulated metals. For most of the TCLP regulated semivolatile and volatile organic compounds, Pace used a detection limit equal to the appropriate regulatory level (Table 33) and verified WRI's results. However, for hexachlorobutadiene, 2,4-dinitrotoluene, and hexachlorobenzene, the Pace detection limits are above the regulatory levels and do not give information that can be used to decide if this material passes TCLP for those compounds.

To summarize the information, which is discussed above and presented in Tables 27-33, Table 34 lists the TCLP pass/fail results for each of the composite groups in the North Site water stream based on their concentrations of the toxicity characteristic regulated analytes. In addition, Table 35 shows those water composite groups that fail the toxicity characteristic and the constituents and their concentrations that cause them to fail.

In addition to the tank bottom water, sludgy water, treolite distillates, and free and distilled water being hazardous, investigation of the nature of the graham waters led to information showing that these materials contain radium 226. Information listed in Table 7 shows that containers 1113-1120 are represented by the graham water composite group. Of these, water stored in drums 1113, 1114, 1117, and 1118 contain 116 picocuries of radium 226, and water stored in drums 1115, 1116, 1119, and 1120 contain 12.4 picocuries of radium 226.

Analysis of the QA/QC Field Trip Blanks for Sampling the Waters

Metals, semivolatile organic, and volatile organic field trip blanks were taken to the field during sampling of the North Site water containers. These blanks were analyzed during analysis of the water samples to check for any contamination of the waters due to the field environment, including sample storage and transportation. The blanks were analyzed by WRI, and none of the TCLP regulated analytes were detected at concentrations above the analytical detection limits, with the exception of chromium, which was reported at 0.1 mg/L. The regulatory action level for chromium is 5.0 mg/L, and the sludgy water, which is the only water that contains hazardous levels of chromium, was reported to contain much higher levels at 2.7 and 6.0 mg/L. Results from analysis of the field trip blanks, as well as, QA/QC data from analyses of instrument blanks and matrix spikes are included with the water data in Appendix E.

Table 34. TCLP Pass/Fail Results for the North Site Water Stream Based on Total Concentration of TCLP Regulated Analytes in the Water

Composite	Characterization	WRI Data	CLP Data
Tank Bottom Water pH = 5.9	TCLP Metals TCLP BNA's ^a TCLP Volatiles	Fail --- ^b Pass	Fail --- ^b --- ^b
Retort Water pH = 9.2	TCLP Metals TCLP BNA's TCLP Volatiles	Pass Pass Pass	Pass --- ^b --- ^b
Graham Water pH = 9.1	TCLP Metals TCLP BNA's TCLP Volatiles	Pass Pass Pass	Pass --- ^c Pass
Tank Cleanout Water pH = 9.3	TCLP Metals TCLP BNA's TCLP Volatiles	Pass Pass Pass	Pass --- ^b --- ^b
Sludgy Water pH = 7.1	TCLP Metals TCLP BNA's TCLP Volatiles	Fail Pass Pass	Fail Pass --- ^b
Treolite Distillate pH = 5.0	TCLP Metals TCLP BNA's TCLP Volatiles	Pass --- ^b Fail	--- ^b --- ^b Fail
Free & Distilled Water pH = 7.0	TCLP Metals TCLP BNA's TCLP BNA's	Fail Fail Fail	Fail Fail Fail
Water Scavenger pH = 2.5	TCLP Metals TCLP BNA's TCLP Volatiles	Pass Pass Pass	Pass --- ^c Pass
Water, Coal Fines, Oil pH = 7.9	TCLP Metals TCLP BNA's TCLP Volatiles	Pass Pass Pass	Pass --- ^b Pass
Unidentified UCG Water pH = 8.1	TCLP Metals TCLP BNA's TCLP Volatiles	Pass Pass Pass	Pass --- ^b Pass
Hoe Creek Water pH = 8.3	TCLP Metals TCLP BNA's TCLP Volatiles	Pass Pass Pass	Pass --- ^b Pass
RM-1 Water pH = 8.3	TCLP Metals TCLP BNA's TCLP Volatiles	Pass Pass Pass	Pass --- ^b Pass
CROW Water pH = 6.9	TCLP Metals TCLP BNA's TCLP Volatiles	Pass Pass Pass	--- ^d --- ^d --- ^d

^a Regulated semivolatile organic compounds, base, neutral, and acid (BNA's)

^b The method detection limit is greater than the regulatory level. As a result, no pass/fail decision can be made.

^c Sample not analyzed for pyridine

^d Sample not submitted for analysis

Table 35. Composite Groups in the North Site Water Stream Failing TCLP Regulatory Levels

Composite	Container No. Represented	Failure	
		WRI	CLP
Tank Bottom Water	824, 825, 889, 947	As: 15 ppm Se: 1.6 ppm	As: 8.5 ppm Se: 1.2 ppm
Sludgy Water	550	Cd: 5.3 ppm	As: 14.0 ppm Cd: 13.4 ppm Cr: 6.0 ppm
Treolite Distillates	618	Benzene: 2 ppm	Benzene: 58 ppm
Free & Distilled Water	1201	Se: 1.9 ppm Cresol: 1,550 ppm Benzene: 18 ppm	Se: 1.5 ppm Cresol: 709 ppm Benzene: 29 ppm

Results from Analysis of the Tars, Oils, and Hydrocarbon Liquids

Two of the composite groups in the tar, oil, and hydrocarbon liquid stream were characterized by TCLP extraction and were determined to be nonhazardous based on toxicity. These are the oil pitch and tank bottom heavy oil solid (Tables 17 and 18). The remaining materials under this product stream were to be characterized for their total concentrations of the TCLP regulated analytes due to the difficulty in applying the TCLP.

As discussed in the description of the analyses of the North Site tars, oils, and hydrocarbon liquids, due to the nature of these materials, difficulties were encountered by both WRI and the CLP laboratories in analyzing them for the TCLP regulated analytes. High levels of dilution that were required for analyses caused the analytical detection limits for many of the regulated TCLP analytes to be greater than the TCLP action levels. An approach was taken to analyze the materials for their benzene concentrations, as well as their concentrations of the regulated metals, to identify those materials that can be classified as hazardous based on their concentrations of these regulated analytes and to reduce the number of materials requiring more difficult analyses.

Results from Benzene Analysis of the Tars, Oils, and Hydrocarbon Liquids

The concentrations of benzene, which were determined to be present in the composite and individual samples that are part of the tar, oil, and hydrocarbon liquid stream, are listed in Table 36. All of the samples listed were analyzed for their benzene concentrations by WRI, and nine of the materials were also sent to Pace for benzene analysis to verify WRI's results. The benzene concentrations listed in Table 36 all exceed the TCLP action level of 0.5 mg/L for wastes. If the samples listed in Table 36 were tested by TCLP, and the total amount of benzene they contain was extracted into the TCLP extract, the concentration of benzene would be diluted by the extraction fluid. For solid materials, the dilution factor would be equal to 20, and for multiphasic samples, the dilution factor would be less than 20 and would vary depending on the percent solids in the sample. To determine the percent solids in the oily materials as specified in the TCLP would have been extremely costly and time consuming for this project. As a result, it was decided to evaluate the toxicity of the oily materials based on their total concentration of benzene, which means that all of the materials listed in Table 36 are hazardous if they require disposal. This approach may seem very conservative; however, if the benzene concentrations listed in Table 36 are divided by 20, which is a higher dilution factor than would be required for the multiphasic wastes, the resulting concentrations for all of the materials, except the tank oil and tank bottom heavy oil, still exceed the TCLP action level of 0.5 mg/L as shown in Table 37. Benzene data from WRI and Pace analyses of the materials in the tar, oil, and hydrocarbon liquid stream can be found in Appendix E.

Table 36. Concentrations of Benzene in Composite and Individual Samples of the Tar, Oil, and Hydrocarbon Liquid Stream, ppm

Composite/Individual Sample	Benzene	
	WRI	CLP
Shale Oil-1	45	--- ^a
Shale Oil-2	26	200
Shale Oil-3	36	--- ^a
Shale Oil Distillates	260	120
Tar Sand Heavy Oil	18	35
Heavy Oil Plus Coal	290	160
Dirty Oil & Sludge	>2.6	140
Coal Tar	2,900	>1,900
Heavy Oil	130	--- ^a
Heavy Fuel Oil	13	--- ^a
Heavy Crude Oil	21	23
Tank Bottom	130	170
Tank Oil	7.2	--- ^a
Distillate Light Oil	7,700	--- ^a
Oily Material Plus Water	330	300
Tank Bottom Heavy Oil	2.1	--- ^a

^a Sample not analyzed

Table 37. Concentrations of Benzene in Composite and Individual Samples of the Tar, Oil, and Hydrocarbon Liquid Stream Divided by a Dilution Factor of 20, ppm

Composite/Individual Sample	Benzene	
	WRI	CLP
Shale Oil-1	45/20 = 2.2	--- ^a
Shale Oil-2	26/20 = 1.3	200/20 = 10
Shale Oil-3	36/20 = 1.8	--- ^a
Shale Oil Distillates	260/20 = 13	120/20 = 6
Tar Sand Heavy Oil	18/20 = 0.9	35/20 = 1.7
Heavy Oil Plus Coal	290/20 = 14.5	160/20 = 8
Dirty Oil & Sludge	>2.6/20 = >0.13	140/20 = 7
Coal Tar	2,900/20 = 145	>1,900/20 = >95
Heavy Oil	130/20 = 6.5	--- ^a
Heavy Fuel Oil	13/20 = 0.65	--- ^a
Heavy Crude Oil	21/20 = 1.0	23/20 = 1.1
Tank Bottom	130/20 = 6.5	170/20 = 8.5
Tank Oil	7.2/20 = 0.36	--- ^a
Distillate Light Oil	7,700/20 = 385	--- ^a
Oily Material Plus Water	330/20 = 16.5	300/20 = 15
Tank Bottom Heavy Oil	2.1/20 = 0.10	--- ^a

^a Sample not analyzed

For the most part, the benzene concentrations determined by WRI and Pace (Table 36) vary between the two laboratories. This is most likely due to the nature of the materials. However, data from WRI and Pace are in agreement, showing concentrations of benzene above the TCLP action level (Tables 36 and 37).

Volatile Analysis of the Tank Oil and Tank Water

Tank oil and tank water samples were analyzed by WRI for their concentrations of the other regulated volatile organic compounds. Concentrations of trichloroethene greater than the TCLP regulatory level of 0.5 mg/L were detected in both materials. The tank water, which would not be diluted as part of the TCLP extraction, contains 2.2 ppm trichloroethene, and the tank oil contains 1,400 ppm. The concentration of trichloroethene in the tank oil would exceed the regulatory level even with a dilution factor of 20 applied. As a result, both the tank oil and tank water are hazardous. Data from WRI analysis of the tank oil and tank water are included in Appendix E.

Other Organic Analytes Determined in the Tars, Oils, and Hydrocarbon Liquids Above TCLP Action Levels

Trichloroethene was also determined to be present in the shale oil-1 and heavy oil composites at concentrations above the TCLP regulatory value of 0.5 mg/L. WRI detected 0.71 ppm trichloroethene in the shale oil-1 composite sample and 43 ppm trichloroethene in the heavy oil composite sample. Both of these composite groups are hazardous as wastes based on their benzene concentrations (Tables 36 and 37). Forty-three parts per million of trichloroethene, even with a dilution factor of 20 applied, also causes the heavy oil to be hazardous. WRI detected 410 ppm methyl ethyl ketone in both the coal tar composite sample and the distillate light oil composite sample. The TCLP regulatory level for methyl ethyl ketone is 200 mg/L. The coal tar and distillate light oil composite groups are also hazardous as wastes based on their benzene concentrations (Table 36 and 37). These materials are hazardous if they are to be disposed, but do not have any restrictions if they are used as fuels.

For most of the semivolatile organic compounds in the tars, oils, and hydrocarbon liquids, the WRI and Pace analytical detection limits were much higher than the TCLP action levels because of the sample dilutions that were required. Very few of the oily samples were analyzed by Pace and WRI for the regulated semivolatile organic compounds. WRI did report 8.5 ppm pyridine in the tank cleanout material. The TCLP action level for pyridine is 5.0 mg/L. Data from WRI's analyses of the materials in the tar, oil, and hydrocarbon liquid stream for the regulated volatile and semivolatile organic compounds can be found in Appendix E, along with the limited semivolatile data that were reported by Pace.

Results from Metals Analysis of the Tars, Oils, and Hydrocarbon Liquids

After some experimentation, the method that was selected for metals analysis of the oily materials was sample preparation by combustion using bomb calorimetry followed by atomic absorption and inductively coupled plasma spectrometry. SVL Analytical could not analyze most of the tars, oils, and hydrocarbon liquids without raising their detection limits above the TCLP action levels, and they do not perform the ASTM oxygen bomb combustion method. As a result, most of the metals data for the materials in the tar, oil, and hydrocarbon liquid stream were generated by WRI only. WRI metals data for the individual and composite samples in this product stream are listed in Table 38. Many of the metal concentrations listed in Table 38 exceed their TCLP regulatory values. It should be noted that, even with a dilution factor of 20 applied, the concentrations of lead in the tar sand heavy oil and heavy oil composite samples exceed the regulatory value of 5.0 mg/L. The data given in Table 38 will be used in determining proper disposal means for the oily materials. Copies of the data report forms received for WRI metal analyses of the tars, oils, and hydrocarbon liquids are included in Appendix E.

Table 38. TCLP Regulated Metal Concentrations in the North Site Tar, Oil, and Hydrocarbon Liquid Stream, ppm

Composite/ Individual Sample	As (5.0) ^a	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Shale Oil-1	8.97	<0.1	0.10	0.28	4.52	0.35	1.26	<0.1
Shale Oil-2	6.12	0.13	<0.1	0.14	4.15	0.21	<1.0	<0.1
Shale Oil-3	14.1	<0.1	<0.1	0.18	1.08	0.10	<1.0	<0.1
Shale Oil Distillates	<2.0	0.08	0.25	0.80	0.43	0.08	<1.0	<0.1
Tar Sand Heavy Oil	4.16	6.74	0.79	2.24	174	0.07	<1.0	<0.1
Heavy Oil Plus Coal	2.93	22.3	0.58	11.8	14.4	0.03	<1.0	0.28
Dirty Oil & Sludge	5.16	11.0	0.32	0.97	72.7	<0.02	<0.5	<0.1
Coal Tar	2.37	61.1	0.85	12.4	5.60	0.54	2.35	0.60
Heavy Oil	24.3	58.7	0.76	18.7	121	0.14	1.75	1.48
Heavy Fuel Oil	<2.0	0.14	0.08	0.14	0.41	<0.02	<1.0	<0.1
Heavy Crude Oil	6.60	<0.1	<0.1	0.13	0.53	<0.02	<1.0	<0.1
Tank Bottom	22.2	224	0.26	3.42	31.0	0.32	<1.0	0.69
Tank Water	2.32	0.12	<0.08	0.12	<0.5	<0.002	0.86	<0.08
Tank Oil	<2.0	8.04	<0.1	0.93	<0.5	0.10	<1.0	<0.1
Distillate Light Oil	<2.0	<0.1	<0.1	3.02	<0.5	0.19	<1.0	<0.1
Tank Cleanout	3.35	<0.1	<0.1	<0.1	<0.4	<0.02	2.23	<0.1
Tank Cleanout Oil	3.42	11.3	2.15	4.66	12.8	0.40	11.1	0.59
Oily Material Plus Water	<2.0	1.12	<0.1	0.52	<0.5	<0.02	<0.5	<0.1
Tank Bottom Heavy Oil	42.9	11.4	2.06	5.52	19.1	0.24	1.02	0.61

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

Dilutions of the tank cleanout and tank cleanout oil materials resulted in extremely high detection limits for analyses of their volatile organic compounds. As a result, no useful volatile data were obtained for these materials. However, metals data for the tank cleanout and tank cleanout oil were determined and are listed in Table 38. Both of these materials contain concentrations of the TCLP regulated metals above their action levels.

As mentioned above, many of the materials in the tar, oil, and hydrocarbon liquid stream were not analyzed by SVL Analytical, and very little useful metals data were received from the CLP laboratory for the oily materials because of their high detection limits. The metals data received from SVL for the dirty oil and sludge composite sample, coal tar composite sample, and tank cleanout oil composite sample are listed in Table 39, along with WRI data for the composite samples. For the most part, the metal concentrations determined by WRI and SVL for the composite samples agree. However, there are some discrepancies, such as for the concentration of barium in the dirty oil and sludge, the concentrations of chromium and silver in the coal tar, and the concentrations of arsenic, barium, and selenium in the tank cleanout oil. A concentration of arsenic at 107 ppm, which was detected by SVL in the tank cleanout oil, makes this material hazardous, even with application of a dilution factor of 20.

Table 39. Metal Concentrations in the Dirty Oil and Sludge, Coal Tar, and Tank Cleanout Oil Composite Samples Determined by SVL Analytical^a and WRI, ppm

Composite/ Individual Sample	As (5.0) ^b	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Dirty Oil & Sludge								
WRI	5.16	11.0	0.32	0.97	72.7	<0.02	<0.5	<0.1
SVL	<8.0	1.18	<0.4	0.74	76.7	<0.1	<8.0	<0.4
Coal Tar								
WRI	2.37	61.1	0.85	12.4	5.60	0.54	2.35	0.60
SVL	<8.0	64.2	0.72	6.4	<8.0	0.57	<8.0	1.12
Tank Cleanout Oil								
WRI	3.42	11.3	2.15	4.66	12.8	0.40	11.1	0.59
SVL	107	35.7	1.55	5.26	11.5	0.30	22.7	<0.4

^a SVL Analytical is the inorganic CLP laboratory that was used in phase I to verify WRI's analytical results.

^b The value given in parentheses is the regulatory level in mg/L for each analyte.

The higher detection limits, which were reported by SVL, limit comparison of the data in Table 39. In addition to WRI metals data, the SVL metals data will also be used to provide information for selecting proper disposal options for the materials in this product stream. All metals data, which were generated by SVL for the tar, oil, and hydrocarbon liquid stream, are included in Appendix E.

Flash Point Characterization of the Shale Oil Distillate Samples and the Distillate Light Oil Composite Sample

Samples of the three materials comprising the shale oil distillate composite group and a composite sample of the distillate light oil (Table 8) were analyzed by WRI and Pace for their flash point. The flash point values for the samples are listed in Table 40. As specified in 40 CFR 261.21 (1992), a waste exhibits the characteristic of ignitability if it has a flash point less than 140°F (60°C). Based on this criterion, the oil shale distillates and the distillate light oil composite sample exhibit the hazardous characteristic of ignitability. For shale oil distillate samples 614 and 615, WRI did not report a flash point value that classifies the materials as hazardous based on ignitability; however, for these samples, Pace did report values that are less than 140°F. As a result, the samples will be considered hazardous based on ignitability.

Table 40. Flash Point Values for the Shale Oil Distillate Samples and the Distillate Light Oil Composite Sample

Sample	Flash Point, °F	Regulatory Value, °F
Shale Oil Distillate-614		
WRI	140	<140
Pace ^a	120	<140
Shale Oil Distillate-615		
WRI	168	<140
Pace	134	<140
Shale Oil Distillate-656		
WRI	— ^b	<140
Pace	128	<140
Distillate Light Oil Composite		
WRI	<82	<140
Pace	118	<140

^a Pace Laboratory is the organic CLP laboratory that was used in phase I to verify WRI's analytical results.

^b WRI reported that the sample contained too much water for flash point determination.

Btu Characterization of the Heavy Fuel Oils

Individual samples of the materials comprising the heavy fuel oil composite group (Table 8) were analyzed by WRI for their Btu content to provide information on their usefulness as fuels. Btu values for the six materials ranged from 16,752 to 17,543 Btu/lb, with an average value of 17,311 Btu/lb.

Hazard Classification of the Tars, Oils, and Hydrocarbon Liquids

The hazard classification for each of the materials in the tar, oil, and hydrocarbon liquid stream is given in Table 41, along with the failing characteristic. All of the composite groups in the tar, oil, and hydrocarbon liquid stream, except the oil pitch and tank bottom heavy oil solid are hazardous.

Table 41. Hazard Classification for the Tars, Oils, and Hydrocarbon Liquids

Composite Group	Hazard Classification	Failing Characteristic/ Analyte
Tank Bottom Heavy Oil Solid	Nonhazardous	
Oil Pitch	Nonhazardous	
Shale Oil-1	Hazardous	Toxicity/Benzene
Shale Oil-2	Hazardous	Toxicity/Benzene
Shale Oil-3	Hazardous	Toxicity/Benzene
Shale Oil Distillates	Hazardous	Toxicity/Benzene Ignitability/Flash Point
Tar Sand Heavy Oil	Hazardous	Toxicity/Benzene, Lead
Heavy Oil Plus Coal	Hazardous	Toxicity/Benzene
Dirty Oil & Sludge	Hazardous	Toxicity/Benzene
Coal Tar	Hazardous	Toxicity/Benzene
Heavy Oil	Hazardous	Toxicity/Benzene, Trichloroethene, Lead
Heavy Fuel Oil	Hazardous	Toxicity/Benzene
Heavy Crude Oil	Hazardous	Toxicity/Benzene
Tank Bottom	Hazardous	Toxicity/Benzene
Tank Water	Hazardous	Toxicity/Trichloroethene
Tank Oil	Hazardous	Toxicity/Trichloroethene, Benzene
Distillate	Hazardous	Toxicity/Benzene
Light Oil		Ignitability/Flash Point
Tank Cleanout	Hazardous	Toxicity
Tank Cleanout Oil	Hazardous	Toxicity/Arsenic
Oily Material	Hazardous	Toxicity/Benzene
Plus Water		
Tank Bottom Heavy Oil	Hazardous	Toxicity

As discussed, the oil pitch and tank bottom heavy oil solid composite samples were characterized for toxicity by TCLP extraction. The TCLP extracts of both materials contained none of the TCLP regulated analytes in concentrations above their TCLP regulatory levels, and as a result, these composite groups are nonhazardous based on toxicity.

As shown in Table 39, SVL Analytical detected 107 ppm of arsenic in the tank cleanout oil composite sample. Dividing 107 ppm by a dilution factor of 20, which is most likely high for this material, gives a value of 5.3 ppm. The regulatory level for arsenic is 5.0 mg/L, and as a result, the tank cleanout oil is hazardous based on the SVL data. This value is questionable since WRI reported only 3.42 ppm arsenic in the composite sample; however, to save the costs of additional sampling and analyses, a conservative approach was taken, and the material is considered to be hazardous.

For disposal, the tank cleanout material will also be considered hazardous. As mentioned, this material contains 8.5 ppm pyridine, and as shown in Table 38, the tank cleanout also contains 2.2 ppm selenium. However, these concentrations should be divided by a dilution factor for toxicity characteristic evaluation. In addition, volatile and semivolatile organic analyses of this material gave many analytical detection limits that were above the regulatory levels. As a result, to correctly classify this material as hazardous or nonhazardous, TCLP extraction is required. However, because there is only one 30-gallon container of this material, it is more cost effective to dispose of it as a hazardous waste than to pay for the extraction and analyses for TCLP characterization.

For disposal, the tank bottom heavy oil will also be classified as hazardous. As shown in Tables 36 and 38, this material contains several of the TCLP regulated analytes at concentrations above the TCLP action levels. However, once again these concentrations should be divided by a dilution factor for toxicity characteristic evaluation. In addition, semivolatile organic analyses of this material gave many analytical detection limits that were above the regulatory levels. As a result, to correctly classify this material as hazardous or nonhazardous, TCLP extraction is required. Once again, it is believed to be more cost effective for the project to dispose of the materials in this composite group as hazardous wastes, rather than to pay for the extraction and analyses for TCLP characterization.

Analysis of Tars, Oils, and Hydrocarbon Liquids QA/QC Samples

Metals, semivolatile organic, and volatile organic field trip blanks were taken to the field during sampling of the tank cleanout, tank cleanout oil, oily material plus water, dirty oil and sludge, and coal tar materials. These blanks were analyzed during analysis of the oily materials to check for any contamination due to the field environment, including sample storage and transportation. The blanks were

analyzed by WRI, and none of the TCLP regulated analytes were detected at concentrations above the analytical detection limits.

Two coal tar composite samples were prepared in phase I. The first of these was split, and the coal tar composite and its split were submitted to WRI and the CLP laboratories as blind samples for analysis of benzene and the regulated metals. Table 42 shows the data from these analyses. Copies of the data report forms for these samples are also included with the tars, oils, and hydrocarbon liquids data in Appendix E. There is good agreement between the metal values listed in Table 42, both between WRI and SVL values and between values determined by the two laboratories for the splits. Unfortunately, for arsenic, lead, and selenium, SVL could only report less than 8 ppm; however, the values, which were determined by WRI for these elements, were less than 8 ppm as reported by SVL. Silver is the only element for which the values reported by the laboratories do not agree. For the hazard classifications, this is not a problem. In the oily materials, silver is not an element of concern because most of the concentrations of silver that were detected in the samples are less than 0.1 ppm.

For benzene analysis of the coal tar and its split (Table 42), greater than values were reported by both WRI and Pace. In all cases, the greater than values are much higher than the regulatory value of 0.5 mg/L, and even with a dilution factor of 20 applied, all result in a hazard classification for the coal tar material.

Table 42. QA/QC Data from Analyses of a Coal Tar Composite and Its Blind Split, ppm ^a

TCLP Analyte	Coal Tar Composite		Blind Split	
	WRI	CLP	WRI	CLP
Arsenic	1.90	<8.0	1.97	<8.0
Barium	57.4	64.2	61.1	57.4
Cadmium	0.64	0.72	0.85	0.59
Chromium	5.16	6.42	6.77	4.41
Lead	5.18	<8.0	5.60	<8.0
Mercury	0.48	0.57	0.54	<0.1
Selenium	2.07	<8.0	2.35	<8.0
Silver	0.60	1.12	<0.1	0.94
Benzene	≥26	>1,900	>1,600	>1,300

^a These values may differ from those listed in Tables 36, 37, 38, and 39 because two coal tar composites were prepared. The values reported in Tables 36, 37, 38, and 39 are the highest concentrations that were determined from analysis of the two composites.

Analysis of the North Site Chemicals and Unknown Materials

The unknown materials and chemicals listed in Tables 9 and 10 were analyzed by WRI using screening methods to provide information on their composition and identity. The only material that was not analyzed is the chlorinated solvent, which was deemed hazardous based on knowledge that it is indeed chlorinated solvent. Initial screening showed the artie 75/90 material to be diesel fuel. Screening also showed the pellets composite to contain no organic compounds that are amenable to gas chromatographic analysis. As a result, the pellet composite was extracted by TCLP for the regulated metals. Results for this extraction, which were discussed in the section of this report on results from TCLP extraction of composite and individual samples (see Tables 17 and 18), along with the information from the organic screen, show that the pellets are not hazardous. The identity of the chemicals, monoethanolamine, which has a pH of 12.6, and tretolite, were verified, and these materials were deemed hazardous. Also the material labeled unknown material, which is a liquid solvent, was determined to be hazardous based on its concentrations of benzene at 4,200 ppm and lead at 13 ppm.

The remaining materials listed in Tables 9 and 10 were determined to contain primarily inorganic constituents and were further analyzed to determine the concentrations of their inorganic components. These are listed in Table 43. Based on the data given in this table and previous analyses, the identity of the material labeled as soda ash was confirmed.

To classify the remaining materials listed in Table 43 as hazardous or nonhazardous and to save the time and expense of TCLP extractions, the materials were analyzed directly for the TCLP regulated metals and semivolatile and volatile organic compounds. The concentrations of the TCLP regulated metals that were determined to be present in the unknown materials and chemicals are listed in Table 44. As shown, none of the metals exceed the TCLP regulatory levels. In addition, none of the TCLP regulated semivolatile organic compounds were detected in these materials at concentrations above their analytical detection limits, and only very low concentrations (0.05-2.3 ppm) of methyl ethyl ketone were detected in the unknown liquid, caustic soda, boiler water treatment, and dry water treatment-1. The regulatory level for methyl ethyl ketone is 200 mg/L. This is the only volatile organic compound that was detected above the analytical detection limits in any of the unknown materials and chemicals listed in Tables 43 and 44. As a result, these materials can be classified as nonhazardous. The data report forms for analysis of the chemicals and unknown materials can be found in Appendix E.

Metals, semivolatile organic, and volatile organic field trip blanks were taken to the field during sampling of the North Site chemicals and unknown materials. These blanks were analyzed by WRI to check for any contamination of the materials due to the field environment, including sample storage and transportation. None of the TCLP regulated analytes were detected at concentrations above their analytical detection limits in any of the blanks. Results from analysis of the field trip blanks are included with the unknown material and chemical data in Appendix E.

Table 43. Inorganic Characterization of the North Site Chemicals and Unknown Materials

Composite	Metals	Anions
Dry Water Treatment-1 (Solid) pH = 10.2 (17:1 water:solid)	46.6% Na 489 ppm K 251 ppm Co	160,000 ppm Sulfate 1,400 ppm Chloride 1,300 ppm Nitrate as N
Dry Water Treatment-2 (Liquid) pH = 6.5	2.7% Na 128 ppm K	12,400 ppm Sulfate 2,700 ppm Orthophosphate as P 350 ppm Chloride
Caustic Soda (Liquid-labeled 50% Aqueous NaOH) pH = 7.7	6.64% Na	<10 ppm Mineral Carbon 13 ppm Sulfate (Anion screen can not detect hydroxide. Absence of other major anions indicates presence of hydroxide.
Boiler Water Treatment (Liquid) pH = 12.1	3.14% Na 247 ppm K 93 ppm Ca	3,600 ppm Sulfate 930 ppm Chloride 900 ppm Ortho- Phosphate as P 289 ppm Mineral Carbon
Soda Ash (Solid) pH = 10.7 (1:1 water:solid)	46.7% Na 96.5 ppm Ca	11% Mineral Carbon
Unknown Liquid (Water Soluble) pH = 6.3	3.19% Na 3,554 ppm K 3,177 ppm B 471 ppm Ni 337 ppm Mg	54,000 ppm Chloride 12,000 ppm Sulfate 21 ppm Nitrate as N
SAI Comp Material- Liquid pH = 8.1	4.42% Na 198 ppm K 44.8 ppm Si	450 ppm Nitrate as N 190 ppm Chloride 70 ppm Sulfate
SAI Comp Material- Solid pH = 7.5 (5:1 water:solid)	22.1% Na 2,270 ppm Ca 375 ppm Si	360,000 ppm Sulfate 3,100 ppm Chloride 2,600 ppm Nitrate as N

Table 44. TCLP Regulated Metal Concentrations in the North Site Unknown Materials and Chemicals, ppm

Composite/ Individual Sample	As (5.0) ^a	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Dry Water Treatment-1	<0.6	<0.7	<0.7	<0.5	<1.5	<0.02	<0.6	<0.6
Dry Water Treatment-2	3.21	0.285	0.023	0.419	<0.5	<0.002	<0.1	<0.1
Caustic Soda	<1.0	<0.1	<0.1	0.10	<1.0	0.093	<1.0	<1.0
Boiler Water Treatment	<1.0	<0.1	<0.1	0.31	<5.0	<0.002	<1.0	<0.1
Unknown Liquid	<1.0	0.24	<0.1	0.20	<1.0	<0.002	<1.0	<1.0
SAI Comp Material- Liquid	<0.1	0.083	0.143	2.78	<0.5	<0.002	<0.1	<0.1
SAI Comp Material- Solid	<0.6	<0.6	<0.6	2.04	<1.4	<0.02	<0.6	<0.6

^a The value given in parentheses is the regulatory level in mg/L for each analyte.

Results from Analysis of the Field Equipment Blanks

Two sets of field equipment blanks, scoop blanks and coliwasa blanks, were analyzed by WRI for the regulated metals, semivolatile organic compounds, and volatile organic compounds to show any contamination of the North Site samples contributed by the sampling equipment. As discussed, disposable glass coliwasa and plastic scoops were primarily used for sampling the North Site materials. In both the scoop and coliwasa field equipment blanks, all concentrations of the TCLP regulated metals and semivolatile organic compounds were reported below analytical detection limits. The same was true for the concentrations of the regulated volatile organic compounds, except a concentration of methyl ethyl ketone at 0.02 mg/L was detected in the coliwasa equipment blank. The regulatory level for this compound is 200 mg/L. Based on these results, it appears that the sampling equipment did not contribute any contamination to the North Site samples that affected the sample data. Copies of the data report forms for analyses of the field equipment blanks can be found in Appendix E.

CONCLUSIONS

The objective of phase I of this cleanup project was to define the North Site product streams requiring disposal or use. Information on the identity and composition of the materials in each of the product streams, as well as their hazard classification, has been obtained. Sixty-nine composite or individual samples were characterized. Forty-one of these are nonhazardous, and 28 are hazardous based on the characteristic of toxicity. Two of the composite groups that fail toxicity also fail the characteristic of ignitability. Most of the composite groups that were determined to be hazardous are oily materials that contain high concentrations of benzene. Hazard classification information for the North Site composite groups is summarized in Table 45. The information presented in this report represents the bulk of the North Site materials requiring characterization. However, as the project proceeds, there may be additional materials that require hazard testing. Depending on the nature of these materials, they will be characterized in the same manner used for the materials described in this report. Information obtained in phase I will now be used in phases II and III of the North Site cleanup project. These phases, which involve disposal or use of the North Site materials, can now begin.

Table 45. Hazard Classification of the North Site Composite Groups

Product Stream/ Composite Group	Containers Represented	Hazard Classification	Comments
<u>Unprocessed Tar Sands</u>			
Tar Sand	14-48, 50-54, 56-63, 65, 221- 223, 226-240, 862-885, 1159 1180	Nonhazardous	Passes TCLP Extraction 1,589 Btu/lb
Tar Sand Sludge	49	Nonhazardous	Passes TCLP Extraction 7,885 Btu/lb
<u>Unprocessed Coals</u>			
Unprocessed Western Coal	83-94, 97-114, 116, 117, 119- 138, 213-220, 372, 553-560, 567-569, 573, 574, 812-814, 939-942, 983, 988, 990, 1070, 1071, 1161-1166	Nonhazardous	Passes TCLP Extraction 9,772 Btu/lb
Unprocessed Eastern Coal	1-4, 95, 96, 115, 201-212, 810, 811, 1212	Nonhazardous	Passes TCLP Extraction 10,880 Btu/lb
<u>Raw Oil Shales</u>			
Raw Western Oil Shale	139-161, 241- 277, 374-406, 409-421, 424- 434, 436-473, 547-549, 815, 816	Nonhazardous	Passes TCLP Extraction 2,394 Btu
Raw Eastern Oil Shale	162-180, 182, 183, 185-200, 337-343, 354- 362, 407, 408, 855, 856, 1167	Nonhazardous	Passes TCLP Extraction 2,928 Btu
Raw Shale Pile	1260, 1262- 1264	Nonhazardous	Passes TCLP Extraction 2,138 Btu

**Table 45. Hazard Classification of the North Site Composite Groups
(continued)**

Product Stream/ Composite Group	Containers Represented	Hazard Classification	Comments
<u>Spent Oil Shale, Processed Tar Sand, Activated Charcoal</u>			
Spent Oil Shale-1	328-332, 363- 367, 541- 546, 818	Nonhazardous	Passes TCLP Extraction
Spent Oil Shale-2	1080, 1081	Nonhazardous	Passes TCLP Extraction
Spent Oil Shale Pile	1259, 1261	Nonhazardous	Passes TCLP Extraction
Spent Tar Sand	368-371, 373	Nonhazardous	Passes TCLP Extraction
Activated Charcoal	684-702, 826- 838, 840-852, 1170, 1226, 1227	Nonhazardous	Passes TCLP Extraction
Unused Activated Charcoal	859, 860	Nonhazardous	Passes TCLP Extraction
MG Fines, Char	1204-1211, 1213-1219, 1221-1225, 1257	Nonhazardous	Passes TCLP Extraction
<u>Miscellaneous Materials</u>			
Oily Insulation	948, 949	Nonhazardous	Passes TCLP Extraction
Tank Bottom Liner	820, 821, 823	Nonhazardous	Passes TCLP Extraction
Evaporation Tank Bottom Dirt	933, 1244, 1245	Nonhazardous	Passes TCLP Extraction
Oily Dirt	645-655, 999	Nonhazardous	Passes TCLP Extraction
Sulfur	950	Nonhazardous	Passes TCLP Extraction
Crushed KC Rock	1121	Nonhazardous	Passes TCLP Extraction
Fly Ash	891-912	Nonhazardous	Passes TCLP Extraction

**Table 45. Hazard Classification of the North Site Composite Groups
(continued)**

Product Stream/ Composite Group	Containers Represented	Hazard Classification	Comments
<u>Waters</u>			
Retort Water	350, 1079, 1122	Nonhazardous	Analyzed for TCLP regulated analytes pH = 9.2
Graham Water	1113-1120	Nonhazardous but Radioactive	Analyzed for TCLP regulated analytes pH = 9.1 Contains Radium 226
Tank Cleanout Water	931, 944	Nonhazardous	Analyzed for TCLP regulated analytes pH = 9.3
Water Scavenger	493-495	Nonhazardous	Analyzed for TCLP regulated analytes pH = 2.5
Water, Coal Fines, Oil	1198	Nonhazardous	Analyzed for TCLP regulated analytes pH = 7.9
Unidentified UCG Water	1271	Nonhazardous	Analyzed for TCLP regulated analytes pH = 8.1
Hoe Creek Water	1273	Nonhazardous	Analyzed for TCLP regulated analytes pH = 8.3
RM1 Water	1272	Nonhazardous	Analyzed for TCLP regulated analytes pH = 8.3
CROW Water	1267, 1268	Nonhazardous	Analyzed for TCLP regulated analytes pH = 6.9

**Table 45. Hazard Classification of the North Site Composite Groups
(continued)**

Product Stream/ Composite Group	Containers Represented	Hazard Classification	Comments
<u>Waters (continued)</u>			
Tank Bottom Water	824, 825, 889 947	Hazardous	Analyzed for TCLP regulated analytes-Fails As & Se pH = 5.9
Sludgy Water	550	Hazardous	Analyzed for TCLP regulated analytes-Fails As, Cd, Cr pH = 7.1
Treolite Distillates	618	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene pH = 5.0
Free & Distilled Water	1201	Hazardous	Analyzed for TCLP regulated analytes-Fails Se, Cresol, Benzene pH = 7.0
<u>Tars, Oils, and Hydrocarbon Liquids</u>			
Tank Bottom Heavy Oil Solid	55, 643, 890	Nonhazardous	Passes TCLP Extraction
Oil Pitch	951-956, 975, 976, 1258	Nonhazardous	Passes TCLP Extraction
Shale Oil-1	279, 282, 293, 294, 295, 298, 299, 301, 319, 320, 322	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene
Shale Oil-2	344, 346-348	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene

**Table 45. Hazard Classification of the North Site Composite Groups
(continued)**

Product Stream/ Composite Group	Containers Represented	Hazard Classification	Comments
<u>Tars, Oils, and Hydrocarbon Liquids (continued)</u>			
Shale Oil-8	776-784	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene
Shale Oil Distillates	614, 615, 656	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene Fails Ignitability Flash pt.=<140°F
Tar Sand Heavy Oil	64, 498, 577- 599, 1139, 1141	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene, Pb
Heavy Oil Plus Coal	474-477, 500- 502	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene
Dirty Oil & Sludge	785, 794, 795 858	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene
Coal Tar	482, 959-974, 1135-1138	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene
Heavy Oil	66, 305, 489, 490, 491, 937	Hazardous	Analyzed for TCLP regulated analytes-Fails Pb, Trichloro- ethene, Benzene
Heavy Fuel Oil	6, 7, 9, 10, 11, 12	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene 17,811 Btu/lb
Heavy Crude Oil	787, 792, 793	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene

**Table 45. Hazard Classification of the North Site Composite Groups
(continued)**

Product Stream/ Composite Group	Containers Represented	Hazard Classification	Comments
<u>Tars, Oils, and Hydrocarbon Liquids (continued)</u>			
Tank Bottom	943, 957, 958, 978	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene
Tank Water	1265	Hazardous	Analyzed for TCLP regulated analytes-Fails Trichloroethene
Tank Oil	1266	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene and Trichloroethene
Distillate Light Oil	1199, 1200	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene Fails Ignitability Flash pt. < 140°F
Tank Cleanout	623	Hazardous	Analyzed for TCLP regulated analytes- Decision made to call hazardous
Tank Cleanout Oil	619, 620	Hazardous	Analyzed for TCLP regulated analytes-Fails As
Oily Material Plus Water	600-610, 945	Hazardous	Analyzed for TCLP regulated analytes-Fails Benzene
Tank Bottom Heavy Oil	627-642, 886-888, 929, 930	Hazardous	Analyzed for TCLP regulated analytes- Decision made to call hazardous

**Table 45. Hazard Classification of the North Site Composite Groups
(continued)**

Product Stream/ Composite Group	Containers Represented	Hazard Classification	Comments
<u>Unknown Materials</u>			
Pellets	518-520, 552	Nonhazardous	Passes TCLP Extraction for Metals; GC analysis shows no organics
Unknown Liquid	496	Nonhazardous	Analyzed for TCLP regulated analytes; Major component is NaCl; pH = 6.3
Unknown Material	992, 993	Hazardous	Solvent Contains 4,200 ppm Benzene & 18 ppm Pb
SAI Comp Material-Liquid	1067, 1068	Nonhazardous	Analyzed for TCLP regulated analytes; Major component is NaNO ₃ ; pH = 8.1
SAI Comp Material-Solid	1140	Nonhazardous	Analyzed for TCLP regulated analytes; Major component is Na ₂ SO ₄
Artic 75/90	853, 854	Hazardous	Diesel Fuel
Chlorinated Solvents	1074	Hazardous	
<u>Chemicals</u>			
Monoethanolamine	487	Hazardous	
Tretolite	352, 617	Hazardous	

**Table 45. Hazard Classification of the North Site Composite Groups
(continued)**

Product Stream/ Composite Group	Containers Represented	Hazard Classification	Comments
<u>Chemicals (continued)</u>			
Caustic Soda	803, 804	Nonhazardous	50% Aqueous NaOH; Analyzed for TCLP regulated analytes pH = 7.7
Boiler Water Treatment	805	Nonhazardous	Analyzed for TCLP regulated analytes; Major component is Na₂SO₄; pH = 12.1
Dry Water Treatment-1	806	Nonhazardous	Analyzed for TCLP regulated analytes; Major component is Na₂SO₄
Dry Water Treatment-2	807, 808	Nonhazardous	Analyzed for TCLP regulated analytes; Major component is Na₂SO₄ pH = 6.5
Soda Ash	92	Nonhazardous	Na₂CO₃

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2 of 2

NORTH SITE MATERIALS HANDLING DATA BASE

As mentioned, the North Site Materials Handling Data Base was created as a quick and accurate means for producing reports on the status of the cleanup project. The system is written in FoxPro 2.0, which is based on a superset of the dBase language. It consists of five primary and two helper data base files. The function of each of these is summarized below. The capitalized letters in the file descriptions are field names.

North Site Materials File (HAZMAT.DBF)

This file contains a record for each container of material requiring disposal or use. Each record contains the container's serial number (SERIAL_NO), common name of the material (COMMN_NAME), location (LOCATION), project account number under which the material was generated (ACCT_NO), last name of the project manager (PROJ_MNGR), hazard classification (EPA Hazardous Waste Number; HAZ_CLASS), container type (CONTAINER), container volume in gallons, (CONT_VOLUM), quantity in pounds (QTY_LBS), storage environment (STRG_ENVIR), date material was accumulated (ACCUMULATED), date material came on site (DATEONSITE), date material was last inspected (LAST_INSPEC), process by which the material was created (WRI_USE), product stream identification number (PRDCTSTRM), composite group identification (COMPGROUP), and comments (COMMENTS).

The following list gives the identification numbers and descriptions for the CONTAINER, STRG_ENVIR, and PRDCTSTRM fields.

- **CONTAINER**

- 1 Plastic
- 2 Stainless Steel
- 3 Steel
- 4 Steel with Plastic Liner
- 5 Cardboard

- **STRG_ENVIR**

- 1 Ambient
- 2 Cold

- **PRDCTSTRM**

- 1 Chemicals
- 2 Miscellaneous Materials
- 3 Raw Oil Shales
- 4 Spent Oil Shale, Processed Tar Sand, Activated Charcoal
- 5 Tars, Oils, and Hydrocarbon Liquids
- 6 Unknown Materials
- 7 Unprocessed Coals
- 8 Unprocessed Tar Sands
- 9 Waters

Composite Group File (COMPGRP.DBF)

This file contains a record of each composite group in the North Site product streams. Each record contains the composite group's name (NAME), identification number (COMPGROUP), list of serial numbers of the containers in the composite group (SN1 and SN2), the hazard status (FAIL, true if hazardous; ANALYFAIL, true if found hazardous by analysis; FORCEFAIL, true if declared hazardous), and product stream identification number (PRDCTSTRM).

Sample File (SAMPLE.DBF)

This file contains a record for each sample that was taken during characterization of the North Site materials. Each record contains the sample's identification number (SAMPLE_ID), composite group to which the sample belongs (COMPGRP), sample type (TYPE), date and time the sample was taken (DATE;TIME), sampling method (METHOD), name of sample collector (WHO), comments (INSP_COMM), reference to the sampling and laboratory logbooks (FIELDBOOK, FIELDPAGE; LABBOOK, LABPAGE), types of analyses performed on the sample (QUICK, IGNITABILITY, CORROSIVITY, REACTIVITY, TCLP_FULL, TCLP_PART, TOTAL_CHAR, SEMI_QUANT, BTU_CHARAC), related samples (REL_SAMPLE), serial number of the container sampled (SERIAL_NO), and quantity of sample collected (QTY;UNITS).

Each sample identification number consists of the logbook number and logbook page number where the sample is described, followed by either the serial number of the container sampled, or for extracts, composite samples, and blanks, a number assigned to the material. In the data base, a "normal" sample refers to the sample collected at the North Site, and "related" samples are the composite sample to which it was added, a split of the sample, and/or its TCLP extract. The identification numbers and descriptions of the TYPE, METHOD, and WHO fields are listed below.

• TYPE

- 1 Field Blank
- 2 Normal
- 3 Split
- 4 Equipment Blank
- 5 Method Blank
- 6 Composite
- 7 Extract

- **METHOD**

- 1 Auger
- 2 Coliwasa
- 3 Dipper
- 4 Scoop
- 5 Shovel
- 6 Thief
- 7 Trier
- 8 Weighted Bottle
- 9 Scissors
- 10 Drum Handler Drained from Valve

- **WHO**

- 1 Gitke, Les
- 2 Sorini, Susan

Analysis File (ANALYSIS.DBF)

This file contains a record for each analysis performed on the samples in SAMPLE.DBF. Each record contains the analysis identification (ANALY_ID, computer generated), identification number of the sample (SAMPLE_ID), analysis type (ANALYTYPE), analytical method (ANALYMETH), laboratory identification (WHERE), date analysis was performed (DATE), name of analyst (WHO), notebook reference to sample analysis (LABBOOK;LABPAGE), quantity analyzed (QTY;UNITS), whether the sample passes hazardous waste criteria based on results from analysis (PASS, true indicates nonhazardous), whether the sample is a matrix spike (MATRIXSPIK, true indicates that it is a spike), the identification number of the associated matrix spike (MATRIXTEST), and comments (COMMENTS).

The identification numbers and descriptions for the WHERE, ANALYMETH, and ANALYTYPE are given below.

- **WHERE**

- 1 Pace
- 2 Silver Valley Labs
- 3 Western Research Institute

• **ANALYMETH**

- 1 ASTM D2015
- 2 ASTM D240
- 3 ASTM D3050,D3683,D3684
- 4 ASTM D93
- 5 EPA 1311
- 6 EPA 3010,3050, & 6010
- 7 EPA 3580,8000
- 8 EPA 7.3.3.2 & 7.3.4.2
- 9 EPA 9040
- 10 EPA 200.7
- 11 EPA 8240
- 12 EPA 8250
- 13 ASTM 3684, 7.1-7.6/7470
- 14 ASTM 3684, 7.1-7.6/7060
- 15 ASTM 3684, 7.1-7.6/7740
- 16 EPA 3050/6010
- 17 EPA 7471
- 18 EPA 3050/7060
- 19 EPA 3050/7740
- 20 EPA 3050/6010
- 21 EPA 7470
- 22 EPA 3010/6010

• **ANALYTYPE**

- 1 Btu Characterization
- 2 Corrosivity
- 3 TCLP (Volatiles)
- 4 Ignitability
- 5 TCLP (Metals & Semivolatiles)
- 6 Screen
- 7 Reactivity
- 8 Semiquantitative Screening
- 9 Total Characterization

Results File (RESULTS.DBF)

This file contains a record for each analyte for which testing was conducted. Each record contains the analytical identification number (ANALY_ID), name of the analyte (LABEL), quantity of analyte found (QTY;UNITS), and whether the value for the analyte passes or fails the hazardous criteria (PASS_HWNO, if pass, this is set to PASS; if fail, this is set to the EPA Hazardous Waste Number; if inconclusive, this is set to ???).

Regulatory Analyte File (REGLEVEL.DBF)

This file contains a record for each TCLP regulated analyte. Each record contains the analyte's name (LABEL), abbreviation (ABBREV), low and high limits (LOWLIMIT;HILIMIT), EPA Hazardous Waste Number (EPAHWNO), units of the limits (UNITS), and three fields used for internal data base operations (TYPE, ORDER, LIMIT).

Label File (POPUP.DBF)

This file contains the various labels and associated identification symbols described for the data bases.

Data Base Reports

Reports providing various types of information can be generated using the North Site Materials Handling Data Base. Information that can be generated includes container inventory, which is Appendix A of this report (serial number and material name), testing results by product stream (product stream, composite group, hazard classification, failing characteristic, analyte, and quantity found), failing containers (includes composite groups to which the containers belong), and passing containers (also includes composite groups to which the containers belong). Examples of data base reports for phase I of the North Site cleanup project are included in Appendix F.

DISCLAIMER

Mention of specific brand names or models of equipment is for information only and does not imply endorsement of any particular brand.

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