Frontier Hard Chrome Remedial Action Report

Work Assignment Number: 153-RARA-1027

EPA Contract: 68-W7-0026

December 2003

EPA Region V

RAC

Response Action Contract

Weston Solutions, Inc. · 190 Queen Anne Avenue North · Seattle, WA 98109-4926

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REMEDIAL ACTION REPORT
FRONTIER HARD CHROME SUPERFUND SITE
VANCOUVER, WASHINGTON

EPA CERCLIS ID NUMBER: WAD053614988

Prepared for

U.S. Environmental Protection Agency
Region X
1200 Sixth Avenue
Seattle, WA 98101

Contract No. 68-W7-0026
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Prepared by

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TABLE OF CONTENTS

TABLE OF CONTENTS (*Continued*)

LIST OF FIGURES

SECTION 1

INTRODUCTION

1.1 GENERAL

The Remedial Action for Frontier Hard Chrome (FHC) was completed on 10 September 2003 and the final inspection was performed on 18 September 2003. This report provides site-specific information and a summary of the remedial action activities completed.

1.2 SITE NAME, LOCATION, AND DESCRIPTION

The Frontier Hard Chrome Superfund Site is located in the southwestern part of the State of Washington, in the City of Vancouver, Washington. The address of the site is 113 Y Street, Vancouver, Washington. The FHC site is in an industrial area of the city directly across the Columbia River from the city of Portland, Oregon (see Figure 1). The area is generally flat, extending south, east, and west. About one quarter mile to the north, a ridge rises steeply to where a large residential area begins. The site is approximately one-half mile north of the Columbia River and covers about one-half acre.

1.3 ENVIRONMENTAL SETTING

1.3.1 General

The FHC site is located in the northern part of the Portland Basin, a sediment-filled structural basin located in northwestern Oregon and southwestern Washington. Older Eocene to Miocene volcanic and sedimentary rocks underlie the basin. The basin is filled with consolidated and unconsolidated non-marine sedimentary rocks containing important water-bearing units.

Five geologic units underlie the FHC site. The youngest unit—the fill unit—consists of hydraulic fill and construction debris placed prior to development of the site. The fill unit was placed on fine-grained Holocene alluvium underlain by glacial flood deposits of the Pleistocene age. The Pleistocene flood deposits blanketed an ancient floodplain and several abandoned channels of the Columbia River, which were incised into the underlying Troutdale Formation. The sedimentary rocks of the Troutdale Formation in turn overlie a series of basalt flows that are part of the Columbia River basalt group. Approximately 1,600 feet of sediments overlie the Columbia River basalts in the vicinity of the FHC site.

1.3.2 Fill Unit

Before its development, the site was part of a gently undulating, swampy, alluvial floodplain terrace along the Columbia River. This surface has been modified by grading and the placement of up to 20 feet of fill for local industrial developments. Fill materials consist of both hydraulic fill (silt and sand) and construction fill. During the 1940s, hydraulic fill was used to level a

swampy area between Pearson Air Park and Grove Street. The hydraulic fill materials consist of generally fine-grained sand, with silty sand near the surface and sand at depth. Construction fill was also placed at portions of the site beginning in the 1960s. The construction fill consists of concrete debris, asphaltic debris, red bricks, metal (iron chips), silt, sand, gravel, and minor quantities of clay. The construction debris fill is characteristically heterogeneous and poorly compacted. Approximately 12 to 20 feet of fill is present in the area of the FHC site.

1.3.3 Alluvial Unit

Underlying the fill unit is the alluvial unit, which consists of a thin, clayey silt subunit and a sand-and-gravel subunit. The clayey silt unit displays a heterogeneous character ranging from silt to clayey silt to silty clay, with a variety of color ranging from reddish brown to dark bluish gray, and textures varying both laterally and vertically. Locally, the unit is rich with organic root fragments and displays shades of green to black. The unit typically appears massive in character; however, it is locally mottled and interbedded with a thin lamination of fine sand and silt. The unit is typically 3 to 7 feet thick, but thins to the north and is absent along the northern margin of the floodplain.

Underlying the clayey silt unit of the alluvial unit is the sand-and-gravel unit. This subunit generally consists of poorly sorted sandy gravels, silty sandy gravels, and sandy silts. These sands and gravels are predominantly basaltic in composition with lesser amounts of quartz, metamorphics, and silicic volcanics. The fine-grained fraction consists primarily of brown to gray silt with minor amounts of clay. The sand and gravels are typically subrounded to rounded. Particle grain size ranges up to 8 inches in diameter; however, scattered larger cobbles are present.

In general, three lithofacies are present within this alluvial subunit: (1) poorly sorted deposits of silty sandy gravel to silty gravelly sand, (2) moderate to well-sorted deposits of coarse sandy gravel to gravelly sand, and (3) very dense deposits of sandy silt to silty sand. These three types of deposits display variation in particle size distribution and degree of sorting and, in general, are interbedded and discontinuous.

The deposits of silty sandy gravel to silty gravelly sand are interpreted to result from overbank deposition during major Columbia River flooding, when the river is carrying a large sediment load and little to no particle sorting occurs. These deposits are characterized by a high silt content, are generally dense, and appear well compacted.

The deposits of coarse sandy gravel to gravelly sand are interpreted to result from channel deposition that resulted in a higher degree of particle sorting than the associated overbank deposits. These deposits are characterized by a lower silt content and increased permeability.

In the general site area, a 1-to-5-foot-thick, semicontinous layer of very dense sandy silt to silty sand with lesser amounts of clay and gravel is present at approximately -3 to -7.5 (MSL). This layer is separate from, and lies below the clayey silt subunit which separates the fill unit from the Alluvial unit. This fine-grained unit was characterized by a high resistance to drilling and sampler penetration, with little to no groundwater inflow into boreholes during drilling.

Although this layer may be a local semiconfining unit, the evidence suggests that this unit is not a significant hydraulic barrier within the alluvial aquifer.

1.3.4 Hydrogeology

Shallow groundwater in the FHC area occurs within a heterogeneous alluvial unit that is hydraulically connected to the Columbia River. In general, the alluvial unit exhibits both semiconfined and confined aquifer characteristics. This semiconfined condition is due, in part, to a low-permeability clayey silt subunit that directly overlies the alluvial aquifer and to permeability contrasts within the alluvial aquifer.

The site hydrogeology consists of (1) 15 to 20 feet of fill and silty sand that is largely unsaturated (fill unit), (2) a 3-to-7-foot-thick, upper, discontinuous layer of clayey silt, and (3) a heterogeneous anisotropic alluvial aquifer system that may be as thick as 70 feet beneath the site (Alluvial unit). Localized zones of perched groundwater are present within the fill materials above the top of the clayey silt. Figure 2 illustrates the general hydrostratigraphy inferred to be locally present in the FHC site area.

The uppermost hydrogeologic unit consists of perched groundwater in the fill unit. The fill unit is generally unsaturated, but locally perched water is present. The dry well used by FHC to discharge chromium-containing wastewater was open at the base of the fill unit. Groundwater in the perched aquifer is generally recharged from precipitation by direct infiltration and by stormwater dry wells and roof drains. Separating the fill unit from the alluvial unit is the 3-to-7 foot-thick, discontinuous, fine-grained unit.

Underlying the clayey silt unit is the alluvial aquifer. The alluvial aquifer is a sand-and-gravel layer beginning 15 to 20 feet below ground surface (bgs). The upper portion of the alluvial unit was subdivided in the RI into two water-bearing zones based on the presence of a discontinuous silty sand or sandy silt zone at a depth of 25 to 35 feet bgs. The upper zone has been referred to as the A-zone or A-aquifer, and the lower zone has been designated as the B-zone or B-aquifer. The silt zone, when present, varies from 1 to 3 feet in thickness and appears to be discontinuous.

The groundwater potentiometric surface generally slopes very shallowly to the south in the vicinity of the FHC sit. Recharge to the alluvial aquifer system occurs north of the site along the northern margin of the floodplain from another hydraulically connected alluvial aquifer. In addition, recharge also occurs from direct infiltration of precipitation. Groundwater discharges to the Columbia River. Seasonal fluctuations in the river stage exert a strong influence on water levels and the hydraulic gradients within the alluvial aquifer system.

1.4 OPERATIONAL HISTORY

The site has been primarily occupied by two businesses, both engaged in the chrome plating business. Pioneer Plating operated at the site from 1958 to 1970. The site was then occupied by FHC until 1983. The property has been leased to various other businesses since 1983. Most recently, a portion of the facility was being used as a metal fabrication shop.

1.5 WASTE MANAGEMENT PRACTICES AND ENFORCEMENT

During the operation of Pioneer and the initial operation of FHC, chromium plating wastes were discharged to the sanitary sewer system. In 1975, the City of Vancouver determined that chromium in the wastewater from FHC was upsetting the operation of its new secondary treatment system. FHC was directed by the city and the Washington State Department of Ecology (Ecology) to cease discharge to the sewer system until an appropriate wastewater treatment system could be installed to remove the chromium at the site.

In 1976, Ecology gave the FHC facility a wastewater disposal permit for discharge of chromium-contaminate wastewater to an on-site dry well. The permit also contained a schedule for the installation of an appropriate treatment system for the FHC wastewater stream. Between 1976 and 1981, several extensions of the permit and schedule were granted, as the deadlines were passed without compliance.

In 1982, Ecology found FHC in violation of the Washington State Dangerous Waste Act for the illegal disposal of hazardous wastes. Ecology also discovered that an industrial supply well about one quarter mile southwest of FHC was contaminated with chromium at more than twice the federal drinking water standard (50 µg/L). FHC's wastewater permit was again modified with a new compliance date. FHC again did not comply with the permit requirements for economic reasons, and in December 1982, the site was proposed for inclusion on the National Priorities List under CERCLA (Superfund). The listing was finalized in September 1983.

In 1983, Ecology ordered FHC to stop discharge of chromium plating wastes to the dry well. FHC was also required to prepare a plan for the investigation of the groundwater. At that time, FHC closed down all operations at the site. The company did not undertake the investigation.

In March 1983, EPA and Ecology signed a Cooperative Agreement which gave Ecology the lead for investigation of the FHC site under Superfund. Ecology began the investigation in the fall of 1984.

1.6 SITE INVESTIGATION RESULTS

Releases from FHC operations contaminated groundwater with chromium concentrations as high as 300,000 µg/L. At the time the contamination was first detected in 1982, a groundwater plume exceeding federal drinking water standards extended approximately 1600 feet southwest from the facility. Groundwater monitoring since initial discovery has shown that the plume has receded. Monitoring in 2000 indicated that the plume exceeding state groundwater cleanup standards extends approximately 1000 feet south of the site.

Total chromium concentrations were detected in surface soil (collected during the RI) as high as 5,200 mg/kg while recent surface soil samples revealed concentrations of hexavalent chromium near the FHC building as high as 42 mg/kg. Subsurface concentrations for total and hexavalent chromium have been noted as high as 31,800 mg/kg and 7,506 mg/kg, respectively. Contaminated subsurface soil extended beneath the neighboring Richardson Metal Works Building.

1.7 PREVIOUS REMOVAL ACTIONS

Ecology completed a removal action in 1994 to reduce the threat of direct exposure and further impacts to groundwater from the most heavily contaminated surface soil. This action consisted of excavation of surface soil with chromium concentrations exceeding 210 mg/kg from the eastern most portion of the site. The area of excavation was subsequently backfilled with clean material and has been developed. Development consisted of construction of a commercial office building and adjacent parking.

1.8 OPERABLE UNITS

There are two operable units at this site; soil and groundwater. This remedial action report applies to both operable units.

SECTION 2

SITE BACKGROUND

2.1 LAND USE

Land use in the FHC area is primarily industrial, with some manufacturing and commercial uses. Land ownership in the area is predominantly private, with the exception of Pearson Air Park, which is publicly owned. The site and surrounding properties are zoned "ML" by the City of Vancouver, allowing light industrial use. While residential development south of the site along the Columbia river is occurring, projected land use at the site and in the immediate vicinity is expected to remain light industrial. Light industrial land use is the basis for which the remediation objectives, cleanup goals and remedial action were determined.

2.2 OBJECTIVES

EPA established the following objectives for contaminated groundwater at the site:

- Restore all hexavalent chromium-contaminated groundwater to groundwater cleanup standards (MTCA Method A standards)
- Prevent ingestion of hexavalent chromium-contaminated groundwater above state groundwater cleanup standards (MTCA Method A standards)
- Prevent chromium-contaminated groundwater from seeping into the Columbia River above chronic state standards for the protection of fresh water aquatic organisms

EPA established the following Remedial Action Objectives (RAOs) for contaminated soil at the site:

- Prevent hexavalent chromium in soil from serving as an uncontrolled, ongoing source of contamination to groundwater
- Prevent current and future exposure to soil contaminated with chromium above state standards for unrestricted future use

2.3 RECORD OF DECISION AND AMENDMENTS

EPA issued separate Record of Decisions (RODs) for the soil/source control operable unit (December 1987) and the groundwater operable unit (July 1988). The December 1987 ROD called for removal, stabilization and replacement of 7,400 cubic yards of soil—or all soil with concentrations greater than 550 mg/kg total chromium (this number was based on a site specific leachate test for protection of groundwater). The July 1988 ROD called for extraction of groundwater from the area of greatest contamination (levels of chromium in excess of 50,000 µg/L) via extraction wells, and treatment of extracted groundwater.

Evaluation of the soil remedy by EPA after the ROD was issued revealed that the chosen stabilization method was ineffective at preventing the leaching of hexavalent chromium from site soil. Groundwater monitoring conducted after the ROD was issued indicated that the contaminated groundwater plume was decreasing in size as down-gradient industrial supply wells located at FMC were taken off line. Because new, cost-effective technologies were becoming available that provided the potential for more effective groundwater remediation, EPA reevaluated the need for pump-and-treat as the most appropriate solution for groundwater cleanup.

Since the original RODs were issued, EPA continued to monitor groundwater and soil, and evaluate new, innovative cleanup technologies to address the persistently high concentrations in soil and groundwater at the FHC site. In May 2000, EPA finalized a Focused Feasibility Study (FS) which identified and evaluated several new and innovative technologies for addressing the problems at the site. One of the promising new in-situ treatment technologies identified in the Focused FS, In-Situ Redox Manipulation, or ISRM, was further evaluated in a bench scale test in February 2001. The results of the bench scale test indicated that the technology would be appropriate for use at the FHC site.

In June 2001, EPA issued a Proposed Plan for cleanup of both soil and groundwater at the site. The Proposed Plan identified in-situ treatment using reducing compounds as EPA's Preferred Alternative. The public comment period for the Proposed Plan ended on 25 July 2001. An amended ROD was issued in August 2001.

2.4 ROD REQUIREMENTS

Cleanup levels specified in the ROD amendment are provided in Table 2-1.

Table 2-1—Summary of Cleanup Levels

Medium	Chemicals of Concern	Cleanup Levels	Source of Cleanup Level
Groundwater	Total Chromium	50 µg/L 10.5 µg/L	MTCA A State Chronic Surface Water Criteria
Soil	Hexavalent Chromium Trivalent Chromium	19 mg/kg 80,000 mg/kg	MTCA A MTCA B

MTCA A = Model Toxics Control Act, Method A is set by the Washington State of Department of Ecology. Values are set for unrestricted future use. A value of 100 µg/L may be used if the chromium in groundwater is trivalent chromium.

MTCA A for hexavalent chromium in soil is established for the protection of groundwater. Values are set for unrestricted future use

MTCA B for hexavalent chromium in soil is established for human health protection through direct contact. The value of 400 mg/kg is determined not to be protective of groundwater at the site. Therefore, the MTCA A hexavalent chromium value of 19 mg/kg will serve as the cleanup level for cleanup.

MTCA B for trivalent chromium is established for human health protection through direct contact. EPA will demonstrate that this value is also protective of groundwater through historical data evaluation, modeling, and/or future monitoring (see Section 10 below for further discussion).

To meet the above cleanup goals, the ROD specified the following remedy:

- *Contain Highly-Contaminated Groundwater:* Containment of the most heavily contaminated groundwater at the site, or groundwater hot spot, will involve the delivery, through injection or augering/injection, of reducing compounds on the down-gradient side

of the soil source area, into the groundwater and soil. The compounds delivered to the area will reduce the naturally occurring iron, thereby creating an in-situ treatment barrier which reacts directly with the hexavalent chromium in groundwater. As chromium-contaminated groundwater moving down-gradient passes through the permeable reactive zone, the hexavalent chromium in the groundwater is reduced to trivalent chromium, which is insoluble, and non-mobile.

- *In-Situ Treatment of Source Area Soil and Groundwater Hot Spot:* In-situ treatment of the soil source area and the groundwater hot spot will involve the delivery of reducing compounds directly to site soil exceeding 19 mg/kg hexavalent chromium (soil source area) and contaminated groundwater with concentrations of hexavalent chromium exceeding 5,000 µg/L by augering/injecting or through injection wells.
- Once the source area for soil (exceeding 19 mg/kg hexavalent chromium) and groundwater (exceeding 5,000 µg/L hexavalent chromium) have been treated, remaining groundwater exceeding the state groundwater cleanup standard of 50 µg/L (MTCA Method A, total chromium) is expected to disperse and dilute. Regular monitoring of down-gradient groundwater to ensure dilution and dispersion of affected groundwater outside of the source area would be conducted until all remaining groundwater meets state standards for groundwater cleanup.
- Institutional controls and monitoring will be implemented to protect human health and the environment during the time required for dispersion and dilution to reduce chromium concentrations in plume areas outside of the hot spot. Monitoring of existing wells will also be needed to track the concentrations in groundwater over time.

2.5 DESIGN

The remedial design was completed as 3 different design phases to allow the construction to proceed sequentially to meet a tight project schedule.

Building demolition was the first design to be completed. Field utility surveys, building surveys and ground penetrating radar surveys were completed to support design. This design started in April 2002 and was completed in August 2002.

Installation of the Insitu Redox Manipulation (ISRM) Treatment Wall was the second design to be completed. Completion of this design required that bench and pilot scale tests be completed to determine critical design parameters such as reductant quantities and radius of treatment (PNNL 2002a). The bench and pilot scale tests were started in May 2002 and were completed in October 2002 (PNNL 2002b). The pilot scale test involved installation of an injection well and surrounding monitoring wells, completion of 2 rounds of baseline groundwater monitoring, completion of a tracer test, injection of sodium dithionite, and three rounds of post-injection groundwater monitoring. The ISRM Treatment Wall design was completed in December 2002.

The Source Area Treatment Design was the last design to be completed. This design began in October 2002 and was completed in February 2003. Completion of the Source Area Treatment Design required that a treatability study be performed (Weston 2002a). Weston Solutions, Inc.

solicited the assistance of EPA's Environmental Services Assistance Team (ESAT) to perform the treatability test. Chemical analyses were completed by an EPA Contract Laboratory Program (CLP) lab. The treatability test evaluated 3 different reductants; sodium metabisulfite, ferrous sulfate heptahydrate and HydroBlend® (Weston 2002b). HydroBlend® is a material manufactured by Olin Corporation which consists of a blend of sodium dithionite and ferrous sulfate.

SECTION 3

CONSTRUCTION ACTIVITIES

3.1 BUILDING DEMOLITION (WORK ASSIGNMENT 143-RARA-1027)

3.1.1 Asbestos and Lead Based Paint Survey

The Frontier Hard Chrome Building and the Richardson Metal Works Building were demolished. Prior to demolition, an asbestos and lead based paint survey were completed by Prezant and Associates located in Seattle, Washington.

The Frontier Hard Chrome Building had approximately 2,600 square feet of asbestos containing materials (primarily joint compound). Paint on the FHC Building had no lead based paint (i.e., paint with lead concentrations equal to or greater than 1 mg/cm^2).

The Richardson Metal Works Building had approximately 495 square feet of asbestos containing materials (vinyl sheeting, cement board and roofing paper). Lead based paint was found in very small areas such as on one external door and a wooden door stop.

Results of the lead based paint and asbestos survey can be found in the Final Data Evaluation Report (Weston 2003a).

3.1.2 Phase 1 Building Demolition

Building demolition was performed in two phases by ICONCO located in Seattle, Washington. Prior to demolition, another (the second) utility locate was completed, and all utilities were shutoff and disconnected. Phase 1 demolition consisted of removing the building structures (foundations and floor slabs were left in-place for dust and infiltration control). Numerous concrete samples were taken from the floor and walls of both buildings to determine proper disposal methods for the debris. Samples were analyzed for metals, polychlorinated biphenyls (PCBs) and total petroleum hydrocarbons (TPH). Results of the slab and wall survey can be found in the Final Data Evaluation Report (Weston 2003a).

The Richardson Metal Works Building samples contained no PCBs and very low levels of metals. TPH concentrations were as high as 7,000 mg/kg.

The FHC Building samples contained no PCBs and high concentrations of metals (chromium). Chromium concentrations were as high as 21,000 mg/kg in the flue and 3,700 mg/kg in the floor slab. Toxic Characteristic Leach Procedure (TCLP) analyses were also run for waste characterization purposes. TCLP chromium concentrations ranged as high as 57 mg/L in floor slab samples. High chromium concentrations were primarily in the areas where former underground and aboveground tanks were present. Figure 3 shows the layout of the FHC building floor slab and associated chromium concentrations. TPH concentrations ranged as high as 2,300 mg/kg.

Phase 1 demolition began by demolishing the FHC building. This building consisted of concrete block walls and flat metal and wood roof. Inside the building was a flue used to exhaust gasses from the plating baths. The flue was constructed of concrete block and was heavily stained. Samples collected from the flue were yellow and contained chromium at concentrations of 21,000 mg/kg.

External walls of the FHC building were demolished and removed, leaving the flue which was subsequently demolished. The concrete wall debris (non-hazardous waste) was taken to a Subtitle D landfill operated by Waste Management (Hillsboro, Oregon). Flue debris was a hazardous waste and was taken to the Subtitle C hazardous waste landfill operated by Waste Management in Arlington, Oregon.

The metal sheeting on the steel structure of the Richardson Metal Works Building was removed and sent to Schnitzer Steel for recycling. One small section of the building, constructed of concrete, was demolished and sent to a concrete recycling facility. The steel structure of the Richardson Metal Works Building was dismantled for reuse.

Test pits were also dug in locations where ground penetrating radar detected buried underground objects. A videotape of the test pits was made for Source Area Treatment bidding purposes. Test pits were dug to depths of 15 feet. Pieces of concrete, steel tanks, wire and other miscellaneous debris was found.

3.1.3 Phase 2 Building Demolition

Phase 2 demolition consisted of removing the building foundations, utilities and concrete slabs. This work was scheduled such that it was completed just prior to the beginning of Source Area Treatment.

The FHC building foundation was removed first to check for support piling. Twenty support piling approximately 20-25 feet long were found under the foundations along the east wall and along 30 feet of both the north and south wall. The piling were in groups of 2 or 3 with concrete pile caps. The piling were pulled and one composite sample was collected from each group of 5 piling for a total of 4 samples. Samples were composited along the full length of the piling. The samples were analyzed for the 8 RCRA metals. No metals were found at elevated concentrations except for chromium in one sample. Chromium concentrations were 1.4, 24, 49, and 270 mg/kg. The sample containing 270 mg/kg was analyzed for TCLP chromium; the TCLP chromium concentration was 0.2 mg/kg. None of the piling were determined to be a hazardous waste and were recycled.

During demolition of the FHC building floor, it was discovered that the southern half of the original floor slab had been overlaid with 3 inches of clean concrete. The original floor was heavily stained and had a yellow-green color. Based on the concrete floor samples and color, the majority of the FHC floor and foundation was disposed of as hazardous waste in the Arlington landfill. The remainder of the floor was disposed at the landfill in Hillsboro. Figure 3 shows the sections of floor disposed in each of the two landfills.

Under the floor of the FHC building were 3 concrete tanks. One tank was located in the southeast corner of the building and was approximately 4' in diameter and 5' deep. The two other tanks were found east of the flue; one tank was 4'W x 5'L x 8'D. The other tank was 4'W x 5'L x 3'D. The concrete from all tanks was stained yellow-green. Soil around the flue, and in the southwestern portion of the building, also had a yellow-green color.

The sanitary sewer line running from the FHC Building to the street was noted to have a yellow-green color inside the pipe.

The Richardson Metal Works Building foundations and floor slab were removed after the FHC building floor slab. An old foundation approximately 20 feet long was found slightly inside the footing line and under the floor slab in the northwest corner of the Richardson Metal Works Building. The old foundation was yellow-green in color and had been paved over with asphalt. This concrete floor of the Richardson Metal Works Building had then been constructed over the asphalt. The yellow-green foundation was removed and disposed as hazardous waste. Yellow soil was also present around and under this old foundation.

The Richardson Metal Works foundation and floor slab were removed and sent to a concrete recycler. Two large machine foundations were also removed. One foundation was located in the northwest corner of the building. The other foundation was located in the approximate center of the building. Both foundations were approximately 5'W x 5'D x 15' L.

Outside the east end of the Richardson Metal Works Building was an unknown concrete slab approximately 45' long by 30' wide by 4" thick buried under approximately 6 inches of gravel. This slab was also removed and sent to a concrete recycler. This slab appeared to be an old apron used for storing fabricated metal parts and metal stock. The slab had no unusual staining or color.

Two additional test pits were dug under the building slabs to determine the presence of buried debris. One pit was dug under the west end of the FHC Building and another was dug in the northern middle portion of the Richardson Metal Works Building. No buried debris was found in these pits.

After demolition was complete, the demolition equipment was decontaminated. Demolition personnel and equipment were demobilized.

3.1.4 Demolition Health and Safety

A series of particulate and real time air monitors were set up around the site for dust monitoring and control.

During Phase 1 demolition work, one upwind and two downwind real time and particulate air monitors were set up along the site perimeter fence. The monitors were moved as necessary to keep them downwind of the area where work was being performed. Real time air monitoring was also performed inside the fence in the work zone. Water was used when necessary to control dust. Filter samples from the particulate monitors were sent to an offsite laboratory for metals analysis with a 1 day turnaround.

Dust Time Weighted Average concentrations were well below the 2.5 mg/m^3 action level based on real time dust monitoring. Particulate analysis also indicated that the concentrations of metals in air were well below (orders of magnitude) the site action levels. Based on this information and ICONCO's strict control of dusting, the air monitoring stations were reduced to one upwind and one downwind during Phase 2 demolition. Metal concentrations in air at the site perimeter (calculated from particulate analyses) are summarized in Section 5.

All workers inside the exclusion zone were 40 hour health and safety trained and wore appropriate personnel protection equipment. During the time the flue was demolished, the equipment operator wore a respirator as an additional precautionary measure to control exposure to chromium laden dust.

Exclusion zones and decontamination stations were established and delineated. Daily safety meetings were held.

3.1.5 Building Demolition Unit Quantities

Demolition unit quantities and disposal methods are shown in Table 3-1.

Table 3-1—Demolition Unit Quantities and Disposal Methods

Material	Tonnage	Location	Disposition
Hazardous concrete	339	Waste Management Arlington Oregon	Disposal
Non-hazardous, regulated concrete	353	Waste Management Hillsboro, Oregon	Disposal
Non-hazardous, non-regulated concrete	1160	Porter Yet Portland, Oregon	Recycle
Miscellaneous Non-Hazardous Debris Disposal	134	Materials Recovery Facility Landfill Castle Rock, Washington	Disposal
Metal	21	Schnitzer Steel Portland Oregon	Recycle

3.2 ISRM WALL INSTALLATION (WORK ASSIGNMENT 153-RARA-1027)

3.2.1 Wall Alignment Characterization

The ISRM wall alignment was specified in the ISRM Treatment Wall Design document (Weston 2002c). A series of 7 push-probes were completed along this alignment (using a Geoprobe unit) to determine the elevation of the low and high permeability soil horizons. Groundwater samples were also collected and analyzed for hexavalent chromium to confirm the wall design depth of 35 feet. Figure 4 shows the location of the pilot test wells and characterization push-probes. Figure 5 graphically depicts the soil horizons along the proposed alignment and the groundwater hexavalent chromium concentrations at various depths based on the push-probe data.

After groundwater samples were collected from the push-probe, the push-probes were configured as temporary 2-inch wells. These wells were then subjected to a down-hole borehole flowmeter test to determine the permeability of the various soil horizons.

Upon completion of the borehole testing, the push-probe installed wells were removed and the holes abandoned.

The goeprobe casing became stuck at the location where injection wells RA-IW-4A and 4B were to be installed. These tools had to be abandoned in place.

The wall alignment characterization work was performed by EPA's Environmental Services Assistance Team with support by Pacific Northwest National Laboratory (PNNL). The wall alignment characterization was managed, coordinated, and supervised by Weston Solutions, Inc.

3.2.2 Phase 1 ISRM Well Installation and Injection

Injection wells were installed at 3 locations using a sonic drill rig. The initial set of injection wells installed consisted of RA-IW-2A and 2B, RA-IW-3A and 3B, and RA-IW-4A and 4B. Each injection location consisted of a series of two wells; a shallow well to target the low permeability upper zone which contained the greatest concentrations of hexavalent chromium and a deeper well to target the more permeable deeper portion of the aquifer.

The wells were installed in the exact location of the push-probes with the exception of injection wells RA-IW-4A and 4B. These two wells were installed approximately 1 foot away from where the push-probe tools were abandoned as discussed above.

A series of functional and operational wells, and up- and down-gradient monitoring wells were also installed. Figure 6 provides the locations of the injection wells and the other associated monitoring wells installed during Phase 1 and 2 and reflects wells abandoned during these two phases of work. Appendix A provides information regarding well construction and the well drilling subcontractor responsible for installation. Survey coordinates and well installation logs are also provided in Appendix A.

The six injection wells (RA-IW-2A and 2B, RA-IW-3A and 3B, and RA-IW-4A and 4B) were aggressively developed after installation to obtain the needed injection capacity. After development, the wells were hydraulically tested by injecting water at a flow rate and pressure similar to that required for the reagent injection. All wells behaved as desired except for one pair: RA-IW-4A and –4B. When these injection wells were flow tested in incremental sections along their length, it was determined that water was bypassing the formation and flowing back into the well screen at a different location. It is believed that this bypass was the result of a conduit caused by the adjacent push-probe tools. As a result, these wells were not used during the Phase 1 Injection and were replaced in Phase 2 of the ISRM Treatment Wall installation.

Injection of reagent into the 4 Phase 1 injection wells was completed the end of May 2003 as planned. Injections occurred at wells RA-IW-2A, -2B and RA-IW-3A, -3B. After the appropriate reaction period, extraction occurred to remove the remaining reagent. Extraction began at RA-IW-3A and -3B on 31 May 2003. The extraction occurred over a period of 2 days.

Approximately 45,000 gallons of liquid was extracted from the two wells. Total dissolved solids (TDS) in the extracted liquid were measured. Approximately 15% of the injected reagent was removed based on total dissolved solids measurements. Extraction was performed subsequently on RA-IW-2A and -2B beginning on 5 June 2003. The extraction was pulsed in an effort to recover more of the reagent. This approach resulted in higher concentrations of reagent being extracted initially but reagent concentrations dropped rapidly. The pulsed extraction occurred over a period of 5 days. Approximately 32,400 gallons of liquid was extracted. TDS samples indicated that 5% of the injected reagent was removed.

Low reagent recoveries were not unusual and were due to the high permeability of the aquifer. The low recoveries were discussed with EPA Region X and the decision was made to forego recovery efforts in future Phase 2 injections due to the small quantity of reagent recovered and the high cost associated with the recovery effort.

3.2.3 Phase 2 ISRM Well Installation and Injection

Phase 2 monitoring and injection wells were installed the end of June 2003. Injection wells installed consisted of RA-IW-5A and 5B, RA-IW-6A and 6B, RA-IW-7A and 7B, RA-IW-8A and 8B. Replacement wells RA-IW-4A and 4B were also installed during this time and the original 2 ineffective injection wells were abandoned.

Development and flow testing of the newly installed injection wells was completed. The wells performed as expected; the 2 replacement wells had no leaks or bypass.

Phase 2 injections began on 13 July 2003 and were completed on 10 August 2003. Injections were completed in the 5 pairs of injection wells as well as in the pilot scale injection wells INJ-1 and INJ-2. Figure 7 shows the estimated location of the completed ISRM Treatment Wall.

Wastewater was generated from well development, purging, equipment decontamination and reagent extraction. Approximately 142,300 gallons of wastewater was generated (including 32,400 gallons generated from reagent extraction). This wastewater was treated with sodium metabisulfite to reduce the hexavalent chromium to trivalent chromium. The wastewater was then discharged to the City of Vancouver POTW via a drain line located on the south end of the site along 1st Street. A permit was obtained from the city prior to discharge.

See Appendix B for cost and performance details for ISRM Treatment Wall Installation.

3.3 SOURCE AREA TREATMENT (WORK ASSIGNMENT 153-RARA-1027)

3.3.1 Construction Activities

The Source Area Treatment contract was awarded to Williams Environmental Services (WES), located in Frisco Texas. Three 5,000 gallon poly reagent tanks, pumps, cement batch plant, pumps, soil mixing equipment (SOILMECH R-622 HD Drill Rig), 2 excavators, equipment trailer and office trailer were mobilized and set up within the site boundary. Pre-excavation

began east of the former FHC and Richardson Metal Works buildings to remove buried debris. Significant quantities of debris and metals were removed.

WES planned on using EcoBond reagent manufactured by Metals Treatment Technology (MT^2) located in Wheat Ridge Colorado. Treatability testing was subsequently performed by MT^2. A summary report was prepared by MT^2 and provided to WES recommending the quantity of reagent to be used. EcoBond is a proprietary sulfur-based reagent designed to treat hexavalent chromium and reduce the leachability of other metals.

Field testing was initiated on 20 June 2003 to optimize equipment operation and confirm the reagents effectiveness in treating hexavalent chromium. Difficulties with flow meter operation resulted in addition of more reagent than planned by WES. Soil testing (performed by ESAT) confirmed hexavalent chromium levels in the overtreated area were at non-detectable concentrations. WES made process modifications to add the reagent on a mass basis rather than volumetric basis. Additional testing was performed.

Based on the optimization test and treatability test results, it was decided to use 2 weight percent (wt %) reagent in the low hexavalent chromium concentration (i.e., less than 100 mg/kg) areas, use 3 wt % reagent in areas with hexavalent chromium greater than 100 mg/kg and use 4.5 wt % reagent in the area under the southern half of the former FHC Building where the highest concentrations of hexavalent chromium (in the thousands of mg/kg) were found. The decision to use 4.5 wt % reagent was made after one of the first few locations treated in this area exceeded the cleanup goal of 19 mg/kg hexavalent chromium.

Areas were pre-excavated to a depth of approximately 20 feet to remove buried debris prior to treatment. The excavated soil and debris was screened to remove the debris and reduce the quantity of material requiring landfill disposal. Large debris was broken into smaller pieces using a hoe ram to meet landfill requirements. Debris was placed in piles and sampled to determine disposal requirements. Debris was hauled to Coffin Butte Landfill in Oregon for disposal.

Soil treatment on a production basis began on 25 June 2003 in the low hexavalent chromium concentration area located in the southwest corner of the site. Treatment progressed northward working around an area designated for treatment to 33 feet deep. Once the northern edge of the treatment zone was reached, treatment progressed to the east. A 10 foot diameter auger was used in areas where the treatment depth was 20 feet. WES performed frequent testing to confirm soil treatment criteria were attained. ESAT performed additional confirmatory testing to confirm WES results.

Due to difficulty attaining the 25 foot treatment depth on the eastern edge of the site, the 10 foot diameter auger was reduced to 6 feet in diameter. This reduction in size allowed the auger to attain the 25 foot depth required. The eastern portion of the site was treated to 25 feet deep.

An untreated area approximately 60 feet wide by 100 feet long in the center of the site was sampled by ESAT on 11 and 12 August 2003 to confirm the depth of treatment necessary to treat impacted groundwater. It was scheduled near the end of the job due to the possibility of requiring treatment to a depth of 33 feet. ESAT collected four samples from a depth of 25 feet

and 6 samples from a depth of 30 feet and analyzed them for hexavalent chromium. All samples were below the treatment criteria of 5,000 µg/l. The groundwater elevation in this area at the time of sampling was approximately 20 feet.

Work then progressed to this center area. The area was treated to a depth of 20 feet. Treatment was completed on 26 August 2003. Surface treatment along the roadway was begun and completed on 29 August 2003. The surface treatment consisted of adding EcoBond (a sulfur based reducing reagent manufactured by Metals Treatment Technology) to the soil and mixing it to a depth of 2.5 feet using a backhoe. A shallow watermain was present in the area of surface treatment. EcoBond was applied to the surface of the soil and allowed to soak into the soil. This method of treatment near the watermain was used to avoid rupturing the line.

Throughout the treatment phase, fluff soil was stockpiled onsite and sampled. Sample results were used to determine the appropriate disposal method. Treated fluff soil was hauled to Coffin Butte Landfill in Oregon for disposal.

Overall, 53 soil and 20 groundwater confirmation samples (includes duplicates) were collected from within the treatment zone. At the end of the site work, 28 surface soil samples (26 samples plus two duplicates) were also collected along the perimeter of the exclusion zone and along both sides of Y Street and 1st Street. These samples were collected to ensure no contaminated soil was tracked offsite that could pose a human health risk. Analytical results for samples collected within the treatment zone as well as offsite are summarized in Section 5.

See Appendix B for cost and performance details for treatment of the source area.

3.3.2 Source Area Treatment Health and Safety

Similar to demolition activities, a series of particulate and real time air monitors were set up around the site for dust control.

One upwind and two downwind real time and air particulate monitors were set up along the site perimeter fence. The monitors were moved as necessary to keep them downwind of the area where work was being performed. Real time air monitoring was also performed inside the fence in the work zone. Water was used when necessary to control dust.

Filter samples from the particulate monitors were sent to an offsite laboratory for metals analysis with a 1 day turnaround. Initially, 2 sets of 3 samples were collected per week and sent to the laboratory for analysis. After approximately 30 air samples had been collected with no detectable metals concentrations in air, the sampling frequency was reduced to one set of 3 samples per week. Real time dust monitoring was performed daily. An increase in the dust concentrations would trigger an increase in the collection of particulate samples for analysis. However, because of the wet nature of the soil treatment work, dust levels remained low and particulate sampling remained on a one set per week basis.

Time Weighted Average (TWA) dust concentrations were well below the 2.5 mg/m^3 action level based on real time dust monitoring. Metals concentrations in air at the site perimeter (calculated from particulate analyses) are summarized in Section 5.

All workers inside the exclusion zone were 40 hour health and safety trained and wore appropriate personnel protection equipment. WES workers wore tyvek coveralls, gloves and liquid proof boots.

3.3.3 Source Area Treatment Unit Quantities

Source Area Treatment unit quantities and disposal methods are shown in Table 3-2.

Table 3-2—Source Area Treatment Unit Quantities and Disposal Methods

Material	Quantity	Location	Disposition
Treated Soil	20,962 Cubic Yard (CY)	Not Applicable	Not Applicable
Non-hazardous, regulated concrete	1,190 Tons	Coffin Butte Landfill Corvallis, Oregon	Disposal
Hazardous concrete	7.7 Tons	Waste Management Arlington, Oregon	Disposal
Fluff soil	7,138 Tons 383 Tons	Coffin Butte Landfill Corvallis, Oregon Waste Management Landfill Hillsboro, Oregon	Disposal

SECTION 4

CHRONOLOGY OF EVENTS

A chronology of events associated with the Frontier Hard Chrome Site is provided below.

Date	Event
December 1987	Soil Record of Decision
July 1988	Groundwater Record of Decision
1990 to 1999	Groundwater monitoring performed
7 July 2000	Final Focused Feasibility Study completed
30 August 2001	Record of Decision Amendment signed
3 October 2001	EPA issues Remedial Design Scope of Work
May-October 2002	Began and completed ISRM Pilot Scale Test
12 August 2002	Demolition design completed
25 October 2002	Source Area Treatability Test completed
11 December 2002	ISRM Wall design completed
10 February 2003	Source Area Treatment design completed
19 November 2002	Characterized building materials for disposal
29 Jan-7 Feb 2003	Began and completed Phase 1 building demolition
5-26 March 2003	Performed ISRM Treatment Wall alignment characterization
21 April-2 May 2003	Installed Phase 1 ISRM injection wells
5-14 May 2003	Began and completed Phase 2 building demolition
27 May-8 June 2003	Began and completed Phase 1 ISRM Treatment Wall installation
9 June 2003	Source Area Treatment subcontractor mobilized equipment to site
17-25 June 2003	Began debris excavation for full scale soil treatment. Completed optimization testing
24 June-2 July 2003	Completed installation of Phase 2 monitoring and ISRM injection wells
25 June 2003	Began full scale Source Area Treatment
9 July-10 August 2003	Began and completed Phase 2 ISRM Treatment Wall installation
28 July-1 August 2003	Began and completed hauling and disposal of excavated source area debris
12 August-8 September	Began and completed hauling fluff soil
29 August 2003	Completed Source Area Treatment
10 September 2003	Completed final site grading. All site construction work completed. Demobilized construction equipment from site. Held pre-final inspection
18 September 2003	EPA completed final inspection

SECTION 5

PERFORMANCE STANDARDS AND CONSTRUCTION QUALITY CONTROL

5.1 CONSTRUCTION QUALITY CONTROL PLAN

A Construction Quality Control Plan (CQAP) was developed for the Remedial Action (Weston 2003b). Construction quality control requirements for Building Demolition, ISRM Treatment Wall Installation, and Source Area Treatment are provided in the CQAP.

5.2 BUILDING DEMOLITION

Frontier Hard Chrome and Richardson Metal Works Building materials were characterized for hazardous materials prior to demolition. A lead based paint and asbestos survey was completed by a company certified to perform both surveys.

Concrete floor samples were collected from both buildings and analyzed for TPH, PCBs, and metals (totals and TCLP). TPH was analyzed using Method NWTPH-Dx. PCBs were analyzed using EPA Method 8082. Metals were analyzed using Method 6010B/7471A.

The Frontier Hard Chrome Building had approximately 6,800 square feet of floor slab. Twenty-one (21) samples were collected from the floor slab to characterize it for disposal. The Richardson Metal Works Building had approximately 10,100 square feet of floor slab. Nine (9) concrete samples were collected for disposal characterization. Floor samples were collected where evidence of contamination was present. TCLP analyses were run where the total metal concentrations could result in the materials having the toxicity characteristic. TCLP lead analyses were also run on the metal siding of the Richardson Metal Works Building that had high lead concentrations. None of the samples exceeded the lead TCLP criteria (5 mg/L).

Based on the sample results, the extent of the hazardous floor slab concrete and other building materials was defined and accepted by the receiving landfills.

Dust was minimized by controlling debris during demolition and using water when needed. Real time dust monitoring was completed; although there were times when the instantaneous dust level exceeded the 2.5 mg/m^3 action level, the time weighted average concentration was well below the action level. The maximum 8 hour time weighted average dust concentration during building demolition was 0.63 mg/m^3.

Particulate air samples were collected and analyzed to ensure dust controls were adequate to control exposure to the surrounding industrial facilities. Thirteen field samples and 2 filter blank samples were analyzed. The exposure limits and concentration ranges are summarized in Table 5-1. Individual sample results are provided in Appendix C.

Table 5-1—Exposure Limits and Concentration Ranges

Analyte	OSHA 8-hr PEL (mg/m^3)	Maximum Site Concentration (mg/m^3)
Arsenic	0.01	0[a]
Beryllium	0.002	0[a]
Cadmium	0.005	0[a]
Chromium (Total)	1	0.00122
Copper	1	0.00045
Lead	0.03	0.00038
Nickel	1	0.00005
Zinc	5	0.00069

a: This constituent was not detected in the air particulate samples.

5.3 ISRM WALL INSTALLATION

Seven pairs of injection wells were installed during ISRM Wall Installation. These wells were installed by Washington State licensed well drillers in accordance with WAC 173-162 *Regulation and Licensing of Well Contractors and Operators.*

Each pair of wells included a deep well (screened from approximately 28 to 33 feet below ground surface) and a shallow well (screened from approximately 23 to 28 feet below ground surface). Each well screen was carefully measured during installation; the screens were installed to within 3-8 inches of their desired location. The horizontal distance between wells was also carefully measured during installation. Each well was installed to within 1 foot of its desired location with 2 exceptions. The seals in one well pair (RA-IW-4A and 4B) failed during testing; the replacement well pair was installed approximately 4 feet south of its design location. Well pair RA-IW-8A and 8B were installed 5 feet west of their desired location due to overhead power lines which interfered with the tower of the sonic drill rig.

Each well pair was injected with 5,700 gallons of sodium dithionite reagent supplied by EnviroChem Technical Services (located in Vancouver, Washington). Each load of reagent underwent an assay (pH, density and temperature) prior to delivery. The reagent was mixed with water prior to injection such that a total of approximately 40,000 gallons were injected into each well pair (the total quantity of diluted reagent varied from well pair to well pair depending on permeation rates). Conductivity and sampling probes were installed in monitoring wells surrounding the injection wells to evaluate the radial penetration of the reagent. The injection and associated monitoring was completed by Pacific Northwest National Laboratory (PNNL), the technology developer. PNNL completed the technical aspects of the ISRM wall installation to ensure quality control and performance requirements were met.

Installation of the ISRM Treatment Wall met performance requirements. Based on monitoring during installation, no significant gaps in the treatment zone are present. The treatment wall is

approximately 240 feet long and greater than 33 feet deep. The treatment zone extends from approximately 22 feet below ground surface to the bottom of the wall. The exact bottom of the treatment zone is not known due to sinking of the reagent but is likely significantly deeper than the 33 foot installation depth.

Recovery of the injected reagent was initially attempted. Recoveries of approximately 5 to 15 percent were achieved. Recovery efforts were abandoned after the first two well pair extractions due to the high cost and little benefit gained.

A pilot scale test of the ISRM technology was completed to determine ISRM Wall design information. Prior to performing the pilot scale test, two rounds of baseline sampling was performed (June 2002) by ESAT in the area where the pilot scale test was to be completed. The 3 wells with the highest groundwater hexavalent chromium content had initial hexavalent chromium concentrations ranging from 2,000 to 4,500 µg/l. After the pilot scale test was completed, an additional 3 rounds of performance sampling was completed. The last sampling round (#5) was completed approximately 2 months (December 2002) after the pilot scale test was performed. Groundwater sampling information can be found in the Final Data Evaluation Report, Appendix E (Weston 2003a).

The post pilot scale test data showed no detectable concentrations of hexavalent chromium in the pilot scale test wells. Similarly during full scale wall installation, a set of monitoring wells (RA-MW-12A, B and C) located between two injection points had hexavalent chromium concentrations as high as 620 µg/l. After injection, sampling determined that hexavalent chromium concentrations in these nearby monitoring wells were non-detectable.

5.4 SOURCE AREA TREATMENT

Treatment of hexavalent chromium in the source area soil and groundwater was completed by using in-situ soil mixing equipment. Treatment areas were located and staked using survey equipment to provide locational accuracy. A drawing was created identifying each circular area and a unique number was given to each area.

Treatment depths varied from 20 to 25 feet below ground surface. The stem of the auger had depths marked in 1 foot increments. Attainment of the desired treatment depth was confirmed by checking the penetration depth using the depth markings. Weston Solutions Inc. continuously checked the work and maintained a daily log of progress. Quality control checks consisted of treatment location, depth and quantity of reagent used. Figure 8 shows the soil column numbers, treatment depth and percent reagent mixed with the soil. Table C-1 in Appendix C provides specific soil treatment quality control information. Overall, approximately 21,000 cubic yards of soil were treated.

Confirmatory soil and groundwater sampling was also performed by ESAT. This sampling was done to confirm treatment requirements were met. Sampling was performed using a Geoprobe push-probe rig. Sampling was performed a minimum of 4 days after treatment occurred to allow equilibrium of subsurface conditions.

ESAT collected a minimum of one soil sample approximately 500 cubic yards of soil treated. Sample depths varied; samples were generally collected at a depth of 1/3 and 2/3 in the treated column. Groundwater samples were also collected; the goal was to collect 1 groundwater sample every 1600 square feet of site surface area. Groundwater samples were to be collected in the middle of the water column. In several areas, groundwater was not present in the area treated. This was likely the result of: 1) the cement added to the treated soil which made the soil less permeable and, 2) the dry summer which lowered the water table.

Overall, the technology performed as required. Fifty-three (forty-five samples and 8 duplicates) soil and 20 (19 samples and 1 duplicate) groundwater confirmation samples were collected from the treated areas (additional samples were also collected during startup optimization testing). The data indicate that the soil treatment goal of 19 mg/kg and groundwater treatment goal of 5,000 µg/L have been met. Only one area had to be retreated due to failure of treatment criteria. Area O19 initially had a hexavalent chromium concentration of 26 mg/kg after treatment; the area was retreated and resampled. Hexavalent chromium in the area after retreatment was not detected. Samples were analyzed using Hach field colorimetric test kits. Duplicate samples were sent to an offsite laboratory for confirmation.

Figure 9 and 10 provides a summary of the soil and groundwater confirmatory sampling performed by ESAT/Weston. Detailed sample analysis information is provided in Tables C-2 and C-3 in Appendix C.

Treated soil samples were also collected and sent to an offsite geotechnical laboratory for compressive strength testing. All samples tested exceeded the 30 pounds per square inch criteria. A summary of the compressive strength testing data is provided in Table 5-2. Detailed compressive strength test data is provided in Table C-4 in Appendix C.

Table 5-2—Compressive Strength Results

Item	Column	Compressive Strength (psi)
Minimum Strength	N18, D10,SS8,	30
Maximum Strength	CC7	230
Median Strength	Not Applicable	70
Average Strength	Not Applicable	80

Excavated debris was placed into piles and sampled to determine disposal requirements. Thirteen samples of the debris were collected (one sample per 100 tons approximate). Total metal concentrations were determined using EPA Method 6010B. The maximum chromium content detected in the samples was 500 mg/kg, however, most samples did not exceed 25 mg/kg chromium. Samples which exceeded 100 mg/kg chromium were also analyzed using TCLP methods (Methods 1311/6010B). Samples analyzed using TCLP methods did not exceed 5 mg/L chromium. Therefore, the excavated debris was disposed as nonhazardous waste. Selected metal analytical results are provided in Table 5-3.

Table 5-3—Debris Analytical Results

Debris Pile Designation	Min-Max Chromium Concentration (mg/kg)	Min-Max Lead Concentration (mg/kg)	Max TCLP Chromium Concentration (mg/L)	Max TCLP Lead Concentration (mg/L)
Pile "A"	96-500	36-74	2.1	NA
Pile "B"	13-130	ND-180	1.2	2.6
Pile "C"	6-9	ND-7	NA	NA
Pile "D"	8-11	ND	NA	NA
Pile "E"	9-24	ND	NA	NA

ND: Not Detected
NA: Not Analyzed

Particulate air samples were collected and analyzed to ensure dust controls were adequate to control exposure to the surrounding industrial facilities. Fifty-seven field samples were collected and analyzed using NIOSH 7300/6010. The exposure limits and actual concentration ranges are summarized in the Table 5-4. Individual sample results are provided in Appendix C.

Table 5-4—Exposure Limits and Concentration Ranges

Analyte	OSHA 8-hr PEL (mg/m^3)	Maximum Site Concentration (mg/m^3)
Arsenic	0.01	0[a]
Beryllium	0.002	0[a]
Cadmium	0.005	0[a]
Chromium (Total)	1	0[a]
Copper	1	0[a]
Lead	0.03	0[a]
Nickel	1	0[a]
Zinc	5	0[a]

a: This constituent was not detected in the air particulate samples.

Samples of the excess fluff soil were collected and analyzed using EPA Method 6010B to determine the concentration of metals for disposal purposes. Nineteen samples were collected and sent to an offsite laboratory for analysis. Approximately one sample of soil per 500 cubic yards was collected. Results were sent to the landfill to obtain disposal permission. A summary of the fluff soil sample data used for disposal purposes is provided in Table 5-5.

Table 5-5—Fluff Soil Metal Analytical Results

Fluff Soil Pile Designation (Characterization Sample #)	Min-Max Total Chromium Concentration (mg/kg)	Min-Max Lead Concentration (mg/kg)	Max TCLP Total Chromium Concentration (mg/L)	Max TCLP Lead Concentration (mg/L)
Pile "1" (FL-001)	1200	210	3.1	2.4
Pile "2" (FL-003)	860	150	ND	ND
Pile "3" (FL-004)	800	170	0.95	4.6
Pile "4" (FL-005, -006, -007)	1200-2200	230-320	ND-0.042	ND
Pile "5" (FL-008, -009)	730-1800	220-260	ND-0.057	ND
Pile "6" (FL-010, -011)	920-1200	270-430	ND-0.048	ND
Pile "7" (FL-012, -013)	740-1100	240-240	0.26-1.5	ND-0.24
Pile "8" (FL-014, -015)	690-800	180-320	ND	ND
Pile "9" (FL-016, -017)	620-720	240-330	0.06-0.10	ND
Pile "10" (FL-018, -019)	750-960	110-120	0.02-0.04	ND
Pile "11" (FL-020)	620	170	0.035	ND

After site construction work was completed, soil samples were collected along the perimeter of the site as well as along Y Street and 1st Street. Figure 11 shows the location of the samples and their chromium concentration. These samples were collected to determine if soil contaminated with chromium had been tracked offsite. Considerable care was taken during site work to prevent offsite areas from becoming contaminated with soil containing chromium. Twenty-eight samples (twenty-six samples and 2 duplicates) were collected. Ten samples were collected along the outside of the exclusion zone and 16 were collected along both sides of Y Street and 1st Street.

Chromium concentrations ranged from 7 mg/kg to 990 mg/kg. With the exception of one sample, all samples were less than 300 mg/kg with most samples containing chromium at concentrations less than 100 mg/kg. All individual soil samples outside the site boundary were less than 2,000 mg/kg total chromium and 19 mg/kg hexavalent chromium, which are the Model Toxic Control Act (MTCA) action levels for unrestricted land use. The upper 95th confident level about the mean of the total soil chromium concentration outside the site boundary (based on 26 samples) is 172 mg/kg; also well below the MTCA threshold of 2,000 mg/kg.

The data indicate that soil outside the work area has not been adversely impacted with chromium.

A summary of analytical results obtained from confirmatory samples collected during Source Area Treatment is shown in Table 5-6.

Table 5-6—Source Area Treatment Confirmatory Sample Data

Matrix	Number of Samples Collected	Cr (VI) Concentration (mg/kg)		Total Cr Concentration (mg/kg)		Total Cr UCL_{95} (mg/kg)
		Minimum	Maximum	Minimum	Maximum	
Treated Soil	67[a]	<5[b]	<5[b]	620[c]	2,200[c]	1,169[c]
Groundwater (pre- and post treatment)	19[d]	<0.8[e]	<0.8[e]	Not Analyzed	Not Analyzed	Not Applicable
Exclusion Area Perimeter Soil	10[d]	<1[b]	<1[b]	46	990	359
Streetside Soil	16[d]	<5[b]	<5[b]	7	210	59

a: Includes 48 subsurface soil samples and 19 fluff soil pile samples. Does not include duplicates.

b: Hexavalent chromium was not detected; the value listed is the detection limit.

c: Based on 19 fluff soil pile samples which originated from the surface of the treated area.

d: Does not include duplicates.

e: Hexavalent chromium was not detected in treated groundwater; the detection limit was 0.8 mg/L. Groundwater in the south central area of the site was tested prior to treatment; its maximum hexavalent chromium concentration was 0.2 mg/L.

A survey of site elevation was performed after the final grading was completed. Final site elevations are shown in Figure 12.

SECTION 6

FINAL INSPECTION AND CERTIFICATIONS

6.1 BUILDING DEMOLITION

The pre-final and final inspection for building demolition was performed on 14 May 2003. Representatives from Weston Solutions, Inc. and ICONCO were present. Weston Solutions Inc. confirmed that all structures had been demolished and that all debris had been removed from the site. Site conditions were inspected to ensure potential runoff was not an issue. Documentation was reviewed.

It was noted that disposal manifests and unit quantity documentation was needed before final payment could be made. The inspections also noted that: 1) the silt fence needed to be repaired/reinstalled, 2) deep holes needed to be filled, 3) plastic needed to be placed over the chromium stained soil, 4) the site needed general cleanup and, 5) miscellaneous garbage needed to be picked up. ICONCO made the necessary corrections and the final inspection was completed. Final project documentation would be received from ICONCO prior to submitting the final invoice. This documentation was received as promised several weeks later.

No deficiencies were noted.

6.2 ISRM WALL INSTALLATION

The pre-final ISRM wall inspection was held on 12 August 2003. Weston's Project Manager and Construction Manager, and EPA's Project Manager attended the pre-final inspection. Each of the wells was inspected and the area where the wells were installed was perused to observe ground surface and general area conditions.

Four items were noted in the inspection: 1) mark the wells with identification tags, 2) fill the area around one pair of the injection wells where the soil has subsided, 3) treat and dispose of approximately 4,500 gallons of wastewater in the onsite storage tank, and 4) clean out the well monuments/clean and paint the monument lids.

The items noted in the pre-final inspection were completed on 19 August 2003. A final inspection was completed and no deficiencies were found.

6.3 SOURCE AREA TREATMENT

A pre-final inspection was performed on 10 September 2003. Weston's Project Manager, Construction Manager and Williams Environmental Services personnel attended. Several punchlist items were noted in the inspection: 1) perform further leveling of the soil in the northeast corner of the site, 2) remove pieces of rebar from the site and dispose, 3) remove

chunks of broken asphalt from the site and dispose, 4) remove miscellaneous minor remaining debris and dispose, 5) decontaminate and remove remaining equipment.

The items noted on the pre-final inspection were completed by 11 September 2003. Weston's Project Manager and EPA's Project Manager held the final inspection on 18 September 2003. No deficiencies were noted during this final inspection.

6.4 HEALTH AND SAFETY

The project was completed in accordance with the project Health and Safety Plan (Weston 2002d). In addition, the Building Demolition subcontractor (ICONCO), the ISRM Wall Installation subcontractor (PNNL) and the Source Area Treatment subcontractor (Williams Environmental Services) each prepared their own health and safety plan to compliment the overall project health and safety plan. Each of the subcontractors had a site health and safety officer responsible for site safety.

Level D personal protection equipment was required for the work. In cases where direct contact with contaminated materials was significant, modified level D was used. Generally, Building Demolition personnel and Source Area Treatment personnel wore modified level D. Respirators were available during building demolition for demolition personnel, however, the level of dust did not require their use.

Daily tailgate safety meetings were held. Weston Solutions Inc.'s health and safety officer monitored the work throughout the day for safety issues. All health and safety requirements were met. Dust levels were controlled throughout the project to well below action levels. Particulate samples were collected along the site boundary to ensure air quality at the perimeter as well as offsite was within human health guidelines. The analytical data from the particulate samples confirmed that perimeter and offsite air quality met OSHA guidelines.

6.5 INSTITUTIONAL CONTROLS

An institutional control plan has been prepared (Weston 2003c). Implementation of this plan is being discussed by EPA Region X, Washington State department of Ecology and the Clark County Health Department. The plan is in the process of being implemented.

SECTION 7

MONITORING REQUIREMENTS

The remedy selected for this site was in-situ treatment. The remedy is a passive remedy. No operation or maintenance is required.

The ISRM wall has been installed with a series of monitoring wells. These wells will be sampled twice after the remedial action has been completed to confirm the remedy is operational and functional. The two sets of monitoring data will be collected in October and November 2003. Specific requirements for the first two rounds of operational and functional monitoring can be found in the Sampling and Analysis Plan (Weston 2003d).

In addition, monitoring wells both onsite and offsite will be sampled during long term monitoring. Long term monitoring is currently planned quarterly for the first two years (years 1 and 2), semi- annually (twice per year) for the next two years (years 3 and 4) and annually thereafter. Monitoring is currently planned for 5 years at which time a 5 year review will be held and future monitoring requirements determined. Monitoring requirements are provided in the Frontier Hard Chrome Long Term Monitoring Plan. The purpose of the long term monitoring is to confirm the ISRM Wall remains operational and functional and to track downgradient chromium concentrations in groundwater to protect human health and the environment.

During the long term monitoring phase, wells in the vicinity of the Cassidy Building (both injection wells and monitoring wells) will also be observed for damage and to ensure locking caps are present on the wells.

Hexavalent chromium detected in groundwater in wells installed within the treatment barrier, or downgradient in excess of post-treatment concentrations (i.e., hundreds to thousands of parts per billion) may indicate the treatment wall has expired. In that situation, additional reagent injections could be completed. The injection wells have been left in place and provided with protective monuments and locking well caps. Additional reagent injection could be completed if necessary to reactivate the treatment wall. This additional reagent injection would be completed under another EPA work assignment, if necessary. The work would be funded by EPA.

Future construction on the site should also be reviewed and monitored to ensure the injection wells are not damaged and to ensure structures are not constructed over the wells. Any additional building expansions in this area should have foundations and or floor slabs designed to allow access to the injection and monitoring wells. These inspections could occur at the same time groundwater samples are being collected from the wells during long term monitoring.

SECTION 8

SUMMARY OF PROJECT COSTS

Specific details regarding project costs are provided in Appendix B.

Project design and construction costs are summarized in Table 8-1 below.

Table 8-1—Project Design and Construction Costs

Item	Cost ($)
Design	185,000
ISRM Bench and Pilot Scale Test	250,000
Property Purchase	200,000 (est.)
Building Demolition	306,400
ISRM Wall Installation	1,030,000
Source Area Treatment	2,596,000
Total Cost	4,567,400

Note: Costs are in 2003 dollars

Total estimated project costs compared to the ROD estimates are provided in Table 8-2 below.

Table 8-2—Estimated Total Project Cost

Cost Item	ROD Estimate[a] (2000 $$)	ROD Estimate[b] (2003 $$)	Actual Cost (2003 $$)
Design	177,000	193,400	185,000
RA Capital Cost	3,143,200	3,435,600	4,382,400
RA Operating Cost	0	0	0
Total RA Cost	3,320,200	3,629,000	4,567,400
Projected Monitoring Costs	306,600	335,100	296,000[c]
Total Cost	3,626,800	3,964,100	4,863,400

Notes:

a: Cost breakdown obtained from the Focused Feasibility Study.

b: 2003 costs were adjusted from 2000 to 2003 using a 3% annual inflation rate.

c: Groundwater monitoring costs. Based on quarterly sampling for the first 2 years and annual sampling/reporting for the remaining 15 years; 5% discount factor.

The actual project cost was approximately 23% greater than the Record of Decision estimate. Actual project cost variations from the Record of Decision estimate is primarily due to the following factors:

- An ISRM pilot scale test was performed during the design phase which was not included in the ROD estimate.
- A significant portion of the FHC building was hazardous waste which increased disposal costs. In addition, building demolition was performed as an environmental project requiring stricter controls than a standard demolition project.
- Complications in treating the Source Area soil and groundwater due to buried debris were underestimated in the ROD cost estimate. Buried debris removal and disposal costs were not considered significant in the ROD.

Unit costs for the various phases of the work are as follows (includes preparation of all plans, project management, site supervision, markups and disposal costs).

- Demolition of buildings in an environmental project setting cost approximately $18 per square foot.
- Installation of the ISRM Treatment Wall cost approximately $330 per square foot. This cost is highly variable and is anticipated to be on the high side for shallow walls (less than 40 feet deep) due to the geological complexity of this site.
- Insitu treatment of hexavalent chromium contaminated soil cost approximately $124 per cubic yard. This cost is all inclusive and includes items such as construction management, mobilization, demobilization, health and safety, testing, sampling and analysis, and disposal of debris and fluff soil as non-hazardous waste.

SECTION 9

OBSERVATIONS AND LESSONS LEARNED

Observations and lessons learned for each phase of the RD/RA are provided below.

9.1 SUBCONTRACTING

- Allow adequate time during the bid process for technology treatability testing by the potential bidders.
- It is difficult to provide a treatability test soil sample to each bidder that contains similar concentration of contaminants. Collect, homogenize and sample the treatability test matrix before providing it to the bidders.
- Specify sample turnaround times, time durations for activities to be completed by the resident engineer, analytical methods, and other specific information in the subcontract. This information will help keep change orders to a minimum.
- Make the subcontractor is responsible for materials, resources and testing necessary to complete their portion of the work. Providing these resources to the subcontractor can result in change orders due to delays.
- Hold a site walk during the bidding process and discuss specifics of the project. Provide handouts with project specific information and an agenda for the site walk to help the bidders fully understand all technical and scheduling aspects of the project.
- Complete a detailed review of the bids. Request clarifications for any significant aspect of the project that is unclear and make sure the bidder includes the response in their bid. Make no assumptions as to what the subcontractor is proposing; if it's not clear, obtain more specific information.

9.2 BUILDING DEMOLITION

- A thorough characterization of building materials (contaminant levels, lead based paint, potential for debris to be a hazardous waste, etc.) is critical in completing the design and accurately estimating project costs.
- It is very difficult to visually determine when concrete has been contaminated to the point of being a hazardous waste. Concrete can show no or minimal signs of contamination yet still fail TCLP testing for certain metal contaminants.
- Check with potential landfills to determine their characterization requirements for building debris prior to beginning demolition. Complete this characterization before demolition occurs.
- Perform characterization of building materials prior to demolition to avoid co-mingling potentially hazardous and non-hazardous wastes.

- Subsurface structures and foundations are usually greater than expected. Obtain building design drawings, if available, to obtain the best estimate of subsurface work required.

9.3 ISRM TREATMENT WALL INSTALLATION

- Injection well seals can be susceptible to blow out or bypass during injection testing and during the injection itself. Avoid installing injection wells in areas that have been disturbed by geoprobing or have had debris buried nearby. Abandoned push-probe tools, inadequately abandoned push-probe holes, or voids in the subsurface can cause injection fluids to bypass or short circuit less permeable areas of the formation for higher permeable areas.
- A large diameter waterline connected to a fire hydrant can be a safety issue due to the high pressure involved. Use a pressure reducing valve to avoid injury from a broken line. High pressure water can also damage injection well seals during flow testing.
- It can difficult to install push-probe wells with quality well seals. This difficulty is primarily due to the low clearance between the well casing and the probe casing which can result in voids when placing seal material.
- Geological heterogeneity has a significant cost on ISRM Treatment Wall installation. Highly heterogeneous site are complex, require significant more characterization and can result in a significant use of reagent with little benefit if not fully understood.

9.4 SOURCE AREA TREATMENT

- Subsurface geology is a key factor in determining shallow soil mixing treatment depths and costs. Fully characterize the site geology to the treatment depths required. Carefully evaluate use of shallow soil mixing technology based on subsurface geology. Provide boring logs to the company providing shallow soil mixing services during the bid process.
- Subsurface debris can be a significant problem with use of in-situ shallow soil mixing. Large debris will require removal prior to in-situ soil treatment.
- Removal of fluff soil generated during shallow soil mixing can be expensive if it requires offsite disposal. Fluff soil can range as high as 40% of the treated soil volume.
- Soil cutting fluid management can be a problem on small sites or sites where limited infiltration areas are available.
- Insitu soil mixing requires specialized equipment and places significant stress on the equipment. Hire a company specializing in this technology and one that has completed numerous projects. Make sure the subcontractor has well maintained and reliable equipment, and has the resources to repair equipment promptly.

SECTION 10

CONTACT INFORMATION

10.1 EPA PROJECT MANAGER

Sean Sheldrake
U.S. Environmental Protection Agency
1200 Sixth Avenue M/S: ECL-112
Seattle, WA 98101
206-553-1200

10.2 EPA REMEDIAL DESIGN AND REMEDIAL ACTION CONTRACTOR

Weston Solutions Inc. was the Remedial Design and Remedial Action Oversight Contractor. Weston Solutions Inc. performed the design and subcontracted the remedial action construction work.

Local Office Contact Information:

Larry Vanselow P.E.
Weston Solutions, Inc.
190 Queen Anne Avenue North, Suite 200
Seattle, WA 98109
206-521-7600

Contract No. 68-W7-0026
Work Assignment No. 134-RDRD-1027, 143-RARA-1027, 153-RARA-1027

10.3 MAJOR REMEDIAL ACTION SUBCONTRACTORS AND CONTACTS

10.3.1 Building Demolition

Greg Nickell
ICONCO
5409 Ohio Avenue South
Seattle, WA 98134
206-763-0900

10.3.2 ISRM Wall Installation

Vince Vermeul
Pacific Northwest National Laboratory
902 Battelle Blvd.
Richland, WA 99352
509-375-2121

10.3.3 Source Area Treatment

Aiman Naguib
Williams Environmental Services, Inc.
9741 Preston Road, Suite 205
Frisco, TX 75034
972-335-3282

10.3.4 Analytical Services

Air Samples

Severn Trent
5755 8th Street East
Tacoma, WA 98424
253-922-2310

Laucks Testing Laboratory
940 South Harney Street
Seattle, WA 98108
206-767-5060

Debris (concrete, wood, metal)

OnSite Environmental Incorporated
14648 NE 95th St.
Redmond, WA 98052
425-883-3881

Soil and Groundwater

U.S. EPA Environmental Services Assistance Team (ESAT)
Manchester Environmental Laboratory
7411 Beach Drive East
Port Orchard, WA 98366
Phone 360-871-8800

SECTION 11

REFERENCES

Pacific Northwest National Laboratory (PNNL) 2002a. Test Plan. Insitu Redox Manipulation Bench- and Pilot-scale Tests. Remedial Design Support for ISRM Barrier Deployment. Frontier Hard Chrome Superfund Site. Vancouver, Washington. April.

PNNL 2002b. Insitu Redox Manipulation Pilot-scale Test. Remedial Design Support for ISRM Barrier Deployment. Frontier Hard Chrome Superfund Site. Vancouver, Washington. December.

Weston (Weston Solutions, Inc.) 2003a. Frontier Hard Chrome Final Data Evaluation Report. February.

Weston 2003b. Frontier Hard Chrome ISRM Wall Installation/Source Area Treatment Construction Quality Assurance Plan. March.

Weston 2003c. Frontier Hard Chrome Draft Institutional Controls Plan, December.

Weston 2003d. Frontier Hard Chrome ISRM Wall Installation/Source Area Treatment Sampling and Analysis Plan. April.

Weston 2002a. Frontier Hard Chrome Source Area Treatability Test Plan. May

Weston 2002b. Frontier Hard Chrome Source Area Treatability Test Report. October.

Weston 2002c. Frontier Hard Chrome ISRM Treatment Wall Design. December.

Weston 2002d. Frontier Hard Chrome Health and Safety Plan. April.

APPENDIX A

WELL INSTALLATION INFORMATION AND SURVEY COORDINATES

Table A-1—Well Installation Information

Well No.	Well Dia. (in)	Well Depth (feet)	Top of Screen Depth (ft)	Bottom of Screen Depth (ft)	Screen Length (ft)	Screen Slot Size (in)	Date Installed	Drilling Method	Drilling Company
Injection Wells									
INJ-1	6	35.5	20.5	34.9	14.4	0.02	5/20/02	Sonic	Boart-Longyear
INJ-2	6	27.7	22.8	27.2	4.4	0.02	8/29/02	Sonic	Boart-Longyear
RA-IW-2A	6	28.2	23.4	27.4	4.0	0.02	4/23/03	Sonic	Boart-Longyear
RA-IW-2B	6	33.7	28.3	32.7	4.4	0.02	4/22/03	Sonic	Boart-Longyear
RA-IW-3A	6	28.1	23.3	27.3	4.0	0.02	4/23/03	Sonic	Boart-Longyear
RA-IW-3B	6	33.7	28.3	32.7	4.4	0.02	4/22/03	Sonic	Boart-Longyear
RA-IW-4A	6	27.5	22.6	27.0	4.4	0.02	6/25/03	Sonic	Boart-Longyear
RA-IW-4B	6	33.7	28.3	32.7	4.4	0.02	6/24/03	Sonic	Boart-Longyear
RA-IW-5A	6	28.1	23.2	27.6	4.4	0.02	6/26/03	Sonic	Boart-Longyear
RA-IW-5B	6	33.3	27.9	32.3	4.4	0.02	6/25/03	Sonic	Boart-Longyear
RA-IW-6A	6	25.9	21.0	25.4	4.4	0.02	6/27/03	Sonic	Boart-Longyear
RA-IW-6B	6	31.6	25.2	29.6	4.4	0.02	6/27/03	Sonic	Boart-Longyear
RA-IW-7A	6	24.9	19.9	24.3	4.4	0.02	6/28/03	Sonic	Boart-Longyear
RA-IW-7B	6	30.1	24.7	29.1	4.4	0.02	6/28/03	Sonic	Boart-Longyear
RA-IW-8A	6	28.1	23.1	27.5	4.4	0.02	6/30/03	Sonic	Boart-Longyear
RA-IW-8B	6	33.7	28.3	32.7	4.4	0.02	6/29/03	Sonic	Boart-Longyear
Monitoring Wells									
MW-1	2	34.5	19.2	34.0	14.8	0.01	5/21/02	HSA	Holt Drilling
MW-3	2	37.3	21.7	36.5	14.8	0.01	5/20/02	HSA	Holt Drilling
MW-7	2	47.2	41.6	46.4	4.8	0.01	5/20/02	HSA	Boart-Longyear
MW-20	2	27.3	21.9	26.6	4.7	0.01	5/22/02	HSA	Holt Drilling
MW-21	2	35.6	30.4	35.1	4.7	0.01	5/22/02	HSA	Holt Drilling
RA-MW-11A	2	27.8	22.9	27.6	4.7	0.01	5/2/03	HSA	Holt Drilling
RA-MW-11B	2	33.1	28.3	32.9	4.6	0.01	5/1/03	HSA	Holt Drilling
RA-MW-12A	2	28.1	23.2	27.9	4.7	0.01	5/1/03	HSA	Holt Drilling
RA-MW-12B	2	33.0	28.3	32.8	4.5	0.01	5/1/03	HSA	Holt Drilling
RA-MW-12C	2	39.2	34.5	39.0	4.5	0.01	4/30/03	HSA	Holt Drilling
RA-MW-13A	2	27.3	22.5	27.1	4.6	0.01	6/3/03	HSA	Holt Drilling
RA-MW-13B	2	32.1	27.3	31.9	4.6	0.01	6/3/03	HSA	Holt Drilling
RA-MW-13C	2	39.7	34.6	39.5	4.9	0.01	6/3/03	HSA	Holt Drilling
RA-MW-14A	2	25.3	20.3	25.1	4.8	0.01	6/4/03	HSA	Holt Drilling
RA-MW-14B	2	30.3	25.5	30.1	4.6	0.01	6/4/03	HSA	Holt Drilling
RA-MW-15A	2	26.6	22.1	26.6	4.5	0.01	5/30/03	HSA	Holt Drilling
RA-MW-15B	2	32.7	27.7	32.5	4.8	0.01	5/30/03	HSA	Holt Drilling
RA-MW-16A	2	26.8	22.2	26.7	4.5	0.01	6/2/03	HSA	Holt Drilling
RA-MW-16B	2	32.7	27.9	32.5	4.6	0.01	6/2/03	HSA	Holt Drilling
RA-MW-17A	2	26.4	21.7	26.2	4.5	0.01	6/5/03	HSA	Holt Drilling

Note: HSA = Hollow stem auger

Table A-2—Well Survey Coordinates and Information

Well No.	Northing	Easting	Case Elevation (ft)	Monument Elevation (ft)
W97-18A	112299.62	1091919.98	25.44	25.72
W97-18B	112299.13	1091926.64	25.36	25.73
B85-4	112324.18	1091631.89	25.38	26.18
B87-8	112344.00	1091529.10	25.95	26.21
W92-16B	112424.30	1091445.85	25.51	25.87
W92-16A	112438.05	1091446.66	25.62	25.98
W85-2B	112427.94	1091417.06	25.77	26.09
W92-15A*	112486.10	1091498.95	26.03	26.40
W92-15B*	112485.45	1091514.65	25.89	26.38
MW-17	112478.11	1091624.96	26.07	26.28
MW-5*	112464.46	1091631.93	25.71	26.06
MW-21	112462.58	1091617.43	25.77	26.14
MW-20	112462.35	1091613.99	25.75	26.09
MW-22*	112460.86	1091609.46	25.70	26.11
INJ-2	112450.91	1091608.07	25.79	26.01
INJ-1	112447.61	1091616.21	25.94	26.11
MW-7	112442.22	1091620.89	25.66	25.93
MW-1	112441.82	1091607.30	25.69	26.00
MW-3	112433.24	1091610.54	25.69	26.04
MW-4*	112424.34	1091616.25	25.62	25.84
MW-10*	112414.65	1091603.09	25.65	25.88
W85-1B*	112601.88	1091623.45	25.28	26.04
W85-3B	112824.23	1091514.26	26.77	27.14
W85-3A	112824.50	1091509.69	26.40	26.97
W92-14A*	112571.75	1091550.54	25.74	26.08
RA-IW-7A	112447.22	1091670.20	24.75	25.21
RA-IW-7B	112449.32	1091667.86	24.72	25.28
RA-MW-14A	112447.10	1091654.85	25.06	25.44
RA-MW-14B	112444.72	1091652.41	25.00	25.38
RA-IW-6A	112449.10	1091639.46	25.22	25.57
RA-IW-6B	112451.53	1091637.59	25.32	25.70
RA-MW-16A	112413.87	1091630.20	25.14	25.47
RA-MW-16B	112414.70	1091626.50	25.45	25.68
RA-MW-13C	112453.33	1091595.78	25.55	25.97
RA-MW-13A	112449.48	1091594.97	25.69	25.96
RA-MW-13B	112448.39	1091592.13	25.61	25.86
RA-IW-5A	112452.33	1091580.90	25.68	26.09
RA-IW-5B	112452.78	1091578.33	25.72	26.11

Table A-2—Well Survey Coordinates and Information

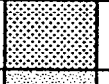
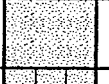
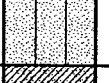
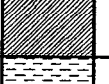
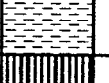
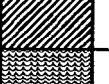
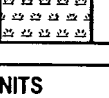
Well No.	Northing	Easting	Case Elevation (ft)	Monument Elevation (ft)
RA-MW-15B	112413.29	1091557.10	25.79	26.10
RA-MW-15A	112412.99	1091561.36	25.76	26.11
RA-MW-17A	112478.04	1091624.86	25.96	26.23
RA-IW-8B	112480.54	1091460.17	25.52	25.82
RA-IW-8A	112477.29	1091459.63	25.50	25.90
RA-IW-2B	112484.49	1091495.75	26.49	26.73
RA-IW-2A	112482.82	1091498.21	26.36	26.60
RA-MW-11B	112479.76	1091510.42	26.17	26.45
RA-MW-11A	112482.47	1091514.95	26.17	26.45
RA-IW-3B	112484.97	1091526.11	26.00	26.57
RA-IW-3A	112484.11	1091528.87	26.09	26.58
RA-MW-12C	112484.97	1091542.35	26.01	26.48
RA-MW-12B	112480.85	1091541.13	26.16	26.53
RA-MW-12A	112479.92	1091544.46	26.17	26.47
RA-IW-4B	112467.82	1091551.73	25.97	26.35
RA-IW-4A	112467.78	1091554.62	25.76	26.40

Note:

* indicates well was abandoned as part of the remedial action.

Elevation determined from City of Vancouver Benchmark #108 at East Fifth and East Reserve Street on the north curb on Grand Boulevard in curb centerline south using 53.756 feet; “Official Benchmarks City of Vancouver Washington 1929 N.G.V.D. Datum” book revised January 31, 1997.

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

MAJOR DIVISIONS					SOIL DESCRIPTIONS
COARSE GRAINED SOILS (MORE THAN HALF IS LARGER THAN NO. 200 SIEVE)	GRAVELS (MORE THAN HALF COARSE FRACTION IS RETAINED ON THE NO. 4 SIEVE SIZE)	CLEAN GRAVELS WITH LESS THAN 5% FINES	GW		WELL GRADED GRAVELS
			GP		POORLY GRADED GRAVELS
		GRAVELS WITH OVER 15% FINES	GM		SILTY GRAVELS
			GC		CLAYEY GRAVELS
	SANDS (MORE THAN HALF COARSE FRACTION PASSES THE NO. 4 SIEVE SIZE)	CLEAN SANDS WITH LESS THAN 5% FINES	SW		WELL GRADED SANDS
			SP		POORLY GRADED SANDS
		SANDS WITH OVER 15% FINES	SM		SILTY SANDS
			SC		CLAYEY SANDS
FINE GRAINED SOILS (MORE THAN HALF IS SMALLER THAN NO. 200 SIEVE)	SILTS AND CLAYS (LIQUID LIMIT LESS THAN 50)		ML		SILT
			CL		LEAN CLAY
			OL		LOW ORGANIC SILT
	SILTS AND CLAYS (LIQUID LIMIT GREATER THAN 50)		MH		ELASTIC SILT
			CH		FAT CLAY
			OH		ORGANIC CLAY
HIGHLY ORGANIC			PT		PEAT

EXPLANATION OF SYMBOLS

LABORATORY

GS - Grain Size
TOC - Total Organic Carbon
HCID - Hydrocarbon ID
VOC - Volatile Organic Compounds
Cr (VI) - Hexavalent Chromium
PCB - Polychlorinated Biphenyls
PCP - Pentachlorophenol
PAH - Polycyclic Aromatic Hydrocarbons
418.1 - Total Petroleum Hydrocarbons
TPH-G - Total Petroleum Hydrocarbons (Gas)
BNA - Base/Neutral/Acid (Semi-Volatile)
METALS - TAL Metals
MC - Moisture Content

CONTACT BETWEEN UNITS

Sharp
Gradational
Approximate

SAMPLE TYPE

"Undisturbed"
Bulk/Grab
Not Recovered

BLOWS PER FOOT

The number of hammer blows needed to drive the sampler the final 12 inches of the sample interval

Hammer is 140 pounds with 30 inch drop unless otherwise noted

WATER

Static Water Level
Water Level at Time of Drilling

MOISTURE DESCRIPTION

Dry - Absense of moisture, dusty, dry to the touch
Moist - Damp, but not visible water
Wet - Visible free water, usually soil is below water table

Explanation of Boring Log & Soil Classification Symbols

WESTON SOLUTIONS

templates/PlateA-1.ai

Monitoring Well RA-IW-2A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED April 23, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 26.36
GROUND SURFACE ELEV (ft) 26.6
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0						SP	SAND (SP), Gray, wet, (Fill).
5							
10							
15							
20						MH	Clayey SILT (MH), Gray, moist, (Alluvium).
25		FHC-GW-PP011-0250				GM	Silty GRAVEL with SAND (GM), Gray, 50% gravel, 30% sand, 20% silt, wet, (Alluvium). 50% gravel, 40% sand, 10% silt.
30						GW	Sandy GRAVEL with SILT (GW), Gray, 40% cobbles, 30% gravel, 25% sand, 5% silt, wet, (Alluvium). Bottom of hole @ 29 feet

Well Diagram

- Flush mounted surface mon. w/ locking well cap
- Concrete surface seal
- Bentonite grout seal
- Bentonite chip seal
- #10/20 sand
- 6" ID schedule 40 PVC circumslot screen with 0.020" factory cut slots
- Endcap
- Bentonite chips

Plate
A-1

Monitoring Well RA-IW-2B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED April 22, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 26.49
GROUND SURFACE ELEV (ft) 26.73
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0						SP	Meduim SAND (SP), Gray, wet, (Fill).
5							
10							
15							
20						MH	Clayey SILT (MH), Gray, moist, (Alluvium).
25		FHC-GW-PP011-0250				GM	Silty GRAVEL with SAND (GM), Gray, 50% gravel, 30% sand, 20% silt, wet, (Alluvium). 50% gravel, 40% sand, 10% silt.
30		FHC-GW-PP011-0300 FHC-GW-PP011-0310				GW	Sandy GRAVEL with SILT (GW), Gray, 40% cobbles, 30% gravel, 25% sand, 5% silt, wet, (Alluvium). 30% cobbles, 40% gravel, 28% sand, 2% silt.
35		FHC-GW-PP011-0350					5% silt.
40						GM	Sandy GRAVEL with COBBLES (GM), Gray, 40% cobbles, 30% gravel, 15% sand, 15% silt, wet, (Alluvium).
45							Bottom of hole @ 42 feet

Well Diagram

- Flush mounted surface mon. w/ locking well cap
- Concrete surface seal
- Bentonite grout seal
- Bentonite chip seal
- #10/20 sand
- 6" ID schedule 40 PVC wire-wrapped screen with 0.020" slots
- Endcap
- Bentonite chips

Plate
A-2

Monitoring Well RA-IW-3A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED April 23, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 26.09
GROUND SURFACE ELEV (ft) 26.58
LOGGED BY D. Dinkuhn (WESTON)

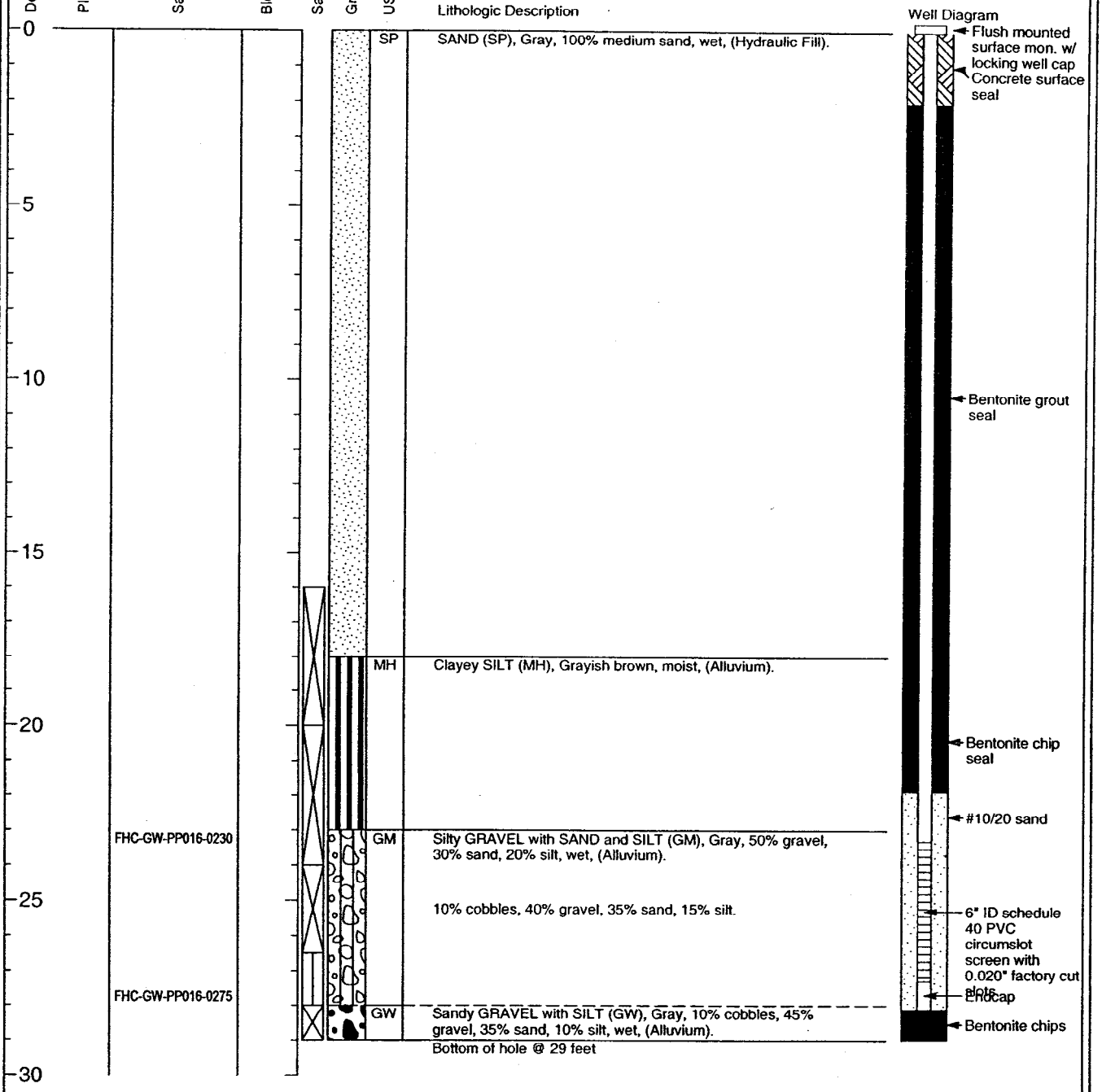


Plate
A-3

Monitoring Well RA-IW-3B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED April 22, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 26
GROUND SURFACE ELEV (ft) 26.57
LOGGED BY D. Dinkuhn (WESTON)

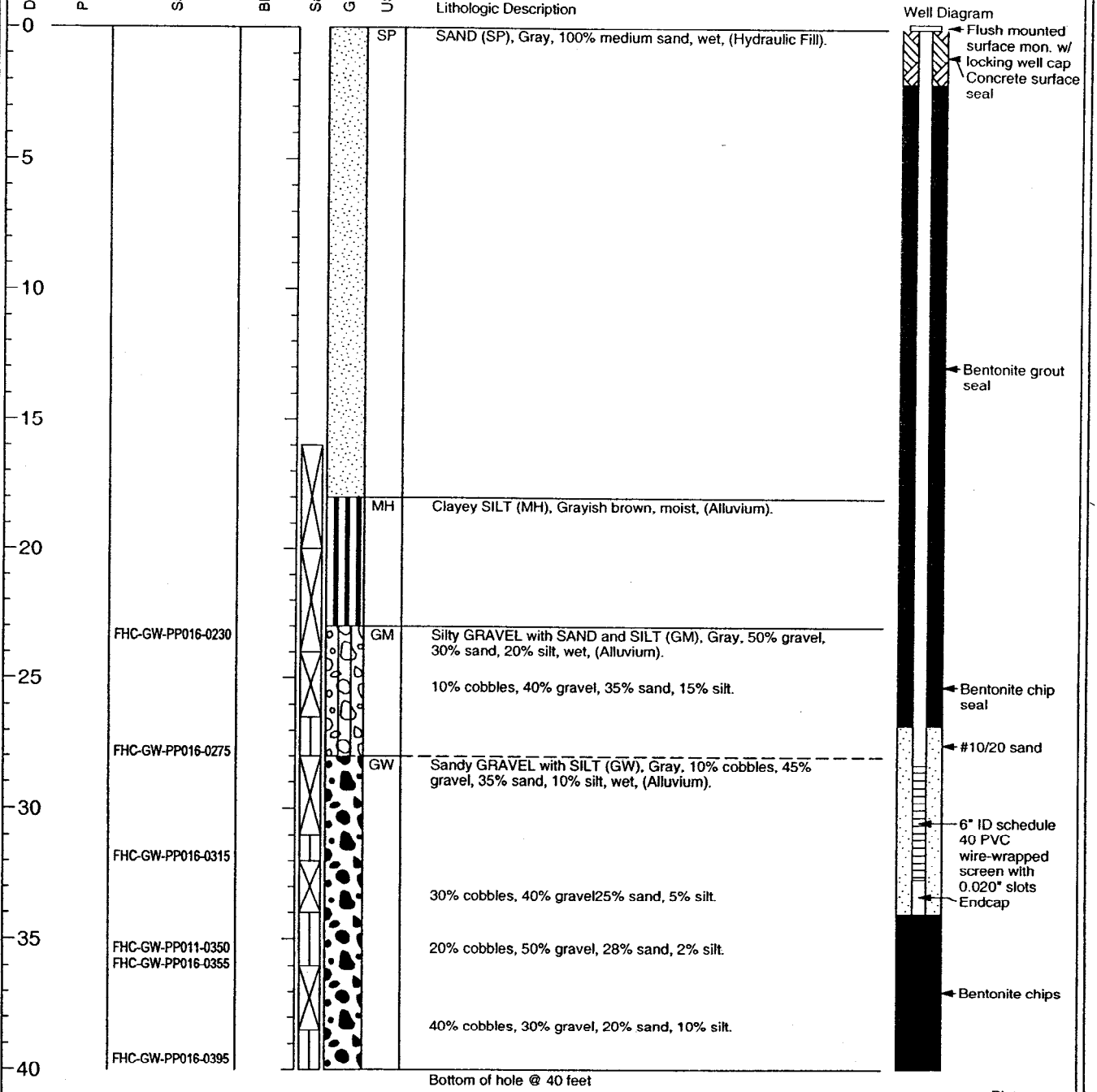


Plate
A-4

Monitoring Well RA-IW-4A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 25, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) NA
GROUND SURFACE ELEV (ft) 26.4
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0						SP	SAND (SP), (Hydraulic Fill).
5							
10							
15						MH	Clayey SILT (MH), Grayish brown, moist, (Alluvium).
20						GM	Silty GRAVEL with SAND (GM), Grayish brown, 10% cobbles, 30% gravel, 25% sand, 35% silt, wet, (Alluvium).
25		FHC-GW-PP017-0230					20% cobbles, 40% gravel, 20% sand, 20% silt.
30		FHC-GW-PP017-0275				GW	GRAVEL with SAND and SILT (GW), Gray, 30% cobbles, 30% gravel, 30% sand, 10% silt, wet, (Alluvium).
							Bottom of hole @ 30 feet

Well Diagram

- Flush mounted surface mon. w/ locking well cap
- Concrete surface seal
- Cement grout seal
- Bentonite chip seal
- #10/20 sand
- 6" ID schedule 40 PVC wire-wrapped screen with 0.020" slots
- Endcap
- Bentonite chips

Plate
A-5

Monitoring Well RA-IW-4B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 24, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) NA
GROUND SURFACE ELEV (ft) 26.35
LOGGED BY D. Dinkuhn (WESTON)

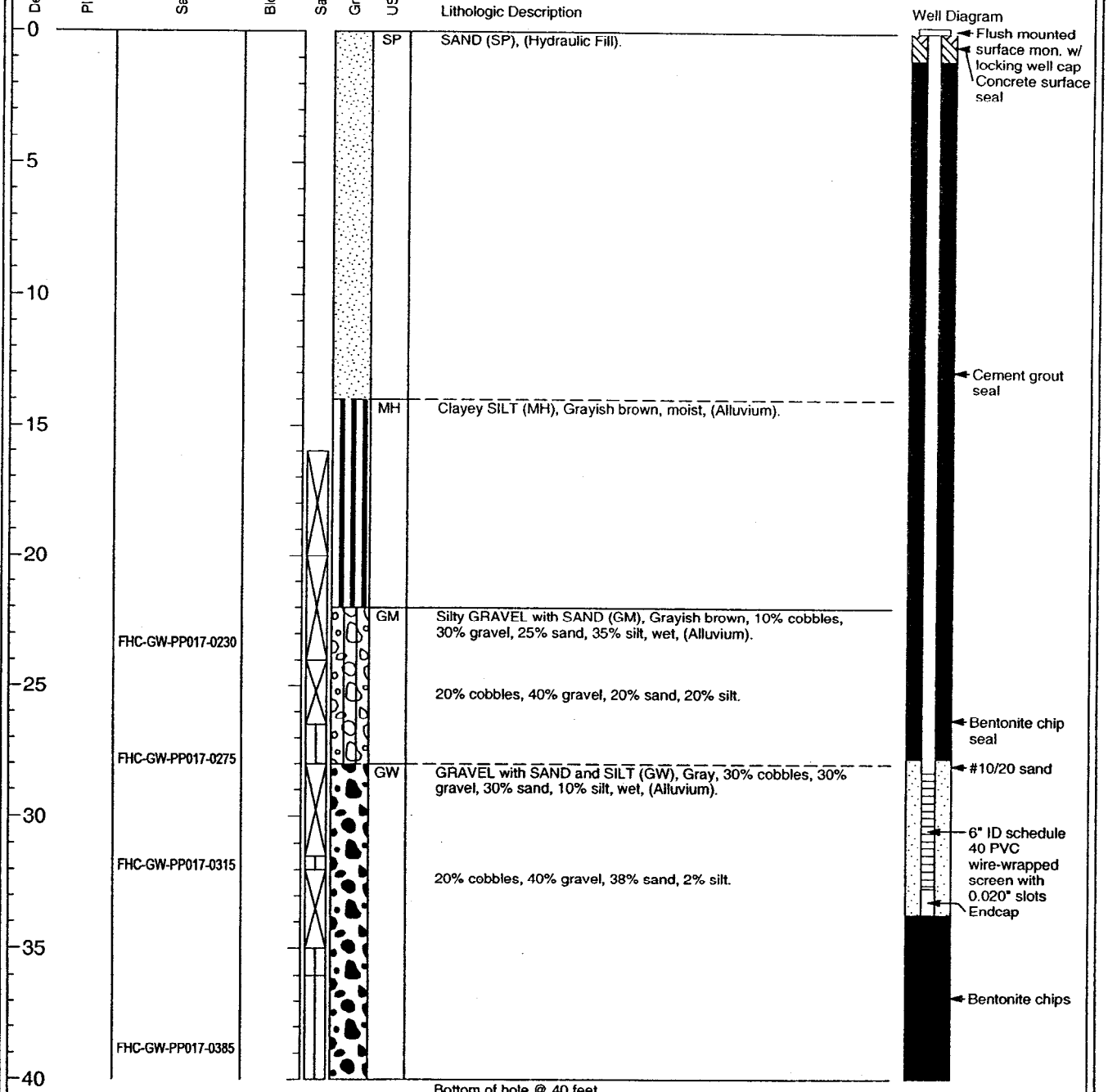


Plate
A-6

Monitoring Well RA-IW-5A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 26, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 25.68
GROUND SURFACE ELEV (ft) 26.09
LOGGED BY D. Dinkuhn (WESTON)

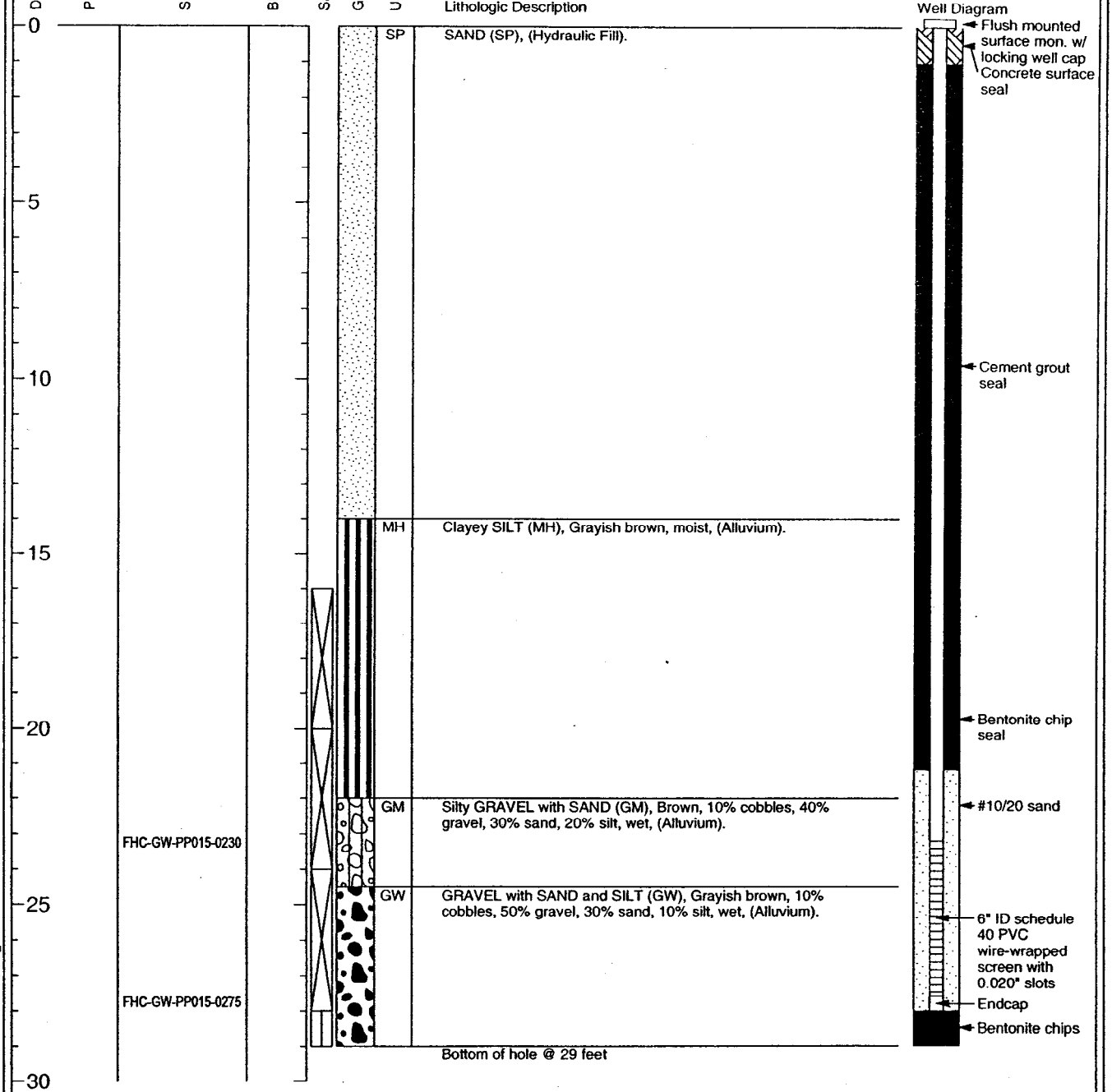


Plate
A-7

Monitoring Well RA-IW-5B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 25, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 25.72
GROUND SURFACE ELEV (ft) 26.11
LOGGED BY D. Dinkuhn (WESTON)

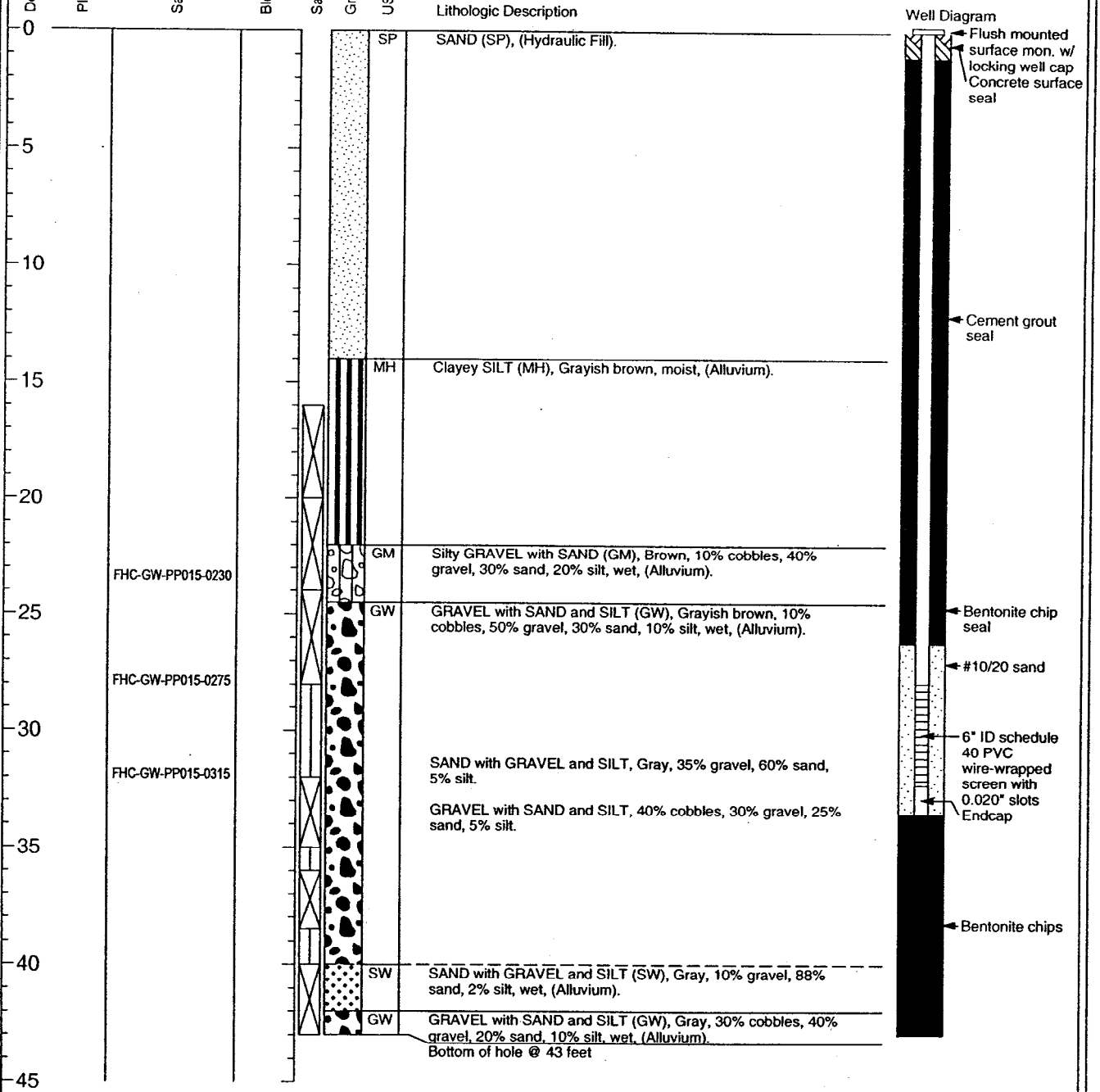


Plate
A-8

Monitoring Well RA-IW-6A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 27, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 25.22
GROUND SURFACE ELEV (ft) 25.57
LOGGED BY D. Dinkuhn (WESTON)

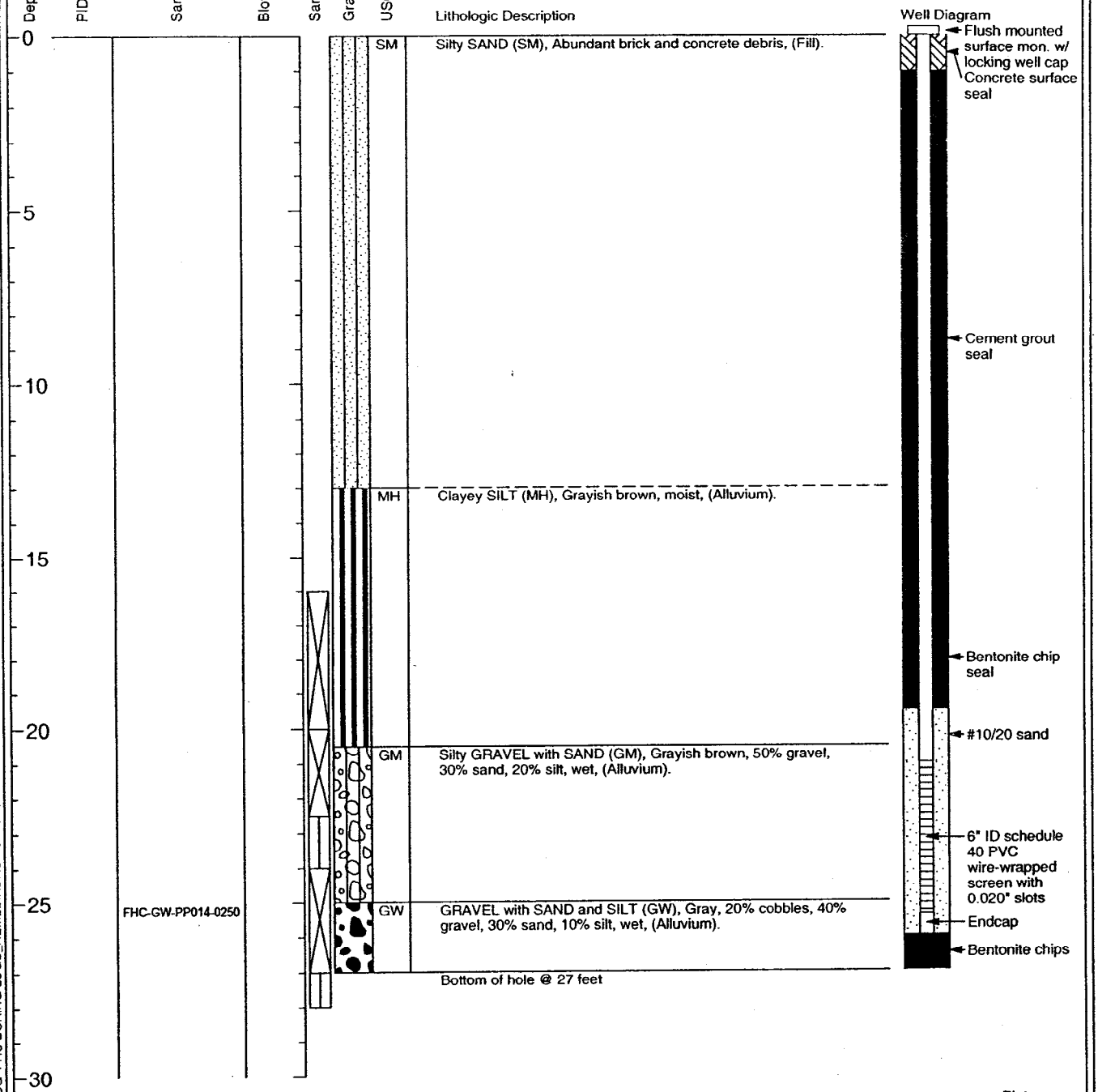


Plate
A-9

Monitoring Well RA-IW-6B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 27, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 25.32
GROUND SURFACE ELEV (ft) 25.7
LOGGED BY D. Dinkuhn (WESTON)

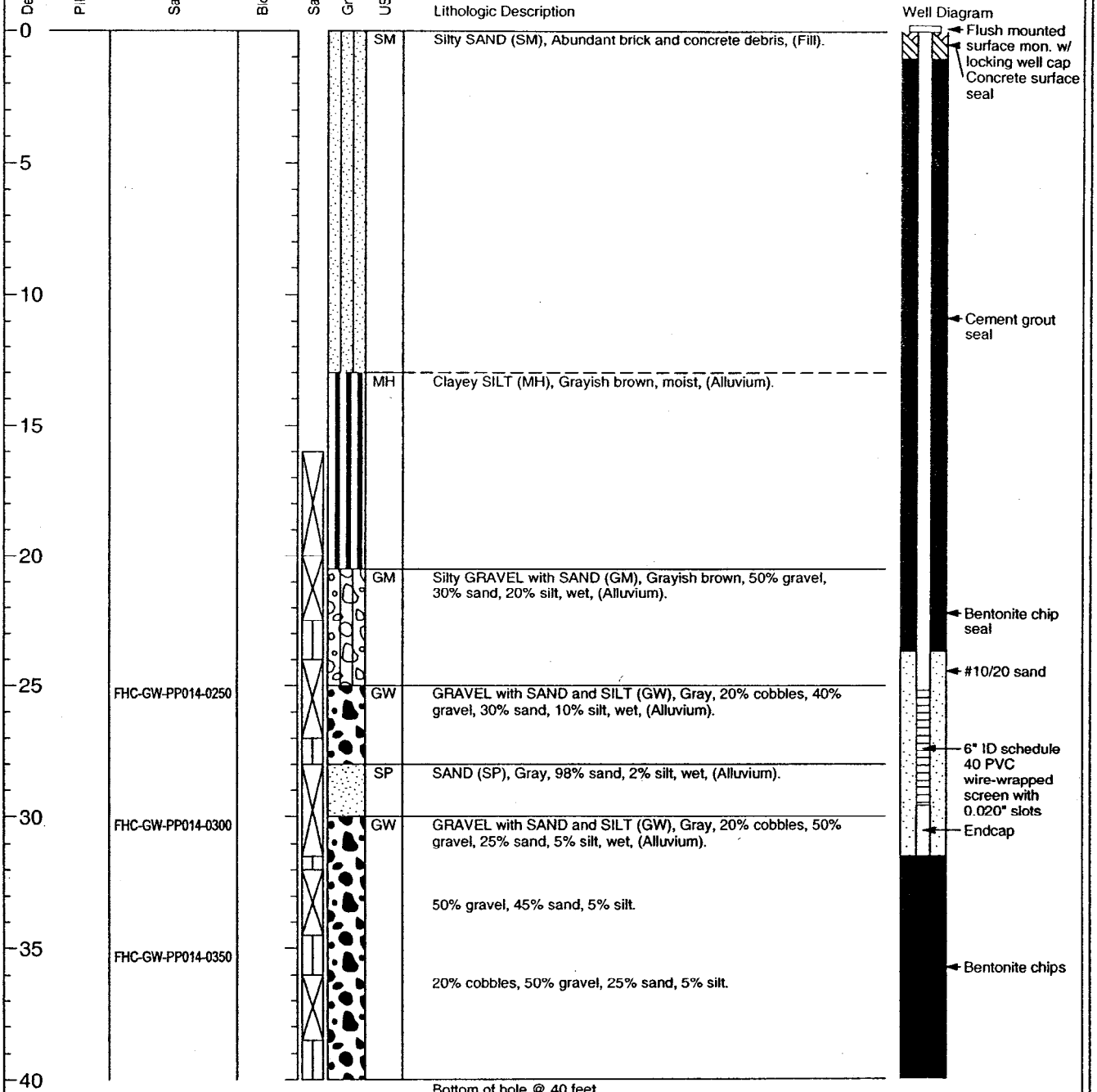


Plate
A-10

Monitoring Well RA-IW-7A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 28, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 24.75
GROUND SURFACE ELEV (ft) 25.21
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0						SM	Silty SAND (SM), Abundant brick and concrete debris, (Fill).
15						MH	Clayey SILT (MH), Grayish brown, moist, (Alluvium).
20						GM	Silty GRAVEL with SAND (GM), Grayish brown, 50% gravel, 30% sand, 20% silt, wet, (Alluvium).
		FHC-GW-PP013-0220					
25		FHC-GW-PP013-0250				GW	GRAVEL with SAND and SILT (GW), Grayish brown, 30% cobbles, 40% gravel, 20% sand, 10% silt, (Alluvium).
							Bottom of hole @ 27 feet

Well Diagram

- Flush mounted surface mon. w/ locking well cap
- Concrete surface seal
- Cement grout seal
- Bentonite chip seal
- #10/20 sand
- 6" ID schedule 40 PVC wire-wrapped screen with 0.020" slots
- Endcap
- Bentonite chips

Plate
A-11

Monitoring Well RA-IW-7B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 28, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 24.72
GROUND SURFACE ELEV (ft) 25.28
LOGGED BY D. Dinkuhn (WESTON)

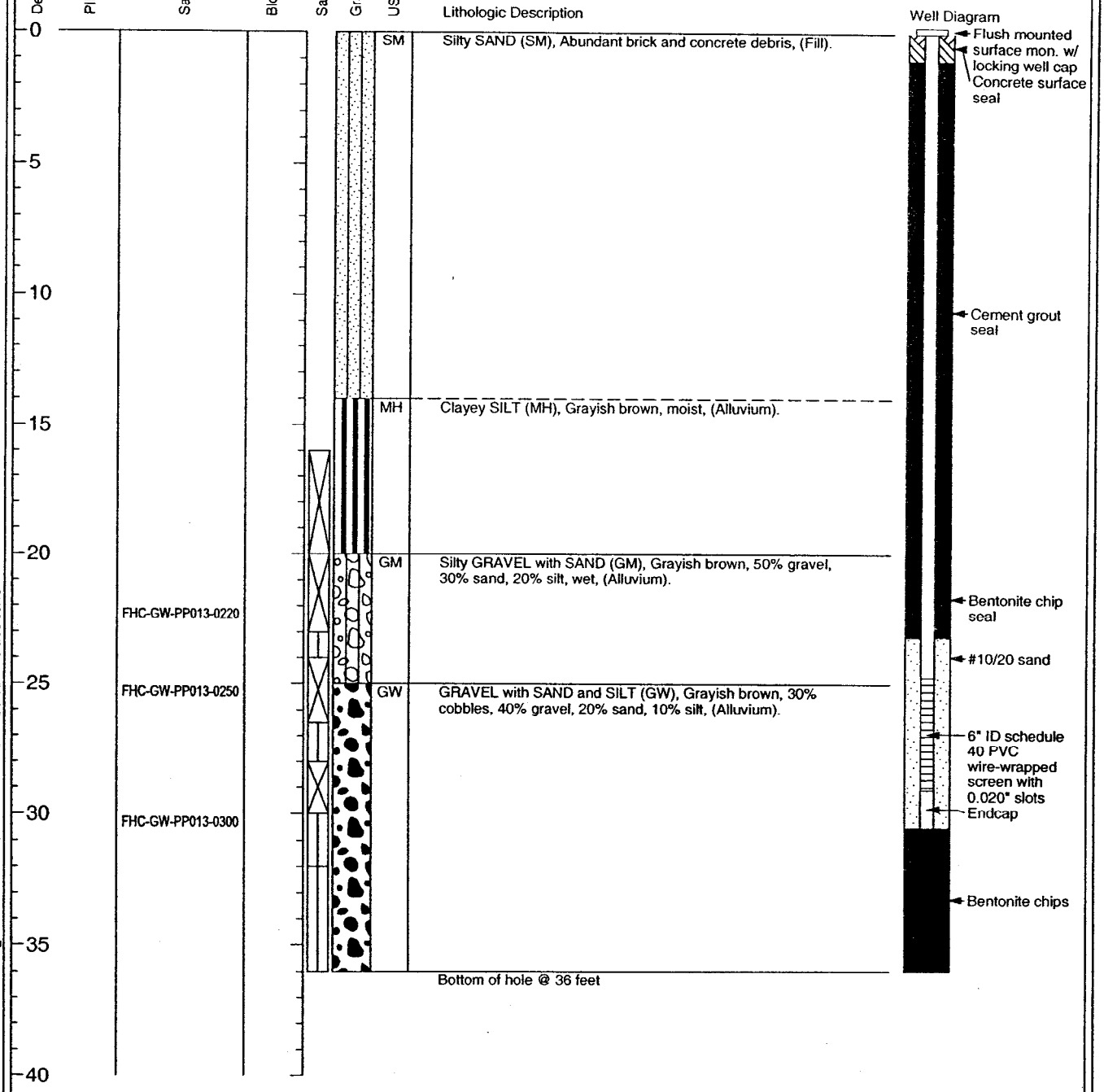


Plate
A-12

Monitoring Well RA-IW-8A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 30, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 25.5
GROUND SURFACE ELEV (ft) 25.9
LOGGED BY D. Dinkuhn (WESTON)

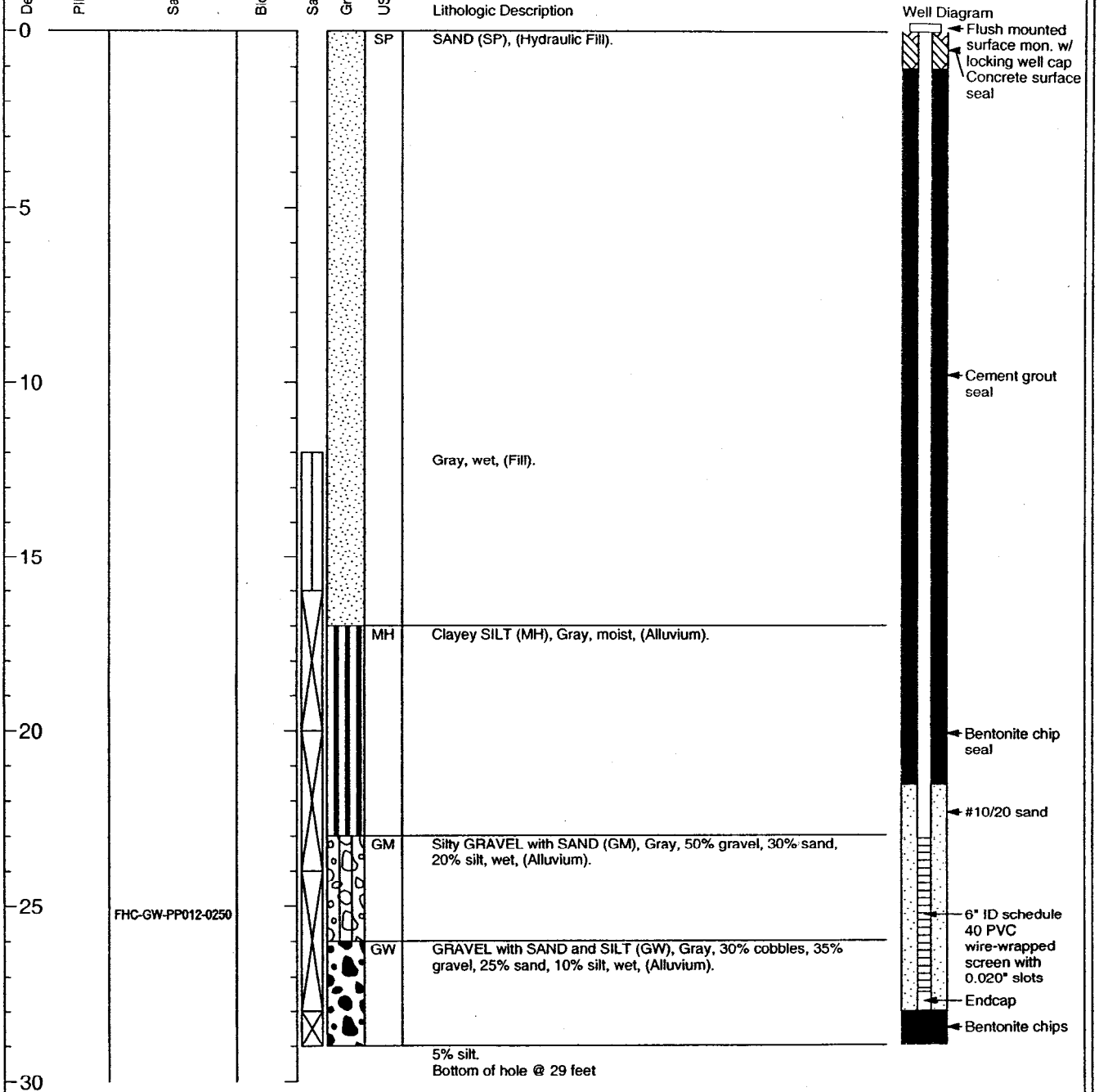


Plate
A-13

Monitoring Well RA-IW-8B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 29, 2003
DRILLING METHOD Sonic - Boart Longyear
TOP OF CASING ELEV (ft) 25.52
GROUND SURFACE ELEV (ft) 25.82
LOGGED BY D. Dinkuhn (WESTON)

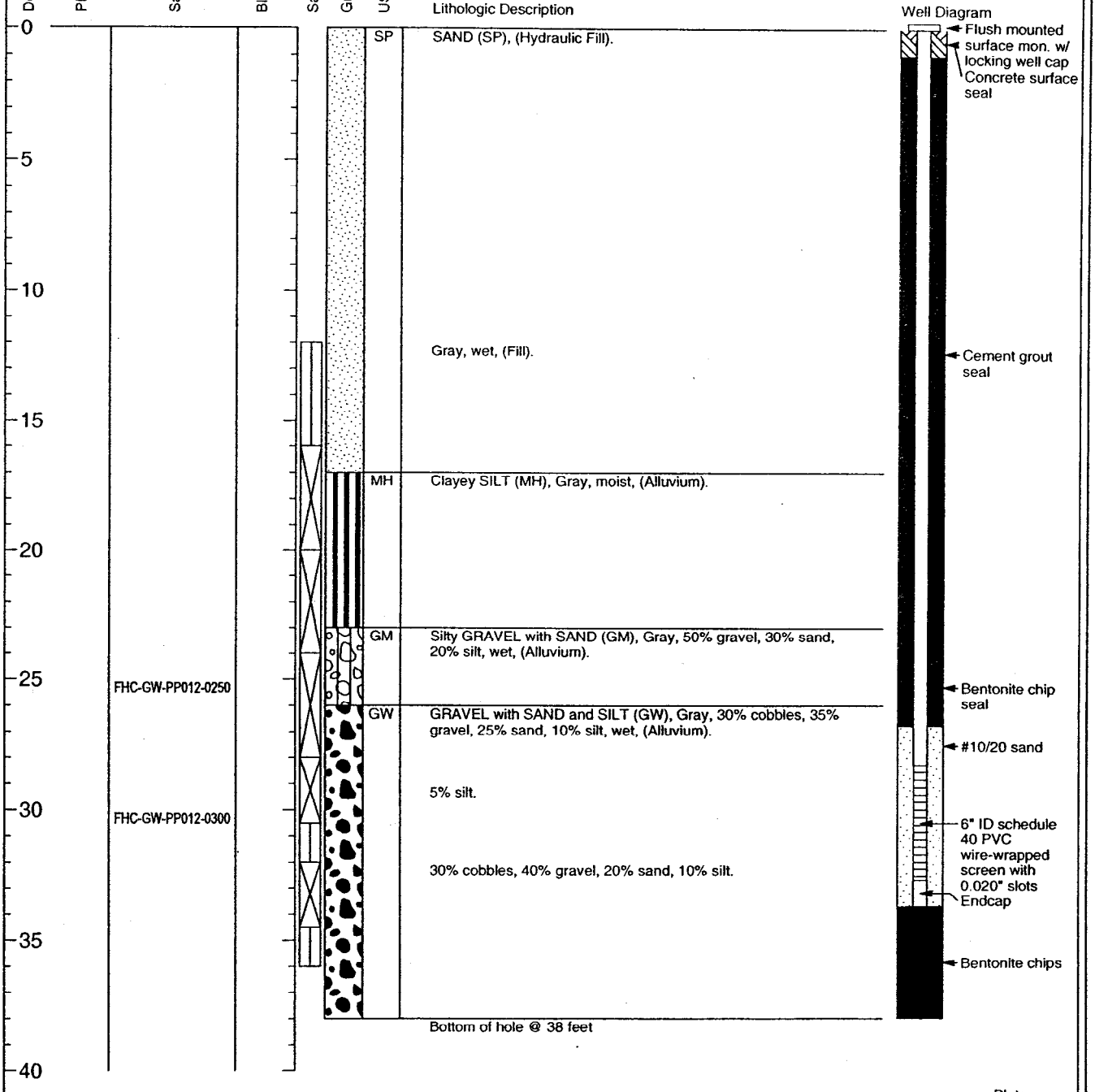


Plate
A-14

Monitoring Well RA-MW-11A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED May 2, 2003
DRILLING METHOD HSA 11" OD - Holt Drilling
TOP OF CASING ELEV (ft) 26.17
GROUND SURFACE ELEV (ft) 26.45
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							Bottom of hole @ 29 feet

Well Diagram

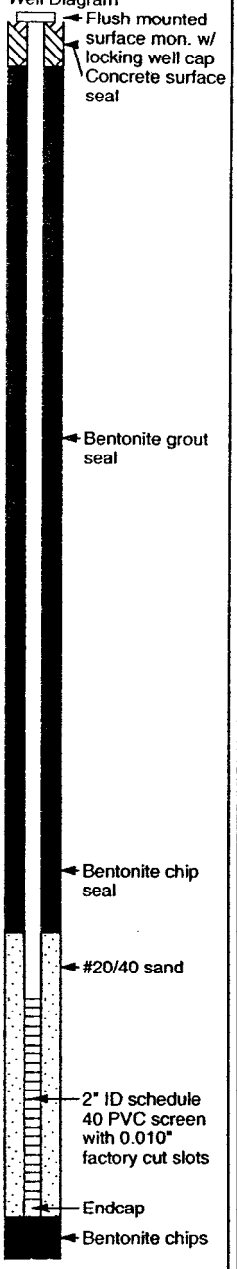


Plate
A-15

BOREHOLE LOG FHC BORING LOGS_REMEDIAL ACTION.GPJ RFW SEATTLE.GDT 10/8/03 08:20

Monitoring Well RA-MW-11B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED May 1, 2003
DRILLING METHOD HSA 11" OD - Holt Drilling
TOP OF CASING ELEV (ft) 26.17
GROUND SURFACE ELEV (ft) 26.45
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							
35							Bottom of hole @ 34 feet

Well Diagram

Plate
A-16

Monitoring Well RA-MW-12A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED May 1, 2003
DRILLING METHOD HSA 11" OD - Holt Drilling
TOP OF CASING ELEV (ft) 26.17
GROUND SURFACE ELEV (ft) 26.47
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							Bottom of hole @ 29 feet

Well Diagram

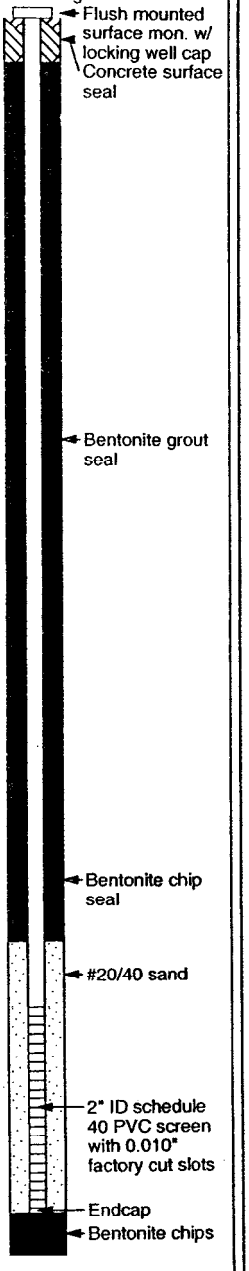


Plate
A-17

Monitoring Well RA-MW-12B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED May 1, 2003
DRILLING METHOD HSA 11" OD - Holt Drilling
TOP OF CASING ELEV (ft) 26.16
GROUND SURFACE ELEV (ft) 26.53
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							
35							Bottom of hole @ 34 feet

Well Diagram

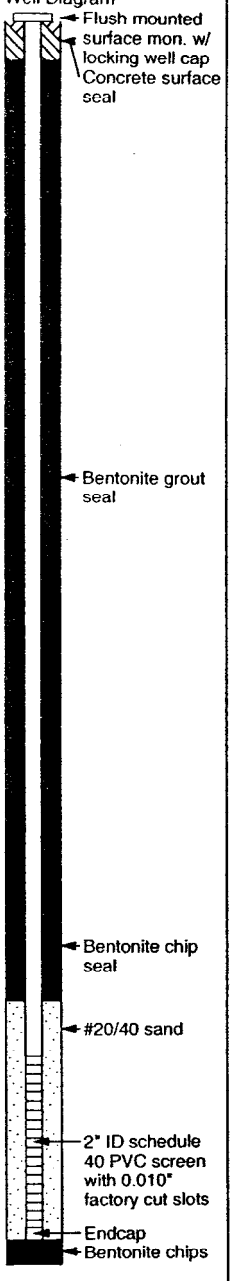


Plate
A-18

Monitoring Well RA-MW-12C

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED April 30, 2003
DRILLING METHOD HSA 11" OD - Holt Drilling
TOP OF CASING ELEV (ft) 26.01
GROUND SURFACE ELEV (ft) 26.48
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
40							Bottom of hole @ 40 feet

Well Diagram

- Flush mounted surface mon. w/ locking well cap
- Concrete surface seal
- Bentonite grout seal
- Bentonite chip seal
- #20/40 sand
- 2" ID schedule 40 PVC screen with 0.010" factory cut slots
- Endcap
- Bentonite chips

Plate
A-19

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Monitoring Well RA-MW-13A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 3, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25.69
GROUND SURFACE ELEV (ft) 25.96
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							Bottom of hole @ 28.5 feet

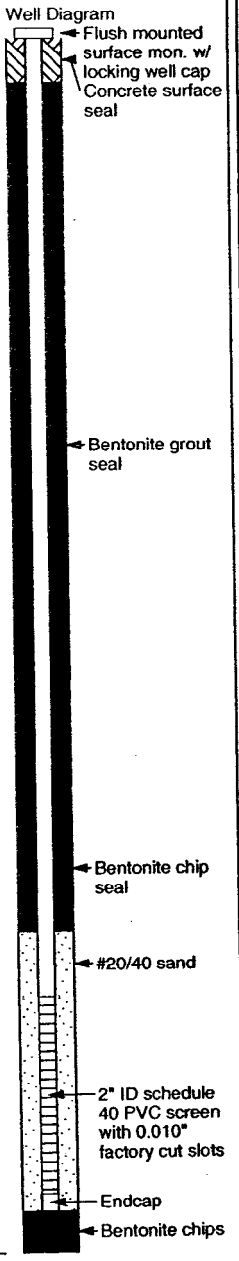

Plate
A-20

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Monitoring Well RA-MW-13B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 3, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25.61
GROUND SURFACE ELEV (ft) 25.86
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							
35							Bottom of hole @ 33.5 feet

Well Diagram

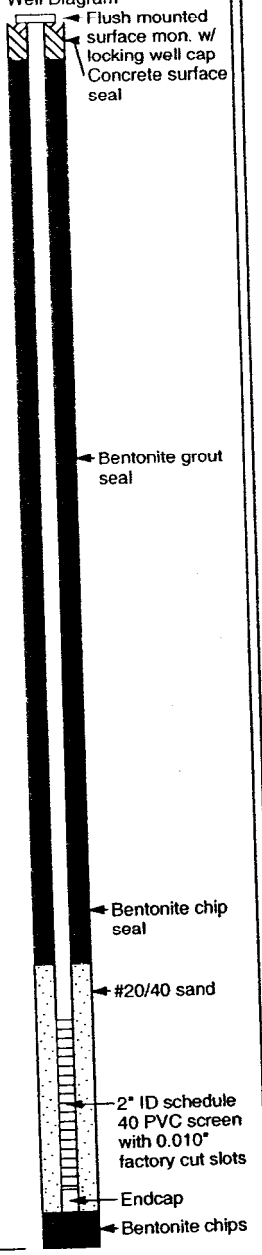

Plate
A-21
PAGE 1 OF 1

BOREHOLE LOG FHC BORING LOGS_REMEDIAL ACTION.GPJ RPW SEATTLE.GDT 10/8/03 08:20

Monitoring Well RA-MW-13C

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 3, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25.55
GROUND SURFACE ELEV (ft) 25.97
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							
35							
40							Bottom of hole @ 40 feet

Well Diagram

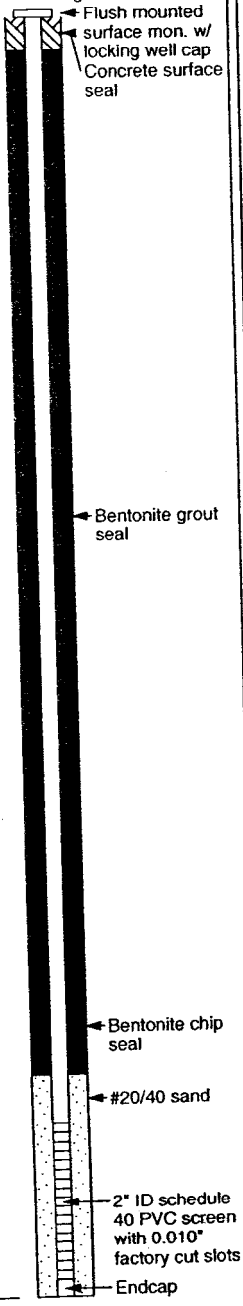

Plate
A-22

PAGE 1 OF 1

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BOREHOLE LOG FHC BORING LOGS_REMEDIAL ACTION.GPJ RFW SEATTLE.GDT 10/8/03 08:20

Monitoring Well RA-MW-14A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 4, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25.06
GROUND SURFACE ELEV (ft) 25.44
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							Bottom of hole @ 26.5 feet

Well Diagram

- Flush mounted surface mon. w/ locking well cap
- Concrete surface seal
- Bentonite grout seal
- Bentonite chip seal
- #20/40 sand
- 2" ID schedule 40 PVC screen with 0.010" factory cut slots
- Endcap
- Bentonite chips

Plate
A-23

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Monitoring Well RA-MW-14B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 4, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25
GROUND SURFACE ELEV (ft) 25.38
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							
35							Bottom of hole @ 31.5 feet

Well Diagram

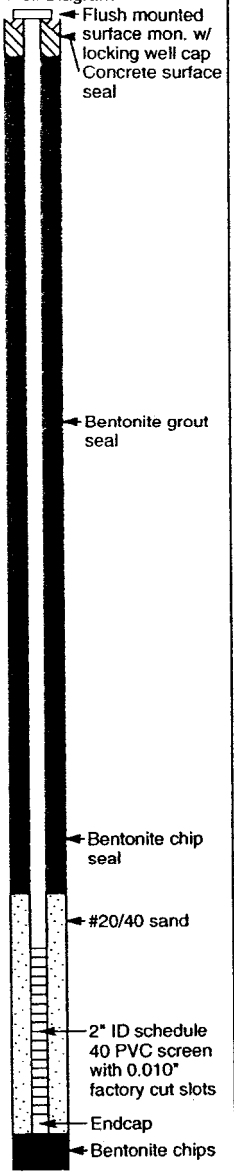

Plate
A-24

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Monitoring Well RA-MW-15A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED May 30, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25.76
GROUND SURFACE ELEV (ft) 26.11
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							Bottom of hole @ 28 feet

Well Diagram

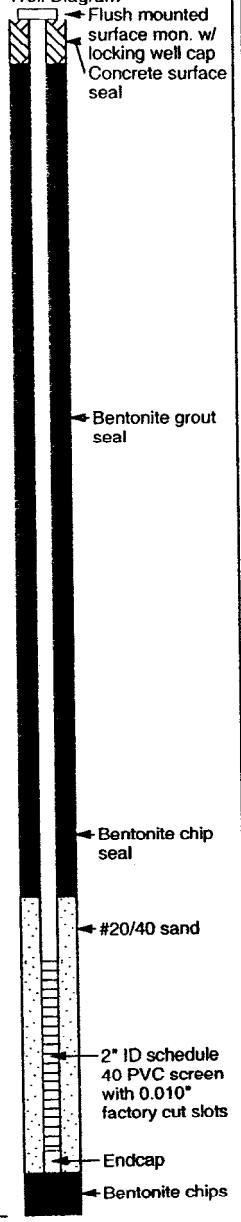

Plate
A-25

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Monitoring Well RA-MW-15B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED May 30, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25.79
GROUND SURFACE ELEV (ft) 26.1
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							
35							Bottom of hole @ 34 feet

Well Diagram

- Flush mounted surface mon. w/ locking well cap
- Concrete surface seal
- Bentonite grout seal
- Bentonite chip seal
- #20/40 sand
- 2" ID schedule 40 PVC screen with 0.010" factory cut slots
- Endcap
- Bentonite chips

Plate
A-26

Monitoring Well RA-MW-16A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 2, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25.14
GROUND SURFACE ELEV (ft) 25.47
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							Bottom of hole @ 28 feet

Well Diagram

- Flush mounted surface mon. w/ locking well cap
- Concrete surface seal
- Bentonite grout seal
- Bentonite chip seal
- #20/40 sand
- 2" ID schedule 40 PVC screen with 0.010" factory cut slots
- Endcap
- Bentonite chips

Plate
A-27

Monitoring Well RA-MW-16B

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 2, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25.45
GROUND SURFACE ELEV (ft) 25.68
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							
35							Bottom of hole @ 33.5 feet

Well Diagram

Plate
A-28

Monitoring Well RA-MW-17A

PROJECT Frontier Hard Chrome: Remedial Action
JOB NUMBER 20064-153-100-1040
DATE COMPLETED June 5, 2003
DRILLING METHOD HSA 10" OD - Holt Drilling
TOP OF CASING ELEV (ft) 25.96
GROUND SURFACE ELEV (ft) 26.23
LOGGED BY D. Dinkuhn (WESTON)

Depth (ft)	PID Reading (ppm)	Sample No.	Blows Per Foot	Sample Recovery	Graphic Log	USCS Classification	Lithologic Description
0							Refer to nearest injection well log for lithologic description.
5							
10							
15							
20							
25							
30							Bottom of hole @ 27.5 feet

Well Diagram

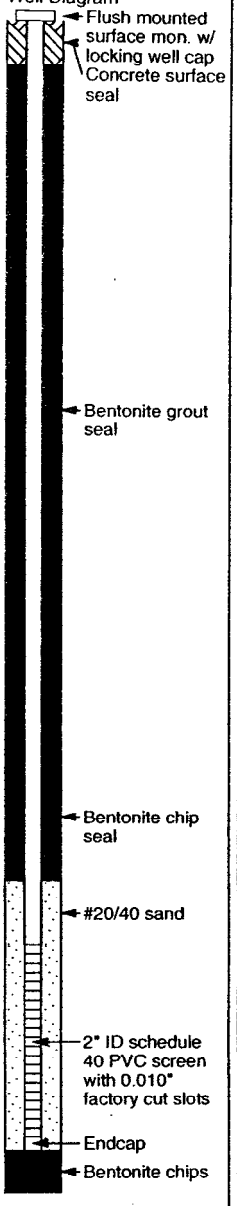

Plate
A-29

APPENDIX B

COST AND PERFORMANCE SUMMARY

COST INFORMATION

Source Area Treatment Costs

The following table provides the cost for treating the source area using in-situ shallow soil mixing technology.

Source Area Treatment Technology Costs

Cost Category/Element	Cost ($)	Unit Cost Calculations
Technology Capital Costs		
Technology Mobilization, Setup, Demobilization	236,000	
Planning and Preparation	84,000	
Site Work	10,000	
Equipment and Appurtances	0	
Startup and Testing	68,000	
Other	0	
Total Capital Costs ($)		398,000
Technology O&M		
Labor and Equipment	1,261,300	
Materials	450,000	
Utilities and Fuel	50,000	
Performance Testing and Analysis	25,500	
Fluff Soil Disposal	180,500	
Earthwork	9,200	
Health and Safety	45,000	
Total Operation and Maintenance Costs ($)		2,021,500
Other Technology Specific Costs		0
Other Project Costs		
Drummed Soil Management	16,500	
Debris Excavation, Screening and Disposal	160,000	
Total Other Project Costs		176,500
Total Cost for Calculating Unit Cost ($)		2,596,000
Quantity Treated (Cubic Yards)		20,962
Calculated Unit Cost ($/CY)		124
Basis for Quantity Treated		Actual CY from site reports

Note: Costs are in Year 2003 $.

ISRM Treatment Wall Installation Costs

The following table provides the costs for installing a 240 foot long ISRM Treatment Wall. Due to the nature of this remedy, no unit quantities of groundwater treated could be determined as this will occur over the next several decades. A unit cost for treatment wall installation was determined.

ISRM Treatment Wall Installation Costs

Cost Category/Element	Cost ($)[a]	Unit Cost Calculations
Technology Capital Costs		
Technology Mobilization, Setup, Demobilization	91,000	
Planning and Preparation	74,300	
Site Work (well installation)	185,000	
Equipment and Appurtances	0	
Startup and Testing	0	
Other	0	
Total Capital Costs ($)		*350,300*
Technology O&M		
Labor and Equipment	461,700	
Materials	214,000	
Utilities and Fuel	2,000	
Performance Testing and Analysis	2,000	
Total Operation and Maintenance Costs ($)		679,700
Other Technology Specific Costs		0
Other Project Costs		0
Total Cost for Calculating Unit Cost ($)		1,030,000
Treatment Wall Size (sq. ft.)		3,120[b]
Calculated Unit Cost ($/sq. ft.)		330
Basis for Cost		Project-specific information

Notes:

a: Costs are in Year 2003 $.

b: Costs are based on reactive treatment area (240' long x [35-22]' deep)

PERFORMANCE INFORMATION

Source Area Treatment

Source Area Treatment Performance Information

Performance Topic	Specific Information
Technology Type and Specific Information	• Shallow Insitu Soil Mixing • Treatment depths up to 25 feet • Auger diameter: 6 to 10 feet • Reagent: Sulfur based. Cement used to provide structural strength
Soil Type	• Clayey silt overlain with silty sand
Types of Samples Collected	• Soil and Groundwater
Sample Frequency	• Soil: 51 samples collected, minimum 1/500 CY treated • Groundwater: 20 samples collected, minimum 1/1600 square feet area treated
Quantity of Material Treated	• Soil: 20,962 Cubic Yards (27,000 ft^2 x 20-25 ft deep) • Groundwater: 185,000 gallons (27,000 ft^2 x 0-5 ft groundwater depth)
Concentrations of Treated and Untreated Contaminants	• Soil Initial Conditions: Maximum Cr (VI): 7,500 mg/kg • Soil Treated Conditions: Maximum Cr (VI): ND (<5 mg/kg) • Groundwater Initial Conditions: Maximum Cr (VI): 300,000 µg/L • Groundwater Treated Conditions: Maximum Cr (VI); ND (<800 µg/L)
Cleanup Objectives	• Soil: Cr (VI): <19 mg/kg • Groundwater: Cr (VI): <5,000 µg/L
Comparison with Cleanup Objectives	• The technology was very effective at meeting cleanup goals. The sulfur-based reagent reduced the Cr (VI) concentrations in soil and groundwater to non-detectable levels.
Method of Analysis	• Mobile Field Lab. Field Testing by USEPA ESAT contractor. Method: Colorimetric; Hach Test Kit.
Quality Assurance and Quality Control	• Weston Solutions was responsible for QA/QC • Sampling and analysis performed per EPA approved sampling and analysis plan • Sampling and analysis performed by USEPA ESAT contractor • Offsite lab duplicates analyzed • No exceptions to data quality noted
Other Residues	• Concrete Debris: 1,190 tons disposed offsite as nonhazardous waste. Analyzed in offsite lab for metals per EPA Method SW-6010B • Fluff Soil: 7,521 tons disposed offsite as nonhazardous material. Analyzed in offsite lab for total and TCLP metals per EPA Method SW-6010B

Factors Affecting Cost and Performance

Parameter	Value	Notes
Reagent Use	2% to 4.5%	Reagent cost was a significant factor in overall cost. Reagent cost accounted for approximately $20/CY soil treated
Treatment Depth	20 to 25 feet	Due to the stiff clayey silt and gravels below 20 feet, the time necessary to treat deeper increased and cost increased accordingly.
Buried Debris	1,190 tons	The majority of the site was pre-excavated to remove buried debris. This process had a large effect on cost. Excavation and disposal of debris accounted for approximately 6% of total project cost
Fluff Soil Disposal	7,521 tons	Fluff soil is a significant cost factor if excess soil can't be dealt with onsite. Offsite disposal can be very expensive depending on classification. Fluff soil disposal accounted for approximately 7% of the total project cost.

ISRM Treatment Wall Installation

ISRM Treatment Wall Installation Performance Information

Performance Topic	Specific Information
Technology Type and Specific Information	• Insitu Redox Manipulation • Treatment wall depth: 22 to 35 feet • Wall Length: 240 feet long x 30 feet wide • Reagent: Active ingredient—Sodium Dithionite
Soil Type	• Clayey silt underlain by sand/gravel
Types of Samples Collected	• Groundwater
Sample Frequency	• Groundwater: In-process
Quantity of Material Treated	• Not Applicable
Concentrations of Treated and Untreated Contaminants	• Groundwater Initial Conditions: Max Cr (VI): 72,000 µg/L • Groundwater Treated Conditions: Max Cr (VI): To be determined after sampling
Cleanup Objectives	• Groundwater: Cr (VI): 5,000 µg/L
Comparison with Cleanup Objectives	• To be determined. Operational samples have determined no-detectable concentrations of Cr (VI) within the treatment wall. Downgradient samples will be collected during long term monitoring.
Method of Analysis	• SW-6010B (future)
Quality Assurance and Quality Control	• Weston Solutions was responsible for QA/QC during treatment wall installation • Sampling and analysis during installation performed by PNNL • Future sampling and analysis to be performed by USEPA ESAT contractor
Other Residues	• None

Factors Affecting Cost and Performance

Parameter	Value	Notes
Subsurface Geology	Not Applicable	Complicated subsurface geology can lead to increased injection points increasing the cost for well installation and injection labor, modeling and testing. Injection and test wells accounted for approximately 17% of the overall cost.
Wall Length and Depth	Not Applicable	The greater the length and depth, the more reagent required. Reagent costs for this project accounted for approximately 21% of the overall cost.
Spacing between Injection Locations	Not Applicable	Closer spacing requires more injection wells and labor. However, reagent costs are less due to the wall being less wide.
Reagent Cost	5$/gallon (undiluted)	Dithionite reagent has a high cost.
Spent Reagent Extraction and Disposal	Not Applicable	Extraction of the reagent and its disposal can be costly. Disposal of the spent reagent to a POTW is a low cost disposal option that should be evaluated.

APPENDIX C

QUALITY ASSURANCE/QUALITY CONTROL INFORMATION

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
N14	6/23/03	14:30	24	2.25	3873	3873	7.763	13362	13362	57.96	58	Refusal at 24 feet
N15	6/23/03	12:47	25	9	16137	20010	25.521	45760	59122	60.37	118	
M7	6/24/03	9:05	15	2.25	0	20010	2.25	6825	65947	0	118	Refusal at 15 feet due to debris. Will be retreated.
A20	6/24/03	12:00	20	2.25	3227	23237	8.217	11786	77733	48.3	167	
A19	6/24/03	15:24	20	1.5	2152	25389	7.454	10692	88425	48.3	215	
A18	6/25/03	8:00	20	2.25	3227	28616	7.477	10725	99150	48.3	263	First production column
A17	6/25/03	9:15	20	2.25	3227	31843	5.557	7971	107121	48.3	312	
B20	6/25/03	10:30	20	2.25	3227	35070	5.576	7998	115119	48.3	360	
B19	6/25/03	11:05	20	2.25	3227	38297	5.579	8003	123122	48.3	408	
B18	6/25/03	11:45	20	2.25	3227	41524	5.564	7981	131103	48.3	456	
C17	6/25/03	13:00	20	2.25	3227	44751	5.408	7757	138860	48.3	505	
C18	6/25/03	15:30	20	2.25	3227	47978	5.57	5427	144287	48.3	553	
C19	6/25/03	14:45	20	2.25	3227	51205	5.57	7990	152277	48.3	601	
C20	6/25/03	17:15	20	2.25	3227	54432	5.618	8058	160335	48.3	650	
D20	6/26/03	8:48	20	2.25	3227	57659	5.568	7987	168322	48.3	698	
D19	6/26/03	9:28	20	2.25	3227	60886	5.595	8025	176347	48.3	746	
D18	6/26/03	10:05	20	2.25	3227	64113	5.572	7992	184339	48.3	795	
E20	6/28/03	8:52	20	2.044	1214	65327	0.846	1214	185553	48.3	843	New reagent delivery process fabricated. Poly tank monitored for each column. Problem with Ecobond calculation on Williams's spreadsheet indicates under-application of Ecobond in all holes treated today, <1%, or 140 gallons.
E19	6/28/03	9:40	20	2.044	1214	66541	0.846	1214	186767	48.3	891	
E18	6/28/03	10:12	20	2.044	1214	67755	0.846	1214	187981	48.3	939	
E17	6/28/03	10:50	20	2.044	1214	68969	0.846	1214	189195	48.3	988	
F20	6/28/03	11:40	20	2.044	1214	70183	0.846	1214	190409	48.3	1036	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
F19	6/28/03	13:00	20	2.044	1214	71397	0.846	1214	191623	48.3	1084	
F18	6/28/03	13:40	20	2.044	1214	72611	0.846	1214	192837	48.3	1133	
G20	6/28/03	14:30	20	2.044	1214	73825	0.846	1214	194051	48.3	1181	
G19	6/28/03	15:08	20	2.044	1214	75039	0.846	1214	195265	48.3	1229	
G18	6/30/03	9:40	20	2.044	2931	77970	2.044	2931	198196	48.3	1278	Tank calibrated to 2%, approx. 270 gallons
G17	6/30/03	10:45	20	2.044	2931	80901	2.044	2931	201127	48.3	1326	
H20	6/30/03	11:42	20	2.044	2931	83832	2.044	2931	204058	48.3	1374	
H19	6/30/03	12:46	20	2.044	2931	86763	2.044	2931	206989	48.3	1422	
H18	6/30/03	13:30	20	2.044	2931	89694	2.044	2931	209920	48.3	1471	
I20	6/30/03	14:10	20	2.044	2931	92625	2.044	2931	212851	48.3	1519	
I19	6/30/03	14:50	20	2.044	2931	95556	2.044	2931	215782	48.3	1567	
I18	6/30/03	15:30	20	2.044	2931	98487	2.044	2931	218713	48.3	1616	
I17	6/30/03	15:56	20	2.044	2931	101418	2.044	2931	221644	48.3	1664	
J18	6/30/03	17:00	20	2.044	2931	104349	2.044	2931	224575	48.3	1712	
J19	6/30/03	17:30	20	2.044	2931	107280	2.044	2931	227506	48.3	1761	
J20	6/30/03	18:10	20	2.044	2931	110211	2.044	2931	230437	48.3	1809	
K20	7/1/03	9:11	25	3.066	5496	115707	3.066	5496	235933	60.37	1869	Tank recalibrated for 3% and 25 feet, approx 513 gallons
K19	7/1/03	10:25	25	3.066	5496	121203	3.066	5496	241429	60.37	1930	
K18	7/1/03	11:00	25	3.066	5496	126699	3.066	5496	246925	60.37	1990	
K17	7/1/03	11:30	25	3.066	5496	132195	3.066	5496	252421	60.37	2050	
L18	7/1/03	13:45	25	3.066	5496	137691	3.066	5496	257917	60.37	2111	
L19	7/1/03	14:08	25	3.066	5496	143187	3.066	5496	263413	60.37	2171	
L20	7/1/03	14:45	25	3.066	5496	148683	3.066	5496	268909	60.37	2231	
M20	7/1/03	15:15	25	3.066	5496	154179	3.066	5496	274405	60.37	2292	
M19	7/1/03	15:30	25	3.066	5496	159675	3.066	5496	279901	60.37	2352	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
M18	7/1/03	16:00	25	3.066	5496	165171	3.066	5496	285397	60.37	2413	
M17	7/1/03	16:41	25	3.066	5496	170667	3.066	5496	290893	60.37	2473	
N21	7/2/03	7:55	25	3.066	5496	176163	3.066	5496	296389	60.37	2533	
N20	7/2/03	9:00	25	3.066	5496	181659	3.066	5496	301885	60.37	2594	
N19	7/2/03	9:55	25	3.066	5496	187155	3.066	5496	307381	60.37	2654	
N18	7/2/03	11:00	25	3.066	5496	192651	3.066	5496	312877	60.37	2714	
O20	7/2/03	12:30	25	3.066	5496	198147	3.066	5496	318373	60.37	2775	
O19	7/2/03	13:00	25	3.066	5496	203643	3.066	5496	323869	60.37	2835	
O18	7/2/03	14:45	25	3.066	5496	209139	3.066	5496	329365	60.37	2895	
O17	7/3/03	14:45	25	3.066	5496	214635	3.066	5496	334861	60.37	2956	
R21	7/7/03	9:00	20	3.066	4397	219032	3.066	4397	339258	48.3	3004	
T21	7/7/03	10:00	20	3.066	4397	223429	3.066	4397	343655	48.3	3052	
U17	7/7/03	11:00	20	3.066	4397	227826	3.066	4397	348052	48.3	3101	
U18	7/7/03	12:00	20	3.066	4397	232223	3.066	4397	352449	48.3	3149	
U19	7/7/03	13:00	20	3.066	4397	236620	3.066	4397	356846	48.3	3197	
U20	7/7/03	14:00	20	3.066	4397	241017	3.066	4397	361243	48.3	3246	
U16	7/8/03	7:00	20	3.066	4397	245414	3.066	4397	365640	48.3	3294	
U15	7/8/03	7:30	20	3.066	4397	249811	3.066	4397	370037	48.3	3342	
U14	7/8/03	8:00	20	3.066	4397	254208	3.066	4397	374434	48.3	3391	
U13	7/8/03	9:00	20	3.066	4397	258605	3.066	4397	378831	48.3	3439	
U12	7/8/03	10:00	20	3.066	4397	263002	3.066	4397	383228	48.3	3487	
U11	7/8/03	10:30	20	3.066	4397	267399	3.066	4397	387625	48.3	3535	
U10	7/8/03	11:00	20	3.066	4397	271796	3.066	4397	392022	48.3	3584	
U9	7/8/03	12:00	20	3.066	4397	276193	3.066	4397	396419	48.3	3632	
U8	7/8/03	13:00	20	3.066	4397	280590	3.066	4397	400816	48.3	3680	
U7	7/8/03	14:00	20	3.066	4397	284987	3.066	4397	405213	48.3	3729	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
U6	7/8/03	15:00	18.5	3.066	4397	289384	3.066	4397	409610	44.7	3773	Refusal at 18.5 feet
U5	7/8/03	16:00	19	3.066	4397	293781	3.066	4397	414007	45.9	3819	Refusal at 19 feet
S20	7/9/03	7:00	20	3.066	4397	298178	3.066	4397	418404	48.3	3868	
T20	7/9/03	8:00	20	3.066	4397	302575	3.066	4397	422801	48.3	3916	
T19	7/9/03	8:30	20	3.066	4397	306972	3.066	4397	427198	48.3	3964	
T18	7/9/03	9:00	20	3.066	4397	311369	3.066	4397	431595	48.3	4012	
T17	7/9/03	10:00	20	3.066	4397	315766	3.066	4397	435992	48.3	4061	
T16	7/9/03	10:30	20	3.066	4397	320163	3.066	4397	440389	48.3	4109	
T15	7/9/03	11:00	20	3.066	4397	324560	3.066	4397	444786	48.3	4157	
T14	7/9/03	12:00	20	3.066	4397	328957	3.066	4397	449183	48.3	4206	
T13	7/14/03	8:00	20	3.066	4397	333354	3.066	4397	453580	48.3	4254	
T12	7/14/03	9:00	20	3.066	4397	337751	3.066	4397	457977	48.3	4302	
T11	7/14/03	10:00	20	3.066	4397	342148	3.066	4397	462374	48.3	4351	
T10	7/14/03	11:00	20	3.066	4397	346545	3.066	4397	466771	48.3	4399	
T9	7/14/03	12:00	20	3.066	4397	350942	3.066	4397	471168	48.3	4447	
T8	7/14/03	13:00	20	3.066	4397	355339	3.066	4397	475565	48.3	4495	
T7	7/14/03	14:00	20	3.066	4397	359736	3.066	4397	479962	48.3	4544	
T6	7/14/03	15:00	20	3.066	4397	364133	3.066	4397	484359	48.3	4592	
T5	7/14/03	16:00	20	3.066	4397	368530	3.066	4397	488756	48.3	4640	
T4	7/14/03	17:00	20	3.066	4397	372927	3.066	4397	493153	48.3	4689	
S3	7/15/03	9:30	20	3.066	4397	377324	3.066	4397	497550	48.3	4737	
S4	7/15/03	10:00	20	3.066	4397	381721	3.066	4397	501947	48.3	4785	
S5	7/15/03	10:30	20	3.066	4397	386118	3.066	4397	506344	48.3	4834	
S6	7/15/03	11:00	20	3.066	4397	390515	3.066	4397	510741	48.3	4882	
S7	7/15/03	11:30	20	3.066	4397	394912	3.066	4397	515138	48.3	4930	
S8	7/15/03	12:00	20	3.066	4397	399309	3.066	4397	519535	48.3	4978	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
S9	7/15/03	13:00	20	3.066	4397	403706	3.066	4397	523932	48.3	5027	
S10	7/15/03	14:00	20	3.066	4397	408103	3.066	4397	528329	48.3	5075	
S11	7/15/03	13:00	20	3.066	4397	412500	3.066	4397	532726	48.3	5123	
S12	7/15/03	14:00	20	3.066	4397	416897	3.066	4397	537123	48.3	5172	
S13	7/15/03	15:00	20	3.066	4397	421294	3.066	4397	541520	48.3	5220	
S14	7/15/03	16:00	20	3.066	4397	425691	3.066	4397	545917	48.3	5268	
S15	7/15/03	17:00	20	3.066	4397	430088	3.066	4397	550314	48.3	5317	
S16	7/16/03	10:00	20	3.066	4397	434485	3.066	4397	554711	48.3	5365	
S17	7/16/03	11:00	20	3.066	4397	438882	3.066	4397	559108	48.3	5413	
S18	7/16/03	12:00	20	3.066	4397	443279	3.066	4397	563505	48.3	5461	
S19	7/16/03	13:00	20	3.066	4397	447676	3.066	4397	567902	48.3	5510	
Q20	7/16/03	13:30	20	3.066	4397	452073	3.066	4397	572299	48.3	5558	
R20	7/16/03	14:00	20	3.066	4397	456470	3.066	4397	576696	48.3	5606	
P20	7/16/03	15:00	20	3.066	4397	460867	3.066	4397	581093	48.3	5655	
P21	7/16/03	16:00	20	3.066	4397	465264	3.066	4397	585490	48.3	5703	
O19	7/16/03	17:00	24.5	3.066	4397	469661	3.066	5496	590986	59.2	5762	
O16	7/17/03	8:00	25	3.066	4397	474058	3.066	5496	596482	60.37	5823	Design called for 4.5% reagent
P16	7/17/03	8:30	20	3.066	4397	478455	3.066	4397	600879	48.3	5871	Design called for 4.5% reagent
P17	7/17/03	9:00	20	3.066	4397	482852	3.066	4397	605276	48.3	5919	
P18	7/17/03	9:30	20	3.066	4397	487249	3.066	4397	609673	48.3	5967	
P19	7/17/03	10:00	20	3.066	4397	491646	3.066	4397	614070	48.3	6016	
Q15	7/17/03	11:00	20	3.066	4397	496043	3.066	4397	618467	48.3	6064	
Q16	7/17/03	11:30	20	3.066	4397	500440	3.066	4397	622864	48.3	6112	
Q17	7/17/03	12:00	20	3.066	4397	504837	3.066	4397	627261	48.3	6161	
Q18	7/17/03	12:30	20	3.066	4397	509234	3.066	4397	631658	48.3	6209	
Q19	7/17/03	13:00	20	3.066	4397	513631	3.066	4397	636055	48.3	6257	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
R15	7/17/03	13:30	20	3.066	4397	518028	3.066	4397	640452	48.3	6306	
R16	7/17/03	14:00	20	3.066	4397	522425	3.066	4397	644849	48.3	6354	
R17	7/17/03	15:00	20	3.066	4397	526822	3.066	4397	649246	48.3	6402	
R18	7/17/03	16:00	20	3.066	4397	531219	3.066	4397	653643	48.3	6450	
R19	7/17/03	17:00	20	3.066	4397	535616	3.066	4397	658040	48.3	6499	
Q14	7/17/18/03	19:45	20	3.066	4397	540013	3.066	4397	662437	48.3	6547	Night shift
R14	7/17/18/03	20:17	20	3.066	4397	544410	3.066	4397	666834	48.3	6595	
Q13	7/17/18/03	21:20	20	3.066	4397	548807	3.066	4397	671231	48.3	6644	
R13	7/17/18/03	21:50	20	3.066	4397	553204	3.066	4397	675628	48.3	6692	
Q12	7/17/18/03	22:24	20	3.066	4397	557601	3.066	4397	680025	48.3	6740	
R12	7/17/18/03	22:55	20	3.066	4397	561998	3.066	4397	684422	48.3	6789	
Q11	7/17/18/03	23:32	20	3.066	4397	566395	3.066	4397	688819	48.3	6837	
R11	7/17/18/03	0:20	20	3.066	4397	570792	3.066	4397	693216	48.3	6885	
Q10	7/17/18/03	2:00	20	3.066	4397	575189	3.066	4397	697613	48.3	6933	
R10	7/17/18/03	2:33	20	3.066	4397	579586	3.066	4397	702010	48.3	6982	
Q9	7/17/18/03	4:00	20	3.066	4397	583983	3.066	4397	706407	48.3	7030	
Q8	7/18/03	12:00	20	3.066	4397	588380	3.066	4397	710804	48.3	7078	Day shift
R9	7/18/03	12:30	20	3.066	4397	592777	3.066	4397	715201	48.3	7127	
R8	7/18/03	13:00	20	3.066	4397	597174	3.066	4397	719598	48.3	7175	
J10	7/18/03	16:00	20	2.044	2931	600105	2.044	2931	722529	48.3	7223	
I10	7/18/03	17:00	20	2.044	2931	603036	2.044	2931	725460	48.3	7272	
H10	7/18/03	18:00	20	2.044	2931	605967	2.044	2931	728391	48.3	7320	
E10	7/18/19/03	19:00	20	2.044	2931	608898	2.044	2934	731325	48.3	7368	Night shift
D10	7/18/19/03	20:00	20	2.044	2931	611829	2.044	2934	734259	48.3	7416	
G10	7/18/19/03	21:00	20	2.044	2931	614760	2.044	2934	737193	48.3	7465	
F10	7/18/19/03	22:30	20	2.044	2931	617691	2.044	2934	740127	48.3	7513	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
I9	7/18/19/03	23:45	20	2.044	2931	620622	2.044	2934	743061	48.3	7561	
G9	7/18/19/03	1:00	20	2.044	2931	623553	2.044	2934	745995	48.3	7610	
E9	7/18/19/03	1:45	20	2.044	2931	626484	2.044	2934	748929	48.3	7658	
H9	7/18/19/03	2:30	20	2.044	2931	629415	2.044	2934	751863	48.3	7706	
D9	7/18/19/03	3:00	20	2.044	2931	632346	2.044	2934	754797	48.3	7755	
F9	7/18/19/03	3:30	20	2.044	2931	635277	2.044	2934	757731	48.3	7803	
R4	7/21/03	9:00	20	3.066	4397	639674	3.066	4397	762128	48.3	7851	Day shift
R5	7/21/03	10:00	20	3.066	4397	644071	3.066	4397	766525	48.3	7899	
R6	7/21/03	11:00	20	3.066	4397	648468	3.066	4397	770922	48.3	7948	
R7	7/21/03	12:00	20	3.066	4397	652865	3.066	4397	775319	48.3	7996	
Q7	7/21/03	13:00	20	3.066	4397	657262	3.066	4397	779716	48.3	8044	
Q6	7/21/03	14:00	20	3.066	4397	661659	3.066	4397	784113	48.3	8093	
Q5	7/21/03	15:00	20	3.066	4397	666056	3.066	4397	788510	48.3	8141	
Q4	7/21/03	16:00	20	3.066	4397	670453	3.066	4397	792907	48.3	8189	
R3	7/21/03	16:30	15	3.066	4397	674850	3.066	4397	797304	36.22	8225	Refusal at 15 feet due to debris. Will be retreated.
Q1	7/21/03	17:00	15	3.066	4397	679247	3.066	4397	801701	33.81	8259	Refusal at 15 feet due to debris. Will be retreated.
Q3	7/21/03	17:30	15	3.066	4397	683644	3.066	4397	806098	31.39	8291	Refusal at 15 feet due to debris. Will be retreated.
P15	7/21/22/03	20:30	20	4.5	6454	690098	4.5	6454	812552	48.3	8339	Night shift
P14	7/21/22/03	21:00	20	4.5	6454	696552	4.5	6454	819006	48.3	8387	
P13	7/21/22/03	22:30	20	4.5	6454	703006	4.5	6454	825460	48.3	8436	
P12	7/21/22/03	23:15	20	4.5	6454	709460	4.5	6454	831914	48.3	8484	
P11	7/21/22/03	24:00:00	20	4.5	6454	715914	4.5	6454	838368	48.3	8532	
P10	7/21/22/03	1:00	25	4.5	8068	723982	4.5	8068	846436	60.37	8593	
P9	7/21/22/03	2:00	25	4.5	8068	732050	4.5	8068	854504	60.37	8653	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
P8	7/21/22/03	2:30	25	4.5	8068	740118	4.5	8068	862572	60.37	8713	
P7	7/21/22/03	4:30	23	4.5	8068	748186	4.5	8068	870640	55.54	8769	Refusal at 23 feet.
P6	7/22/03	9:00	25	4.5	8068	756254	4.5	8068	878708	60.37	8829	Day shift
O9	7/22/03	10:00	25	4.5	8068	764322	4.5	8068	886776	60.37	8890	
O10	7/22/03	11:00	25	4.5	8068	772390	4.5	8068	894844	60.37	8950	
O11	7/22/03	12:00	25	4.5	8068	780458	4.5	8068	902912	60.37	9010	
N10	7/22/03	13:00	25	4.5	8068	788526	4.5	8068	910980	60.37	9071	
M10	7/22/03	14:00	25	4.5	8068	796594	4.5	8068	919048	60.37	9131	
M9	7/28/29/03	18:00	25	4.5	8068	804662	4.5	8068	927116	60.37	9191	Night shift
N9	7/28/29/03	19:00	25	4.5	8068	812730	4.5	8068	935184	60.37	9252	
O8	7/28/29/03	20:00	24	4.5	8068	820798	4.5	8068	943252	57.96	9310	Refusal at 24 feet
M8	7/28/29/03	20:30	25	4.5	8068	828866	4.5	8068	951320	60.37	9370	
N8	7/28/29/03	21:00	25	4.5	8068	836934	4.5	8068	959388	60.37	9430	Refusal at 24 feet
O7	7/28/29/03	24:00:00	21	4.5	8068	845002	4.5	8068	967456	50.71	9481	Refusal at 21 feet, will be retreated
K10	7/28/29/03	01:30	25	4.5	8068	853070	4.5	8068	975524	60.37	9542	
L10	7/28/29/03	02:00	25	4.5	8068	861138	4.5	8068	983592	60.37	9602	
M7	7/28/29/03	03:00	24	4.5	8068	869206	4.5	8068	991660	57.96	9660	Refusal at 24 feet
L9	7/29/03	10:00	23	4.5	8068	877274	4.5	8068	999728	55.54	9715	Day shift. Refusal at 23 feet
K9	7/29/03	11:00	23	4.5	8068	885342	4.5	8068	1007796	55.54	9771	Refusal at 23 feet
H9	7/29/03	13:00	20	2.044	0	885342	2.044	0	1007796	0	9771	Drilled by mistake. Treated previously.
G8	7/29/03	14:00	20	2.044	2934	888276	2.044	2934	1010730	48.3	9819	
G7	7/29/03	16:00	20	2.044	2934	891210	2.044	2934	1013664	48.3	9868	
F7	7/29/30/03	6:28	20	2.044	2934	894144	2.044	2934	1016598	48.3	9916	Night shift
E6	7/29/30/03	7:01	20	2.044	2934	897078	2.044	2934	1019532	48.3	9964	
D6	7/29/30/03	7:32	13	2.044	2934	900012	2.044	2934	1022466	31.39	9996	Refusal at 13 feet. No Grout. Will be retreated.
F8	7/29/30/03	8:50	20	2.044	2934	902946	2.044	2934	1025400	48.3	10044	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
E7	7/29/30/03	9:33	20	2.044	2934	905880	2.044	2934	1028334	48.3	10092	
D7	7/29/30/03	10:07	13	2.044	2934	908814	2.044	2934	1031268	33.81	10126	Refusal at 13 feet. No Grout. Will be retreated.
E8	7/29/30/03	11:21	20	2.044	2934	911748	2.044	2934	1034202	48.3	10174	
D8	7/29/30/03	12:40	20	2.044	2934	914682	2.044	2934	1037136	48.3	10223	
C7	7/29/30/03	1:22	20	2.044	2934	917616	2.044	2934	1040070	48.3	10271	
C8	7/29/30/03	2:41	20	2.044	2934	920550	2.044	2934	1043004	48.3	10319	
C9	7/29/30/03	3:28	20	2.044	2934	923484	2.044	2934	1045938	48.3	10367	
C10	7/29/30/03	4:08	20	2.044	2934	926418	2.044	2934	1048872	48.3	10416	
B8	7/30/03	19:00	10	2.044	0	926418	2.044	0	1048872	0	10416	Day shift, refusal at 10 feet; will be retreated.
JJ14	7/30/31/03	21:00	25	4.5	2903	929321	4.5	2903	1051775	21.72	10437	Night shift
KK13	7/30/31/03	22:00	25	4.5	2903	932224	4.5	2903	1054678	21.72	10459	
JJ13	7/30/31/03	23:00	25	4.5	2903	935127	4.5	2903	1057581	21.72	10481	
NN10	7/30/31/03	0:30	25	4.5	2903	938030	4.5	2903	1060484	21.72	10503	
NN9	7/30/31/03	1:15	25	4.5	2903	940933	4.5	2903	1063387	21.72	10524	
MM13	7/30/31/03	2:00	25	4.5	2903	943836	4.5	2903	1066290	21.72	10546	
LL13	7/30/31/03	2:45	25	4.5	2903	946739	4.5	2903	1069193	21.72	10568	
MM12	7/30/31/03	3:30	25	4.5	2903	949642	4.5	2903	1072096	21.72	10590	
MM11	7/30/31/03	4:00	25	4.5	2903	952545	4.5	2903	1074999	21.72	10611	
MM10	7/30/31/03	4:30	25	4.5	2903	955448	4.5	2903	1077902	21.72	10633	
LL12	7/30/31/03	5:00	25	4.5	2903	958351	4.5	2903	1080805	21.72	10655	
LL11	7/31/03	7:30	25	4.5	2903	961254	4.5	2903	1083708	21.72	10676	Day shift
LL10	7/31/03	8:00	25	4.5	2903	964157	4.5	2903	1086611	21.72	10698	
LL9	7/31/03	8:30	25	4.5	2903	967060	4.5	2903	1089514	21.72	10720	
KK12	7/31/03	9:30	25	4.5	2903	969963	4.5	2903	1092417	21.72	10742	
KK11	7/31/03	10:00	25	4.5	2903	972866	4.5	2903	1095320	21.72	10763	
KK10	7/31/03	10:30	25	4.5	2903	975769	4.5	2903	1098223	21.72	10785	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
KK9	7/31/03	11:00	25	4.5	2903	978672	4.5	2903	1101126	21.72	10807	
KK8	7/31/03	11:30	25	4.5	2903	981575	4.5	2903	1104029	21.72	10828	
JJ12	7/31/03	14:30	25	4.5	2903	984478	4.5	2903	1106932	21.72	10850	
JJ11	7/31/03	15:00	25	4.5	2903	987381	4.5	2903	1109835	21.72	10872	
JJ10	7/31/03	16:30	25	4.5	2903	990284	4.5	2903	1112738	21.72	10894	
JJ9	7/31/03	17:00	25	4.5	2903	993187	4.5	2903	1115641	21.72	10915	
JJ8	7/31/03	17:30	25	4.5	2903	996090	4.5	2903	1118544	21.72	10937	
II14	7/31/8/1/03	18:30	25	2.044	1319	997409	2.044	1319	1119863	21.72	10959	Night shift
HH14	7/31/8/1/03	19:30	25	2.044	1319	998728	2.044	1319	1121182	21.72	10980	
II13	7/31/8/1/03	20:30	25	2.044	1319	1000047	2.044	1319	1122501	21.72	11002	
II12	7/31/8/1/03	21:30	25	2.044	1319	1001366	2.044	1319	1123820	21.72	11024	
II11	7/31/8/1/03	22:30	25	2.044	1319	1002685	2.044	1319	1125139	21.72	11046	
GG13	7/31/8/1/03	23:15	20	2.044	1055	1003740	2.044	1055	1126194	17.38	11063	
HH13	7/31/8/1/03	24:00	25	2.044	1319	1005059	2.044	1319	1127513	21.72	11085	
II10	7/31/8/1/03	0:30	25	2.044	1319	1006378	2.044	1319	1128832	21.72	11106	
HH12	7/31/8/1/03	1:00	25	2.044	1319	1007697	2.044	1319	1130151	21.72	11128	
FF13	7/31/8/1/03	1:30	20	2.044	1055	1008752	2.044	1055	1131206	17.38	11146	Not grouted due to rig failure. Grouting occurred on 8/1 night shift.
GG12	8/1/2/03	19:00	25	2.044	1319	1010071	2.044	1319	1132525	21.72	11167	Night shift
II9	8/1/2/03	20:00	25	2.044	1319	1011390	2.044	1319	1133844	21.72	11189	
II8	8/1/2/03	20:30	25	2.044	1319	1012709	2.044	1319	1135163	21.72	11211	
HH11	8/1/2/03	21:15	25	2.044	1319	1014028	2.044	1319	1136482	21.72	11232	
HH10	8/1/2/03	22:00	25	2.044	1319	1015347	2.044	1319	1137801	21.72	11254	
HH9	8/1/2/03	23:00	25	2.044	1319	1016666	2.044	1319	1139120	21.72	11276	
HH8	8/1/2/03	24:00:00	25	2.044	1319	1017985	2.044	1319	1140439	21.72	11298	
EE13	8/1/2/03	0:30	20	2.044	1055	1019040	2.044	1055	1141494	17.38	11315	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
FF12	8/1/2/03	1:19	25	2.044	1319	1020359	2.044	1319	1142813	21.72	11337	
EE12	8/1/2/03	1:22	20	2.044	1055	1021414	2.044	1055	1143868	17.38	11354	
GG11	8/1/2/03	2:17	25	2.044	1319	1022733	2.044	1319	1145187	21.72	11376	
GG10	8/1/2/03	2:48	25	2.044	1319	1024052	2.044	1319	1146506	21.72	11398	
GG9	8/1/2/03	3:40	25	2.044	1319	1025371	2.044	1319	1147825	21.72	11419	
GG8	8/1/2/03	4:14	25	2.044	1319	1026690	2.044	1319	1149144	21.72	11441	
EE11	8/1/2/03	4:50	25	2.044	1319	1028009	2.044	1319	1150463	21.72	11463	
FF11	8/1/2/03	5:20	25	2.044	1319	1029328	2.044	1319	1151782	21.72	11484	
FF10	8/2/03	8:30	25	2.044	1319	1030647	2.044	1319	1153101	21.72	11506	Day shift
FF9	8/2/03	9:00	25	2.044	1319	1031966	2.044	1319	1154420	21.72	11528	
FF8	8/2/03	9:30	24	2.044	1319	1033285	2.044	1319	1155739	20.86	11549	Treated to 24 ft instead of 25
EE9	8/2/03	10:00	25	2.044	1319	1034604	2.044	1319	1157058	21.72	11570	
EE8	8/2/03	10:30	24	2.044	1319	1035923	2.044	1319	1158377	20.86	11591	Treated to 24 ft instead of 25
DD10	8/2/03	11:00	25	2.044	1319	1037242	2.044	1319	1159696	21.72	11613	
DD9	8/2/03	11:30	25	2.044	1319	1038561	2.044	1319	1161015	21.72	11635	
DD8	8/2/03	12:00	25	2.044	1319	1039880	2.044	1319	1162334	21.72	11656	
CC9	8/2/03	13:00	25	2.044	1319	1041199	2.044	1319	1163653	21.72	11678	
EE10	8/2/03	13:30	25	2.044	1319	1042518	2.044	1319	1164972	21.72	11700	
CC8	8/2/03	14:00	25	2.044	1319	1043837	2.044	1319	1166291	21.72	11722	
CC7	8/2/03	14:30	25	2.044	1319	1045156	2.044	1319	1167610	21.72	11743	
BB9	8/2/03	15:30	25	2.044	1319	1046475	2.044	1319	1168929	21.72	11765	
BB8	8/2/03	16:00	25	2.044	1319	1047794	2.044	1319	1170248	21.72	11787	
BB7	8/2/03	17:00	25	2.044	1319	1049113	2.044	1319	1171567	21.72	11808	
AA8	8/2/3/03	18:55	20	2.044	1055	1050168	2.044	1055	1172622	17.38	11826	Night shift
AA7	8/2/3/03	20:00	25	2.044	1319	1051487	2.044	1319	1173941	21.72	11848	
Z12	8/2/3/03	21:10	20	2.044	1055	1052542	2.044	1055	1174996	17.38	11865	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
Z7	8/2/3/03	21:40	20	2.044	1055	1053597	2.044	1055	1176051	17.38	11882	
Z10	8/2/3/03	22:05	20	2.044	1055	1054652	2.044	1055	1177106	17.38	11900	
Z6	8/2/3/03	22:30	20	2.044	1055	1055707	2.044	1055	1178161	17.38	11917	
Z9	8/2/3/03	22:59	20	2.044	1055	1056762	2.044	1055	1179216	17.38	11934	
Z5	8/2/3/03	23:00	20	2.044	1055	1057817	2.044	1055	1180271	17.38	11952	
Z2	8/2/3/03	23:19	20	2.044	1055	1058872	2.044	1055	1181326	17.38	11969	
Y4	8/2/3/03	1:00	20	2.044	1055	1059927	2.044	1055	1182381	17.38	11987	
X5	8/2/3/03	1:30	20	2.044	1055	1060982	2.044	1055	1183436	17.38	12004	
X6	8/2/3/03	2:00	20	2.044	1055	1062037	2.044	1055	1184491	17.38	12021	
X7	8/2/3/03	2:21	20	2.044	1055	1063092	2.044	1055	1185546	17.38	12039	
X8	8/2/3/03	2:53	20	2.044	1055	1064147	2.044	1055	1186601	17.38	12056	
X9	8/2/3/03	3:15	20	2.044	1055	1065202	2.044	1055	1187656	17.38	12074	
X10	8/2/3/03	3:40	20	2.044	1055	1066257	2.044	1055	1188711	17.38	12091	
W10	8/2/3/03	4:00	20	2.044	1055	1067312	2.044	1055	1189766	17.38	12108	
W9	8/2/3/03	4:19	20	2.044	1055	1068367	2.044	1055	1190821	17.38	12126	
V10	8/2/3/03	4:40	20	2.044	1055	1069422	2.044	1055	1191876	17.38	12143	
V9	8/2/3/03	5:09	20	2.044	1055	1070477	2.044	1055	1192931	17.38	12160	
W8	8/3/03	5:25	20	2.044	1055	1071532	2.044	1055	1193986	17.38	12178	Day shift
W7	8/3/03	6:14	20	2.044	1055	1072587	2.044	1055	1195041	17.38	12195	
V8	8/3/03	5:49	20	2.044	1055	1073642	2.044	1055	1196096	17.38	12213	
V7	8/3/03	6:34	20	2.044	1055	1074697	2.044	1055	1197151	17.38	12230	
WW5	8/6/03	14:30	20	3.066	1583	1076280	3.066	1583	1198734	17.38	12247	
WW4	8/6/03	15:00	20	3.066	1583	1077863	3.066	1583	1200317	17.38	12265	
VV4	8/6/03	15:30	20	3.066	1583	1079446	3.066	1583	1201900	17.38	12282	
VV3	8/6/03	16:00	20	3.066	1583	1081029	3.066	1583	1203483	17.38	12299	
VV2	8/6/03	16:30	20	3.066	1583	1082612	3.066	1583	1205066	17.38	12317	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
UU6	8/6/03	17:00	20	3.066	1583	1084195	3.066	1583	1206649	17.38	12334	
UU5	8/6/03	17:30	20	3.066	1583	1085778	3.066	1583	1208232	17.38	12352	
TT6	8/6/03	18:00	20	4.5	2323	1088101	4.5	2323	1210555	17.38	12369	
UU4	8/6/7/03	18:27	20	3.066	1583	1089684	3.066	1583	1212138	17.38	12386	Night shift
UU3	8/6/7/03	18:51	20	3.066	1583	1091267	3.066	1583	1213721	17.38	12404	
UU2	8/6/7/03	19:25	20	3.066	1583	1092850	3.066	1583	1215304	17.38	12421	
TT0	8/6/7/03	19:55	20	4.5	2323	1095173	4.5	2323	1217627	17.38	12438	
TT1	8/6/7/03	20:17	20	4.5	2323	1097496	4.5	2323	1219950	17.38	12456	
TT2	8/6/7/03	20:47	20	4.5	2323	1099819	4.5	2323	1222273	17.38	12473	
TT7	8/6/7/03	21:11	20	4.5	2323	1102142	4.5	2323	1224596	17.38	12491	
TT3	8/6/7/03	21:42	20	4.5	2323	1104465	4.5	2323	1226919	17.38	12508	
TT4	8/6/7/03	22:07	20	4.5	2323	1106788	4.5	2323	1229242	17.38	12525	
TT5	8/6/7/03	22:33	20	4.5	2323	1109111	4.5	2323	1231565	17.38	12543	
SS8	8/6/7/03	23:03	25	4.5	2903	1112014	4.5	2903	1234468	21.72	12564	
SS7	8/6/7/03	0:45	25	4.5	2903	1114917	4.5	2903	1237371	21.72	12586	
SS6	8/6/7/03	1:18	25	4.5	2903	1117820	4.5	2903	1240274	21.72	12608	
SS5	8/6/7/03	1:42	25	4.5	2903	1120723	4.5	2903	1243177	21.72	12630	
SS4	8/6/7/03	2:15	25	4.5	2903	1123626	4.5	2903	1246080	21.72	12651	
SS3	8/6/7/03	2:44	25	4.5	2903	1126529	4.5	2903	1248983	21.72	12673	
SS2	8/6/7/03	3:17	25	4.5	2903	1129432	4.5	2903	1251886	21.72	12695	
SS1	8/6/7/03	3:43	25	4.5	2903	1132335	4.5	2903	1254789	21.72	12717	
RR0	8/7/03	8:09	25	4.5	2903	1135238	4.5	2903	1257692	21.72	12738	Day shift
RR1	8/7/03	8:47	25	4.5	2903	1138141	4.5	2903	1260595	21.72	12760	
RR2	8/7/03	9:12	25	4.5	2903	1141044	4.5	2903	1263498	21.72	12782	
RR3	8/7/03	9:36	25	4.5	2903	1143947	4.5	2903	1266401	21.72	12803	
RR4	8/7/03	10:10	25	4.5	2903	1146850	4.5	2903	1269304	21.72	12825	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
RR5	8/7/03	10:39	24	4.5	2903	1149753	4.5	2903	1272207	20.86	12846	Refusal at 24 feet
RR11	8/7/03	12:50	21	4.5	2903	1152656	4.5	2903	1275110	18.24	12864	Refusal at 21 feet
RR12	8/7/03	12:25	25	4.5	2903	1155559	4.5	2903	1278013	21.72	12886	
QQ12	8/7/03	13:01	23	4.5	2903	1158462	4.5	2903	1280916	19.98	12906	Refusal at 23 feet
RR10	8/7/03	13:31	23	4.5	2903	1161365	4.5	2903	1283819	19.98	12926	Refusal at 23 feet
QQ11	8/7/03	14:11	24	4.5	2903	1164268	4.5	2903	1286722	20.85	12947	Refusal at 24 feet
PP11	8/7/03	15:10	23	4.5	2903	1167171	4.5	2903	1289625	19.98	12967	Refusal at 23 feet
RR9	8/7/03	15:26	23	4.5	2903	1170074	4.5	2903	1292528	19.98	12987	Refusal at 23 feet
QQ10	8/7/03	16:08	25	4.5	2903	1172977	4.5	2903	1295431	21.72	13008	
PP10	8/7/03	16:29	24	4.5	2903	1175880	4.5	2903	1298334	20.85	13029	Refusal at 24 feet
OO11	8/7/03	17:00	23	4.5	2903	1178783	4.5	2903	1301237	19.98	13049	Refusal at 23 feet
OO10	8/7/8/03	18:35	25	4.5	2903	1181686	4.5	2903	1304140	21.72	13071	Night shift
PP9	8/7/8/03	19:12	25	4.5	2903	1184589	4.5	2903	1307043	21.72	13093	
QQ9	8/7/8/03	20:40	25	4.5	2903	1187492	4.5	2903	1309946	21.72	13114	
RR8	8/7/8/03	21:32	25	4.5	2903	1190395	4.5	2903	1312849	21.72	13136	
RR7	8/7/8/03	22:22	25	4.5	2903	1193298	4.5	2903	1315752	21.72	13158	
RR6	8/7/8/03	22:53	25	4.5	2903	1196201	4.5	2903	1318655	21.72	13180	
QQ8	8/7/8/03	0:26	25	4.5	2903	1199104	4.5	2903	1321558	21.72	13201	
PP8	8/7/8/03	0:59	25	4.5	2903	1202007	4.5	2903	1324461	21.72	13223	
OO9	8/7/8/03	1:38	25	4.5	2903	1204910	4.5	2903	1327364	21.72	13245	
QQ7	8/7/8/03	2:15	25	4.5	2903	1207813	4.5	2903	1330267	21.72	13266	
PP7	8/7/8/03	2:45	25	4.5	2903	1210716	4.5	2903	1333170	21.72	13288	
OO8	8/7/8/03	3:18	25	4.5	2903	1213619	4.5	2903	1336073	21.72	13310	
NN8	8/7/8/03	3:57	25	4.5	2903	1216522	4.5	2903	1338976	21.72	13332	
MM9	8/8/03	10:35	25	4.5	2903	1219425	4.5	2903	1341879	21.72	13353	Day shift
LL8	8/8/03	11:01	25	4.5	2903	1222328	4.5	2903	1344782	21.72	13375	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
MM8	8/8/03	11:45	25	4.5	2903	1225231	4.5	2903	1347685	21.72	13397	
NN7	8/8/03	12:55	25	4.5	2903	1228134	4.5	2903	1350588	21.72	13419	
OO7	8/8/03	13:16	25	4.5	2903	1231037	4.5	2903	1353491	21.72	13440	
PP6	8/8/03	13:52	25	4.5	2903	1233940	4.5	2903	1356394	21.72	13462	
QQ6	8/8/03	14:16	25	4.5	2903	1236843	4.5	2903	1359297	21.72	13484	
KK7	8/8/03	15:05	25	4.5	2903	1239746	4.5	2903	1362200	21.72	13505	
LL7	8/8/03	15:35	25	4.5	2903	1242649	4.5	2903	1365103	21.72	13527	
MM7	8/8/03	16:02	25	4.5	2903	1245552	4.5	2903	1368006	21.72	13549	
NN6	8/8/03	16:25	25	4.5	2903	1248455	4.5	2903	1370909	21.72	13571	
OO6	8/8/03	16:50	25	4.5	2903	1251358	4.5	2903	1373812	21.72	13592	
QQ1	8/8/9/03	18:57	25	4.5	2903	1254261	4.5	2903	1376715	21.72	13614	Night shift
QQ2	8/8/9/03	19:30	25	4.5	2903	1257164	4.5	2903	1379618	21.72	13636	
QQ3	8/8/9/03	19:58	25	4.5	2903	1260067	4.5	2903	1382521	21.72	13657	
QQ4	8/8/9/03	20:27	25	4.5	2903	1262970	4.5	2903	1385424	21.72	13679	
QQ5	8/8/9/03	20:55	25	4.5	2903	1265873	4.5	2903	1388327	21.72	13701	
PP5	8/8/9/03	21:25	25	4.5	2903	1268776	4.5	2903	1391230	21.72	13723	
PP1	8/8/9/03	22:13	25	4.5	2903	1271679	4.5	2903	1394133	21.72	13744	
PP2	8/8/9/03	22:40	25	4.5	2903	1274582	4.5	2903	1397036	21.72	13766	
PP3	8/8/9/03	23:08	25	4.5	2903	1277485	4.5	2903	1399939	21.72	13788	
PP4	8/8/9/03	23:32	25	4.5	2903	1280388	4.5	2903	1402842	21.72	13809	
OO5	8/8/9/03	23:58	25	4.5	2903	1283291	4.5	2903	1405745	21.72	13831	
OO4	8/8/9/03	0:30	25	4.5	2903	1286194	4.5	2903	1408648	21.72	13853	
OO3	8/8/9/03	1:33	25	4.5	2903	1289097	4.5	2903	1411551	21.72	13875	
OO2	8/8/9/03	1:59	25	4.5	2903	1292000	4.5	2903	1414454	21.72	13896	
OO1	8/8/9/03	2:29	25	4.5	2903	1294903	4.5	2903	1417357	21.72	13918	
NN1	8/8/9/03	3:05	25	4.5	2903	1297806	4.5	2903	1420260	21.72	13940	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
NN5	8/8/9/03	3:36	25	4.5	2903	1300709	4.5	2903	1423163	21.72	13962	
NN4	8/8/9/03	4:16	25	4.5	2903	1303612	4.5	2903	1426066	21.72	13983	
NN3	8/9/03	7:45	25	4.5	2903	1306515	4.5	2903	1428969	21.72	14005	Day shift
NN2	8/9/03	8:18	25	4.5	2903	1309418	4.5	2903	1431872	21.72	14027	
MM1	8/9/03	8:50	25	4.5	2903	1312321	4.5	2903	1434775	21.72	14048	
MM2	8/9/03	9:20	25	4.5	2903	1315224	4.5	2903	1437678	21.72	14070	
MM3	8/9/03	9:48	25	4.5	2903	1318127	4.5	2903	1440581	21.72	14092	
MM4	8/9/03	10:12	25	4.5	2903	1321030	4.5	2903	1443484	21.72	14114	
MM5	8/9/03	10:32	25	4.5	2903	1323933	4.5	2903	1446387	21.72	14135	
MM6	8/11/03	8:05	25	4.5	2903	1326836	4.5	2903	1449290	21.72	14157	
LL6	8/11/03	8:40	25	4.5	2903	1329739	4.5	2903	1452193	21.72	14179	
LL5	8/11/03	9:16	25	4.5	2903	1332642	4.5	2903	1455096	21.72	14200	
LL4	8/11/03	9:47	24	4.5	2903	1335545	4.5	2903	1457999	20.85	14221	Refusal at 24 feet
LL3	8/11/03	10:16	24	4.5	2903	1338448	4.5	2903	1460902	20.85	14242	Refusal at 24 feet
LL2	8/11/03	10:37	24	4.5	2903	1341351	4.5	2903	1463805	20.85	14263	Refusal at 24 feet
LL1	8/11/03	11:11	25	4.5	2903	1344254	4.5	2903	1466708	21.72	14285	
KK6	8/11/03	13:10	25	4.5	2903	1347157	4.5	2903	1469611	21.72	14306	
JJ7	8/11/03	13:59	25	4.5	2903	1350060	4.5	2903	1472514	21.72	14328	
JJ6	8/11/03	14:21	25	4.5	2903	1352963	4.5	2903	1475417	21.72	14350	
KK5	8/11/03	13:31	25	4.5	2903	1355866	4.5	2903	1478320	21.72	14372	
KK4	8/11/03	14:41	25	4.5	2903	1358769	4.5	2903	1481223	21.72	14393	
KK3	8/11/03	15:02	25	4.5	2903	1361672	4.5	2903	1484126	21.72	14415	
KK2	8/11/03	15:34	25	4.5	2903	1364575	4.5	2903	1487029	21.72	14437	
KK1	8/11/03	16:00	25	4.5	2903	1367478	4.5	2903	1489932	21.72	14458	
JJ5	8/11/03	16:23	25	4.5	2903	1370381	4.5	2903	1492835	21.72	14480	
JJ4	8/11/03	16:49	25	4.5	2903	1373284	4.5	2903	1495738	21.72	14502	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
JJ3	8/11/03	17:13	25	4.5	2903	1376187	4.5	2903	1498641	21.72	14524	
JJ2	8/11/12/03	18:53	25	4.5	2903	1379090	4.5	2903	1501544	21.72	14545	Night shift
JJ1	8/11/12/03	19:32	25	4.5	2903	1381993	4.5	2903	1504447	21.72	14567	
II7	8/11/12/03	20:12	25	2.044	1319	1383312	2.044	1319	1505766	21.72	14589	
II6	8/11/12/03	20:49	25	2.044	1319	1384631	2.044	1319	1507085	21.72	14611	
II5	8/11/12/03	21:20	25	2.044	1319	1385950	2.044	1319	1508404	21.72	14632	
II4	8/11/12/03	21:48	25	2.044	1319	1387269	2.044	1319	1509723	21.72	14654	
II3	8/11/12/03	22:28	25	2.044	1319	1388588	2.044	1319	1511042	21.72	14676	
II2	8/11/12/03	22:58	25	2.044	1319	1389907	2.044	1319	1512361	21.72	14697	
II1	8/11/12/03	23:28	25	2.044	1319	1391226	2.044	1319	1513680	21.72	14719	
HH7	8/11/12/03	0:34	25	2.044	1319	1392545	2.044	1319	1514999	21.72	14741	
HH6	8/11/12/03	1:37	25	2.044	1319	1393864	2.044	1319	1516318	21.72	14763	
HH5	8/11/12/03	2:08	25	2.044	1319	1395183	2.044	1319	1517637	21.72	14784	
HH4	8/11/12/03	3:02	25	2.044	1319	1396502	2.044	1319	1518956	21.72	14806	
HH3	8/11/12/03	3:32	25	2.044	1319	1397821	2.044	1319	1520275	21.72	14828	
HH2	8/11/12/03	4:10	25	2.044	1319	1399140	2.044	1319	1521594	21.72	14849	
HH1	8/11/12/03	4:55	25	2.044	1319	1400459	2.044	1319	1522913	21.72	14871	
GG7	8/12/03	13:50	25	2.044	1319	1401778	2.044	1319	1524232	21.72	14893	Day shift
GG6	8/12/03	14:20	25	2.044	1319	1403097	2.044	1319	1525551	21.72	14915	
GG5	8/12/03	14:45	25	2.044	1319	1404416	2.044	1319	1526870	21.72	14936	
GG4	8/12/03	15:30	25	2.044	1319	1405735	2.044	1319	1528189	21.72	14958	
GG3	8/12/03	16:00	25	2.044	1319	1407054	2.044	1319	1529508	21.72	14980	
GG2	8/12/03	17:00	25	2.044	1319	1408373	2.044	1319	1530827	21.72	15001	
GG1	8/12/03	17:30	25	2.044	1319	1409692	2.044	1319	1532146	21.72	15023	
FF7	8/13/03	7:00	25	2.044	1319	1411011	2.044	1319	1533465	21.72	15045	
FF6	8/13/03	7:30	25	2.044	1319	1412330	2.044	1319	1534784	21.72	15067	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
FF5	8/13/03	8:00	25	2.044	1319	1413649	2.044	1319	1536103	21.72	15088	
FF4	8/13/03	8:30	25	2.044	1319	1414968	2.044	1319	1537422	21.72	15110	
FF3	8/13/03	9:00	25	2.044	1319	1416287	2.044	1319	1538741	21.72	15132	
FF2	8/13/03	9:30	25	2.044	1319	1417606	2.044	1319	1540060	21.72	15154	
FF1	8/13/03	10:00	25	2.044	1319	1418925	2.044	1319	1541379	21.72	15175	
EE7	8/13/03	10:30	25	2.044	1319	1420244	2.044	1319	1542698	21.72	15197	
EE6	8/13/03	11:00	25	2.044	1319	1421563	2.044	1319	1544017	21.72	15219	
EE5	8/13/03	11:30	25	2.044	1319	1422882	2.044	1319	1545336	21.72	15240	
EE4	8/13/03	12:00	25	2.044	1319	1424201	2.044	1319	1546655	21.72	15262	
EE3	8/13/03	12:30	25	2.044	1319	1425520	2.044	1319	1547974	21.72	15284	
EE2	8/13/03	13:00	24	2.044	1319	1426839	2.044	1319	1549293	20.86	15305	Refusal at 24 feet
EE1	8/13/03	13:30	24	2.044	1319	1428158	2.044	1319	1550612	20.85	15326	Refusal at 24 ft
DD7	8/13/03	14:00	24	2.044	1319	1429477	2.044	1319	1551931	20.85	15346	Refusal at 24 ft
DD6	8/13/03	14:30	25	2.044	1319	1430796	2.044	1319	1553250	21.72	15368	
DD5	8/13/03	15:00	25	2.044	1319	1432115	2.044	1319	1554569	21.72	15390	
DD4	8/13/03	15:30	25	2.044	1319	1433434	2.044	1319	1555888	21.72	15412	
DD3	8/13/03	16:00	25	2.044	1319	1434753	2.044	1319	1557207	21.72	15433	
DD2	8/13/03	16:30	25	2.044	1319	1436072	2.044	1319	1558526	21.72	15455	
CC1	8/14/03	7:30	25	2.044	1319	1437391	2.044	1319	1559845	21.72	15477	
CC2	8/14/03	8:00	25	2.044	1319	1438710	2.044	1319	1561164	21.72	15498	
CC3	8/14/03	8:30	25	2.044	1319	1440029	2.044	1319	1562483	21.72	15520	
CC4	8/14/03	9:00	24	2.044	1319	1441348	2.044	1319	1563802	20.86	15541	Refusal at 24 feet
CC5	8/14/03	9:30	25	2.044	1319	1442667	2.044	1319	1565121	21.72	15563	
CC6	8/14/03	10:00	25	2.044	1319	1443986	2.044	1319	1566440	21.72	15584	
BB2	8/14/03	10:30	25	2.044	1319	1445305	2.044	1319	1567759	21.72	15606	
BB3	8/14/03	11:00	24	2.044	1319	1446624	2.044	1319	1569078	20.86	15627	Refusal at 24 feet

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
BB4	8/14/03	11:30	24	2.044	1319	1447943	2.044	1319	1570397	20.86	15648	Refusal at 24 feet
BB5	8/14/03	12:30	25	2.044	1319	1449262	2.044	1319	1571716	21.72	15670	
BB6	8/14/03	13:30	24	2.044	1319	1450581	2.044	1319	1573035	20.86	15690	Refusal at 24 feet
AA6	8/14/03	15:00	25	2.044	1319	1451900	2.044	1319	1574354	21.72	15712	
AA5	8/15/03	8:06	24	2.044	1319	1453219	2.044	1319	1575673	20.86	15733	Refusal at 24 feet
AA4	8/15/03	8:37	24	2.044	1319	1454538	2.044	1319	1576992	20.86	15754	Refusal at 24 feet
AA3	8/15/03	9:12	24	2.044	1319	1455857	2.044	1319	1578311	20.86	15775	Refusal at 24 feet
O15	8/15/03	15:14	25	4.5	8068	1463925	4.5	8068	1586379	60.37	15835	
N17	8/15/03	16:02	25	4.5	8068	1471993	4.5	8068	1594447	60.37	15896	
O14	8/15/03	16:39	25	4.5	8068	1480061	4.5	8068	1602515	60.37	15956	
N16	8/16/03	8:58	25	4.5	8068	1488129	4.5	8068	1610583	60.37	16016	
M16	8/16/03	9:32	25	4.5	8068	1496197	4.5	8068	1618651	60.37	16077	
M15	8/16/03	10:18	24	4.5	8068	1504265	4.5	8068	1626719	57.96	16135	Refusal at 24 feet
L17	8/16/03	11:04	25	4.5	8068	1512333	4.5	8068	1634787	60.37	16195	
K16	8/16/03	11:40	25	4.5	8068	1520401	4.5	8068	1642855	60.37	16255	
L16	8/16/03	13:08	25	4.5	8068	1528469	4.5	8068	1650923	60.37	16316	
L15	8/16/03	13:53	25	4.5	8068	1536537	4.5	8068	1658991	60.37	16376	
K15	8/16/03	14:28	25	4.5	8068	1544605	4.5	8068	1667059	60.37	16436	
O13	8/16/03	15:05	25	4.5	8068	1552673	4.5	8068	1675127	60.37	16497	
O12	8/16/03	16:15	25	4.5	8068	1560741	4.5	8068	1683195	60.37	16557	
N11	8/18/03	7:43	25	4.5	8068	1568809	4.5	8068	1691263	60.37	16618	
N12	8/18/03	10:05	25	4.5	8068	1576877	4.5	8068	1699331	60.37	16678	
N13	8/18/03	9:23	25	4.5	8068	1584945	4.5	8068	1707399	60.37	16738	
M11	8/18/03	12:45	25	4.5	8068	1593013	4.5	8068	1715467	60.37	16799	
M12	8/18/03	11:26	25	4.5	8068	1601081	4.5	8068	1723535	60.37	16859	
M13	8/18/03	10:52	25	4.5	8068	1609149	4.5	8068	1731603	60.37	16919	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
M14	8/18/03	8:36	25	4.5	8068	1617217	4.5	8068	1739671	60.37	16980	
L11	8/18/03	13:20	25	4.5	8068	1625285	4.5	8068	1747739	60.37	17040	
L12	8/18/03	16:09	25	4.5	8068	1633353	4.5	8068	1755807	60.37	17100	
L13	8/18/03	15:37	25	4.5	8068	1641421	4.5	8068	1763875	60.37	17161	
L14	8/18/03	14:12	25	4.5	8068	1649489	4.5	8068	1771943	60.37	17221	
K11	8/18/03	18:10	25	4.5	8068	1657557	4.5	8068	1780011	60.37	17282	
K12	8/18/03	17:23	25	4.5	8068	1665625	4.5	8068	1788079	60.37	17342	
K13	8/18/03	16:49	25	4.5	8068	1673693	4.5	8068	1796147	60.37	17402	
K14	8/18/03	14:48	25	4.5	8068	1681761	4.5	8068	1804215	60.37	17463	
J11	8/21/03	14:12	20	2.044	2934	1684695	2.044	2934	1807149	48.3	17511	
J12	8/21/03	13:20	20	2.044	2934	1687629	2.044	2934	1810083	48.3	17559	
J13	8/21/03	12:45	20	2.044	2934	1690563	2.044	2934	1813017	48.3	17608	
J14	8/21/03	11:26	20	2.044	2934	1693497	2.044	2934	1815951	48.3	17656	
J15	8/21/03	10:52	20	2.044	2934	1696431	2.044	2934	1818885	48.3	17704	
J16	8/21/03	8:36	20	2.044	2934	1699365	2.044	2934	1821819	48.3	17753	
J17	8/21/03	7:43	20	2.044	2934	1702299	2.044	2934	1824753	48.3	17801	
I11	8/21/03	17:23	20	2.044	2934	1705233	2.044	2934	1827687	48.3	17849	
I12	8/21/03	16:49	20	2.044	2934	1708167	2.044	2934	1830621	48.3	17897	
I13	8/21/03	16:09	20	2.044	2934	1711101	2.044	2934	1833555	48.3	17946	
I14	8/21/03	15:37	20	2.044	2934	1714035	2.044	2934	1836489	48.3	17994	
I15	8/21/03	14:48	20	2.044	2934	1716969	2.044	2934	1839423	48.3	18042	
I16	8/21/03	10:05	20	2.044	2934	1719903	2.044	2934	1842357	48.3	18091	
H16	8/21/03	9:23	20	2.044	2934	1722837	2.044	2934	1845291	48.3	18139	
H17	8/21/03	18:10	20	2.044	2934	1725771	2.044	2934	1848225	48.3	18187	
H11	8/22/03	9:53	20	2.044	2934	1728705	2.044	2934	1851159	48.3	18236	
H12	8/22/03	9:24	20	2.044	2934	1731639	2.044	2934	1854093	48.3	18284	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
H13	8/22/03	9:00	20	2.044	2934	1734573	2.044	2934	1857027	48.3	18332	
H14	8/22/03	8:35	20	2.044	2934	1737507	2.044	2934	1859961	48.3	18380	
H15	8/22/03	7:45	20	2.044	2934	1740441	2.044	2934	1862895	48.3	18429	
G11	8/22/03	12:34	20	2.044	2934	1743375	2.044	2934	1865829	48.3	18477	
G12	8/22/03	12:13	20	2.044	2934	1746309	2.044	2934	1868763	48.3	18525	
G13	8/22/03	11:43	20	2.044	2934	1749243	2.044	2934	1871697	48.3	18574	
G14	8/22/03	11:19	20	2.044	2934	1752177	2.044	2934	1874631	48.3	18622	
G15	8/22/03	10:52	20	2.044	2934	1755111	2.044	2934	1877565	48.3	18670	
G16	8/22/03	10:26	20	2.044	2934	1758045	2.044	2934	1880499	48.3	18719	
F11	8/22/03	16:15	20	2.044	2934	1760979	2.044	2934	1883433	48.3	18767	
F12	8/22/03	15:16	20	2.044	2934	1763913	2.044	2934	1886367	48.3	18815	
F13	8/22/03	14:41	20	2.044	2934	1766847	2.044	2934	1889301	48.3	18863	
F14	8/22/03	14:11	20	2.044	2934	1769781	2.044	2934	1892235	48.3	18912	
F15	8/22/03	13:41	20	2.044	2934	1772715	2.044	2934	1895169	48.3	18960	
F16	8/22/03	13:15	20	2.044	2934	1775649	2.044	2934	1898103	48.3	19008	
F17	8/22/03	12:56	20	2.044	2934	1778583	2.044	2934	1901037	48.3	19057	
E11	8/23/03	7:30	20	2.044	2934	1781517	2.044	2934	1903971	48.3	19105	
E12	8/23/03	8:00	20	2.044	2934	1784451	2.044	2934	1906905	48.3	19153	
E13	8/23/03	8:30	20	2.044	2934	1787385	2.044	2934	1909839	48.3	19202	
E14	8/23/03	9:00	20	2.044	2934	1790319	2.044	2934	1912773	48.3	19250	
E15	8/23/03	9:30	20	2.044	2934	1793253	2.044	2934	1915707	48.3	19298	
E16	8/23/03	10:00	20	2.044	2934	1796187	2.044	2934	1918641	48.3	19346	
D11	8/23/03	10:30	20	2.044	2934	1799121	2.044	2934	1921575	48.3	19395	
D12	8/23/03	11:00	20	2.044	2934	1802055	2.044	2934	1924509	48.3	19443	
D13	8/23/03	11:30	20	2.044	2934	1804989	2.044	2934	1927443	48.3	19491	
D14	8/23/03	12:00	20	2.044	2934	1807923	2.044	2934	1930377	48.3	19540	

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
D15	8/23/03	13:00	20	2.044	2934	1810857	2.044	2934	1933311	48.3	19588	
D16	8/23/03	13:30	20	2.044	2934	1813791	2.044	2934	1936245	48.3	19636	
D17	8/23/03	14:00	20	2.044	2934	1816725	2.044	2934	1939179	48.3	19685	
C16	8/23/03	14:30	20	2.044	2934	1819659	2.044	2934	1942113	48.3	19733	
C15	8/25/03	8:30	20	2.044	2934	1822593	2.044	2934	1945047	48.3	19781	
C14	8/25/03	9:00	20	2.044	2934	1825527	2.044	2934	1947981	48.3	19829	
C13	8/25/03	9:34	20	2.044	2934	1828461	2.044	2934	1950915	48.3	19878	
C12	8/25/03	10:04	20	2.044	2934	1831395	2.044	2934	1953849	48.3	19926	
C11	8/25/03	10:33	20	2.044	2934	1834329	2.044	2934	1956783	48.3	19974	
B17	8/25/03	11:06	20	2.044	2934	1837263	2.044	2934	1959717	48.3	20023	
B16	8/25/03	12:02	20	2.044	2934	1840197	2.044	2934	1962651	48.3	20071	
B15	8/25/03	13:02	20	2.044	2934	1843131	2.044	2934	1965585	48.3	20119	
B14	8/25/03	13:26	20	2.044	2934	1846065	2.044	2934	1968519	48.3	20168	
B13	8/25/03	14:01	20	2.044	2934	1848999	2.044	2934	1971453	48.3	20216	
B12	8/25/03	16:15	20	2.044	2934	1851933	2.044	2934	1974387	48.3	20264	
B11	8/25/03	17:02	20	2.044	2934	1854867	2.044	2934	1977321	48.3	20312	
A16	8/26/03	8:30	20	2.044	2934	1857801	2.044	2934	1980255	48.3	20361	
A15	8/26/03	9:00	20	2.044	2934	1860735	2.044	2934	1983189	48.3	20409	
A14	8/26/03	9:34	20	2.044	2934	1863669	2.044	2934	1986123	48.3	20457	
A13	8/26/03	10:04	20	2.044	2934	1866603	2.044	2934	1989057	48.3	20506	
A12	8/26/03	10:31	20	2.044	2934	1869537	2.044	2934	1991991	48.3	20554	
A11	8/26/03	11:06	20	2.044	2934	1872471	2.044	2934	1994925	48.3	20602	
A10	8/26/03	13:10	20	2.044	2934	1875405	2.044	2934	1997859	48.3	20651	
West Surface	8/30/2003		2.5	2.044	16940	1892345	2.044	16940	2014799	279.2	20930	Mixed to 2.5 feet deep with excavator.

Table C-1—Frontier Hard Chrome Column Completion QA/QC Tracking Form (continued)

				Design Reagent			Actual Reagent			Soil Treated		Comments
Column	Date	Time	Depth	%	lbs	Cum.	%	lbs	Cum.	CY	Cum.	
Water Main Surface	8/30/2003		2.5	2.044	1955	1894300	2.044	1955	2016754	32.22	20962	Topical application. Area soaked to 2.5 feet with reagent

Table C-2—ESAT/WESTON Field Analytical Samples

Sampler	Sample No.	Type	Matrix	Depth (ft)	Location (Column No.)	EcoBond (wt. %)	Date Column Treated	Date Analyzed	Column Treated Age (days)	Cr (VI) Result (mg/kg or mg/L)	Sample Frequency
ESAT	FHC-SO-PP027-0070	Confirmation	soil	7	O19	3.066	7/1/03	7/8/03	7	5	1 per 250 cy
ESAT	FHC-SO-PP027-0170	Confirmation	soil	17	O19	3.066	7/2/03	7/8/03	6	26	1 per 250 cy
ESAT	FHC-SO-PP027-0170 (dup)	Confirmation	soil	17	O19	3.066	7/2/03	7/8/03	6	21	1 per 250 cy
ESAT	FHC-SO-PP028-0170	Confirmation	soil	17	O17	3.066	7/2/03	7/10/03	8	<5	1 per 200 cy
ESAT	FHC-SO-PP029-0170	Confirmation	soil	17	O20	3.066	7/2/03	7/10/03	8	<5	1 per 200 cy
ESAT	FHC-SO-PP031-0070	Confirmation	soil	7	U16	3.066	7/8/03	7/14/03	6	<5	1 per 300 cy
ESAT	FHC-SO-PP031-0170	Confirmation	soil	17	U16	3.066	7/8/03	7/14/03	6	<5	1 per 300 cy
ESAT	FHC-SO-PP032-0070	Confirmation	soil	7	R21	3.066	7/7/03	7/15/03	8	<5	1 per 300 cy
ESAT	FHC-SO-PP032-0170	Confirmation	soil	17	R21	3.066	7/7/03	7/15/03	8	<5	1 per 300 cy
ESAT	FHC-SO-PP033-0070	Confirmation	soil	7	T8	3.066	7/14/03	7/21/03	7	<5	1 per 500 cy
ESAT	FHC-SO-PP033-0170	Confirmation	soil	17	T8	3.066	7/14/03	7/21/03	7	<5	1 per 500 cy
ESAT	FHC-SO-PP034-0170	Confirmation	soil	7	O19	3.066	7/16/03	7/21/03	5	<5	1 per 500 cy
ESAT	FHC-SO-PP034-1170 (dup)	Confirmation	soil	17	O19	3.066	7/16/03	7/21/03	5	<5	1 per 500 cy
ESAT	FHC-SO-PP035-0070	Confirmation	soil	7	Q16	3.066	7/17/03	7/22/03	5	<5	1 per 500 cy
ESAT	FHC-SO-PP035-0170	Confirmation	soil	17	Q16	3.066	7/17/03	7/22/03	5	<5	1 per 500 cy
ESAT	FHC-SO-PP036-0070	Confirmation	soil	7	R12	3.066	7/17/03	7/28/03	11	<5	1 per 500 cy
ESAT	FHC-SO-PP036-0170	Confirmation	soil	17	R12	3.066	7/17/03	7/28/03	11	<5	1 per 500 cy
ESAT	FHC-SO-PP036-1170 (dup)	Confirmation	soil	17	R12	3.066	7/17/03	7/28/03	11	<5	1 per 500 cy
ESAT	FHC-SO-PP037-0070	Confirmation	soil	7	R4	3.066	7/21/03	8/4/03	14	<5	1 per 250 cy
ESAT	FHC-SO-PP037-0170	Confirmation	soil	17	R4	3.066	7/21/03	8/4/03	14	<5	1 per 250 cy
ESAT	FHC-SO-PP039-0070	Confirmation	soil	7	C7	2.044	7/29/03	8/5/03	7	<5	1 per 350 cy
ESAT	FHC-SO-PP039-0170	Confirmation	soil	17	C7	2.044	7/29/03	8/5/03	7	<5	1 per 350 cy
ESAT	FHC-SO-PP045-0070	Confirmation	soil	7	KK11	4.5	7/31/03	8/18/03	18	<5	1 per 500 cy
ESAT	FHC-SO-PP045-0170	Confirmation	soil	17	KK11	4.5	7/31/03	8/18/03	18	<5	1 per 500 cy
ESAT	FHC-SO-PP046-0070	Confirmation	soil	7	LL4	4.5	8/11/03	8/18/03	7	<5	1 per 500 cy
ESAT	FHC-SO-PP046-0170	Confirmation	soil	17	LL4	4.5	8/11/03	8/18/03	7	<5	1 per 500 cy
ESAT	FHC-SO-PP047-0070	Confirmation	soil	7	RR6	4.5	8/7/03	8/18/03	11	<5	1 per 500 cy
ESAT	FHC-SO-PP047-0170	Confirmation	soil	17	RR6	4.5	8/7/03	8/18/03	11	<5	1 per 500 cy
ESAT	FHC-SO-PP048-0070	Confirmation	soil	7	O8	4.5	8/7/03	8/19/03	12	<5	1 per 500 cy
ESAT	FHC-SO-PP048-0170	Confirmation	soil	17	O8	4.5	8/7/03	8/19/03	12	<5	1 per 500 cy
ESAT	FHC-SO-PP049-0070	Confirmation	soil	7	HH8	4.5	8/1/03	8/19/03	18	<5	1 per 500 cy
ESAT	FHC-SO-PP049-0170	Confirmation	soil	17	HH8	2.044	8/1/03	8/19/03	18	<5	1 per 500 cy

Table C-2—ESAT/WESTON Field Analytical Samples (continued)

Sampler	Sample No.	Type	Matrix	Depth (ft)	Location (Column No.)	EcoBond (wt. %)	Date Column Treated	Date Analyzed	Column Treated Age (days)	Cr (VI) Result (mg/kg or mg/L)	Sample Frequency
ESAT	FHC-SO-PP049-0170 (dup)	Confirmation	soil	17	HH8	2.044	8/1/03	8/19/03	18	<5	1 per 500 cy
ESAT	FHC-SO-PP050-0070	Confirmation	soil	7	DD4	2.044	8/13/03	8/20/03	7	<5	1 per 500 cy
ESAT	FHC-SO-PP050-0070 (dup)	Confirmation	soil	7	DD4	2.044	8/13/03	8/20/03	7	<5	1 per 500 cy
ESAT	FHC-SO-PP050-0170	Confirmation	soil	17	DD4	2.044	8/13/03	8/20/03	7	<5	1 per 500 cy
ESAT	FHC-SO-PP051-0070	Confirmation	soil	7	G9	2.044	7/18/03	8/20/03	33	<5	1 per 500 cy
ESAT	FHC-SO-PP051-0170	Confirmation	soil	17	G9	2.044	7/18/03	8/20/03	33	<5	1 per 500 cy
ESAT	FHC-SO-PP051-0170 (dup)	Confirmation	soil	17	G9	2.044	7/18/03	8/20/03	33	<5	1 per 500 cy
ESAT	FHC-SO-PP052-0070	Confirmation	soil	7	I13	2.044	7/31/03	8/26/03	26	<5	1 per 500 cy
ESAT	FHC-SO-PP052-0070 (dup)	Confirmation	soil	7	I13	2.044	7/31/03	8/26/03	26	<5	1 per 500 cy
ESAT	FHC-SO-PP052-0170	Confirmation	soil	17	I13	2.044	7/31/03	8/26/03	26	<5	1 per 500 cy
ESAT	FHC-SO-PP053-0070	Confirmation	soil	7	L13	4.5	8/18/03	8/26/03	6	<5	1 per 500 cy
ESAT	FHC-SO-PP053-0170	Confirmation	soil	17	L13	4.5	8/18/03	8/26/03	6	<5	1 per 500 cy
ESAT	FHC-SO-PP054-0070	Confirmation	soil	7	O12	4.5	8/16/03	8/26/03	10	<5	1 per 500 cy
ESAT	FHC-SO-PP054-0170	Confirmation	soil	17	O12	4.5	8/16/03	8/26/03	10	<5	1 per 500 cy
ESAT	FHC-SO-PP054-0170 (dup)	Confirmation	soil	17	O12	4.5	8/16/03	8/26/03	10	<5	1 per 500 cy
ESAT	FHC-SO-PP055-0070	Confirmation	soil	7	F13	2.044	8/22/03	8/28/03	6	<5	1 per 500 cy
ESAT	FHC-SO-PP055-0170	Confirmation	soil	17	F13	2.044	8/22/03	8/28/03	6	<5	1 per 500 cy
ESAT	FHC-SO-PP056-0070	Confirmation	soil	7	C13	2.044	8/25/03	8/28/03	3	<5	1 per 500 cy
ESAT	FHC-SO-PP056-0170	Confirmation	soil	17	C13	2.044	8/25/03	8/28/03	3	<5	1 per 500 cy
Weston	FHC-SO-SS001-0015	Confirmation	soil	1.5	Surface Treatment Area	2.044	8/29/03	9/2/03	3	<5	1 per 150 cy
Weston	FHC-SO-SS002-0015	Confirmation	soil	1.5	Surface Treatment Area	2.044	8/29/03	9/2/03	3	<5	1 per 150 cy
ESAT	FHC-GW-PP027-0230	Confirmation	water	23	O19	3.066	7/2/03	7/8/03	6	<0.8	1 per 500 ft2
ESAT	FHC-GW-PP038-0300	Confirmation	water	30	C14	0	untreated	8/5/03	NA	0.01	NA
ESAT	FHC-GW-PP046-0240	Confirmation	water	24	LL4	4.5	8/11/03	8/18/03	7	<0.8	1 per 1100 ft2
ESAT	FHC-GW-PP047-0200	Confirmation	water	20	RR6	4.5	8/7/03	8/18/03	11	<0.8	1 per 1100 ft2
ESAT	FHC-GW-PP049-0250	Confirmation	water	25	HH8	2.044	8/1/03	8/19/03	18	<0.8	1 per 1100 ft2
ESAT	FHC-GW-PP049-0250 (dup)	Confirmation	water	25	HH8	2.044	8/1/03	8/19/03	18	<0.8	1 per 1100 ft2
ESAT	FHC-GW-PP050-0240	Confirmation	water	24	DD4	2.044	8/13/03	8/20/03	7	<0.8	1 per 1100 ft2
ESAT	FHC-GW-PP058-0240	Confirmation	water	24	S14	3.066	7/15/03	8/27/03	43	<0.8	1 per 1600 ft2

Table C-2—ESAT/WESTON Field Analytical Samples (continued)

Sampler	Sample No.	Type	Matrix	Depth (ft)	Location (Column No.)	EcoBond (wt. %)	Date Column Treated	Date Analyzed	Column Treated Age (days)	Cr (VI) Result (mg/kg or mg/L)	Sample Frequency
ESAT	FHC-GW-PP057-0240	Confirmation	water	24	R13	3.066	7/17/03	8/27/03	41	<0.8	1 per 1600 ft2
ESAT	FHC-GW-PP060-0240	Confirmation	water	24	U5	3.066	7/8/03	8/27/03	50	<0.8	1 per 1600 ft2
ESAT	FHC-GW-PP059-0240	Confirmation	water	24	S14	3.066	7/15/03	8/28/03	44	<0.8	1 per 1600 ft2
ESAT	FHC-GW-PP040-0250	Pre-Treatment[a]	water	25	M14	0	NA	8/11/03	NA	0.2	1 per 1000 ft2
ESAT	FHC-GW-PP040-0300	Pre-Treatment[a]	water	30	M14	0	NA	8/11/03	NA	0.05	1 per 1000 ft2
ESAT	FHC-GW-PP041-0250	Pre-Treatment[a]	water	25	J14	0	NA	8/11/03	NA	0.2	1 per 1000 ft2
ESAT	FHC-GW-PP041-0300	Pre-Treatment[a]	water	30	J14	0	NA	8/11/03	NA	0	1 per 1000 ft2
ESAT	FHC-GW-PP042-0250	Pre-Treatment[a]	water	25	F14	0	NA	8/12/03	NA	0	1 per 1000 ft2
ESAT	FHC-GW-PP042-0300	Pre-Treatment[a]	water	30	F14	0	NA	8/12/03	NA	0	1 per 1000 ft2
ESAT	FHC-GW-PP043-0300	Pre-Treatment[a]	water	30	H12	0	NA	8/12/03	NA	0.01	1 per 1000 ft2
ESAT	FHC-GW-PP044-0250	Pre-Treatment[a]	water	25	H16	0	NA	8/12/03	NA	0	1 per 1000 ft2
ESAT	FHC-GW-PP044-0300	Pre-Treatment[a]	water	30	H16	0	NA	8/12/03	NA	0.01	1 per 1000 ft2
Weston	FHC-SO-SS003-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS004-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS005-0000	Off Site	soil	surface	Roadway	NA	NA	9/3/03	NA	<1	1 per 100 ft
Weston	FHC-SO-SS006-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS007-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS008-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS009-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS010-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS011-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS012-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS012-1000 (dup)	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS013-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS014-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS015-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS015-1000 (dup)	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS016-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS017-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS018-0000	Off Site	soil	surface	Roadway	NA	NA	9/4/03	NA	<5	1 per 100 ft
Weston	FHC-SO-SS019-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft
Weston	FHC-SO-SS020-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft

Table C-2—ESAT/WESTON Field Analytical Samples (continued)

Sampler	Sample No.	Type	Matrix	Depth (ft)	Location (Column No.)	EcoBond (wt. %)	Date Column Treated	Date Analyzed	Column Treated Age (days)	Cr (VI) Result (mg/kg or mg/L)	Sample Frequency
Weston	FHC-SO-SS021-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft
Weston	FHC-SO-SS022-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft
Weston	FHC-SO-SS023-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft
Weston	FHC-SO-SS024-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft
Weston	FHC-SO-SS025-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft
Weston	FHC-SO-SS026-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft
Weston	FHC-SO-SS027-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft
Weston	FHC-SO-SS028-0000	Off Site	soil	surface	Perimeter	NA	NA	9/3/03	NA	<1	1 per 75 ft
ESAT	FHC-SO-PP018-0070	Optimization	soil	7	N14	7.8	6/23/03	6/26/03	3	<6	1 per 20 cy
ESAT	FHC-SO-PP018-0170	Optimization	soil	17	N14	7.8	6/23/03	6/26/03	3	<7	1 per 20 cy
ESAT	FHC-SO-PP018-0220	Optimization	soil	22	N14	7.8	6/23/03	6/26/03	3	<6	1 per 20 cy
ESAT	FHC-SO-PP019-0070	Optimization	soil	7	N15	25.5	6/23/03	6/27/03	4	<6	1 per 20 cy
ESAT	FHC-SO-PP019-0170	Optimization	soil	17	N15	25.5	6/23/03	6/27/03	4	<6	1 per 20 cy
ESAT	FHC-SO-PP019-0220	Optimization	soil	22	N15	25.5	6/23/03	6/27/03	4	<6	1 per 20 cy
ESAT	FHC-SO-PP020-0070	Optimization	soil	7	A20	8.2	6/24/03	6/27/03	3	<8	1 per 50 cy
ESAT	FHC-SO-PP020-0170	Optimization	soil	17	A20	8.2	6/24/03	6/27/03	3	<8	1 per 50 cy
ESAT	FHC-SO-PP021-0070	Optimization	soil	7	E18	0.9	6/28/03	7/2/03	4	<5	1 per 100 cy
ESAT	FHC-SO-PP021-0170	Optimization	soil	17	E18	0.9	6/28/03	7/2/03	4	<5	1 per 100 cy
ESAT	FHC-SO-PP022-0070	Optimization	soil	7	G19	0.9	6/28/03	7/2/03	4	<5	1 per 100 cy
ESAT	FHC-SO-PP022-0170	Optimization	soil	17	G19	0.9	6/28/03	7/2/03	4	<5	1 per 100 cy
ESAT	FHC-SO-PP023-0070	Optimization	soil	7	H18	2.044	6/30/03	7/3/03	3	<5	1 per 150 cy
ESAT	FHC-SO-PP023-0170	Optimization	soil	17	H18	2.044	6/30/03	7/3/03	3	<5	1 per 150 cy
ESAT	FHC-SO-PP024-0070	Optimization	soil	7	J19	2.044	6/30/03	7/3/03	3	<5	1 per 150 cy
ESAT	FHC-SO-PP024-0170	Optimization	soil	17	J19	2.044	6/30/03	7/3/03	3	<5	1 per 150 cy
ESAT	FHC-SO-PP025-0070	Optimization	soil	7	L20	3.066	7/1/03	7/7/03	6	<5	1 per 100 cy
ESAT	FHC-SO-PP025-0170	Optimization	soil	17	L20	3.066	7/1/03	7/7/03	6	<5	1 per 100 cy
ESAT	FHC-SO-PP025-0220	Optimization	soil	22	L20	3.066	7/1/03	7/7/03	6	<5	1 per 100 cy
ESAT	FHC-SO-PP026-0070	Optimization	soil	7	M17	3.066	7/1/03	7/8/03	7	<5	1 per 100 cy
ESAT	FHC-SO-PP026-0170	Optimization	soil	17	M17	3.066	7/1/03	7/8/03	7	<5	1 per 100 cy
ESAT	FHC-SO-PP026-0240	Optimization	soil	24	M17	3.066	7/1/03	7/8/03	7	<5	1 per 100 cy
ESAT	FHC-GW-PP021-0190	Optimization	water	19	E18	0.9	6/28/03	7/2/03	4	<0.8	1 per 300 ft2
ESAT	FHC-GW-PP022-0190	Optimization	water	19	G19	0.9	6/28/03	7/2/03	4	<0.8	1 per 300 ft2

Table C-2—ESAT/WESTON Field Analytical Samples (continued)

Sampler	Sample No.	Type	Matrix	Depth (ft)	Location (Column No.)	EcoBond (wt. %)	Date Column Treated	Date Analyzed	Column Treated Age (days)	Cr (VI) Result (mg/kg or mg/L)	Sample Frequency
ESAT	FHC-GW-PP023-0190	Optimization	water	19	H18	2.044	6/30/03	7/3/03	3	<0.8	1 per 400 ft2
ESAT	FHC-GW-PP024-0190	Optimization	water	19	J19	2.044	6/30/03	7/3/03	3	<0.8	1 per 400 ft2
ESAT	FHC-GW-PP025-0220	Optimization	water	22	L20	3.066	7/1/03	7/7/03	6	<0.8	1 per 350 ft2

a: These samples are also considered confirmation samples.

Table C-3—Williams Environmental Field Analytical Samples

Sampler	Sample No.	Type	Matrix	Depth (ft)	Location (Column No.)	EcoBond (wt. %)	Date Column Treated	Date Analyzed	Column Treated Age (days)	Cr (VI) Result (mg/kg or mg/L)	Sample Frequency
Williams	N18	Confirmation	soil	composite	N18	3.066	7/2/03	7/2/03	1	<5	1 per 500 cy
Williams	R21	Confirmation	soil	composite	R21	3.066	7/7/03	7/7/03	1	<5	1 per 300 cy
Williams	U13	Confirmation	soil	composite	U13	3.066	7/8/03	7/8/03	1	<5	1 per 600 cy
Williams	T4	Confirmation	soil	composite	T4	3.066	7/14/03	7/14/03	1	<5	1 per 300 cy
Williams	T13	Confirmation	soil	composite	T13	3.066	7/14/03	7/14/03	1	<5	1 per 300 cy
Williams	S7	Confirmation	soil	composite	S7	3.066	7/15/03	7/15/03	1	<5	1 per 300 cy
Williams	S13	Confirmation	soil	composite	S13	3.066	7/15/03	7/15/03	1	<5	1 per 300 cy
Williams	O19	Confirmation	soil	composite	O19	3.066	7/16/03	7/16/03	1	<5	1 per 400 cy
Williams	O16	Confirmation	soil	composite	O16	3.066	7/17/03	7/17/03	1	<5	1 per 500 cy
Williams	Q17	Confirmation	soil	composite	Q17	3.066	7/17/03	7/17/03	1	<5	1 per 500 cy
Williams	Q10	Confirmation	soil	composite	Q10	3.066	7/17/18/03	7/17/18/03	1	<5	1 per 500 cy
Williams	E10	Confirmation	soil	composite	E10	2.044	7/18/19/03	7/18/19/03	1	<5	1 per 500 cy
Williams	Q7	Confirmation	soil	composite	Q7	3.066	7/21/03	7/21/03	1	<5	1 per 350 cy
Williams	P10	Confirmation	soil	composite	P10	4.5	7/21/22/03	7/21/22/03	1	<5	1 per 250 cy
Williams	P11	Confirmation	soil	composite	P11	4.5	7/21/22/03	7/21/22/03	1	<5	1 per 250 cy
Williams	P14	Confirmation	soil	composite	P14	4.5	7/22/03	7/22/03	1	<5	1 per 350 cy
Williams	P15	Confirmation	soil	composite	P15	4.5	7/22/03	7/22/03	1	<5	1 per 350 cy
Williams	K10	Confirmation	soil	composite	K10	4.5	7/28/29/03	7/28/29/03	1	<5	1 per 500 cy
Williams	D8	Confirmation	soil	composite	D8	2.044	7/29/30/03	7/29/30/03	1	<5	1 per 500 cy
Williams	MM10	Confirmation	soil	composite	MM10	4.5	7/30/31/03	7/30/31/03	1	<5	1 per 300 cy
Williams	GG8	Confirmation	soil	composite	GG8	2.044	8/1/2/02	8/1/2/03	1	<5	1 per 300 cy
Williams	CC7	Confirmation	soil	composite	CC7	2.044	8/2/03	8/2/03	1	<5	1 per 300 cy
Williams	X7	Confirmation	soil	composite	X7	2.044	8/2/3/03	8/2/3/03	1	<5	1 per 400 cy
Williams	SS8	Confirmation	soil	composite	SS8	4.5	8/6/03	8/6/03	1	<5	1 per 500 cy
Williams	RR11	Confirmation	soil	composite	RR11	4.5	8/7/03	8/7/03	1	<5	1 per 350 cy
Williams	OO8	Confirmation	soil	composite	OO8	4.5	8/7/03	8/7/03	1	<5	1 per 250 cy
Williams	OO5	Confirmation	soil	composite	OO5	4.5	8/8/03	8/8/03	1	<5	1 per 600 cy
Williams	HH7	Confirmation	soil	composite	HH7	2.044	8/11/03	8/11/03	1	<5	1 per 750 cy
Williams	DD7	Confirmation	soil	composite	DD7	2.044	8/13/03	8/13/03	1	<5	1 per 500 cy
Williams	BB6	Confirmation	soil	composite	BB6	2.044	8/14/03	8/14/03	1	<5	1 per 250 cy
Williams	K15	Confirmation	soil	composite	K15	4.5	8/16/03	8/16/03	1	<5	1 per 300 cy
Williams	K16	Confirmation	soil	composite	K16	4.5	8/16/03	8/16/03	1	<5	1 per 300 cy
Williams	L11	Confirmation	soil	composite	L11	4.5	8/18/03	8/18/03	1	<5	1 per 900 cy

Table C-4—Compressive Strength Data

Treated Soil Column No.	Days of Curing	Compressive Strength (psi)
F-18	17	150
C-20	17	130
A-19	17	120
A-20	17	85
C-17	17	100
L-18	29	32
N-18	28	30
R-21	35	51
T-13	28	60
O-19	28	50
P-11	28	60
Q-10	28	60
Q-17	28	50
D-10	28	30
CC-7	28	230
OO-5	28	55
SS-8	28	30
OO-8	28	140
EE-7	28	130
J-15	28	110
D-15	28	100
A-14	28	50
D-8	28	70
RR-11	28	50
MM-10	28	50
HH-7	28	70
X-7	28	40
B-10	1	80
K-15	1	110
O-7	1	90
K-16	1	130
F-15	1	40
BB-6	1	70
L-11	1	70

Table C-5—Frontier Hardchrome Phase 1 Demolition Perimeter Air Sampling

Sample Number		DD-AA001-0000		DD-AA002-0000		DD-AA003-0000		DD-AA004-0000	
Date Collected		28-Jan-03		28-Jan-03		28-Jan-03		30-Jan-03	
Air Flow (L)		1221		1214		863		1883	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)
Arsenic	0.01	0	0	0	0	0	0	0	0
Beryllium	0.002	0	0	0	0	0	0	0	0
Cadmium	0.005	0	0	0	0	0	0	0	0
Chromium (Total)	1	0.000577	0.000473	0.000575	0.000474	0.000358	0.000415	0.00228	0.001211
Copper	1	0.000073	0.000060	0.000073	0.000060	0.000051	0.000059	0.000839	0.000446
Lead	0.03	0.000031	0.000025	0.000069	0.000057	0.000017	0.000020	0.000699	0.000371
Nickel	1	0.000042	0.000034	0.000051	0.000042	0.000036	0.000042	0.000078	0.000041
Zinc	5	0.000116	0.000095	0.000127	0.000105	0	0	0.00128	0.000680

Sample Number		DD-AA005-0000		DD-AA006-0000		DD-AA006-4000		DD-AA007-0000	
Date Collected		30-Jan-03		30-Jan-03		30-Jan-03		4-Feb-03	
Air Flow (L)		1838		1809		Blank Sample		1552	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)
Arsenic	0.01	0	0	0	0	0	NA	0	0
Beryllium	0.002	0	0	0	0	0	NA	0	0
Cadmium	0.005	0	0	0	0	0	NA	0	0
Chromium (Total)	1	0.00102	0.000555	0.000559	0.000309	0.000611	NA	0	0
Copper	1	0.000264	0.000144	0.000094	0.000052	0.000038	NA	0	0
Lead	0.03	0.00026	0.000141	0.000024	0.000013	0.000013	NA	0	0
Nickel	1	0.000047	0.000026	0.000095	0.000053	0.000364	NA	0	0
Zinc	5	0.000865	0.000471	0.000394	0.000218	0.00005	NA	0	0

Sample Number		DD-AA008-0000		DD-AA009-0000		DD-AA009-4000	
Date Collected		4-Feb-03		4-Feb-03		4-Feb-03	
Air Flow (L)		1556		1513		Blank Sample	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)
Arsenic	0.01	0	0	0	0	0	NA
Beryllium	0.002	0	0	0	0	0	NA
Cadmium	0.005	0	0	0	0	0	NA
Chromium (Total)	1	0.000567	0.000364	0.000626	0.000414	0.000536	NA
Copper	1	0	0	0	0	0	NA
Lead	0.03	0	0	0	0	0	NA
Nickel	1	0	0	0	0	0.00062	NA
Zinc	5	0	0	0	0	0	NA

NA: Not Applicable
Zero (0): Not Detected

Table C-5—Frontier Hardchrome Phase 2 Demolition Perimeter Air Sampling

Sample Number		DD-AA-AA010-0000		DD-AA-AA011-0000		DD-AA012-0000		DD-AA013-0000	
Date Collected		6-May-03		6-May-03		9-May-03		9-May-03	
Air Flow (L)		1458		1796		1449		1349	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)
Arsenic	0.01	0	0	0	0	0	0	0	0
Beryllium	0.002	0	0	0	0	0	0	0	0
Cadmium	0.005	0	0	0	0	0	0	0	0
Chromium (Total)	1	0.000717	0.000492	0.000711	0.000396	0.000813	0.000561	0.000718	0.000532
Copper	1	0	0	0	0	0	0	0	0
Lead	0.03	0	0	0	0	0	0	0	0
Nickel	1	0	0	0	0	0	0	0	0
Zinc	5	0	0	0	0	0	0	0	0

Sample Number		DD-AA013-4000		DD-AA014-0000		DD-AA015-0000		DD-AA0016-0000	
Date Collected		9-May-03		13-May-03		13-May-03		14-May-03	
Air Flow (L)		Blank Sample		1993		1980		1952	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)
Arsenic	0.01	0	NA	0	0.004942848	0	0	0	0
Beryllium	0.002	0	NA	0	0	0	0	0	0
Cadmium	0.005	0	NA	0	0	0	0	0	0
Chromium (Total)	1	0.00101	NA	0.00104	0.000522	0.000895	0.000452	0.000847	0.000434
Copper	1	0	NA	0	0	0	0	0	0
Lead	0.03	0	NA	0	0	0	0	0	0
Nickel	1	0	NA	0	0	0	0	0	0
Zinc	5	0	NA	0	0	0	0	0	0

Sample Number		DD-AA017-0000	
Date Collected		14-May-03	
Air Flow (L)		2044	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter (mg)	Concentration (mg/m^3)
Arsenic	0.01	0	0
Beryllium	0.002	0	0
Cadmium	0.005	0	0
Chromium (Total)	1	0.000738	0.000361
Copper	1	0	0
Lead	0.03	0	0
Nickel	1	0	0
Zinc	5	0	0

NA: Not Applicable
Zero (0): Not Detected

Table C-6—Frontier Hardchrome Source Area Treatment Perimeter Air Sampling

Sample Number		FHC-AA-AA018-0000		FHC-AA-AA018-4000		FHC-AA-AA019-0000		FHC-AA-AA020-0000	
Date Collected		20-Jun-03		20-Jun-03		20-Jun-03		20-Jun-03	
Air Flow (L)		1340		Blank Sample		1140		2046	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.007	0.0096	NA	0.0096	0.008	0.0096	0.005
Beryllium	0.002	0.0019	0.001	0.0019	NA	0.0019	0.002	0.0019	0.001
Cadmium	0.005	0.0048	0.004	0.0048	NA	0.0048	0.004	0.0048	0.002
Chromium (Total)	1	0.9600	0.716	0.9600	NA	0.9600	0.842	0.9600	0.469
Copper	1	0.9600	0.716	0.9600	NA	0.9600	0.842	0.9600	0.469
Lead	0.03	0.0288	0.021	0.0288	NA	0.0288	0.025	0.0288	0.014
Nickel	1	0.0288	0.021	0.0288	NA	0.0288	0.025	0.0288	0.014
Zinc	5	4.8	3.582	4.8	NA	4.8	4.211	4.8	2.346

Sample Number		FHC-AA-AA021-0000		FHC-AA-AA022-0000		FHC-AA-AA023-0000		FHC-AA-AA024-0000	
Date Collected		21-Jun-03		21-Jun-03		21-Jun-03		23-Jun-03	
Air Flow (L)		1628		1608		1568		2144	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.006	0.0096	0.005	0.0096	0.006	0.0096	0.004
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.003	0.0048	0.003	0.0048	0.003	0.0048	0.002
Chromium (Total)	1	0.9600	0.590	0.9600	0.597	0.9600	0.612	0.9600	0.448
Copper	1	0.9600	0.590	0.9600	0.597	0.9600	0.612	0.9600	0.448
Lead	0.03	0.0288	0.018	0.0288	0.018	0.0288	0.018	0.0288	0.013
Nickel	1	0.0288	0.018	0.0288	0.018	0.0288	0.018	0.0288	0.013
Zinc	5	4.8	2.949	4.8	2.985	4.8	3.061	4.8	2.239

Sample Number		FHC-AA-AA025-0000		FHC-AA-AA026-0000		FHC-AA-AA027-0000		FHC-AA-AA028-0000	
Date Collected		23-Jun-03		23-Jun-03		25-Jun-03		25-Jun-03	
Air Flow (L)		2101		2352		2235		604	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.005	0.0096	0.004	0.0096	0.004	0.0096	0.016
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.003
Cadmium	0.005	0.0048	0.002	0.0048	0.002	0.0048	0.002	0.0048	0.008
Chromium (Total)	1	0.9600	0.457	0.9600	0.408	0.9600	0.430	0.9600	1.589
Copper	1	0.9600	0.457	0.9600	0.408	0.9600	0.430	0.9600	1.589
Lead	0.03	0.0288	0.014	0.0288	0.012	0.0288	0.013	0.0288	0.048
Nickel	1	0.0288	0.014	0.0288	0.012	0.0288	0.013	0.0288	0.048
Zinc	5	4.8	2.284	4.8	2.041	4.8	2.148	4.8	7.947

NA: Not Applicable

**: Not detected, mass listed is the detection limit.

Table C-6—Frontier Hardchrome Source Area Treatment Perimeter Air Sampling (continued)

Sample Number		FHC-AA-AA029-0000		FHC-AA-AA030-0000		FHC-AA-AA031-0000		FHC-AA-AA032-0000	
Date Collected		25-Jun-03		30-Jun-03		30-Jun-03		30-Jun-03	
Air Flow (L)		1756		2059		1333		1468	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.005	0.0096	0.005	0.0096	0.007	0.0096	0.007
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.003	0.0048	0.002	0.0048	0.004	0.0048	0.003
Chromium (Total)	1	0.9600	0.547	0.9600	0.466	0.9600	0.720	0.9600	0.654
Copper	1	0.9600	0.547	0.9600	0.466	0.9600	0.720	0.9600	0.654
Lead	0.03	0.0288	0.016	0.0288	0.014	0.0288	0.022	0.0288	0.020
Nickel	1	0.0288	0.016	0.0288	0.014	0.0288	0.022	0.0288	0.020
Zinc	5	4.8	2.733	4.8	2.331	4.8	3.600	4.8	3.270

Sample Number		FHC-AA-AA033-0000		FHC-AA-AA034-0000		FHC-AA-AA035-0000		FHC-AA-AA036-0000	
Date Collected		1-Jul-03		1-Jul-03		1-Jul-03		9-Jul-03	
Air Flow (L)		2116		1988		2208		1392	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.005	0.0096	0.005	0.0096	0.004	0.0096	0.007
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.002	0.0048	0.002	0.0048	0.002	0.0048	0.003
Chromium (Total)	1	0.9600	0.454	0.9600	0.483	0.9600	0.435	0.9600	0.690
Copper	1	0.9600	0.454	0.9600	0.483	0.9600	0.435	0.9600	0.690
Lead	0.03	0.0288	0.014	0.0288	0.014	0.0288	0.013	0.0288	0.021
Nickel	1	0.0288	0.014	0.0288	0.014	0.0288	0.013	0.0288	0.021
Zinc	5	4.8	2.268	4.8	2.415	4.8	2.174	4.8	3.448

Sample Number		FHC-AA-AA037-0000		FHC-AA-AA038-0000		FHC-AA-AA039-0000		FHC-AA-AA040-0000	
Date Collected		9-Jul-03		9-Jul-03		11-Jul-03		11-Jul-03	
Air Flow (L)		1440		2072		1984		1044	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.007	0.0096	0.005	0.0096	0.005	0.0096	0.009
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.002
Cadmium	0.005	0.0048	0.003	0.0048	0.002	0.0048	0.002	0.0048	0.005
Chromium (Total)	1	0.9600	0.667	0.9600	0.463	0.9600	0.484	0.9600	0.920
Copper	1	0.9600	0.667	0.9600	0.463	0.9600	0.484	0.9600	0.920
Lead	0.03	0.0288	0.020	0.0288	0.014	0.0288	0.015	0.0288	0.028
Nickel	1	0.0288	0.020	0.0288	0.014	0.0288	0.015	0.0288	0.028
Zinc	5	4.8	3.333	4.8	2.317	4.8	2.419	4.8	4.598

NA: Not Applicable
**: Not detected, mass listed is the detection limit.

Table C-6—Frontier Hardchrome Source Area Treatment Perimeter Air Sampling (continued)

Sample Number		FHC-AA-AA041-0000		FHC-AA-AA042-0000		FHC-AA-AA043-0000		FHC-AA-AA044-0000	
Date Collected		11-Jul-03		15-Jul-03		15-Jul-03		15-Jul-03	
Air Flow (L)		2028		1859		1867		1900	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.005	0.0096	0.005	0.0096	0.005	0.0096	0.005
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.002	0.0048	0.003	0.0048	0.003	0.0048	0.003
Chromium (Total)	1	0.9600	0.473	0.9600	0.517	0.9600	0.514	0.9600	0.505
Copper	1	0.9600	0.473	0.9600	0.517	0.9600	0.514	0.9600	0.505
Lead	0.03	0.0288	0.014	0.0288	0.015	0.0288	0.015	0.0288	0.015
Nickel	1	0.0288	0.014	0.0288	0.015	0.0288	0.015	0.0288	0.015
Zinc	5	4.8	2.367	4.8	2.583	4.8	2.571	4.8	2.526

Sample Number		FHC-AA-AA045-0000		FHC-AA-AA046-0000		FHC-AA-AA047-0000		FHC-AA-AA048-0000	
Date Collected		17-Jul-03		17-Jul-03		17-Jul-03		22-Jul-03	
Air Flow (L)		1899		1942		1980		1938	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.005	0.0096	0.005	0.0096	0.005	0.0096	0.005
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.003	0.0048	0.002	0.0048	0.002	0.0048	0.002
Chromium (Total)	1	0.9600	0.505	0.9600	0.494	0.9600	0.485	0.9600	0.495
Copper	1	0.9600	0.505	0.9600	0.494	0.9600	0.485	0.9600	0.495
Lead	0.03	0.0288	0.015	0.0288	0.015	0.0288	0.015	0.0288	0.015
Nickel	1	0.0288	0.015	0.0288	0.015	0.0288	0.015	0.0288	0.015
Zinc	5	4.8	2.527	4.8	2.471	4.8	2.424	4.8	2.476

Sample Number		FHC-AA-AA049-0000		FHC-AA-AA050-0000		FHC-AA-AA051-0000		FHC-AA-AA052-0000	
Date Collected		22-Jul-03		22-Jul-03		24-Jul-03		24-Jul-03	
Air Flow (L)		1904		1996		1584		1580	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.005	0.0096	0.005	0.0096	0.006	0.0096	0.006
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.003	0.0048	0.002	0.0048	0.003	0.0048	0.003
Chromium (Total)	1	0.9600	0.504	0.9600	0.481	0.9600	0.606	0.9600	0.608
Copper	1	0.9600	0.504	0.9600	0.481	0.9600	0.606	0.9600	0.608
Lead	0.03	0.0288	0.015	0.0288	0.014	0.0288	0.018	0.0288	0.018
Nickel	1	0.0288	0.015	0.0288	0.014	0.0288	0.018	0.0288	0.018
Zinc	5	4.8	2.521	4.8	2.405	4.8	3.030	4.8	3.038

NA: Not Applicable
**: Not detected, mass listed is the detection limit.

Table C-6—Frontier Hardchrome Source Area Treatment Perimeter Air Sampling (continued)

Sample Number		FHC-AA-AA053-0000		FHC-AA-AA054-0000		FHC-AA-AA055-0000		FHC-AA-AA056-0000	
Date Collected		29-Jul-03		29-Jul-03		29-Jul-03		1-Aug-03	
Air Flow (L)		1592		1646		1516		2148	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.006	0.0096	0.006	0.0096	0.006	0.0096	0.004
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.003	0.0048	0.003	0.0048	0.003	0.0048	0.002
Chromium (Total)	1	0.9600	0.603	0.9600	0.583	0.9600	0.633	0.9600	0.447
Copper	1	0.9600	0.603	0.9600	0.583	0.9600	0.633	0.9600	0.447
Lead	0.03	0.0288	0.018	0.0288	0.017	0.0288	0.019	0.0288	0.013
Nickel	1	0.0288	0.018	0.0288	0.017	0.0288	0.019	0.0288	0.013
Zinc	5	4.8	3.015	4.8	2.917	4.8	3.167	4.8	2.235

Sample Number		FHC-AA-AA057-0000		FHC-AA-AA058-0000		FHC-AA-AA059-0000		FHC-AA-AA060-0000	
Date Collected		1-Aug-03		1-Aug-03		6-Aug-03		6-Aug-03	
Air Flow (L)		2161		2168		2012		2094	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.004	0.0096	0.005	0.0096	0.005	0.0096	0.005
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.002	0.0048	0.002	0.0048	0.002	0.0048	0.002
Chromium (Total)	1	0.9600	0.444	0.9600	0.443	0.9600	0.477	0.9600	0.459
Copper	1	0.9600	0.444	0.9600	0.443	0.9600	0.477	0.9600	0.459
Lead	0.03	0.0288	0.013	0.0288	0.013	0.0288	0.014	0.0288	0.014
Nickel	1	0.0288	0.013	0.0288	0.013	0.0288	0.014	0.0288	0.014
Zinc	5	4.8	2.221	4.8	2.214	4.8	2.385	4.8	2.293

Sample Number		FHC-AA-AA061-0000		FHC-AA-AA062-0000		FHC-AA-AA063-0000		FHC-AA-AA064-0000	
Date Collected		6-Aug-03		13-Aug-03		13-Aug-03		13-Aug-03	
Air Flow (L)		2103		2374		2386		2392	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.005	0.0096	0.004	0.0096	0.004	0.0096	0.004
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.002	0.0048	0.002	0.0048	0.002	0.0048	0.002
Chromium (Total)	1	0.9600	0.457	0.9600	0.404	0.9600	0.402	0.9600	0.401
Copper	1	0.9600	0.457	0.9600	0.404	0.9600	0.402	0.9600	0.401
Lead	0.03	0.0288	0.014	0.0288	0.012	0.0288	0.012	0.0288	0.012
Nickel	1	0.0288	0.014	0.0288	0.012	0.0288	0.012	0.0288	0.012
Zinc	5	4.8	2.283	4.8	2.022	4.8	2.012	4.8	2.007

NA: Not Applicable
**: Not detected, mass listed is the detection limit.

Table C-6—Frontier Hardchrome Source Area Treatment Perimeter Air Sampling (continued)

Sample Number		FHC-AA-AA065-0000		FHC-AA-AA066-0000		FHC-AA-AA067-0000		FHC-AA-AA068-0000	
Date Collected		21-Aug-03		21-Aug-03		21-Aug-03		27-Aug-03	
Air Flow (L)		2425		2450		2456		1994	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.004	0.0096	0.004	0.0096	0.004	0.0096	0.005
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.002	0.0048	0.002	0.0048	0.002	0.0048	0.002
Chromium (Total)	1	0.9600	0.396	0.9600	0.392	0.9600	0.391	0.9600	0.482
Copper	1	0.9600	0.396	0.9600	0.392	0.9600	0.391	0.9600	0.482
Lead	0.03	0.0288	0.012	0.0288	0.012	0.0288	0.012	0.0288	0.014
Nickel	1	0.0288	0.012	0.0288	0.012	0.0288	0.012	0.0288	0.014
Zinc	5	4.8	1.979	4.8	1.959	4.8	1.954	4.8	2.408

Sample Number		FHC-AA-AA069-0000		FHC-AA-AA070-0000		FHC-AA-AA071-0000		FHC-AA-AA072-0000	
Date Collected		27-Aug-03		27-Aug-03		3-Sep-03		3-Sep-03	
Air Flow (L)		2019		2034		2128		2149	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.005	0.0096		0.0096	0.005	0.0096	0.004
Beryllium	0.002	0.0019	0.001	0.0019	0.001	0.0019	0.001	0.0019	0.001
Cadmium	0.005	0.0048	0.002	0.0048	0.002	0.0048	0.002	0.0048	0.002
Chromium (Total)	1	0.9600	0.475	0.9600	0.472	0.9600	0.451	0.9600	0.447
Copper	1	0.9600	0.475	0.9600	0.472	0.9600	0.451	0.9600	0.447
Lead	0.03	0.0288	0.014	0.0288	0.014	0.0288	0.014	0.0288	0.013
Nickel	1	0.0288	0.014	0.0288	0.014	0.0288	0.014	0.0288	0.013
Zinc	5	4.8	2.377	4.8	2.360	4.8	2.256	4.8	2.233

Sample Number		FHC-AA-AA073-0000	
Date Collected		3-Sep-03	
Air Flow (L)		2155	
Analyte	OSHA 8-hr PEL (mg/m^3)	Mass on Filter** (mg)	Concentration (mg/m^3)
Arsenic	0.01	0.0096	0.004
Beryllium	0.002	0.0019	0.001
Cadmium	0.005	0.0048	0.002
Chromium (Total)	1	0.9600	0.446
Copper	1	0.9600	0.446
Lead	0.03	0.0288	0.013
Nickel	1	0.0288	0.013
Zinc	5	4.8	2.228

NA: Not Applicable
**: Not detected, mass listed is the detection limit.