Monroe County Dept. of Health

REPORT

REMEDIAL INVESTIGATION AND RISK ASSESSMENT R.D. SPECIALTIES FACILITY

R.D. Specialties, Inc.

Webster, New York

November 1989

BLASLAND & BOUCK ENGINEERS, P.C.
BLASLAND, BOUCK & LEE
ENGINEERS & GEOSCIENTISTS

ATTORNEY-CLIENT WORK PRODUCT

REPORT

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R.D. SPECIALTIES FACILITY

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BLASLAND & BOUCK ENGINEERS, P.C.
6723 TOWPATH ROAD
BOX 66
SYRACUSE, NEW YORK 13214

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd.)

TABLES

FIGURES

APPENDICES

SECTION 1 - INTRODUCTION

1.1 Background

Nixon, Hargrave, Devans & Doyle, Attorneys and Counselors at Law, retained Blasland & Bouck Engineers, P.C. (Blasland & Bouck) to implement a modified RI/FS for an alleged inactive hazardous waste disposal site at R.D. Specialties, Inc., located at 560 Salt Road, Webster, Monroe County, New York. At the request of the New York State Department of Environmental Conservation (NYSDEC), this investigation has been completed to define the extent of chromium contamination at the site, and to prepare an assessment of the potential for human and environmental exposure. In addition, the information gathered during the site investigation has been used to evaluate the need for remediation.

1.2 Site Description

R.D. Specialties, Inc., is a small manufacturing facility located in an industrial-zoned area on Salt Road in Webster, New York. Land use in the area is primarily residential and agricultural. Xerox Corporation, a major industrial complex, is located one-half mile southwest of the site. The site location relative to surrounding landmarks is shown on Figure 1.

R.D. Specialties manufactures wire-wound metal rods used to spread fine coatings on paper, film, and foils. As part of the manufacturing process, some of the rods are plated with chrome to create a hard surface that is resistant to abrasion.

Between 1966 and 1982, the plating rinse water was discharged to a dry sump located at the rear of the building, as shown on Figure 2. This rinse water contained chromium wastes primarily in the form of hexavalent chromium [Cr(VI)]. In addition to the plating rinse water, approximately 40 to 50 gallons of chrome plating solution were emptied into the dry sump on one occasion between 1970 and 1980. After 1982, chromium rinse water was treated to reduce Cr(VI) to trivalent chromium [Cr(III)] which would then precipitate. The aqueous portion was decanted and the sludge was dried and transported off-site for disposal. The aqueous portion was then discharged to a new cement containment structure in the area of the former dry sump. A sump pump in the containment structure pumped the liquid to a perforated? drainage pipe and ditch. As of 1984, neither chrome rinse water nor plating solution were released to the environment. A limited investigation of the site by Lozier Architects and Engineers in September 1985, revealed the presence of chromium contamination in soils and stream sediments.

1.3 Geologic Setting

The site is located within the Erie-Ontario Lowlands Physiographic Province on the broad lake plain which slopes toward Lake Ontario. The lake is located approximately 2½ miles north of the site.

Regionally, the bedrock units dip to the south and a transverse from south to north intercepts outcropping bedrock units of increasing age. The uppermost bedrock formation below the site is the Grimsby sandstone, which is lower Silurian in age. The Grimsby is predominately a reddish-colored sandstone with interbedded siltstone. Green mottling and layering is common in both the upper and lower part of the formation.

Unconsolidated material in the area is of glacial origin, and ranges from fine-grained lacustrine deposits to coarser-grained fluvial and ablation features. Within the site boundaries, soils were found to consist primarily of fine to medium sand and silt with a lesser fraction of gravel.

SECTION 2 - FIELD INVESTIGATION

2.1 Monitoring Well Installation

A total of eight ground-water monitoring wells were installed at the site between March 8, 1989 and March 17, 1989. The wells were positioned in areas having the greatest potential for contamination and in perimeter areas to define the extent of chromium migration. Locations were chosen in the field with the concurrence of an on-site representative of the NYSDEC. Monitoring well locations are shown on Figure 2. Seasonally, ground water occurs at or within one foot of the ground surface over much of the site area. The wells were constructed to a maximum depth of 11 feet and intercept flow in the overburden sediments and/or the upper part of bedrock.

At each well location, the boring was initially advanced with 4¼-inch I.D. hollow-stem augers to the bedrock surface. As the augers were advanced, soil samples were collected in two-foot intervals with a steel split-barrel sampler. Descriptions of the recovered soil samples were prepared by an on-site geologist, and representative soils were retained for later reference. The details of each boring and well installation are given on the logs included as Appendix A. In order to retain the drilling water used while coring, it was necessary to create a closed system by removing the augers and spinning a temporary four-inch casing into the top of rock. The NX core barrel was then lowered into the hole and advanced to the desired depth. Core samples of the bedrock were retained and are stored on-site.

Each well was constructed with 5 feet of 2-inch diameter, .01-inch slotted Schedule 40 PVC screen. Schedule 40 PVC riser was extended to above the ground surface for all wells with the exception of RD-5, which was finished as a flush-mount installation. Grade 0 sand was placed around the screen and was extended at least 1 foot above the slotted portion of the screen. A bentonite seal with a minimum thickness of 1 foot was placed above the sand pack. A protective casing was then grouted in place with an approximate stick-up of 2 feet at each location, with the exception of RD-5. At the RD-5 location, cement grout was brought to within 1 foot of the ground surface, a 0.5-foot thickness of sand was left to drain any accumulating precipitation away from the well head, and a flush-mount well assembly was grouted in place. Each well installation was fitted with a locking cap.

The wells were developed by repeatedly surging and then bailing water from the screened interval of the well. As development progressed, the level of suspended solids (i.e., turbidity of the water) was monitored with a turbidimeter. The levels of turbidity attained in each of the wells following development, given in nephelometric turbidity units (NTUs) are shown in Table 1.

2.2 Sampling

A Sampling and Analysis Plan was designed and implemented to define the extent of elevated chromium concentrations in soil, ground water, and surface water. The plan was also designed to provide the data necessary to prepare the Risk Assessment which is included as Section 4 of this report. At the request of the NYSDEC, a number of analyses were also completed for volatile organic compounds and Hazardous Substance List (HSL) metals.

2.2.1 Soils

The soil sampling program was concentrated along surface drainage routes and suspected wastewater and sludge handling areas.

A series of samples were collected at five different profile locations traversing surface drainage paths, as shown on Figure 2. At each profile location, a sediment sample was collected from the center of the drainage channel and a composite sample was obtained on each side of the channel. Each composite sample was composed of soils obtained from one to three feet in depth. This sampling configuration was chosen to define the degree of chromium migration, if any, occurring in a radial direction from the drainage routes.

Additional soil sampling locations were chosen to provide data in a background location (SB-1) and in areas of suspected waste handling (SB-2, SB-3). A final sample (SB-4) was collected adjacent to the on-site marshy area. At each of the four locations, two grab samples were collected, one at a depth of one-foot from the ground surface and a second at a depth of three feet. Select samples were split with on-site NYSDEC representatives.

The method of sample collection was altered as the sampling program progressed to adapt to field conditions. Samples were collected with a shovel, hand auger, or power auger. Decontamination procedures, as outlined in the September 1988 Work Plan, were followed. These procedures included a soapy water wash followed by successive rinses with nitric acid, dilute methanol, and deionized water. Water generated during the decontamination process was collected and containerized. Quality Assurance/Quality Control (QA/QC) samples included a trip blank, a duplicate sample, and a laboratory spiked sample.

2.2.2 Ground Water

Ground-water samples were obtained from each of the monitoring wells on March 22, 1989. All of the samples were submitted for total and hexavalent chromium analyses. Additionally, two of the wells (RD-2 and RD-3) were sampled for arsenic, barium, cadmium, lead, mercury, selenium, and silver. Analysis of a field rinse blank, a duplicate sample, and a spiked sample were completed as part of the QA/QC requirements.

A second sampling round was completed on July 12, 1989, when samples were collected from five of the wells. The drummed water contained during the decontamination of field equipment (steam cleaning and the washing of equipment by hand) was also sampled at this time. Samples were submitted for total chromium and hexavalent chromium analyses.

Sampling protocols included removal of three times the volume of water contained in the well and the sand pack column with a bailer prior to sampling when the recharge rate of the well allowed. Wells that went dry were allowed to recharge and then the sample was collected. To minimize the degree of agitation and the resulting rise in turbidity of the well water, samples were collected with a peristaltic pump. A dedicated, in-line, 0.45 micron filter was used at each well location. Duplicate samples were collected prior to filtration by on-site NYSDEC personnel. All purge water was contained pending the receipt of analytical data to determine the correct method of disposal.

The decontamination of sampling equipment was completed in accordance with established protocols which specify a soapy water wash followed by rinses with nitric acid, dilute methanol, and deionized water. The decontamination rinse water was collected and containerized.

2.2.3 Surface Water

During the sampling round completed on March 22, 1989, surface water samples were collected from an upgradient stream location (SW-1) and a downgradient location (SW-2), as shown on Figure 2. In July of 1989, when the second round of sampling was completed, the intermittent stream was dry. Alternatively, a sample was obtained from the on-site marshy area (pond), with the concurrence of the on-site NYSDEC representative.

2.3 Site Survey

On July 21, 1989, a topographic survey of the work area was completed. The relative locations of site features and sampling points were recorded and this information was used to generate the site base map. An assumed site datum was adopted, and the relative elevations of RD-1 through RD-8 were recorded to the nearest .01-foot. For a summary of monitoring well elevations, refer to Table 2.

2.4 Water Level Measurements

Water level measurements were made in each of the monitoring wells with an electronic water sensor prior to each sampling event. A summary of the field measurements obtained on March 21, 1989 and July 12, 1989 is included as Table 3. The seasonal change in the water table is dramatically demonstrated by a comparison of the measurements made on the two dates.

Water levels dropped by an average of 3.9 feet over that time interval. A discussion of ground-water flow is included in Section 3.

2.5 In-Situ Permeability Testing

Permeability testing was completed in four of the eight wells. For each test, a cylinder or "slug" with a known volume was introduced into the well and water level measurements over time were recorded as the water level in the well dropped. A number of methods exist for the evaluation of this test data, and three separate methods were used. Tests were completed in monitoring wells RD-1, RD-4, RD-6, and RD-7. The results for RD-1 and RD-6 were inconclusive due to inconsistent borehole geometry with depth. The hydraulic conductivities in RD-4 and RD-7 ranged from 1.3×10^{-4} to 4.9×10^{-4} cm/sec., and backup data sheets for these analyses are included as Appendix B. These values are relatively high for sandstone deposits, which is likely due to the high degree of horizontal fracturing in the upper portion of the rock.

SECTION 3 - SUMMARY OF SITE HYDROGEOLOGY

The bedrock surface slopes to the southwest across the site. Bedrock was encountered at a minimum depth of 1 foot in RD-4 and at a maximum depth of 6½ feet in RD-1. The ground surface is relatively flat across the site area and, therefore, overburden materials are present in a wedge-shape overlying bedrock.

From the ground surface to depths ranging from 0.5 to 3 feet, overburden sediments consist of brown silt and fine sand. Sediments present below these surface deposits consist primarily of brown fine to medium-grained sand with minor amounts of silt and gravel. Bedrock, which was encountered in all of the monitoring well borings, is a distinctive reddish-brown fine-grained sandstone with green mottling and layering. A high degree of bioturbation disguises bedding features. Horizontal fracturing is present at frequent intervals, as shown on the boring logs in Appendix 1, and siltation is present along fracture planes indicating the presence of ground-water flow.

The upper part of the bedrock surface and the overlying unconsolidated sediments appear to act as a single hydrologic unit. The monitoring wells at the site are screened within the overburden and/or bedrock and yield comparable water level elevation data. Water level contours for March 21, 1989 and July 12, 1989 are shown on Figures 3 and 4. Flow is to the north, with a hydraulic gradient of .01 foot/foot. As discussed in Section 2.5, in-situ permeability tests were completed in select site wells. The computed hydraulic conductivity of bedrock ranges from 1.3 x 10^{-4} cm/sec to 4.9 x 10^{-4} cm/sec. Assuming an effective porosity of 0.2, flow velocities were found to vary from 7 ft/yr. to 25 ft/yr.

The level of the water table drops dramatically during the summer months, as shown by a comparison of the water levels measured in March with those measured in July. This indicates that ground water discharges to low-lying areas during seasons with a high water table. Surface water features then disappear during seasonal periods with a low water table. The physical appearance of the study area also changes dramatically in response to the water level fluctuations. The intermittent stream and large areas that had contained standing water in March were dry in July. Although the depth to water changes dramatically with the seasons, the configuration of ground-water flow paths remains the same.

SECTION 4 - RISK ASSESSMENT

4.1 Introduction

This Risk Assessment (RA) has been prepared to evaluate levels of chromium contamination and/or other potential hazardous wastes at the R.D. Specialties, Inc., site located in Webster, Monroe County, New York. The objective of the RA is to evaluate the need for specific remedial actions at the site on the basis of potential public and environmental exposure to chromium or other on-site contaminants.

4.2 Contamination Assessment

The objective of the Contamination Assessment is to screen the information that is available on hazardous substances present at the site and to identify chemicals of concern for subsequent consideration in the RA.

4.2.1 Existing Environmental Data

The following is a summary and discussion of the existing environmental data from the site. The present environmental data base consists of chemical-specific data for ground water, surface water, sediments, and soils at the site. As discussed previously, a limited investigation was performed at the site in September 1985 by Lozier Architects and Engineers. Their investigation indicated the presence of chromium contamination in soils and stream bed sediment at the site. The sampling completed as part of this study extensively defines areas of contamination and potential migration routes.

4.2.2 Soils

Twenty-three soil and sediment samples were collected from the site in March 1989 at depths ranging from the ground surface to three feet at the locations shown on Figure 2. All samples were analyzed for CLP total metals, hexavalent chromium (Cr(VI)), volatile organics, and percent total solids. The analytical results and back-up documentation for the soil samples collected by Blasland & Bouck were submitted in May 1989 in a report titled "Phase I Soil Sampling Results Volumes 1 and 2." Summary sheets of this data are included in Appendix C of this report.

Volatile organics and Cr(VI) were not detected in any soil samples. Of the 23 metals for which analyses were completed, 18 were observed above detection limits. Table 4 presents the analytical results from soil sample analyses. NYSDEC has no available soil action levels, so in order to determine which metals should be considered chemicals of concern, observed levels were compared to New Jersey Department of Environmental Protection (NJDEP) Soil Action Levels. NJDEP Soil Action Levels for 16 chemicals are presented in Table 5. These levels are based on background concentrations, attainable detection limits, and exposure risks. These levels are the best available screening criteria to determine which chemicals observed in on-site soils should be further evaluated.

For seven of the observed chemicals, no screening criteria is available. These seven include: aluminum, calcium, cobalt, iron, magnesium, manganese, and potassium. All seven of these chemicals are abundant in the earth's crust and can be found ubiquitously in the environment. As can be seen in Table 4, all but one of these chemicals were observed in almost every soil sample at consistent concentrations, and do not appear to be present beyond natural environmental levels. Cobalt was observed in only two samples at levels not significantly greater than detection limits. For these reasons, these seven chemicals are not expected to present any potential human health or environmental risk and will not be addressed as chemicals of concern on-site.

Four metals were observed above screening criteria: antimony, copper, beryllium, and total chromium. Antimony and copper were both observed above their screening levels of 10 and 170 mg/l, respectively, at 13.3 mg/kg and 265 mg/kg in sediment sample D1C. This sample was from the center of the western end of the drainage ditch. Beryllium was observed twice above its action level of 1.0 mg/kg at 1.1 mg/kg and at 1.8 mg/kg in samples IS1C and IS2C. These samples were obtained from the center of the intermittent stream.

The observed levels of beryllium and antimony are not significantly greater than the screening criteria, and there is no on-site history of disposal of these metals. At the observed concentrations, beryllium and antimony are not considered to pose any potential health or environmental risk and will not be considered chemicals of concern in this RA. Copper will be addressed further in this RA due to the greater concentration observed.

Total chromium was observed above the screening level (100 ppm) in five samples (Table 6). Three of the five samples comprise the soil sampling profile for the eastern end of the drainage ditch. The center sediment sample of the profile at the western end of the drainage trench, D1C, contained the maximum observed chromium concentration of 1,540 mg/kg. Total chromium concentrations observed in soils on-site are shown in Table 6.

The results of the analysis of select split samples collected by the NYSDEC are included in Appendix D. This data supports the results of sampling and analysis completed by Blasland & Bouck.

4.2.3 Water

As per the Work Plan (Blasland & Bouck, 1988), water samples were taken on-site in March and July 1989. Sampling locations are presented on Figure 2. Complete laboratory report packages containing data corresponding to the two sampling events were submitted in reports titled "Ground-Water and Surface Water Sampling Results, Phase I and Phase II," dated May 1989 and August 1989, respectively. Table 7 presents a summary of the concentrations of total and hexavalent chromium found in ground water and surface water.

To determine those chemicals or areas which may present a potential health risk, EPA Maximum Contaminant Levels (MCLs) are used as a screening criteria for ground-water data. MCLs are federal primary drinking water regulations developed to represent allowable lifetime ingestion exposure to specific chemicals in drinking water with no risk to human health.

Two surface water and eight ground-water samples were collected in March 1989. All samples were analyzed for total and hexavalent chromium. In addition, two samples were also tested for metals. Total chromium was observed above the laboratory quantifiable detection limit in five of ten samples and Cr(VI) was observed in six. Total chromium was observed at 0.05 mg/l in one surface water sample (SW-2), a value equivalent to the MCL for total chromium. Total chromium was also observed in four ground-water samples at concentrations ranging from 0.19 mg/l to 4.7 mg/l. Cr(VI) was observed in SW-2 at 0.04 mg/l, a value below the MCL for total chromium (0.05 mg/l). Five ground-water samples contained Cr(VI) at levels ranging from 0.02 to 3.7 mg/l. No other metals were observed at detectable concentrations.

July 1989 monitoring only included wells which tested positive in March 1989, and targeted those metals observed in March, as per the Work Plan (Blasland & Bouck, 1988). Intermittent stream surface water which was sampled in March was no longer present in July. However, as an alternative, a sample was obtained from the on-site marshy area or pond. Therefore, one surface water sample from the pond and five ground-water samples were taken in July 1989. Total chromium was observed in four ground-water samples at concentrations ranging from 0.07 to 1.0 mg/l, all above the total chromium MCL. Cr(VI) was observed in the same four samples, with concentrations ranging from 0.25 to 1.2 mg/l. The maximum observed concentration for both Cr(VI) and total chromium in both sampling rounds was found in monitoring well RD-8 located near the end of the drainage trench. Downgradient monitoring wells RD-7 and RD-4 showed non-detectable concentrations of all compounds in the March monitoring. The four wells with observed concentrations of chromium are in the area of the plant itself. Surface water samples from both monitoring rounds exhibited concentrations either at non-detectable levels or equal to the MCL.

The results of the analysis of select unfiltered water samples by the NYSDEC are included as Appendix D. This data supports the results of sampling and analysis completed by Blasland & Bouck with only slight variations in detected concentrations of chromium.

4.2.4 Discussion

Judging from available data, most metal concentrations observed on-site can be explained as natural background levels. However, total chromium and copper will be further examined as chemicals of concern in soils, and total chromium and Cr(VI) will be examined as chemicals of concern in ground water. Soil contamination is confined to an area adjacent to the dry sump and in the drainage area. Ground-water contamination appears to be localized, in that it was only observed in the four wells near the manufacturing building.

4.3 Exposure Assessment

The objectives of the Exposure Assessment are to identify potential receptor populations and exposure pathways by which these receptors may be exposed to chromium and copper.

4.3.1 Fate and Transport

The source and location of chromium and copper on the site has been discussed previously. A brief analysis of the environmental fate and transport of chromium and copper will be provided in this section.

4.3.1.1 General Environmental Fate

Chromium

Chromium occurs naturally in the earth's crust at concentrations ranging from 10 to 100 ppm (NAS, 1974). The element commonly occurs in the +2, +3, or +6 oxidation state. However, the +3 and +6 oxidation states of chromium are the most stable and significant in terms of environmental fate and transport.

In soils, Cr(III) primarily occurs as insoluble chromium oxide ($Cr_2O_3.nH_2O$), and is relatively non-mobile. However, Cr(III) may be converted to Cr(VI) by the presence of manganese oxides in the soil. Cr(III) also tends to form water-soluble complexes with organic matter. Both processes could increase chromium's mobility in soil. The adsorption of Cr(III) to soil is also dependent on soil pH in addition to organic content. Organic soil matter can also bring about the spontaneous reduction of Cr(VI) to Cr(III) (ATSDR, 1987). Cr(VI) is relatively stable and mobile in sandy soils (or soils low in organic content) with elevated pH. Surface runoff, soil erosion, and leaching through the soil column could transport chromium from soils to surface and ground water. The flooding of soils and subsequent anaerobic decomposition of plant matters may increase the mobilization of chromium in soils due to the formation of soluble complexes.

Laboratory studies by Schroeder and Lee (1975) found that Cr(III) and Cr(VI) are readily interconvertible under natural conditions. Cr(III) will react with aqueous hydroxide ion to form insoluble chromium hydroxide ($Cr(OH)_3$). Precipitation of this material on sediments is thought to be the dominant fate of chromium in natural waters (pH >5). Organic matter present in water will eventually reduce Cr(VI) to Cr(III), which will subsequently precipitate. Small amounts of Cr(III) may remain in solution as soluble complexes with organic matter. These complexes are kinetically inert even under conditions where they are thermodynamically unstable (Cotton and Wilkinson, 1972). Cr(VI) is very soluble and therefore relatively mobile in aqueous systems. Cr(VI) is not sorbed to any significant degree by clays or hydrous metal oxides, whereas Cr(III) is removed by adsorption to sediments. No known chromium compounds can volatilize from water; hence, transport of chromium from water to the atmosphere could only occur via windblown aerosols (ATSDR, 1987; EPA, 1984).

Chromium can be bioaccumulated by aquatic organisms. Bioaccumulation may be affected by water hardness, salinity, temperature, and (to some extent) pH (Bodek et al., 1988). The bioconcentration factor (BCF) for Cr(VI) in rainbow trout is ~1 and the BCF for Cr(VI) and Cr(III) in bottom-feeder species ranges from 86 to 192 (ATSDR, 1987).

Copper

Copper is widely distributed in nature and is present in concentrations averaging about 4 ppm in limestone, 55 ppm in igneous rocks, 50 ppm in sandstone, and 45 ppm in shales (EPA, 1979). Copper forms salts and complexes with valences of +1,

+2, and, very rarely, +3. Copper exists most commonly as Cu(II) under aerobic conditions and Cu(I) under anaerobic conditions. Those Cu(I) compounds which are stable under aerobic conditions are highly insoluble (e.g. CuCl, CuCN).

Sorption is probably the most important controlling mechanism in determining the fate and transport of copper in the environment. Important mechanisms for sorption of copper onto soils are: organic complexation (especially with humic materials), physical adsorption, precipitation, and ion exchange.

Copper has a pronounced tendency to form complexes with both organic and inorganic ligands. The formation of complexes with organic ligands modifies the solubility and precipitation behavior of copper such that complexed copper is more easily adsorbed by clay and other soil particle surfaces. Sorption of copper by precipitating hydrous iron and magnesium oxides found in soil is also an effective control on dissolved copper concentrations within the soil profile (EPA, 1979). In organic-rich environments, however, the effective control on dissolved copper concentration will be the competition between organic complexes in solution and sorption onto clay and particulate organic matter (EPA, 1979).

4.3.1.2 Site-Specific Fate and Transport

On-site, chromium exists in the trivalent form in soils, and in both trivalent and hexavalent forms in ground water. Copper exists only in soils on-site. Judging by site characteristics and environmental data, it appears that all chromium soil contamination above action levels exists alone in soils adjacent to the dry sump location and with copper in the area of the drainage trench. Ground-water contamination appears to be located near the septic tank leachfield east of the manufacturing building and at the end of the drainage trench.

Sample Septic Tank & leachfield

The upgradient monitoring well and downgradient monitoring wells RD-4, RD-6, and RD-7 have tested clean; therefore, it appears very little movement of chromium in ground water is occurring. All surface water samples on-site have been observed at levels at or below detection limits or drinking water standards; therefore, it appears on-site surface water quality has not been impacted.

The data indicate that the only areas of concern are: 1) soils in the area of the dry sump and drainage ditch, and 2) ground water in the immediate area of the manufacturing building, sanitary septic leachfield, and near the sump drainage.

4.3.2 Potential Receptors

R.D. Specialties' chrome-plating operation is still active on-site, however, environmental releases of waste on-site have ceased. The potential for exposure, now and in the future, is restricted to on-site employees. As a worst-case estimate, these workers might be exposed to soils with elevated chromium concentrations during maintenance in the sump and sump drainage area and while mowing the lawn. As a site-specific realistic estimate, exposure would only occur while mowing the lawn since sump maintenance has not occurred prior to this time, nor is it expected to in the future. At times of high water table conditions, workers might be exposed to ground water as well.

Ground water is not used as a potable water source on-site nor in the off-site area within one-half mile. All residences within one-half mile of the site obtain drinking water from a municipal supply. Furthermore, chromium does not appear to be migrating off-site. Samples from perimeter ground-water monitoring wells support the fact of limited chromium migration. Surface water on-site has not been effected by levels of chromium which pose any health or environmental risk. Due to the fact that most of the soil affected exists near on-site buildings, the extent of environmental receptor exposure is considered to be low.

4.3.3 Exposure Pathways

Elevated levels of chromium exist in soils adjacent to the dry sump, at both ends of the drainage trench, and in ground water in the immediate area of the manufacturing building. An elevated level of copper has been observed at the western end of the drainage trench.

Both a worst-case estimate of exposure and a site-specific realistic estimate of exposure will be determined. As a worst-case, it is assumed the most likely receptors to soils and ground water are employees of the facility. These employees might be exposed to soils via dermal contact and incidental ingestion if maintenance in the sump or sump drainage area took place, or while mowing the lawn. To date, no employees have engaged in maintenance of those areas and are not expected to in the future. As a site-specific realistic estimate, exposure to soils via dermal contact and incidental ingestion might occur only while mowing the lawn. In both exposure estimation techniques, employees on-site could also be dermally exposed to ground water during high water table conditions; however, such conditions would be relatively infrequent. Ground water is not used as a potable water source; therefore, no ingestion of ground water is expected.

On-site surface water does not contain levels of chemicals above detection limits or standards. Therefore, surface water exposure is not considered a potential exposure route.

4.3.4 Discussion

On the basis of the preceding discussion, the following exposure pathways are considered potentially significant for purposes of a worst-case risk assessment: 1) dermal and ingestion exposure of employees to soil, and 2) dermal exposure of employees to ground water.

4.4 Toxicity Assessment

The purpose of the Toxicity Assessment is to provide a brief summary of the toxicological properties of chromium and copper and to identify critical toxicity values of these chemicals to be used in the Risk Characterization.

4.4.1 Chromium

Chromium can enter the body via oral, dermal, or inhalation exposure. The primary route of entry in humans is the gastrointestinal (GI) tract from the consumption of food and drinking water. GI rate of uptake of chromium is relatively low and dependent on valence state [Cr(VI) is more readily absorbed than Cr(III)], water solubility, and GI transit time. Once absorbed Cr(VI) will be reduced to Cr(III). Studies have found absorbed chromium distributed to the kidneys, lungs, spleen, and liver. Higher concentrations of chromium in tissue have been found in animals receiving Cr(VI) in drinking water at a concentration of 25 to 100 mg/l, compared to those receiving Cr(III) at an equivalent concentration (ATSDR, 1987). Urinary excretion is the primary route of elimination of absorbed chromium.

Chromium is considered an essential trace element. A safe and adequate daily dietary recommendation of chromium for adults is 0.0007 to 0.005 mg/kg/day (ATSDR, 1987).

Acute oral data indicates that Cr(VI) compounds are more toxic than Cr(III) compounds. Fatal ingestion exposures occurred at concentrations of 2,000 to 5,000 mg of chromate compounds. Symptoms included GI bleeding and liver and kidney damage. Mild nausea was exhibited in a subject after drinking a 5 ppm Cr(VI) solution on an empty stomach (McKee and Wolf, 1963). Some nervous system toxicity was exhibited in animals after exposure to drinking water containing 700 mg/l Cr(VI) (Diaz-Mayans, 1986). Chronic oral reference doses (RfDs) for both Cr(III) and Cr(VI) have been determined to be 1.0 and 0.005 mg/kg/day, respectively (EPA, 1988a). The current MCL for total chromium is 0.05 mg/l based on liver and kidney effects. NYSDEC (1986) has also established this number as a ground-water standard. The proposed MCL is 0.1 mg/l based on GI effects (EPA, 1989). The proposed MCL is a more recent number based on more current research information. Although observed concentrations must be compared to current MCLs, the proposed number represents the fact that chromium is judged to be less toxic than initially believed.

Dermal exposure of humans and animals can result in chromium sensitization to both Cr(VI) and Cr(III). This allergic reaction is highly variable among individuals. In one study, dermatitis caused by such sensitivity became worse after a single oral ingestion of 7.1 mg potassium dichromate in a tablet (Kaaber and Veien, 1977). All Cr(VI) compounds are powerful skin irritants. Cr(VI) applied to broken skin has resulted in severe kidney damage (ATSDR, 1987).

Most of the data on inhalation is based on occupational exposure in the chromium industry. Such exposures have shown chromium to be a respiratory tract irritant at concentrations of 0.2 to 1.2 mg/m^3 (ATSDR, 1987). Studies of chrome-plating industries revealed nasal ulceration or perforation in 12 out of 37 workers exposed to a range of <0.71 to 9.12 mg/m^3 of Cr(VI) aerosols within one year of being employed (Cohen and Kramkowski, 1973; Cohen et al., 1974). Liver and kidney damage have also been seen in animals and humans following inhalation exposures.

Inhalation also tends to be the chromium exposure route associated with cancer. Epidemiological studies reviewed in IARC (1980) and EPA (1984) clearly indicate an increased respiratory cancer risk in workers in chromium industries. Animal studies have tended to implicate Cr(VI) in carcinogenicity. This concurs with mutagenicity studies which have consistently shown positive results for Cr(VI) compounds and negative results for Cr(III) in standard tests (ATSDR, 1987). The difference in activity of the two valence states appears to be the differences in their ability to permeate cell membranes. A cancer potency factor (CPF) for inhalation of Cr(VI) is 41.0 mg/kg/day (EPA, 1988a) and has been based on a dose-related increase in lung cancer death rates in chromate production workers. Ambient Water Quality Criteria (AWQC) developed for the protection of freshwater aquatic species is 0.016 and 0.011 mg Cr(VI)/liter water, acute and chronic exposure, respectively, and 1.7 and 0.21 mg Cr(III)/liter water, acute and chronic exposure, respectively (EPA, 1986). Table 8 presents all applicable standards for chromium.

4.4.2 Copper

Absorption of copper can occur via oral and inhalation routes of exposure. Very little dermal absorption occurs. The liver is the main storage organ of absorbed copper. Absorbed copper can cross the placenta and accumulate in the fetus. Excretion of absorbed copper is primarily through the feces. The biological availability and toxicity are probably related to Cu^{2+} ion activity (EPA, 1987).

Copper is an essential element and is a necessary part of several enzymes. GI absorption of copper is normally regulated by body stores (Casarett and Doull, 1986). This homeostatic balance severely limits episodes of toxicity from high exposures. Copper deficiency is characterized by anemia due to defective hemoglobin synthesis (Casarett and Doull, 1986).

Acute copper poisoning from ingestion has resulted in such symptoms as nausea, vomiting, hypotension, and jaundice. Acute and subchronic oral toxicity studies have shown copper to elicit effects in the liver, kidneys, blood, and fetus (EPA, 1987). However, the doses used in the studies were generally higher than those found in the environment. Limited evidence of teratogenicity in animals were reported at high doses, however, most exposures were not relevant to humans

(EPA, 1987). Chronic human intoxication occurs rarely and then only in individuals with Wilson's disease. This is a genetic condition in which there is abnormally high absorption, retention, and storage of copper by the body (Sittig, 1985). A chronic oral RfD for copper of 0.037 mg/kg/day has been determined (EPA, 1986a).

Inhalation exposure will cause local irritation in the respiratory tract, as well as systemic effects similar to oral exposure. Most industrial inhalation of copper have elicited mild, infrequent, and transient effects. Long-term occupational copper exposure has resulted in mild anemia, contact dermatitis, and leukocytosis (EPA, 1987). The chronic inhalation RfD for copper is 0.01 mg/kg/day (EPA, 1986a).

There is insufficient data to determine the carcinogenic potential of copper; hence, copper is classified in Group D (EPA, 1988).

Toxicity of copper to aquatic species is inversely related to water hardness and alkalinity (EPA, 1986). AWQCs developed for the protection of freshwater aquatic species is 0.018 mg/l for acute effects and 0.012 mg/l for chronic effects (calculated with a water hardness of 100 mg/l) (EPA, 1986).

4.5 Risk Characterization

The purpose of the Risk Characterization is to integrate the results of the Contamination, Toxicity, and Exposure Assessment sections to provide a realistic evaluation of potential human health and environmental risks at the site. This is accomplished through the use of site-specific exposure scenarios which represent the most likely pathways through which receptors could be exposed, as outlined in the Exposure Assessment. The magnitude of exposure is quantified using site-specific monitoring data and assumptions acceptable to toxicological professionals and, in most cases, recommended by EPA. These hypothetical calculated exposure levels are then compared to toxicity guidelines identified in the toxicity assessment to determine if a potential health risk exists.

The scenarios developed in this report represent worst-case assumptions concerning potential human and environmental exposure to chemical constituents in soils and ground water at the R.D. Specialties, Inc., site. Worst-case assumptions are used as protection against any future on-site exposure; actual exposure concentrations are considerably less.

4.5.1 Soils

As discussed in the Exposure Assessment, the most likely receptors who might be exposed to chromium and copper from on-site media are facility employees. As a worst-case estimate, these employees could potentially be exposed to soils in the sump and sump drainage area during maintenance activities. As a more realistic estimate, exposure to soils could occur only while mowing the lawn. Exposure for both estimation techniques could occur via dermal or ingestion exposure. The exposure scenarios developed for these employees is presented in Table 9.

This scenario involves exposure to soils via both incidental ingestion and dermal contact. For the ingestion portion, the adult ingestion rate of 10 mg/day is used for employees (EPA, 1988). For the dermal contact pathway, it is assumed employees might be exposed to dust and soil on their hands and forearms. It was also assumed, in a worst-case scenario, that workers might be exposed via sump and sump drainage maintenance 5 days per year and while mowing the lawn for 10 days per year, for a 15-year period. This conservative exposure duration is developed to protect not only on-site employees, but also any other potential receptors. As a realistic estimate, workers might be exposed only while mowing the lawn for 4 days per year.

Uptake of compounds via dermal contact would be limited by the permeability of the skin (absorption factor) and the tendency of compounds present in the soil to remain adsorbed to soil particles (matrix effect). For these scenarios, a matrix effect of 15 percent and an absorption factor of 6 percent were assumed (GRI, 1988). The basis for these factors was reviewed by Hawley (1985), who reviewed several studies concerning absorption of soil-bound compounds. The dermal absorption factor of 6 percent was based on studies measuring dermal uptake of radiolabeled compounds in solvent vehicles (e.g. acetone) by humans and laboratory animals. With the exception of caffeine, for which 23.3 percent of the administered dose was absorbed in 24 hours, all other compounds had an absorption of 0.4 percent to 10.8 percent of the applied dose. (The higher dermal permeability of caffeine was attributed to its solubility in both water and organic solvents). Therefore, Hawley (1985) recommended 11 percent as an absorption factor for 24-hours per day exposure, and 6 percent as an absorption factor for 12-hour exposures. The 6 percent factor will be used as a conservative estimate of the exposure scenarios discussed. This is a conservative approach because the duration of an exposure event under both the occupational exposure and child exposure is likely to be less than 12 hours. The matrix effect factor of 15 percent was also derived by Hawley (1985), who reported that absorption from a soil-water paste was about 15 percent of the amount absorbed from a methanol vehicle.

Based on these assumptions, it is possible to calculate an exposure dosage, in units of mg of chemical per kg of body weight per day, with the following equations developed from EPA (1988) and GRI (1988):

$$DEX = Ci \times AV \times DA \times F \div BW \div A \times AF \times M$$

$$IEX = Ci \times I \div BW \times F \div A$$

$$TEX = DEX + IEX$$

Where:

DEX = dermal exposure dosage (mg/kg/day)

Ci = weight fraction of compound in soil (kg compound/kg soil, or mg/kg $\div 10^6$)

AV = area available for dermal absorption (cm^2)

DA = dust adherence factor = 1.45 mg/cm^2 (EPA 1988)

F = frequency of exposure events per lifetime

BW = assumed receptor body weight = 70 kg

A = average lifetime = 2.56×10^4 days

AF = absorption factor

M = matrix effect

IEX = ingestion exposure dosage (mg/kg/day)

I = assumed soil ingestion rate

TEX = total exposure dosage (mg/kg/day)

Using these equations, it is possible to calculate a theoretical exposure dosage associated with a given level of chromium and copper in soils. To evaluate the worst possible case and the site-specific realistic estimate for exposure via this scenario, the maximum concentrations of total chromium and total copper detected at the site were used. Applying these concentrations, the results of the calculations are presented in Table 10.

The RfD values for Cr(III), Cr(IV), and copper are presented in Table 8. Non-carcinogenic risks are assessed by comparing calculated total exposure dosages (TEX) to RfD values by means of a Hazard Index (HI):

$$\text{HI (unitless)} = \text{TEX (mg/kg/day)/RfD (mg/kg/day)}$$

HIs were calculated for Cr(VI), as well as Cr(III) and copper, even though no detectable levels of Cr(VI) were observed in soil. This is a worst-case assumption, developed to protect potential receptors from any exposure to Cr(VI) in soils. HIs greater than 1.0 indicate that the calculated exposure dosage exceeds the RfD, and that a potential health risk exists. As shown in Table 10, the calculated exposure dosages were far below RfD values. An overall HI represents the total non-carcinogenic risk posed by exposure via this scenario to the maximum observed concentration of chromium in soils at the site. As shown in Table 10, the worst case HIs are 6.64×10^{-6} for Cr(III), 1.33×10^{-3} for Cr(VI), and 3.09×10^{-5} for copper. All values are much less than one, which is the level of concern (EPA, 1986a). The HIs for the site-specific realistic estimates of exposure are 1.77×10^{-6} for Cr(III), 3.54

x 10^{-4} for Cr(VI), and 8.23 x 10^{-6} for copper. These numbers are again much less than one.

4.5.2 Ground Water

As discussed in the Exposure Assessment, ground water at the facility is not used as a potable water source. Exposure to chemical constituents in ground water is therefore unlikely, but possible. To evaluate potential risks associated with exposure to these compounds, another exposure scenario was developed. For the purposes of this discussion, it was assumed that dermal exposure to ground water is the only potentially significant route of uptake. The exposure scenario for this pathway is summarized in Table 11.

Dermal exposure might occur when workers contacted ground water during high water table conditions while involved in maintenance activities. It was assumed that exposure would occur infrequently, 120 times per year (approximately 4 months of high water table conditions) for 15 years. It was also assumed that the only areas exposed to water containing the compounds would be the lower legs and feet, as would occur when wading or standing in water.

Exposure via this pathway was quantified using an equation developed by EPA (1988):

$$DEX = te \times AV \times C \times PC \times F \times (1\ l/1000\ cm^3) \div BW \div A$$

Where:

DEX = dermal exposure dosage (mg/kg/day)

te = duration of an exposure event (hours/event)

AV = area available for dermal absorption (cm2)

C = chemical concentration in water (mg/l)

PC = dermal permeability constant for the subject compound (cm/hour)

F = frequency of exposure events per lifetime

BW = assumed receptor body weight = 70 kg

A = average lifetime = 2.56×10^4 days

Once again, exposure via this pathway was evaluated using the maximum concentration of total chromium and Cr(VI) detected in ground water at the site. These concentrations are presented in Table 12. Values for other variables in the above equation are listed in Table 11, with the exception of the dermal permeability constant (PC), which is listed in Table 12. This value was taken from the EPA (1988) Superfund Exposure Assessment Manual. As recommended in that document, when no chemical-specific PC was available for a given compound, it was assumed that the PC for that compound was equal to that of water. The exposure levels calculated using the above equation are presented in Table 12.

HIs associated with given exposure dosages were calculated as described previously. As shown in Table 12, the non-carcinogenic HI associated with exposure to the maximum observed ground-water concentration of total chromium is 2.45×10^{-6} and Cr(VI) is 5.89×10^{-4}, both far below the 1.0 level of concern (EPA, 1986a).

SECTION 5 - CONCLUSIONS

As shown by the risk calculations presented in the Risk Characterization, the existing levels of chromium and copper in the soils and ground water at the R.D. Specialties site do not pose a potential risk to employees engaged in maintenance. The manufacturing business on-site is expected to continue its current operation, and additional release of chromium to soils and ground water is not foreseen. Judging from the ground-water monitoring data for downgradient and upgradient wells, as well as levels of chromium observed in surface water, no off-site transport of chromium appears to be occurring.

There is no drinking water use of ground water on-site or in the area. There is also no health or environmental risk associated with potential on-site contact of soils and ground water. For these reasons, as well as the fact that no off-site migration is occurring, there is no human health or environmental risk associated with the observed concentrations of chromium and copper at the site.

The exposure scenarios used to evaluate potential health risks were developed using conservative worst-case assumptions, as well as site-specific realistic estimate assumptions, appropriate for this site. In addition, the calculations in the Risk Characterization were performed using maximum observed concentrations of chromium and copper found in the appropriate media. Therefore, actual exposure concentrations would be expected to be less than those calculated.

On the basis of the limited extent of observed chromium and copper concentrations, as well as other chemical concentrations in soil and ground water, and the fact that the RA demonstrates that present chromium and copper levels will effect neither human health nor other elements of the environment, we recommend that remediation activities appear to be unwarranted at this site.

RESPECTFULLY SUBMITTED,

BLASLAND & BOUCK ENGINEERS, P.C.

Tyler E. Gass, C.P.G.
Vice President

Edward R. Lynch, P.E.
Vice President

Prepared by:

Lisa A. Ryan
Martha S. Morrill

Tables

TABLE 1

MONITORING WELL DEVELOPMENT SUMMARY

R.D. SPECIALTIES
WEBSTER, NEW YORK

Monitoring Well #	Development Date	Development Method[1]	Turbidity Level Attained in NTUs[2]
RD-1	3/16/89	Surge & bail	65
RD-2	3/20/89	Surge & bail	50
RD-3	3/17/89	Surge & bail	23
RD-4	3/17/89	Surge & bail	41
RD-5	3/16/89	Surge & bail	88
RD-6	3/17/89	Surge & bail	3
RD-7	3/16/89	Surge & bail	42
RD-8	3/20/89	Surge & bail	61

Notes:

[1] The wells were developed by gently surging and bailing. A peristaltic pump was then used to evacuate additional water and the turbidity of this discharge water was monitored.

[2] Nephelometric Turbidity Units.

TABLE 2

MONITORING WELL SURVEY DATA[1]

R.D. SPECIALTIES
WEBSTER, NEW YORK

Monitoring Well #	Top of Protective Casing	Top of PVC Well	Ground Surface
RD-1	106.15	105.86	104.2
RD-2	105.06	104.95	102.7
RD-3	103.43	103.26	101.6
RD-4	100.98	100.90	98.5
RD-5	100.12	99.95	100.0
RD-6	104.25	104.03	102.0
RD-7	101.27	100.98	99.5
RD-8	102.80	102.70	100.9

Note:

[1] Elevations were obtained during a field survey completed on July 21, 1989, and are relative to an assumed site datum.

TABLE 3

WATER LEVEL MEASUREMENTS
MARCH 21, 1989 AND JULY 12, 1989

R.D. SPECIALTIES
WEBSTER, NEW YORK

Monitoring Well #	Top of PVC Riser	Measurement Date	Water Level Depth (ft.)	Water Level Elevation (ft.)
RD-1	105.86	3/21/89	4.75	101.11
		7/12/89	8.70	97.16
RD-2	104.95	3/21/89	3.50	101.45
		7/12/89	8.00	96.95
RD-3	103.26	3/21/89	2.90	100.36
		7/12/89	6.90	96.36
RD-4	100.90	3/21/89	3.03	97.87
		7/12/89	6.57	94.33
RD-5	99.95	3/21/89	0.31	99.64
		7/12/89	3.83	96.12
RD-6	104.03	3/21/89	2.71	101.32
		7/12/89	6.72	97.31
RD-7	100.98	3/21/89	2.16	98.82
		7/12/89	6.03	94.95
RD-8	102.70	3/21/89	1.98	100.72
		7/12/89	5.85	96.85

TABLE 4

SOIL AND SEDIMENT ANALYSIS

R.D. SPECIALTIES
WEBSTER, NEW YORK
MARCH 1989

	D1A	D1B	D1C	SB2A	SB2B	SB3A	SB3B	SB4A
Sample Depth (ft.)	1-2	1-2.5	Surface	1	3	1	2.5	1
Chromium Hexavalent (mg/kg)	<1.23	<1.20	<1.4	<1.36	<1.22	<1.28	<1.26	<1.24
Total Metals (mg/kg):								
Aluminum	11400.	10400.	9980.	12000.	8930.	11300.	8000.	9810.
Antimony	<7.41	<7.21	13.3	<7.76	<7.30	<7.68	<7.55	<7.42
Arsenic	<0.62	0.77	3.0	2.1	1.2	0.72	0.72	0.87
Barium	26.6	32.3	39.9	55.8	37.2	38.7	34.0	42.1
Beryllium	0.685	0.680	0.770	0.716	0.679	0.701	0.711	0.680
Cadmium	<0.62	<0.60	0.751	<0.65	<0.61	<0.64	<0.63	<0.62
Calcium	960.	940.	2720.	2880.	1290.	1750.	3210.	2020.
Chromium	34.3	17.5	1540.	209.	39.9	12.5	18.3	12.7
Cobalt	<6.2	<6.0	<6.8	<6.5	<6.1	<6.4	<6.3	<6.2
Copper	12.2	5.27	265.	29.1	9.15	4.61	7.30	4.63
Iron	14400.	13500.	13400.	35300.	14300.	12800.	11300.	14100.
Lead	2.69	3.65	164.	86.7	14.7	8.32	14.3	4.13
Mercury	<0.12	<0.12	<0.14	<0.13	<0.12	<0.13	<0.13	<0.12
Magnesium	2900.	2420.	2140.	2260.	2250.	1850.	2220.	2570.
Manganese	147.	216.	196.	312.	221.	131.	185.	152.
Nickel	12.6	12.6	15.5	23.9	12.2	9.36	9.73	13.4
Potassium	833.	1030.	945.	<646.	1090.	1050.	1310.	1340.
Selenium	<3.1	<3.0	<3.4	<3.2	<3.0	<3.2	<3.1	<3.1
Silver	<1.2	<1.2	<1.4	<1.3	<1.2	<1.3	<1.3	<1.2
Sodium	<617.	<601.	<678.	<647.	<608.	<640.	<629.	<618.
Thallium	<1.2	<1.2	<1.4	<1.3	<1.2	<1.3	<1.3	<1.2
Vanadium	21.8	19.0	21.2	23.2	20.8	24.2	20.0	22.8
Zinc	25.2	25.0	120.	85.7	32.9	31.5	25.5	24.6

TABLE 4 (Cont'd.)

	SB4B	SB1A	SB1B	IS1A	IS1B	IS1C	D2A	D2B
Sample Depth (ft.)	3	1	3	1-3	1-3	Surface	1-3	1-3
Chromium Hexavalent (mg/kg)	<1.2	<1.3	<1.3	<1.2	<1.4	<1.9	<1.5	<1.4
Total Metals (mg/kg):								
Aluminum	10000.	12200.	11100.	6020.	12100.	7100.	9640.	7390.
Antimony	<7.29	<8.0	<7.7	<7.3	<8.4	<11.	<8.7	<8.2
Arsenic	0.91	1.6	1.3	1.4	5.8	3.2	1.4	0.82
Barium	42.0	<27.	<26.	<24.	72.2	47.3	39.2	31.9
Beryllium	0.657	0.737	0.715	0.703	0.735	1.11	0.856	0.815
Cadmium	<0.61	<0.67	<0.64	<0.61	<0.70	<0.93	<0.73	<0.69
Calcium	6670.	<667.	735.	9800.	2940.	3880.	2640.	3240.
Chromium	14.7	9.50	10.8	10.6	17.4	10.3	332.	394.
Cobalt	6.76	<6.7	<6.4	<6.1	<7.0	<9.3	<7.3	<6.9
Copper	6.89	6.47	7.16	7.04	7.77	11.4	12.3	27.2
Iron	15100.	13700.	14000.	12200.	28000.	12100.	9240.	6910.
Lead	3.09	8.41	5.08	2.80	4.94	18.1	8.50	8.31
Mercury	<0.12	<0.13	<0.13	<0.12	<0.14	<0.19	<0.15	<0.14
Magnesium	4180.	1090.	2120.	3040.	3010.	1540.	1580.	1170.
Manganese	271.	64.4	136.	257.	623.	806.	98.5	93.8
Nickel	13.6	<5.3	9.25	8.82	12.5	<7.4	7.64	<5.5
Potassium	1970.	<667.	<638.	<611.	1100.	<925.	<727.	<689.
Selenium	<3.0	<0.67	<0.64	<0.61	<0.70	<0.93	<0.73	<0.69
Silver	<1.2	<1.3	<1.3	<1.2	<1.4	<1.9	<1.5	<1.4
Sodium	<608.	<667.	<638.	<611.	<696.	<925.	<727.	<689.
Thallium	<1.2	<1.3	<1.3	<1.2	<1.4	<1.9	<1.5	<1.4
Vanadium	24.3	24.1	24.1	17.5	30.9	18.6	17.4	15.4
Zinc	25.5	31.9	41.6	26.8	86.9	61.7	33.8	32.7

TABLE 4 (Cont'd.)

Parameter (mg/l)	D2C	IS2A	IS2B	IS2C	IS3A	IS3B	IS3C
Sample Depth (ft.)	Surface	1-3	1-3	Surface	1-3	1-3	Surface
Chromium Hexavalent (mg/kg)	<1.5	<1.3	<1.2	<2.0	<1.6	<1.2	<1.3
Total Metals (mg/kg):							
Aluminum	7180.	9620.	7780.	13000.	6630.	10800.	7380.
Antimony	<9.2	<7.8	<7.2	<12.	<9.4	<7.5	<7.9
Arsenic	1.3	0.84	1.3	4.3	2.8	2.9	1.8
Barium	<31.	43.1	32.2	74.0	42.9	49.9	32.7
Beryllium	0.921	0.739	0.679	1.18	0.954	0.669	0.788
Cadmium	<0.77	<0.65	<0.60	<1.0	<0.78	<0.62	<0.66
Calcium	3190.	4830.	2070.	5380.	4040.	2560.	2140.
Chromium	1050.	26.2	11.0	16.0	10.3	15.6	23.2
Cobalt	<7.7	<6.5	<6.0	<10.	<7.8	7.53	<6.6
Copper	80.0	10.5	7.68	18.8	9.80	6.76	5.68
Iron	7960.	10700.	13000.	16500.	10500.	20800.	11300.
Lead	18.2	5.87	3.92	34.1	18.2	7.84	3.76
Mercury	<0.15	<0.13	<0.12	<0.20	<0.16	<0.12	<0.13
Magnesium	1070.	2440.	2510.	2530.	1480.	3460.	1970.
Manganese	131.	178.	141.	841.	502.	725.	136.
Nickel	<6.1	9.38	9.94	10.7	6.47	14.3	8.13
Potassium	<766.	937.	1200.	1610.	<783.	1710.	1050.
Selenium	<0.77	<0.65	<0.60	<1.0	<0.78	<0.62	<0.66
Silver	<1.5	<1.3	<1.2	<2.0	<1.6	4.31	<1.3
Sodium	<766.	<647.	<598.	<1010.	<796.	<622.	<661.
Thallium	<1.5	<1.3	<1.2	<2.0	<1.6	<1.2	<1.3
Vanadium	15.1	19.3	18.5	26.4	16.3	25.4	14.4
Zinc	58.2	36.1	25.4	87.8	47.5	33.2	38.6

TABLE 5

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

SOIL ACTION LEVELS

Total Priority Pollutant Metals (mg/kg):

Antimony	10
Arsenic	20
Barium	400
Beryllium	1
Cadmium	3
Chromium	100
Copper	170
Lead	250-1000
Nickel	100
Mercury	1
Molybdenum	1
Selenium	4
Silver	5
Thallium	5
Vanadium	100
Zinc	350

TABLE 6

HEXAVALENT AND TOTAL CHROMIUM IN SOILS

R.D. SPECIALTIES
WEBSTER, NEW YORK

MARCH 20, 1989

Sampling Location	Hexavalent (mg/kg)	Total (mg/kg)
D1A	< 1.23	34.3
D1B	< 1.20	17.5
D1C	< 1.4	1,540
SB2A	< 1.36	209
SB2B	< 1.22	39.9
SB3A	< 1.28	12.5
SB3B	< 1.26	18.3
SB4A	< 1.24	12.7
SB4B	< 1.2	14.7
D2A	< 1.5	332
D2B	< 1.4	394
D2C	< 1.5	1,050
SB1A	< 1.3	9.50
SB1B	< 1.3	10.8
IS1A	< 1.2	10.6
IS1B	< 1.4	17.4
IS1C	< 1.9	10.3
IS2A	< 1.3	26.2
IS2B	< 1.2	11.0
IS2C	< 2.0	16.0
IS3A	< 1.6	10.3
IS3B	< 1.2	15.6
IS3C	< 1.3	23.2

TABLE 7

HEXAVALENT AND TOTAL CHROMIUM IN WATER

R.D. SPECIALTIES
WEBSTER, NEW YORK

Sampling Point	3/22/89 Hexavalent (mg/l)	3/22/89 Total (mg/l)	7/12/89 Hexavalent (mg/l)	7/12/89 Total (mg/l)
RD-1	.02	<0.05	<0.01	<0.01
RD-2	0.17	0.19	0.05	0.07
RD-3	0.17	0.23	0.70	0.75
RD-4	<0.01	<0.05	*	*
RD-5	1.9	2.0	0.25	0.34
RD-6	<0.01	<0.05	*	*
RD-7	<0.01	<0.05	*	*
RD-8	3.7	4.7	1.2	1.0
SW-1	<0.01	<0.05	*	*
SW-2	0.04	0.05	*	*
Pond	*	*	<0.01	<0.01
Field Blank	<0.01	<0.01	<0.01	<0.01

Note:

* Sample was not obtained.

TABLE 8

APPLICABLE STANDARDS
CHROMIUM

R.D. SPECIALTIES
WEBSTER, NEW YORK

	Hexavalent	Trivalent	Total
Water (mg/l)			
Proposed MCLG			0.1
Proposed MCL			0.1
Current MCL			0.5
NYS Ground-Water Standard	0.05		
Ambient Water Quality Criteria			
L.O.E.L. Acute	0.016	1.7	
L.O.E.L. Chronic	0.011	0.21	
Soils (mg/kg)			
NJDEP Soil Action Level			100
Toxicity			
RfD (mg/kg/day)			
Oral	0.005	1.0	
Inhalation	N/A	N/A	
CPF $(mg/kg/day)^{-1}$			
Oral	N/A	N/A	
Inhalation	41.0	N/A	

Notes:

MCLG = Maximum Contaminant Level Goal
L.O.E.L. = Lowest Observed Effect Level
N/A = Not Available

TABLE 9

EXPOSURE MODULE FOR ON-SITE EMPLOYEES DERMAL AND INGESTION EXPOSURE TO SOIL

Receptors:	Employees
Adult or Child:	Adult
Activity:	On-Site Outdoor Maintenance
Frequency of Event:	
Worst-Case	15 days/year
Best Estimate	4 days/year
Duration of Exposure:	15 years

Potential Exposure Pathways Considered Significant:

1. Incidental Soil Ingestion

Compounds:	Total Chromium, Total Copper
Data Sets:	Soils Data
Soil Ingestion Rate:	10 mg/day
Matrix Effect:	None
Absorption Factor:	100%

2. Dermal Uptake from Contact with Soils

Compounds:	Total Chromium, Total Copper
Data Sets:	Soils Data
Body Parts Covered with Dust or Soil:	Hands and Forearms
Area of Skin Covered Dust or Soil:	1,865 cm^2
Soil/Dust Adherence:	1.45 mg/cm^2
Percent of Penetration in a 12-Hour Exposure:	6%
Matrix Effect:	15%

TABLE 10

RISK CALCULATIONS FOR ON-SITE EMPLOYEES DERMAL AND INGESTION EXPOSURE TO SOIL

Chemical	Maximum Concent. (mg/kg)	Worst-Case Exposure Dosage (mg/kg/day)	Best Estimate Exposure Dosage (mg/kg/day)	Reference Dose (RfD) (mg/kg/day)	Worst-Case Hazard Index	Site-Specific Realistic Hazard Index
Chromium (III)	1540	6.64×10^{-6}	1.77×10^{-6}	1.0	6.64×10^{-6}	1.77×10^{-6}
Chromium (VI)	1540	6.64×10^{-6}	1.77×10^{-6}	0.005	1.33×10^{-3}	3.54×10^{-4}
Copper	265	1.14×10^{-6}	3.05×10^{-7}	0.037	3.09×10^{-5}	8.23×10^{-6}
TOTAL					1.37×10^{-3}	3.64×10^{-4}

Notes:

NA - Not Available.

TABLE 11

EXPOSURE MODULE FOR ON-SITE EMPLOYEE EXPOSURE TO GROUND WATER DERMAL CONTACT

Receptors:	Employees
Adult or Child:	Adult
Activity:	On-Site Outdoor Maintenance
Frequency of Event:	120 days/year
Duration of Event:	1 hour
Duration of Exposure:	15 years

Potential Exposure Pathways Considered Significant:

1. Dermal Uptake from Contact with Ground Water or Surface Water

Compounds:	Total Chromium and Cr(VI)
Data Sets:	Ground-Water Data
Body Parts Contacting Water:	Lower legs and feet
Area of Skin Contacting Water:	3,055 cm^2
Dermal Permeability:	Chemical-specific (see text)

TABLE 12

RISK CALCULATIONS FOR ON-SITE EMPLOYEE EXPOSURE TO GROUND WATER DERMAL CONTACT

Chemical	Maximum Concent. (mg/l)	Permeability Constant	Exposure Dosage (mg/kg/day)	Cancer Potency Factor (CPF) $(mg/kg/day)^{-1}$	Risk	Reference Dose (RfD) (mg/kg/day)	Hazard Index
Chromium (III)	1.0	0.0008	2.45×10^{-6}	N/A	----	1.0	2.45×10^{-6}
Chromium (VI)	1.2	0.0008	2.95×10^{-6}	N/A	----	0.005	5.89×10^{-4}
TOTAL							5.91×10^{-4}

Notes:

NA - Not Available.

Appendices

APPENDIX A

MONITORING WELL BORING AND INSTALLATION LOGS

DEPTH (FT)	SAMPLES	SAMPLE/RUN NO	SOIL DATA			ROCK DATA				WELL COLUMN	GEOLOGIC COLUMN	SUBSURFACE LOG	ROCK FEATURES
			RECOVERY (FT)	BLOWS / 6 IN	HNU	FROM/TO	% RECOVERY	% RQD	AVERAGE RATE (MIN./FT.)			KEY SOIL / ROCK CLASSIFICATION	

Well designation.

Average rate of down feed of core barrel over the length of run.

Rock Quality Degree: the sum of the length of pieces four-inches long or greater, divided by the length of core run x 100.

Length of core recovered divided by the length of core run x 100.

Depth of core run.

The number of blows delivered by a 140-lb. hammer dropped 30 inches to drive a 2-inch (OD) split-spoon sampler each 6-inch increment in a 24-inch drive.

The length of the sample (recorded in feet) recovered after driving a split-spoon sampler 24 inches or the length shown under the samples column.

The interval that the split barrel sampler was advanced through in soil.

Depth below ground surface (0) in feet.

The interval that the core barrel was advanced through in rock.

SURFACE ELEVATION ________
DATE STARTED ________
DATE COMPLETED ________
CLASSIFIED BY ________

PROJECT R.D. Specialties
LOCATION Webster, New York
PROJECT NO. 251.01
SHEET 1 OF 2

BLASLAND & BOUCK ENGINEERS, P.C.

SUBSURFACE LOG

KEY (CON'T.)

SOIL / ROCK CLASSIFICATION

DEPTH (FT)	SAMPLES	SAMPLE / RUN NO.	SOIL DATA			ROCK DATA				WELL COLUMN	GEOLOGIC COLUMN	SOIL / ROCK CLASSIFICATION	ROCK FEATURES
			RECOVERY (FT)	BLOWS / 6 IN.	HNU	FROM/TO	% RECOVERY	% RQD	AVERAGE RATE (MIN./FT.)				

WELL DESCRIPTION

Protective casing: a 6-inch I.D. steel casing with locking cover, or a flush-mount well cover.

Surface seal: Portland cement.

Well casing: 2-inch ID, flush threaded, Sch. 40 PVC

Seal: bentonite pellets.

Borehole: advanced in rock with HX or NX core barrel.

Well pack: Grade 0 sand.

Well screen: 2" ID, flush threaded PVC with machine cut 0.010-inch slots.

Formation: collapse.

GEOLOGY

Fill materials

Clay

Silt

Sand

Gravel

Weathered siltstone

Siltstone

Sandstone

CORE DESCRIPTIONS

Horizontal fracture irregular and rough.

Vertical fracture. → VF

Mechanical break → MB

Inclined joint w/angle, angle measured as inclination from horizontal. → J10°

Broken zone.

Mechanically broken zone. → MBZN

Iron stained. → Is

SURFACE ELEVATION ________

DATE STARTED ________

DATE COMPLETED ________

CLASSIFIED BY ________

PROJECT R.D. Specialties

LOCATION Webster, New York

PROJECT NO. 251.01

SHEET 2 OF 2

BLASLAND & BOUCK ENGINEERS, P.C.

SUBSURFACE LOG

RD-I

DEPTH (FT)	SAMPLE/RUN NO.	SOIL DATA: RECOVERY (FT)	SOIL DATA: N VALUE	SOIL DATA: HNU	ROCK DATA: FROM/TO	ROCK DATA: % RECOVERY	ROCK DATA: % RQD	ROCK DATA: RATE (MIN/FT)	SOIL/ROCK CLASSIFICATION	ROCK FEATURES
0	1	0.8	3 2 5 25						Brown SILT and fine SAND, moist.	
2	2	1.0	18 16 50/0.3						Brown fine to medium SAND and fine to coarse angular GRAVEL, wet.	
4	3	1.7	12 14 15 18						Brown fine to medium SAND, some fine to coarse angular gravel and silt, wet.	
6	4	0.65	22 50/.15						Reddish-brown fine-grained SANDSTONE with green mottling, highly bioturbated, trace silt along horizontal fractures.	
	R-1				7.5- 11.1	100		11 13 9 10		MB MB
12									Bottom of boring at 11.1'.	

Notes:

4-1/4" I.D. hollow-stem auger 0' - 7.5'.

NX core 7.5' - 11.1'.

2-inch, Schedule 40, .01" slotted screen 5.9' - 10.9'.

2-inch, Schedule 40 PVC riser to 5.9'.

Grade 0 sand 4' - 11.1'.

Bentonite pellets 3' - 4'.

Cement grout 0' - 3'.

Protective steel casing with locking cap @ surface.

SURFACE ELEVATION 104.2[1]
DATE STARTED 3/8/89
DATE COMPLETED 3/9/89
CLASSIFIED BY LAR

PROJECT R.D. Specialties
LOCATION Webster, New York
PROJECT NO. 251.01
SHEET 1 OF 1

BLASLAND & BOUCK ENGINEERS, P.C.

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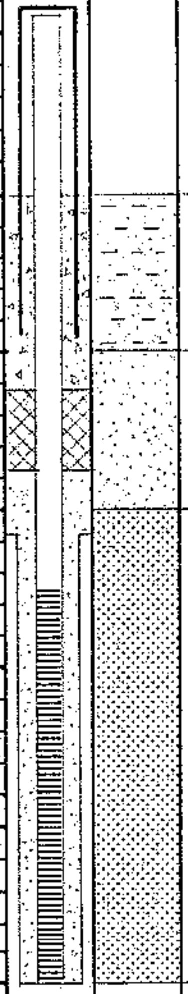
[1] Elevation is relative to an assumed site datum.

SUBSURFACE LOG

RD-2

DEPTH (FT)	SAMPLE/RUN NO.	SOIL DATA RECOVERY (FT.)	SOIL DATA N VALUE	SOIL DATA HNU	ROCK DATA FROM/TO	ROCK DATA % RECOVERY	ROCK DATA % RQD	ROCK DATA RATE (MIN/FT)
0	1	1.1	8					
			3					
			7					
			12					
2	2	1.4	7					
			7					
			12					
			12					
4	3	0.2	50/0.2					
	R-1				4.3- 9.0	89	47	6
6								
8								
	R-2				9-10	140	40	9
10								



SOIL/ROCK CLASSIFICATION

Black-brown SILT and fine SAND, trace organic material, moist.

Brown fine to medium SAND, little silt, moist.

Reddish-brown fine-grained SANDSTONE with green mottling, bioturbated, siltation along horizontal fractures.

ROCK FEATURES

MB

silt seam

MB

Bottom of boring at 10.0'.

Notes:

4-1/4" I.D. hollow-stem auger 0' - 4.3'.

NX core 4.3' - 10'.

2-inch, Schedule 40, .01" slotted screen 5' - 10'.

2-inch, Schedule 40 PVC riser to 5'.

Grade 0 sand 3.5' - 10'.

Bentonite pellets 2.5' - 3.5'.

Cement grout 0' - 2.5'.

Protective steel casing with locking cap.

SURFACE ELEVATION 102.7[1]
DATE STARTED 3/14/89
DATE COMPLETED 3/15/89
CLASSIFIED BY LAR

PROJECT R.D. Specialties
LOCATION Webster, New York
PROJECT NO. 251.01
SHEET 1 OF 1

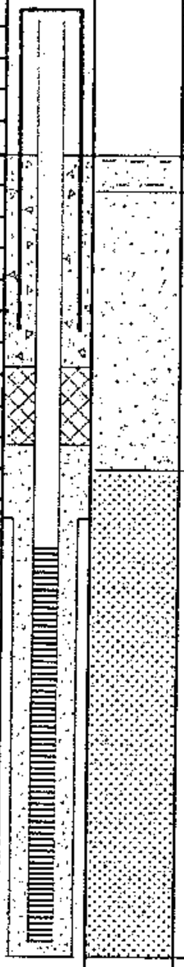
BLASLAND & BOUCK ENGINEERS, P.C.

[1] Elevation is relative to an assumed site datum.

SUBSURFACE LOG

RD-3

DEPTH (FT)	SAMPLE/RUN NO.	SOIL DATA RECOVERY (FT)	SOIL DATA N VALUE	SOIL DATA HNU	ROCK DATA FROM/TO	ROCK DATA % RECOVERY	ROCK DATA % RQD	ROCK DATA RATE (MIN/FT)	SOIL/ROCK CLASSIFICATION	ROCK FEATURES
0	1	1.3	2						Dark brown SILT and fine SAND, trace organics, moist.	
			1						Brown fine to medium SAND, little silt and fine to medium gravel, moist.	
			1							
			12							
2	2	1.5	20							
			15							
			9							
			18							
4									Reddish-brown fine-grained SANDSTONE with green mottling, bioturbated, siltation along horizontal fractures.	
	R-1				4.6- 7.65	100	59	--		MB
6										MB
										MB
8	R-2				7.65- 10.2	100				
10									Bottom of boring at 10.2'.	



Notes:

4-1/4" I.D. hollow-stem auger 0' - 4.6'.

NX core 4.6' - 10.2'.

2-inch, Schedule 40, .01" slotted PVC screen 5' - 10'.

2-inch, Schedule 40 PVC riser to 5.0'.

Grade 0 sand 3.7' - 10.2'.

Bentonite pellets 2.7' - 3.7'.

Cement grout 0' - 2.7'.

Protective steel casing with locking cap.

SURFACE ELEVATION 101.6[1]
DATE STARTED 3/15/89
DATE COMPLETED 3/15/89
CLASSIFIED BY LAR

PROJECT R.D. Specialties
LOCATION Webster, New York
PROJECT NO. 251.01
SHEET 1 OF 1

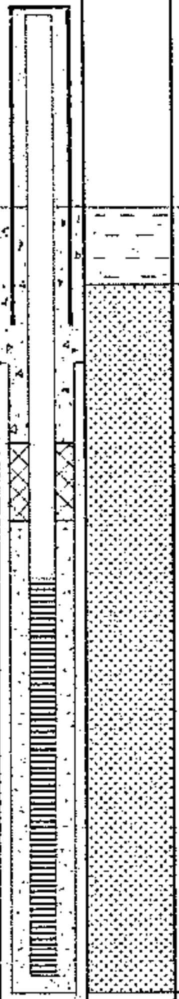
BLASLAND & BOUCK ENGINEERS, P.C.

[1] Elevation is relative to an assumed site datum.

SUBSURFACE LOG

RD-4

DEPTH (FT)	SAMPLES	SAMPLE / RUN NO.	SOIL DATA RECOVERY (FT)	SOIL DATA N VALUE	SOIL DATA HNU	ROCK DATA FROM / TO	ROCK DATA % RECOVERY	ROCK DATA % RQD	ROCK DATA RATE (MIN / FT)
0	☒	1	0.8	3					
				19					
				20/0					
2		R-1				20-	100	0	6
						2.6			
		R-2				2.6-	100	21	5
						5.0			
4									
		R-3				5-	96	26	5
						10.0			
6									
8									
10									



SOIL / ROCK CLASSIFICATION

Brown SILT, some fine to medium sand, moist.

Reddish-brown fine-grained SANDSTONE with green mottling, bioturbated, siltation along horizontal fractures.

Bottom of boring at 10.0'.

Notes:

4-1/4" I.D. hollow-stem auger 0' - 2'.

NX core 2' - 10'.

2-inch, Schedule 40, .01" slotted PVC screen 4.8' - 9.8'.

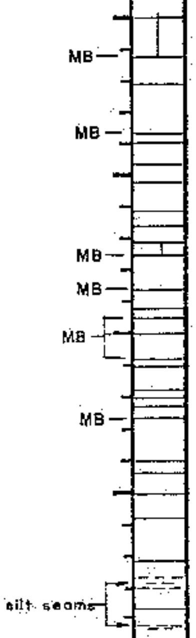
2-inch, Schedule 40 PVC riser.

Grade 0 sand 4' - 10'.

Bentonite seal 3' - 4'.

Cement grout 0' - 3'.

Protective steel casing with locking cap.



SURFACE ELEVATION 98.5[1]
DATE STARTED 3/9/89
DATE COMPLETED 3/13/89
CLASSIFIED BY LAR

PROJECT R.D. Specialties
LOCATION Webster, New York
PROJECT NO. 251.01
SHEET 1 OF 1

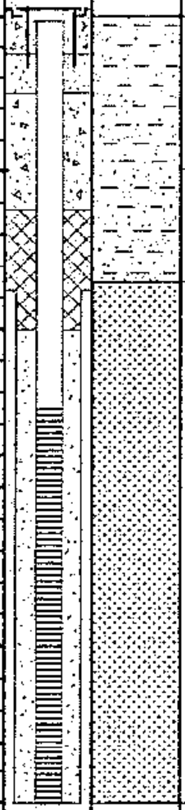
BLASLAND & BOUCK ENGINEERS, P.C.

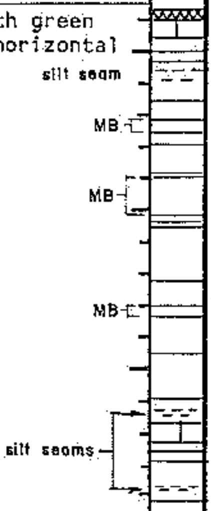
[1] Elevation is relative to an assumed site datum.

SUBSURFACE LOG

RD-5

DEPTH (FT)	SAMPLES	SAMPLE/RUN NO.	SOIL DATA RECOVERY (FT)	SOIL DATA N VALUE	SOIL DATA HNU	ROCK DATA FROM/TO	ROCK DATA % RECOVERY	ROCK DATA % RQD	ROCK DATA RATE (MIN/FT)	SOIL/ROCK CLASSIFICATION
0		1	1.6	5 3 2 4						Black-brown SILT and fine SAND, trace gravel, moist.
2		2	1.1	7 7 50/0	4					Brown SILT and fine SAND, some medium sand, trace gravel, moist.
4		R-1				3.5- 5.1	94	0	4	Reddish-brown fine-grained SANDSTONE with green mottling, bioturbated, siltation along horizontal fractures.
6		R-2				5.1- 10.0	92	63	4	
8										
10										Bottom of boring at 10.0'.





Notes:

4-1/4" I.D. hollow-stem auger 0' - 3.5'.

NX core 3.5' - 10.0'.

2-inch, Schedule 40, .01" slotted PVC screen 5' - 10'.

2-inch, Schedule 40 PVC riser 0' - 5'.

Grade 0 sand 4' - 10'.

Bentonite seal 2.5' - 4'.

Cement grout 1' - 2.5'.

Sand drain 0.5' - 1.0'.

Flush-mount protective casing with locking cap.

SURFACE ELEVATION 100.0[1]
DATE STARTED 3/14/89
DATE COMPLETED 3/14/89
CLASSIFIED BY LAR

PROJECT R.D. Specialties
LOCATION Webster, New York
PROJECT NO. 251.01
SHEET 1 OF 1

BLASLAND & BOUCK ENGINEERS, P.C.

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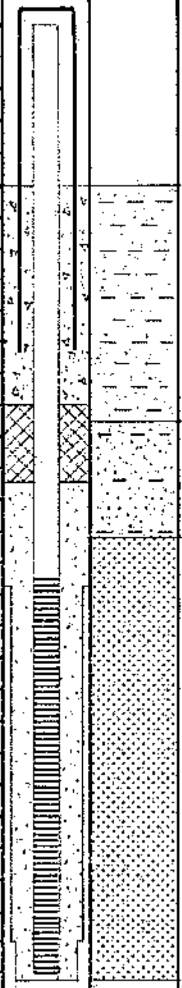
[1] Elevation is relative to an assumed site datum.

SUBSURFACE LOG

RD-6

SOIL/ROCK CLASSIFICATION

DEPTH (FT)	SAMPLES	SAMPLE/RUN NO.	SOIL DATA RECOVERY (FT)	 N VALUE	 HNU	ROCK DATA FROM/TO	 % RECOVERY	 % RQD	 RATE (MIN/FT)
0		1	1.1	1					
				1					
				7					
				17					
2		2	1.5	14					
				30					
				39					
				49					
4		3	0.85	18					
				50/.35					
		R-1				5-	100	82	10
						8			
6									
8		R-2				8-	100	100	8
						8.45			
		R-3				8.45-	83	0	
						9.6			
10		R-4				9.6-	100	100	
						10.1			



Brown fine SAND and SILT, moist.

Brown fine SAND, some silt, little fine to medium angular gravel, wet.

Reddish-brown fine-grained SANDSTONE with green mottling, bioturbated, siltation along horizontal fractures.

ROCK FEATURES

MB

MB

MB

MB

Bottom of boring at 10.1'.

Notes:

4-1/4" hollow-stem auger 0' - 5.1'.
HX core 5.1' - 9.6'.
NX core - 9.6' - 10.1'.
2-inch, Schedule 40, .01" slotted PVC screen 5' - 10'.

2-inch, Schedule 40 PVC riser to 5'.

Grade 0 sand 3.8' - 10.1'.

Bentonite pellets 2.8' - 3.8'.

Cement grout 0' - 2.8'.

Protective steel casing with locking cap.

SURFACE ELEVATION 102.0[1]
DATE STARTED 3/13/89
DATE COMPLETED 3/14/89
CLASSIFIED BY LAR

PROJECT R.D. Specialties
LOCATION Webster, New York
PROJECT NO. 251.01
SHEET 1 OF 1

BLASLAND & BOUCK ENGINEERS, P.C.

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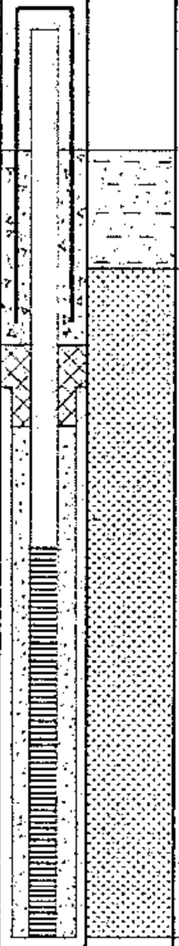
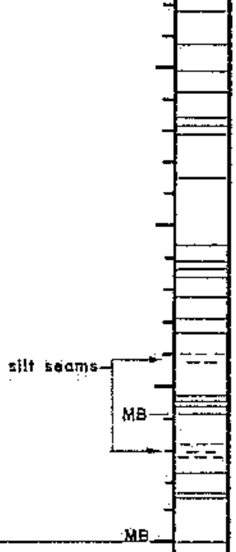
[1] Elevation is relative to an assumed site datum.

SUBSURFACE LOG

RD-7

DEPTH (FT)	SAMPLES	SAMPLE/RUN NO.	SOIL DATA: RECOVERY (FT)	SOIL DATA: N VALUE	SOIL DATA: HNU	ROCK DATA: FROM/TO	ROCK DATA: % RECOVERY	ROCK DATA: % RQD	ROCK DATA: RATE (MIN/FT)	SOIL/ROCK CLASSIFICATION
0		1	0.9	3						Brown SILT and fine to medium SAND, moist.
				5						
				52						
2										Reddish-brown fine-grained SANDSTONE with green mottling, bioturbated, siltation along horizontal fractures.
		R-1				3-5	100	0	5	
4										
		R-2				5-10	100	10	5	
6										
8										
10										Bottom of boring at 10.0'.





Notes:

4-1/4" I.D. hollow-stem auger 0' - 3'.

NX core 3' - 10'.

2-inch, Schedule 40, .01" slotted PVC screen 5' - 10'.

2-inch, Schedule 40 PVC riser to 5.0'.

Grade 0 sand 3.5' - 10.0'.

Bentonite pellets 2.5' - 3.5'.

Cement grout 0' - 2.5'.

Protective steel casing with locking cap.

SURFACE ELEVATION 99.5[1]
DATE STARTED 3/9/89
DATE COMPLETED 3/10/89
CLASSIFIED BY LAR

PROJECT R.D. Specialties
LOCATION Webster, New York
PROJECT NO. 251.01
SHEET 1 OF 1

BLASLAND & BOUCK ENGINEERS, P.C.

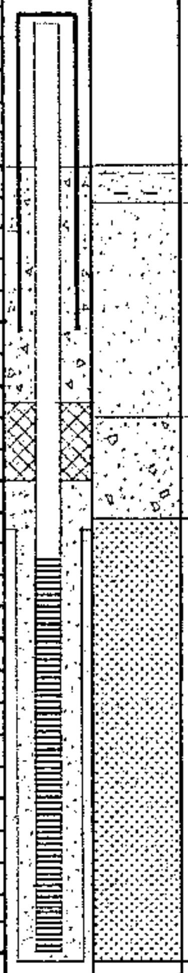
[1] Elevation is relative to an assumed site datum.

SUBSURFACE LOG

RD-8

SOIL/ROCK CLASSIFICATION

DEPTH (FT)	SAMPLE/RUN NO.	SOIL DATA RECOVERY (FT)	SOIL DATA N VALUE	SOIL DATA HNU	ROCK DATA FROM/TO	ROCK DATA % RECOVERY	ROCK DATA % RQD	ROCK DATA RATE (MIN/FT)
0	1	1.3	1					
			1					
			2					
			5					
2	2	1.4	8					
			11					
			17					
			12					
4	3	0.5	12					
			20/0.0					
	R-1				4.6-7.0	100	33	7
6								
	R-2				7.0-9.2	100	22	8
8								
	R-3				9.2-10.1	100	56	8
10								

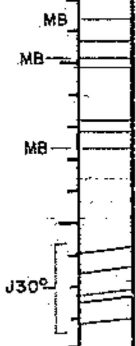


Dark brown SILT and fine SAND, wet.

Brown fine to medium SAND, trace silt, wet.

Brown fine to medium SAND, some fine to coarse angular gravel, trace silt, wet.

Reddish-brown fine-grained SANDSTONE with green mottling, bioturbated, siltation along horizontal fractures.



Bottom of boring at 10.1'.

Notes:

4-1/4" I.D. hollow-stem auger 0' - 4.6'.

NX core 4.6' - 10.1'.

2-inch, Schedule 40, .01" slotted PVC screen 5' - 10'.

2-inch, Schedule 40 PVC riser to 5.0'.

Grade 0 sand 4' - 10.1'.

Bentonite pellets 3' - 4'.

Cement grout 0' - 3'.

Protective steel casing with locking cap.

SURFACE ELEVATION 100.9[1]
DATE STARTED 3/17/89
DATE COMPLETED 3/17/89
CLASSIFIED BY LAR

PROJECT R.D. Specialties
LOCATION Webster, New York
PROJECT NO. 251.01
SHEET 1 OF 1

BLASLAND & BOUCK ENGINEERS, P.C.

[1] Elevation is relative to an assumed site datum.

APPENDIX B

IN-SITU PERMEABILITY TEST DATA

File: SLUGREDU.WKS
MARCH 1989 RD-4
SLUG TEST DATA REDUCTION
RD SPECIALTIES FALLING HEAD TEST

Initial Depth to water (ft): 3.07
Initial Time (seconds): 0.00

Clock Time HR	MN	Sec	Depth to water FT	IN	Elapsed Time in Seconds	Head Change IN FEET	Head Change in cm.
		0	3.07		0.00	0.00	0.00
		11	2.19		11.00	0.88	26.73
		16	2.48		16.00	0.59	17.92
		20	2.54		20.00	0.53	16.10
		22	2.58		22.00	0.49	14.89
		26	2.67		26.00	0.40	12.15
		36	2.68		36.00	0.39	11.85
		40	2.73		40.00	0.34	10.33
		48	2.76		48.00	0.31	9.42
		100	2.82		100.00	0.25	7.60
		111	2.85		111.00	0.22	6.68
		121	2.89		121.00	0.18	5.47
		138	2.91		138.00	0.16	4.86
		210	2.96		210.00	0.11	3.34
		219	2.98		219.00	0.09	2.73
		242	2.99		242.00	0.08	2.43
		252	3.00		252.00	0.07	2.13
		319	3.01		319.00	0.06	1.82
		422	3.03		422.00	0.04	1.22
		440	3.05		440.00	0.02	0.61
		507	3.07		507.00	0.00	0.00

```
SLUGCOMP.WKS        c. S.J. Rossello, March 1988

Project:               RD SPECIALTIES
Project No.:            251.01
Well No.:              RD-4
Test Date:             MARCH 21, 1989
Formation Tested:  BEDROCK(GRIMSBY)
Rising (R) or Falling (F) Head Test:FALLING

-------------------------------------------------------------------------
                                                    |
                                                    |
                                                    |       (cm)
Datum height (ft)                          2.40     |       73.15
Static Water Level (ft)                    3.07     |       93.57
Depth to bottom of screen                  9.80     |      298.70
 (ft from ground level)                             |
Boring Diameter (in)                       3.00     |        7.62
Casing Diameter (in)                       2.00     |        5.08
Screen Diameter (in)                       2.00     |        5.08
Screen Length (ft)                         5.00     |      152.40
Depth to Boundary                         50.00     |     1524.00
Delta H at time 0 (ft)                     0.46     |       14.02
Delta H at Time t (ft)                     0.80     |       24.38
Time t (seconds)                            240     |
Ratio Kh/Kv                                   1     |
Porosity of Filter Pack                     0.3     |
-------------------------------------------------------------------------

                                       cm/sec                gpd/ft2
K (Bouwer-Rice)                       -1.3E-4                  -2.7
K (Hvorslev Time Lag)  .              -1.8E-4                  -3.8
K (Hvorslev Variable Head)            -1.8E-4                  -3.8
```

File: SLUGREDU.WKS
MARCH 1989 RD-7
SLUG TEST DATA REDUCTION
RD SPECIALTIES FALLING HEAD TEST

Initial Depth to water (ft): 2.18
Initial Time (seconds): 0.00

Clock Time HR	MN	Sec	Depth to water FT	IN	Elapsed Time in Seconds	Head Change IN FEET	Head Change in cm.
		0	2.18		0.00	0.00	0.00
		17	1.25		17.00	0.93	28.25
		40	1.47		40.00	0.71	21.57
		50	1.60		50.00	0.58	17.62
		206	1.92		206.00	0.26	7.90
		229	1.98		229.00	0.20	6.08
		318	2.05		318.00	0.13	3.95
		348	2.10		348.00	0.08	2.43
		420	2.13		420.00	0.05	1.52
		457	2.15		457.00	0.03	0.91
		542	2.18		542.00	0.00	0.00

```
SLUGCOMP.WKS        c. S.J. Rossello, March 1988

Project:            RD SPECIALTIES
Project No.:          251.01
Well No.:           RD-7
Test Date:          MARCH 22, 1989
Formation Tested:  BEDROCK(GRIMSBY)
Rising (R) or Falling (F) Head Test:FALLING

------------------------------------------------------------
                                          |
                                          |
                                          |      (cm)
Datum height (ft)                 1.48    |      45.11
Static Water Level (ft)           2.18    |      66.45
Depth to bottom of screen        10.00    |     304.80
 (ft from ground level)                   |
Boring Diameter (in)              3.00    |       7.62
Casing Diameter (in)              2.00    |       5.08
Screen Diameter (in)              2.00    |       5.08
Screen Length (ft)                5.00    |     152.40
Depth to Boundary                50.00    |    1524.00
Delta H at time 0 (ft)            0.85    |      25.91
Delta H at Time t (ft)            0.20    |       6.10
Time t (seconds)                   233    |
Ratio Kh/Kv                          1    |
Porosity of Filter Pack            0.3    |
------------------------------------------------------------
                                cm/sec               gpd/ft2
K (Bouwer-Rice)                 3.5E-4                   7.3
K (Hvorslev Time Lag)           4.9E-4                  10.3
K (Hvorslev Variable Head)      4.8E-4                  10.3
```

APPENDIX C

ANALYTICAL LABORATORY REPORTS - SUMMARY DATA

LABORATORIES, INC.

Laboratory Report

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Soils

DATE COLLECTED 3-20-89 DATE REC'D. 3-21-89 DATE ANALYZED

Description	D1A 1'-2'	D1B 1'-2.5'	D1C Surface	SB2A 1'	SB2B 3'	SB3A 1'	SB3B 2.5'	SB4A 1'	SB4B 3'
Sample #	I2415	I2416	I2417	I2418	I2419	I2420	I2421	I2422	I2423
PERCENT TOTAL SOLIDS	81.0	83.2	73.7	77.3	82.2	78.1	79.5	80.9	82.3
CHROMIUM-HEXAVALENT	<1.23	<1.20	<1.4	<1.36	<1.22	<1.28	<1.26	<1.24	<1.2
Total Metals:									
ALUMINUM	11400.	10400.	9980.	12000.	8930.	11300.	8000.	9810.	10000.
ANTIMONY	<7.41	<7.21	13.3	<7.76	<7.30	<7.68	<7.55	<7.42	<7.29
ARSENIC	<0.62	0.77	3.0	2.1	1.2	0.72	0.72	0.87	0.91
BARIUM	26.6	32.3	39.9	55.8	37.2	38.7	34.0	42.1	42.0
BERYLLIUM	0.685	0.680	0.770	0.716	0.679	0.701	0.711	0.680	0.657
CADMIUM	<0.62	<0.60	0.751	<0.65	<0.61	<0.64	<0.63	<0.62	<0.61
CALCIUM	960.	940.	2720.	2880.	1290.	1750.	3210.	2020.	6670.
CHROMIUM	34.3	17.5	1540.	209.	39.9	12.5	18.3	12.7	14.7
COBALT	<6.2	<6.0	<6.8	<6.5	<6.1	<6.4	<6.3	<6.2	6.76
COPPER	12.2	5.27	265.	29.1	9.15	4.61	7.30	4.63	6.89
IRON	14400.	13500.	13400.	35300.	14300.	12800.	11300.	14100	15100.
LEAD	2.69	3.65	164.	86.7	14.7	8.32	14.3	4.13	3.09
MERCURY	<0.12	<0.12	<0.14	<0.13	<0.12	<0.13	<0.13	<0.12	<0.12
MAGNESIUM	2900.	2420.	2140.	2260.	2250.	1850.	2220.	2570.	4180.
MANGANESE	147.	216.	196.	312.	221.	131.	185.	152.	271.
NICKEL	12.6	12.6	15.5	23.9	12.2	9.36	9.73	13.4	13.6
POTASSIUM	833.	1030.	945.	<646.	1090.	1050.	1310.	1340.	1970.
SELENIUM*	<3.1	<3.0	<3.4	<3.2	<3.0	<3.2	<3.1	<3.1	<3.0

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

UNITS: mg/kg dry weight
Units: mg/l (ppm) unless otherwise noted

Comments: *The detection limit has been raised due to the presence of matrix interferences.

Authorized: Michael K. Pettrell

Date: April 14, 1989

OBG Laboratories Inc
Box 4942 / 1304 Buckley Rd / Syracuse, NY / 13221 / (315) 457-1494

LABORATORIES, INC.

Laboratory Report

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Soils

DATE COLLECTED 3-20-89 DATE REC'D. 3-21-89 DATE ANALYZED

Description	D1A 1'-2'	D1B 1'-2.5'	D1C Surface	SB2A 1'	SB2B 3'	SB3A 1'	SB3B 2.5'	SB4A 1'	SB4B 3'			
Sample #	I2415	I2416	I2417	I2418	I2419	I2420	I2421	I2422	I2423			
Total Metals:												
SILVER	<1.2	<1.2	<1.4	<1.3	<1.2	<1.3	<1.3	<1.2	<1.2			
SODIUM	<617.	<601.	<678.	<647.	<608.	<640.	<629.	<618.	<608.			
THALLIUM	<1.2	<1.2	<1.4	<1.3	<1.2	<1.3	<1.3	<1.2	<1.2			
VANADIUM	21.8	19.0	21.2	23.2	20.8	24.2	20.0	22.8	24.3			
ZINC	25.2	25.0	120.	85.7	32.9	31.5	25.5	24.6	25.5			

UNITS: mg/kg dry weight

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

Units: mg/l (ppm) unless otherwise noted

Comments:

Authorized: Michael H. Pelbalt

Date: April 14, 1989

OBG Laboratories, Inc
Box 4942 / 1304 Buckley Rd. / Syracuse, NY / 13221 / (315) 457-1494

LABORATORIES, INC.

Laboratory Report

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Soils

DATE COLLECTED 3-21-89 DATE REC'D. 3-22-89 DATE ANALYZED

Description	SB1A 1'	SB1B 3'	IS1A 1'-3'	IS1B 1'-3'	IS1C Surface	D2A 1'-3'	D2B 1'-3'	D2C Surface	IS2A 1'-3'	IS2B 1'-3'	IS2C Surface	IS3A 1'-3'
Sample #	12482	12483	12484	12485	12486	12487	12488	12489	12490	12491	12492	12493
PERCENT TOTAL SOLIDS	74.9	78.4	81.8	71.8	54.0	68.8	72.8	65.3	77.3	83.7	49.5	62.8
CHROMIUM-HEXAVALENT	<1.3	<1.3	<1.2	<1.4	<1.9	<1.5	<1.4	<1.5	<1.3	<1.2	<2.0	<1.6
Total Metals:												
ALUMINUM	12200.	11100.	6020.	12100.	7100.	9640.	7390.	7180.	9620.	7780.	13000.	6630.
ANTIMONY	<8.0	<7.7	<7.3	<8.4	<11.	<8.7	<8.2	<9.2	<7.8	<7.2	<12.	<9.4
ARSENIC	1.6	1.3	1.4	5.8	3.2	1.4	0.82	1.3	0.84	1.3	4.3	2.8
BARIUM	<27.	<26.	<24.	72.2	47.3	39.2	31.9	<31.	43.1	32.2	74.0	42.9
BERYLLIUM	0.737	0.715	0.703	0.735	1.11	0.856	0.815	0.921	0.739	0.679	1.18	0.954
CADMIUM	<0.67	<0.64	<0.61	<0.70	<0.93	<0.73	<0.69	<0.77	<0.65	<0.60	<1.0	<0.78
CALCIUM	<667.	735.	9800.	2940.	3880.	2640.	3240.	3190.	4830.	2070.	5380.	4040.
CHROMIUM	9.50	10.8	10.6	17.4	10.3	332.	394.	1050.	26.2	11.0	16.0	10.3
COBALT	<6.7	<6.4	<6.1	<7.0	<9.3	<7.3	<6.9	<7.7	<6.5	<6.0	<10.	<7.8
COPPER	6.47	7.16	7.04	7.77	11.4	12.3	27.2	80.0	10.5	7.68	18.8	9.80
IRON	13700.	14000.	12200.	28000.	12100.	9240.	6910.	7960.	10700.	13000.	16500.	10500.
LEAD	8.41	5.08	2.80	4.94	18.1	8.50	8.31	18.2	5.87	3.92	34.1	18.2
MERCURY	<0.13	<0.13	<0.12	<0.14	<0.19	<0.15	<0.14	<0.15	<0.13	<0.12	<0.20	<0.16
MAGNESIUM	1090.	2120.	3040.	3010.	1540.	1580.	1170.	1070.	2440.	2510.	2530.	1480.
MANGANESE	64.4	136.	257.	623.	806.	98.5	93.8	131.	178.	141.	841.	502.
NICKEL	<5.3	9.25	8.82	12.5	<7.4	7.64	<5.5	<6.1	9.38	9.94	10.7	6.47
POTASSIUM	<667.	<638.	<611.	1100.	<925.	<727.	<689.	<766.	937.	1200.	1610.	<783.
SELENIUM	<0.67	<0.64	<0.61	<0.70	<0.93	<0.73	<0.69	<0.77	<0.65	<0.60	<1.0	<0.78

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

UNITS: mg/kg dry weight
Units: mg/l (ppm) unless otherwise noted

Comments:

Authorized: Michael U. Pettarelli

Date: April 14, 1989

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd / Syracuse, NY / 13221 / (315) 457-1494

LABORATORIES, INC.

Laboratory Report

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Soils

DATE COLLECTED 3-21-89 DATE REC'D. 3-22-89 DATE ANALYZED

Description	SB1A 1'	SB1B 3'	IS1A 1'-3'	IS1B 1'-3'	IS1C Surface	D2A 1'-3'	D2B 1'-3'	D2C Surface	IS2A 1'-3'	IS2B 1'-3'	IS2C Surface	IS3A 1'-3'
Sample #	I2482	I2483	I2484	I2485	I2486	I2487	I2488	I2489	I2490	I2491	I2492	I2493
Total Metals:												
SILVER	<1.3	<1.3	<1.2	<1.4	<1.9	<1.5	<1.4	<1.5	<1.3	<1.2	<2.0	<1.6
SODIUM	<667.	<638.	<611.	<696.	<925.	<727.	<689.	<766.	<647.	<598.	<1010.	<796.
THALLIUM	<1.3	<1.3	<1.2	<1.4	<1.9	<1.5	<1.4	<1.5	<1.3	<1.2	<2.0	<1.6
VANADIUM	24.1	24.1	17.5	30.9	18.6	17.4	15.4	15.1	19.3	18.5	26.4	16.3
ZINC	31.9	41.6	26.8	86.9	61.7	33.8	32.7	58.2	36.1	25.4	87.8	47.5

UNITS: mg/kg dry weight

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

Units: mg/l (ppm) unless otherwise noted

Comments:

Authorized: Michael J. Pettaudi

Date: April 14, 1989

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse, NY / 13221 / (315) 457-1494

LABORATORIES, INC.

Laboratory Report

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Soils

DATE COLLECTED 3-21-89 DATE REC'D. 3-22-89 DATE ANALYZED

Description	IS3B 1'-3'	IS3C Surface
Sample #	12494	12497
PERCENT TOTAL SOLIDS	80.4	75.6
CHROMIUM-HEXAVALENT	<1.2	<1.3
Total Metals:		
ALUMINUM	10800.	7380.
ANTIMONY	<7.5	<7.9
ARSENIC	2.9	1.8
BARIUM	49.9	32.7
BERYLLIUM	0.669	0.788
CADMIUM	<0.62	<0.66
CALCIUM	2560.	2140.
CHROMIUM	15.6	23.2
COBALT	7.53	<6.6
COPPER	6.76	5.68
IRON	20800.	11300.
LEAD	7.84	3.76
MERCURY	<0.12	<0.13
MAGNESIUM	3460.	1970.
MANGANESE	725.	136.
NICKEL	14.3	8.13
POTASSIUM	1710.	1050.
SELENIUM	<0.62	<0.66

UNITS: mg/kg dry weight

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

Units: mg/l (ppm) unless otherwise noted

Comments:

Authorized: Michael W. Pettinelli

Date: April 14, 1989

OBG Laboratories, Inc
Box 4942 / 1304 Buckley Rd / Syracuse, NY / 13221 / (315) 457-1494

LABORATORIES, INC.

Laboratory Report

CLIENT: BLASLAND & BOUCK ENGINEERS, P.C. JOB NO: 2887.013.517

DESCRIPTION: RD Specialties - Soils

DATE COLLECTED: 3-21-89 DATE REC'D.: 3-22-89 DATE ANALYZED:

Description	IS3B 1'-3'	IS3C Surface
Sample #	12494	12497
Total Metals:		
SILVER	4.31	<1.3
SODIUM	<622.	<661.
THALLIUM	<1.2	<1.3
VANADIUM	25.4	14.4
ZINC	33.2	38.6

UNITS: mg/kg dry weight

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

Units: mg/l (ppm) unless otherwise noted

Comments:

Authorized: Michael N. Pettinelli

Date: April 14, 1989

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse, NY / 13221 / (315) 457-1494

OBG LABORATORIES, INC.

Purgeable Priority Pollutants

CLIENT: BLASLAND & BOUCK ENGINEERS, P.C.   JOB NO. 2887.013.517

DESCRIPTION: RD Specialties - Soils

DATE COLLECTED: 3-20-89   DATE REC'D. 3-21-89   DATE ANALYZED 3-22-89

DESCRIPTION:	D1A 1'-2'	D1B 1'-2.5'	D1C Surface	SB2A 1'	SB2B 3'	SB3A 1'
SAMPLE NO.:	I2415	I2416	I2417	I2418	I2419	I2420
Chloromethane	<10.	<10.	<10.	<10.	<10.	<10.
Bromomethane						
Vinyl chloride						
Chloroethane						
Methylene chloride						
1,1-Dichloroethene						
1,1-Dichloroethane						
t-1,2-Dichloroethene						
Chloroform						
1,2-Dichloroethane						
1,1,1-Trichloroethane						
Carbon tetrachloride						
Bromodichloromethane						
1,2-Dichloropropane						
t-1,3-Dichloropropene						
Trichloroethene						
Benzene						
Dibromochloromethane						
1,1,2-Trichloroethane						
c-1,3-Dichloropropene	↓	↓	↓	↓	↓	↓
2-Chloroethylvinyl ether	<100.	<100.	<100.	<100.	<100.	<100.
Bromoform	<100.	<100.	<100.	<100.	<100.	<100.
1,1,2,2-Tetrachloroethane	<10.	<10.	<10.	<10.	<10.	<10.
Tetrachloroethene						
Toluene						
Chlorobenzene						
Ethylbenzene						
Xylenes	↓	↓	↓	↓	↓	↓

UNITS: µg/kg dry weight

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Units: ug/l ppb unless [illegible]

Comments:

Authorized:

Date: April 14, 1989

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse, NY 13221 / (315) 457-1494

OBG LABORATORIES, INC.

Purgeable Priority Pollutants

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Soils

DATE COLLECTED 3-20-89 DATE REC'D. 3-21-89 DATE ANALYZED 3-22-89

DESCRIPTION:	SB3B 2.5'	SB4A 1'	SB4B 3'
SAMPLE NO.:	I2421	I2422	I2423
Chloromethane	<10.	<10.	<10.
Bromomethane	↓	↓	↓
Vinyl chloride	↓	↓	↓
Chloroethane	↓	↓	↓
Methylene chloride	↓	↓	↓
1,1-Dichloroethene	↓	↓	↓
1,1-Dichloroethane	↓	↓	↓
t-1,2-Dichloroethene	↓	↓	↓
Chloroform	↓	↓	↓
1,2-Dichloroethane	↓	↓	↓
1,1,1-Trichloroethane	↓	↓	↓
Carbon tetrachloride	↓	↓	↓
Bromodichloromethane	↓	↓	↓
1,2-Dichloropropane	↓	↓	↓
t-1,3-Dichloropropene	↓	↓	↓
Trichloroethene	↓	↓	↓
Benzene	↓	↓	↓
Dibromochloromethane	↓	↓	↓
1,1,2-Trichloroethane	↓	↓	↓
c-1,3-Dichloropropene	↓	↓	↓
2-Chloroethylvinyl ether	<100.	<100.	<100.
Bromoform	<100.	<100.	<100.
1,1,2,2-Tetrachloroethane	<10.	<10.	<10.
Tetrachloroethene	↓	↓	↓
Toluene	↓	↓	↓
Chlorobenzene	↓	↓	↓
Ethylbenzene	↓	↓	↓
Xylenes	↓	↓	↓

UNITS: µg/kg dry weight

Units: ug/l ppb unless otherwise noted

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Comments:

Authorized:

Date: April 14, 1989

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse, NY 13221 / (315) 457-1494

LABORATORIES, INC.

Purgeable Priority Pollutants

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Soils

DATE COLLECTED 3-21-89 DATE REC'D. 3-22-89 DATE ANALYZED 3-23-89

DESCRIPTION:	SB1A 1'	SB1B 3'	IS1A 1'-3'	IS1B 1'-3'	IS1C Surface	D2A 1'-3'
SAMPLE NO.:	I2482	I2483	I2484	I2485	I2486	I2487
Chloromethane	<10.	<10.	<10.	<10.	<10.	<10.
Bromomethane						
Vinyl chloride						
Chloroethane						
Methylene chloride						
1,1-Dichloroethene						
1,1-Dichloroethane						
t-1,2-Dichloroethene						
Chloroform						
1,2-Dichloroethane						
1,1,1-Trichloroethane						
Carbon tetrachloride						
Bromodichloromethane						
1,2-Dichloropropane						
t-1,3-Dichloropropene						
Trichloroethene						
Benzene						
Dibromochloromethane						
1,1,2-Trichloroethane						
c-1,3-Dichloropropene	↓	↓	↓	↓	↓	↓
2-Chloroethylvinyl ether	<100.	<100.	<100.	<100.	<100.	<100.
Bromoform	<100.	<100.	<100.	<100.	<100.	<100.
1,1,2,2-Tetrachloroethane	<10.	<10.	<10.	<10.	<10.	<10.
Tetrachloroethene						
Toluene						
Chlorobenzene						
Ethylbenzene						
Xylenes	↓	↓	↓	↓	↓	↓

UNITS: µg/kg dry weight

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Units: µg/l (ppb) unless otherwise noted

Comments:

Authorized: Michael R. Pettinelli

Date: April 14, 1989

OBG LABORATORIES, INC.

Purgeable Priority Pollutants

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Soils

DATE COLLECTED 3-21-89 DATE REC'D. 3-22-89 DATE ANALYZED 3-23-89

DESCRIPTION:	D2B 1'-3'	D2C Surface	IS2A 1'-3'	IS2B 1'-3'	IS2C Surface	IS3A 1'-3'
SAMPLE NO.:	I2488	I2499	I2490	I2491	I2492	I2493
Chloromethane	<10.	<10.	<10.	<10.	<10.	<10.
Bromomethane	↓	↓	↓	↓	↓	↓
Vinyl chloride	↓	↓	↓	↓	↓	↓
Chloroethane	↓	↓	↓	↓	↓	↓
Methylene chloride	↓	↓	↓	↓	↓	↓
1,1-Dichloroethene	↓	↓	↓	↓	↓	↓
1,1-Dichloroethane	↓	↓	↓	↓	↓	↓
t-1,2-Dichloroethene	↓	↓	↓	↓	↓	↓
Chloroform	↓	↓	↓	↓	↓	↓
1,2-Dichloroethane	↓	↓	↓	↓	↓	↓
1,1,1-Trichloroethane	↓	↓	↓	↓	↓	↓
Carbon tetrachloride	↓	↓	↓	↓	↓	↓
Bromodichloromethane	↓	↓	↓	↓	↓	↓
1,2-Dichloropropane	↓	↓	↓	↓	↓	↓
t-1,3-Dichloropropene	↓	↓	↓	↓	↓	↓
Trichloroethene	↓	↓	↓	↓	↓	↓
Benzene	↓	↓	↓	↓	↓	↓
Dibromochloromethane	↓	↓	↓	↓	↓	↓
1,1,2-Trichloroethane	↓	↓	↓	↓	↓	↓
c-1,3-Dichloropropene	↓	↓	↓	↓	↓	↓
2-Chloroethylvinyl ether	<100.	<100.	<100.	<100.	<100.	<100.
Bromoform	<100.	<100.	<100.	<100.	<100.	<100.
1,1,2,2-Tetrachloroethane	<10.	<10.	<10.	<10.	<10.	<10.
Tetrachloroethene	↓	↓	↓	↓	↓	↓
Toluene	↓	↓	↓	↓	↓	↓
Chlorobenzene	↓	↓	↓	↓	↓	↓
Ethylbenzene	↓	↓	↓	↓	↓	↓
Xylenes	↓	↓	↓	↓	↓	↓

UNITS: µg/kg dry weight

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Units: µg/l (ppb) unless otherwise noted

Comments:

Authorized: Michael K Pettell

Date: April 14, 1989

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse, NY 13221 / (315) 457-1494

OBG LABORATORIES, INC.

Purgeable Priority Pollutants

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Soils

DATE COLLECTED 3-21-89 DATE REC'D. 3-22-89 DATE ANALYZED 3-23-89

DESCRIPTION:	IS3B* 1'-3'	IS3C* Surface	QC Trip** Blank		
SAMPLE NO.:	I2494	I2497	I2498		
Chloromethane	<10.	<10.	<1.		
Bromomethane	↓	↓	↓		
Vinyl chloride	↓	↓	↓		
Chloroethane	↓	↓	↓		
Methylene chloride	↓	↓	↓		
1,1-Dichloroethene	↓	↓	↓		
1,1-Dichloroethane	↓	↓	↓		
t-1,2-Dichloroethene	↓	↓	↓		
Chloroform	↓	↓	↓		
1,2-Dichloroethane	↓	↓	↓		
1,1,1-Trichloroethane	↓	↓	↓		
Carbon tetrachloride	↓	↓	↓		
Bromodichloromethane	↓	↓	↓		
1,2-Dichloropropane	↓	↓	↓		
t-1,3-Dichloropropene	↓	↓	↓		
Trichloroethene	↓	↓	↓		
Benzene	↓	↓	↓		
Dibromochloromethane	↓	↓	↓		
1,1,2-Trichloroethane	↓	↓	↓		
c-1,3-Dichloropropene	↓	↓	↓		
2-Chloroethylvinyl ether	<100.	<100.	<10.		
Bromoform	<100.	<100.	<10.		
1,1,2,2-Tetrachloroethane	<10.	<10.	<1.		
Tetrachloroethene	↓	↓	↓		
Toluene	↓	↓	↓		
Chlorobenzene	↓	↓	↓		
Ethylbenzene	↓	↓	↓		
Xylenes	↓	↓	↓		

UNITS: *µg/kg dry weight
**µg/l

Methodology: Federal Register—40 CFR, Part 136, October 26, 1984

Units: µg/l (ppb) unless otherwise noted

Comments:

Authorized: Michael K. Pettinelli

Date: April 14, 1989

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse, NY 13221 / (315) 457-1494

OBG LABORATORIES, INC.

Laboratory Report

CLIENT BLASLAND & BOUCK ENGINEERS, P.C. JOB NO. 2887.013.517

DESCRIPTION RD Specialties - Waters

DATE COLLECTED 3-22-89 DATE REC'D. 3-22-89 DATE ANALYZED

	Sample #	CHROMIUM-HEXAVALENT	TOTAL CHROMIUM	TOTAL ARSENIC	TOTAL BARIUM	TOTAL CADMIUM	TOTAL LEAD	TOTAL MERCURY	TOTAL SELENIUM	TOTAL SILVER		
RD1	I2567	0.02	<0.05	-	-	-	-	-	-	-		
RD2	I2568	0.17	0.19	<0.005	<0.5	<0.01	<0.05	<0.0002	<0.005	<0.01		
RD3	I2569	0.17	0.23	<0.005	<0.5	<0.01	<0.05	<0.0002	<0.005	<0.01		
RD4	I2572	<0.01	<0.05	-	-	-	-	-	-	-		
RD5	I2573	1.9	2.0	-	-	-	-	-	-	-		
RD6	I2574	<0.01	<0.05	-	-	-	-	-	-	-		
RD7	I2575	<0.01	<0.05	-	-	-	-	-	-	-		
RD8	I2576	3.7	4.7	-	-	-	-	-	-	-		
FB1	I2577	<0.01	<0.05	-	-	-	-	-	-	-		
SW1	I2578	<0.01	<0.05	-	-	-	-	-	-	-		
SW2	I2579	0.04	0.05	-	-	-	-	-	-	-		

UNITS: mg/l

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

Units: mg/l (ppm) unless otherwise noted

Comments:

Authorized: Michael M. Pettoelli

Date: April 15, 1989

OBG Laboratories, Inc.
Box 4942 / 1304 Buckley Rd. / Syracuse, NY / 13221 / (315) 457-1494

OBG
LABORATORIES, INC.

Laboratory Report

CLIENT BLASLAND & BOUCK ENGINEERS, PC. **JOB NO.** 2887.013.517

DESCRIPTION RD Specialties - Water Samples

DATE COLLECTED 7-12-89 **DATE REC'D.** 7-13-89 **DATE ANALYZED**

Description	Sample #	CHROMIUM HEXAVALENT	TOTAL CHROMIUM
RD -1	I7679	<0.01	<0.01
RD -2	I7680	0.05	0.07
RD -3	I7681	0.70	0.75
RD -5	I7682	0.25	0.34
RD -8	I7685	1.2	1.0
Pond	I7686	<0.01	<0.01
Decon Water	I7687	<0.01	<0.01
FB -1	I7688	<0.01	<0.01

UNITS: mg/l

Methodology: Federal Register — 40 CFR, Part 136, October 26, 1984

Units: mg/ℓ (ppm) unless otherwise noted

Comments:

Authorized: Michael K. Pettelli

Date: August 1, 1989

APPENDIX D

NYSDEC ANALYTICAL LABORATORY REPORT

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233

Thomas C. Jorling
Commissioner

JUN 12 1989

Mr. Tyler E. Gass, C.P.G.
Vice President
Blasland and Bouck Engineers
6723 Towpath Road
Box 66
Syracuse, NY 13214

Dear Mr. Gass:

Re: R.D. Specialties,
Site No. 8-28-062

Please find enclosed herewith a copy of the validated analytical results of the split samples collected from the above-referenced site on March 20 and March 22, 1989. The comparison of this data with the data submitted by you shows the same concentration at each location. The following is the list of NYSDEC I.D. Numbers and the respective locations:

Groundwater and Surface Water

NYSDEC I.D. Number	Site Location
RB8880322-828062-01	RD1
-02	RD4
-03	RD7
-04	RD5
-05	RD6
-06	RD3
-07	RD8
-08	RD2
-09	SW1
-10	SW2

Soils

NYSDEC I.D. Number	Site Location
RB8880320-828062-01	D1A
-02	D1B
-03	D1C
-04	SB2A
-05	SB2B
-06	SB3A
-07	SB3B

Please let me know ahead of time on the second round of sampling to be carried out at the site. If you have any questions please call me at 518/457-0315.

Sincerely,

Vivek Nattanmai
Assistant Sanitary Engineer
Division of Hazardous Waste
Remediation

Enclosure

R.D. SPECIALTIES
8-28-062

DATE: June 1, 1989

The following samples were submitted to NUS Corporation from this site on 3/22/89:

SDG # = 0322

Sample ID	Matrix	Date Received	Assays Requested
RB8880322-828062-01	water	3/23/89	VOA's, metals & Hex Chromium by CLP
-828062-02	water	"	
-828062-03	groundwater	"	"
-828062-04	"	"	"
-828062-05	"	"	"
-828062-06	"	"	"
-828062-07	"	"	"
-828062-08	"	"	"
-828062-09	surface water	"	"
-828062-10	"	"	"

The following samples were submitted on 3/20/89.

SDG #0320

RB8880320-828062-01	soil	3/21/89	VOA's, metals by CLP
-828062-02	"	"	"
-828062-03	"	"	"
-828062-04	"	"	"
-828062-05	"	"	"
-828062-06	"	"	"
-828062-07	"	"	"

Organics Review:

VOA's - Soil SDG #0320

Holding times were met, tunes and calibration supplied with raw data for assay day.

The surrogate recovery, MS/MSD and internal standards were all within QC limits.

The blank summary was enclosed. All samples plus the blank had a TIC, 1,1,2-trichloro-1,2,2-trifluoroethane that coeluted with surrogate compound 1,2-dichloroethane-d4. The lab manager said in his case narrative that this coelution affected the peak area making the estimated concentration of the TIC erroneously high.

The reported TIC concentrations were qualified with an X on the form 1's to indicate this problem.

VOA's - water SDG #0322

Holding times were met, tunes and claibration data for the assay dates was supplied. The blanks had no contaminants except acetone and methylene chloride. The surrogate recovery and MS/MSD recoveries were within QC limits.

The Internal Standard Summary was provided. The bromochloromethane area at 40100 was outside QC limits (530-21200) for sample #828062-04. All other samples including the MS/MSD and related blanks were within QC limits. The lab manager noted that they did not determine this until the holding time had expired. Since only the blank contaminants, acetone and methylene chloride were detected he expected no adverse impact upon the reported results.

Compound Identification - SDG #0320 - soil

Sample ID	Methylene Chloride	Acetone	Carbon Disulfide	Toluene	Benzene
828062-01	1JB(1)	5JB(1)	-	3JB(1)	
" -02	0.9JB(1)	1JB(1)	-	2JB(1)	
" -03	1JB(1)	1JB(1)	-	3JB(1)	
" -04	1JB(1)	1JB(1)	-	2JB(1)	
" -05	1JB(1)	2JB(1)	0.9J	2JB(1)	0.7J
" -06	2JB(1)	1JB(1)	1J	2JB(1)	
" -07	1JB(1)	1JB(1)	1J	2JB(1)	

SDG #0322 - Water

Sample ID	Methylene Chloride	Acetone	Carbon Disulfide	Toluene	Benzene
828062-01	6B(3)	36B(12)	0.7J	-	-
" -02	2JB(3)	-	-	-	-
" -03	2JB(3)	4JB(12)	-	-	-
" -04	2JB(3)	2JB(12)	-	-	-
" -05	-	4JB(11)	-	-	-
" -06	-	15B (11)	-	-	-
" -07	-	2JB(11)	-	-	-
" -08	0.7JB(4)	14B (11)	-	-	-
" -09	-	4JB(11)	-	-	-
" -10	-	2JB(11)	-	-	-

Inorganics Review

SDG #0320 - Soils

HOlding times were met, a cover page and case narrative was supplied. Digestion logs were enclosed. Initial and continuing calibration form and data was supplied. The CRDL Standard for AA and ICP - Form II (part 2) was not supplied. Blank Form II was enclosed. The lab manager noted that the Prep Blank (3/27/89) had Cadmium contamination. They reprepared the samples and re-analyzed for cadmium on 3/29/89.

The spike samples was within QC limits. The Duplicate had aluminum and calcium outside QC limits. These were starred on the Form 1's. The laboratory control sample had no control limits supplied with their solid reference standard so it is difficult to review for compliance. However, the following low recoveries makes their ability to assay for the following doubtful:

Cmpd.	%R
Aluminum	19.1
Antimony	23.7
Barium	22.7
Chromium	58.5
Potassium	3.4
Selenium	0
Sodium	0

A MSA was done for lead on Sample #828062-01 as required. The Quarterly IDL's were supplied. All calculations checked were correct.

SDG #0322 - water

Holding times were met, digestion logs supplied, Initial and Continuing Calibration forms and data supplied. The CRDL Standard for AA - Form II (part 2) was not supplied.

Blanks Forms and Prep Blank were supplied. The spike recoveries were within QC limits except Cadmium. Data was tagged with an N.

Post digestion spikes were within QC limits with the exception of sample #828062-09-Lead. An MSA was done. The duplicate sample had iron and manganese outside QC limits. THe assay results are starred on the form 1's. The laboratory control sample recoveries were within QC limits. The IDL Quarterly forms were supplied.

Compound Identification - SDG #0320 - Soil mg/kg

Cmpd.	-01	-02	-03	-04
Al	14900*	10700*	9850*	11300*
Sb	0.65u	0.62u	11.3	[1.0]
As	1.4	1.3	3.9	2.5
Ba	25.9	33.5	57.2	52.7
Be	0.52u	0.50u	0.64u	0.51u
Cd	0.65u	0.62u	0.79u	0.64u
Ca	1360*	756*	3780*	2520*
Cr	31.0	12.4	2720	211
Co	6.5	6.2u	7.9u	6.4u
Cu	3.9	5.0	386	24.4
Fe	11300	13200	11300	23400
Pb	2.2S	3.0	158	74.8
Mg	1860	1830	1690	2440
Mn	107	160	202	249
Hg	0.1u	0.1u	0.1u	0.1u
Ni	7.8	5.0u	6.4u	7.7
K	[466]	[446]	[509]	[450]
Se	0.39u	0.37u	0.48uW	0.39uW
Ag	1.3u	1.2u	1.6u	1.3u
Na	259u	248u	318u	257u
Tl	0.13u	0.12u	0.16u	0.13u
V	12.9	11.1u	13.7	16.8
Zn	20.7	21.1	141	91.3

Cmpd.	-05	-06	-07
Al	8710*	9370*	7120*
Sb	0.63u	0.66u	0.65u
As	1.5	[1.2]	1.3
Ba	39.1	40.9	31.1
Be	0.51u	0.53u	0.52u
Cd	0.63u	0.66u	0.65u
Ca	1300*	2080*	4420*
Cr	41.7	6.6	14.2
Co	6.3u	6.6u	6.5u
Cu	8.8	[2.6]	5.2
Fe	10700	12900	9840
Pb	16.7	6.2	10.3
Mg	1600	1230	1870
Mn	196	128	167
Hg	0.1u	0.1u	0.1u
Ni	5.1u	13.2	5.2u
K	[619]	[330]	[557]
Se	0.38u	0.40uW	0.39uW
Ag	1.3u	1.3u	1.3u
Na	253u	264u	259u
Tl	0.13u	0.13u	0.13u
V	8.9	11.5	9.3
Zn	26.5	22.4	18.1

SDG #0322 - Water ug/L

Cmpd.	-01	-02	-03	-04	-05	-06
Al	3900	4600	3500	2100	8500	3400
Sb	5.0u	5.0u	5.0u	5.0u	5.0u	5.0u
As	[2.9]	[3.3]	[2.1]	[2.9]	[2.7]	[3.3]W
Ba	100u	100u	100u	100u	100u	100u
Be	4.0u	4.0u	4.0u	4.0u	4.0u	4.0u
Cd	5.0uN	13.0N	5.0uN	5.0uN	10.0N	8.0N
Ca	21000	45300	19600	70000	67000	42700
Cr	10.0	10.0	10.0u	1130	10.0	110
Co	50.0u	50.0u	50.0u	50.0u	50.0u	50.0u
Cu	70.0	[20.0]	30.0	40.0	40.0	[20.0]
Fe	5820*	7900*	4220*	3000*	11100*	4780*
Pb	1.0u	[1.7]W	1.0u	[2.8]W	17.1	1.0u
Mg	[3040]	[3930]	[3020]	9910	11300	7330
Mn	400*	70.0*	30.0*	1200*	160*	200*
Hg	0.2u	0.2u	0.2u	0.2u	0.2u	0.2u
Ni	40.0u	40.0u	50.0	40.0u	40.0u	40.0u
K	[2100]	[4900]	[2000]	[3700]	[3400]	[1900]
Se	1.0u	1.1u	1.0u	1.0u	1.0u	1.0u
Ag	10.0u	10.0u	10.0u	10.0u	10.0u	10.0u
Na	[3000]	[4000]	[2000]	42000	12000	11000
Tl	1.0u	1.0u	1.0u	1.0u	1.0u	1.0u
V	3.0u	[6.6]	3.0u	[3.0]	[8.3]W	3.0uW
Zn	70.0	70.0	40.0	90.0	30.0	20.0
	As mg/L					
**Hexavalent Chromium	0.04	<0.01	0.07	1.3	<0.01	0.06

Cmpd.	-07	-08	-09	-10	-07B
Al	110	3400	1500	200u	200u
Sb	5.0u	[5.4]	5.0u	5.0u	5.0u
As	[2.1]	2.0u	[2.4]	2.0u	2.0u
Ba	100u	100u	[110]	100u	100u
Be	4.0u	4.0u	4.0u	4.0u	4.0u
Cd	5.0uN	5.0uN	9.0N	5.0uN	5.0uN
Ca	59000	52000	39000	39000	45000
Cr	5600	190	10.0u	30.0	10.0u
Co	50.0u	50.0u	50.0u	50.0u	50.0u
Cu	[10.0]	[10.0]	10.0u	10.0u	10.0u
Fe	2140*	4210*	1620*	260*	[50.0]*
Pb	9.5	[3.1]	14.0S	5.3	1.0u
Mg	9460	[4650]	11000	11000	[100]
Mn	60.0*	50.0*	160*	60.0*	[10.0]*
Hg	0.2u	0.2u	0.2u	0.2u	0.2u
Ni	40.0u	40.0u	40.0u	40.0u	40.0u
K	[1700]	[2200]	[4900]	[4700]	[100]
Se	1.0uW	1.0uW	1.0u	1.0u	1.0u
Ag	10.0u	10.0u	10.0u	10.0u	10.0u
Na	11000	11000	44000	43000	2000u
Tl	1.0u	1.0u	1.0u	1.0u	1.0u
V	3.0u	3.0u	[6.7]	3.0u	3.0u
Zn	20.0u	50.0	20.0	20.0	30.0
**Hex. Chromium	5.4	0.10	0.13	0.03	

**The Hexavalent Chromium results were supplied. No data validation information was enclosed. Reviewer could not validate the analyses.

R+D Specialties

Sample Compliance

Sample Number	Matrix	VOA	BNA	Pest/PCB	CN	Total Phenols	Metals	
SDG#0320-828062 -01	Soil	ok	NR	NR	NR	NR	No*	
-02		ok					NO	
-03		ok					NO	
-04		OK					NO	
-05		ok					NO	
-06		OK					NO	
-07	↓	OK					NO	
DG#0322-828062 -01	water	OK					No	Hexavalent Chromium**
-02	"	OK					NO	
-03	Ground water	OK					No	No
-04	"	OK					NO	NO
-05	"	OK					NO	NO
-06	"	OK					NO	NO
-07	"	OK					NO	NO
-08	"	OK					NO	NO
-09	Surface water	OK					NO	NO
-10	"	OK	↓	↓	↓	↓	NO	NO

* Needs CRDL STD for AA Form# (PART 2) to be compliant

** No raw data or Chain of Custody information supplied.

APPENDIX E

REFERENCES

APPENDIX E - REFERENCES

ATSDR, 1987. Draft Toxicological Profile for Chromium. Agency for Toxic Substances and Disease Registry, Oak Ridge National Lab.

Blasland & Bouck Engineers, P.C., 1988. Remedial Investigation/Feasibility Study Work Plan. R.D. Specialties, Inc., Webster, Monroe County, New York. September 1988.

Bodek, I., J.W. Lyman, W.F. Reehl, and D.H. Rosenblatt, ed., 1988. Environmental Inorganic Chemistry: Properties, Processes, and Estimation Methods. Pergamon Press, Elmsford, N.Y.

Casarett, L.J. and J. Doull, 1986. Toxicology: The Basic Science of Poisons, 3rd Ed., MacMillan Publishing Co., New York, NY.

Cohen, S.R. and R.S. Kramkowski, 1973. Health Hazard Evaluation Determination, Report No. 72-118-104. Cincinnati, OH: U.S. Department of Health, Education, and Welfare, NIOSH. Div. of Technical Services, Hazard Evaluation Services Branch.

Cohen, S.R., D.M. Davis, R.S. Kramkowski, 1974. Clinical Manifestations of Chromic Acid Toxicity. Nasal Lesions in Electroplate Workers. Cutis; 13:558-568.

Cotton, R.A. and G. Wilkinson, 1972. Advanced Inorganic Chemistry, 3rd Ed., Interscience Publishers, Div. John Wiley and Sons, W.Y.

Diaz-Mayans, J., R. Laborda, A. Nunez, 1986. Hexavalent Chromium Effects on Motor Activity and Some Metabolic Aspects of Wistar Albino Rats. Comp. Biochem. Physiol.; 83(1):191-5.

EPA, 1979. Environmental Protection Agency. Water-Related Environmental Fate of 129 Priority Pollutants. Vol. I - Introduction, Technical Background, Metals and Inorganics, Pesticides, and Polychlorinated Biphenyls. EPA-440/4-79-029a.

EPA, 1984. Environmental Protection Agency. Health Assessment Document for Chromium. Research Triangle Park, N.C. Environmental Assessment and Criteria Office. EPA/600/8-83-014F.

EPA, 1986. Environmental Protection Agency. Quality Criteria for Water. Office of Water Regulations and Standards. Washington, D.C. EPA/440/5-86-001.

EPA, 1986a. Environmental Protection Agency. Superfund Public Health Evaluation Manual. Office of Emergency and Remedial Response. Washington, D.C.: EPA-540/1-86-060.

EPA, 1987. Environmental Protection Agency. Summary Review of the Health Effects Associated with Copper. Environmental Criteria and Assessment Office. Cincinnati, OH. EPA-600/8-87-001.

EPA, 1988. Environmental Protection Agency. Superfund Exposure Assessment Manual. OSWER Directive 9285.5-1. EPA/540/1-88-001. Pre-Publication Draft. April 1988.

EPA, 1988a. Environmental Protection Agency. Update on Toxicity Data for Risk Characterization. Superfund Public Health Evaluation Manual. Washington, D.C. Office of Emergency and Remedial Response. EPA/540/1-86-060. October 1988.

EPA, 1989. Environmental Protection Agency. Proposed Requirements for 38 Inorganic and Organic Drinking Water Contaminants. Office of Drinking Water. Washington, D.C.

Gas Research Institute (GRI), 1988. Management of Manufactured Gas Plant Sites. Volume III. Risk Assessment. Prepared by Atlantic Environmental Services for GRI, Chicago, IL.

Hawley, J.D., 1985. Assessment of Health Risks from Exposure to Contaminated Soil. Risk Analysis 5(4):289-302.

IARC, 1980. International Agency for Research on Cancer. IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: Vol. 23. Some Metals and Metallic Compounds, Lyons, France: IARC, WHO; p. 205-323.

Kaaber, K., N.K. Veien, 1977. Significance of Chromate Ingestion in Patients Allergic to Chromate. Act Dermato-Venereologica; 57:321-323.

McKee, J.E. and H.E. Wolf, 1963. Water Quality Criteria. Resources Agency of California, State Water Resources Control Board, Pub. No. 3-A.

NAS, 1974. National Academy of Sciences. Medical and Biological Effects of Environmental Pollutants: Chromium. Washington, D.C.: National Academy Press.

NYSDEC, 1986. New York State Department of Environmental Conservation. Water Quality Regulations: Surface Water and Ground Water Classifications and Standards. NYS Codes, Rules, and Regulations, Title 6, Chapter X, Parts 700-705.

Schroeder, D.C. and G.F. Lee, 1975. Potential Transformations of Chromium in Natural Waters. Water Air Soil Pollut., 4:335-65.

Sittig, M., 1985. <u>Handbook of Toxic and Hazardous Chemicals and Carcinogens</u>, 2nd Ed., Noyes Publications, Park Ridge, NJ.